NASA

National Aeronautics and
Space Administration

**Langley Research Center**
Hampton, Virginia 23681-0001

# SOLICITATION

1-39-5681.1014

**REQUIREMENT:** RECERTIFICATION AND CONFIGURATION MANAGEMENT SUPPORT SERVICES

A preproposal conference will be held at Langley Research Center on August 10, 1993. See L.23 for details of the conference.

Your attention is directed to L.35, Proposal Preparation and Submission--Special Instructions, for important proposal preparation instructions and to Section M for important evaluation information.

This procurement is subject to a geographical limitation (See L.34).

Your attention is directed to L.33, Small Disadvantaged Business Subcontracting Goal.

REQUIREMENT FOR SPECIAL TECHNICAL CAPABILITIES

It is NASA policy to obtain maximum practicable competition consistent with the nature of each procurement. However, to prevent unnecessary expense associated with preparation and submission of a proposal, only firms with demonstrated experience and background in the Statement of Work task areas are encouraged to respond to this request.

OMB CONTROL NUMBER 2700-0042

# SOLICITATION, OFFER AND AWARD

1. THIS CONTRACT IS A RATED ORDER UNDER DPAS (15 CFR 350) ▶ RATING DO-C9 | PAGE 1 OF 399 PAGES

| 2. CONTRACT NO. | 3. SOLICITATION NO. | 4. TYPE OF SOLICITATION | 5. DATE ISSUED | 6. REQUISITION/PURCHASE NO. |
|---|---|---|---|---|
| | 1-39-5681.1014 | ☐ SEALED BID (IFB) ☒ NEGOTIATED (RFP) | 7/27/93 | REQUISITION |

7. ISSUED BY CODE

National Aeronautics and Space Administration
Langley Research Center
Hampton, VA 23681-0001

8. ADDRESS OFFER TO (If other than Item 7)

NASA, Langley Research Center
9A Langley Boulevard, Bldg. 1195A, Room 103
Hampton, VA 23681-0001

NOTE: In sealed bid solicitations "offer" and "offeror" mean "bid" and "bidder".

## SOLICITATION

9. Sealed offers in original and twelve (12) copies for furnishing the supplies or services in the Schedule will be received at the place specified in Item 8, or if handcarried, in the depository located in 9A Langley Blvd., Bldg. 1195A, Rm. 103 until 4:00 PM (Hour) local time 9/10/93 (Date)

CAUTION – LATE Submissions, Modifications, and Withdrawals: See Section L, Provision No. 52.214-7 or 52.215-10. All offers are subject to all terms and conditions contained in this solicitation.

10. FOR INFORMATION CALL: ▶ A. NAME | B. TELEPHONE NO. (Include area code) (NO COLLECT CALLS)

11. TABLE OF CONTENTS



## OFFER (Must be fully completed by offeror)

NOTE: Item 12 does not apply if the solicitation includes the provisions at 52.214-16, Minimum Bid Acceptance Period.

12. In compliance with the above, the undersigned agrees, if this offer is accepted within ______ calendar days (60 calendar days unless a different period is inserted by the offeror) from the date for receipt of offers specified above, to furnish any or all items upon which prices are offered at the price set opposite each item, delivered at the designated point(s), within the time specified in the schedule.

| 13. DISCOUNT FOR PROMPT PAYMENT (See Section I, Clause No. 52-232-8) | 10 CALENDAR DAYS | 20 CALENDAR DAYS | 30 CALENDAR DAYS | CALENDAR DAYS |
|---|---|---|---|---|
| | % | % | % | % |

| 14. ACKNOWLEDGMENT OF AMENDMENTS (The offeror acknowledges receipt of amendments to the SOLICITATION for offerors and related documents numbered and dated: | AMENDMENT NO. | DATE | AMENDMENT NO. | DATE |
|---|---|---|---|---|
| | | | | |

15A. NAME AND ADDRESS OF OFFEROR — CODE — FACILITY

16. NAME AND TITLE OF PERSON AUTHORIZED TO SIGN OFFER (Type or print)

15B. TELEPHONE NO. (Include area code)

15C. ☐ CHECK IF REMITTANCE ADDRESS IS DIFFERENT FROM ABOVE - ENTER SUCH ADDRESS IN SCHEDULE

17. SIGNATURE

18. OFFER DATE

## AWARD (To be completed by Government)

19. ACCEPTED AS TO ITEMS NUMBERED

20. AMOUNT

21. ACCOUNTING AND APPROPRIATION

22. AUTHORITY FOR USING OTHER THAN FULL AND OPEN COMPETITION:

☐ 10 U.S.C. 2304(c)( ) ☐ 41 U.S.C. 253(c)( )

23. SUBMIT INVOICES TO ADDRESS SHOWN IN (4 copies unless otherwise specified) ▶ ITEM Block 25 below

24. ADMINISTERED BY (If other than Item 7) CODE

Criticality Designator C

25. PAYMENT WILL BE MADE BY CODE

Financial Management Division
Mail Stop 175, NASA, Langley Research Center
Hampton, VA

26. NAME OF CONTRACTING OFFICER (Type or print)

ROSEMARY C. FROEHLICH

27. UNITED STATES OF AMERICA

(Signature of Contracting Officer)

28. AWARD DATE

IMPORTANT – Award will be made on this Form, or on Standard Form 26, or by other authorized official written notice.

Solicitation No. 1-39-5681.1014

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PART I - THE SCHEDULE

SECTION B - SUPPLIES OR SERVICES AND PRICES/COSTS

B.1 SUPPLIES AND/OR SERVICES TO BE FURNISHED (NASA 18-52.210-72) (DEC 1988)

The Contractor shall provide all resources (except as may be expressly stated in this contract as furnished by the Government) necessary to furnish the required supplies and/or services in accordance with the Description/Specifications/Work Statement in Exhibit A.

B.2 ESTIMATED COST AND FIXED FEE (NASA 18-52.216-74) (DEC 1991)

The estimated cost of this contract is $ exclusive of the fixed fee of $ . The total estimated cost and fixed fee is $ .

B.3 CONTRACT FUNDING (NASA 18-52.232-81) (JUN 1990)

(a) For purposes of payment of cost, exclusive of fee, in accordance with the Limitation of Funds clause, the total amount allotted by the Government to this contract is $ and covers the following estimated period of performance:

(b) An additional amount of $ is obligated under this contract for payment of fee.

B.4 ADMINISTRATION OF CONTRACT FUNDING (LaRC 52.232-100) (OCT 1992)

A. The Contractor agrees that all future incremental funding shall be accomplished by Administrative Change Modification and that the funding procedure shall in no way change the Contractor's notification obligations as set forth in the "Limitation of Funds" clause.

B. In addition to the requirements of the "Limitation of Funds" clause, the Contractor shall notify the Contracting Officer in writing if, at any time, the Contractor has reason to believe that the total cost to the Government for the complete performance of this contract will be greater or substantially less than the then total estimated cost of the contract. Such notification shall give a revised estimate of the total cost for the performance of this contract.

B.5 LEVEL-OF-EFFORT

A. In the performance of work under this contract, the Contractor is obligated to provide up to TBD direct labor hours as defined in paragraph B. below.

B. "Direct labor hours" are those productive hours expended by Contractor personnel in performing work under this contract that are charged as direct labor under the Contractor's established accounting policy and procedures. The term does not include sick leave, vacation, holiday leave, military leave, or any type

## SECTION E - INSPECTION AND ACCEPTANCE

E.1 INSPECTION OF SUPPLIES - COST-REIMBURSEMENT (FAR 52.246-3) (APR 1984)

(a) Definitions. "Contractor's managerial personnel," as used in this clause, means any of the Contractor's directors, officers, managers, superintendents, or equivalent representatives who have supervision or direction of--

(1) All or substantially all of the Contractor's business;

(2) All or substantially all of the Contractor's operation at a plant or separate location at which the contract is being performed; or

(3) A separate and complete major industrial operation connected with performing this contract.

"Supplies," as used in this clause, includes but is not limited to raw materials, components, intermediate assemblies, end products, lots of supplies, and, when the contract does not include the Warranty of Data clause, data.

(b) The Contractor shall provide and maintain an inspection system acceptable to the Government covering the supplies, fabricating methods, and special tooling under this contract. Complete records of all inspection work performed by the Contractor shall be maintained and made available to the Government during contract performance and for as long afterwards as the contract requires.

(c) The Government has the right to inspect and test the contract supplies, to the extent practicable at all places and times, including the period of manufacture, and in any event before acceptance. The Government may also inspect the plant or plants of the Contractor or any subcontractor engaged in the contract performance. The Government shall perform inspections and tests in a manner that will not unduly delay the work.

(d) If the Government performs inspection or test on the premises of the Contractor or a subcontractor, the Contractor shall furnish and shall require subcontractors to furnish all reasonable facilities and assistance for the safe and convenient performance of these duties.

(e) Unless otherwise specified in the contract, the Government shall accept supplies as promptly as practicable after delivery, and supplies shall be deemed accepted 60 days after delivery, unless accepted earlier.

(f) At any time during contract performance, but no later than 6 months (or such other time as may be specified in the contract) after acceptance of the supplies to be delivered under the contract, the Government may require the Contractor to replace or correct any supplies that are nonconforming at time of delivery. Supplies are nonconforming when they are defective in material or workmanship or are otherwise not in conformity with contract requirements. Except as otherwise provided in paragraph (h) below, the cost of replacement or correction shall be included in allowable cost, determined as provided in the Allowable Cost and Payment clause, but no additional fee shall be paid. The Contractor shall not tender for acceptance supplies required to be replaced or corrected without disclosing the former requirement for replacement or correction, and, when required, shall disclose the corrective action taken.

(g) (1) If the Contractor fails to proceed with reasonable promptness to perform required replacement or correction, the Government may--

(i) By contract or otherwise, perform the replacement or correction and charge to the Contractor any increased cost or make an equitable reduction in any fixed fee paid or payable under the contract;

E.3 FINAL INSPECTION AND ACCEPTANCE (LARC 52.246-94) (OCT 1992)

Final inspection and acceptance of all items specified for delivery under this contract shall be accomplished by the Contracting Officer or his duly authorized representative at destination.

SECTION F - DELIVERIES OR PERFORMANCE

F.1 STOP-WORK ORDER (FAR 52.212-13) (AUG 1989)

(a) The Contracting Officer may, at any time, by written order to the Contractor, require the Contractor to stop all, or any part, of the work called for by this contract for a period of 90 days after the order is delivered to the Contractor, and for any further period to which the parties may agree. The order shall be specifically identified as a stop-work order issued under this clause. Upon receipt of the order, the Contractor shall immediately comply with its terms and take all reasonable steps to minimize the incurrence of costs allocable to the work covered by the order during the period of work stoppage. Within a period of 90 days after a stop-work order is delivered to the Contractor, or within any extension of that period to which the parties shall have agreed, the Contracting Officer shall
either -

(1) Cancel the stop-work order; or

(2) Terminate the work covered by the order as provided in the Default, or the Termination for Convenience of the Government, clause of this contract.

(b) If a stop-work order issued under this clause is canceled or the period of the order or any extension thereof expires, the Contractor shall resume work. The Contracting Officer shall make an equitable adjustment in the delivery schedule or contract price, or both, and the contract shall be modified, in writing, accordingly, if -

(1) The stop-work order results in an increase in the time required for, or in the Contractor's cost properly allocable to, the performance of any part of this contract; and

(2) The Contractor asserts its right to the adjustment within 30 days after the end of the period of work stoppage; provided, that, if the Contracting Officer decides the facts justify the action, the Contracting Officer may receive and act upon the claim submitted at any time before final payment under this contract.

(c) If a stop-work order is not canceled and the work covered by the order is terminated for the convenience of the Government, the Contracting Officer shall allow reasonable costs resulting from the stop-work order in arriving at the termination settlement.

(d) If a stop-work order is not canceled and the work covered by the order is terminated for default, the Contracting Officer shall allow, by equitable adjustment or otherwise, reasonable costs resulting from the stop-work order.

F.2 PERIOD OF PERFORMANCE (NASA 18-52.212-74) (DEC 1988)

The period of performance of this contract shall be 60 months from the effective date of the contract.

F.3 PLACES OF PERFORMANCE

The places of performance shall be the Contractor's facility and NASA, Langley Research Center, Hampton, Virginia 23681-0001.

F.4 PLACE OF DELIVERY

Delivery of all items hereunder shall be f.o.b. Langley Research Center.

F.5 REPORTS AND DOCUMENTATION DELIVERY

The Contractor shall provide to the Government all reports and items of documentation as required by the SOW, Section I (Contract Clauses), and Exhibit B (Contract Documentation Requirements).

SECTION G - CONTRACT ADMINISTRATION DATA

G.1 CONTRACT CLOSEOUT (LARC 52.242-90) (JUN 1988)

A. Reassignment--After receipt, inspection, and acceptance by the Government of all required articles and/or services, and resolution of any pending issues raised during the Period of Performance, this contract will be reassigned to the NASA Langley Research Center Contracting Officer for Contract Closeout. All transactions subsequent to the physical completion of the contract should, therefore, be addressed to the said Contracting Officer at NASA Langley Research Center, Mail Stop 126, who may be reached by telephone at (804) 864-2462.

B. "Quick Closeout"--Paragraph (f) of the Allowable Cost and Payment clause of this contract addresses the "Quick Closeout Procedure" delineated by Subpart 42.7 of the Federal Acquisition Regulation (FAR). It should be understood that the said procedure applies to the settlement of indirect costs for a specific contract in advance of the determination of final indirect cost rates when the amount of unsettled indirect cost to be allocated to the contract is relatively insignificant. Therefore, the "Quick Closeout" procedure does not preclude the provisions of paragraph (d) of the Allowable Cost and Payment clause nor does it constitute a waiver of final audit of the Contractor's Completion Voucher.

C. Completion Voucher Submittal--Notwithstanding the provisions of the Allowable Cost and Payment clause, as soon as practicable after settlement of the Contractor's indirect cost rates applicable to performance of the contract, the Contractor shall submit a Completion Voucher as required by the aforesaid clause. The Completion Voucher shall be supported by a cumulative claim and reconciliation statement and executed NASA Forms 778, Contractor's Release, and 780, Contractor's Assignment of Refunds, Rebates, Credits, and Other Amounts. Unless directed otherwise by the Contracting Officer for Contract Closeout, the Contractor shall forward the said Completion Voucher directly to the cognizant Government Agency to which audit functions under the contract have been delegated.

G.2 SUBMISSION OF INVOICES

Proper invoices, as determined under the Section I clause entitled "Prompt Payment," shall be addressed to the designated payment office shown in Block 12 on

Page 1 of this contract. Cost invoices shall be submitted through the delegated Government Audit Agency, which shall be the designated billing office. Fee invoices shall be submitted through the NASA Contracting Officer with a copy to the delegated Audit Agency.

G.3 PAYMENTS--COST AND FIXED FEE

Payments of cost shall be made in monthly installments. Payments of fixed fee shall be made in monthly installments based upon percentage of completion of work as determined by the Contracting Officer and subject to the withholding provisions of the Section I clause entitled "Fixed Fee."

## SECTION H - SPECIAL CONTRACT REQUIREMENTS

H.1 RIGHTS TO PROPOSAL DATA (TECHNICAL) (FAR 52.227-23) (JUN 1987)

Except for data contained on pages ________, it is agreed that as a condition of award of this contract, and notwithstanding the conditions of any notice appearing thereon, the Government shall have unlimited rights (as defined in the "Rights in Data - General" clause contained in this contract) in and to the technical data contained in the proposal dated ________________, upon which this contract is based.

H.2 KEY PERSONNEL AND FACILITIES (NASA 18-52.235-71) (MAR 1989)

(a) The personnel and/or facilities listed below (or specified in the Contract Schedule) are considered essential to the work being performed under this contract. Before removing, replacing, or diverting any of the listed or specified personnel or facilities, the Contractor shall (1) notify the Contracting Officer reasonably in advance and (2) submit justification (including proposed substitutions) in sufficient detail to permit evaluation of the impact on this contract.
(b) The Contractor shall make no diversion without the Contracting Officer's written consent; provided, that the Contracting Officer may ratify in writing the proposed change, and that ratification shall constitute the Contracting Officer's consent required by this clause.
(c) The list of personnel and/or facilities (shown below or as specified in the Contract Schedule) may, with the consent of the contracting parties, be amended from time to time during the course of the contract to add or delete personnel and/or facilities.

To Be Negotiated

H.3 STATEMENT OF EQUIVALENT RATES FOR FEDERAL HIRES (FAR 52.222-42) (MAY 1989)

In compliance with the Service Contract Act of 1965, as amended, and the regulations of the Secretary of Labor (29 CFR Part 4), this clause identifies the classes of service employees expected to be employed under the contract and states the wages and fringe benefits payable to each if they were employed by the contracting agency subject to the provisions of 5 U.S.C. 5341 or 5332.

THIS STATEMENT IS FOR INFORMATION ONLY: IT IS NOT A WAGE DETERMINATION

| Employee Class | Monetary Wage |
|---|---|
| System Safety Analyst | $16.11 |
| NDE Technician III | $12.05 |
| Staff Assistant | $10.89 |
| Administrative Assistant | $ 8.79 |
| Designer | $12.05 |
| Technician II | $ 9.80 |
| NDE Technician I | $ 7.85 |
| Technician I | $ 7.85 |
| Drafter I | $ 8.79 |
| Word Processor | $ 7.00 |
| Data Entry II | $ 7.85 |
| Facility CM Program Librarian | $ 7.00 |
| Clerk | $ 6.41 |

FRINGE BENEFITS

Annual Leave - Receives 13 days paid leave for service up to 3 years; 20 days for 3 to 15 years service; and 26 days for 15 years service or over.

Sick Leave - Receives 13 days paid leave per year.

Holidays - Receives 10 paid holidays per year.

Health Insurance - Government pays up to 60% of health insurance.

Group Life Insurance - Government pays two-thirds of life insurance rate premiums.

Retirement - The Government provides three retirement plans identified as the Civil Service Retirement System (CSRS), the Federal Employees Retirement System (FERS), and the CSRS Offset. Under the CSRS, the Government contributes 7% of the employees' base pay towards the retirement benefit and 1.45% towards Medicare. Under the FERS, the Government contributes 12.9% of the employees' base pay towards a basic benefit plan, 6.2% to Social Security, 1.45% towards Medicare, and 1% (plus matching contributions of up to 4% of basic pay, depending on employees' contributions) to a thrift savings plan. Under the CSRS Offset, the Government contributes 0.8% of the employees' base pay towards the retirement benefit, 6.2% to Social Security, and 1.45% towards Medicare.

Part-time Federal employees receive pro rata annual leave, sick leave, holiday leave, health insurance, and group life insurance benefits based on the number of hours worked.

H.4 LIST OF INSTALLATION-PROVIDED PROPERTY AND SERVICES (NASA 18-52.245-77) (MAR 1989)

In accordance with the Installation Provided Government Property clause of this contract, the Contractor is authorized use of the types of property and services listed below, to the extent they are available, while on-site at the NASA installation. In addition, the items marked by an asterisk (*) will be available for use by both on-site and off-site Contractor personnel.

(a) Office space, work area space, and utilities. The Contractor shall use Government telephones for official purposes only.

(b) General- and special-purpose equipment, including office furniture.

(1) Equipment to be made available to the Contractor for use in performance of this contract on-site and at such other locations as approved by the Contracting Officer is listed in Exhibit C. The Government retains accountability for this property under the Installation-Provided Government Property clause, regardless of its authorized location.

(2) If the Contractor acquires property as a direct cost under this contract, this property also shall become accountable to the Government upon its entry into the NASA Equipment Management System (NEMS) in accordance with the property-reporting requirements of this contract.

(3) The Contractor shall not bring on-site for use under this contract any property owned or leased by the Contractor, or other property that the Contractor is accountable for under any other Government contract, without the Contracting Officer's prior written approval. This restriction does not pertain to the Contractor-furnished vehicles.

(c) Building maintenance for facilities occupied by Contractor personnel.

(d) Moving and hauling for movement of large equipment and delivery of supplies. Moving services shall be provided on-site, as approved by the Contracting Officer.

(e) The responsibilities of the Contractor as contemplated by paragraph (a) of the Installation-Provided Government Property clause are defined in the following property management directives and installation supplements to these Directives:

(1) NHB 4200.1, NASA Equipment Management Manual.
(2) NHB 4200.2, NASA Equipment Management System (NEMS) User's Guide for Property Custodians.
(3) NHB 4300.1, NASA Personal Property Disposal Manual.
(4) NHB 4100.1, NASA Materials Inventory Management Manual.

*(f) Material analysis capability.

*(g) Access to LaRC's computer from the Contractor's local facility via modem.

*(h) Access to LaRC's library facilities and engineering drawing files.

*(i) Government material cards issued to permit authorized Contractor personnel to draw from the LaRC store issue supplies, provided such withdrawals are approved by the COTR.

*(j) Emergency medical treatment, primarily of a first aid nature for injuries and illnesses sustained on duty at LaRC; and pre-assignment, periodic and termination examinations for employees engaged in hazardous duties.

*(k) Fuel, scheduled maintenance, parts and repairs (except those covered by manufacturer's warranty) for all Contractor-provided vehicles.

*(l) Cafeteria privileges for Contractor employees during normal operating hours.

*(m) On-Center mail delivery service.

H.5 OBSERVATION OF REGULATIONS AND IDENTIFICATION OF CONTRACTOR'S EMPLOYEES (LaRC 52.212-104) (MAR 1992)

A. Observation of Regulations--In performance of that part of the contract work which may be performed at Langley Research Center or other Government installation, the Contractor shall require its employees to observe the rules and regulations as prescribed by the authorities at Langley Research Center or other installation.

B. Identification Badges--At all times while on LaRC property, the Contractor shall require its employees, subcontractors and agents to wear badges which will be issued by the NASA Contract Badge and Pass Office, located at 1 Langley Boulevard (Building No. 1228). Badges shall be issued only between the hours of 6:30 a.m. and 4:30 p.m., Monday through Friday. Contractors will be held accountable for these badges, and may be required to validate outstanding badges on an annual basis with the NASA LaRC Security Office. Immediately after employee termination or contract completion, badges shall be returned to the NASA Contract Badge and Pass Office.

H.6 VIRGINIA AND LOCAL SALES TAXES (LaRC 52.229-92) (APR 1992)

To perform this contract, the Contractor must be knowledgeable of relevant state and local taxes when making purchases of tangible personal property. The Contractor shall refrain from paying nonapplicable taxes or taxes where an exemption exists, but shall pay applicable taxes that are reimbursable pursuant to FAR 31.205-41, Taxes. Even though title to property purchased under this contract may pass to the Government and the price is reimbursable under contract cost principles, such transactions do not in themselves provide tax immunity to the Contractor. Therefore, within 30 days after the effective date of this contract, the Contractor shall request from the Virginia State Tax Commission a ruling on any tax exemptions that may be applicable to purchases made under this contract. The Contractor shall provide all facts relevant to the situation and shall pursue an interpretation of the law that is most favorable to both the Contractor and the Government.

H.7 WAGE DETERMINATIONS AND FRINGE BENEFITS (LaRC 52.237-90) (NOV 1990)

The Register of Wage Determinations and Fringe Benefits, Number 78-1030 (Rev. 23), dated August 8, 1992 lists the wage rate and fringe benefits for designated labor classifications which shall be the minimum paid under this contract. See Exhibit E for a copy of this wage determination. This determination constitutes the "attachment" as referred to in paragraph (a), Compensation, of the Section I clause entitled "Service Contract Act of 1965."

H.8 AUTOMATED INFORMATION SECURITY (AIS) PROGRAM/EMPLOYEE NATIONAL AGENCY CHECK (NAC) AND USER AGREEMENT EXECUTION (LaRC 52.239-90) (MAY 1991)

A. Work to be performed under this contract requires access to ADP equipment and processing areas. Therefore, the Contractor shall comply with the requirements of NASA's Automated Information Security Program. This program is separate and distinct from security programs for safeguarding classified information. Prior to performing any work in restricted-access computer rooms or accessing NASA ADPE (either remotely or on-site at LaRC), all Contractor employees must have a favorable NAC completed. The Contractor shall submit a properly executed NASA Form 531 (NF 531), Name Check Request, to the LaRC Security Officer, Mail Stop 182, for each Contractor employee who will work in restricted access computer rooms and/or access NASA ADPE. In addition, each such employee is required to be fingerprinted at the LaRC Badge and Pass Office, Building 1228, or by any authorized agency or department utilizing Fingerprint Card FD-258. Approximately 75 days are required to complete the NAC after receipt of the NF 531 and FD-258. The NAC is not required if an employee has a Secret or higher clearance. When it is necessary for an employee to perform any work in restricted access computer rooms prior to completion of the NAC, the employee may be escorted while at the site by an individual who has a favorable NAC or a higher level of investigation favorably adjudicated, or a Secret or higher clearance, or as otherwise approved by the Security Officer. Employees may access NASA ADP equipment prior to completion of the NAC only as approved by the LaRC Security Officer on a case-by-case basis.

B. The Contractor shall insure that all Contractor personnel execute a user agreement, Form No. ACD N-865, Responsibilities of Users of the NASA/LaRC Central Scientific Computer Complex, and any other forms that may be required by the Government prior to having access to NASA ADP resources. Unauthorized access to and/or use of LaRC computing systems is a violation of law and punishable under the provisions of 18 USC 1029, 18 USC 1030, and other applicable statutes. For compliance with Center Computer security policy, the Contractor shall promptly notify the Contracting Officer's Technical Representative (COTR) when an authorized user employee no longer requires computer access.

H.9 INCORPORATION OF SECTION K OF THE PROPOSAL BY REFERENCE

Pursuant to FAR 15.406-1(b), the completed Section K of the proposal dated is hereby incorporated herein by reference.

H.10 SUBCONTRACTING PLAN*

The approved Contractor plan for subcontracting with small business and small disadvantaged business concerns is attached hereto as Exhibit D and is hereby made a part of this contract.

H.11 EVIDENCE OF INSURANCE

The Contractor shall submit evidence of the insurance coverage, required by the NASA Clause 18-52.228-75 in Section I entitled "Minimum Insurance Coverage" (i.e., a Certificate of Insurance or other confirmation), to the Contracting Officer prior to performing under this contract. In the event the Government exercises its options to extend the term of the contract, the Contractor shall also present such evidence to the Contracting Officer prior to commencement of performance under the extension.

H.12 CONSENT TO SUBCONTRACT**

Notwithstanding the provisions of FAR 52.244-2, Subcontracts (Cost Reimbursement and Letter Contracts) (JUL 1985) Alternate I (APR 1985), the Contractor shall obtain the Contracting Officer's consent before award of a subcontract exceeding $25,000.

H.13 OPTION TO PURCHASE CONTRACTOR-PROVIDED VEHICLES***

At the end of the contract period of performance, the Contractor grants the Government the following options regarding any Contractor-provided vehicles purchased for and used in performance of this contract: (1) The Contractor agrees to sell the vehicles to a successor Contractor at their depreciated value

*Not applicable to Small Business.
**If the Contractor has an approved purchasing system, this clause may be deleted.
***Applicable clause will be negotiated into the contract. Reference Attachment 7 for Contractor-furnished vehicle requirements.

based on the Contractor's depreciation schedule; or (2) The Contractor agrees to sell the vehicles to the Government at their depreciated value based on the Contractor's depreciation schedule; or (3) The Contractor agrees to utilize the depreciated vehicles on a follow-on contract if the Contractor is the successor Contractor; or (4) The Contractor agrees to sell the vehicles for their fair market value within 90 days after the end of the period of performance and to credit the contract for the amount of any excess of the sale price minus the depreciated value and selling expenses. The Government may exercise one of the above options by unilateral modification issued to the Contractor not later than 30 days after the end of the contract period of performance.

H.14 OPTION TO TRANSFER LEASE ON CONTRACTOR-PROVIDED VEHICLES*

The Contractor agrees to enter into a long-term lease(s) for any Contractor-furnished vehicles to be used in the performance of this contract, which is subject to being canceled if the prime Contractor does not continue to perform the contract throughout the useful life of the vehicles (e.g., the Contractor is not selected in a subsequent recompetition). The lease(s) shall have an option to transfer the lease(s) to a successor Contractor.

H.15 PENSION PORTABILITY

In order for pension costs attributable to prime Contractor employees assigned to this contract to be allowable costs under this contract, the plans covering such employees must:

A. Comply with all applicable Government laws and regulations;

B. Be a defined contribution plan, or multiparty defined benefit plan operated under a collective bargaining agreement where the plan follows the employee, not the employer;

C. Provide for 100 percent employee vesting after no more than 1 year of continuous employment;

D. Not be modified, terminated, or a new plan adopted without the prior written approval of the cognizant NASA Contracting Officer.

H.16 OPTIONS

A. Priced Options for Extended Services

Pursuant to FAR 37.111 and to the Section I clause entitled "Option to Extend the Term of the Contract (MAR 1989)," the Contractor hereby grants to the Government options to extend the term of the contract for six additional periods of one month each. Such options are to be exercisable by issuance of a unilateral modification no later than one calendar day prior to the expiration of the

*Applicable clause will be negotiated into the contract. Reference Attachment 7 for Contractor-furnished vehicle requirements.

| | |
|---|---|
| Fourth Option Period | TBD hours |
| Fifth Option Period | TBD hours |
| Sixth Option Period | TBD hours |

2. When any increment of the above option is exercised, the contract cost and fee set forth in B.2, Estimated Cost and Fixed Fee will be increased using the appropriate rates set forth below:

| | | Rate Per Hour |
|---|---|---|
| Initial Period | Cost | $ |
| | Fixed Fee | $ |
| First Option | Cost | $ |
| | Fixed Fee | $ |
| Second Option | Cost | $ |
| | Fixed Fee | $ |
| Third Option | Cost | $ |
| | Fixed Fee | $ |
| Fourth Option | Cost | $ |
| | Fixed Fee | $ |
| Fifth Option | Cost | $ |
| | Fixed Fee | $ |
| Sixth Option | Cost | $ |
| | Fixed Fee | $ |

PART II - CONTRACT CLAUSES

SECTION I - CONTRACT CLAUSES

I.1 LISTING OF CLAUSES INCORPORATED BY REFFRENCE:

NOTICE: The following solicitation provisions and/or contract clauses pertinent to this section are hereby incorporated by reference.

FEDERAL ACQUISITION REGULATION (48 CFR CHAPTER 1) CLAUSES

| CLAUSE NUMBER | TITLE AND DATE |
|---|---|
| 52.202-1 | Definitions (SEP 1991) |
| 52.203-1 | Officials Not to Benefit (APR 1984) |
| 52.203-3 | Gratuities (APR 1984) |
| 52.203-5 | Covenant Against Contingent Fees (APR 1984) |
| 52.203-6 | Restrictions on Subcontractor Sales to the Government (JUL 1985) |
| 52.203-7 | Anti-Kickback Procedures (OCT 1988) |
| 52.203-10 | Price or Fee Adjustment for Illegal or Improper Activity (SEP 1990) |
| 52.209-6 | Protecting the Government's Interest when Subcontracting with Contractors Debarred, Suspended, or Proposed for Debarment (NOV 1992) |
| 52.210-5 | New Material (APR 1984) |
| 52.212-8 | Defense Priority and Allocation Requirements (SEP 1990) |
| 52.215-1 | Examination of Records by Comptroller General (FEB 1993) |
| 52.215-2 | Audit - Negotiation (FEB 1993) |
| 52.215-22 | Price Reduction for Defective Cost or Pricing Data (JAN 1991) |
| 52.215-24 | Subcontractor Cost or Pricing Data (DEC 1991) |
| 52.215-27 | Termination of Defined Benefit Pension Plans (SEP 1989) |
| 52.215-33 | Order of Precedence (JAN 1986) |
| 52.215-39 | Reversion or Adjustment of Plans for Postretirement Benefits Other Than Pensions (JUL 1991) |
| 52.216-7 | Allowable Cost and Payment (JUL 1991) |
| 52.216-8 | Fixed Fee (APR 1984) |
| 52.219-8 | Utilization of Small Business Concerns and Small Disadvantaged Business Concerns (FEB 1990) |
| 52.219-9 | Small Business and Small Disadvantaged Business Subcontracting Plan (JAN 1991) |
| 52.219-13 | Utilization of Women-Owned Small Businesses (AUG 1986) |
| 52.219-16 | Liquidated Damages - Small Business Subcontracting Plan (AUG 1989) |
| 52.220-3 | Utilization of Labor Surplus Area Concerns (APR 1984) |
| 52.220-4 | Labor Surplus Area Subcontracting Program (APR 1984) |
| 52.222-1 | Notice to the Government of Labor Disputes (APR 1984) |
| 52.222-3 | Convict Labor (APR 1984) |
| 52.222-4 | Contract Work Hours and Safety Standards Act - Overtime Compensation (MAR 1986) |
| 52.222-26 | Equal Opportunity (APR 1984) |
| 52.222-28 | Equal Opportunity Preaward Clearance of Subcontracts (APR 1984) |
| 52.222-35 | Affirmative Action for Special Disabled and Vietnam Era Veterans (APR 1984) |
| 52.222-36 | Affirmative Action for Handicapped Workers (APR 1984) |
| 52.223-2 | Clean Air and Water (APR 1984) |
| 52.225-3 | Buy American Act - Supplies (JAN 1989) |
| 52.225-11 | Restrictions on Certain Foreign Purchases (APR 1991) |
| 52.227-1 | Authorization and Consent (APR 1984) |

| | |
|---|---|
| 52.227-2 | Notice and Assistance Regarding Patent and Copyright Infringement (APR 1984) |
| 52.227-11 | Patent Rights - Retention by the Contractor (Short Form) (JUN 1989)--as modified by NASA FAR Supplement 18-52.227-11 |
| 52.227-14 | Rights in Data - General (JUN 1987) -- as modified by NASA FAR Supplement 18-52.227-14 |
| 52.227-19 | Commercial Computer Software - Restricted Rights (JUN 1987)--as modified by NASA FAR Supplement 18-52.227-19 |
| 52.228-7 | Insurance - Liability to Third Persons (APR 1984) |
| 52.230-2 | Cost Accounting Standards (AUG 1992) |
| 52.230-3 | Disclosure and Consistency of Cost Accounting Practices (AUG 1992) |
| 52.230-5 | Administration of Cost Accounting Standards (AUG 1992) |
| 52.232-9 | Limitation on Withholding of Payments (APR 1984) |
| 52.232-17 | Interest (JAN 1991) |
| 52.232-22 | Limitation of Funds (APR 1984)--as modified by NASA FAR Supplement 18-32.705-2 |
| 52.232-23 | Assignment of Claims (JAN 1986) |
| 52.232-28 | Electronic Funds Transfer Payment Methods (APR 1989)--as modified by NASA FAR Supplement 18-32.908 |
| 52.233-1 | Disputes (DEC 1991) Alternate I (DEC 1991) |
| 52.233-3 | Protest After Award (AUG 1989) Alternate I (JUN 1985) |
| 52.237-2 | Protection of Government Buildings, Equipment and Vegetation (APR 1984) |
| 52.237-3 | Continuity of Services (JAN 1991) |
| 52.242-1 | Notice of Intent to Disallow Costs (APR 1984) |
| 52.243-2 | Changes - Cost-Reimbursement (AUG 1987) Alternate II (APR 1984) |
| 52.244-2 | Subcontracts (Cost-Reimbursement and Letter Contracts) (JUL 1985) Alternate I (APR 1985) |
| 52.244-5 | Competition in Subcontracting (APR 1984) |
| 52.245-5 | Government Property (Cost-Reimbursement, Time-and-Material, or Labor-Hour Contracts) (JAN 1986) |
| 52.246-25 | Limitation of Liability - Services (APR 1984) |
| 52.248-1 | Value Engineering (MAR 1989) |
| 52.249-6 | Termination (Cost-Reimbursement) (MAY 1986) |
| 52.249-14 | Excusable Delays (APR 1984) |
| 52.251-1 | Government Supply Sources (APR 1984) |
| 52.253-1 | Computer Generated Forms (JAN 1991) |

NASA FAR SUPPLEMENT (48 CFR CHAPTER 18) CLAUSES

| CLAUSE NUMBER | TITLE AND DATE |
|---|---|
| 18-52.204-70 | Report on NASA Subcontracts (NOV 1992) |
| 18-52.204-71 | NASA Contractor Financial Management Reporting (DEC 1988) |
| 18-52.219-74 | Use of Rural Area Small Businesses (SEP 1990) |
| 18-52.219-76 | NASA Small Disadvantaged Business Goal (JUL 1991) |
| 18-52.223-70 | Safety and Health (DEC 1988) |
| 18-52.237-70 | Emergency Evacuation Procedures (DEC 1988) |

| | |
|---|---|
| 18-52.242-72 | Observance of Legal Holidays (AUG 1992) |
| 18-52.245-70 | Acquisition of Centrally Reportable Equipment (MAR 1989) |
| 18-52.245-71 | Installation-Provided Government Property (MAR 1989) Alternate I (MAR 1989) |
| 18-52.245-73 | Financial Reporting of Government-Owned/Contractor-Held Property (MAR 1989) |
| 18-52.252-70 | Compliance with NASA FAR Supplement (MAR 1989) |

I.2 CLAUSES IN FULL TEXT

The clauses listed below follow in full text:

| | |
|---|---|
| 52.252-2 | Clauses Incorporated by Reference (JUN 1988) |
| 52.203-9 | Requirement for Certificate of Procurement Integrity - Modification (NOV 1990) |
| 52.203-12 | Limitation on Payments to Influence Certain Federal Transactions (JAN 1990) |
| 52.215-26 | Integrity of Unit Prices (APR 1991) |
| 52.222-2 | Payment for Overtime Premiums (JUL 1990) |
| 52.222-37 | Employment Reports on Special Disabled Veterans and Veterans of the Vietnam Era (JAN 1988) |
| 52.222-41 | Service Contract Act of 1965, as Amended (MAY 1989) |
| 52.223-6 | Drug-Free Workplace (JUL 1990) |
| 52.232-25 | Prompt Payment (SEP 1992) |
| 52.242-13 | Bankruptcy (APR 1991) |
| 52.252-6 | Authorized Deviations in Clauses (APR 1984) |
| 18-52.204-76 | Security Requirements for Unclassified Automated Information Resources (JUN 1990) |
| 18-52.204-78 | Security Plan for Unclassified Automated Information Resources (JAN 1992) |
| 18-52.209-71 | Limitation of Future Contracting (DEC 1988) |
| 18-52.219-75 | Small Business and Small Disadvantaged Business Subcontracting Reporting (SEP 1992) |
| 18-52.242-70 | Technical Direction (MAR 1989) |

I.3 CLAUSES INCORPORATED BY REFERENCE (FAR 52.252-2) (JUN 1988)

This contract incorporates one or more clauses by reference, with the same force and effect as if they were given in full text. Upon request, the Contracting Officer will make their full text available.

I.4 REQUIREMENT FOR CERTIFICATE OF PROCUREMENT INTEGRITY--MODIFICATION (FAR 52.203-9) (NOV 1990)

(a) Definitions. The definitions set forth in FAR 3.104-4 are hereby incorporated in this clause.
(b) The Contractor agrees that it will execute the certification set forth in paragraph (c) of this clause when requested by the contracting officer in connection with the execution of any modification of this contract.
(c) Certification. As required in paragraph (b) of this clause, the officer or employee responsible for the modification proposal shall execute the following certification:

CERTIFICATE OF PROCUREMENT INTEGRITY--MODIFICATION (NOV 1990)

(1) I, ______________________________________________,
[Name of certifier]
am the officer or employee responsible for the preparation of this modification proposal and hereby certify that, to the best of my knowledge and belief, with the exception of any information described in this certification, I have no information concerning a violation or possible violation of subsections 27(a), (b), (d), or (f) of the Office of Federal Procurement Policy Act, as amended* (41 U.S.C. 423), (hereinafter referred to as "the Act"), as implemented in the FAR, occurring during the conduct of this procurement

______________________________
(contract and modification number).

(2) As required by subsection 27(e)(1)(B) of the Act, I further certify that, to the best of my knowledge and belief, each officer, employee, agent, representative, and consultant of ______________________________
[Name of Offeror]
who has participated personally and substantially in the preparation or submission of this proposal has certified that he or she is familiar with, and will comply with, the requirements of subsection 27(a) of the Act, as implemented in the FAR, and will report immediately to me any information concerning a violation or possible violation of subsections 27(a), (b), (d), or (f) of the Act, as implemented in the FAR, pertaining to this procurement.

(3) Violations or possible violations: (Continue on plain bond paper if necessary and label Certificate of Procurement Integrity--Modification (Continuation Sheet), ENTER NONE IF NONE EXIST) ______________________________

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______________________________
[Signature of the officer or employee responsible for the modification proposal and date]

______________________________
[Typed name of the officer or employee responsible for the modification proposal]

*Subsections 27(a), (b), and (d) are effective on December 1, 1990. Subsection 27(f) is effective on June 1, 1991.

THIS CERTIFICATION CONCERNS A MATTER WITHIN THE JURISDICTION OF AN AGENCY OF THE UNITED STATES AND THE MAKING OF A FALSE, FICTITIOUS, OR FRAUDULENT CERTIFICATION MAY RENDER THE MAKER SUBJECT TO PROSECUTION UNDER TITLE 18, UNITED STATES CODE, SECTION 1001.

(End of certification)

(d) In making the certification in paragraph (2) of the certificate, the officer or employee of the competing Contractor responsible for the offer or bid, may rely upon a one-time certification from each individual required to submit a certification to the competing Contractor, supplemented by periodic training. These certifications shall be obtained at the earliest possible date after an individual required to certify begins employment or association with the Contractor. If a Contractor decides to rely on a certification executed prior to suspension of Section 27 (i.e., prior to December 1, 1989), the Contractor shall ensure that an individual who has so certified is notified that Section 27 has been reinstated. These certifications shall be maintained by the Contractor for a period of 6 years from the date a certifying employee's employment with the company ends or, for an agency, representative, or consultant, 6 years from the date such individual ceases to act on behalf of the Contractor.
(e) The certification required by paragraph (c) of this clause is a material representation of fact upon which reliance will be placed in executing this modification.

## 1.5 LIMITATION ON PAYMENTS TO INFLUENCE CERTAIN FEDERAL TRANSACTIONS (FAR 52.203-12) (JAN 1990)

(a) Definitions.
"Agency," as used in this clause, means executive agency as defined in 2.101.
"Covered Federal action," as used in this clause, means any of the following Federal actions:
(1) The awarding of any Federal contract.
(2) The making of any Federal grant.
(3) The making of any Federal loan.
(4) The entering into of any cooperative agreement.
(5) The extension, continuation, renewal, amendment, or modification of any Federal contract, grant, loan, or cooperative agreement.

"Indian tribe" and "tribal organization," as used in this clause, have the meaning provided in section 4 of the Indian Self-Determination and Education Assistance Act (25 U.S.C. 450B) and include Alaskan Natives.

"Influencing or attempting to influence," as used in this clause, means making, with the intent to influence, any communication to or appearance before an officer or employee of any agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with any covered Federal action.

"Local government," as used in this clause, means a unit of government in a State and, if chartered, established, or otherwise recognized by a State for the performance of a governmental duty, including a local public authority, a special district, an intrastate district, a council of governments, a sponsor group representative organization, and any other instrumentality of a local government.

"Officer or employee of an agency," as used in this clause, includes the following individuals who are employed by an agency:
(1) An individual who is appointed to a position in the Government under title 5, United States Code, including a position under a temporary appointment.
(2) A member of the uniformed services, as defined in subsection 101(3), title 37, United States Code.
(3) A special Government employee, as defined in section 202, title 18, United States Code.

(4) An individual who is a member of a Federal advisory committee, as defined by the Federal Advisory Committee Act, title 5, United States Code appendix 2.

"Person," as used in this clause, means an individual, corporation, company, association, authority, firm, partnership, society, State, and local government, regardless of whether such entity is operated for profit, or not for profit. This term excludes an Indian tribe, tribal organization, or any other Indian organization with respect to expenditures specifically permitted by other Federal law.

"Reasonable compensation," as used in this clause, means, with respect to a regularly employed officer or employee of any person, compensation that is consistent with the normal compensation for such officer or employee for work that is not furnished to, not funded by, or not furnished in cooperation with the Federal Government.

"Reasonable payment," as used in this clause, means, with respect to professional and other technical services, a payment in an amount that is consistent with the amount normally paid for such services in the private sector.

"Recipient," as used in this clause, includes the Contractor and all subcontractors. This term excludes an Indian tribe, tribal organization, or any other Indian organization with respect to expenditures specifically permitted by other Federal law.

"Regularly employed," as used in this clause, means, with respect to an officer or employee of a person requesting or receiving a Federal contract, an officer or employee who is employed by such person for at least 130 working days within one year immediately preceding the date of the submission that initiates agency consideration of such person for receipt of such contract. An officer or employee who is employed by such person for less than 130 working days within one year immediately preceding the date of the submission that initiates agency consideration of such person shall be considered to be regularly employed as soon as he or she is employed by such person for 130 working days.

"State," as used in this clause, means a State of the United States, the District of Columbia, the Commonwealth of Puerto Rico, a territory or possession of the United States, an agency or instrumentality of a State, and multi-State, regional, or interstate entity having governmental duties and powers.

(b) Prohibitions.

(1) Section 1352 of title 31, United States Code, among other things, prohibits a recipient of a Federal contract, grant, loan, or cooperative agreement from using appropriated funds to pay any person for influencing or attempting to influence an officer or employee of any agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with any of the following covered Federal actions: the awarding of any Federal contract; the making of any Federal grant; the making of any Federal loan; the entering into of any cooperative agreement; or the modification of any Federal contract, grant, loan, or cooperative agreement.

(2) The Act also requires Contractors to furnish a disclosure if any funds other than Federal appropriated funds (including profit or fee received under a covered Federal transaction) have been paid, or will be paid, to any person for influencing or attempting to influence an officer or employee of any agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with a Federal contract, grant, loan, or cooperative agreement.

(3) The prohibitions of the Act do not apply under the following conditions:

(i) Agency and legislative liaison by own employees.

(A) The prohibition on the use of appropriated funds, in subparagraph (b)(1) of this clause, does not apply in the case of a payment of reasonable compensation made to an officer or employee of a person requesting or receiving a covered Federal action if the payment is for agency and legislative liaison activities not directly related to a covered Federal action.

(B) For purposes of subdivision (b)(3)(i)(A) of this clause, providing any information specifically requested by an agency or Congress is permitted at any time.

(C) The following agency and legislative liaison activities are permitted at any time where they are not related to a specific solicitation for any covered Federal action:

(1) Discussing with an agency the qualities and characteristics (including individual demonstrations) of the person's products or services, conditions or terms of sale, and service capabilities.

(2) Technical discussions and other activities regarding the application or adaptation of the person's products or services for an agency's use.

(D) The following agency and legislative liaison activities are permitted where they are prior to formal solicitation of any covered Federal action -

(1) Providing any information not specifically requested but necessary for an agency to make an informed decision about initiation of a covered Federal action;

(2) Technical discussions regarding the preparation of an unsolicited proposal prior to its official submission; and

(3) Capability presentations by persons seeking awards from an agency pursuant to the provisions of the Small Business Act, as amended by Pub. L. 95-507, and subsequent amendments.

(E) Only those services expressly authorized by subdivision (b)(3)(i)(A) of this clause are permitted under this clause.

(ii) Professional and technical services.

(A) The prohibition on the use of appropriated funds, in subparagraph (b)(1) of this clause, does not apply in the case of -

(1) A payment of reasonable compensation made to an officer or employee of a person requesting or receiving a covered Federal action or an extension, continuation, renewal, amendment, or modification of a covered Federal action, if payment is for professional or technical services rendered directly in the preparation, submission, or negotiation of any bid, proposal, or application for that Federal action or for meeting requirements imposed by or pursuant to law as a condition for receiving that Federal action.

(2) Any reasonable payment to a person, other than an officer or employee of a person requesting or receiving a covered Federal action or an extension, continuation, renewal, amendment, or modification of a covered Federal action if the payment is for professional or technical services rendered directly in the preparation, submission, or negotiation of any bid, proposal, or application for that Federal action or for meeting requirements imposed by or pursuant to law as a condition for receiving that Federal action. Persons other than officers or employees of a person requesting or receiving a covered Federal action include consultants and trade associations.

(B) For purposes of subdivision (b)(3)(ii)(A) of this clause, "professional and technical services" shall be limited to advice and analysis directly applying any professional or technical discipline. For example, drafting of a legal document accompanying a bid or proposal by a lawyer is allowable. Similarly, technical advice provided by an engineer on the performance or operational capability of a piece of equipment rendered directly in the negotiation of a contract is allowable. However, communications with the intent to influence made by a professional (such as a licensed lawyer) or a technical person (such as a licensed accountant) are not allowable under this section unless they provide advice and analysis directly applying their professional or technical expertise and unless the advice or analysis is rendered directly and solely in the preparation, submission or negotiation of a covered Federal action. Thus, for example, communications with the intent to influence made by a lawyer that do not provide legal advice or analysis directly and solely related to the legal aspects of his or her client's proposal, but generally advocate one proposal over another are not allowable under this section because the lawyer is not providing professional legal services. Similarly, communications with the intent to influence made by an engineer providing an engineering analysis prior to the preparation or submission of a bid or proposal are not allowable under this section since the engineer is providing technical services but not directly in the preparation, submission or negotiation of a covered Federal action.

(C) Requirements imposed by or pursuant to law as a condition for receiving a covered Federal award include those required by law or regulation and any other requirements in the actual award documents.

(D) Only those services expressly authorized by subdivisions (b)(3)(ii)(A)(1) and (2) of this clause are permitted under this clause.

(E) The reporting requirements of FAR 3.803(a) shall not apply with respect to payments of reasonable compensation made to regularly employed officers or employees of a person.

(iii) Disclosure.

(A) The Contractor who requests or receives from an agency a Federal contract shall file with that agency a disclosure form, OMB standard form LLL, Disclosure of Lobbying Activities, if such person has made or has agreed to make any payment using nonappropriated funds (to include profits from any covered Federal action), which would be prohibited under subparagraph (b)(1) of this clause, if paid for with appropriated funds.

(B) The Contractor shall file a disclosure form at the end of each calendar quarter in which there occurs any event that materially affects the accuracy of the information contained in any disclosure form previously filed by such person under subparagraph (c)(1) of this clause. An event that materially affects the accuracy of the information reported includes -

(1) A cumulative increase of $25,000 or more in the amount paid or expected to be paid for influencing or attempting to influence a covered Federal action; or

(2) A change in the person(s) or individual(s) influencing or attempting to influence a covered Federal action; or

(3) A change in the officer(s), employee(s), or Member(s) contacted to influence or attempt to influence a covered Federal action.

(C) The Contractor shall require the submittal of a certification, and if required, a disclosure form by any person who requests or receives any subcontract exceeding $100,000 under the Federal contract.

(D) All subcontractor disclosure forms (but not certifications) shall be forwarded from tier to tier until received by the prime Contractor. The prime Contractor shall submit all disclosures to the Contracting Officer at the end of the calendar quarter in which the disclosure form is submitted by the subcontractor. Each subcontractor certification shall be retained in the subcontract file of the awarding Contractor.

(iv) Agreement. The Contractor agrees not to make any payment prohibited by this clause.

(v) Penalties.

(A) Any person who makes an expenditure prohibited under paragraph (a) of this clause or who fails to file or amend the disclosure form to be filed or amended by paragraph (b) of this clause shall be subject to civil penalties as provided for by 31 U.S.C. 1352. An imposition of a civil penalty does not prevent the Government from seeking any other remedy that may be applicable.

(B) Contractors may rely without liability on the representation made by their subcontractors in the certification and disclosure form.

(vi) Cost allowability. Nothing in this clause makes allowable or reasonable any costs which would otherwise be unallowable or unreasonable. Conversely, costs made specifically unallowable by the requirements in this clause will not be made allowable under any of the provisions.

I.6 INTEGRITY OF UNIT PRICES (FAR 52.215-26) (APR 1991)

(a) Any proposal submitted for the negotiation of prices for items of supplies shall distribute costs within contracts on a basis that ensures that unit prices are in proportion to the items' base cost (e.g., manufacturing or acquisition costs). Any method of distributing costs to line items that distorts unit prices shall not be used. For example, distributing costs equally among line items is not acceptable except when there is little or no variation in base cost. Nothing in this paragraph requires submission of cost or pricing data not otherwise required by law or regulation.
(b) The requirement in paragraph (a) of this clause does not apply to any contract or subcontract item of supply for which the unit price is, or is based on, an established catalog or market price for a commercial item sold in substantial quantities to the general public. A price is based on a catalog or market price only if the item being purchased is sufficiently similar to the catalog or market price commercial item to ensure that any difference in price can be identified and justified without resort to cost analysis.
(c) The Offeror/Contractor shall also identify those supplies which it will not manufacture or to which it will not contribute significant value when requested by the Contracting Officer. The information shall not be required for commercial items sold in substantial quantities to the general public when the price is, or is based on, established catalog or market prices.
(d) The Contractor shall insert the substance of this clause, less paragraph (c), in all subcontracts.

I.7 PAYMENT FOR OVERTIME PREMIUMS (FAR 52.222-2) (JUL 1990)

(a) The use of overtime is authorized under this contract if the overtime premium cost does not exceed zero or the overtime premium is paid for work -

(1) Necessary to cope with emergencies such as those resulting from accidents, natural disasters, breakdowns of production equipment, or occasional production bottlenecks of a sporadic nature;

(2) By indirect-labor employees such as those performing duties in connection with administration, protection, transportation, maintenance, standby plant protection, operation of utilities, or accounting;

(3) To perform tests, industrial processes, laboratory procedures, loading or unloading of transportation conveyances, and operations in flight or afloat that are continuous in nature and cannot reasonably be interrupted or completed otherwise; or

(4) That will result in lower overall costs to the Government.

(b) Any request for estimated overtime premiums that exceeds the amount specified above shall include all estimated overtime for contract completion and shall -

(1) Identify the work unit; e.g., department or section in which the requested overtime will be used, together with present workload, staffing, and other data of the affected unit sufficient to permit the Contracting Officer to evaluate the necessity for the overtime;

(2) Demonstrate the effect that denial of the request will have on the contract delivery or performance schedule;

(3) Identify the extent to which approval of overtime would affect the performance or payments in connection with other Government contracts, together with identification of each affected contract; and

(4) Provide reasons why the required work cannot be performed by using multishift operations or by employing additional personnel.

## I.8 EMPLOYMENT REPORTS ON SPECIAL DISABLED VETERANS AND VETERANS OF THE VIETNAM ERA (FAR 52.222-37) (JAN 1988)

(a) The contractor shall report at least annually, as required by the Secretary of Labor, on:

(1) The number of special disabled veterans and the number of veterans of the Vietnam era in the workforce of the contractor by job category and hiring location; and

(2) The total number of new employees hired during the period covered by the report, and of that total, the number of special disabled veterans, and the number of veterans of the Vietnam era.

(b) The above items shall be reported by completing the form entitled "Federal Contractor Veterans' Employment Report VETS-100."

(c) Reports shall be submitted no later than March 31 of each year beginning March 31, 1988.

(d) The employment activity report required by paragraph (a)(2) of this clause shall reflect total hires during the most recent 12-month period as of the ending date selected for the employment profile report required by paragraph (a)(1) of this clause. Contractors may select an ending date: (1) As of the end of any pay period during the period January through March 1st of the year the report is due, or (2) as of December 31, if the contractor has previous written approval from the Equal Employment Opportunity Commission to do so for purposes of submitting the Employer Information Report EEO-1 (Standard Form 100).

(e) The count of veterans reported according to paragraph (a) of this clause shall be based on voluntary disclosure. Each contractor subject to the reporting requirements at 38 U.S.C. 2012(d) shall invite all special disabled veterans and veterans of the Vietnam era who wish to benefit under the affirmative action

program at 38 U.S.C. 2012 to identify themselves to the contractor. The invitation shall state that the information is voluntarily provided, that the information will be kept confidential, that disclosure or refusal to provide the information will not subject the applicant or employee to any adverse treatment and that the information will be used only in accordance with the regulations promulgated under 38 U.S.C. 2012.
(f) Subcontracts. The contractor shall include the terms of this clause in every subcontract or purchase order of $10,000 or more unless exempted by rules, regulations, or orders of the Secretary.

I.9 SERVICE CONTRACT ACT OF 1965, AS AMENDED (FAR 52.222-41) (MAY 1989)

(a) **Definitions.** "Act," as used in this clause, means the Service Contract Act of 1965, as amended (41 U.S.C. 351, et seq.).

"Contractor," as used in this clause or in any subcontract, shall be deemed to refer to the subcontractor, except in the term "Government Prime Contractor."

"Service employee," as used in this clause, means any person engaged in the performance of this contract other than any person employed in a bona fide executive, administrative, or professional capacity, as these terms are defined in Part 541 of Title 29, Code of Federal Regulations, as revised. It includes all such persons regardless of any contractual relationship that may be alleged to exist between a Contractor or subcontractor and such persons.

(b) **Applicability**. This contract is subject to the following provisions and to all other applicable provisions of the Act and regulations of the Secretary of Labor (29 CFR Part 4). This clause does not apply to contracts or subcontracts administratively exempted by the Secretary of Labor or exempted by 41 U.S.C. 356, as interpreted in Subpart C of 29 CFR Part 4.

(c) **Compensation**.

(1) Each service employee employed in the performance of this contract by the Contractor or any subcontractor shall be paid not less than the minimum monetary wages and shall be furnished fringe benefits in accordance with the wages and fringe benefits determined by the Secretary of Labor, or authorized representative, as specified in any wage determination attached to this contract.

(2) (i) If a wage determination is attached to this contract, the Contractor shall classify any class of service employee which is not listed therein and which is to be employed under this contract (i.e., the work to be performed is not performed by any classification listed in the wage determination) so as to provide a reasonable relationship (i.e., appropriate level of skill comparison) between such unlisted classifications and the classifications listed in the wage determination. Such conformed class of employees shall be paid the monetary wages and furnished the fringe benefits as are determined pursuant to the procedures in this paragraph (c).

(ii) This conforming procedure shall be initiated by the Contractor prior to the performance of contract work by the unlisted class of employee. The Contractor shall submit Standard Form (SF) 1444, Request For Authorization of Additional Classification and Rate, to the Contracting Officer no later than 30 days after the unlisted class of employee performs any contract work. The Contracting Officer shall review the proposed classification and rate and promptly submit the completed SF 1444 (which must include information regarding the agreement or disagreement of the employees' authorized representatives or the employees themselves together with the agency recommendation), and all pertinent information to the Wage and Hour Division, Employment Standards Administration, U.S. Department of Labor. The Wage and Hour Division will approve, modify, or disapprove the action or render a final determination in the event of disagreement within 30 days of receipt or will notify the Contracting Officer within 30 days of receipt that additional time is necessary.

(iii) The final determination of the conformance action by the Wage and Hour Division shall be transmitted to the Contracting Officer who shall promptly notify the Contractor of the action taken. Each affected employee shall be furnished by the Contractor with a written copy of such determination or it shall be posted as a part of the wage determination.

(iv) (A) The process of establishing wage and fringe benefit rates that bear a reasonable relationship to those listed in a wage determination cannot be reduced to any single formula. The approach used may vary from wage determination to wage determination depending on the circumstances. Standard wage and salary administration practices which rank various job classifications by pay grade pursuant to point schemes or other job factors may, for example, be relied upon. Guidance may also be obtained from the way different jobs are rated under Federal pay systems (Federal Wage Board Pay System and the General Schedule) or from other wage determinations issued in the same locality. Basic to the establishment of any conformable wage rate(s) is the concept that a pay relationship should be maintained between job classifications based on the skill required and the duties performed.

(B) In the case of a contract modification, an exercise of an option, or extension of an existing contract, or in any other case where a Contractor succeeds a contract under which the classification in question was previously conformed pursuant to paragraph (c) of this clause, a new conformed wage rate and fringe benefits may be assigned to the conformed classification by indexing (i.e., adjusting) the previous conformed rate and fringe benefits by an amount equal to the average (mean) percentage increase (or decrease, where appropriate) between the wages and fringe benefits specified for all classifications to be used on the contract which are listed in the current wage determination, and those specified for the corresponding classifications in the previously applicable wage determination. Where conforming actions are accomplished in accordance with this paragraph prior to the performance of contract work by the unlisted class of employees, the Contractor shall advise the Contracting Officer of the action taken but the other procedures in subdivision (c)(ii) of this clause need not be followed.

(C) No employee engaged in performing work on this contract shall in any event be paid less than the currently applicable minimum wage specified under section 6(a)(1) of the Fair Labor Standards Act of 1938, as amended.

(v) The wage rate and fringe benefits finally determined under this subparagraph (c)(2) of this clause shall be paid to all employees performing in the classification from the first day on which contract work is performed by them in the classification. Failure to pay the unlisted employees the compensation agreed upon by the interested parties and/or finally determined by the Wage and Hour Division retroactive to the date such class of employees commenced contract work shall be a violation of the Act and this contract.

(vi) Upon discovery of failure to comply with subparagraph (c)(2) of this clause, the Wage and Hour Division shall make a final determination of conformed classification, wage rate, and/or fringe benefits which shall be retroactive to the date such class or classes of employees commenced contract work.

(3) **Adjustment of Compensation.** If the term of this contract is more than 1 year, the minimum monetary wages and fringe benefits required to be paid or furnished thereunder to service employees under this contract shall be subject to adjustment after 1 year and not less often than once every 2 years, under wage determinations issued by the Wage and Hour Division.

(d) **Obligation to Furnish Fringe Benefits.** The Contractor or subcontractor may discharge the obligation to furnish fringe benefits specified in the attachment or determined under subparagraph (c)(2) of this clause by furnishing equivalent combinations of bona fide fringe benefits, or by making equivalent or differential cash payments, only in accordance with Subpart D of 29 CFR Part 4.

(e) **Minimum Wage.** In the absence of a minimum wage attachment for this contract, neither the Contractor nor any subcontractor under this contract shall pay any person performing work under this contract (regardless of whether the person is a service employee) less than the minimum wage specified by section 6(a)(1) of the Fair Labor Standards Act of 1938. Nothing in this clause shall relieve the Contractor or any subcontractor of any other obligation under law or contract for the payment of a higher wage to any employee.

(f) **Successor Contracts.** If this contract succeeds a contract subject to the Act under which substantially the same services were furnished in the same locality and service employees were paid wages and fringe benefits provided for in a collective bargaining agreement, in the absence of the minimum wage attachment for this contract setting forth such collectively bargained wage rates and fringe benefits, neither the Contractor nor any subcontractor under this contract shall pay any service employee performing any of the contract work (regardless of whether or not such employee was employed under the predecessor contract), less than the wages and fringe benefits provided for in such collective bargaining agreement, to which such employee would have been entitled if employed under the predecessor contract, including accrued wages and fringe benefits and any prospective increases in wages and fringe benefits provided for under such agreement. No Contractor or subcontractor under this contract may be relieved of the foregoing obligation unless the limitations of 29 CFR 4.1b(b) apply or unless the Secretary of Labor or the Secretary's authorized representative finds, after a hearing as provided in 29 CFR 4.10 that the wages and/or fringe benefits provided for in such agreement are substantially at variance with those which prevail for services of a character similar in the locality, or determines, as provided in 29 CFR 4.11, that the collective bargaining agreement applicable to service employees employed under the predecessor contract was not entered into as a result of arm's length negotiations. Where it is found in accordance with the review procedures provided in 29 CFR 4.10 and/or 4.11 and Parts 6 and 8 that some or all of the wages and/or fringe benefits contained in a predecessor Contractor's collective bargaining agreement are substantially at variance with those which prevail for services of a character similar in the locality, and/or that the collective bargaining agreement applicable to service employees employed under the predecessor contract was not entered into as a result of arm's length negotiations, the Department will issue a new or revised wage determination setting forth the applicable wage rates and fringe benefits. Such determination shall be made part of the contract or subcontract, in accordance with the decision of the Administrator, the Administrative Law Judge, or the Board of Service Contract Appeals, as the case may be, irrespective of whether such issuance occurs prior to or after the award of a contract or subcontract (53 Comp. Gen. 401

(1973)). In the case of a wage determination issued solely as a result of a finding of substantial variance, such determination shall be effective as of the date of the final administrative decision.

(g) **Notification to Employees**. The Contractor and any subcontractor under this contract shall notify each service employee commencing work on this contract of the minimum monetary wage and any fringe benefits required to be paid pursuant to this contract, or shall post the wage determination attached to this contract. The poster provided by the Department of Labor (Publication WH 1313) shall be posted in a prominent and accessible place at the worksite. Failure to comply with this requirement is a violation of Section 2(a)(4) of the Act and of this contract.

(h) **Safe and Sanitary Working Conditions**. The Contractor or subcontractor shall not permit any part of the services called for by this contract to be performed in buildings or surroundings or under working conditions provided by or under the control or supervision of the Contractor or subcontractor which are unsanitary, hazardous, or dangerous to the health or safety of the service employees. The Contractor or subcontractor shall comply with the safety and health standards applied under 29 CFR Part 1925.

(i) **Records**. (1) The Contractor and each subcontractor performing work subject to the Act shall make and maintain for 3 years from the completion of the work, and make them available for inspection and transcription by authorized representatives of the Wage and Hour Division, Employment Standards Administration, a record of the following:

(i) For each employee subject to the Act -

(A) Name and address and social security number;

(B) Correct work classification or classifications, rate or rates of monetary wages paid and fringe benefits provided, rate or rates of payments in lieu of fringe benefits, and total daily and weekly compensation;

(C) Daily and weekly hours worked by each employee; and

(D) Any deductions, rebates, or refunds from the total daily or weekly compensation of each employee.

(ii) For those classes of service employees not included in any wage determination attached to this contract, wage rates or fringe benefits determined by the interested parties or by the Administrator or authorized representative, under the terms of paragraph (c) of this clause. A copy of the report required by subdivision (c)(2)(ii) of this clause will fulfill this requirement.

(iii) Any list of the predecessor Contractor's employees which had been furnished to the Contractor as prescribed by paragraph (n) of this clause.

(2) The Contractor shall also make available a copy of this contract for inspection or transcription by authorized representatives of the Wage and Hour Division.

(3) Failure to make and maintain or to make available these records for inspection and transcription shall be a violation of the regulations and this contract, and in the case of failure to produce these records, the Contracting Officer, upon direction of the Department of Labor and notification to the Contractor, shall take action to cause suspension of any further payment or advance of funds until such violation ceases.

(4) The Contractor shall permit authorized representatives of the Wage and Hour Division to conduct interviews with employees at the worksite during normal working hours.

(j) **Pay Periods**. The Contractor shall unconditionally pay to each employee subject to the Act all wages due free and clear and without subsequent deduction (except as otherwise provided by law or Regulations, 29 CFR Part 4), rebate, or kickback on any account. These payments shall be made no later than one pay period following the end of the regular pay period in which the wages were earned or accrued. A pay period under this Act may not be of any duration longer than semi-monthly.

(k) **Withholding of Payment and Termination of Contract**. The Contracting Officer shall withhold or cause to be withheld from the Government Prime Contractor under this or any other Government contract with the Prime Contractor such sums as an appropriate official of the Department of Labor requests or such sums as the Contracting Officer decides may be necessary to pay underpaid employees employed by the Contractor or subcontractor. In the event of failure to pay any employees subject to the Act all or part of the wages or fringe benefits due under the Act, the Contracting Officer may, after authorization or by direction of the Department of Labor and written notification to the Contractor, take action to cause suspension of any further payment or advance of funds until such violations have ceased. Additionally, any failure to comply with the requirements of this clause may be grounds for termination of the right to proceed with the contract work. In such event, the Government may enter into other contracts or arrangements for completion of the work, charging the Contractor in default with any additional cost.

(l) **Subcontracts**. The Contractor agrees to insert this clause in all subcontracts subject to the Act.

(m) **Collective Bargaining Agreements Applicable to Service Employees**. If wages to be paid or fringe benefits to be furnished any service employees employed by the Government Prime Contractor or any subcontractor under the contract are provided for in a collective bargaining agreement which is or will be effective during any period in which the contract is being performed, the Government Prime Contractor shall report this fact to the Contracting Officer, together with full information as to the application and accrual of such wages and fringe benefits, including any prospective increases, to service employees engaged in work on the contract, and a copy of the collective bargaining agreement. Such report shall be made upon commencing performance of the contract, in the case of collective bargaining agreements effective at such time, and in the case of such agreements or provisions or amendments thereof effective at a later time during the period of contract performance such agreements shall be reported promptly after negotiation thereof.

(n) **Seniority List**. Not less than 10 days prior to completion of any contract being performed at a Federal facility where service employees may be retained in the performance of the succeeding contract and subject to a wage determination which contains vacation or other benefit provisions based upon length of service with a Contractor (predecessor) or successor (29 CFR Part 4.173), the incumbent Prime Contractor shall furnish the Contracting Officer a certified list of the names of all service employees on the Contractor's or subcontractor's payroll during the last month of contract performance. Such list shall also contain anniversary dates of employment on the contract either with the current or predecessor Contractors of each such service employee. The Contracting Officer shall turn over such list to the successor Contractor at the commencement of the succeeding contract.

(o) **Rulings and Interpretations**. Rulings and interpretations of the Act are contained in Regulations, 29 CFR Part 4.

(p) **Contractor's Certification.**

(1) By entering into this contract, the Contractor (and officials thereof) certifies that neither it (nor he or she) nor any person or firm who has substantial interest in the Contractor's firm is a person or firm ineligible to be awarded Government contracts by virtue of the sanctions imposed under section 5 of the Act.

(2) No part of this contract shall be subcontracted to any person or firm ineligible for award of a Government contract under section 5 of the Act.

(3) The penalty for making false statements is prescribed in the U.S. Criminal Code, 18 U.S.C. 1001.

(q) **Variations, Tolerances, and Exemptions Involving Employment.** Notwithstanding any of the provisions in paragraphs (b) through (o) of this clause, the following employees may be employed in accordance with the following variations, tolerances, and exemptions, which the Secretary of Labor, pursuant to section 4(b) of the Act prior to its amendment by Public L. 92-473, found to be necessary and proper in the public interest or to avoid serious impairment of the conduct of Government business.

(1) Apprentices, student-learners, and workers whose earning capacity is impaired by age, physical or mental deficiency, or injury may be employed at wages lower than the minimum wages otherwise required by section 2(a)(1) or 2(b)(1) of the Act without diminishing any fringe benefits or cash payments in lieu thereof required under section 2(a)(2) of the Act, in accordance with the conditions and procedures prescribed for the employment of apprentices, student-learners, handicapped persons, and handicapped clients of sheltered workshops under Section 14 of the Fair Labor Standards Act of 1938, in the regulations issued by the Administrator (29 CFR Parts 520, 521, 524, and 525).

(2) The Administrator will issue certificates under the Act for the employment of apprentices, student-learners, handicapped persons, or handicapped clients of sheltered workshops not subject to the Fair Labor Standards Act of 1938, or subject to different minimum rates of pay under the two acts, authorizing appropriate rates of minimum wages (but without changing requirements concerning fringe benefits or supplementary cash payments in lieu thereof), applying procedures prescribed by the applicable regulations issued under the Fair Labor Standards Act of 1938 (29 CFR Parts 520, 521, 524, and 525).

(3) The Administrator will also withdraw, annul, or cancel such certificates in accordance with the regulations in 29 CFR Parts 525 and 528.

(r) **Apprentices.** Apprentices will be permitted to work at less than the predetermined rate for the work they perform when they are employed and individually registered in a bona fide apprenticeship program registered with a State Apprenticeship Agency which is recognized by the U.S. Department of Labor, or if no such recognized agency exists in a State, under a program registered with the Bureau of Apprenticeship and Training, Employment and Training Administration, U.S. Department of Labor. Any employee who is not registered as an apprentice in an approved program shall be paid the wage rate and fringe benefits contained in the applicable wage determination for the journeyman classification of work actually performed. The wage rates paid apprentices shall not be less than the wage rate for their level of progress set forth in the registered program, expressed as the appropriate percentage of the journeyman's rate contained in the applicable wage determination. The allowable ratio of apprentices to journeymen employed on the contract work in any craft classification shall not be greater than the ratio permitted to the Contractor as to his entire work force under the registered program.

(s) **Tips**. An employee engaged in an occupation in which the employee customarily and regularly receives more than $30 a month in tips may have the amount of tips credited by the employer against the minimum wage required by section 2(a)(1) or section 2(b)(1) of the Act, in accordance with section 3(m) of the Fair Labor Standards Act and Regulations 29 CFR Part 531. However, that the amount of credit shall not exceed $1.34 per hour beginning January 1, 1981. To use this provision -

(1) The employer must inform tipped employees about this tip credit allowance before the credit is utilized;

(2) The employees must be allowed to retain all tips (individually or through a pooling arrangement and regardless of whether the employer elects to take a credit for tips received);

(3) The employer must be able to show by records that the employee receives at least the applicable Service Contract Act minimum wage through the combination of direct wages and tip credit; and

(4) The use of such tip credit must have been permitted under any predecessor collective bargaining agreement applicable by virtue of section 4(c) of the Act.

(t) **Disputes Concerning Labor Standards**. The U.S. Department of Labor has set forth in 29 CFR Parts 4, 6, and 8 procedures for resolving disputes concerning labor standards requirements. Such disputes shall be resolved in accordance with those procedures and not the Disputes clause of this contract. Disputes within the meaning of this clause include disputes between the Contractor (or any of its subcontractors) and the contracting agency, the U.S. Department of Labor, or the employees or their representatives.

I.10 DRUG-FREE WORKPLACE (FAR 52.223-6) (JUL 1990)

(a) Definitions. As used in this clause,

"Controlled substance" means a controlled substance in Schedules I through V of Section 202 of the Controlled Substances Act (21 U.S.C. 812) and as further defined in regulation at 21 CFR 1308.11 - 1308.15.

"Conviction" means a finding of guilt (including a plea of nolo contendere) or imposition of sentence, or both, by any judicial body charged with the responsibility to determine violations of the Federal or State criminal drug statutes.

"Criminal drug statute" means a Federal or non-Federal criminal statute involving the manufacture, distribution, dispensing, possession or use of any controlled substance.

"Drug-free workplace" means the site(s) for the performance of work done by the Contractor in connection with a specific contract at which employees of the Contractor are prohibited from engaging in the unlawful manufacture, distribution, dispensing, possession, or use of a controlled substance.

"Employee" means an employee of a Contractor directly engaged in the performance of work under a Government contract. "Directly engaged" is defined to include all direct cost employees and any other Contractor employee who has other than a minimal impact or involvement in contract performance.

"Individual" means an offeror/Contractor that has no more than one employee including the offeror/Contractor.

(b) The Contractor, if other than an individual, shall - within 30 calendar days after award (unless a longer period is agreed to in writing for contracts of 30 calendar days or more performance duration); or as soon as possible for contracts of less than 30 calendar days performance duration -

(1) Publish a statement notifying its employees that the unlawful manufacture, distribution, dispensing, possession, or use of a controlled substance is prohibited in the Contractor's workplace and specifying the actions that will be taken against employees for violations of such prohibition;

(2) Establish an ongoing drug-free awareness program to inform such employees about -

(i) The dangers of drug abuse in the workplace;

(ii) The Contractor's policy of maintaining a drug-free workplace;

(iii) Any available drug counseling, rehabilitation, and employee assistance programs; and

(iv) The penalties that may be imposed upon employees for drug abuse violations occurring in the workplace.

(3) Provide all employees engaged in performance of the contract with a copy of the statement required by subparagraph (b)(1) of this clause;

(4) Notify such employees in writing in the statement required by subparagraph (b)(1) of this clause that, as a condition of continued employment on this contract, the employee will -

(i) Abide by the terms of the statement; and

(ii) Notify the employer in writing of the employee's conviction under a criminal drug statute for a violation occurring in the workplace no later than 5 days after such conviction.

(5) Notify the Contracting Officer in writing within 10 calendar days after receiving notice under subdivision (b)(4)(ii) of this clause, from an employee or otherwise receiving actual notice of such conviction. The notice shall include the position title of the employee;

(6) Within 30 calendar days after receiving notice under subdivision (b)(4)(ii) of this clause of a conviction, take one of the following actions with respect to any employee who is convicted of a drug abuse violation occurring in the workplace:

(i) Taking appropriate personnel action against such employee, up to and including termination; or

(ii) Require such employee to satisfactorily participate in a drug abuse assistance or rehabilitation program approved for such purposes by a Federal, State, or local health, law enforcement, or other appropriate agency.

(7) Make a good faith effort to maintain a drug-free workplace through implementation of subparagraphs (b)(1) through (b)(6) of this clause.

(c) The Contractor, if an individual, agrees by award of the contract or acceptance of a purchase order, not to engage in the unlawful manufacture, distribution, dispensing, possession, or use of a controlled substance in the performance of this contract.

(d) In addition to other remedies available to the Government, the Contractor's failure to comply with the requirements of paragraphs (b) or (c) of this clause may, pursuant to FAR 23.506, render the Contractor subject to suspension of contract payments, termination of the contract for default, and suspension or debarment.

1.11 PROMPT PAYMENT (FAR 52.232-25) (SEP 1992)

Notwithstanding any other payment clause in this contract, the Government will make invoice payments and contract financing payments under the terms and conditions specified in this clause. Payment shall be considered as being made on the day a check is dated or an electronic funds transfer is made. Definitions of pertinent terms are set forth in 32.902. All days referred to in this clause are calendar days, unless otherwise specified. The term "foreign vendor" means an incorporated concern not incorporated in the United States, or an unincorporated concern having its principal place of business outside the United States.

(a) Invoice Payments.

(1) For purposes of this clause, "invoice payment" means a Government disbursement of monies to a Contractor under a contract or other authorization for supplies or services accepted by the Government. This includes payments for partial deliveries that have been accepted by the Government and final cost or fee payments where amounts owed have been settled between the Government and the Contractor.

(2) Except as indicated in subparagraph (a)(3) and paragraph (c) of this clause, the due date for making invoice payments by the designated payment office shall be the later of the following two events:

(i) The 30th day after the designated billing office has received a proper invoice from the Contractor.

(ii) The 30th day after Government acceptance of supplies delivered or services performed by the Contractor. On a final invoice where the payment amount is subject to contract settlement actions, acceptance shall be deemed to have occurred on the effective date of the contract settlement. However, if the designated billing office fails to annotate the invoice with the actual date of receipt, the invoice payment due date shall be deemed to be the 30th day after the date the Contractor's invoice is dated, provided a proper invoice is received and there is no disagreement over quantity, quality, or Contractor compliance with contract requirements.

(3) The due date on contracts for meat, meat food products, or fish; contracts for perishable agricultural commodities, contracts for dairy products, edible fats or oils, and food products prepared from edible fats or oils, and contracts not requiring submission of an invoice shall be as follows:

(i) The due date for meat and meat food products, as defined in Section 2(a)(3) of the Packers and Stockyard Act of 1921 (7 U.S.C. 182(3)) and further defined in Pub. L. 98-181 to include any edible fresh or frozen poultry meat, any perishable poultry meat food product, fresh eggs, and any perishable egg product, will be as close as possible to, but not later than, the 7th day after product delivery.

(ii) The due date for fresh or frozen fish, as defined in Section 204(3) of the Fish and Seafood Promotion Act of 1986 (16 U.S.C. 4003(3)), will be as close as possible to, but not later than, the seventh day after product delivery.

(iii) The due date for perishable agricultural commodities, as defined in section 1(4) of the Perishable Agricultural commodities Act of 1930 (7 U.S.C. 499a(44)), will be as close as possible to, but not later than, the 10th day after product delivery, unless another date is specified in the contract.

(iv) The due date for dairy products, as defined in section 111(e) of the Dairy Production Stabilization Act of 1983 (7 U.S.C. 4502(e)), edible fats or oils, and food products prepared from edible fats or oils, will be as close as possible to, but not later than, the 10th day after the date on which a proper invoice has been received.

(v) If the contract does not require submission of an invoice for payment (e.g., period lease payments), the due date will be as specified in the contract.

(4) An invoice is the Contractor's bill or written request for payment under the contract for supplies delivered or services performed. An invoice shall be prepared and submitted to the designated billing office specified in the contract. A proper invoice must include the items listed in subdivisions (a)(4)(i) through (a)(4)(viii) of this clause. If the invoice does not comply with these requirements, then the Contractor will be notified of the defect within 7 days after receipt of the invoice at the designated billing office (3 days for meat, meat food products, or fish, and 5 days for perishable agricultural commodities, edible fats or oils, and food products prepared from edible fats or oils. Untimely notification will be taken into account in the computation of any interest penalty owed the Contractor in the manner described in subparagraph (a)(6) of this clause.

(i) Name and address of the Contractor.

(ii) Invoice date.

(iii) Contract number or other authorization for supplies delivered or services performed (including order number and contract line item number).

(iv) Description, quantity, unit of measure, unit price, and extended price of supplies delivered or services performed.

(v) Shipping and payment terms (e.g., shipment number and date of shipment, prompt payment discount terms). Bill of lading number and weight of shipment will be shown for shipments on Government bills of lading.

(vi) Name and address of Contractor official to whom payment is to be sent (must be the same as that in the contract or in a proper notice of assignment).

(vii) Name (where practicable), title, phone number and mailing address of person to be notified in event of a defective invoice.

(viii) Any other information or documentation required by other requirements of the contract (such as evidence of shipment).

(5) An interest penalty shall be paid automatically by the Government, without request from the Contractor, if payment is not made by the due date and the conditions listed in subdivisions (a)(5)(i) through (a)(5)(iii) of this clause are met, if applicable. An interest penalty shall not be paid on contracts awarded to foreign vendors outside the United States for work performed outside the United States.

(i) A proper invoice was received by the designated billing office.

(ii) A receiving report or other Government documentation authorizing payment was processed and there was no disagreement over quantity, quality, or Contractor compliance with any contract term or condition.

(iii) In the case of a final invoice for any balance of funds due the Contractor for supplies delivered or services performed, the amount was not subject to further contract settlement actions between the Government and the Contractor.

(6) The interest penalty shall be at the rate established by the Secretary of the Treasury under Section 12 of the Contract Disputes Act of 1978 (41 U.S.C. 611) that is in effect on the day after the due date, except where the interest penalty is prescribed by other governmental authority.

This rate is referred to as the "Renegotiation Board Interest Rate," and it is published in the Federal Register semiannually on or about January 1 and July 1. The interest penalty shall accrue daily on the invoice payment amount approved by the Government and be compounded in 30-day increments inclusive from the first day after the due date through the payment date. That is, interest accrued at the end of any 30-day period will be added to the approved invoice payment amount and be subject to interest penalties if not paid in the succeeding 30-day period. If the designated billing office failed to notify the Contractor of a defective invoice within the periods prescribed in paragraph (a)(4) of this clause, then the due date on the corrected invoice will be adjusted by subtracting the number of days taken beyond the prescribed notification of defects period. Any interest penalty owed the Contractor will be based on this adjusted due date. Adjustments will be made by the designated payment office for errors in calculating interest penalties, if requested by the Contractor.

(i) For the sole purpose of computing an interest penalty that might be due the Contractor, Government acceptance shall be deemed to have occurred constructively on the 7th day (unless otherwise specified in this contract) after the Contractor delivered the supplies or performed the services in accordance with the terms and conditions of the contract, unless there is a disagreement over quantity, quality, or Contractor compliance with a contract provision. In the event that actual acceptance occurs within the constructive acceptance period, the determination of an interest penalty shall be based on the actual date of acceptance.

The constructive acceptance requirement does not, however, compel Government officials to accept supplies or services, perform contract administration functions, or make payment prior to fulfilling their responsibilities.

(ii) The following periods of time will not be included in the determination of an interest penalty:

(A) The period taken to notify the Contractor of defects in invoices submitted to the Government, but this may not exceed 7 days (3 days for meat, meat food products, or fish, and 5 days for perishable agricultural commodities, dairy products, edible fats or oils, and food products prepared from edible fats or oils).

(B) The period between the defects notice and resubmission of the corrected invoice by the Contractor.

(iii) Interest penalties will not continue to accrue after the filing of a claim for such penalties under the clause at 52.233-1, Disputes, or for more than 1 year. Interest penalties of less than $1.00 need not be paid.

(iv) Interest penalties are not required on payment delays due to disagreement between the Government and Contractor over the payment amount or other issues involving contract compliance or on amounts temporarily withheld or retained in accordance with the terms of the contract. Claims involving disputes, and any interest that may be payable, will be resolved in accordance with the clause at 52.233-1, Disputes.

(7) An interest penalty shall also be paid automatically by the designated payment office, without request from the Contractor, if a discount for prompt payment is taken improperly. The interest penalty will be calculated as described in subparagraph (a)(6) of this clause on the amount of discount taken for the period beginning with the first day after the end of the discount period through the date when the Contractor is paid.

(8) If this contract was awarded on or after October 1, 1989, a penalty amount, calculated in accordance with regulations issued by the Office of Management and Budget, shall be paid in addition to the interest penalty amount if the Contractor -

(i) Is owed an interest penalty;

(ii) Is not paid the interest penalty within 10 days after the date the invoice amount is paid; and

(iii) Makes a written demand, not later than 40 days after the date the invoice amount is paid, that the agency pay such a penalty.

(b) Contract Financing Payments.

(1) For purposes of this clause, "contract financing payment" means a Government disbursement of monies to a Contractor under a contract clause or other authorization prior to acceptance of supplies or services by the Government. Contract financing payments include advance payments, progress payments based on cost under the clause at 52.232-16, Progress Payments, progress payments based on a percentage or stage of completion (32.102(e)(1)) other than those made under the clause at 52.232-5, Payments Under Fixed-Price Construction Contracts, or the clause at 52.232-10, Payments Under Fixed-Price Architect-Engineer Contracts, and interim payments on cost type contracts.

(2) For contracts that provide for contract financing, requests for payment shall be submitted to the designated billing office as specified in this contract or as directed by the Contracting Officer. Contract financing payments shall be made on the 30th day after receipt of a proper contract financing request by the designated billing office. In the event that an audit or other review of a specific financing request is required to ensure compliance with the terms and conditions of the contract, the designated payment office is not compelled to make payment by the due date specified.

(3) For advance payments, loans, or other arrangements that do not involve recurrent submissions of contract financing requests, payment shall be made in accordance with the corresponding contract terms or as directed by the Contracting Officer.

(4) Contract financing payments shall not be assessed an interest penalty for payment delays.

(c) If this contract contains the clause at 52.213-1, Fast Payment Procedure, payments will be made within 15 days after the date of receipt of the invoice.

I.12 BANKRUPTCY (FAR 52.242-13) (APR 1991)

In the event the Contractor enters into proceedings relating to bankruptcy, whether voluntary or involuntary, the Contractor agrees to furnish, by certified mail, written notification of the bankruptcy to the Contracting Officer responsible for administering the contract. This notification shall be furnished within five days of the initiation of the proceedings relating to bankruptcy filing. This notification shall include the date on which the bankruptcy petition was filed, the identity of the court in which the bankruptcy petition was filed, and a listing of Government contract numbers and contracting offices for all Government contracts against which final payment has not been made. This obligation remains in effect until final payment under this contract.

I.13 AUTHORIZED DEVIATIONS IN CLAUSES (FAR 52.252-6) (APR 1984)

(a) The use in this solicitation or contract of any Federal Acquisition Regulation (48 CFR Chapter 1) clause with an authorized deviation is indicated by the addition of "(DEVIATION)" after the date of the clause.

(b) The use in this solicitation or contract of any NASA/FAR Supplement (48 CFR Chapter 18) clause with an authorized deviation is indicated by the addition of "(DEVIATION)" after the name of the regulation.

I.14 SECURITY REQUIREMENTS FOR UNCLASSIFIED AUTOMATED INFORMATION RESOURCES (NASA 18-52.204-76) (JUN 1990)

(a) In addition to complying with any functional and technical security requirements set forth in the schedule and the clauses of this contract, the Contractor shall obtain special identification, as required by the computer security manager, for its personnel who need unescorted or unsupervised physical access or electronic access to the following limited or controlled areas, systems, programs and data:

(b) The Contractor shall incorporate this clause in all subcontracts where the requirements identified in paragraph (a) are applicable to performance of the subcontract.

I.15 SECURITY PLAN FOR UNCLASSIFIED AUTOMATED INFORMATION RESOURCES (NASA 18-52.204-78) (JAN 1992)

In addition to complying with any functional and technical security requirements set forth in the Schedule and the clauses of this contract, the Contractor shall comply with the Unclassified Automated Information Resources Security Plan submitted pursuant to provision 18-52.204-77, Submission of Security Plan For Unclassified Automated Information Resources, as approved by the Contracting Officer.

I.16 LIMITATION OF FUTURE CONTRACTING (NASA 18-52.209-71) (DEC 1988)

(a) The Contracting Officer has determined that this acquisition may give rise to a potential organizational conflict of interest. Accordingly, the attention of all prospective offerors is invited to FAR Subpart 9.5--Organizational Conflicts of Interest.
(b) The nature of this conflict is that the Contractor and/or a subcontractor will perform inspections of pressure and structural systems and, if necessary, prepare specifications for repairs to the system(s). The Contractor and any subcontractor performing inspections and/or preparing repair specifications shall be ineligible to perform the work described in the specifications as a prime or first-tier subcontractor.
(c) The restrictions upon future contracting are as follows:

(1) If the Contractor, under the terms of this contract, or through the performance of tasks pursuant to this contract, is required to develop specifications or statements of work that are to be incorporated into a solicitation, the Contractor shall be ineligible to perform the work described in that solicitation as a prime or first-tier subcontractor under an ensuing NASA contract. This restriction shall remain in effect for a reasonable time, as agreed to by the Contracting Officer and the Contractor, sufficient to avoid unfair competitive advantage or potential bias (this time shall in no case be less than the duration of the initial production contract). NASA shall not unilaterally require the Contractor to prepare such specifications or statements of work under this contract.

(2) To the extent that the work under this contract requires access to proprietary, business confidential, or financial data of other companies, and as long as such data remains proprietary or confidential, the Contractor shall protect these data from unauthorized use and disclosure and agrees not to use them to compete with those other companies.

I.17 SMALL BUSINESS AND SMALL DISADVANTAGED BUSINESS SUBCONTRACTING REPORTING (NASA/FAR SUPPLEMENT 18-52.219-75) (SEP 1992)

(a) The Contractor shall submit the Summary Subcontract Report (Standard Form [SF] 295) quarterly for the reporting periods specified in Block 1.A. of the form. Reports are due 30 days after the close of each reporting period.
(b) The Contractor shall also complete Item 15 (Subcontract awards to Historically Black Colleges and Universities/Minority Institutions) in accordance with the existing instructions applicable to DOD activities.
(c) All other provisions in the instruction paragraphs of the SF 295 remain in effect.
(d) The Contractor shall include this clause in all subcontracts that include the clause at FAR 52.219-9.

I.18 TECHNICAL DIRECTION (NASA 18-52.242-70) (MAR 1989)

(a) Performance of the work under this contract is subject to the written technical direction of the Contracting Officer's Technical Representative (COTR), who shall be specifically appointed by the Contracting Officer in writing in accordance with NASA FAR Supplement 18-42.270. "Technical direction" means a directive to the Contractor that approves approaches, solutions, designs, or refinements; fills in details or otherwise completes the general description of work or documentation items; shifts emphasis among work areas or tasks; or furnishes similar instruction to the Contractor. Technical direction includes requiring studies and pursuit of certain lines of inquiry regarding matters within the general tasks and requirements in Section C of this contract.
(b) The COTR does not have the authority to, and shall not, issue any instructions purporting to be technical direction that -
(1) Constitutes an assignment of additional work outside the statement of work;
(2) Constitutes a change as defined in the changes clause;
(3) In any manner causes an increase or decrease in the total estimated contract cost, the fixed fee (if any), or the time required for contract performance;
(4) Changes any of the expressed terms, conditions, or specifications of the contract; or
(5) Interferes with the Contractor's rights to perform the terms and conditions of the contract.
(c) All technical direction shall be issued in writing by the COTR.
(d) The Contractor shall proceed promptly with the performance of technical direction duly issued by the COTR in the manner prescribed by this clause and within the COTR's authority. If, in the Contractor's opinion, any instructions or direction by the COTR falls within any of the categories defined in paragraph (b) above, the Contractor shall not proceed but shall notify the Contracting Officer in writing within 5 working days after receiving it and shall request the Contracting Officer to take action as described in this clause. Upon receiving this notification, the Contracting Officer shall either issue an appropriate contract modification within a reasonable time or advise the Contractor in writing within 30 that the instruction is -
(1) Rescinded in its entirety; or

(2) Within the scope of the contract and does not constitute a change under the changes clause of the contract and that the Contractor should proceed promptly its performance.

(e) A failure of the Contractor and Contracting Officer to agree that the instruction or direction is both within the scope of the contract and does not constitute a change under the changes clause, or a failure to agree upon the contract action to be taken with respect to the instruction or direction shall be subject to the Disputes clause of this contract.

(f) Any action(s) taken by the Contractor in response to any direction given by any person other than the Contracting Officer or the COTR shall be at the Contractor's risk.

PART III - LIST OF DOCUMENTS, EXHIBITS AND OTHER ATTACHMENTS

SECTION J - LIST OF ATTACHMENTS

| | |
|---|---|
| Exhibit A | Statement of Work, June 1, 1993, 38 pages |
| Exhibit B | Contract Documentation Requirements, 7 pages |
| Exhibit C | Installation-Provided Government Property, 1 page |
| Exhibit D | Subcontracting Plan* |
| Exhibit E | Register of Wage Determination and Fringe Benefits, 24 pages |

The following are located after the last section of this solicitation:

| | |
|---|---|
| Attachment 1 | Certificate of Current Cost or Pricing Data, Form PROC./P-281, May 1986, 1 page |
| Attachment 2 | Contract Pricing Proposal Cover Sheet, Standard Form 1411, July 1987 with instructions, 4 pages |
| Attachment 3 | FAR Provision 52.203-8, Requirement for Certificate of Procurement Integrity (NOV 1990) Alternate I (SEP 1990), 2 pages |
| Attachment 4 | Cost Proposal Forms, 4 pages |
| Attachment 5 | Staffing and Position Qualifications, 16 pages |
| Attachment 6 | Bidder's Library Information, 1 page |
| Attachment 7 | Contractor-Furnished Vehicle Requirements, 1 page |
| Attachment 8 | Geographical Limitation/10 Mile Radius Map, 1 page |
| Attachment 9 | NASA Handbook (NHB) 1700.6, Guide for Inservice Inspection of Ground-Based Pressure Vessels and Systems (January 18, 1976), 56 pages |
| Attachment 10 | NASA Langley Handbook (LHB) 1710.40, Safety Regulations Covering Pressurized Systems (November 1988), 40 pages |
| Attachment 11 | NASA Langley Handbook (LHB) 1710.41, Langley Research Center Standard for the Evaluation of Socket and Branch Connection Welds (April 1989), 31 pages |
| Attachment 12 | NASA Langley Handbook (LHB) 1740.4, Facility System Safety Analysis and Configuration Management (March 1992), 50 pages |
| Attachment 13 | NASA Langley Management Instruction (LMI) 7000.2, Review Program for Langley Research Center (LaRC) Construction of Facilities (CoF) Projects (June 25, 1991), 17 pages |

*Not applicable to Small Businesses.

Attachment 14 NASA Langley Management Instruction (LMI) 7120.1, Aeronautic and Space Flight Projects and Experiments Review Program (October 21, 1980), 7 pages

Attachment 15 Langley Guidance (NFM-1C), Guide for the Certification/Recertification of Wind Tunnel Structural Systems (February 1993), 24 pages

# STATEMENT OF WORK

RECERTIFICATION AND CONFIGURATION MANAGEMENT
SUPPORT SERVICES

1-39-5681.1014
EXHIBIT A

JUNE 27, 1993

NASA — LANGLEY RESEARCH CENTER

HAMPTON, VA

23681-0001

## 1.0 SCOPE

The Contractor shall perform a two-fold effort under this contract, (1) Inservice Inspection of Langley Research Center's (LaRC's) structural and high-pressure fluid systems, and (2) Configuration Management of the documents identified as vital to the safe operation of LaRC's facilities.

For Inservice Inspection, the Contractor shall: (1) define, analyze, inspect and document the existing structural and high-pressure fluid systems; (2) develop repair specifications for structural and pressure systems; (3) perform limited emergency repairs; and (4) provide storage for radiographs (Note: In most instances, these systems will be pressurized during the Inservice Inspection.)

For Configuration Management, the Contractor shall: (1) evaluate and update the documentation in the Research Facility Configuration Management Program; (2) maintain a Risk Evaluation Program for designated "Laboratory" type facilities; (3) maintain an Asbestos Configuration Management Program; (4) maintain a Pressure Systems Configuration Management Program; (5) field verify and reformat the existing Recertification documentation; (6) provide safety engineering support for major and minor Construction of Facilities (CoF) projects; (7) track and monitor Problem Failure Reports; (8) organize, document and track CoF design reviews; (9) maintain a Configuration Management Program for designated Flight Projects; (10) control and update all of the Aerothermal Loads Branch's supporting facility documents; and (11) operate the on-site 8'-Foot High Temperature Tunnel Library.

## 2.0 INSERVICE INSPECTION PROGRAM

2.1 The Contractor shall perform Inservice Inspections of all ground-based, nonrecertified pressure systems at LaRC. (These systems may include high pressure gas, steam and liquid systems.) In performing this Inservice Inspection, the Contractor shall follow the procedures described in the NASA Handbook NHB 1700.6, "Guide for Inservice Inspection of Ground-Based Pressure Vessels and Systems," January 18, 1976.

The Contractor shall perform Inservice Inspections of the structural systems in the wind tunnels listed in Attachment I. In performing this Inservice Inspection, the Contractor shall follow the procedures described in NFM-1C, "Guide for the Certification/Recertification of Wind Tunnel Structural Systems", February 1993.

2.1.1 The Contractor shall perform Inservice Inspections of pressure and structural systems designated by the Contracting Officer Technical Representative (COTR), in the order of priority established by the Government. Milestone schedules for each inspection shall be developed by the Contractor and will be approved by the COTR. These schedules will be subject to revision to accommodate unanticipated factors affecting their performance.

2.1.1.1 For analytical procedures, the Contractor shall use the appropriate guides and national consensus codes in analyzing the system components.

2.1.1.2 For inspections and tests, the Contractor shall: (1) nondestructively examine all high-stress areas identified in the analyses; and (2) nondestructively examine 10 ± 1/2% of the systems' welds. Pressure-containing welds shall be radiographically examined. All other welds shall be inspected as specified in the appropriate national consensus codes.

2.1.1.3 The Contractor shall perform additional nondestructive examinations (NDE) as required.

2.1.1.4 In performing the NDE of pressure systems, the Contractor shall satisfy the following requirements.

2.1.1.4.1 The Contractor shall use the NDE techniques given in Section V, American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code in completing the NDEs.

2.1.1.4.2 The Contractor shall use the matrix below to determine the acceptance criteria in evaluating the results of the NDEs.

| Type of NDE | Pressure Vessels | Pressure Piping | |
|---|---|---|---|
| Ultrasonic | Section VIII, Div. 1<br>Paragraph 12-3<br>ASME B&PV Code | ANSI/ASME<br>B31.3<br>Para. 344.6.2 | |
| Radiographic | Section VIII, Div. 1<br>Paragraph UW-51<br>ASME B&PV Code | Butt Welds<br><br>ANSI/ASME<br>B31.3<br>Para. 341.3.2<br><br>Severe Cyclic<br>Conditions | Socket & Branch<br>Conn. Welds<br>LHB 1710.41 |

| Type of NDE | Pressure Vessels | Pressure Piping |
|---|---|---|
| Magnetic Particle | Section VIII, Div. 1<br>Paragraph 6-4<br>ASME B&PV Code | ANSI/ASME<br>B31.3<br>Para. 341.3.2 |
| Liquid Penetrant | Section VIII, Div. 1<br>Paragraph 8-4<br>ASME B&PV Code | ANSI/ASME<br>B31.3<br>Para. 341.3.2 |

2.1.1.5 In performing the NDE of structural systems, the Contractor shall satisfy the requirements of the appropriate national consensus codes.

2.1.1.6 The Contractor shall develop weld location drawings that locate and number each weld in the systems.

2.1.1.7 The Contractor shall mark on the weld all unacceptable areas identified by the NDE.

2.1.1.8 The Contractor shall add all NDE results into the existing data-management system which currently uses the PC-FILE 5.01 database program.

2.1.1.9 The Contractor shall provide staging as necessary for performing NDE.

2.1.1.10 As required, the Contractor shall provide for: the removal of asbestos; packaging for disposal in accordance with applicable OSHA and EPA regulations; and delivery to an on-site storage container.

2.1.2 The Contractor shall develop drawings, specifications and cost estimates for repairs and/or replacement of various pressure and structural systems. After the repairs are completed, the Government will provide NDE results to the Contractor. The Contractor shall enter these results into the existing, data-management system.

2.1.3 The Contractor shall perform emergency repairs identified by the Government.

2.1.3.1 The Contractor shall coordinate access to all NASA facilities, and all NDE with the cognizant NASA Facility Coordinators.

2.1.3.2 The Contractor shall monitor all radiographic inspections with NASA-certified monitors. NASA will provide the training required for this certification.

2.1.4 The Contractor shall provide continuous storage and security for all existing and future radiographs of pressure and structural systems.

# 3.0 CONFIGURATION MANAGEMENT

3.1 The Contractor shall maintain LaRC's existing Configuration Management (CM) Program. The LHB 1740.4, "Facility System Safety Analysis and Configuration Management," March 1992, describes the operation of the CM Program.

3.1.1 Research Facility Configuration Management: On a continuing basis, the Contractor shall update all Configuration Controlled Documents (CCD) when Change Notification Sheets (CNS) and other required documents are submitted to the Contractor. Attachment II of this SOW lists the facilities currently in this program. This updating requires completion of the following activities. (CCD's include system safety analyses, procedures and checklists, and drawings.)

3.1.1.1 The Contractor shall appropriately modify the existing system safety analyses when changes are made to facilities in the CM Program.

3.1.1.2 The Contractor shall appropriately modify the existing operating procedures and checklists when changes are made to facilities in the CM Program.

3.1.1.3 The Contractor shall appropriately modify the existing Configuration Controlled Drawings when changes are made to the facilities in the CM Program. As required, the Contractor shall field verify the configuration of the systems shown on the Configuration Controlled Drawings.

3.1.1.4 The Contractor shall participate in Annual CM Meetings described in Paragraph 4.3.a of LHB 1740.4.

3.1.1.5 The Contractor shall support LaRC's Safety Manager in conducting a minimum of 10 annual operating procedures demonstrations described in Paragraph 4.3.b of LHB 1740.4. Support includes accompanying facility personnel performing specific procedural tasks and noting deviations from existing procedures.

3.1.1.6 The Contractor shall review and recommend either approval or disapproval of all CNS packages and attached documentation received at the Safety Office.

3.1.1.6.1 The Contractor shall, after evaluating an incoming CNS package, recommend either approval or disapproval of the package by Head, Facility Assurance Section (FAS), Risk Management Branch (RMB); Systems Safety, Quality, and Reliability Division (SSQRD).

3.1.1.6.2 The Contractor shall, when recommending disapproval of the CNS package, coordinate with the facility on clarification and resolution of problem areas. Disapproval shall be agreed to by Head, FAS, RMB, SSQRD, before returning the CNS package to the facility.

3.1.1.6.3 The Contractor shall, when recommending approval of the CNS package, submit it to the Head, FAS for approval signature and transmit the package to the Facilities Configuration Coordinator, Facilities Engineering Division for review and approval.

3.1.1.7 The Contractor shall store and secure optical disks containing approximately 7000 configuration controlled drawings. The Contractor shall modify the drawings stored on these disks as required. The Contractor shall send a paper copy of each modified drawing to LaRC's Engineering Drawing Files after each modification is completed. These drawings were scanned using an optical scanner, producing a raster image in CCITT Group IV, Byte Compressed Format. The Contractor shall modify these drawings using a system that is compatible with the existing optical disks.

3.1.1.8 The Contractor shall, on a continuing basis, update and add documentation to the CM Program in accordance with LHB 1740.4, for the facilities listed in Attachment III.

3.1.1.9 The Contractor shall provide continuous storage and security for the Safety Analysis Reports, operating procedures, and checklists.

3.1.2 Laboratory Risk Evaluation and Configuration Management. The Contractor shall produce risk evaluations and operating procedures for the asterisked facilities listed in Attachment IV. The Contractor shall maintain the CM program for the non-asterisked facilities listed in Attachment IV and add the asterisked facilities upon completion of their risk evaluations and operating procedures.

3.1.3 Asbestos Configuration Management. The Contractor shall maintain the Asbestos Configuration Management Program for the facilities listed in Attachment V.

3.1.4 Pressure Systems Configuration Management. The Contractor shall maintain the Pressure Systems Configuration Management (PSCM) Program for the facilities listed in Attachment VI. The Contractor shall field verify all modifications to pressure systems in the PSCM Program.

3.1.5 The Contractor shall field check, update, and reformat the Recertification documentation on the asterisked facilities in Attachment VI.

3.1.6 System Safety Engineering. When directed by the Government, the Contractor shall provide system safety engineering support for CoF projects.

3.1.7 Problem Failure Report Support. The Contractor shall track and monitor Problem Failure Reports (PFRs) submitted by facilities operating within the CM Program and/or under a Safety Permit. The Contractor shall prepare summary reports for the Safety Manager's approval and distribution.

3.1.8 Facility Design Review Support. The Contractor shall coordinate CoF Design Reviews for the FENGD in accordance with LMI 7000.2, "Review Program for Langley Research Center (LaRC) Construction of Facilities (CoF) Projects."

3.1.8.1 The Contractor shall schedule the design reviews; reserve a suitable meeting room; in conjunction with appropriate LaRC management, establish the review committee and send out meeting notices.

3.1.8.2 The Contractor shall attend the design reviews, draft the review minutes; compile the action items from the review, distribute the minutes and action items, and maintain the files of the minutes and action items.

3.1.8.3 The Contractor shall track all open action items and, issue monthly status reports.

3.1.9 Flight Projects Configuration Management. The Contractor shall maintain the configuration management program for the flight projects listed in Attachment VII.

3.1.9.1 The Contractor shall use NASA and LaRC guidelines in maintaining the program's procedures.

3.1.9.2 The Contractor shall receive and review change packages for completeness and prepare packages for distribution to include suspense control, tracking and scheduling of Configuration Control Board (CCB) actions.

3.1.9.3 The Contractor shall coordinate the scheduling of the LaRC CCB meetings and serve as secretary.

3.1.9.4 The Contractor shall prepare completed change packages for the concurrence of the particular flight project office.

3.1.9.5 The Contractor shall perform CM audits and assist in quality assurance and physical audits.

3.1.9.6 The Contractor shall support LaRC in Flight Project design reviews, which are described in LMI 7120.1, "Planning and Approval of Major Research and Development Projects", by assuring that an adequate Configuration Management Program is in place.

3.1.10 The Contractor shall control and update all of the Aerothermal Loads Branch's Supporting Facility Documents (SFD).

3.1.10.1 The Contractor shall develop procedures for identifying, controlling, and updating SFDs and other related documentation.

3.1.10.2 The Contractor shall control, update and distribute all SFDs and other documentation as required.

3.1.11 The Contractor shall operate the facility document library located at the 8-Foot High Temperature Tunnel (8'HTT). An inventory of all library documents shall be maintained.

3.1.11.1 The Contractor shall assure that all 8'HTT SFDs are in Engineering Drawings Files.

3.1.11.2 The Contractor shall issue the latest copies of all procedures for test runs to the Test Director, 8'HTT and maintain an inventory of all library documents.

# STRUCTURAL SYSTEMS INSERVICE INSPECTION

# RESEARCH FACILITIES LIST

ATTACHMENT I
TO EXHIBIT A

| BUILDING NUMBER | RESEARCH FACILITY |
|---|---|
| 582A | Low Turbulence Pressure Tunnel |
| 585 | 6-Inch X 19-Inch Transonic Tunnel |
| 640 | 8-Foot Transonic Pressure Tunnel |
| 643 | 30 X 60-Foot Tunnel |
| 648 | Transonic Dynamics Tunnel |
| 1146 | 16-Foot Transonic Tunnel |
| 1208 | Acoustics Research Laboratory |
| 1212C | 14-Foot X 22-Foot Subsonic Tunnel |
| 1221A | Jet Noise and Thermal Acoustic Fatigue Apparatuses |
| 1221D | Combustion-Heated Scramjet Test Facility |
| 1236 | National Transonic Facility |
| 1242 | 0.3-Meter Transonic Cryogenic Tunnel |
| 1247A-D | Hypersonic Facilities Complex |
| 1251 | Unitary Wind Tunnel |
| 1251A | 31-Inch Mach 10 Tunnel and 15-Inch Mach 6 High Temperature Tunnel |
| 1257-62 | Aircraft Landing Dynamics Facility |
| 1264 | 7-Inch High Temperature Pilot Tunnel |
| 1265 | 8 Foot High Temperature Tunnel |
| 1275 | 20-Inch M6 CF4 Tunnel |

ATTACHMENT I
TO EXHIBIT A

# CONFIGURATION MANAGEMENT FACILITIES LIST

ATTACHMENT II
TO EXHIBIT A

| EFFORT CODE | FACILITY | BUILDING NUMBER |
|---|---|---|
| 01 | West Area High Pressure Air System | N/A |
| 02 | 20-Inch Mach 6 CF4 Tunnel | 1275 |
| 03 | 8-Foot High Temperature Tunnel | 1265 |
| 05 | Hypersonic Blowdown Tunnels | 1247D |
| 07 | 20-Inch Mach 17 N2 Tunnel | 1247B |
| 12 | Aero Thermal Arc Tunnels | 1267 |
| 13 | Visual Motion Simulator | 1268A |
| 14 | Drive Control Facility | 1241 |
| 16 | 31-Inch Mach 10 Tunnel | 1251A |
| 17 | 15-Inch Mach 6 High-Temperature Tunnel | 1251A |
| 18 | Transonic Dynamics Tunnel | 648 |
| 19 | 14 X 22 Foot Subsonic Tunnel | 1212C |
| 21 | 16-Foot Transonic Tunnel | 1146A-D |
| 22 | Acoustics Research Laboratory | 1208 |
| 23 | Hypersonic Materials Test Apparatus | 1148 |
| 24 | Unitary Wind Tunnel | 1251 |
| 25 | Scramjet Test Facility | 1247B |
| 26 | 60-Inch Mach 18 Helium Tunnel Complex | 1247H |
| 27 | 60-Inch Mach 18 Helium Recovery System | 1247B |
| 28 | Hypersonic Helium Tunnel Facility | 1247B |
| 29 | Aircraft Landing Dynamics Facility | 1257-1262 |
| 30* | HPB Ceramic Heated Combustion Facility | 1263 |
| 31* | Vortex Research Facility | 720B |
| 33 | Impact Dynamics Research Facility | 1297 |
| 34 | 0.3 Meter Transonic Cryogenic Tunnel | 1242 |
| 35 | Anechoic Noise Facility | 1218A |
| 36 | Jet Noise Apparatus | 1221A |
| 37 | Thermal Acoustic Fatigue Apparatus | 1221A |
| 38 | East Area High Pressure Air System | N/A |
| 39 | 8-Foot Transonic Pressure Tunnel | 640 |
| 40 | Low-Turbulence Pressure Tunnel | 582A |
| 43 | 6-Inch X 19-Inch Transonic Tunnel | 585 |

ATTACHMENT II
TO EXHIBIT A

| EFFORT CODE | FACILITY | BUILDING NUMBER |
|---|---|---|
| 50 | Vacuum Sphere Control and 60-Foot Simulator | 1295B-D |
| 52* | High Speed 7 X 10- Foot Tunnel | 1212B |
| 58 | Impact and Projectile Range | 1275 |
| 59* | Chemical Kinetic Shock Tube | 1275 |
| 60 | 30 X 60- Foot Tunnel | 643 |
| 61 | 12-Foot Low-Speed Tunnel | 644 |
| 62 | 20-Foot Vertical Spin Tunnel | 645 |
| 64 | DC-9 Simulator | 1220 |
| 66 | Differential Maneuvering Simulator | 1268A |
| 67 | General Purpose Simulator | 1220 |
| 68 | General Aviation Simulator | 1268A |
| 69 | 7-Inch High Temperature Tunnel | 1264 |
| 71 | Vitiated Heater, Test Cell #2 | 1221C |
| 80 | Combustion and Mixing Research Apparatus, Test Cell # 1 | 1221C |
| 84 | Hangar Water Deluge System | 1244 |
| 85 | Hevi-Duty Brazing Vacuum Furnace | 1232A |
| 86 | 16-Meter Thermal Vacuum Chamber | 1293B |
| 89 | Building 1267A Autoclaves | 1267A |
| 91 | Composite Shop Autoclave | 1238B |
| 92 | Hypersonic Helium Tunnel Recovery System | 1247B |
| 93 | Transport System Res. Vehicle Simulator | 1268B |
| 95 | Space Environment Effects Lab | 1120 |
| 97 | Space Structures Research Lab | 1293A |
| 98 | West Area Heating Plant & Steam Distribution | 1215 |
| 99** | National Transonic Facility | 1236 |

* Facility in standby status at this time.

** The Contractor is not required to provide updated facility drawings for Effort Code 99.

# LIST OF FACILITIES REQUIRING CRITICAL ITEMS LISTS & UPGRADES

ATTACHMENT III
TO EXHIBIT A

| EC | FACILITY NAME |
|---|---|
| 14 | Drive Control Facility |
| 17 | 15-Inch Mach 6 High-Temperature Tunnel |
| 22 | Acoustics Research Laboratory |
| 24 | Unitary Wind Tunnel |
| 25 | Scramjet Test Facility |
| 26 | 60-Inch, Mach 18 Helium Tunnel Complex |
| 27 | 60-Inch, Mach 18 Helium Recovery System |
| 35 | Anechoic Noise Facility |
| 37 | Thermal Acoustic Fatigue Apparatus |
| 39 | 8 Foot Transonic Pressure Tunnel |
| 40 | Low-Turbulence Pressure Tunnel |
| 50 | Vacuum Sphere Control and 60-Foot Space Simulator |
| 61 | 12-Foot Low Speed Tunnel |
| 62 | 20-Foot Vertical Spin Tunnel |
| 68 | General Aviation Simulator |
| 84 | Hangar Water Deluge System |

ATTACHMENT III
TO EXHIBIT A

# LABORATORY TYPE FACILITIES

ATTACHMENT IV
TO EXHIBIT A

| LABORATORY FACILITY | | BUILDING |
|---|---|---|
| 1. | Instron, Test Machine A | 1148 |
| 2. | Instron, Test Machine B | 1148 |
| 3. | Instron, Test Machine C | 1148 |
| 4. | Instron, 25-KIP Test Machine | 1148 |
| 5. | Tinius Olsen, 30-KIP Test Machine | 1148 |
| 6. | MTS, 50-KIP Test Machine A | 1148 |
| 7. | MTS, 50-KIP Test Machine B | 1148 |
| 8. | MTS, 100-KIP Test Machine | 1148 |
| 9. | Satec, 100-KIP Test Machine | 1148 |
| 10. | Satec, 120-KIP Test Machine A | 1148 |
| 11. | Satec, 120-KIP Test Machine B | 1148 |
| 12. | Satec, 300-KIP Test Machine | 1148 |
| 13. | Satec, 1200-KIP Test Machine | 1148 |
| 14. | Abar, High Temperature Vacuum Furnace A | 1148 |
| 15. | Abar, High Temperature Vacuum Furnace B | 1148 |
| 16. | Super Plastic Forming System | 1148 |
| 17. | Super Plastic Stretch Forming | 1148 |
| 18. | Shore Western, 10-KIP Hydraulic Fatigue Test System #6 | 1205 |
| 19. | Shore Western, 20-KIP Hydraulic Fatigue Test System #10 | 1205 |
| 20. | Shore Western, 50-KIP Hydraulic Fatigue Test System #12 | 1205 |
| 21. | Shore Western, 20-KIP Hydraulic Fatigue Test System #15 | 1205 |
| 22. | MTS, 50-KIP Hydraulic Test System #16 | 1205 |
| 23. | NASA-Fabricated, ATB Hydraulic Test System #17 | 1205 |
| 24. | MTS, 100-KIP Hydraulic Fatigue Test System #18 | 1205 |

ATTACHMENT IV
TO EXHIBIT A

| | LABORATORY FACILITY | BUILDING |
|---|---|---|
| 25. | MTS, 50-KIP Hydraulic Fatigue Test System #19 | 1205 |
| 26. | MTS, 300-KIP Hydraulic Fatigue Test System #20 | 1205 |
| 27. | Western Booneshaft, 400-KIP Hydraulic Fatigue Test System #21 | 1205 |
| 28. | NASA-Fabricated, Biaxial Hydraulic Fatigue Test System #22 | 1205 |
| 29. | MTS, 20-KIP Hydraulic Fatigue Test System #23 | 1205 |
| 30. | MTS, 20-KIP Hydraulic Fatigue Test System #24 | 1205 |
| 31. | MTS, 20-KIP Hydraulic Fatigue Test System #25 | 1205 |
| 32. | Shore Western, 20-KIP Hydraulic Fatigue Test System #26 | 1205 |
| 33. | MTS, 100-KIP Hydraulic Fatigue Test System #27 | 1205 |
| 34. | Instron, Screw-Driven Fatigue Test Stand #1 | 1205 |
| 35. | Harrop, Lab Multi-parameter Test Stand #1 | 1205 |
| 36. | Harrop, Lab Multi-parameter Test Stand #2 | 1205 |
| 37. | Harrop, Lab Multi-parameter Test Stand #3 | 1205 |
| 38. | MTS, Tension, 5-KIP Torsion, 2,000-inch pounds, Test Stand #13 | 1205 |
| 39. | MTS, Tension, 20-KIP Torsion, 10,000-inch pounds, Test Stand #14 | 1205 |
| 40. | Instron, 100-KIP Fatigue Test Stand #2 | 1205 |
| 41. | Instron, 50-KIP Fatigue Test Stand #3 | 1205 |
| 42. | Instron, 50-KIP Fatigue Test Stand #4 | 1205 |
| 43. | Instron, 20-KIP Fatigue Test Stand #5 | 1205 |
| 44. | Instron, 20-KIP Fatigue Test Stand #6 | 1205 |
| 45. | Instron, 20-KIP Fatigue Test Stand #7 | 1205 |
| 46. | Instron, 20-KIP Fatigue Test Stand #8 | 1205 |
| 47. | Satec Creep Test Stand #1 | 1205 |
| 48. | Satec Creep Test Stand #2 | 120 |

ATTACHMENT IV
TO EXHIBIT A

| | LABORATORY FACILITY | BUILDING |
|---|---|---|
| 49. | Satec Creep Test Stand #3 | 1205 |
| 50. | Satec Creep Test Stand #4 | 1205 |
| 51. | Satec Creep Test Stand #5 | 1205 |
| 52. | Arcweld Creep Test Stand #6 | 1205 |
| 53. | Satec Creep Test Stand #7 | 1205 |
| 54. | Satec Creep Test Stand #8 | 1205 |
| 55. | Satec Creep Test Stand #9 | 1205 |
| 56. | Arcweld Creep Test Stand #10 | 1205 |
| 57. | Satec Creep Test Stand #11 | 1205 |
| 58. | Arcweld Creep Test Stand #12 | 1205 |
| 59. | Satec Creep Test Stand #13 | 1205 |
| 60. | Satec Creep Test Stand #14 | 1205 |
| 61. | Arcweld Creep Test Stand #15 | 1205 |
| 62. | Satec Creep Test Stand #16 | 1205 |
| 63. | 30" x 4' Autoclave System | 1293C |
| 64. | 200# Vacuum Furnace | 1237A |
| 65. | 3-Ft. Centrifuge Furnace | 1237A |
| 66. | 6-Ft. Centrifuge Furnace | 1237A |
| 67. | DYNAVAC Sputter System #1 and PLASMA THERM RF Power Supply | 1238A |
| 68. | Materials Research Corp (MRC) Sputtering System #2 and RF Power Supply | 1238A |
| 69. | 18" NASA Modified Vacuum Chamber #3 | 1238A |
| 70. | 30" Vacuum Chamber #4, NASA Fabricated | 1238A |
| 71. | Vacuum Chamber #5, NASA Fabricated | 1238A |
| 72. | Scanning Electron Microscope (SEM) #1 | 1238A |

ATTACHMENT IV
TO EXHIBIT A

| LABORATORY FACILITY | | BUILDING |
|---|---|---|
| 73. | Scanning Electron Microscope (SEM) #2 | 1238A |
| 74. | Thermal Structures Lab 110 KIP MTS Machine | 1267 |
| 75. | Pasadena 50 KIP Hydraulic Press #1 | 1267A |
| 76. | Wabash 30 KIP Hydraulic Press #2 | 1267A |
| 77. | Wabash 30 KIP Hydraulic Press #3 | 1267A |
| 78. | Wabash 12 KIP Hydraulic Press #4 | 1267A |
| 79. | Erie 300 KIP Hydraulic Press #5 | 1267A |
| 80. | Oliver 500 KIP Hydraulic Press #6 | 1267A |
| 81. | Low Temperature Oven #1 | 1267A |
| 82. | Low Temperature Oven #2 | 1267A |
| 83. | Low Temperature Oven #3 | 1267A |
| 84. | Low Temperature Oven #4 | 1267A |
| 85. | Low Temperature Oven #5 | 1267A |
| 86. | Heavy-duty Pit Furnace | 1267A |
| 87. | Harrop Box Furnace | 1267A |
| 88. | Limberg Furnace #1 | 1267A |
| 89. | Limberg Furnace #2 | 1267A |
| 90. | Limberg Furnace #3 | 1267A |
| 91. | West Pit Furnace | 1267A |
| 92. | Flame Spray | 1296 |
| 93. | X-Ray Lab | 1296 |
| 94 | Variable Frequency Converter No. 1 | 1235 |
| 95. | Variable Frequency Converter No. 2 | 1235 |
| 96. | Variable Frequency Converter No. 3 | 1235 |
| 97. | Acoustic Flow Impedance Tube | 1287 |
| 98. | Thermal Structures Test Apparatus | 1208 |
| *99. | Mach-4 Blowdown tunnel | 1221C |

ATTACHMENT IV
TO EXHIBIT A

| LABORATORY FACILITY | BUILDING |
|---|---|
| *100. Swirljet Facility | 1221C |
| *101. Atmospheric Controlled Combustion Apparatus | 1265 |
| *102. Intelligent Systems Research Laboratory | 1220 |
| *103. Automated Structural Assembly Laboratory | 1220 |
| *104. Telerobotics Systems Research Laboratory | 1220 |
| *105. Magnetic Suspension and Balance System | 1212 |
| *106. 3-Inch Helium Tunnel | 1247B |
| *107. 15-Inch Low-Speed Tunnel | 1247B |
| *108. 7-Inch By 11-Inch Low-Speed Tunnel | 1247B |
| *109. 2X3 Low Speed Boundary Layer Channel | 1247H |
| *110. 2" x 6" Low-Speed Tunnel | 1247H |
| *111. Basic Aerodynamics Research Tunnel | 720B |
| *112. Instron, 20-KIP Fatigue Test Stand #LD1 | 1205 |
| *113. Instron, 20-KIP Fatigue Test Stand #LD2 | 1205 |
| *114. Instron, 20-KIP Fatigue Test Stand #LD3 | 1205 |
| *115. Instron, 20-KIP Fatigue Test Stand #LD4 | 1205 |
| *116. Instron, 20-KIP Fatigue Test Stand #LD5 | 1205 |
| *117. Instron, 20-KIP Fatigue Test Stand #LD6 | 1205 |
| *118. Instron, 20-KIP Fatigue Test Stand #LD7 | 1205 |
| *119. Instron, 20-KIP Fatigue Test Stand #LD8 | 1205 |
| *120. Instron, 20-KIP Fatigue Test Stand #LD9 | 1205 |
| *121. Instron, 20-KIP Fatigue Test Stand #LD10 | 1205 |
| *122. Instron, 50-KIP Fatigue Test Stand #LD11 | 1205 |
| *123. Instron, 50-KIP Fatigue Test Stand #LD12 | 1205 |
| *124. Instron, 50-KIP Fatigue Test Stand #LD13 | 1205 |
| *125. Instron, 50-KIP Fatigue Test Stand #LD14 | 1205 |
| *126. Instron, 50-KIP Fatigue Test Stand #LD15 | 1205 |

ATTACHMENT IV
TO EXHIBIT A

| LABORATORY FACILITY | | BUILDING |
|---|---|---|
| *127. | Instron, 50-KIP Fatigue Test Stand #LD16 | 1205 |
| *128. | Instron, 50-KIP Fatigue Test Stand #LD17 | 1205 |
| *129. | Instron, 50-KIP Fatigue Test Stand #LD18 | 1205 |
| *130. | Instron, 50-KIP Fatigue Test Stand #LD19 | 1205 |
| *131. | Instron, 50-KIP Fatigue Test Stand #LD20 | 1205 |
| *132. | Tire Test Rig #1 | 1262 |
| *133. | Tire Test Rig #2 | 1262 |
| *134. | Diagonal Braking Vehicle | 1262 |
| *135. | Instrumented Tire Test Vehicle | 1262 |
| *136. | 18-Ft. Shock Test Machine | 1262 |
| *137. | 120 KIP Emery/Baldwin Test Machine | 1262 |
| *138. | 10 KIP Digital Tinius Olsen Test Machine | 1262 |
| *139. | MTS 810, 22-KIP, Material Test System | 1267 |
| *140. | MTS 312, 110-KIP, Material Test System | 1267 |
| *141. | Applied Test System, Series 3710A Furnace | 1267 |
| *142. | R.I. Controls, Parabolic Clamshell, Radiant Heating Chamber | 1267 |
| *143. | Oriel Corp., Model 66022 Collimated Light Source | 1267 |
| *144. | Agema, Thermovision, Thermal Camera | 1267 |
| *145. | Shore-Western, 500 KIP, Hydraulic Test Stand | 1267 |
| *146. | Clamshell Furnace | 1267 |
| *147. | Furnace and Controller | 1267 |
| *148. | Tape Prepregging Machine | 1293C |
| *149. | LEPEL RF Power Supply | 1238A |

*The Contractor shall add these laboratory-type facilities to the Configuration Management Program.

ATTACHMENT IV
TO EXHIBIT A

# ASBESTOS CONFIGURATION MANAGEMENT FACILITIES LIST

ATTACHMENT V
TO EXHIBIT A

| BLDG. | FACILITY |
|---|---|
| 582,A | Low Turbulence Pressure Tunnel |
| 583 | 26-Inch & 6 X 28-Inch Transonic Tunnel Facility |
| 583A | East Area Rough Storage |
| 584 | Langley Air Force Office Building |
| 640 | 8-Foot Transonic Pressure Tunnel |
| 641 | 8-Foot TPT Office Building |
| 643 | 30 X 60-Foot Tunnel |
| 644 | 12-Foot Low-Speed Tunnel |
| 645 | 20-Foot Vertical Spin Tunnel |
| 645A | Spin Research Office Facility |
| 646 | East Area Compressor Station/Engineering Technology Lab |
| 647 | General Rotor Aeroelasticity Lab |
| 648 | Transonic Dynamics Tunnel/Flutter & Aeroelasticity |
| 720,A,B | Hydrodynamics Research Facility |
| 1120 | Space Environment Effects Lab |
| 1133B | PSCN Earth Station |
| 1146,A,B,C | 16-Foot Transonic Tunnel |
| 1148 | Structures & Materials Lab |
| 1149 | Technology Utilization and Medical Center |
| 1151 | Management Support/Security Services |

ATTACHMENT V
TO EXHIBIT A

| BLDG. | FACILITY |
|---|---|
| 1209 | Facilities and Systems Engineering Building |
| 1212 | Subsonic Tunnels Offices/13-Inch Magnetic Suspension Lab |
| 1212B | High Speed 7 X 10 Foot Tunnel |
| 1212C | 14 X 22 Foot Subsonic Tunnel |
| 1213 | Cafeteria |
| 1215 | West Heating Plant |
| 1218 | Executive Conference Center |
| 1218A | Anechoic Noise Facility |
| 1219 | Headquarters |
| 1220 | Information Systems Research Facility |
| 1221,A,B,D | Hypersonic Propulsion Facility |
| 1222 | H.J.E. Reid Conference Center |
| 1225 | Advanced Machining Development Lab |
| 1228 | Main Gate House/Badge & Pass Office |
| 1229,A | Structural Mechanics & Dynamics Lab |
| 1230 | Instrumentation Research Lab |
| 1231A | Langley Skywatchers Observatory |
| 1232,A,B | Space Technology Lab |
| 1234 | Jet Exit Test Facility |
| 1235 | Frequency Converter Facility |

ATTACHMENT V
TO EXHIBIT A

| BLDG. | FACILITY |
|---|---|
| 1236,A | National Transonic Facility |
| 1237A,B,C | Foundry/Glass Blowing Lab |
| 1238,A | Electronics Technology Lab |
| 1241 | Drive Control Facility |
| 1242,A | 0.3-Meter Transonic Cryogenic Tunnel/Cryo LN2 Tank 5 |
| 1244,C,D | Hangar & Flight Research Office Bldg./Space Station Complex |
| 1247A-D,H | Gas Dynamics Lab Complex |
| 1247E | Compressor Station |
| 1247G | OSD - LOB & TOB Section Office |
| 1248 | Fire Protection Facility |
| 1249 | Environmentally Controlled Warehouse |
| 1251 | Unitary Plan Wind Tunnel & Research Offices |
| 1251A | 31-Inch Mach 10 Tunnel/15-Inch Mach 6 High Temperature Tunnel |
| 1256 | Micrographics & Engineering Drawing Files |
| 1256A | Space Environment Effects Lab |
| 1258 | Landing Loads Compressor & Control Building |
| 1259A | Refrigeration Facility |
| 1262 | Aircraft Landing Dynamics Office/Shop |
| 1263 | 7" HTT DAS Building |
| 1264 | 7-Inch High Temperature Tunnel |
| 1265,A-E | 8-Foot High Temperature Tunnel |
| 1267,A,B | Thermal Structures Laboratory/West |
| 1268 | Data Reduction Center |

ATTACHMENT V
TO EXHIBIT A

| BLDG. | FACILITY |
|---|---|
| 1268A | Flight Simulation Laboratory |
| 1270 | Printed Circuit & Encapsulation Lab |
| 1270B | Composite Storage Building |
| 1271 | Engineering Support Lab #2 |
| 1272 | Engineering Support Lab #3 |
| 1273 | Lidar Lab |
| 1274 | Planetary Entry Radiation Lab |
| 1275 | Radiation Reentry Research Lab |
| 1276 | Lidar Research Lab Storage |
| 1283 | Engineering Lab/Fabrication Lab |
| 1284A | Storage |
| 1284B | Component Verification Facility |
| 1284C | Cloud Chemistry Lab |
| 1292 | Building Trades Shop |
| 1293A | Advanced Composite Materials Lab |
| 1293B | Spacecraft Dynamics Lab |
| 1294 | Engineering Support Lab #1 |
| 1295 | 60-Foot Vacuum Sphere Shop |
| 1296 | Ceramic Spray Shop |
| 1297,A | Impact Dynamics Research Facility |

ATTACHMENT V
TO EXHIBIT A

| BLDG. | FACILITY |
|---|---|
| 1298 | Guidance & Control Research Lab |
| 1299 | Flight Electronics Lab |
| 1300 | Hypersonic Technology Office |
| 1312 | LAFB Liaison Office |

ATTACHMENT V
TO EXHIBIT A

| BLDG. NUMBER | FACILITY NAME |
|---|---|
| 582,A | Low Turbulence Pressure Tunnel |
| 585 | 6 X 19 Inch Transonic Tunnel |
| 640 | 8 Foot Transonic Pressure Tunnel |
| 643* | 30 X 60 Foot Tunnel |
| 648 | Transonic Dynamics Tunnel |
| 1146,A-D* | 16 Foot Transonic Tunnel |
| 1148 | Structures and Materials Lab |
| 1204* | Electrical Systems Section Lab |
| 1205* | Materials Research Lab |
| 1208* | Acoustic Research Lab |
| 1212B* | High Speed 7 X 10 Foot Tunnel |
| 1212C* | 14 X 22 Foot Subsonic Tunnel |
| 1215 | West Heating Plant |
| 1218A* | Anechoic Noise Facility |
| 1220* | Information Systems Research Facility |
| 1221,A-D | Hypersonic Propulsion Facility |
| 1225* | Advanced Machine Development Lab |
| 1230A* | Gas Flow Calibration Lab |
| 1232A | Fabrication Shop |
| 1234 | Jet Exit Test Facility |
| 1236 | National Transonic Facility |

ATTACHMENT VI
TO EXHIBIT A

| BLDG. NUMBER | FACILITY NAME |
|---|---|
| 1242* | 0.3 Meter Transonic Cryogenic Tunnel |
| 1244* | Hangar & Flight Research Office Building |
| 1247A,B,C,D,H | Gas Dynamics Lab Complex |
| 1251 | Unitary Wind Tunnel |
| 1251A | 31 Inch Mach 10 Tunnel |
| 1258*,A* | Landing Loads Comp & Cont Bldg./Jet Valve Bldg. |
| 1264 | 7 Inch High Temperature Tunnel |
| 1265,A-E* | 8 Foot High Temperature Tunnel |
| 1267 | Thermal Structures Lab |
| 1267A | Materials Processing and Development Shop |
| 1268A* | Flight Simulation Lab |
| 1270* | Printed Circuit and Encapsulation Lab |
| 1275 | Radiation Reentry Research Facility |
| 1284B* | Component Verification Building |
| 1287* | Flow Impedance Test Lab |
| 1293B* | Spacecraft Dynamics Lab |
| East Air | East Area High Pressure Air System |
| West Air | West Area High Pressure Air System |

*Documentation requires verification and reformatting.

ATTACHMENT VI
TO EXHIBIT A

# FLIGHT PROJECTS LIST

ATTACHMENT VII
TO EXHIBIT A

1. Clouds and the Earth's Radiant Energy System (CERES)
2. Lidar In-Space Technology Experiment (LITE)
3. Measurements of Air Pollution from Satellites (MAPS)
4. Small Expendable Deployment System (SEDS)
5. Spectroscopy of the Atmosphere Using Far Infrared Emission (SAFIRE)
6. Stratospheric Aerosol and Gas Experiment III (SAGE III)

ATTACHMENT VII
TO EXHIBIT A

# ABBREVIATIONS

ATTACHMENT VIII
TO EXHIBIT A

## ABBREVIATIONS

| | | |
|---|---|---|
| 1. | ASME | American Society of Mechanical Engineers |
| 2. | CCB | Configuration Control Board |
| 3. | CCD | Configuration Controlled Documents |
| 4. | CM | Configuration Management |
| 5. | CNS | Change Notification Sheets |
| 6. | CoF | Construction of Facilities |
| 7. | COTR | Contracting Officer Technical Representative |
| 8. | 8' HTT | 8 FT. High Temperature Tunnel |
| 9. | EPA | Environmental Protection Agency |
| 10. | FAS | Facility Assurance Section |
| 11. | FENGD | Facilities Engineering Division |
| 12. | LaRC | Langley Research Center |
| 13. | LHB | Langley Handbook |
| 14. | LMI | Langley Management Instructions |
| 15. | NASA | National Aeronautics and Space Administration |
| 16. | NDE | Nondestructive Examinations |
| 17. | NHB | NASA Handbook |
| 18. | OSHA | Occupational Safety and Health Administration |
| 19. | PC-File | Personal Computer File |
| 20. | PFRs | Problem Failure Reports |
| 21. | PLC | Programmable Logic Controller |
| 22. | PSCM | Pressure Systems Configuration Management |
| 23. | RMB | Risk Management Branch |
| 24. | SFD | Supporting Facility Document |
| 25. | SSQRD | Systems Safety, Quality, and Reliability Division |

ATTACHMENT VIII
TO EXHIBIT A

EXHIBIT B
CONTRACT DOCUMENTATION REQUIREMENTS

## EXHIBIT B - CONTRACT DOCUMENTATION REQUIREMENTS

I. DOCUMENTATION PREPARATION/SUBMISSION INSTRUCTIONS

A. Financial Management Reports--The Contractor shall comply with the Section I clause of this contract entitled "NASA Contractor Financial Management Reporting" by monthly submission of NASA Form 533M. The form shall be prepared and submitted in accordance with the instructions set forth on the reverse side of the form and NASA Handbook "Procedures for Contractor Reporting of Correlated Cost and Performance Data" (NHB 9501.2) as further definitized below.

1. Due not later than the 10th operating day following the close of the Contractor's accounting month being reported.

2. Columns 7.b. and d. shall be completed using the time-phased financial baseline plan approved as part of the Management and Operations Plan.

3. Columns 8.a. and b. shall be completed using estimates (forecasts) for the succeeding two months.

4. Minimum reporting categories:

To be negotiated

5. Each 533M shall include a narrative explanation for monthly variances exceeding 10 percent between planned hours and dollars and actual hours and dollars for each reporting category.

B. Quarterly Financial Management Report--The Contractor shall submit a quarterly financial report detailed by categories specified in A.4 above on NASA Form 533Q at times and in accordance with the instructions contained on the reverse side of the form.

C. Management and Operations Plan--Within 15 calendar days after contract award, the Contractor shall submit for the Contracting Officer's approval a comprehensive Management and Operations Plan containing, as a minimum, the following:

1. Continuing Plan--Detailed plans for maintaining competent staffing at each organizational level. These plans shall include the methods to be employed in accommodating fluctuating workloads, for backup arrangements to accommodate personnel absences, for personnel training and for recruiting replacements and additional personnel. Include management policies which contribute to employee retention, morale, and productivity, such as career development, fringe benefits, leave, salary, employee recognition, and recognizing and correcting morale problems. Include policies and procedures for recruiting, hiring, training, and career development of disabled persons. Also, include program(s) for motivating and incentivizing employees to continuously improve and increase productivity.

2. Technical Operations Plan--Plans for organizing, assigning resources, and performing each task area outlined in the Statement of Work;

tracking and controlling the work; recognizing and reporting technical problems and schedule slippages and follow-up on reported problems. In addition, include a brief description of: the proposed method of controlling actual versus planned costs; procurement functions to be performed at the Contractor's facility/home office; your purchasing practices and procedures; plans for selecting, monitoring and administering any proposed subcontract effort; and plans for maintaining operational status of Contractor-furnished Items and Government-furnished Equipment.

3. Contractor's Facility--Location, general description, and interior layout of the facility, including lease and/or purchase agreements, the method planned for maintaining full operational capability of the facility.

4. Organization--An organization chart and narrative describing the proposed organization, Contractor/Government interfaces, lines of authority within the organization, and responsibilities and authority of the Key Personnel including a discussion of the proposed managerial authority, autonomy and relationship with the "home office," if applicable.

5. Financial Baseline Plan--A time-phased financial baseline plan, detailing by month how you plan to incur costs for the period, shall be submitted for the first 12-month interval of the total five year contract period. Financial baseline plans for each of the remaining 12-month intervals shall be submitted within 10 days of the anniversary of the effective date of this contract. Financial baseline plan revisions resulting from the exercise of priced option hours shall be submitted 10 days following the effective date of the option being exercised. This plan shall include the periods by the cost categories specified in Paragraph A.4 above. The total estimated cost and level of effort reflected in the baseline plans must equal the contract values for the total contract period.

The Management and Operations Plan shall be updated as required during the contract performance by submission of revised pages for approval of the Contracting Officer.

D. Safety and Health Plan--Within 30 calendar days after the effective date of the contract, the Contractor shall submit a detailed safety and health plan showing how the Contractor intends to protect the life, health, and well being of NASA and Contractor employees as well as property and equipment. This plan, as approved by the Contracting Officer, shall be in accordance with NASA FAR Supplement 18-52.223-73 and should contain, as a minimum, the following:

1. Points of Contact and Responsibility - Organizational flow chart and description of responsibilities of each employee in your organization for safety.

2. Employee Safety Training, Certification and Programs - Detailed information on type of training required, parties responsible for certification, and outline of applicable regulations. Detail company programs which emphasize personal safety and motivated employees to be safety conscious.

3. LaRC Safety Policies/Procedures - Recognition of applicable LaRC safety policies and procedures such as Langley Handbook 1710.10, LaRC Red Tag System.

quarterly. The reporting periods shall end December, March, June, and September with the respect due by the 30th day of the month following the close of the period.

You are further instructed to include the following information in Block 18 of the SF 294. NOTE: This information is a subset of Items 15A and 16 and should also include information obtained from your subcontractors SF 294's.

Subcontract awards to Women-Owned Small Business Concerns this reporting period: $_______________.

Subcontract awards to Historically Black Colleges and Universities and/or Minority Educational Institutions this reporting period: $__________.

M. Skill Mix and Wage Report--Within 30 calendar days after the effective date of this contract, the Contractor shall furnish to the Government a skill mix and wage report that includes company position titles and current hourly rates. Unless new or additional, any company job titles that differ from the Government job titles specified in Attachments 6 and 7 of the RFP shall be cross-referenced to the Government job titles.

Within 30 calendar days after the end of each contract year, the Contractor shall furnish to the Government a follow-up report that includes the foregoing information plus the percentage (if any) each labor rate has escalated since the last report, an explanation by position of those escalations which exceed (*) percent since the last report, and the amount of cash awards or bonuses (if any).

N. FENGD Design Reviews Action Item Status and Summary--The Contractor shall submit a monthly report detailing the status of Action Items submitted during FENGD Design Reviews.

O. Summary of Problem/Failure Report--The Contractor shall submit a quarterly summary report of failures and a yearly analysis of trending data.

II. DOCUMENT DISTRIBUTION REQUIREMENTS--ALTERNATE I (LaRC 52.210-96) (JUN 1988)

A. Unless otherwise specified elsewhere in this contract, reports and other documentation shall be submitted F.O.B. destination as specified below, addressed as follows:

National Aeronautics and Space Administration
Langley Research Center
Attn: ___________________, Mail Stop ____
Contract NAS1-
Hampton, VA 23681-0001

*To be negotiated.

B. The following letter codes designate the recipients of reports and other documentation which are required to be delivered prepaid to Langley Research Center by the Contractor:

A--Contract Specialist, Mail Stop 126

B--Contracting Officer Technical Representative, Mail Stop 437

C--Cost Accounting, Mail Stop 135

D--Safety Manager, Mail Stop 429

E--Industry Relations Office, Mail Stop 105

F--Programs and Resources Division, Mail Stop 104

G--Industrial Property Office, Mail Stop 377

H--Industry Assistance Office, Mail Stop 144

I--According to instructions on form

C. The following are the distribution requirements for reports and other documentation required with the numeral following the letter code specifying the number of copies to be provided:

| DOCUMENT | LETTER CODE AND DISTRIBUTION |
|---|---|
| Financial Management Report (NASA Forms 533M and 533Q) | A-1, B-1, C-2, D-1, E-1, F-1 |
| Management and Operations Plan and Revisions | A-1, B-3 |
| Safety and Health Plan and Revisions | A-1, B-1, D-1 |
| Quarterly Technical Progress Report | A-1, B-1, D-1 |
| Quarterly Accident/Injury Report | A-1, B-1, D-1 |
| Conformable Wage Rate Agreement | A-1, B-1, E-1 |
| Report of Government-Owned/Contractor-Held Property (NASA Form 1018) | A-1, B-1, G-2 |
| Subcontracting Report for Individual Contracts (Standard Form 294) | A-1, H-1 |
| Summary Subcontractor Report (Standard Form 295) | A-1, H-1, I |
| Report on NASA Subcontracts (NASA Form 667) | A-1, H-1, I |

# EXHIBIT C

## INSTALLATION-PROVIDED GOVERNMENT PROPERTY

# EXHIBIT C

## INSTALLATION-PROVIDED GOVERNMENT PROPERTY

Installation-Provided Government Property that will be provided to the Contractor on-site at Langley Research Center.

| ITEM | QUANTITY |
|---|---|
| Bookcase | 4 |
| Chair, Office | 4 |
| Chair, Side | 4 |
| Desk, Office | 4 |
| Desk, Computer | 3 |
| Drawing Rack | 5 |
| File Cabinet | 18 |
| Lamp, Desk | 3 |
| Table, 30" X 60" | 1 |
| Table, Printer | 1 |

EXHIBIT D

SUBCONTRACTING PLAN
(To be incorporated at contract award.)

EXHIBIT E

REGISTER OF WAGE DETERMINATION AND FRINGE BENEFITS

U.S. DEPARTMENT OF LABOR
EMPLOYMENT STANDARDS ADMINISTRATION
WAGE AND HOUR DIVISION
WASHINGTON, D.C. 20210

REGISTER OF WAGE DETERMINATIONS UNDER
THE SERVICE CONTRACT ACT
By direction of the Secretary of Labor

Alan L. Moss
Director

Division of
Wage Determinations

| LOCALITY | State: Virginia |
|---|---|
| | Area: VA COUNTIES: HAMPTON |

Wage Determination No.: 78-1030 (Rev. 23) Date: 08/08/1992

| Class of Service Employees | Minimum Hourly Wage | Fringe Benefit Payments | | | |
|---|---|---|---|---|---|
| | | Health & Welfare | Vacation | Holiday | Other |

Employed on contracts for Administrative, Clerical, and Technical services at NASA Langley Research Center in the above locality:

| | |
|---|---|
| 1. Accounting Clerk I | $ 6.55 |
| 2. Accounting Clerk II | $ 8.21 |
| 3. Accounting Clerk III | $ 8.55 |
| 4. Accounting Clerk IV | $ 10.37 |
| 5. File Clerk I | $ 5.17 |
| 6. File Clerk II | $ 5.73 |
| 7. File Clerk III | $ 6.99 |
| 8. Inventory Clerk | $ 5.39 |
| 9. Messenger | $ 5.62 |
| 10. Order Clerk I | $ 6.36 |
| 11. Order Clerk II | $ 8.34 |
| 12. Payroll Clerk | $ 7.50 |
| 13. Receptionist | $ 6.09 |
| 14. Secretary I | $ 7.50 |
| 15. Secretary | $ 8.67 |
| 16. Secretary III | $ 9.23 |
| 17. Secretary IV | $ 10.13 |
| 18. Secretary V | $ 10.58 |
| 19. Stenographer I | $ 7.63 |
| 20. Stenographer II | $ 8.56 |

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U.S. DEPARTMENT OF LABOR
EMPLOYMENT STANDARDS ADMINISTRATION
WAGE AND HOUR DIVISION
WASHINGTON, D.C. 20210

REGISTER OF WAGE DETERMINATIONS UNDER THE SERVICE CONTRACT ACT
By direction of the Secretary of Labor

Alan L. Moss
Director

Division of
Wage Determinations

LOCALITY
State: Virginia
Area: VA COUNTIES: HAMPTON

Wage Determination No.: 78-1030 (Rev. 23) Date: 08/08/1992

| Class of Service Employees | Minimum Hourly Wage | Fringe Benefit Payments | | | |
|---|---|---|---|---|---|
| | | Health & Welfare | Vacation | Holiday | Other |
| 21. Switchboard Operator | $ 6.34 | | | | |
| 22. Switchboard Operator-Receptionist | $ 6.65 | | | | |
| 23. Typist I | $ 6.41 | | | | |
| 24. Typist II | $ 7.67 | | | | |
| 25. Word Processor I | $ 6.43 | | | | |
| 26. Word Processor II | $ 7.97 | | | | |
| 27. Computer Data Librarian | $ 7.47 | | | | |
| 28. Computer Operator I | $ 7.73 | | | | |
| 29. Computer Operator II | $ 9.06 | | | | |
| 30. Computer Operator III | $ 10.84 | | | | |
| 31. Computer Operator IV | $ 12.46 | | | | |
| 32. Computer Programmer I 4/ | $ 10.92 | | | | |
| 33. Computer Programmer II 4/ | $ 13.50 | | | | |
| 34. Computer Programmer III 4/ | $ 16.03 | | | | |
| 35. Computer Systems Analyst I 4/ | $ 14.65 | | | | |
| 36. Computer Systems Analyst II 4/ | $ 16.57 | | | | |
| 37. Computer Systems Analyst III 4/ | $ 19.34 | | | | |
| 38. Key Entry Operator I | $ 6.35 | | | | |
| 39. Key Entry Operator II | $ 7.86 | | | | |
| 40. Peripheral Equipment Operator | $ 7.22 | | | | |
| 41. Aircraft Mechanic | $ 13.09 | | | | |
| 42. Aircraft Sheetmetal Mechanic | $ 13.09 | | | | |
| 43. Aircraft Worker | $ 11.96 | | | | |
| 44. Drafter I | $ 7.01 | | | | |

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U.S. DEPARTMENT OF LABOR
EMPLOYMENT STANDARDS ADMINISTRATION
WAGE AND HOUR DIVISION
WASHINGTON, D.C. 20210

REGISTER OF WAGE DETERMINATIONS UNDER THE SERVICE CONTRACT ACT

By direction of the Secretary of Labor

Alan L. Moss, Director
Division of Wage Determinations

LOCALITY — State: Virginia
Area: VA COUNTIES: HAMPTON

Wage Determination No.: 78-1030 (Rev. 23) Date: 08/08/1992

| Class of Service Employees | Minimum Hourly Wage | Fringe Benefit Payments: Health & Welfare | Vacation | Holiday | Other |
|---|---|---|---|---|---|
| 45. Drafter II | $ 8.74 | | | | |
| 46. Drafter III | $ 10.65 | | | | |
| 47. Drafter IV | $ 13.36 | | | | |
| 48. Drafter V | $ 16.25 | | | | |
| 49. Illustrator I | $ 7.09 | | | | |
| 50. Illustrator II | $ 8.84 | | | | |
| 51. Illustrator III | $ 10.77 | | | | |
| 52. Technician I | $ 8.21 | | | | |
| 53. Technician II | $ 10.16 | | | | |
| 54. Technician III | $ 12.24 | | | | |
| 55. Photo Lab Techician | $ 8.06 | | | | |
| 56. Emergency Medical Technician 4/ | $ 10.00 | | | | |
| 57. Registered Industrial Nurse 4/ | $ 13.39 | | | | |
| Fringe benefits applicable to all classes of service employees engaged in contract performance: | | 1/ | 2/ | 3/ | |

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1/ HEALTH & WELFARE: Life, accident, and health insurance plans, sick leave, pension plans, civic and personal leave, severance pay, and savings and thrift plans: Employer contributions costing an average of $2.23 per hour computed on the basis of all hours worked by service employees employed on the contract.

2/ VACATION: 2 weeks paid vacation after 1 year of service with a contractor or successor; 3 weeks after 10 years of service. Length of service includes the whole span of continuous service with the present (successor) contractor, wherever employed, and with the predecessor contractors in the performance of similar work at the same Federal facility. (Reg. 4.173)

3/ HOLIDAYS: 10 paid holidays per year: New Year's Day, Martin Luther King Jr.'s Birthday, Washington's Birthday, Memorial Day, Independence Day, Labor Day, Columbus Day, Veterans' Day, Thanksgiving Day, and Christmas Day. (A contractor may substitute for any of the name holidays another day off with pay in accordance with a plan communicated to the employees involved.)

4/ The term "Service employee" does not include any employee who qualifies as an executive, administrative, or professional employee as those terms are identified in Regulations, Part 541, issued under the Fair Labor Standards Act. (See CFR, Part 541).

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NOTE: The contracting officer shall require that any class of service employee which is not listed herein and which is to be employed under the contract (i.e., the work to be performed is not performed by any classification listed in the wage determination), be classified by the contractor so as to provide a reasonable relationship (i.e., appropriate level of skill comparison) between such unlisted classifications and the classifications listed in the wage determination. Such conformed classes of employees shall be paid the monetary wages and furnished the fringe benefits as are determined. Such conforming procedures shall be initiated by the contractor prior to the performance of contract work by such unlisted class(es) of employees. A written report of the proposed conforming action, including information regarding the agreement or disagreement of the authorized representative of the employees involved or, where there is no authorized representative, the employees themselves, shall be submitted by the contractor to the contracting officer no later than 30 days after such unlisted class(es) of employees performs any contract work. The contracting officer shall review the proposed action and promptly submit a report of the action, together with the agencys' recommendation and all pertinent information including the position of the contractor and the employees, to the Wage and Hour Division, Employment Standards Administration, U.S. Department of Labor, for review. (See section 4.6 (b)(2) of Regulations 29 CFR 4)

UNIFORM ALLOWANCE: If employees are required to wear uniforms in the performance of this contract (either by the terms of the Government contract, by the employer, by the state or local law, etc.), the cost of furnishing such uniforms and maintaining (by laundering or dry cleaning) such uniforms is an expense that may not be borne by an employee where such cost reduces the hourly rate below that required by the wage determination. The Department of Labor will accept payment in accordance with the following standards as compliance:

The contractor or subcontractor is required to furnish all employees with an adequate number of uniforms without cost or to reimburse employees for the actual cost of the uniforms. In addition, where uniform cleaning and maintenance is made the responsibility of the employee, all contractors and subcontractors subject to this wage determination shall (in the absence of a bona fide collective bargaining agreement providing for a different amount, or the furnishing of contrary affirmative proof as to the actual cost), reimburse all employees for such cleaning and maintenance at a rate of $3.80 a week (or 76 cents a day); and effective April 1, 1991, the note shall be $4.25 per week (or $.85 cents per day). However, in those instances where the uniforms furnished are made of "wash and wear" materials, may be routinely washed and dried with other personal garments, and do not require any special treatment such as dry cleaning, daily washing, or commercial laundering in order to meet the cleanliness or appearance standards set by the terms of the Government contract, by the contractor, by law, or by the nature of the work, there is no requirement that employees be reimbursed for uniform maintenance costs.

OTE: The duties of employees under job titles listed are those described in the Service Contract ct Directory of Occupations, Second Edition, July 1986, unless otherwise indicated. See also 29 FR Part 4 Section 4.152.

****************** OCCUPATIONS NOT INCLUDED IN THE SCA DIRECTORY OF OCCUPATIONS ******************

HOTO LAB TECHNICIAN

he photo lab technician must be able to process and evaluate the quality of the exposed rolls of erial film, annotate the film with required identifying numbers and letters, make and process ontact prints from aerial film, and make to scale project photoindexes of the mosaicked strips of erial photography by use of a copy camera.

# Appendix B. Occupational Descriptions

The primary purpose of preparing job descriptions for the Bureau's wage surveys is to assist its field representatives in classifying into appropriate occupations workers who are employed under a variety of payroll titles and different work arrangements from establishment to establishment and from area to area. This permits grouping of occupational wage rates representing comparable job content. Because of this emphasis on comparability of occupational content, the Bureau's job descriptions may differ significantly from those in use in individual establishments or those prepared for other purposes. In applying these job descriptions, the Bureau's field representatives are instructed to exclude working supervisors; apprentices; and part-time, temporary, and probationary workers. Handicapped workers whose earnings are reduced because of their handicap are also excluded. Learners, beginners, and trainees, unless specifically included in the job description, are excluded.

The titles in this appendix are taken from the 1980 edition of the *Standard Occupational Classification Manual (SOC)* , issued by the U.S. Department of Commerce, Office of Federal Statistical Policy and Standards.

In general, the Bureau of Labor Statistics' occupational descriptions are much more specific than those found in the SOC manual. The BLS occupation, "Registered Industrial Nurse," for example, is limited to workers providing medical assistance and other related services (e.g., health education) to persons who are ill or become ill or suffer an injury in a factory or other establishment. The SOC occupation (code 29) includes a variety of registered nurses (e.g., school nurse, head nurse, general duty nurse, private duty nurse) that are excluded from the BLS description.

Thus, in comparing the results of this survey with other sources, factors such as differences in occupational definitions and survey scope should be taken into consideration.

## Office

SECRETARY

Provides principal secretarial support in an office, usually to one individual, and, in some cases, also to the subordinate staff of that individual. Maintains a close and highly responsive relationship to the day-to-day activities of the supervisor and staff. Works fairly independently, receiving a minimum of detailed supervision and guidance. Performs varied clerical and secretarial duties requiring a knowledge of office routine and an understanding of the organization, programs, and procedures related to the work of the office.

*Exclusions.* Not all positions that are titled "secretary" possess the above characteristics. Examples of positions which are excluded from the definition are as follows:

a. Clerks or secretaries working under the direction of secretaries or administrative assistants as described in e;
b. Stenographers not fully performing secretarial duties;
c. Stenographers or secretaries assigned to two or more professional, technical, or managerial persons of equivalent rank.
d. Assistants or secretaries performing any kind of technical work, e.g., personnel, accounting, or legal

work;

e. Administrative assistants or supervisors performing duties which are more difficult or more responsible than the secretarial work described in LR-1 through LR-4.
f. Secretaries receiving additional pay primarily for maintaining confidentiality of payroll records or other sensitive information;
g. Secretaries performing routine receptionist, typing, and filing duties following detailed instructions and guidelines; these duties are less responsible than those described in LR-1 below;
h. Trainees

*Classification by level.* Secretary jobs which meet the required characteristics are matched at one of five levels according to two factors: (a) Level of the secretary's supervisor within the overall organizational structure, and (b) level of the secretary's responsibility. The table following the explanations of these factors indicates the level of the secretary for each combination of factors.

*Level of Secretary's Supervisor (LS)*

Secretaries should be matched at one of the three LS levels below best describing the organization of the secretary's supervisor.

LS-1 Organizational structure is not complex and internal procedures and administrative controls are simple and informal: supervisor directs staff through face-to-face meetings.

LS-2 Organizational structures is complex and is divided into subordinate groups that usually differ from each other as to subject matter, function, etc.; supervisor usually directs staff through intermediate supervisors; internal procedures and administrative controls are formal. An entire organization (e.g., division, subsidiary, or parent organization) may contain a variety of subordinate groups which meet the LS-2 definition. Therefore, it is not unusual for one LS-2 supervisor to report to another LS-2 supervisor. The presence of subordinate supervisors does not by itself mean LS-2 applies, e.g., a clerical processing organization divided into several units, each performing very similar work, is placed in LS-1. In smaller organizations or industries such as retail trades, with relatively few organizational levels, the supervisor may have an impact on the policies and major programs of the entire organization, and may deal with important outside contacts as described in LS-3.

LS-3 Organizational structure is divided into two or more subordinate supervisory levels (of which at least one is a managerial level) with several subdivisions at each level. Executive's program(s) are usually interlocked on a direct and continuing basis with other major organizational segments requiring constant attention to extensive formal coordination, clearances and procedural controls. Executive typically has: Financial decision making authority for assigned program(s); considerable impact on the entire organization's financial position or image; and responsibility for, or has staff specialists in, such areas as personnel and administration for assigned organization. Executive plays an important role in determining the policies and major programs of the entire organization, and spends considerable time dealing with outside parties actively interested in assigned program(s) and current or contraversial issues.

*Level of Secretary's Responsibility (LR)*

This factor evaluates the nature of the work relationship between the secretary and the supervisor or staff, and the extent to which the secretary is expected to exercise initiative and judgment. Secretaries should be matched at the level best describing their level of responsibility. When a position's duties span more than one LR level, the introductory paragraph at the beginning of each LR level should be used to determine which of the levels best matches the position. (Typically, secretaries performing at the higher levels of responsibility also perform duties described at the lower levels.)

LR-1 Carries out recurring office procedures independently. Selects the guideline or reference which fits the specific case. Supervisor provides specific instructions on new assignments and checks completed work for accuracy. Performs varied duties including or comparable to the following:

a. Responds to routine telephone requests which have standard answers; refers calls and visitors to appropriate staff. Controls mail and assures timely staff response; may send form letters.
b. As instructed, maintains supervisor's calendar, makes appointments, and arranges for meeting rooms.
c. Reviews materials prepared for supervisor's approvals for typographical accuracy and proper format.
d. Maintains recurring internal reports, such as time and leave records, office equipment listings, correspondence controls, training plans, etc.
e. Requisitions supplies, printing, maintenance, or other services. Types, takes and transcribes dictation, and establishes and maintains office files.

LR-2 Handles differing situations, problems, and deviations in the work of the office according to the supervisor's general instructions, priorities, duties, policies, and program goals. Supervisor may assist secretary with special assignments. Duties include or are comparable to the following:

a. Screens telephone calls, visitors, and incoming correspondence; personally responds to requests for information concerning office procedures; determines which requests should be handled by the supervisor, appropriate staff member, or other offices. May prepare and sign routine, nontechnical correspondence in own or supervisor's name.
b. Schedules tentative appointments without prior clearance. Makes arrangements for conferences and meetings and assembles established background materials, as directed. May attend meetings and record and report on the proceedings.
c. Reviews outgoing materials and correspondence for internal consistency and conformance with supervisor's procedures; assures that proper clearances have been obtained, when needed.
d. Collects information from the files or staff for routine inquiries on office program(s) or periodic reports. Refers nonroutine requests to supervisor or staff.
e. Explains to subordinate staff supervisor's requirements concerning office procedures. Coordinates personnel and administrative forms for the office and forwards for processing.

LR-3 Uses greater judgment and initiative to determine the approach or action to take in nonroutine situations. Interprets and adapts guidelines, including unwritten policies, precedents, and practices, which are not always completely applicable to changing situations. Duties include or are comparable to the following:

a. Based on a knowledge of the supervisor's views, composes correspondence on own initiative about administrative matters and general office policies for supervisor's approval.

b. Anticipates and prepares materials needed by the supervisor for conferences, correspondence, appointments, meetings, telephone calls, etc., and informs supervisor on matters to be considered.

c. Reads publications, regulations, and directives and takes action or refers those that are important to the supervisor and staff.

d. Prepares special or one-time reports, summaries, or replies to inquiries, selecting relevant information from a variety of sources such as reports, documents, correspondence, other offices, etc., under general directions.

e. Advises secretaries in subordinate offices on new procedures, requests information needed from the subordinate offices for periodic or special conferences, reports, inquiries, etc. Shifts clerical staff to accommodate workload needs.

LR-4 Handles a wide variety of situations and conflicts involving the clerical or administrative functions of the office which often cannot be brought to the attention of the executive. The executive sets the overall objectives of the work. Secretary may participate in developing the work deadlines. Duties include or are comparable to the following:

a. Composes correspondence requiring some understanding of technical matters; may sign for executive when technical or policy content has been authorized.

b. Notes commitments made by executive during meetings and arranges for staff implementation. Own initiative, arranges for staff member to represent organization at conferences and meetings, establishes appointment priorities, or reschedules or refuses appointments or invitations.

c. Reads outgoing correspondence for executive's approval and alerts writers to any conflict with the file or departure from policies or executive's viewpoints; gives advice to resolve the problems.

d. Summarizes the content of incoming materials, specially gathered information, or meetings to assist executive; coordinates the new information with background office sources, draws attention to important parts or conflicts.

e. In the executive's absence, ensures that requests for action or information are relayed to the appropriate staff member; as needed, interprets request and helps implement action; makes sure that information is furnished in a timely manner; decides whether executive should be notified of important or emergency matters.

Exclude secretaries performing any of the following duties: Acts as office manager for the executive's organization, e.g., determines when new procedures are needed for changing situations and devises and implements alternatives; revises or clarifies procedures to eliminate conflict or duplication; identifies and resolves various problems that affect the orderly flow of work in transactions with parties outside the organization. Prepares agenda for conferences; explains discussion topics to participants; drafts introduction and develops background information and prepares outlines for executive or staff members to use in writing speeches. Advises individuals outside the organization on the executive's views on major policies or current issues facing the organization; contacts or responds to contacts from high-ranking outside officials (e.g., city or State officials, members of Congress, presidents of national unions or large national or international firms, etc.) in unique situations. These officials may be relatively inaccessible, and each contact typically must be handled differently, using judgment and discretion.

Criteria for Matching Secretaries by Level

| Level of Secretary's Supervisor | Level of Secretary's Responsibility | | | |
|---|---|---|---|---|
| | LR-1 | LR-2 | LR-3 | LR-4 |
| LS-1 | I* | II | III | IV |
| LS-2 | I* | III | IV | V |
| LS-3 | I* | IV | V | V |

* Regardless of LS Level

STENOGRAPHER

Primary duty is to take dictation using shorthand, and to transcribe the dictation. May also type from written copy. May operate from a stenographic pool. May occasionally transcribe from voice recordings. (If primary duty is transcribing from recordings, see Transcribing-machine typist.)

Excluded from this definition are:

a. Trainee positions not requiring a fully qualified stenographer.

b. Secretaries providing the principal secretarial support in an office and performing more responsible and discretionary tasks, as described in LR-1 through LR-4 in the secretary definition above.

c. Stenographers who take dictation involving the frequent use of a wide variety of technical or specialized vocabulary. Typically this kind of vocabulary cannot be learned in a relatively short period of time, e.g., a month or two.

d. Stenographers, such as shorthand reporters, who record material verbatim at hearings, conferences, or similar proceedings.

Stenographer I

Takes and transcribes dictation, receiving specific assignments along with detailed instructions on such requirements as form and presentation. The transcribed material is typically reviewed in rough draft, and the final transcription is reviewed for conformance with the rough draft. May maintain files, keep simple records, or perform other relatively routine clerical tasks.

Stenographer II

Takes and transcribes dictation determining the most appropriate format. Performs stenographic duties requiring significantly greater independence and responsibility than Stenographer I. Supervisor typically provides general instructions. Work requires a thorough working knowledge of general business and office procedures and of the specific telecommunications capabilities, and also have capabilities for adding to or upgrading features. Automatic or electronic typewriters with limited text editing capabilities and often with single line electronic display "windows" are not considered word processing equipment.)

Excluded from this definition are:

a. Workers whose primary function is to enter a data base for purposes other than composition (see key entry operator);
b. Workers who use equipment and data base for purposes such as accounting, inventory control, sales, or original writing and editing;
c. Workers responsible for preparation of published reports; including page layout or selection of different type sizes.

Positions are classified into levels on the basis of the following definitions:

Word Processor I

Performs tasks requiring a knowledge of the word processing equipment and familiarity with the formats and forms used in the establishment. Proficiency in grammar, spelling, and punctuation is also required to produce printed materials accurately. May refer problems to supervisor or higher level processor, or refer to operating manual.

Word Processor II

Work at this level requires considerable classroom or on-the-job training and may involve working directly with task originator rather than through supervisor. In addition to work assignments described for level I, duties include one or more of the following:

a. Uses the more sophisticated features of the equipment to carry out complex assignments, such as sorting, merging, and organizing text, or maintaining files;
b. Applies knowledge of specialized terminology or foreign language;
c. Tests new applications and procedures; or
d. Trains lower level processors.

FILE CLERK

Files, classifies, and retrieves material in an established filing system. May perform clerical and manual tasks required to maintain files. Positions are classified into levels on the basis of the following definitions:

File Clerk I

Performs routine filing of material that has already been classified or which is easily classified in a simple serial classification system (e.g., alphabetical, chronological, or numerical). As requested, locates readily available material in files and forwards material; may fill out withdrawal charge. May perform simple clerical and manual tasks required to maintain and service files.

File Clerk II

Sorts, codes, and files unclassified material by simple (subject matter) headings or partly classified material by finer subheadings. Prepares simple related index and cross-reference aids. As requested, locates clearly identified material in files and forwards material. May perform related clerical tasks required to maintain and service files.

File Clerk III

Classifies and indexes file material such as correspondence, reports, technical documents, etc., in an established filing system containing a number of varied subject matter files. May also file this material. May keep records of various types in conjunction with the files. May lead a small group of lower level file clerks.

MESSENGER

Performs various routine duties such as running errands, operating minor office machines such as sealers or mailers, opening mail, distributing mail on a regularly scheduled route or in a familiar area, and other minor clerical work. May deliver mail that requires some special handling, e.g., mail that is insured, registered, or marked for special delivery.

Excluded are positions which include any of the following as significant duties:

a. Operating motor vehicles.
b. Delivering valuables or security-classified mail when the work requires a continuing knowledge of special procedures for handling such items.
c. Weighing mail, determining postage, or recording and controlling registered, insured, and certified mail in the mail room.
d. Making deliveries to unfamiliar or widely separated buildings or points which are not part of an established route; or
e. Directing other workers.

RECEPTIONIST

Greets visitors, determines nature of visits, and directs visitors to appropriate persons. Receptionist duties may also include providing formation, making appointments, answering a telephone (other than switchboard or console), keeping a log of visitors, and issuing visitor passes. May also perform typing or other routine clerical duties which may occupy a major portion of time, and are usually performed at the reception desk.

This classification excludes workers operating a telephone switchboard or console, performing guard duties, or performing more difficult clerical duties.

SWITCHBOARD OPERATOR

Operates a telephone switchboard or console used with a private branch exchange (PBX) system to relay incoming, outgoing, and intrasystem calls. May provide information to callers, record and transmit messages, keep record of calls placed and toll charges. Besides operating a telephone switchboard or console, may also type or perform routine clerical work (typing or routine clerical work may occupy the major portion of the worker's time, and is usually performed while at the switchboard or console). Chief or lead operators in establishments employing more than one operator are excluded. For an operator who also acts as a receptionist, see Switchboard operator-receptionist.

SWITCHBOARD OPERATOR-RECEPTIONIST

At a single position telephone switchboard or console, acts both as an operator--see Switchboard operator--and as a receptionist. Receptionist's work involves such duties as greeting visitors, determining nature of visitor's business and providing appropriate information; referring visitor to appropriate person in the organization or contacting that person by telephone and arranging an appointment; keeping a log of visitors.

INVENTORY CLERK

A person who keep periodic or perpetual records of the amount, kind, and value of merchandise, material, or stock on hand; makes an actual physical count of the stock items; compares inventories taken by other workers with office records, or check sales, equipment, shipping, production, purchases and stock records; checks clerical computations with physical count of stock, adjusting errors in computations or count; makes up inventory reports. May operate an adding machine.

ORDER CLERK

Receives written or verbal customer's purchase orders for material or merchandise from customers or sales people. Work typically involves some combination of the following duties: Quoting prices; determining availability of ordered items and suggesting substitutes when necessary; advising expected delivery date and method of delivery; recording order and customer information on order sheets; checking order sheets for accuracy and adequacy of information recorded; ascertaining credit rating of customer; furnishing customer with acknowledgment of receipt of order; following up to see that order is delivered by the specified date or to let customer know of a delay in delivery; maintaining order file; checking shipping invoice against original order. Exclude workers paid on a commission basis or whose duties include any of the following: Receiving orders for services rather than for material or merchandise; providing customers with consultative advice using knowledge gained from engineering or extensive technical training; emphasizing selling skills; handling material or merchandise as an integral part of the job.

Positions are classified into levels according to the following definitions:

Order Clerk I

Handles orders involving items which have readily identified uses and applications. May refer to a catalog, manufacturer's manual, or similar document to insure that proper item is supplied or to verify price of ordered item.

Order Clerk II

Handles orders that involve making judgments such as choosing which specific product or material from the establishment's product lines will satisfy the customer's needs, or determining the price to be quoted when pricing involves more than merely referring to a price list or making some simple mathematical calculations.

ACCOUNTING CLERK

Performs one or more accounting tasks such as posting to registers and ledgers; balancing and reconciling accounts; verifying the internal consistency, completeness, and mathematical accuracy of accounting documents; assigning prescribed accounting distribution codes; examining and verifying the clerical accuracy of various types of reports, lists, calculations, posting, etc.; preparing journal vouchers; or making entries or adjustments to accounts.

Levels I and II require a basic knowledge of routine clerical methods and office practices and procedures as they relate to the clerical processing and recording of transactions and accounting information. Levels III and IV require a knowledge and understanding of the established and standardized bookkeeping and accounting procedures and techniques used in an accounting system, or a segment of an accounting system, where there are few variations in the types of transactions handled. In addition, some jobs at each level may require a basic knowledge and understanding of the terminology, codes, and processes used in an automated accounting system.

Accounting Clerk I

Performs very simple and routine accounting clerical operations, for example, recognizing and comparing easily identified numbers and codes on similar and repetitive accounting documents, verifying mathematical accuracy, and identifying discrepancies and bringing them to the supervisor's attention. Supervisor gives clear and detailed instructions for specific assignments. Employee refers to supervisor all matters not covered by instructions. Work is closely controlled and reviewed in detail for accuracy, adequacy, and adherence to instructions.

Accounting Clerk II

Performs one or more routine accounting clerical operations, such as: Examining, verifying, and correcting accounting transactions to ensure completeness and accuracy of data and proper identification of accounts, and checking that expenditures will not exceed obligations in specified accounts; totaling, balancing, and reconciling collection vouchers; posting data to transaction sheets where employee identifies proper accounts and items to be posted; and coding documents in accordance with a chart (listing) of accounts. Employee follows specific and detailed accounting procedures. Completed work is reviewed for accuracy and compliance with procedures.

Accounting Clerk III

Uses a knowledge of double entry bookkeeping in performing one or more of the following: Posts actions to journals, identifying subsidiary accounts affected and debit and credit entries to be made and assigning proper codes; reviews computer printouts against manually maintained journals, detecting and correcting erroneous postings, and preparing documents to adjust accounting classifications and other data; or reviews lists of transactions rejected by an automated system, determining reasons for rejections, and preparing necessary correcting material. On routine assignments, employee selects and applies established procedures and techniques. Detailed instructions are provided for difficult or unusual assignments. Completed work and methods used are reviewed for technical accuracy.

Accounting Clerk IV

Maintains journals or subsidiary ledgers of an accounting system and balances and reconciles accounts. Typical duties include one or both of the following: Reviews invoices and statements (verifying information, ensuring sufficient funds have been obligated, and if questionable, resolving with the submitting unit, determining accounts involved, coding transactions, and processing material through data processing for application in the accounting system); and/or analyzes and reconciles computer printouts with operating unit reports (contacting units and research causes of discrepancies, and taking action to ensure that accounts balance). Employee resolves problems in recurring assignments in accordance with previous training and experience. Supervisor provides suggestions for handling unusual or nonrecurring transactions. Conformance with requirements and technical soundness of completed work are reviewed by the supervisor or are controlled by mechanisms built into the accounting system.

NOTE: Excluded from level IV are positions responsible for maintaining either a general ledger or a general ledger in combination with subsidiary accounts.

PAYROLL CLERK

Performs the clerical tasks necessary to process payrolls and to maintain payroll records. Work involves most of the following: Processing workers' time or production records; adjusting workers' records for changes in wage rates, supplementary benefits, or tax deductions, editing payroll listings against source records; tracing and correcting errors in listings; and assisting in preparation of periodic summary payroll reports. In a nonautomated payroll system, computes wages. Work may require a practical knowledge of governmental regulations, company payroll policy, or the computer system for processing payrolls.

KEY ENTRY OPERATOR

Operates keyboard-controlled data entry device such as keypunch machine or key-operated magnetic tape or disk encoder to transcribe data into a form suitable for computer processing. Work requires skill in operating an alphanumeric keyboard and an understanding of transcribing procedures and relevant data entry equipment.

Positions are classified into levels on the basis of the following definitions:

Key Entry Operator I

Work is routine and repetitive. Under close supervision or following specific procedures or detailed instructions, works from various standardized source documents which have been coded and require little or no selecting, coding, or interpreting of data to be entered. Refers to supervisor problems arising from erroneous items, codes, or missing information.

Key Entry Operator II

Work requires the application of experience and judgment in selecting procedures to be followed and in searching for, interpreting, selecting, or coding items to be entered from a variety of source documents. On occasion may also perform routine work as described for level I.

NOTE: Excluded are operators above level II using the key entry controls to access, read, and evaluate the substance of specific records to take substantive actions, or to make entries requiring a similar level of knowledge.

## Professional and Technical

### COMPUTER SYSTEMS ANALYST, BUSINESS

Analyzes business problems to formulate procedures for solving them by use of electronic data processing equipment. Develops a complete description of all specifications needed to enable programmers to prepare required digital computer programs. Work involves most of the following: Analyzes subject matter operations to be automated and identifies conditions and criteria required to achieve satisfactory results; specifies number and types of records, files, and documents to be used; outlines actions to be performed by personnel and computers in sufficient detail for presentation to management and for programming (typically this involves preparation of work and data flow charts): coordinates the development of test problems and participates in trial runs of new and revised systems; and recommends equipment changes to obtain more effective overall operations. (NOTE: Workers performing both systems analysis and programming should be classified as systems analysts if this is the skill used to determine their pay.)

Does not include employees primarily responsible for the management or supervision of other electronic data processing employees, or systems analysts primarily concerned with scientific or engineering problems.

For wage study purposes, systems analysts are classified as follows:

Computer Systems Analyst I

Works under immediate supervision, carrying out analyses as assigned, usually of a single activity. Assignments are designed to develop and expand practical experience in the application of procedures and skills required for systems analysis work. For example, may assist a higher level systems analyst by preparing the detailed specifications required by programmers from information developed by the higher level analyst.

Computer Systems Analyst II

Works independently or under only general direction on problems that are relatively uncomplicated to analyze, plan, program, and operate. Problems are of limited complexity because sources of input data are homogeneous and the output data are closely related. (For example, develops systems for maintaining depositor accounts in a bank, maintaining accounts receivable in a retail establishment, or maintaining inventory accounts in a manufacturing or wholesale establishment.) Confers with persons concerned to determine the data processing problems and advises subject-matter personnel on the implications of the data processing systems to be applied. OR

Works on a segment of a complex data processing scheme or system, as described for level III. Works independently on routine assignments and receives instruction and guidance on complex assignments. Work is reviewed for accuracy of judgment, compliance with instructions, and to insure proper alignment with the overall system.

Computer Systems Analyst III

Works independently or under only general direction on complex problems involving all phases of systems analysis. Problems are complex because of diverse sources of input data and multiple-use requirements of output data. (For example, develops an integrated production scheduling, inventory control, cost analysis, and sales analysis record in which every item of each type is automatically processed through the full system of records and appropriate follow-up actions are initiated by the computer.) Confers with persons concerned to determine the data processing problems and advises subject-matter personnel on the implications of new or revised systems of data processing operations. Makes recommendations, if needed, for approval of major systems installations or changes and for obtaining equipment.

May provide functional direction to lower level systems analysts who are assigned to assist.

COMPUTER PROGRAMMER, BUSINESS

Converts statements of business problems, typically prepared by a systems analyst, into a sequence of detailed instructions which are required to solve the problems by automatic data processing equipment. Working from charts or diagrams, the programmer develops the precise instructions which, when entered into the computer system in coded language, cause the manipulation of data to achieve desired results. Work involves most of the following. Applies knowledge of computer capabilities, mathematics, logic employed by computers, and particular subject matter involved to analyze charts and diagrams of the problem to be programmed; develops sequence of program steps; writes detailed flow charts to show order in which data will be processed; converts these charts to coded instructions for machine to follow; tests and corrects programs; prepares instructions for operating personnel during production run; analyzes, reviews, and alters programs to increase operating efficiency or adapt to new requirements; maintains records of program development and revisions. (NOTE: Workers performing both systems analysis and programming should be classified as systems analysts if this is the skill used to determine their pay.)

Does not include employees primarily responsible for the management or supervision of other electronic data processing employees, or programmers primarily concerned with scientific and/or engineering problems.

For wage study purposes, programmers are classified as follows:

Computer Programmer I

Makes practical applications of programming practices and concepts usually learned in formal training courses. Assignments are designed to develop competence in the application of standard procedures to routine problems. Receives close supervision on new aspects of assignments; and work is reviewed to verify its accuracy and conformance with required procedures.

Computer Programmer II

Works independently or under only general direction on relatively simple programs, or on simple segments of complex programs. Programs (or segments) usually process information to produce data in two or three varied sequences or formats. Reports and listings are produced by refining, adapting, arraying, or making minor additions to or deletions from input data which are readily available. While numerous records may be processed, the data have been refined in prior actions so that the accuracy and sequencing of data can be tested by using a few routine checks. Typically, the program deals with routine recordkeeping operations. OR

Works on complex programs (as described for level III) under close direction of a higher level programmer or supervisor. May assist higher level programmer by independently performing less difficult tasks assigned, and performing more difficult tasks under fairly close direction. May guide or instruct lower level programmers.

Computer Programmer III

Works independently or under only general direction on complex problems which require competence in all phases of programming concepts and practices. Working from diagrams and charts which identify the nature of desired results, major processing steps to be accomplished, and the relationships between various steps of the problem solving routine; plans the full range of programming actions needed to efficiently utilize the computer system in achieving desired end products.

At this level, programming is difficult because computer equipment must be organized to produce several interrelated but diverse products from numerous and diverse data elements. A wide variety and extensive number of internal processing actions must occur. This requires such actions as development of common operations which can be reused, establishment of linkage points between operations, adjustments to data when program requirements exceed computer storage capacity, and substantial manipulation and resequencing of data elements to form a highly integrated program.

May provide functional direction to lower level programmers who are assigned to assists.

COMPUTER OPERATOR

In accordance with operating instructions, monitors and operates the control console of a digital computer to process data. Executes runs by either serial processing (processes one program at a time) or multiprocessing (processes two or more programs simultaneously). The following duties characterize the work of a computer operator:

a. Studies operating instructions to determine equipment setup needed;
b. Loads equipment with required items (tapes, cards, disks, paper, etc.)
c. Switches necessary auxiliary equipment into system;
d. Starts and operates computer.
e. Responds to operating and computer output instructions;
f. Reviews error messages and makes corrections during operation or refers problems;
g. Maintains operating record.

May test run new or modified programs. May assist in modifying systems or programs. The scope of this definition includes trainees working to become fully qualified computer operators, fully qualified computer operator, and lead operators providing technical assistance to lower level operators. It excludes workers who monitor and operator remote terminals.

For wage study purposes, computer operators are classified as follows:

Computer Operator I

Work assignments are limited to established production runs (i.e., programs which present few operating problems). Assignments may consist primarily of on-the-job training (sometimes augmented by classroom instruction). When learning to run programs, the supervisor or a higher level operator provides detailed written or oral guidance to the operator before and during the run. After the operator has gained experience with a program, however, the operator works fairly independently in applying standard operating or corrective procedures in responding to computer output instructions or error conditions, but refers problems to a higher level operator or the supervisor when standard procedures fail.

Computer Operator II

In addition to established production runs, work assignments include runs involving new programs, applications, and procedures (i.e., situations which require the operator to adapt to a variety of problems). At this level, the operator has the training and experience to work fairly independently in carrying out most assignments. Assignments may require the operator to select from a variety of standard setup and operating procedures. In responding to computer output instructions or error conditions, applies standard operating or corrective procedures, but may deviate from standard procedures when standard procedures fail if deviation does not materially alter the computer unit's production plans. Refers the problem or aborts the program when procedures applied do not provide a solution. May guide lower level operators.

Computer Operator III

In addition to work assignments described for Computer Operator II (see above) the work of Computer Operator III involves at least one of the following:

a. Deviates from standard procedures to avoid the loss of information or to conserve computer time even though the procedures applied materially alter the computer unit's production plans;
b. Tests new programs, applications, and procedures;
c. Advises programmers and subject-matter experts on setup techniques;
d. Assists in (1) maintaining, modifying, and developing operating systems or programs; (2) developing operating instructions and techniques to cover problem situations; and/or (3) switching to emergency backup procedures (such assistance requires a working knowledge of program language, computer features, and software systems).

An operator at this level typically guides lower level operators.

PERIPHERAL EQUIPMENT OPERATOR

Operates peripheral equipment which directly supports digital computer operations. Such equipment is uniquely and specifically designed for computer applications, but need not be physically or electronically connected to a computer. Printers, plotters, card read/punches, tape readers, tape units or drives, disk units or drives, and data display units are examples of such equipment.

The following duties characterize the work of a peripheral equipment operator:

a. Loading printers and plotters with correct paper; adjusting controls for forms, thickness, tension, printing density, and location; and unloading hard copy;
b. Labeling tape reels, disks or card decks;
c. Checking labels and mounting and dismounting designated tape reels or disks on specified units or drives;
d. Setting controls which regulate operation of the equipment;
e. Observing panel lights for warnings and error indications and taking appropriate action;
f. Examining tapes, cards, or other material for creases, tears, or other defects which could cause processing problems.

This classification excludes workers (1) who monitor and operate a control console (see Computer Operator) or a remote terminal, or (2) whose duties are limited to operating decollaters, bursters, separators, or similar equipment.

COMPUTER DATA LIBRARIAN

Maintains library of media (tapes, disks, cards, cassettes) used for automatic data processing applications. The following or similar duties characterize the work of a computer data librarian: Classifying, cataloging, and storing media in accordance with a standardized system; upon proper requests, releasing media for processing; maintaining records of releases and return; inspecting returned media for damage or excessive wear to determine whether or not they need replacing. May perform minor repairs to damaged tapes.

## DRAFTER

Performs drafting work requiring knowledge and skill in drafting methods, procedures, and techniques. Prepares drawings of structures, mechanical and electrical equipment, piping and duct systems and ether similar equipment, systems, and assemblies. Uses recognized systems of symbols, legends, shadings, and lines having specific meanings in drawings. Drawings are used to communicate engineering ideas, designs, and information in support of engineering functions.

The following are excluded when they constitute the primary purpose of the job:

a. Design work requiring the technical knowledge, skill, and ability to conceive or originate designs;
b. Illustrating work requiring artistic ability;
c. Work involving the preparation of charts, diagrams, room arrangements, floor plans, etc.;
d. Cartographic work involving the preparation of maps or plats and related materials, and drawings of geological structures; and
e. Supervisory work involving the management of a drafting program or the supervision of drafters.

Positions are classified into levels on the basis of the following definitions.

### Drafter I

Working under close supervision, traces or copies finished drawings, making clearly indicated revisions. Uses appropriate templates to draw curved lines. Assignments are designed to develop increasing skill in various drafting techniques. Work is spotchecked during progress and reviewed upon completion.

NOTE: Exclude drafters performing elementary tasks while receiving training in the most basic drafting methods.

### Drafter II

Prepares drawings of simple, easily visualized parts of equipment from sketches or marked-up prints. Selects appropriate templates and other equipment needed to complete assignments. Drawings fit familiar patterns and present few technical problems. Supervisor provides detailed instructions on new assignments, gives guidance when questions arise, and reviews completed work for accuracy.

### Drafter III

Prepares various drawings of parts and assemblies, including sectional profiles, irregular or reverse curves, hidden lines, and small or intricate details. Work requires use of most of the conventional drafting techniques and a working knowledge of the terms and procedures of the industry. Familiar or recurring work is assigned in general terms; unfamiliar assignments include information on methods, procedures, sources of information, and precedents to be followed. Simple revisions to existing drawings may be assigned with a verbal explanation of the desired results; more complex revisions are produced from sketches which clearly depict the desired product.

### Drafter IV

Prepares complete sets of complex drawings which include multiple views, detail drawings, and assembly drawings. Drawings include complex design features that require considerable drafting skill to visualize and portray. Assignments regularly require the use of mathematical formulas to compute weights, load capacities, dimensions, quantities of materials, etc. Working from sketches and verbal information supplied by an engineer or designer, determines the most appropriate views, detail drawings, and supplementary information needed to complete assignments. Selects required information from precedents, manufacturers' catalogs, and technical guides. Independently resolves most of the problems encountered. Supervisor or designer may suggest methods of approach or provide advice on unusually difficult problems.

NOTE: Exclude drafters performing work of similar difficulty to that described at this level but who provide support for a variety of organizations which have widely differing functions or requirements.

Drafter V

Works closely with design originators, preparing drawings of unusual, complex or original designs which require a high degree of precision. performs unusually difficult assignments requiring considerable initiative, resourcefulness, and drafting expertise. Assures that anticipated problems in manufacture, assembly, installation, and operation are resolved by the drawings produced. Exercises independent judgment in selecting and interpreting data based on a knowledge of the design intent. Although working primarily as a drafter, may occasionally perform engineering design work in interpreting general designs prepared by others or in completing missing design details. May provide advice and guidance to lower level drafters or serve as coordinator and planner for large and complex drafting projects.

TECHNICIAN

This classification includes various positions described as Electronics Technician, Instrument Technician, Mechanical Technician, Instrumentation Technician, Photo Lab Maintenance Technician, and Photo Optical Technician among others. Works on various types of electronic, optical, mechanical, instrumentation, motion picture and film processing, photo optical, and calibration equipment and related devices by performing on or a combination of the following: Installing, fabricating, maintaining, repairing, overhauling, troubleshooting, modifying, constructing, testing, and operating work requires practical application of technical knowledge of related principles, ability to determine malfunctions and to resolve problems, and skills to maintain equipment in required operating condition.

Positions are classified into levels on the basis of the following definitions.

Class I

Applies working technical knowledge to perform simple or routine tasks in working on various equipment following detailed instructions which cover virtually all procedures. This knowledge may be acquired through assignments designed to increase competence (including classroom training) so that worker can advance to higher level technician.

Receives technical guidance, as required from supervisor or higher level technician. Work is typically spot checked, but is given detailed review when new or advanced assignments are involved. (Assignments may include operational duties.)

Class II

Applies comprehensive technical knowledge to solve complex problems (i.e., those that typically can be solved solely by properly interpreting manufacturers' manuals or similar documents) in working on various equipment.

Receives technical guidance, as required, from supervisor or higher level technician and work is reviewed for specific compliance with accepted practices and work assignments. May provide technical guidance to lower level technicians. (Assignments may include operational duties.)

Class III

Applies advanced knowledge to solve unusually complex problems (i.e., those that typically cannot be solved solely by reference to manufacturers' manuals or similar documents) in working on various equipment.

Work may be reviewed by supervisor (frequently an engineer or designer) for general compliance with accepted practices. May provide technical guidance to lower level technicians. (Assignments may include operational duties.)

REGISTERED INDUSTRIAL NURSE

A registered nurse gives nursing service under general medical direction to ill or injured employees or other persons who become ill or suffer an accident on the premises of a factory or other establishment. Duties involve a combination of the following: Giving first aid to the ill or injured; attending to subsequent dressing of employees' injuries; keeping records of patients treated; preparing accident reports for compensation or other purposes; assisting in physical examinations and health evaluations of applicants and employees; and planning and carrying out programs involving health education, accident prevention, evaluation of plant environment, or other activities affecting the health, welfare, and safety of all personnel. Nursing supervisors or head nurses in establishments employing more than one nurse are excluded.

EMERGENCY MEDICAL TECHNICIAN

Administers first aid treatment to sick or injured persons and transports them to a medical facility, working as member of emergency medical team. Responds to instructions from emergency medical dispatcher and drives specially equipped emergency vehicle to specified location. Monitors communication equipment to maintain contact with dispatcher. Removes or assists in removal of victims from scene of accident or catastrophe. Determines nature and extent of illness or injury, or magnitude of catastrophe, to establish first aid procedures to be followed or need for additional assistance, basing decisions on statements of persons involved, examination of victim or victims, and knowledge of emergency medical practice. Administers prescribed first aid treatment at site of emergency, or in specially-equipped vehicle, performing such activities as application of splints, administration of oxygen or intravenous injections, treatment of minor wounds or abrasions, or administration of artificial resuscitation. Communicates with professional medical personnel at emergency treatment facility to obtain instructions regarding further treatment and to arrange for reception of victims at treatment facility. Assists in removal of victims from vehicle and transfer of victims to treatment center. Assists treatment center admitting personnel to obtain and record information related to victim's vital statistics and circumstances of emergency. Maintains vehicles and medical and communication equipment and replenishes first aid equipment and supplies. May assist in controlling crowds, protecting valuables, or performing other duties at scene of catastrophe. May assist professional medical personnel in emergency treatment administered at medical facility.

PHOTO LABORATORY TECHNICIAN

Applies fundamental processes, methods and techniques in the processing and printing of black and white photographs and/or slides, or transparencies. Applies specific criteria and standard procedures in contact or projection printing, processing negatives and/or producing slides and transparencies by projection, contact, or other copying processes. Operates film processing machines and equipment according to established procedures. Work does not involve any special knowledge about the subject matter; does not involve producing of special effects, dodging and burning or other involving processes; and does not include color work. Carries out routine tasks without close supervision; however, may receive assignments, assistance and review of work designed to train and develop in film processing techniques. Performs routine set up and maintenance of equipment and prepares routine reports as required. High school graduate plus technical photographic processing training and 1 year experience in photographic laboratory work.

AIRCRAFT MECHANIC

Services, repairs, and overhauls aircraft and aircraft engines to insure airworthiness: Repairs, replaces, and assembles parts, such as wings, fuselage, tail assembly, landing gear, control cables, propeller assembly, and fuel and oil tanks, using tools, such as power shears, sheet metal breaker, arc and acetylene welding equipment, rivet gun, and air or electric drills to rebuild or replace airframe or its components. Consults manufacturers' manuals and airline's maintenance manual for specifications and to determine feasibility of repair or replacement according to malfunction. Examines engines for cracked cylinders and oil leaks and listens to detect sounds of malfunctioning, such as sticking or burnt valves. Inspects turbine blades to detect cracks or breaks. Tests engine operation, using testing equipment, such as ignition analyzer, compression checker, distributor timer, and ammeter to locate source of malfunction. Replaces or repairs worn or damaged components, such as carburetors, superchargers, and magnetos using handtools, gauges and testing equipment. Removes engine from aircraft, using hoist or forklift truck. Disassembles and inspects parts for wear, warping, or other defects. Repairs or replaces defective engine parts and reassembles and installs engine in aircraft. Adjusts and repairs electrical wiring system and aircraft accessories and instruments. Inspects, services, and repairs pneumatic and hydraulic systems. Performs miscellaneous duties to service aircraft, including flushing crankcase, cleaning screens, greasing moving parts, and checking brakes. May be required to be licensed by Federal Aviation Administration. May service engines and airframe components at line station making repairs, short of overhaul, required to keep aircraft in safe operating condition.

AIRCRAFT WORKER

Makes repairs to aircraft following orders of higher grade worker. Removes, cleans, reinstalls, or replaces defective parts, accessories, and components such as worn gaskets, couplings, and fittings; bad actuators, accumulators, gauges, sections of corroded fuel and oil lines, worn cable pulleys, frayed spark plug cables, and burned-out landing lights, using handtools. Makes adjustments and settings such as cable tension and seat movement settings and adjustments. Obtains standard parts such as fuel and oil line connections and fittings, cable linkage, and spark plug cables and harnesses by referring to parts manuals and by making comparisons with samples.

AIRCRAFT MECHANIC HELPER

Assists in assembling and installing parts and units by getting tools and supplies, carrying materials, and lifting and holding materials in place during operation. Cleans work areas, and keeps work benches clean and orderly, and tools and machines clean and lubricated.

PART IV - REPRESENTATIONS AND INSTRUCTIONS

SECTION K - REPRESENTATIONS, CERTIFICATIONS AND OTHER STATEMENTS OF OFFERORS

K.1 CONTINGENT FEE REPRESENTATION AND AGREEMENT (FAR 52.203-4) (APR 1984)

(a) Representation. The offeror represents that, except for full-time bona fide employees working solely for the offeror, the offeror -
(NOTE: The offeror must check the appropriate boxes. For interpretation of the representation, including the term "bona fide employee", see Subpart 3.4 or the Federal Acquisition Regulation.)

(1) ( ) has, ( ) has not, employed or retained any person or company to solicit or obtain this contract; and

(2) ( ) has, ( ) has not, paid or agreed to pay to any person or company employed or retained to solicit or obtain this contract any commission, percentage, brokerage, or other fee contingent upon or resulting from the award of this contract.

(b) Agreement. The offeror agrees to provide information relating to the above Representation as requested by the Contracting Officer and, when subparagraph (a)(1) or (a)(2) is answered affirmatively, to promptly submit to the Contracting Officer -

(1) A completed Standard Form 119, Statement of Contingent or Other Fees, (SF 119); or

(2) A signed statement indicating that the SF 119 was previously submitted to the same contracting office, including the date and applicable solicitation or contract number, and representing that the prior SF 119 applies to this offer or quotation.

K.2 CERTIFICATION AND DISCLOSURE REGARDING PAYMENTS TO INFLUENCE CERTAIN FEDERAL TRANSACTIONS (FAR 52.203-11) (APR 1991)

(a) The definitions and prohibitions contained in the clause, at FAR 52.203-12, Limitation on Payments to Influence Certain Federal Transactions, included in this solicitation, are hereby incorporated by reference in paragraph (b) of this certification.

(b) The offeror, by signing its offer, hereby certifies to the best of his or her knowledge and belief, that on or after December 23, 1989, -

(1) No Federal appropriated funds have been paid or will be paid to any person for influencing or attempting to influence an officer or employee of any agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress on his or her behalf in connection with the awarding of any Federal contract, the making of any Federal grant, the making of any Federal loan, the entering into of any cooperative agreement, and the extension, continuation, renewal, amendment, or modification of any Federal contract, grant, loan, or cooperative agreement.

(2) If any funds other than Federal appropriated funds (including profit or fee received under a covered Federal transaction) have been paid, or will be paid, to any person for influencing or attempting to influence an officer or employee of

any agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress on his or her behalf in connection with this solicitation, the offeror shall complete and submit, with its offer, OMB standard form LLL, Disclosure of Lobbying Activities, to the Contracting Officer; and

(3) He or she will include the language of this certification in all subcontracts at any tier and require that all recipients of subcontract awards in excess of $100,000 shall certify and disclose accordingly.

(c) Submission of this certification and disclosure is a prerequisite for making or entering into this contract imposed by section 1352, title 31, United States Code. Any person who makes an expenditure prohibited under this provision or who fails to file or amend the disclosure form to be filed or amended by this provision, shall be subject to a civil penalty of not less than $10,000, and not more than $100,000, for each such failure.

K.3 TAXPAYER IDENTIFICATION (FAR 52.204-3) (SEP 1992)

(a) Definitions.
"Common parent," as used in this solicitation provision, means that corporate entity that owns or controls an affiliated group of corporations that files its Federal income tax returns on a consolidated basis, and of which the offeror is a member.
"Corporate status," as used in this solicitation provision, means a designation as to whether the offeror is a corporate entity, an unincorporated entity (e.g., sole proprietorship or partnership), or a corporation providing medical and health care services.
"Taxpayer Identification Number (TIN)," as used in this solicitation provision, means the number required by the IRS to be used by the offeror in reporting income tax and other returns.
(b) All offerors are required to submit the information required in paragraphs (c) through (e) of this solicitation provision in order to comply with reporting requirements of 26 U.S.C. 6041, 6041A, and 6050M and implementing regulations issued by the Internal Revenue Service (IRS). If the resulting contract is subject to the reporting requirements described in 4.903, the failure or refusal by the offeror to furnish the information may result in a 20 percent reduction of payments otherwise due under the contract.
(c) Taxpayer Identification Number (TIN).
( ) TIN: ____________________
( ) TIN has been applied for.
( ) TIN is not required because:
( ) Offeror is a nonresident alien, foreign corporation, or foreign partnership that does not have income effectively connected with the conduct of a trade or business in the U.S. and does not have an office or place of business or a fiscal paying agent in the U.S.;
( ) Offeror is an agency or instrumentality of a foreign government;
( ) Offeror is an agency or instrumentality of a Federal, state, or local government;
( ) Other. State basis. ______________________________________________
(d) Corporate Status.
( ) Corporation providing medical and health care services, or engaged in the billing and collecting of payments of such services;

( ) Other corporate entity;
( ) Not a corporate entity;
( ) Sole proprietorship
( ) Partnership
( ) Hospital or extended care facility described in 26 CFR 501(c)(3) that is exempt from taxation under 26 CFR 501(a).

(e) Common Parent.

( ) Offeror is not owned or controlled by a common parent as defined in paragraph (a) of this clause.

( ) Name and TIN of common parent:

Name ______________________________________________

TIN ______________________________________________

K.4 CERTIFICATION REGARDING DEBARMENT, SUSPENSION, PROPOSED DEBARMENT, AND OTHER RESPONSIBILITY MATTERS (FAR 52.209-5) (MAY 1989)

(a)(1) The Offeror certifies, to the best of its knowledge and belief, that -

(i) The Offeror and/or any of its Principals -

(A) Are ( ) are not ( ) presently debarred, suspended, proposed for debarment, or declared ineligible for the award of contracts by any Federal agency;

(B) Have ( ) have not ( ), within a three-year period preceding this offer, been convicted of or had a civil judgment rendered against them for: commission of fraud or a criminal offense in connection with obtaining, attempting to obtain, or performing a public (Federal, state, or local) contract or subcontract; violation of Federal or state antitrust statutes relating to the submission of offers; or commission of embezzlement, theft, forgery, bribery, falsification or destruction of records, making false statements, or receiving stolen property; and

(C) Are ( ) are not ( ) presently indicted for, or otherwise criminally or civilly charged by a governmental entity with, commission of any of the offenses enumerated in subdivision (a)(1)(i)(B) of this provision.

(ii) The Offeror has ( ) has not ( ), within a three-year period preceding this offer, had one or more contracts terminated for default by any Federal agency.

(2) "Principals," for the purposes of this certification, means officers; directors; owners; partners; and, persons having primary management or supervisory responsibilities within a business entity (e.g., general manager; plant manager; head of a subsidiary, division, or business segment, and similar positions).

THIS CERTIFICATION CONCERNS A MATTER WITHIN THE JURISDICTION OF AN AGENCY OF THE UNITED STATES AND THE MAKING OF A FALSE, FICTITIOUS, OR FRAUDULENT CERTIFICATION MAY RENDER THE MAKER SUBJECT TO PROSECUTION UNDER SECTION 1001, TITLE 18, UNITED STATES CODE.

(b) The Offeror shall provide immediate written notice to the Contracting Officer if, at any time prior to contract award, the Offeror learns that its certification was erroneous when submitted or has become erroneous by reason of changed circumstances.

(c) A certification that any of the items in paragraph (a) of this provision exists will not necessarily result in withholding of an award under this solicitation. However, the certification will be considered in connection with a determination of the Offeror's responsibility. Failure of the Offeror to furnish a certification or provide such additional information as requested by the Contracting Officer may render the Offeror nonresponsible.
(d) Nothing contained in the foregoing shall be construed to require establishment of a system of records in order to render, in good faith, the certification required by paragraph (a) of this provision. The knowledge and information of an Offeror is not required to exceed that which is normally possessed by a prudent person in the ordinary course of business dealings.
(e) The certification in paragraph (a) of this provision is a material representation of fact upon which reliance was placed when making award. If it is later determined that the Offeror knowingly rendered an erroneous certification, in addition to other remedies available to the Government, the Contracting Officer may terminate the contract resulting from this solicitation for default.

K.5 TYPE OF BUSINESS ORGANIZATION (FAR 52.215-6) (JUL 1987)

The offeror or quoter, by checking the applicable box, represents that -
(a) It operates as ( ) a corporation incorporated under the laws of the State of ______________________________________________, ( ) an individual, ( ) a partnership, ( ) a nonprofit organization, or ( ) a joint venture; or
(b) If the offeror or quoter is a foreign entity, it operates as ( ) an individual, ( ) a partnership, ( ) a nonprofit organization, ( ) a joint venture, or ( ) a corporation, registered for business in ____________________.
country

K.6 AUTHORIZED NEGOTIATORS (FAR 52.215-11) (APR 1984)

The offeror or quoter represents that the following persons are authorized to negotiate on its behalf with the Government in connection with this request for proposals or quotations: (list names, titles, and telephone numbers of the authorized negotiators).

________________________________________________________________________________

________________________________________________________________________________

K.7 PERIOD FOR ACCEPTANCE OF OFFER (FAR 52.215-19) (APR 1984)

In compliance with the solicitation, the offeror agrees, if this offer is accepted within ________ calendar days (60 calendar days unless a different period is inserted by the offeror) from the date specified in the solicitation for receipt of offers, to furnish any or all items on which prices are offered at the price set opposite each item, delivered at the designated point(s), within the time specified in the Schedule.

K.8 SMALL BUSINESS CONCERN REPRESENTATION (FAR 52.219-1) (JAN 1991)

(a) Representation. The offeror represents and certifies as part of its offer that it ( ) is, ( ) is not a small business concern and that ( ) all, ( ) not all end items to be furnished will be manufactured or produced by a small business

concern in the United States, its territories or possessions, Puerto Rico, or the Trust Territory of the Pacific Islands.
(b) Definition. "Small business concern," as used in this provision, means a concern, including its affiliates, that is independently owned and operated, not dominant in the field of operation in which it is bidding on Government contracts, and qualified as a small business under the criteria and size standards in this solicitation.
(c) Notice. Under 15 U.S.C. 645(d), any person who misrepresents a firm's status as a small business concern in order to obtain a contract to be awarded under the preference programs established pursuant to sections 8(a), 8(d), 9, or 15 of the Small Business Act or any other provision of Federal law that specifically references section 8(d) for a definition of program eligibility, shall -
(1) be punished by imposition of fine, imprisonment, or both;
(2) be subject to administrative remedies, including suspension and debarment; and
(3) be ineligible for participation in programs conducted under the authority of the Act.

K.9 SMALL DISADVANTAGED BUSINESS CONCERN REPRESENTATION
(FAR 52.219-2) (FEB 1990)

(a) Representation. The offeror represents that it ( ) is, ( ) is not a small disadvantaged business concern.
(b) Definitions.
"Asian-Pacific Americans," as used in this provision, means United States citizens whose origins are in Japan, China, the Philippines, Vietnam, Korea, Samoa, Guam, the U.S. Trust Territory of the Pacific Islands (Republic of Palau), the Northern Mariana Islands, Laos, Kampuchea (Cambodia), Taiwan, Burma, Thailand, Malaysia, Indonesia, Singapore, Brunei, Republic of the Marshall Islands, or the Federated States of Micronesia.
"Indian tribe," as used in this provision, means any Indian tribe, band, nation, or other organized group or community of Indians, including any Alaska Native Corporation as defined in 13 CFR 124.100 which is recognized as eligible for the special programs and services provided by the U.S. to Indians because of their status as Indians, or which is recognized as such by the State in which such tribe, band, nation, group, or community resides.
"Native Americans," as used in this provision, means American Indians, Eskimos, Aleuts, and native Hawaiians.
"Native Hawaiian Organization," as used in this provision, means any community service organization serving Native Hawaiians in, and chartered as a not-for-profit organization by, the State of Hawaii, which is controlled by Native Hawaiians, and whose business activities will principally benefit such Native Hawaiians.
"Small business concern," as used in this provision, means a concern, including its affiliates, that is independently owned and operated, not dominant in the field of operation in which it is bidding on Government contracts, and qualified as a small business under the criteria and size standards in 13 CFR 121.
"Small disadvantaged business concern," as used in this provision, means a small business concern that (a) is at least 51 percent unconditionally owned by one or more individuals who are both socially and economically disadvantaged, or a publicly owned business having at least 51 percent of its stock unconditionally owned by one or more socially and economically disadvantaged individuals and (b)

has its management and daily business controlled by one or more such individuals. This term also means a small business concern that is at least 51 percent unconditionally owned by an economically disadvantaged Indian tribe or Native Hawaiian Organization, or a publicly owned business having at least 51 percent of its stock unconditionally owned by one of these entities which has its management and daily business controlled by members of an economically disadvantaged Indian tribe or Native Hawaiian Organization, and which meets the requirements of 13 CFR 124.

"Subcontinent Asian Americans," as used in this provision, means United States citizens whose origins are in India, Pakistan, Bangladesh, Sri Lanka, Bhutan, or Nepal.

(c) Qualified groups. The offeror shall presume that socially and economically disadvantaged individuals include Black Americans, Hispanic Americans, Native Americans, Asian-Pacific Americans, Subcontinent Asian Americans, and other individuals found to be qualified by SBA under 13 CFR 124. The offeror shall also presume that socially and economically disadvantaged entities also include Indian tribes and Native Hawaiian Organizations.

K.10 WOMEN-OWNED SMALL BUSINESS REPRESENTATION (FAR 52.219-3) (APR 1984)

(a) Representation. The offeror represents that it ( ) is, ( ) is not, a women-owned small business concern.

(b) Definitions.

"Small business concern", as used in this provision, means a concern, including its affiliates, that is independently owned and operated, not dominant in the field of operation in which it is bidding on Government contracts, and qualified as a small business under the criteria and size standards in 13 CFR 121.

"Women-owned", as used in this provision, means a small business that is at least 51 percent owned by a woman or women who are U.S. citizens and who also control and operate the business.

K.11 PREFERENCE FOR LABOR SURPLUS AREA CONCERNS (FAR 52.220-1) (APR 1984)

(a) This acquisition is not a set aside for labor surplus area (LSA) concerns. However, the offeror's status as such a concern may affect (1) entitlement to award in case of tie offers or (2) offer evaluation in accordance with the Buy American Act clause of this solicitation. In order to determine whether the offeror is entitled to a preference under (1) or (2) above, the offeror must identify, below, the LSA in which the costs to be incurred on account of manufacturing or production (by the offeror or the first-tier subcontractors) amount to more than 50 percent of the contract price.

______________________________________________________________________

______________________________________________________________________

(b) Failure to identify the locations as specified above will preclude consideration of the offeror as an LSA concern. If the offeror is awarded a contract as an LSA concern and would not have otherwise qualified for award, the offeror shall perform the contract or cause the contract to be performed in accordance with the obligations of an LSA concern.

K.12 CERTIFICATION OF NONSEGREGATED FACILITIES (FAR 52.222-21) (APR 1984)

(a) "Segregated facilities", as used in this provision, means any waiting rooms, work areas, rest rooms and wash rooms, restaurants and other eating areas, time clocks, locker rooms and other storage or dressing areas, parking lots, drinking fountains, recreation or entertainment areas, transportation, and housing facilities provided for employees, that are segregated by explicit directive or are in fact segregated on the basis of race, color, religion, or national origin because of habit, local custom, or otherwise.
(b) By the submission of this offer, the offeror certifies that it does not and will not maintain or provide for its employees any segregated facilities at any of its establishments, and that it does not and will not permit its employees to perform their services at any location under its control where segregated facilities are maintained. The offeror agrees that a breach of this certification is a violation of the Equal Opportunity clause in the contract.
(c) The offeror further agrees that (except where it has obtained identical certifications from proposed subcontractors for specific time periods) it will -
(1) Obtain identical certifications from proposed subcontractors before the award of subcontracts under which the subcontractor will be subject to the Equal Opportunity clause;
(2) Retain the certifications in the files; and
(3) Forward the following notice to the proposed subcontractors (except if the proposed subcontractors have submitted identical certifications for specific time periods):

NOTICE TO PROSPECTIVE SUBCONTRACTORS OF REQUIREMENT FOR CERTIFICATIONS OF NONSEGREGATED FACILITIES

A Certification of Nonsegregated Facilities must be submitted before the award of a subcontract under which the subcontractor will be subject to the Equal Opportunity clause. The certification may be submitted either for each subcontract or for all subcontracts during a period (i.e., quarterly, semiannually, or annually.

NOTE: The penalty for making false statements in offers is prescribed in 18 U.S.C. 1001.

K.13 PREVIOUS CONTRACTS AND COMPLIANCE REPORTS (FAR 52.222-22) (APR 1984)

The offeror represents that -
(a) It ( ) has, ( ) has not, participated in a previous contract or subcontract subject either to the Equal Opportunity clause of this solicitation, the clause originally contained in Section 310 of Executive Order No. 10925, or the clause contained in Section 201 of Executive Order No. 11114;
(b) It ( ) has, ( ) has not, filed all required compliance reports; and
(c) Representations indicating submission of required compliance reports, signed by proposed subcontractors, will be obtained before subcontract awards.

K.14 AFFIRMATIVE ACTION COMPLIANCE (FAR 52.222-25) (APR 1984)

The offeror represents that (a) it ( ) has developed and has on file, ( ) has not developed and does not have on file, at each establishment, affirmative action programs required by the rules and regulations of the Secretary of Labor (41 CFR 60-1 and 60-2), or (b) it ( ) has not previously had contracts subject to the written affirmative action programs requirement of the rules and regulations of the Secretary of Labor.

K.15 EXEMPTION FROM APPLICATION OF SERVICE CONTRACT ACT PROVISIONS (FAR 52.222-48) (MAY 1989)

(a) The following certification shall be checked:

CERTIFICATION

The offeror certifies ( )/does not certify ( ): (i) The items of equipment to be serviced under this contract are commercial items which are used regularly for other than Government purposes, and are sold or traded by the Contractor in substantial quantities to the general public in the course of normal business operations; (ii) The contract services are furnished at prices which are, or are based on, established catalog or market prices for the maintenance, calibration, and/or repair of certain ADP, scientific and medical, and/or office and business equipment. An "established catalog price" is a price included in a catalog, price list schedule, or other form that is regularly maintained by the manufacturer or the Contractor, is either published or otherwise available for inspection by customers, and states prices at which sales are currently, or were last, made to a significant number of buyers constituting the general public. An "established market price" is a current price, established in the usual course of trade between buyers and sellers free to bargain, which can be substantiated from sources independent of the manufacturer or Contractor; and (iii) The Contractor utilizes the same compensation (wage and fringe benefits) plan for all service employees performing work under the contract as the Contractor uses for equivalent employees servicing the same equipment of commercial customers.
(b) If a negative certification is made and a Service Contract Act wage determination is not attached to the solicitation, the Contractor shall notify the Contracting Officer as soon as possible.
(c) Failure to execute the certification in paragraph (a) of this clause or to contact the Contracting Officer as required in paragraph (b) of this clause may render the bid or offer nonresponsive.

K.16 CLEAN AIR AND WATER CERTIFICATION (FAR 52.223-1) (APR 1984)

The offeror certifies that -
(a) Any facility to be used in the performance of this proposed contract ( ) is, ( ) is not, listed on the Environmental Protection Agency List of Violating Facilities;
(b) The offeror will immediately notify the Contracting Officer, before award, of the receipt of any communication from the Administrator, or a designee, of the Environmental Protection Agency, indicating that any facility that the offeror proposes to use for the performance of the contract is under consideration to be listed on the EPA List of Violating Facilities; and

(c) The offeror will include a certification substantially the same as this certification, including this paragraph (c), in every nonexempt subcontract.

K.17 CERTIFICATION REGARDING A DRUG-FREE WORKPLACE (FAR 52.223-5) (JUL 1990)

(a) Definitions. As used in this provision,

"Controlled substance" means a controlled substance in Schedules I through V of Section 202 of the Controlled Substances Act (21 U.S.C. 812) and as further defined in regulation at 21 CFR 1308.11 - 1308.15.

"Conviction" means a finding of guilt (including a plea of nolo contendere) or imposition of sentence, or both, by any judicial body charged with the responsibility to determine violations of the Federal or State criminal drug statutes.

"Criminal drug statute" means a Federal or non-Federal criminal statute involving the manufacture, distribution, dispensing, possession or use of any controlled substance.

"Drug-free-workplace" means the site(s) for the performance of work done by the Contractor in connection with a specific contract at which employees of the Contractor are prohibited from engaging in the unlawful manufacture, distribution, dispensing, possession, or use of a controlled substance.

"Employee" means an employee of a Contractor directly engaged in the performance of work under a Government contract. "Directly engaged" is defined to include all direct cost employees and any other Contractor employee who has other than minimal impact or involvement in contract performance.

"Individual" means an offeror/Contractor that has no more than one employee including the offeror/Contractor.

(b) By submission of its offer, the offeror, if other than an individual, who is making an offer that equals or exceeds $25,000, certifies and agrees that, with respect to all employees of the offeror to be employed under a contract resulting from this solicitation, it will - no later than 30 calendar days after contract award (unless a longer period is agreed to in writing), for contracts of 30 calendar days or more performance duration, or as soon as possible for contracts of less than 30 calendar days performance duration; but in any case, by a date prior to when performance is expected to be completed -

(1) Publish a statement notifying such employees that the unlawful manufacture, distribution, dispensing, possession or use of a controlled substance is prohibited in the Contractor's workplace and specifying the actions that will be taken against employees for violations of such prohibition;

(2) Establish an ongoing drug-free awareness program to inform such employees about -

(i) The dangers of drug abuse in the workplace;

(ii) The Contractor's policy of maintaining a drug-free workplace;

(iii) Any available drug counseling, rehabilitation, and employee assistance programs; and

(iv) The penalties that may be imposed upon employees for drug abuse violations occurring in the workplace;

(3) Provide all employees engaged in performance of the contract with a copy of the statement required by subparagraph (b)(1) of this provision;

(4) Notify such employees in writing in the statement required by subparagraph (b)(1) of this provision that, as a condition of continued employment on the contract resulting from this solicitation, the employee will -

(i) Abide by the terms of the statement; and

(ii) Notify the employer in writing of the employee's conviction under a criminal drug statute for a violation occurring in the workplace no later than 5 calendar days after such conviction;

(5) Notify the Contracting Officer in writing within 10 calendar days after receiving notice under subdivision (b)(4)(ii) of this provision, from an employee or otherwise receiving actual notice of such conviction. The notice shall include the position title of the employee; and

(6) Within 30 calendar days after receiving notice under subdivision (b)(4)(ii) of this provision of a conviction, take one of the following actions with respect to any employee who is convicted of a drug abuse violation occurring in the workplace:

(i) Take appropriate personnel action against such employee, up to and including termination; or

(ii) Require such employee to satisfactorily participate in a drug abuse assistance or rehabilitation program approved for such purposes by a Federal, State, or local health, law enforcement, or other appropriate agency.

(7) Make a good faith effort to maintain a drug-free workplace through implementation of subparagraphs (b)(1) through (b)(6) of this provision.

(c) By submission of its offer, the offeror, if an individual who is making an offer of any dollar value, certifies and agrees that the offeror will not engage in the unlawful manufacture, distribution, dispensing, possession, or use of a controlled substance in the performance of the contract resulting from this solicitation.

(d) Failure of the offeror to provide the certification required by paragraphs (b) or (c) of this provision, renders the offeror unqualified and ineligible for award. (See FAR 9.104-1(g) and 19.602-1(a)(2)(i).)

(e) In addition to other remedies available to the Government, the certification in paragraphs (b) or (c) of this provision concerns a matter within the jurisdiction of an agency of the United States and the making of a false, fictitious, or fraudulent certification may render the maker subject to prosecution under Title 18, United States Code, Section 1001.

K.18 BUY AMERICAN CERTIFICATE (FAR 52.225-1) (DEC 1989)

The offeror certifies that each end product, except those listed below, is a domestic end product (as defined in the clause entitled "Buy American Act - Supplies"), and that components of unknown origin are considered to have been mined, produced, or manufactured outside the United States.

| Excluded End Products | Country of Origin |
|---|---|
| | |
| | |
| | |

(List as necessary)

Offerors may obtain from the Contracting Officer lists of articles, materials, and supplies excepted from the Buy American Act.

K.19 REPRESENTATION OF LIMITED RIGHTS DATA AND RESTRICTED COMPUTER SOFTWARE (FAR 52.227-15) (JUN 1987)

(a) This solicitation sets forth the work to be performed if a contract award results, and the Government's known delivery requirements for data (as defined in FAR 27.401). Any resulting contract may also provide the Government the option to order additional data under the Additional Data Requirements clause at 52.227-16 of the FAR, if included in the contract. Any data delivered under the resulting contract will be subject to the Rights in Data - General clause at 52.227-14 that is to be included in this contract. Under the latter clause, a Contractor may withhold from delivery data that qualify as limited rights data or restricted computer software, and deliver form, fit, and function data in lieu thereof. The latter clause also may be used with its Alternates II and/or III to obtain delivery of limited rights data or restricted computer software, marked with limited rights or restricted rights notices, as appropriate. In addition, use of Alternate V with this latter clause provides the Government the right to inspect such data at the Contractor's facility.
(b) As an aid in determining the Government's need to include any of the aforementioned Alternates in the clause at 52.227-14, Rights in Data - General, the offeror's response to this solicitation shall, to the extent feasible, complete the representation in paragraph (b) of this provision to either state that none of the data qualify as limited rights data or restricted computer software, or identify which of the data qualifies as limited rights data or restricted computer software. Any identification of limited rights data or restricted computer software in the offeror's response is not determinative of the status of such data should a contract be awarded to the offeror.

REPRESENTATION CONCERNING DATA RIGHTS

Offeror has reviewed the requirements for the delivery of data or software and states (offeror check appropriate block) -

( ) None of the data proposed for fulfilling such requirements qualifies as limited rights data or restricted computer software.

( ) Data proposed for fulfilling such requirements qualify as limited rights data or restricted computer software and are identified as follows:

______________________________

______________________________

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NOTE: "Limited rights data" and "Restricted computer software" are defined in the contract clause entitled "Rights in Data - General."

K.20 COST ACCOUNTING STANDARDS NOTICES AND CERTIFICATION (NATIONAL DEFENSE 52.230-1) (AUG 1992)

NOTE: This notice does not apply to small businesses or foreign governments. This notice is in four parts, identified by Roman numerals I. through IV. Offerors shall examine each part and provide the requested information in order to determine Cost Accounting Standards (CAS) requirements applicable to any resultant contract.

*I. Disclosure Statement - Cost Accounting Practices and Certification*

(a) Any contract in excess of $500,000 resulting from this solicitation, except contracts in which the price negotiated is based on (1) established catalog or market prices of commercial items sold in substantial quantities to the general public, or (2) prices set by law or regulation, will be subject to the requirements of parts 9903 and 9904, except for those contracts which are exempt as specified in 9903-201-1.

(b) Any offeror submitting a proposal which, if accepted, will result in a contract subject to the requirements of parts 9904 and 9904 must, as a condition of contracting, submit a Disclosure Statement as required by 9903.202. The Disclosure Statement must be submitted as a part of the offeror's proposal under this solicitation unless the offeror has already submitted a Disclosure Statement disclosing the practice used in connection with the pricing of this proposal. If an applicable Disclosure Statement has already been submitted, the offeror may satisfy the requirement for submission by providing the information requested in paragraph (c) of Part I of this provision.

CAUTION: In the absence of specific regulations or agreement, a practice disclosed in a Disclosure Statement shall not, by virtue of such disclosure, be deemed to be a proper, approved, or agreed-to practice for pricing proposals or accumulating and reporting contract performance cost data.

(c) Check the appropriate box below:

( ) (1) Certificate of Concurrent Submission of Disclosure Statement.

The offeror hereby certifies that, as a part of the offer, copies of the Disclosure Statement have been submitted as follows: (i) original and one copy to the cognizant Administrative Contracting Officer (ACO), and (ii) one copy to the cognizant contract auditor.

(Disclosure must be on Form Number CASB-DS-1. Forms may be obtained from the cognizant ACO.)

Date of Disclosure Statement ________________________

Name and Address of Cognizant ACO where filed ________________________

________________________________________________________________

The offeror further certifies that practices used in estimating costs in pricing this proposal are consistent with the cost accounting practices disclosed in the Disclosure Statement.

( ) (2) Certificate of Previously Submitted Disclosure Statement.

The offeror hereby certifies that Disclosure Statement was filed as follows:

Date of Disclosure Statement ________________________

Name and Address of Cognizant ACO where filed ________________________

________________________________________________________________

The offeror further certifies that the practices used in estimating costs in pricing this proposal are consistent with the cost accounting practices disclosed in the applicable Disclosure Statement.

( ) (3) Certificate of Monetary Exemption.

The offeror hereby certifies that the offeror, together with all divisions, subsidiaries, and affiliates under common control, did not receive net awards of negotiated prime contracts and subcontracts subject to CAS totaling more than $10 million in the cost accounting period immediately preceding the period in which this proposal was submitted. The offeror further certifies that if such status changes before an award resulting from this proposal, the offeror will advise the Contracting Officer immediately.

( ) (4) Certificate of Interim Exemption.

The offeror hereby certifies that (i) the offeror first exceeded the monetary exemption for disclosure, as defined in (3) above, in the cost accounting period immediately preceding the period in which this offer was submitted and (ii) in accordance with 9903.202-1, the offeror is not yet required to submit a Disclosure Statement. The offeror further certifies that if an award resulting from this proposal has not been made within 90 days after the end of that period, the offeror will immediately submit a revised certificate to the Contracting Officer, in the form specified under subparagraphs (c)(1) or (c)(2) of Part I of this provision, as appropriate, to verify submission of a completed Disclosure Statement.

CAUTION: Offerors currently required to disclose because they were awarded a CAS-covered prime contract or subcontract of $10 million or more in the current cost accounting period may not claim this exemption (4). Further, the exemption applies only in connection with proposals submitted before expiration of the 90-day period following the cost accounting period in which the monetary exemption was exceeded.

*II. Cost Accounting Standards - Exemption for Contracts of $500,000 or Less*

If this proposal is expected to result in the award of a contract of $500,000 or less, the offeror shall indicate whether the exemption below is claimed. Failure to check the box below shall mean that the resultant contract is subject to CAS requirements or that the offeror elects to comply with such requirements.

( ) The offeror hereby claims an exemption from the CAS requirements under the provisions of 9903.201-1(b)(2).

*III. Cost Accounting Standards - Eligibility for Modified Contract Coverage*

If the offeror is eligible to use the modified provisions of 9903.201-2(b) and elects to do so, the offeror shall indicate by checking the box below. Checking the box below shall mean that the resultant contract is subject to the Disclosure and Consistency of Cost Accounting Practices clause in lieu of the Cost Accounting Standards clause.

( ) The offeror hereby claims an exemption from the Cost Accounting Standards clause under the provisions of 9903.201-2(b) and certifies that the offeror is eligible for use of the Disclosure and Consistency of Cost Accounting Practices clause because (i) during the cost accounting period immediately preceding the period in which this proposal was submitted, the offeror received less than $10 million in awards of CAS-covered prime contracts and subcontracts, and (ii) the sum of such awards equaled less than 10 percent of total sales during that cost accounting period. The offeror further certifies that if such status changes before an award resulting from this proposal, the offeror will advise the Contracting Officer immediately.

CAUTION: An offeror may not claim the above eligibility for modified contract coverage if this proposal is expected to result in the award of a CAS-covered contract of $10 million or more or if, during its current cost accounting period, the offeror has been awarded a single CAS-covered prime contract or subcontract of $10 million or more.

*IV. Additional Cost Accounting Standards Applicable to Existing Contracts*

The offeror shall indicate below whether award of the contemplated contract would, in accordance with subparagraph (a)(3) of the Cost Accounting Standards clause, require a change in established cost accounting practices affecting existing contracts and subcontracts.

( ) YES ( ) NO

K.21 CONTRACTS BETWEEN NASA AND FORMER NASA EMPLOYEES (NASA 18-52.203-70) (DEC 1988) (NASA/FAR SUPPLEMENT)

The offeror represents that he or she ( ) is, or ( ) is not, an individual who was employed by NASA during the past two (2) years, or a firm in which such an individual is a partner, principal officer, or majority shareholder or that is otherwise controlled or predominantly staffed by such individuals.

K.22 PAYMENT INFORMATION (LARC 52.232-98) (JUN 1988)

The following is the address to which payment must be sent, if payment is made by check.

________________________________________

________________________________________

________________________________________

## SECTION L - INSTRUCTIONS, CONDITIONS, AND NOTICES TO OFFERORS

L.1 ORGANIZATIONAL CONFLICTS OF INTEREST CERTIFICATE--MARKETING CONSULTANTS (FAR 52.209-7) (NOV 1991)

(a) Definitions.

(1) "Marketing consultant" means any independent contractor who furnishes advice, information, direction, or assistance to an offeror or any other contractor in support of the preparation or submission of an offer for a Government contract by that offeror. An independent contractor is not a marketing consultant when rendering --

(i) Services excluded in Subpart 37.2;

(ii) Routine engineering and technical services (such as installation, operation, or maintenance of systems, equipment, software, components, or facilities);

(iii) Routine legal, actuarial, auditing, and accounting services; or

(iv) Training services.

(2) Organizational conflict of interest means that because of other activities or relationships with other persons, a person is unable or potentially unable to render impartial assistance or advice to the Government, or the person's

objectivity in performing the contract work is or might be otherwise impaired, or a person has an unfair competitive advantage.

(b) An individual or firm that employs, retains, or engages contractually one or more marketing consultants in connection with a contract, shall submit to the contracting officer, with respect to each marketing consultant, the certificates described below, if the individual or firm is notified that it is the apparent successful offeror.

(c) The certificate must contain the following:

(1) The name of the agency and the number of the solicitation in question.

(2) The name, address, telephone number, and federal taxpayer identification number of the marketing consultant.

(3) The name, address, and telephone number of a responsible officer or employee of the marketing consultant who has personal knowledge of the marketing consultants involvement in the contract.

(4) A description of the nature of the services rendered by or to be rendered by the marketing consultant.

(5) The name, address, and telephone number of the client or clients, and the name of a responsible officer or employee of the marketing consultant who is knowledgeable about the services provided to such client(s), and a description of the nature of the services rendered to such client(s), if, based on information provided to the Contractor by the marketing consultant, any marketing consultant is rendering or, in the 12 months preceding the date of the certificate, has rendered services respecting the same subject matter of the instant solicitation, or directly relating to such subject matter, to the Government or any other client (including any foreign Government or person).

(6) A statement that the person who signs the certificate for the prime Contractor has informed the marketing consultant of the existence of Subpart 9.5 and Office of Federal Procurement Policy Letter 89-1.

(7) The signature, name, title, employer's name, address, and telephone number of the persons who signed the certificates for both the apparent successful offeror and the marketing consultant.

(d) In addition, the apparent successful offeror shall forward to the Contracting Officer a certificate signed by the marketing consultant that the marketing consultant has been told of the existence of Subpart 9.5 and Office of Federal Procurement Policy Letter 89-1, and the marketing consultant has made inquiry, and to the best of the consultant's knowledge and belief, the consultant has provided no unfair competitive advantage to the prime Contractor with respect to the services rendered or to be rendered in connection with the solicitation, or that any unfair competitive advantage that, to the best of the consultant's knowledge and belief, does or may exist, has been disclosed to the offeror.

(e) Failure of the offeror to provide the certifications may result in the offeror being determined ineligible for award. Misrepresentation of any fact may result in the assessment of penalties associated with false certifications or such other provisions provided for by law or regulation.

L.2 NOTICE OF PRIORITY RATING FOR NATIONAL DEFENSE USE (FAR 52.212-7) (SEP 1990)

Any contract awarded as a result of this solicitation will be a ( ) DX rated order; ( X) DO rated order certified for national defense use under the Defense Priorities and Allocations System (DPAS) (15 CFR 700), and the Contractor will be required to follow all of the requirements of this regulation.

L.3 SOLICITATION DEFINITIONS (FAR 52.215-5) (JUL 1987)

"Offer" means "proposal" in negotiation.
"Solicitation" means a request for proposals (RFP) or a request for quotations (RFQ) in negotiation.
"Government" means United States Government.

L.4 UNNECESSARILY ELABORATE PROPOSALS OR QUOTATIONS (FAR 52.215-7) (APR 1984)

Unnecessarily elaborate brochures or other presentations beyond those sufficient to present a complete and effective response to this solicitation are not desired and may be construed as an indication of the offeror's or quoter's lack of cost consciousness. Elaborate art work, expensive paper and bindings, and expensive visual and other presentation aids are neither necessary nor wanted.

L.5 AMENDMENTS TO SOLICITATIONS (FAR 52.215-8) (DEC 1989)

(a) If this solicitation is amended, then all terms and conditions which are not modified remain unchanged.
(b) Offerors shall acknowledge receipt of any amendment to this solicitation (1) by signing and returning the amendment; (2) by identifying the amendment number and date in the space provided for this purpose on the form for submitting an offer; (3) by letter or telegram or (4) facsimile, if facsimile offers are authorized in the solicitation. The Government must receive the acknowledgment by the time specified for receipt of offers.

L.6 SUBMISSION OF OFFERS (FAR 52.215-9) (DEC 1989)

(a) Offers and modifications thereof shall be submitted in sealed envelopes or packages (1) addressed to the office specified in the solicitation, and (2) showing the time specified for receipt, the solicitation number, and the name and address of the offeror.
(b) Telegraphic offers will not be considered unless authorized by the solicitation; however, offers may be modified by written or telegraphic notice.
(c) Facsimile offers, modifications or withdrawals will not be considered unless authorized by the solicitation.
(d) Item samples, if required, must be submitted within the time specified for receipt of offers. Unless otherwise specified in the solicitation, these samples shall be (1) submitted at no expense to the Government and (2) returned at the sender's request and expense, unless they are destroyed during preaward testing.

L.7 LATE SUBMISSIONS, MODIFICATIONS, AND WITHDRAWALS OF PROPOSALS (FAR 52.215-10) (DEC 1989)

(a) Any proposal received at the office designated in the solicitation after the exact time specified for receipt will not be considered unless it is received before award is made and it -

(1) Was sent by registered or certified mail not later than the fifth calendar day before the date specified for receipt of offers (e.g., an offer submitted in response to a solicitation requiring receipt of offers by the 20th of the month must have been postmarked by the 15th);

(2) Was sent by mail or, if authorized by the solicitation, was sent by telegram or via facsimile and it is determined by the Government that the late receipt was due solely to mishandling by the Government after receipt at the Government installation;

(3) Was sent by U.S. Postal Service Express Mail Next Day Service-Post Office to Addressee, not later than 5:00 p.m. at the place of mailing two working days prior to the date specified for receipt of proposals. The term "working days" excludes weekends and U.S. Federal holidays; or

(4) Is the only proposal received.

(b) Any modification of a proposal or quotation, except a modification resulting from the Contracting Officer's request for "best and final" offer, is subject to the same conditions as in subparagraphs (a)(1), (2), and (3) of this provision.

(c) A modification resulting from the Contracting Officer's request for "best and final" offer received after the time and date specified in the request will not be considered unless received before award and the late receipt is due solely to mishandling by the Government after receipt at the Government installation.

(d) The only acceptable evidence to establish the date of mailing of a late proposal or modification sent either by registered or certified mail is the U.S. or Canadian Postal Service postmark on the envelope or wrapper and on the original receipt from the U.S. or Canadian Postal Service. Both postmarks must show a legible date or the proposal, quotation, or modification shall be processed as if mailed late. "Postmark" means a printed, stamped, or otherwise placed impression (exclusive of a postage meter machine impression) that is readily identifiable without further action as having been supplied and affixed by employees of the U.S. or Canadian Postal Service on the date of mailing. Therefore, offerors or quoters should request the postal clerks to place a legible hand cancellation bull's-eye postmark on both the receipt and the envelope or wrapper.

(e) The only acceptable evidence to establish the time of receipt at the Government installation is the time/date stamp of that installation on the proposal wrapper or other documentary evidence of receipt maintained by the installation.

(f) The only acceptable evidence to establish the date of mailing of a late offer, modification, or withdrawal sent by Express Mail Next Day Service-Post Office to Addressee is the date entered by the post office receiving clerk on the "Express Mail Next Day Service-Post Office to Addressee" label and the postmark on both the envelope or wrapper and on the original receipt from the U.S. Postal Service. "Postmark" has the same meaning as defined in paragraph (d) of this provision, excluding postmarks of the Canadian Postal Service. Therefore, offerors or quoters should request the postal clerk to place a legible hand cancellation bull's-eye postmark on both the receipt and the envelope or wrapper.

(g) Notwithstanding paragraph (a) of this provision, a late modification of an otherwise successful proposal that makes its terms more favorable to the Government will be considered at any time it is received and may be accepted.

(h) Proposals may be withdrawn by written notice or telegram (including mailgram) received at any time before award. If the solicitation authorizes facsimile proposals, proposals may be withdrawn via facsimile received at any time before award, subject to the conditions specified in the provision entitled "Facsimile Proposals." Proposals may be withdrawn in person by an offeror or an authorized representative, if the representative's identity is made known and the representative signs a receipt for the proposal before award.

L.8 PREPARATION OF OFFERS (FAR 52.215-13) (APR 1984)

(a) Offerors are expected to examine the drawings, specifications, Schedule, and all instructions. Failure to do so will be at the offeror's risk.
(b) Each offeror shall furnish the information required by the solicitation. The offeror shall sign the offer and print or type its name on the Schedule and each continuation sheet on which it makes an entry. Erasures or other changes must be initialed by the person signing the offer. Offers signed by an agent shall be accompanied by evidence of that agent's authority, unless that evidence has been previously furnished to the issuing office.
(c) For each item offered, offerors shall (1) show the unit price/cost, including, unless otherwise specified, packaging, packing, and preservation and (2) enter the extended price/cost for the quantity of each item offered in the "Amount" column of the Schedule. In case of discrepancy between a unit price/cost and an extended price/cost, the unit price/cost will be presumed to be correct, subject, however, to correction to the same extent and in the same manner as any other mistake.
(d) Offers for supplies or services other than those specified will not be considered unless authorized by the solicitation.
(e) Offerors must state a definite time for delivery of supplies or for performance of services, unless otherwise specified in the solicitation.
(f) Time, if stated as a number of days, will include Saturdays, Sundays, and holidays.

L.9 EXPLANATION TO PROSPECTIVE OFFERORS (FAR 52.215-14) (APR 1984)

Any prospective offeror desiring an explanation or interpretation of the solicitation, drawings, specifications, etc., must request it in writing soon enough to allow a reply to reach all prospective offerors before the submission of their offers. Oral explanations or instructions given before the award of the contract will not be binding. Any information given to a prospective offeror concerning a solicitation will be furnished promptly to all other prospective offerors as an amendment of the solicitation, if that information is necessary in submitting offers or if the lack of it would be prejudicial to any other prospective offerors.

L.10 FAILURE TO SUBMIT OFFER (FAR 52.215-15) (APR 1984)

Recipients of this solicitation not responding with an offer should not return this solicitation, unless it specifies otherwise. Instead, they should advise the issuing office by letter or postcard whether they want to receive future solicitations for similar requirements. If a recipient does not submit an offer and does not notify the issuing office that future solicitations are desired, the recipient's name may be removed from the applicable mailing list.

L.11 CONTRACT AWARD (FAR 52.215-16) (JUL 1990)--ALTERNATE II (NOV 1992)

(a) The Government will award a contract resulting from this solicitation to the responsible offeror whose offer conforming to the solicitation will be most advantageous to the Government, cost or price and other factors, specified elsewhere in this solicitation, considered.

(b) The Government may (1) reject any or all offers if such action is in the public interest, (2) accept other than the lowest offer, and (3) waive informalities and minor irregularities in offers received.
(c) The Government intends to evaluate proposals and award a contract after written or oral discussions with all responsible offerors who submit proposals within the competitive range. However, each initial offer should contain the offeror's best terms from a cost or price and technical standpoint.
(d) The Government may accept any item or group of items of an offer, unless the offeror qualifies the offer by specific limitations. *Unless otherwise provided in the Schedule, offers may be submitted for quantities less than those specified. The Government reserves the right to make an award on any item for a quantity less than the quantity offered, at the unit cost or prices offered, unless the offeror specifies otherwise in the offer.*
(e) A written award or acceptance of offer mailed or otherwise furnished to the successful offeror within the time for acceptance specified in the offer shall result in a binding contract without further action by either party. Before the offer's specified expiration time, the Government may accept an offer (or part of an offer, as provided in paragraph (d) above), whether or not there are negotiations after its receipt, unless a written notice of withdrawal is received before award. Negotiations conducted after receipt of an offer do not constitute a rejection or counteroffer by the Government.
(f) Neither financial data submitted with an offer, nor representations concerning facilities or financing, will form a part of the resulting contract. However, if the resulting contract contains a clause providing for price reduction for defective cost or pricing data, the contract price will be subject to reduction if cost or pricing data furnished is incomplete, inaccurate, or not current.
(g) The Government may determine that an offer is unacceptable if the prices proposed are materially unbalanced between line items or subline items. An offer is materially unbalanced when it is based on prices significantly less than cost for some work and prices which are significantly overstated in relation to cost for other work, and if there is a reasonable doubt that the offer will result in the lowest overall cost to the Government, even though it may be the low evaluated offer, or it is so unbalanced as to be tantamount to allowing an advance payment.

L.12 FACILITIES CAPITAL COST OF MONEY (FAR 52.215-30) (SEP 1987)

(a) Facilities capital cost of money will be an allowable cost under the contemplated contract, if the criteria for allowability in subparagraph 31.205-10 (a)(2) of the Federal Acquisition Regulation are met. One of the allowability criteria requires the prospective Contractor to propose facilities capital cost of money in its offer.
(b) If the prospective Contractor does not propose this cost, the resulting contract will include the clause Waiver of Facilities Capital Cost of Money.

L.13 TYPE OF CONTRACT (FAR 52.216-1) (APR 1984)

The Government contemplates award of a cost-plus-fixed-fee contract resulting from this solicitation.

## L.14 SIC CODE AND SMALL BUSINESS SIZE STANDARD (FAR 52.219-22) (JAN 1991)

(a) The standard industrial classification (SIC) code for this acquisition is 8711.

(b)(1) The small business size standard is $13,500,000.

(2) The small business size standard for a concern which submits an offer in its own name, other than on a construction or service contract, but which proposes to furnish a product which it did not itself manufacture, is 500 employees.

## L.15 PREAWARD ON-SITE EQUAL OPPORTUNITY COMPLIANCE REVIEW (FAR 52.222-24) (APR 1984)

An award in the amount of $1 million or more will not be made under this solicitation unless the offeror and each of its known first-tier subcontractors (to whom it intends to award a subcontract of $1 million or more) are found, on the basis of a compliance review, to be able to comply with the provisions of the Equal Opportunity clause of this solicitation.

## L.16 EVALUATION OF COMPENSATION FOR PROFESSIONAL EMPLOYEES (FAR 52.222-46) (FEB 1993)

(a) Recompetition of service contracts may in some cases result in lowering the compensation (salaries and fringe benefits) paid or furnished professional employees. This lowering can be detrimental in obtaining the quality of professional services needed for adequate contract performance. It is therefore in the Government's best interest that professional employees, as defined in 29 CFR 541, be properly and fairly compensated. As a part of their proposals, offerors will submit a total compensation plan setting forth salaries and fringe benefits proposed for the professional employees who will work under the contract. The Government will evaluate the plan to assure that it reflects a sound management approach and understanding of the contract requirements. This evaluation will include an assessment of the offeror's ability to provide uninterrupted high-quality work. The professional compensation proposed will be considered in terms of its impact upon recruiting and retention, its realism, and its consistency with a total plan for compensation. Supporting information will include data, such as recognized national and regional compensation surveys and studies of professional, public and private organizations, used in establishing the total compensation structure.

(b) The compensation levels proposed should reflect a clear understanding of work to be performed and should indicate the capability of the proposed compensation structure to obtain and keep suitably qualified personnel to meet mission objectives. The salary rates or ranges must take into account differences in skills, the complexity of various disciplines, and professional job difficulty. Additionally, proposals envisioning compensation levels lower than those of predecessor Contractors for the same work will be evaluated on the basis of maintaining program continuity, uninterrupted high-quality work, and availability of required competent professional service employees. Offerors are cautioned that lowered compensation for essentially the same professional work may indicate lack of sound management judgment and lack of understanding of the requirement.

(c) The Government is concerned with the quality and stability of the work force to be employed on this contract. Professional compensation that is

unrealistically low or not in reasonable relationship to the various job categories, since it may impair the Contractor's ability to attract and retain competent professional service employees, may be viewed as evidence of failure to comprehend the complexity of the contract requirements.
(d) Failure to comply with these provisions may constitute sufficient cause to justify rejection of a proposal.

L.17 ROYALTY INFORMATION (FAR 52.227-6) (APR 1984)

(a) Cost or charges for royalties. When the response to this solicitation contains costs or charges for royalties totaling more than $250, the following information shall be included in the response relating to each separate item of royalty or license fee:
(1) Name and address of licensor.
(2) Date of license agreement.
(3) Patent numbers, patent application serial numbers, or other basis on which the royalty is payable.
(4) Brief description, including any part or model numbers of each contract item or component on which the royalty is payable.
(5) Percentage or dollar rate of royalty per unit.
(6) Unit price of contract item.
(7) Number of units.
(8) Total dollar amount of royalties.
(b) Copies of current licenses. In addition, if specifically requested by the Contracting Officer before execution of the contract, the offeror shall furnish a copy of the current license agreement and an identification of applicable claims of specific patents.

L.18 SERVICE OF PROTEST (FAR 52.233-2) (NOV 1988)

(a) Protests, as defined in Section 33.101 of the Federal Acquisition Regulation, that are filed directly with an agency, and copies of any protests that are filed with the General Accounting Office (GAO) or the General Services Administration Board of Contract Appeals (GSBCA), shall be served on the Contracting Officer (addressed as follows) by obtaining written and dated acknowledgment of receipt from William R. Kivett, NASA, Langley Research Center, Mail Stop 134, Hampton, VA 23681-0001.
(b) The copy of any protest shall be received in the office designated above on the same day a protest is filed with the GSBCA or within one day of filing a protest with the GAO.

L.19 RESTRICTION ON USE AND DISCLOSURE OF PROPOSAL/QUOTATION INFORMATION (DATA) (NASA 18-52.215-72) (DEC 1984)

It is NASA policy to use information contained in proposals and quotations for evaluation purposes only. While this policy does not require that the proposal or quotation bear a restrictive notice, offerors and quoter should, in order to maximize protection of trade secrets or other information that is commercial or financial and confidential or privileged, place the following notice on the title page of the proposal or quotation and specify the information subject to the notice by inserting appropriate identification, such as page numbers, in the notice. In any event, information (data) contained in proposals and quotations will be protected to the extent permitted by law, but NASA assumes no liability for use and disclosure of information not made subject to the notice.

RESTRICTION ON USE AND DISCLOSURE OF PROPOSAL AND QUOTATION INFORMATION (DATA)

The information (data) contained in (insert page numbers or other identification) of this proposal or quotation constitutes a trade secret and/or information that is commercial or financial and confidential or privileged. It is furnished to the Government in confidence with the understanding that it will not, without permission of the offeror, be used or disclosed for other than evaluation purposes; provided, however, that in the event a contract is awarded on this proposal or quotation the Government shall have the right to use and disclose this information (data) to the extent provided in the contract. This restriction does not limit the Government's right to use or disclose this information (data) if obtained from another source without restriction.

L.20 EXPENSES RELATED TO OFFEROR SUBMISSIONS (NASA 18-52.215-7~~5~~) (DEC 1988)

This solicitation neither commits the Government to pay any cost incurred in the submission of the offer or in making necessary studies or designs for preparing the offer, nor to contract for services or supplies. Any costs incurred in anticipation of a contract shall be at the offeror's own risk.

L.21 FALSE STATEMENTS (NASA 18-52.215-76) (DEC 1988)

PROPOSALS MUST SET FORTH FULL, ACCURATE, AND COMPLETE INFORMATION AS REQUIRED BY THE SOLICITATION (INCLUDING ATTACHMENTS). THE PENALTY FOR MAKING FALSE STATEMENTS IN PROPOSALS IS PRESCRIBED IN 18 U.S.C. 1001.

L.22 DISPOSAL OF UNSUCCESSFUL PROPOSALS (NASA 18-52.215-80) (DEC 1988)

After contract award, one or more copies of each unsuccessful proposal will be retained in the Government's official contract file, and all other copies will be destroyed.

L.23 PREPROPOSAL/PRE-BID CONFERENCE (NASA 18-52.215-77) (DEC 1988)

(a) A preproposal/pre-bid conference will be held as indicated below:

Date: August 10, 1993
Time: 8:30 a.m.
Location: NASA LaRC, H.J.E. Reid Conference Center, 14 Langley Boulevard, Building 1222, Main Auditorium
Other information: The conference is expected to last approximately three hours

For planning your itinerary, the following is a tentative agenda for the conference:

Agenda

Registration 8:30 a.m. - 9:00 a.m.
Opening Remarks 9:00 a.m. - 9:15 a.m.
LaRC Presentations 9:15 a.m. - 10:15 a.m.
Break 10:15 a.m. - 10:30 a.m.
Facilities Tour 10:30 a.m. - 11:30 a.m.
Questions and Answers 11:30 a.m. - 12:00 Noon

Attendance will be limited to a maximum of three representatives per offeror. The briefing will be unclassified. If you desire to attend the conference, you should so indicate by written or telephone contact with the appropriate individual specified in L.25 no later than August 8, 1993. After the briefing, advise this Center if you intend to submit a proposal.

In order that as many questions as possible may be answered at the NASA presentations during the briefing, written questions must be submitted to the contact listed in L.25 no later than August 8, 1993. A limited time may be available for answering questions submitted on the day of the conference. However, as there is no assurance that adequate time to answer such questions will remain, submission of questions prior to the conference, by the date specified above, will assure their being fully answered.

(b) Attendance at the preproposal/pre-bid conference is recommended; however, attendance is neither required nor a prerequisite for proposal/bid submission and will not be considered in the evaluation.

L.24 CERTIFICATE OF PROCUREMENT INTEGRITY - OFFERS (LaRC 52.203-90) (OCT 1992)

The certificate required by Federal Acquisition Regulation (FAR) provision 52.203-8, Requirement for Certificate of Procurement Integrity, Alternate I, is attached to this solicitation. In accordance with FAR 3.104-9, the officer or employee responsible for your offer for this procurement must execute this certificate after negotiation of the contract and prior to award. Do not submit the certificate with your proposal.

L.25 COMMUNICATIONS REGARDING THIS SOLICITATION (LaRC 52.204-95) (AUG 1992)

Any communications in reference to this solicitation shall cite the solicitation number and be directed to the following Government representative:

Name: R. Todd Lacks
Phone: (804) 864-2477 (COLLECT CALLS NOT ACCEPTED)
Facsimile: 804-864-7709
Address: National Aeronautics and Space Administration
Langley Research Center
Attn: R. Todd Lacks, Mail Code 126
Hampton, VA 23681-0001

Any written communications must include the mail code on the envelope or on the telex.

L.26 NASA'S POLICY ON FACILITIES CAPITAL COST OF MONEY (LaRC 52.215-95) (JUN 1988)

As required by NASA FAR Supplement 18-15.970-3, when facilities capital cost of money is included as an item of cost in the Contractor's proposal, a reduction in the profit objective shall be made in an amount equal to the amount of facilities capital cost of money allowed in accordance with FAR 31.205-10(a).

L.27 CERTIFICATION OF COST OR PRICING DATA (LaRC 52.215-97) (JUN 1988)

Pursuant to the provisions of Public Law 87-653, as amended by Public Law 97-86, the Contractor will be required to certify, except where the price negotiated is based on adequate price competition, as determined by the Contracting Officer, or established catalog or market prices of commercial items sold in substantial quantities to the general public, or prices set by law or regulation, that the cost or pricing data submitted or identified on Standard Form 1411 are accurate, complete, and current. The required certificate is set forth in FAR 15.804-4, a copy of which is attached (NASA-Langley Form PROC./P-281) and which shall be properly executed after negotiation and prior to contract award.

L.28 BIDDER'S LIBRARY

A bidder's library has been established and is located at 1 N. Dryden Street (Bldg. 1209), Room 187A at NASA LaRC. Information regarding the library and its contents is included in Attachment 6 - Bidder's Library Information. The library contains NASA Handbooks (NHB's), Langley Handbooks (LHB's), Langley Management Instructions (LMI's), and other standards, guidelines and sample reports referenced in the RFP. The hours of operation are from 8:30 a.m. to 4:00 p.m. Monday through Friday, excluding holidays. The library will be open for operation from release of the RFP through the proposal due date. Offerors wishing to visit the bidders library should contact Ms. Tracy Patterson at (804) 864-7289 to schedule an appointment. All users of the bidders library must have a proper NASA Visitor's Badge, which may be obtained from the NASA Langley Badge and Pass Office located at the Main Gate (1 Langley Boulevard). Limited copying support will be provided for materials in the bidders library. The maximum total number of pages (single side, one copy each side) which may be copied per offeror is 20.

L.29 REJECTION, NEGOTIATION, AWARD AND EXPENDITURE OF FUNDS

This solicitation does not commit the Government to award a contract, since the Government reserves the right to reject any or all proposals, or to negotiate separately with any source considered qualified. The Contracting Officer is the only individual who can legally commit the Government to the expenditure of public funds in connection with the proposed procurement.

L.30 DRAFT PROVISION - IDENTIFICATION OF UNCOMPENSATED OVERTIME

(a) As used in this provision, the following definitions apply: (i) "Uncompensated overtime" means the hours worked in excess of an average of 40 hours per week by direct charge employees who are exempt from the Fair Labor Standards Act (FLSA) without additional compensation. Compensated personal absences, such as holiday, vacations, and sick leave shall be included in the normal work week for purposes of computing uncompensated overtime hours. For purposes of this clause, uncompensated overtime also includes hours worked in excess of an average of 40 hours per week by direct charge FLSA-exempt employees for which less than full compensation was received. (ii) "Effectively hourly rate" is the rate which results from multiplying the hourly rate for a 40-hour work week by 40, and then dividing by the proposed hours per week. For example 45 hours proposed on a 40-hour work week basis at $20.00 per hour would be converted to an effective hourly rate of $17.78 per hour [($20.00 X 40) divided by 45 = $17.78.]

(b) For any hours proposed against which an effective hourly rate is applied, the Offeror shall identify in its proposal the hours in excess of an average of 40 hours per week, at the same level of detail as the initial 40 hours, and the effective hourly rate, whether at the prime or subcontract level. Such identification is required for FLSA-exempt employees who charge all or some of their time (including overtime) direct. The Offeror shall also identify any compensated overtime hours included in indirect cost pools for employees whose regular hours are normally charged direct (for example, FLSA-exempt employees placed in indirect cost pools for allocating costs among tasks under a service contract).

(c) Proposals which include unrealistically low labor rates, or which do not otherwise demonstrate cost realism, will be considered in a risk assessment and evaluated for award in accordance with that assessment.

(d) The Offeror's accounting practices used to estimate uncompensated overtime must be consistent with its cost accounting practices used to accumulate and report uncompensated overtime hours.

(e) The Offeror shall include with its proposal a copy of its policy addressing uncompensated overtime, including a description of the timekeeping and accounting systems used to record all hours worked by exempt employees.

L.31 USE OF GOVERNMENT SUPPLY SOURCES

You may assume for proposal preparation purposes that use of Government sources such as GSA Contractors will be authorized. Reference FAR Clause 52.251-1.

L.32 SMALL BUSINESS AND SMALL DISADVANTAGED BUSINESS SUBCONTRACTING PLAN (NASA 18-52.219-73) (DEC 1988) ALTERNATE I (DEC 1988)

(a) This provision is not applicable to small business concerns.
(b) The contract expected to result from this solicitation will contain FAR clause 52.219-9, "Small Business and Small Disadvantaged Business Subcontracting Plan." Each offeror must submit the complete plan with its initial proposal.

L.33 SMALL DISADVANTAGED BUSINESS SUBCONTRACTING GOAL

This solicitation requires the submission of a Small Business and Small Disadvantaged Business Subcontracting plan in accordance with the clause at FAR 52.219-9. Offerors are advised that, in keeping with Congressionally-mandated goals, NASA seeks to place its contract dollars, where feasible, with small disadvantaged business concerns as defined in 52.219-8 of the FAR and 18-52.219-76 of the NASA FAR Supplement. The Contracting Officer has determined that a goal of 5 percent of the total dollar value of your proposal is a suitable minimum goal for small disadvantaged businesses, and that such goal should constitute the minimum acceptable small disadvantaged business subcontracting goal for contract award. Note: NASA Prime Contractor can only count first tier subcontracting dollars toward the achievement of the 5 percent goal.

NOTE: NASA encourages all offerors to attempt to meet and/or exceed this goal to the maximum extent practicable and to continue to encourage small disadvantaged business development throughout the contract period. The extent of each offeror's proposed small business and small disadvantaged business subcontracting plan as it relates to the effective achieving or exceeding of this goal will be a subfactor considered by the Source Evaluation Committee in Factor 4, Other Considerations.

L.34 CONTRACTOR'S OFF-SITE FACILITY/GEOGRAPHICAL LIMITATION

The successful offeror shall provide an off-site facility to house all personnel and Contractor-furnished property. The successful offeror shall have a facility that is located within a 10-mile radius of LaRC (see Attachment 8) to qualify for consideration under this procurement. This geographical limitation is essential for the immediate resolution of emergency pressure system failures and performance of emergency repairs. NOTE: The Contractor's off-site facility must have approximately 100 square feet of storage area to house the radiographs and drawings identified in the Statement of Work (Exhibit A).

L.35 PROPOSAL PREPARATION AND SUBMISSION--SPECIAL INSTRUCTIONS

A. Number of Proposals, Time and Place of Submission--The offeror shall submit the original and 12 copies of each volume of his proposal to the address shown in Block 8 of the Standard Form (SF) 33 (face page of this solicitation), or if hand carried, to the depository listed in Block 9 of the SF 33. Offers must be received at the place indicated on or before the date and hour shown in Block 9 of the SF 33. Each volume of the original must be designated as such, and each volume of all other copies shall be numbered, one through 12, on the outside cover.

B. Proposal Clarity--Your proposal should be specific, complete, and concise. The offeror is urged to examine this solicitation in its entirety and to assure that his proposal contains all the necessary information, provides all required documentation and is complete in all respects since evaluation of the proposal will be based on the actual material presented and not on the basis of what is implied. You should ensure that your cost proposal is consistent with your technical proposal in all respects since the cost proposal may be used as an aid to determine the offeror's understanding of the technical requirements. Discrepancies may be viewed as a lack of understanding.

C. Proposal Format and Content

1. Proposals must be submitted in two (2) volumes: Volume I, Mission Suitability Proposal, and Volume II, Business Proposal. No cost information shall be presented in the Mission Suitability Proposal except the salary data requested for proposed Key Personnel.

2. Based upon our experience with procurements of this size and complexity, the items to be addressed in your Mission Suitability Proposal can be covered in 75 pages, exclusive of resumes, cover page, table of contents, list of figures, and dividers. The Government, therefore, requests that the offeror limit the Mission Suitability Proposal to a total of 75 pages. Each "page" is one side of one sheet, 8-1/2" by 11" with at least one-inch margins on all sides. Foldouts count as an equivalent number of 8-1/2" by 11" pages. Type should be no smaller than 12 points. Text should be double-spaced (no more than three lines per inch) and either variable pitch or fixed pitch of no more than 12 characters per inch. The text contained on charts, figures, and tables should also follow the same text formatting guidelines. All pages of each volume should be numbered sequentially.

D. <u>MISSION SUITABILITY PROPOSAL - VOLUME I</u>

The prime Contractor will be responsible for satisfactory accomplishment of the contract awarded hereunder. In the event other organizations are proposed as being involved in the conduct of this work, their relationship during the effort shall be indicated, and their proposed contributions to the work and to your proposal shall be identified and integrated into each part of the proposal as applicable.

<u>FACTOR 1 - MISSION SUITABILITY</u>

1. <u>Subfactor 1 - Technical Approach</u>

This subfactor will be used to evaluate your understanding of the technical requirements of the Statement of Work and your approach for meeting the requirements.

a. <u>[illegible] Services</u>--Discuss the technical issues involved [illegible] effort and your approach for performing [illegible] Statement of Work, Exhibit A to this RFP. Your [illegible]

(2) the analytical procedures that will be used in analyzing the systems;

(3) the rationale for determining the structural integrity of system components;

(4) the types of tests that will be used to establish the structural integrity of the systems;

(5) the rationale for using various nondestructive techniques;

(6) the rationale for establishing periodic inspections;

(7) the procedures for dealing with essential systems when anomalies are identified; and

(8) the procedures for developing repair specifications; and

(9) the methods of performing emergency repairs.

In addition to the above, to further convey your understanding, your proposal should discuss typical problems associated with pressure systems recertification effort and proposed resolutions. Include contingency plans, as applicable. You should discuss any innovative ideas or improvements that may be applied in performing the pressure systems recertification effort.

Insure that your proposal includes all information necessary to clearly convey that you understand the pressure systems recertification effort and can effectively perform it.

b. <u>Configuration Management (CM) Services</u>--Discuss the technical issues involved in performing CM services and your approach for performing Section 3.0 of the Statement of Work, Exhibit A to this RFP. Your proposal should address, as a minimum, the following:

(1) approach to controlling safety through CM (as described in NASA LHB 1740.4, Facility System Safety Analysis and Configuration Management, June 1987);

(2) procedures for updating Safety Analysis Reports, operating procedures, checklists, and Configuration Controlled Drawings;

(3) methods of incorporating recertification documentation into the CM program;

(4) approach to interfacing with NASA facility personnel;

(5) techniques for assisting LaRC's Safety Manager in conducting operating procedure demonstrations;

(6) methods of evaluating Change Notification Sheets;

(7) procedures for maintaining the Laboratory Risk Evaluations, Asbestos CM, and Pressure Systems CM Programs;

(8) methods and equipment that will be used in processing Configuration Controlled Drawings;

(9) system safety techniques to evaluate risks associated with Construction-of-Facilities projects;

(10) processes for tracking and monitoring Problem Failure Reports;

(11) techniques for maintaining the CM Program for Flight Projects;

(12) methods for controlling and updating the Aerothermal Loads Branch's supporting facility documentation; and

(13) procedures for operating the 8' High Temperature Tunnel's Library.

In addition to the above, to further convey your understanding, your proposal should discuss typical problems associated with the CM effort and proposed resolutions. Include contingency plans, as applicable. You should discuss any innovative ideas or improvements that may be applied in performing the CM effort.

Insure that your proposal includes all information necessary to clearly convey that you understand the CM effort and can effectively perform it.

2. Subfactor 2 - Phase-In Plan, Staffing and Continuing Personnel Management

This subfactor will be used to calculate the excellence of your plans for: initial phase-in, minimizing changeover difficulties, maximizing continuity of services to the Government, and maintaining competent staffing for the term of the contract. Accordingly, your proposal should include the following:

a. Description and schedule of all phase-in activities. NOTE: For purposes of establishing your phase-in milestones, assume Contractor selection in December 1993, contract award in January 1994, and a contract start date of March 1, 1994.

b. Plans for reaching the required complement of qualified personnel by contract start (March 1, 1994); a table of personnel sources noting the percentage of the total initial work force which you intend to obtain from the following: your own resources, other divisions of your company, subcontractor or team agreements, outside recruitment, and incumbent personnel retention. Provide your basis for anticipated incumbent work force retention and the proposed mix of personnel sources. You should discuss your plans for making operational any non-personnel resources required for contract performance; e.g., facility, materials, equipment, and vehicles.

c. Description of the recruitment and employment methods your company will use to staff the contract during the contract term. Programs and policies for minimizing turnover and retaining experienced personnel. Additionally, you should identify specific recruitment plans for the following highly skilled and difficult-to-locate positions:

Lead Structural & Pressure Systems Engineer
Lead Systems Safety Engineer
Senior Structural Engineer

For each position identified above describe, through the use of position descriptions, hiring vacancy announcements, or sample resumes, the qualifications necessary to perform the function. Also, discuss specific sources of recruitment; sources of advertisement; time frame required to effect hire; and typical problems encountered in filling the vacancies and proposed solutions to these problems. Describe your company's past recruiting experiences with similar skills.

d. Description of your training, orientation, and career development plans.

e. Description of your programs for motivating and incentivizing employees to continuously improve performance and increase productivity.

f. Discussion of your plans for accommodating personnel absences and fluctuating workloads.

3. Subfactor 3 - Total Compensation Plan

This subfactor will be used to evaluate the suitability of the proposed compensation structure to assure that highly qualified employees are attracted to perform the effort and their continued interest and employment are likely to occur. Accordingly, the offeror should submit a Total Compensation Plan for the professional and non-professional employees proposed to perform the Statement of Work to include salaries/wages and a detailed description of fringe benefits and leave policies. Itemize the benefits that require employee contributions and the amount of that contribution as a percentage of the total cost of the benefit and of the employee's salary or wage. Describe your policies for establishing the wage levels of any retained incumbent Contractor employees and explain the eligibility and vesting for hired incumbent Contractor employees for your proposed fringe benefits; e.g., vacation, medical insurance, sick leave, and retirement. Describe how pre-existing medical conditions for incumbents and their dependents will be handled under your health insurance plan. Highlight differences, if any, between the compensation policies for professional and non-professional personnel. The Total Compensation Plan should be submitted in accordance with FAR 52.222-46 (see L.16 of this RFP). Include your compensation plans for all professional positions as defined in 29 CFR 541.

(5) Any corporate support that will be available under this contract.

E. BUSINESS PROPOSAL - VOLUME II

1. FACTOR 2 - COST

a. Offerors are required to submit cost proposals using Standard Form (SF) 1411, Contract Pricing Proposal Cover Sheet, a copy of which is included as Attachment 2 of the solicitation. Offerors shall fully comply with the requirements of Table 15-2, Instructions for Submission of a Contract Pricing Proposal, which begins on Page 2 of the SF 1411. Provide supporting information for each cost element as required by Table 15-2. Offerors shall also provide Cost Forms as specified in Attachment 4, on diskette as well as in their written proposals, to aid the source evaluation committee in comparing the proposed costs. SF 1411's and cost forms shall be provided as follows:

| | Forms | Period |
|---|---|---|
| Phase-In | SF 1411 | Prior to 3/1/94 |
| First Year of Initial Contract Period | A-1, B-1 | 3/1/94 - 2/28/95 |
| Second Year of Initial Contract Period | A-2, B-2 | 3/1/95 - 2/29/96 |
| Third Year of Initial Contract Period | A-3, B-3 | 3/1/96 - 2/28/97 |
| Fourth Year of Initial Contract Period | A-4, B-4 | 3/1/97 - 2/28/98 |
| Fifth Year of Initial Contract Period | A-5, B-5 | 3/1/98 - 2/28/99 |
| Total Initial Contract Period (Five Years) | SF 1411, A-6 | 3/1/94 - 2/28/99 |
| Options to Extend 1 - 6 (One Mo. Each) | SF 1411, A-7, B-6 | 3/1/99 - 8/31/99 |
| Options to Increase Direct Labor | SF 1411, C | 3/1/94 - 2/28/99 |
| Total, Ph.-In, Init. Contr. and All Opts. | SF 1411, A-8 | 3/1/94 - 8/31/99 |

If your proposed costs for the six one-month extension options will be the same for each of the months, you may submit one Form A-7, one Form B-6, and one SF 1411; otherwise submit one of each form for each month. (Make additional copies of A-7 and B-6 in the spreadsheet file if submission of six each is necessary.) Diskettes containing the forms in a spreadsheet file will be provided to offerors upon request, and the Government-provided spreadsheets must be completed and submitted as part of your proposal. Forms must also be submitted on paper, and a complete paper set will be provided to offerors with the diskette if requested. The forms included in Attachment 4 were printed as Lotus 1-2-3 for Windows spreadsheets. The Government-provided diskettes will be furnished as 1-2-3 2.x, 1-2-3 3x, 1-2-3 W, or Quattro Pro for DOS or Windows spreadsheets as requested by the proposer. Also specify diskette size (3-1/2" or 5-1/4") and density (360Kb, 720Kb, 1.2 Mb, 1.44 Mb). The paper forms you submit with your proposal may be printed from your completed spreadsheets; they need not have the same appearance as the examples in Attachment 4 as long as they are readable. You may change column widths, formats, fonts, etc., but DO NOT MOVE CELLS and DO NOT INSERT OR DELETE ROWS OR COLUMNS. Submit two copies of your diskette(s). In the event of any inconsistency between the diskettes and the paper forms, the paper forms will be considered the intended version.

You are encouraged, but not required, to prepare your entire cost proposal using a spreadsheet program, and to connect the proposal to the NASA forms with spreadsheet formulas.

b. Your cost proposal as represented by the Standard Forms 1411 must be prepared in accordance with your accounting system and your Cost Accounting Standards Disclosure Statement if applicable.

c. Instructions for Cost Forms A, B, and C

(1) Offerors shall complete the A and B series of forms and Form C in accordance with the following instructions, even though the resulting cost classifications may differ from the offeror's accounting system and practices. If these costs classifications differ from your established classification system, identify, reconcile, and explain the differences.

(2) Amounts proposed for each cost element must be separately supported by an explanation of the method by which the amount was determined. Insert "N/A" where cost elements on the forms do not apply.

(3) If escalation of salaries and wages or any other cost elements is proposed, the offeror should discuss the rationale and provide the offeror's escalation history for the past three years.

(4) Instructions for specific items on the forms follow.

(a) Direct labor - Forms B-1 through B-6 must be used to present your proposed direct labor costs, and totals from B-1 through B-6 should be entered in the appropriate spaces in Forms A-1 through A-8. For Year 1 you must propose the direct labor hours (as defined in B.5.B) necessary to provide the 51 positions set forth in "Staffing and Position Qualifications for Year 1," under Attachment 5. For Years 2 through 5 and for the six one-month options you must propose the direct labor hours necessary to provide the 46 positions set forth in "Staffing and Position Qualifications for Year 2 through Year 5," under Attachment 5. Explain the number of hours you use to calculate the costs for each position.

A copy of the Register of Wage Determinations and Fringe Benefits issued by the Department of Labor for employees under this proposed contract is included in Exhibit F. It should be noted that the wage rates specified therein are minimum rates. It should also be noted that the wage determination may not list all labor classes to be employed under this contract. Paragraph (a) of the Section I clause entitled "Service Contract Act of 1965" states that in this event, conformable rates must be established for those service employees to be employed under the contract but not listed on the wage determination. These conformable wage rates will be the result of a three-party agreement between the employees, Contractor, and the Government.

Any composite hourly rates on forms B-1 through B-6 must be explained.

If you propose to subcontract any part of the required direct labor, have the prospective subcontractor complete separate SF 1411's, Forms A-1 through A-8, B-1 through B-6, and, if applicable, C. (The prospective subcontractor should complete the forms as if it is a prime contract proposer.)

Any shift differential costs should be entered in the appropriate places on Forms A-1 through A-8.

(b) Fringes and Payroll Taxes - Enter the fringe benefits and payroll tax costs applicable to direct labor costs and any labor shown under "Allocated Labor Other than G&A." Fringe benefits and payroll taxes applicable to subcontracts for level of effort labor should be included by the prime proposer in "Costs Other than Labor, and Profit, for Subcontracts in LOE."

If it is your normal practice to account for fringe benefits and payroll taxes as direct costs, or if you intend to include these costs in a fringe benefit or overhead pool dedicated to the proposed contract only, estimate the costs for each element and enter on the forms. If these costs are part of a fringe benefit or overhead pool that will allocate to other cost objectives as well as to the proposed contract, and you normally estimate such costs by projecting a fringe benefit or overhead rate to be applied to a base such as direct labor cost, estimate the costs according to the normal practice and divide the costs among the various individual elements in a logical manner.

(c) Costs Other than Labor, and Profit, for Subcontracts in LOE - Enter, and provide details in supporting data, all of your level-of-effort subcontracts' costs except the labor costs entered under "Subcontract Direct Level of Effort Labor" above, and the profits or fees you expect to negotiate with the subcontractors. As noted previously, any such subcontractors should complete forms A-1 through A-8 and B-1 through B-6.

(d) Subcontracts Other than Level of Effort - Enter the costs of any subcontracts other than those that will provide a part of the required level of effort. Any such subcontracts in excess of $500,000 must be supported by SF 1411's and applicable cost or pricing data.

(e) Material, Equipment, Equipment Rental, and Emergency Repair Services - These costs are estimated by the Government to be $347,000 per year for each of the five years in the initial contract period, and you should use these amounts in your proposal. "Equipment" as used in this cost item means purchased equipment required for specific tasks, as opposed to equipment such as vehicles and furniture necessary for the overall performance of the contract. Depreciation costs related to the latter should be shown under "Capital Equipment Costs/Leased Equipment Costs." If G&A or other burden applies to some or all of these items, include the cost under G&A and/or "Cost Not Shown Elsewhere." If G&A or other burden applies to some but not all of these items, estimate the costs insofar as possible and explain.

(f) Nondestructive Examination (NDE) - The Government estimates that the costs for nondestructive examination and asbestos removal, transportation, and disposal services will be $400,000 per year for each of the five years of the initial contract, and you should use these amounts in your proposal. However, you should also thoroughly explain how you will provide NDE (subcontract, in-house, etc.) and explain the composition of the costs. if NDE will be subcontracted, include in the appropriate place any burden or G&A that will apply. If you will perform NDE directly, (1) assume that the $400,000 amount given includes labor, overhead, and all other direct costs, and show G&A in the G&A line; and (2) indicate labor rates for personnel who will provide the NDE work, and explain all other charges that will apply. NOTE: The NDE and the asbestos removal requirements are sporadic and highly dependent on the availability of Government funding. Historically, these services have been subcontracted.

(g) Buildings and Related Costs - Enter the costs related to your facility. It should include rent or depreciation or allocated portion thereof, property taxes if applicable, insurance, costs of modifications that will be charged to the proposed contract, utilities, telephone service, maintenance of buildings and grounds, fixtures, and security if applicable.

(h) Capital Equipment Costs/Leased Equipment Costs - Enter the costs related to vehicles and any other tangible capital equipment. Fully explain the costs and provide the rationale for the methods of acquisition selected. Provide the term of any proposed leases.

(i) Allocated Labor Other than G&A - Enter any non-G&A labor costs that will be allocated to the proposed contract through an indirect cost pool other than one entirely dedicated to the proposed contract.

(j) City/County Business License Tax - Consult applicable local jurisdictions to determine any applicable business license taxes and enter your estimates here. Consult the City of Hampton regarding personnel to be housed at LaRC even if your facility will not be located in Hampton.

(k) Costs not Shown Elsewhere - Enter any costs not covered by one of the preceding cost elements, facilities capital cost of money, or G&A. Examples of possible entries here are material burden if applicable; and costs included in a labor overhead pool that have not been entered under "Fringes and Payroll Taxes."

(l) G&A - Enter G&A costs, and identify separately the rates used to determine the costs. Provide the composition of the G&A pool costs and allocation bases upon which the rates were determined. Provide G&A rate history for the preceding three fiscal years.

(m) Facilities Capital Cost of Money - Enter FCCOM if you choose to include it in your proposal (please note L.12). If you do not propose FCCOM, Clause 52.215-31, WAIVER OF FACILITIES CAPITAL COST OF MONEY (SEPT 1987) will be included in the contract.

(n) Award Fee - Enter the amounts, and provide your rationale for determining the proposed amount.

(o) Options to Increase the Direct Labor Hours (Ref. H.16.B) - Use Form C for the costs of the options to increase the direct labor hours specified by B.5.A. The maximum additional direct labor hours required should be based on:

| | Period | Man-Years or *Man-Months |
|---|---|---|
| First Year of Initial Contract | 3/1/94 - 2/28/95 | 4 |
| Second Year of Initial Contract | 3/1/95 - 2/29/96 | 8 |
| Third Year of Initial Contract | 3/1/96 - 2/28/97 | 12 |
| Fourth Year of Initial Contract | 3/1/97 - 2/28/98 | 16 |
| Fifth Year of Initial Contract | 3/1/98 - 2/28/99 | 20 |
| Each of six one-month extension options | 3/1/99 - 8/31/99 | *20 |

You should use the weighted average straight-time rate of all direct labor personnel except for Job Titles 1 through 6 as identified in Attachment 5, Staffing and Position Qualifications, to cost the optional effort.

Please refer to the previous instructions for completing individual cost elements to make entries on Form C.

2. FACTOR 3 - RELEVANT EXPERIENCE AND PAST PERFORMANCE

You should submit a summary of your experience and performance history with respect to meeting technical objectives on schedule and within cost on related efforts. You should also submit a summary of the experience and performance history on related efforts of proposed major subcontractors. Experience is the accomplishment of work which is comparable or related to the work or effort required by this RFP. This factor includes the evaluation of overall corporate or offeror experience and past performance, but not the experience and performance of individuals who are proposed to be involved with work pursuant to this RFP. You are cautioned that omissions or an inaccurate or inadequate response to this evaluation factor will have a negative effect on your overall evaluation. Your summary should include the following for each related contract: contract number, contracting agency, telephone number, point of contact at agency, contract type, dollar value, dates contract began and ended or ends, description of contract work and explanation of relevance of work to this RFP, and actual delivery and cost performance versus delivery and cost agreed to in contract. For award fee contracts, separately state in dollars the base fee and award fee available and the award fee actually received, on a contract year basis.

3. FACTOR 4 - OTHER CONSIDERATIONS

a. Subfactor 1 - Subcontracting Plan for Small Business and Small Disadvantaged Business Concerns

The offeror (except small businesses) shall include a proposed subcontracting plan for small business and small disadvantaged business concerns for consideration in the source evaluation and selection process. The planned subcontracting amounts should be broken out and provided for each contract period, for a total contract duration of five years. This plan must comply with the Section I clause entitled, "Small Business and Small Disadvantaged Business Subcontracting Plan," and should provide for the small disadvantaged business goal that is equal to or greater than the goal referenced in L.33.

NOTE: Your proposed subcontracting goal to small disadvantaged business concerns shall include any planned subcontract awards to small disadvantaged business concerns as defined in FAR Clause 52.219-8 and Women-Owned Businesses, Historically Black Colleges and Universities, and other Minority Educational Institutions as defined in NASA FAR Supplement Clause 18-52.219-76.

b. Subfactor 2 - Financial Condition and Capability

In order for your financial responsibility to be evaluated, you must submit profit and loss statements for your last three Fiscal Years and balance sheets as of the end of your last three Fiscal Years. In addition, indicate your current credit rating, lines of credit, sources of funds, and proposed means for financing any resulting contract.

c. Subfactor 3 - Facility

Your attention is directed to the requirements of L.34. Include evidence that you have or will have a facility by contract start date (March 1, 1994). You should specify the size, general description, and interior layout of the local facility (layout drawings should be to scale). You should provide evidence of your proposed lease or purchase arrangements including costs, your plan for maintaining the operational status of the facility, and any options for future expansion of the facility to house all or a portion of the work force contained in the options set forth in H.16. Members of the Source Evaluation Committee may inspect the proposed off-site facility.

d. Subfactor 4 - Contract Terms and Conditions

You should cite any proposed exceptions that you have to the terms and conditions, together with an explanation of the basis therefor, and your proposed means for resolving any such exceptions should be discussed. This same information for any additive terms and conditions should be provided.

## SECTION M - EVALUATION FACTORS FOR AWARD

### M.1 METHOD OF EVALUATION

A. Proposals received in response to this RFP will be evaluated by a Source Evaluation Committee (SEC) in accordance with procedures similar to those prescribed in the NASA Handbook (NHB) 5103.6B. Mission Suitability will be scored. Cost, Relevant Experience and Past Performance and Other Considerations will be evaluated but not scored. The Source Selection Official, after consultation with the SEC, will select the offeror (or offerors) for final negotiation which he considers can perform the contract in a manner most advantageous to the Government, all factors considered.

B. Alternate Evaluation Procedures--The SEC may use evaluation procedures outlined in NHB 5103.6B or may use alternate procedures outlined in the NASA Streamlined Acquisition Handbook which dispense with initial scoring. Under the alternate procedure, proposals are initially reviewed to eliminate unacceptable proposals and determine strong and weak points, develop questions and proceed directly to written and/or oral discussion. Following questions, "Best and Final Offers," are requested. Based on the "Best and Final Offers," proposals are reexamined and scored.

C. Evaluation will be on the basis of material presented and substantiated in your proposal and not on the basis of what may be implied. Vague statements will be interpreted as a lack of understanding on the part of the offeror and/or inability to demonstrate adequate qualifications. Your attention is directed to Section L, L.35, which provides important instructions concerning proposal preparation.

M.2 EVALUATION FACTORS

A. <u>Factor 1 - Mission Suitability</u>--The content of this section of your proposal will provide the basis for evaluation of your response to the technical requirements of the RFP. The Mission Suitability Subfactors to be considered and scored in the evaluation of your Mission Suitability Proposal are set forth below:

1. <u>Subfactor 1 - Technical Approach</u>

a. <u>Structural and Pressure Systems Recertification Effort</u>--This subfactor will be used to evaluate the offeror's understanding of the structural and pressure systems recertification technical requirements, ability to accomplish the work as demonstrated by the discussion of the technical issues involved, the proposed approach for performing the structural and pressure systems recertification effort, and any innovative ideas or improvements.

b. <u>Configuration Management Effort</u>--This subfactor will be used to evaluate the offeror's understanding of the configuration management requirements, the ability to accomplish the work as demonstrated by the discussion of the technical issues involved, the proposed approach for performing the configuration management effort, and any innovative ideas or improvements.

2. <u>Subfactor 2 - Phase-In Plan, Staffing, Continuing Personnel Management</u>

Under this subfactor an evaluation will be made regarding the excellence of your plans for initial phase-in, minimizing changeover difficulties, maximizing continuity of services to the Government, and maintaining competent staffing during the term of the contract. The following items will be evaluated:

a. Effectiveness of your phase-in schedule including your approach to meeting each milestone.

b. Effectiveness of your plan to fully staff the contract by contract start (March 1, 1994) with qualified personnel and make operational the non-personnel resources, e.g., facility, materials, equipment, and vehicles. Soundness of the rationale for the proposed mix of personnel sources will be evaluated.

c. Effectiveness of your recruitment and employment methods proposed to staff the contract during the contract term for all personnel and the effectiveness of your programs and policies for minimizing turnover and retaining experienced personnel. In addition, the offeror's position descriptions, hiring vacancy announcements, or sample resumes for the highly skilled and difficult-to-locate positions identified will be evaluated with regard to education, experience, and other qualifications to insure that they reflect an understanding of the requirements to be performed. The effectiveness of specific recruitment plans for the highly skilled and difficult-to-locate positions identified.

d. Approach to training, orientation, and career development will be evaluated to assess your company's understanding of the needs relevant to this proposed effort.

e. Effectiveness of your programs for motivating and incentivizing employees to continuously improve performance and increase productivity.

f. Excellence of your plans for accommodating personnel absences and fluctuating workloads.

3. Subfactor 3 - Total Compensation Plan

Your proposed Total Compensation Plan (professional and non-professional) will be evaluated regarding the suitability, reasonableness, and equitableness of the proposed compensation structure (both salaries/wages and fringe benefits) to assure that highly qualified personnel are attracted to the effort and their continued interest and employment are likely to occur. Professional and non-professional compensation will also be evaluated to assure that the proposed compensation reflects an understanding of the requirements to be performed. NOTE: Reference L.16, Evaluation of Compensation for Professional Employees, for additional instructions.

4. Subfactor 4 - Key Personnel and Organization

a. Qualifications and Availability of Key Personnel--This subfactor will be used to evaluate the education, experience, and other qualifications of your proposed Key Personnel against their proposed functions/duties and the position qualifications set forth in Attachment 5, Staffing and Position Qualifications. The evidence of availability of key personnel at reasonable compensation level will be evaluated. Consideration will be given to the capability and knowledge demonstrated by proposed Key Personnel at oral discussions, if held, as well as the findings of any reference checks which are made.

b. Organization--This subfactor will be used to evaluate the adequacy and suitability of the proposed organization, including the key personnel and any subcontracting or teaming agreements proposed, for performing the work efficiently and effectively. Corporate support will be evaluated regarding the extent, suitability, and availability of the support for this contract. The following items will be considered in the Government's evaluation:

(1) Corporate/company/team organization.

(2) Contract unit's organization, the placement and reporting relationship of any subcontractor or team member within the contract unit, and subcontractor/team effort integration with the prime effort. Proposed subcontracting and/or consulting agreements, including the rationale for the arrangement, the qualifications of the subcontractor or team members, nature and extent of effort, and commitment of subcontractor to this effort.

(3) Distribution of management and administrative effort.

(4) Duties, responsibilities, authority of key positions, and the rationale for the designation of key personnel.

(5) Extent, suitability, and availability of corporate support proposed for this contract effort will be evaluated.

B. Factor 2 - Cost--An analysis of the proposed cost and fee for the basic and priced option periods, and for the options for additional labor will be conducted to determine their validity and the extent to which they reflect performance addressed in the Mission Suitability proposal. An assessment will be made of the offeror's capability to accomplish the contract objectives within the estimated cost proposed. The reasonableness of the proposed fixed fee will also be determined in accordance with the guidelines set forth in NASA FAR Supplement 18-15.902. A probable cost will be developed in accordance with NHB 5103.6 for each proposal in the competitive range or, in the event the Alternate Evaluation Procedures are used, for each acceptable proposal. The cost proposal may be used as an aid to determine the offeror's understanding of Mission Suitability Requirements.

C. Factor 3 - Relevant Experience and Past Performance--Experience and past performance will be assessed to determine the extent to which contract objectives (including technical, schedule and cost) have been achieved on related efforts. Experience will be viewed as the demonstrated accomplishment of work which is comparable and relevant to the objectives of this procurement. This factor includes the evaluation of overall corporate or offeror experience and past performance, including major subcontractors, but not the experience and performance of individuals who are proposed to be involved in the required work. Independent verification will be made as needed.

D. Factor 4 - Other Considerations--The following subfactors will be evaluated based on information presented in your proposal and all other information available to NASA.

1. Subfactor 1 - Small Business and Small Disadvantaged Business Subcontracting Plan

Your plan will be evaluated to determine the extent of the offeror's compliance with NASA policy to afford maximum practicable opportunity for small and small disadvantaged business concerns to participate in Government contracts. This subfactor will consider the extent that the proposed small disadvantaged business goal is greater or less than the goal stated in L.33 and your probability of meeting these goals based on your plan. A proposed small disadvantaged goal less than the goal referenced in L.33, will have a negative effect on your evaluation of this subfactor. NOTE: This subfactor does not apply to small business offerors.

2. Subfactor 2 - Financial Condition and Capability

Your financial position (and that of all proposed major subcontractors) will be evaluated with regard to its soundness and to insure that adequate financial resources are available to perform this effort for the total potential period of performance.

3. Subfactor 3 - Facility

Your proposed off-site facility will be evaluated to determine the appropriateness of the facility's size, location , and lay-out to house the necessary personnel and equipment, to facilitate the accomplishment of the contract effort. Any lease/purchase agreement will also be reviewed.

4. Subfactor 4 - Contract Terms and Conditions

Your proposal will be reviewed to determine the extent to which terms and conditions as set forth in the RFP are accepted. Your rationale for and the acceptability of any exceptions will be evaluated.

M.3 RELATIVE IMPORTANCE OF EVALUATION FACTORS

A. The weights to be used in the scoring of the Mission Suitability Subfactors are presented below:

| | Subfactors | Weights |
|---|---|---|
| 1. | Technical Approach | 40% |
| 2. | Phase-In, Initial Staffing, and Continuing Personnel Management | 15% |
| 3. | Total Compensation Plan | 15% |
| 4. | Key Personnel and Organization | 30% |
| | | 100% |

The numerical weights assigned to the above subfactors are indicative of the relative importance of those evaluation areas. The weights will be utilized only as a guide.

B. Overall, in the selection of a Contractor for negotiation leading to contract award, Mission Suitability, Cost, Relevant Experience and Past Performance and Other Considerations will be of essentially equal importance. Within Factor 2, Cost, the costs associated with the options for the additional level-of-effort and the six 1-month option periods may be considered of less significance than the costs for the five year base period (including phase-in).

ATTACHMENT I

CERTIFICATE OF CURRENT COST OR PRICING DATA

ATTACHMENT 1

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
LANGLEY RESEARCH CENTER
HAMPTON, VIRGINIA 23665-5225

## CERTIFICATE OF CURRENT COST OR PRICING DATA

This is to certify that, to the best of my knowledge and belief, the cost or pricing data (as defined in Section 15.801 of the Federal Acquisition Regulation (FAR) and required under FAR Subsection 15.804-2) submitted, either actually or by specific identification in writing, to the Contracting Officer or the Contracting Officer's representative in support of ____________________* are accurate, complete, and current as of ______________________**
day month year

This certification includes the cost or pricing data supporting any advance agreements and forward pricing rate agreements between the offeror and the Government that are part of the proposal.

FIRM ____________________________

NAME ____________________________

TITLE ____________________________

_________________***
Date of Execution

*Identify the proposal, quotation, request for price adjustment, or other submission involved, giving the appropriate identifying number (e.g., RFP No.).

**Insert the day, month, and year when price negotiations were concluded and the price agreement was reached.

***Insert the day, month, and year of signing, which should be as close as practicable to the date when the price negotiations were concluded and the contract price was agreed to.

ATTACHMENT 2

# CONTRACT PRICING PROPOSAL COVER SHEET

1. SOLICITATION/CONTRACT/MODIFICATION NO.

FORM APPROVED OMB NO. 9000-0013

NOTE: This form is used in contract actions if submission of cost or pricing data is required. *(See FAR 15.804-6(b))*

2. NAME AND ADDRESS OF OFFEROR *(Include ZIP Code)*

3A. NAME AND TITLE OF OFFEROR'S POINT OF CONTACT

3B. TELEPHONE NO.

4. TYPE OF CONTRACT ACTION *(Check)*

- [ ] A. NEW CONTRACT
- [ ] B. CHANGE ORDER
- [ ] C. PRICE REVISION/ REDETERMINATION
- [ ] D. LETTER CONTRACT
- [ ] E. UNPRICED ORDER
- [ ] F. OTHER *(Specify)*

5. TYPE OF CONTRACT *(Check)*

- [ ] FFP
- [ ] CPFF
- [ ] CPIF
- [ ] CPAF
- [ ] FPI
- [ ] OTHER *(Specify)*

6. PROPOSED COST *(A+B=C)*

| A. COST | B. PROFIT/FEE | C. TOTAL |
|---|---|---|
| $ | $ | $ |

7. PLACE(S) AND PERIOD(S) OF PERFORMANCE

8. List and reference the identification, quantity and total price proposed for each contract line item. A line item cost breakdown supporting this recap is required unless otherwise specified by the Contracting Officer. *(Continue on reverse, and then on plain paper, if necessary. Use same headings.)*

| A. LINE ITEM NO. | B. IDENTIFICATION | C. QUANTITY | D. TOTAL PRICE | E. REF. |
|---|---|---|---|---|
| | | | | |

9. PROVIDE NAME, ADDRESS, AND TELEPHONE NUMBER FOR THE FOLLOWING *(If available)*

A. CONTRACT ADMINISTRATION OFFICE

B. AUDIT OFFICE

10. WILL YOU REQUIRE THE USE OF ANY GOVERNMENT PROPERTY IN THE PERFORMANCE OF THIS WORK? *(If "Yes," identify)*

- [ ] YES
- [ ] NO

11A. DO YOU REQUIRE GOVERNMENT CONTRACT FINANCING TO PERFORM THIS PROPOSED CONTRACT? *(If "Yes," complete Item 11B)*

- [ ] YES
- [ ] NO

11B. TYPE OF FINANCING *(✓ one)*

- [ ] ADVANCE PAYMENTS
- [ ] PROGRESS PAYMENTS
- [ ] GUARANTEED LOANS

12. HAVE YOU BEEN AWARDED ANY CONTRACTS OR SUBCONTRACTS FOR THE SAME OR SIMILAR ITEMS WITHIN THE PAST 3 YEARS? *(If "Yes," identify item(s), customer(s) and contract number(s))*

- [ ] YES
- [ ] NO

13. IS THIS PROPOSAL CONSISTENT WITH YOUR ESTABLISHED ESTIMATING AND ACCOUNTING PRACTICES AND PROCEDURES AND FAR PART 31 COST PRINCIPLES? *(If "No," explain)*

- [ ] YES
- [ ] NO

14. COST ACCOUNTING STANDARDS BOARD (CASB) DATA *(Public Law 91-379 as amended and FAR PART 30)*

A. WILL THIS CONTRACT ACTION BE SUBJECT TO CASB REGULATIONS? *(If "No," explain in proposal)*

- [ ] YES
- [ ] NO

B. HAVE YOU SUBMITTED A CASB DISCLOSURE STATEMENT (CASB DS-1 or 2)? *(If "Yes," specify in proposal the office to which submitted and if determined to be adequate)*

- [ ] YES
- [ ] NO

C. HAVE YOU BEEN NOTIFIED THAT YOU ARE OR MAY BE IN NON-COMPLIANCE WITH YOUR DISCLOSURE STATEMENT OR COST ACCOUNTING STANDARDS? *(If "Yes," explain in proposal)*

- [ ] YES
- [ ] NO

D. IS ANY ASPECT OF THIS PROPOSAL INCONSISTENT WITH YOUR DISCLOSED PRACTICES OR APPLICABLE COST ACCOUNTING STANDARDS? *(If "Yes," explain in proposal)*

- [ ] YES
- [ ] NO

This proposal is submitted in response to the RFP, contract, modification, etc. in Item 1 and reflects our best estimates and/or actual costs as of this date and conforms with the instructions in FAR 15.804 6(b) (2), Table 15-2. By submitting this proposal, the offeror, if selected for negotiation, grants the contracting officer or an authorized representative the right to examine, at any time before award, those books, records, documents and other types of factual information, regardless of form or whether such supporting information is specifically referenced or included in the proposal as the basis for pricing, that will permit an adequate evaluation of the proposed price.

15. NAME AND TITLE *(Type)*

16. NAME OF FIRM

17. SIGNATURE

18. DATE OF SUBMISSION

TABLE 15-2 INSTRUCTIONS FOR SUBMISSION OF A CONTRACT PRICING PROPOSAL*

1. SF 1411 provides a vehicle for the offeror to submit to the Government a pricing proposal of estimated and/or incurred costs by contract line item with supporting information, adequately cross-referenced, suitable for detailed analysis. A cost-element breakdown, using the applicable format prescribed in 7A, B, or C below, shall be attached for each proposed line item and must reflect any specific requirements established by the contracting officer. Supporting breakdowns must be furnished for each cost element, consistent with offeror's cost accounting system. When more than one contract line item is proposed, summary total amounts covering all line items must be furnished for each cost element. If agreement has been reached with Government representatives on use of forward pricing rates/factors, identify the agreement, include a copy, and describe its nature. Depending on offeror's system, breakdowns shall be provided for the following basic elements of cost, as applicable:

Materials--Provide a consolidated priced summary of individual material quantities included in the various tasks, orders, or contract line items being proposed and the basis for pricing (vendor quotes, invoice prices, etc.). Include raw materials, parts, components, assemblies, and services to be produced or performed by others. For all items proposed, identify the item and show the source, quantity, and price.

Competitive Methods--For those acquisitions (e.g., subcontracts, purchase orders, material orders, etc.) over $500,000 priced on a competitive basis, also provide data showing degree of competition, and the basis for establishing the source and reasonableness of price. For interorganizational transfers priced at other than cost of the comparable competitive commercial work of the division, subsidiary, or affiliate of the contractor, explain the pricing method (see 31.205-26(e)).

Established Catalog or Market Prices/Prices Set by Law or Regulation--When an exemption from the requirement to submit cost or pricing data is claimed, whether the item was produced by others or by the offeror, provide justification for the exemption as required by 15.804-3(e).

Noncompetitive Methods--For those acquisitions (e.g., subcontracts, purchase orders, material orders, etc.) over $500,000 priced on a noncompetitive basis, also provide data showing the basis for establishing source and reasonableness of price. For standard commercial items fabricated by the offeror that are generally stocked in inventory, provide a separate cost breakdown if priced based on cost. For interorganizational transfers priced at cost, provide a separate breakdown of cost by elements. As required by 15.806-2(a), provide a copy of cost or pricing data submitted by the prospective source in support of each subcontract, or purchase order that is either (i) $1,000,000 or more, or (ii) both more than $500,000 and more than 10 percent of the prime contractor's proposed price. The contracting officer may require submission of cost or pricing data in support of proposals in lower amounts. Submit the results of the analysis of the prospective source's proposal as required by 15.806. When the submission of a prospective source's cost or pricing data is required as described above, it shall be included as part of the offeror's initial pricing proposal.

Direct Labor--Provide a time-phased (e.g., monthly, quarterly, etc.) breakdown of labor hours, rates, and cost by appropriate category, and furnish bases for estimates.

Indirect Costs--Indicate how offeror has computed and applied offeror's indirect costs, including cost breakdowns, and showing trends and budgetary data, to provide a basis for evaluating the reasonableness of proposed rates. Indicate the rates used and provide an appropriate explan. .on.

Other Costs--List all other costs not otherwise included in the categories described above (e.g., special tooling, travel, computer and consultant services, preservation, packaging and packing, spoilage and rework, and Federal excise tax on furnished articles) and provide bases for pricing.

Royalties--If more than $250, provide the following information on a separate page for each separate royalty or license fee: name and address of licensor; date of license agreement; patent numbers, patent application serial numbers, or other basis on which the royalty is payable; brief description (including any part or model numbers of each contract item or component on which the royalty is payable); percentage or dollar rate of royalty per unit; unit price of contract item; number of units; and total dollar amount of royalties. In addition, if specifically requested by the contracting officer, provide a copy of the current license agreement and identification of applicable claims of specific patents. (See FAR 27.204 and 31.205-37).

Facilities Capital Cost of Money--When the offeror elects to claim facilities capital cost of money as an allowable cost, the offeror must submit Form CASB-CMB and show the calculation of the proposed amount (see FAR 31.205-10).

2. As part of the specific information required, the offeror must submit with offeror's proposal, and clearly identify as such, cost or pricing data (that is, data that are verifiable and factual and otherwise as defined at FAR 15.801). In addition, submit with offeror's proposal any information reasonably required to explain offeror's estimating process, including--

a. The judgmental factors applied and the mathematical or other methods used in the estimate, including those used in projecting from known data; and

b. The nature and amount of any contingencies included in the proposed price.

3. Whenever the offeror has incurred costs for work performed before submission of proposal, those costs must be identified in the offeror's cost/price proposal.

4. There is a clear distinction between submitting cost or pricing data and merely making available books, records, and other documents without identification. The requirement for submission of cost or pricing data is met when all accurate cost or pricing data reasonably available to the offeror have been submitted, either actually or by specific identification, to the contracting officer or an authorised representative. As later information comes into the offeror's possession, it should be promptly submitted to the contracting officer. The requirement for submission of cost or pricing data continues up to the time of final agreement on price.

5. In submitting offeror's proposal, offeror must include an index, appropriately referenced, of all the cost or pricing data and information accompanying or identified in the proposal. In addition, any future additions and/or revisions, up to the date of agreement on price, must be annotated on a supplemental index.

*Federal Acquisition Regulation, paragraph 15.804-6(b).

6. By submitting offeror's proposal, the offeror, if selected for negotiation, grants the contracting officer or an authorized representative the right to examine, at any time before award, those books, records, documents, and other types of factual information, regardless of form or whether such supporting information is specifically referenced or included in the proposal as the basis for pricing, that will permit an adequate evaluation of the proposed price.

7. As soon as practicable after final agreement on price, but before the award resulting from the proposal, the offeror shall, under the conditions stated in FAR 15.804-4, submit a Certificate of Current Cost or Pricing Data.

8. HEADINGS FOR SUBMISSION OF LINE-ITEM SUMMARIES:

A. New Contracts (including Letter contracts).

| COST ELEMENTS | PROPOSED CONTRACT ESTIMATE-TOTAL COST | PROPOSED CONTRACT ESTIMATE-UNIT COST | REFERENCE |
|---|---|---|---|
| (1) | (2) | (3) | (4) |

Under Column (1)--Enter appropriate cost elements.

Under Column (2)--Enter those necessary and reasonable costs that in offeror's judgment will properly be incurred in efficient contract performance. When any of the costs in this column have already been incurred (e.g., under a letter contract or unpriced order), describe them on an attached supporting schedule. When preproduction or startup costs are significant, or when specifically requested to do so by the contracting officer, provide a full identification and explanation of them.

Under Column (3)--Optional, unless required by the contracting officer.

Under Column (4)--Identify the attachment in which the information supporting the specific cost element may be found. Attach separate pages as necessary.

B. Change Orders Modifications, and Claims.

| COST ELEMENTS | ESTIMATED COST OF ALL WORK DELETED | COST OF DELETED WORK ALREADY PERFORMED | NET COST TO BE DELETED | COST OF WORK ADDED | NET COST OF CHANGE | REFERENCE |
|---|---|---|---|---|---|---|
| (1) | (2) | (3) | (4) | (5) | (6) | (7) |

Under Column (1)--Enter appropriate cost elements.

Under Column (2)--Include (i) current estimates of what the cost would have been to complete deleted work not yet performed, and (ii) the cost of deleted work already performed.

Under Column (3)--Include the incurred cost of deleted work already performed, actually computed if possible, or estimated in the contractor's accounting records. Attach a detailed inventory of work, materials, parts, components, and hardware already purchased, manufactured, or performed and deleted by the change, indicating the cost and proposed disposition of each line item. Also, if offeror desires to retain these items or any portion of them, indicate the amount offered for them.

Under Column (4)--Enter the net cost to be deleted which is the estimated cost of all deleted work less the cost of deleted work already performed. Column (2) less Column (3) = Column (4).

Under Column (5)--Enter the offeror's estimate for cost of work added by the change. When nonrecurring costs are significant, or when specifically requested to do so by the contracting officer, provide a full identification and explanation of them. When any of the costs in this column have already been incurred, describe them on an attached supporting schedule.

Under Column (6)--Enter the net cost of change which is the cost of work added, less the net cost to be deleted. When this result is negative, place the amount in parentheses. Column (4) less Column (5) = Column (6).

Under Column (7)--Identify the attachment in which the information supporting the specific cost element may be found. Attach separate pages as necessary.

C. Price Revision/Redetermination.

| CUTOFF DATE | NUMBER OF UNITS COMPLETED | NUMBER OF UNITS TO BE COMPLETED | CONTRACT AMOUNT | REDETERMINATION PROPOSAL AMOUNT | DIFFERENCE |
|---|---|---|---|---|---|
| (1) | (2) | (3) | (4) | (5) | (6) |

| COST ELEMENTS | INCURRED COST-PREPRODUCTION | INCURRED COST-COMPLETED UNITS | INCURRED COST-WORK IN PROGRESS | TOTAL INCURRED COST | ESTIMATED COST TO COMPLETE | ESTIMATED TOTAL COST | REFERENCE |
|---|---|---|---|---|---|---|---|
| (7) | (8) | (9) | (10) | (11) | (12) | (13) | (14) |

Under Column (1)--Enter the cutoff date required by the contract if applicable.

Under Column (2)--Enter the number of units completed during the period for which experienced costs of production are being submitted.

Under Column (3)--Enter the number of units remaining to be completed under the contract.

Under Column (4)--Enter the cumulative contract amount.

Under Column (5)--Enter the offeror's redetermination proposal amount.

Under Column (6)--Enter the difference between the contract amount and the redetermination proposal amount. When this result is negative, place the amount in parenthesis. Column (4) less Column (5) = Column (6).

Under Column (7)--Enter appropriate cost elements. When residual inventory exists, the final costs established under fixed-price-incentive and fixed-price-redeterminable arrangements should be net of the fair market value of such inventory. In support of subcontract costs, submit a listing of all subcontracts subject to repricing action, annotated as to their status.

Under Column (8)--Enter all costs incurred under the contract before starting production and other nonrecurring costs (usually referred to as startup costs) from offeror's books and records as of the cutoff date. These include such costs as preproduction engineering, special plant rearrangement, training program, and any identifiable nonrecurring costs such as initial rework, spoilage, pilot runs, etc. In the event the amounts are not segregated in or otherwise available from offeror's records, enter in this column offeror's best estimates. Explain the basis for each estimate and how the costs are charged on offeror's accounting records (e.g., included in production costs as direct engineering labor, charged to manufacturing overhead, etc.). Also show how the costs would be allocated to the units at their various stages of contract completion.

Under Columns (9) and (10)--Enter in Column (9) the production costs from offeror's books and records (exclusive of preproduction costs reported in Column (8)) of the units completed as of the cutoff date. Enter in Column (10) the costs of work in process as determined from offeror's records or inventories at the cutoff date. When the amounts for work in process are not available in contractor's records but reliable estimates for them can be made, enter the estimated amounts in Column (10) and enter in Column (9) the differences between the total incurred costs (exclusive of preproduction costs) as of the cutoff date and these estimates. Explain the basis for the estimates, including identification of any provision for experienced or anticipated allowances, such as shrinkage, rework, design changes, etc. Furnish experienced unit or lot costs (or labor hours) from inception of contract to the cutoff date, improvement curves, and any other available production cost history pertaining to the item(s) to which offeror's proposal relates.

Under Column (11)--Enter total incurred costs (Total of Column (8), (9), and (10)).

Under Column (12)-- Enter those necessary and reasonable costs that in contractor's judgment will properly be incurred in completion the remaining work to be performed under the contract with respect to the item(s) to which contractor's proposal relates.

Under Column (13)--Enter total estimated cost (Total of Column (11) and (12)).

Under Column (14)--Identify the attachment in which the information supporting the specific cost element may be found. Attach separate pages as necessary.

ATTACHMENT 3

REQUIREMENT FOR CERTIFICATE OF PROCUREMENT INTEGRITY
(FAR 52.203-8) (NOV 1990) ALTERNATE I (SEP 1990)

ATTACHMENT 3

REQUIREMENT FOR CERTIFICATE OF PROCUREMENT INTEGRITY
(FAR 52.203-8) (NOV 1990) ALTERNATE I (SEP 1990)

(a) Definitions. The definitions at FAR 3.104-4 are hereby incorporated in this provision.
(b) Certifications. As required in paragraph (c) of this provision, the officer or employee responsible for this offer shall execute the following certification:

CERTIFICATE OF PROCUREMENT INTEGRITY

(1) I, ______________________________
[Name of certifier]
am the officer or employee responsible for the preparation of this offer and hereby certify that, to the best of my knowledge and belief, with the exception of any information described in this certificate, I have no information concerning a violation or possible violation of subsections 27(a), (b), (d), or (f) of the Office of Federal Procurement Policy Act, as amended* (41 U.S.C. 423), (hereinafter referred to as "the Act"), as implemented in the FAR, occurring during the conduct of this procurement ____________________.
(solicitation number)

(2) As required by subsection 27(e)(1)(B) of the Act, I further certify that, to the best of my knowledge and belief, each officer, employee, agent, representative, and consultant of ______________________________
[Name of offeror]
who has participated personally and substantially in the preparation or submission of this offer has certified that he or she is familiar with, and will comply with, the requirements of subsection 27(a) of the Act, as implemented in the FAR, and will report immediately to me any information concerning a violation or possible violation of subsection 27(a), (b), (d), or (f) of the Act, as implemented in the FAR, pertaining to this procurement.

(3) Violations or possible violations: (Continue on plain bond paper if necessary and label Certificate of Procurement Integrity (Continuation Sheet), ENTER NONE IF NONE EXIST)______________________________

______________________________

______________________________

______________________________

(4) I agree that, if awarded a contract under this solicitation, the certifications required by subsection 27(e)(1)(B) of the Act shall be maintained in accordance with paragraph (f) of this provision.

______________________________
[Signature of the officer or employee responsible for the offer and date]

______________________________
[Typed name of the officer or employee responsible for the offer]

*Subsections 27(a), (b), and (d) are effective on December 1, 1990.
Subsection 27(f) is effective on June 1, 1991.

THIS CERTIFICATION CONCERNS A MATTER WITHIN THE JURISDICTION OF AN AGENCY OF THE UNITED STATES AND THE MAKING OF A FALSE, FICTITIOUS, OR FRAUDULENT CERTIFICATION MAY RENDER THE MAKER SUBJECT TO PROSECUTION UNDER TITLE 18, UNITED STATES CODE, SECTION 1001.

(End of certification)

Continued on reverse

(c) For procurements, including contract modifications, in excess of $100,000 made using procedures other than sealed bidding, the signed certifications shall be submitted by the successful Offeror to the Contracting Officer within the time period specified by the Contracting Officer when requesting the certificates except as provided in subparagraphs (c)(1) through (c)(5) of this clause. In no event shall the certificate be submitted subsequent to award of a contract or execution of a contract modification:

(1) For letter contracts, other unpriced contracts, or unpriced contract modifications, whether or not the unpriced contract or modification contains a maximum or not to exceed price, the signed certifications shall be submitted prior to the award of the letter contract, unpriced contract, or unpriced contract modification, and prior to the definitization of the letter contract or the establishment of the price of the unpriced contract or unpriced contract modification. The second certification shall apply only to the period between award of the letter contract and execution of the document definitizing the letter contract, or award of the unpriced contract or unpriced contract modification and execution of the document establishing the definitive price of such unpriced contract or unpriced contract modification.

(2) For basic ordering agreements, prior to the execution of a priced order; prior to the execution of an unpriced order, whether or not the unpriced order contains a maximum or not to exceed price; and, prior to establishing the price of an unpriced order. The second certificate to be submitted for unpriced orders shall apply only to the period between award of the unpriced order and execution of the document establishing the definitive price for such order.

(3) A certificate is not required for indefinite delivery contracts (see Subpart 16.5) unless the total estimated value of all orders eventually to be placed under the contract is expected to exceed $100,000.

(4) For contracts and contract modifications which include options, a certificate is required when the aggregate value of the contract or contract modification and all options (see 3.104-4(e)) exceeds $100,000.

(5) For purposes of contracts entered into under section 8(a) of the SBA, the business entity with whom the SBA contracts, and not the SBA, shall be required to comply with the certification requirements of subsection 27(e). The SBA shall obtain the signed certificate from the business entity and forward the certificate to the Contracting Officer prior to the award of a contract to the SBA.

(6) Failure of an Offeror to submit the signed certificate within the time prescribed by the Contracting Officer shall cause the offer to be rejected.

(d) Pursuant to FAR 3.104-9(d), the Offeror may be requested to execute additional certifications at the request of the Government. Failure of an Offeror to submit the additional certifications shall cause its offer to be rejected.

(e) A certification containing a disclosure of a violation or possible violation will not necessarily result in the withholding of award under this solicitation. However, the Government, after evaluation of the disclosure, may cancel this procurement or take any other appropriate actions in the interests of the Government, such as disqualification of the Offeror.

(f) In making the certification in paragraph (2) of the certificate, the officer or employee of the competing contractor responsible for the offer may rely upon a onetime certification from each individual required to submit a certification to the competing Contractor, supplemented by periodic training. These certifications shall be obtained at the earliest possible date after an individual required to certify begins employment or association with the contractor. If a contractor decides to rely on a certification executed prior to suspension of Section 27 (i.e., prior to December 1, 1989), the contractor shall ensure that an individual who has so certified is notified that Section 27 is reinstated. These certifications shall be maintained by the Contractor for 6 years from the date a certifying employee's employment with the company ends or, for an agent, representative, or consultant, 6 years from the date such individual ceases to act on behalf of the Contractor.

(g) The certifications in paragraphs (b) and (d) of this provision are a material representation of fact upon which reliance will be placed in awarding a contract.

ATTACHMENT 4

COST PROPOSAL FORMS

# ATTACHMENT 4

## REPRESENTATIVE COST FORMS

The following cost forms must be submitted with proposals, on diskette and on paper. (See also Attachment 2, Standard Form 1411.)

| | Forms | Period |
|---|---|---|
| First Year of Initial Contract Period | A-1, B-1 | 3/1/94 - 2/28/95 |
| Second Year of Initial Contract Period | A-2, B-2 | 3/1/95 - 2/29/96 |
| Third Year of Initial Contract Period | A-3, B-3 | 3/1/96 - 2/28/97 |
| Fourth Year of Initial Contract Period | A-4, B-4 | 3/1/97 - 2/28/98 |
| Fifth Year of Initial Contract Period | A-5, B-5 | 3/1/98 - 2/28/99 |
| Total Initial Contract Period (Five Years) | A-6 | 3/1/94 - 2/28/99 |
| Options to Extend 1 - 6 (One Mo. Each) | A-7, B-6 | 3/1/99 - 8/31/99 |
| Options to Increase Direct Labor | C | 3/1/94 - 2/28/99 |
| Total, Ph.-In, Init. Contr. and All Opts. | A-8 | 3/1/94 - 8/31/99 |

Since all the A series forms are similar and all the B series forms are similar, only A-1, B-1, and C are included in this attachment. See section L.35.E for information on obtaining diskettes containing the full set of forms, and instructions for completing the forms.

Form No. A-1

# COST PROPOSAL SUMMARY

Solicitation 1-39-5681.1014
Proposer: ______________________________
Initial Contract, March 1, 1994 through February 28, 1999
This form Covers First Year ------- From: Mar 1, 1994 Through: Feb. 28, 1995

| | Hours | Costs |
|---|---|---|
| **DIRECT LABOR COSTS:** | | |
| Straight Time | | |
| Overtime Excluding Premium, if any | | |
| Overtime Premium, if any | | |
| Subcontract Direct Level of Effort Labor | | |
| TOTAL DIRECT LABOR COST | | |
| **FRINGES AND PAYROLL TAXES:** | | |
| FICA | | |
| FUI | | |
| SUI | | |
| Worker's Compensation | | |
| General Liability Insurance | | |
| Medical/Dental Insurance | | |
| Life/Disability Insurance | | |
| Paid Absence | | |
| Other Fringe (Specify) | | |
| Other Fringe (Specify) | | |
| All Others Fringes (Itemize separately) | | |
| TOTAL FRINGES AND PAYROLL TAXES | | |
| **OTHER:** | | |
| Costs Other than Labor, and Profit, for Direct Labor Subcontracts | | |
| Subcontracts Other than Direct Labor | | |
| Material, Equipment, Equipment Rental, and Emergency Repair Services | | 347,000 |
| Nondestructive Examination and Asbestos Removal | | 400,000 |
| Buildings and Related Costs | | |
| Capital Equipment Costs/Leased Equipment Costs | | |
| Allocated Labor Other than G & A | | |
| City/County Business License Tax | | |
| Costs not shown Elsewhere (Provide Separate Detail) | | |
| TOTAL OTHER | | |
| G & A | | |
| FACILITIES CAPITAL COST OF MONEY | | |
| TOTAL COST | | |
| AWARD FEE | | |
| COST PLUS AWARD FEE | | |

Form No. B-1

DIRECT LABOR COST SUMMARY

Solicitation 1-39-5681.1014
Proposer: ______________________________
Initial Contract, March 1, 1994 through February 28, 1999
This form Covers Year - - - - - - - From: Mar. 1, 1994 To: Feb. 28, 1995

| RFP Position Titles | No. Pos. | Hours | Rates | Costs |
|---|---|---|---|---|
| Contract Manager | 1 | | | |
| Recertification Manager | 1 | | | |
| Configuration Management Manager | 1 | | | |
| Lead Structural and Pressure Systems Manager | 1 | | | |
| Lead Systems Safety Engineer | 1 | | | |
| Senior Structural Engineer | 1 | | | |
| Lead Systems Safety Analyst | 3 | | | |
| Project Configuration Management Analyst | 1 | | | |
| Senior Systems Safety Coordinator | 1 | | | |
| Process Control Engineer | 1 | | | |
| Structural Engineer | 2 | | | |
| Systems Safety Engineer | 5 | | | |
| NDE Group Leader | 1 | | | |
| CAD Group Leader | 1 | | | |
| Systems Safety Analyst | 6 | | | |
| NDE Technician III | 1 | | | |
| Senior Designer | 2 | | | |
| Staff Assistant | 1 | | | |
| Administrative Assistant | 1 | | | |
| Designer | 2 | | | |
| Technician II | 3 | | | |
| NDE Technician I | 1 | | | |
| Technician I | 4 | | | |
| Drafter I | 4 | | | |
| Word Processors | 2 | | | |
| Data Entry II | 1 | | | |
| Librarian | 1 | | | |
| Library Clerk | 1 | | | |
| Total Straight-Time Direct Labor | 51 | | | |
| Overtime (Excluding Premium), if any | | | | |
| Overtime Premium, if any | | | | |
| Total Direct Labor | | | | |

Include above any level of effort labor to be provided by subcontract, and show details on an attachment.

Form No. C

## OPTIONS TO INCREASE THE LEVEL OF EFFORT

Solicitation 1-39-5681.1014
Proposer ______________________

| | Initial Contract Period 3/1/94-2/28/99 | First Ext.Option Period Mar.1999 | Second Ext.Option Period Apr.1999 | Third Ext.Option Period May 1999 | Fourth Ext.Option Period Jun.1999 | Fifth Ext.Option Period Jul.1999 | Sixth Ext.Option Period Aug.1999 |
|---|---|---|---|---|---|---|---|
| TOTAL DIRECT LABOR HOURS .......... | | | | | | | |
| RECT LABOR COSTS .......... | | | | | | | |
| SUBCONTRACT LEVEL OF EFFORT LABOR COSTS .......... | | | | | | | |
| FRINGES AND PAYROLL TAXES .......... | | | | | | | |
| OTHER: | | | | | | | |
| Costs Other than Labor, and Profit, for Subcontracts in LOE .......... | | | | | | | |
| Subcontracts Other than Level of Effort .......... | | | | | | | |
| Buildings and Related Costs .......... | | | | | | | |
| Capital Equipment Costs/Leased Equipment Costs .......... | | | | | | | |
| Allocated Labor Other than G & A .......... | | | | | | | |
| City/County Business License Tax .......... | | | | | | | |
| Costs not shown Elsewhere (Provide Separate Detail) .......... | | | | | | | |
| TOTAL OTHER .......... | | | | | | | |
| G & A .......... | | | | | | | |
| FACILITIES CAPITAL COST OF MONEY .......... | | | | | | | |
| TAL COST .......... | | | | | | | |
| AWARD FEE .......... | | | | | | | |
| COST PLUS AWARD FEE .......... | | | | | | | |
| COST PER LOE HOUR .......... | | | | | | | |
| AWARD FEE PER LOE HOUR .......... | | | | | | | |

ATTACHMENT 5

STAFFING AND POSITION QUALIFICATIONS

# STAFFING AND POSITION QUALIFICATIONS YEAR 2 THROUGH YEAR 5

| Job Title | Position Title | Man-Years |
|---|---|---|
| 1 | *Contract Manager | 1 |
| 2 | *Recertification Manager | 1 |
| 3 | *Configuration Management Manager | 1 |
| 4 | Lead Struct. & Press. Systems Eng. | 1 |
| 5 | Lead Systems Safety Engineer | 1 |
| 6 | Senior Structural Engineer | 1 |
| 7 | Lead Sys. Safety Analyst | 3 |
| 8 | Project Config. Mgmt. Analyst | 1 |
| 9 | Senior Sys. Safety Coordinator | 1 |
| 10 | **Process Control Engineer | 0 |
| 11 | Structural Engineer | 2 |
| 12 | System Safety Engineer | 5 |
| 13 | NDE Group Leader | 1 |
| 14 | CAD Group Leader | 1 |
| 15 | System Safety Analyst | 6 |
| 16 | NDE Technician III | 1 |
| 17 | Senior Designer | 2 |
| 18 | Staff Assistant | 1 |
| 19 | Administrative Assistant | 1 |
| 20 | Designer | 2 |
| 21 | Technician II | 1 |
| 22 | NDE Technician I | 1 |
| 23 | Technician I | 2 |
| 24 | Drafter 1 | 4 |
| 25 | Word Processors | 2 |
| 26 | Data Entry II | 1 |
| 27 | **Facility CM Program Librarian | 1 |
| 28 | **Clerk | 1 |
| | TOTAL | 46 |

*These positions represent Key Personnel
**These positions will perform their duties on-site at LaRC.

## Job Title #1: Contract Manager - One Position

### Duties:

This position directs the overall technical and administrative aspects of the Recertification and Configuration Managements Programs. Monitors contract compliance, customer interface, cost control, personnel administration, security, safety, financial management, and labor relations. Schedules work and controls manpower to meet contract milestones. Coordinates technical and contractual operations with all levels of NASA Langley Research Center (LaRC) management. Monitors contract performance through a management data system and scheduled progress reviews.

### Qualifications:

Should have a minimum of a masters degree in civil, materials, or mechanical engineering or in engineering mechanics. Should have a minimum of 10 years of experience in managing projects involving mechanical design; analysis of pressure vessels, structural systems, piping systems, weldments, and related equipment; safety engineering; and configuration management. Should have a minimum of 15 years experience in working with the ASME/ANSI Boiler and Pressure Vessel Codes and Pressure Piping Codes, the American Institute of Steel Construction Codes and/or the American Welding Society Codes. Shall have a Professional Engineer Registration.

## Job Title #2: Recertification Manager - One Position

### Duties:

This position directs and coordinates the technical aspects of the Inservice Inspection (RECERT) Program for LaRC's structural and pressure systems. Follows the procedures set forth in NHB 1700.6, "Guide for Inservice Inspection of Ground-Based Pressure Vessels and Systems", and NFM-1C, "Guide for the Certification/Recertification of Wind Tunnel Structural Systems", in evaluating systems. Directs the nondestructive examination of structural and pressure systems. Develops options for dealing with components which do not comply with the national consensus codes. Directs development of repair specifications. Develops future inspection plans. Supervises engineers, technicians, and designers. Assists the Contract Manager in preparing inservice inspection schedules. Provides interface and coordinates work requirements with LaRC's Contracting Officer Technical Representative, Facility Coordinators, Facility Safety Heads, Subcontractors and Consultants.

### Qualifications:

Should have a minimum of a bachelors degree in civil, materials or mechanical engineering or in engineering mechanics. Should have a minimum of 6 years experience in managing personnel performing mechanical design and analysis of pressure vessels, structural systems, piping systems, structural weldments, and related equipment. Should have a minimum of 10 years experience in working with the American Society of Mechanical Engineers Boiler and Pressure Vessel Codes and Pressure Piping Codes, the American Institute of Steel Construction Codes and/or the American Welding Society Codes. Shall have a Professional Engineer Registration.

## Job Title #3: Configuration Management Manager - One Position

### Duties:

This position directs and coordinates the technical aspects of the Configuration Management Program for LaRC's ground base research facilities. Follows the policies set forth in the NASA Langley Research Center Handbook entitled, LHB 1740.4, "Facility Systems Safety Analysis and Configuration Management", in performing configuration management. Directs Pressure Systems, Flight Systems and Asbestos Systems Configuration Management Programs. Provides interface and coordinates work requirements with LaRC's COTR, Safety Manager, Facility Safety Heads, Facility Coordinators, and Project Engineers to ensure an effective, efficient, and meaningful Configuration Management program.

### Qualifications:

Should have a minimum of a bachelors degree in electrical, civil, materials or mechanical engineering or in engineering mechanics. Should have a minimum of six years experience in managing personnel performing electrical, mechanical, and safety engineering. Should have a minimum of ten years experience in system safety engineering, configuration management or other safety related areas.

## Job Title #4: Lead Structural and Pressure Systems Engineer - One Position

### Duties:

This position applies sophisticated engineering principles to analyze large, complex structural and pressure systems. Demonstrates a high degree of originality and insight in performing complicated stress, fatigue and thermal analyses for research facilities. Is lead engineer for subordinate level engineers performing less complex analyses. Provides scheduling and job status to Recertification Manager.

### Qualifications:

Should have a bachelors degree in civil, materials or mechanical engineering or in engineering mechanics. Should have a minimum of ten years experience in analyzing pressure and structural systems in accordance with the American Society of Mechanical Engineers Boiler and Pressure Vessel Codes, and Piping Codes, the American Institute of Steel Construction Codes and/or the American Welding Society Codes. Should have a minimum of five years experience as a lead engineer.

## Job Title #5: Lead Systems Safety Engineer - One Position

### Duties:

This position directs the performance of Safety and Hazard Control Analyses and of Risk Assessments. Ensures that facility modifications and new designs are evaluated for all applicable safety requirements. Directs the selection of systems and components for Facility Critical Items Lists. Directs safety engineering support for Construction-of-Facilities Projects. Leads the upgrading and updating of Safety Analysis Reports, Operating Procedures, and affected drawings.

### Qualifications:

Shall have a bachelors degree in electrical, civil, or mechanical engineering, or in engineering mechanics, and a minimum of two years experience working as a Lead Engineer. Shall have a minimum of ten years experience in system safety engineering, configuration management or other safety related areas.

## Job Title #6: Senior Structural Engineer - One Position

### Duties:

This position applies sophisticated finite- element and continuum analysis procedures to the evaluation of complex wind tunnel structures. Establishes the structural areas to be nondestructively examined and defines the techniques to be used in the examinations. Evaluates the suitability of the wind tunnel materials for service loadings, temperatures and environments. Directs subordinate level engineers in performing less sophisticated analyses. Provides scheduling and job status to the Recertification Manager.

### Qualifications:

Shall have a bachelors degree in civil, materials, or mechanical engineering or in engineering mechanics. Shall have a minimum of two years experience directing engineers. Shall have a minimum of five years experience in analyzing structural components in accordance with the American Institute of Steel Construction Code and the American Welding Society Code.

## Job Title #7: Lead System Safety Analyst - Three Positions

### Duties:

Two positions direct the performance of Safety and Hazard Control Analyses. Ensure that facility modifications and new designs are evaluated for all applicable safety requirements. Lead the updating of all Safety Analysis Reports, Operating Procedures and affected drawings. Guide the configuration management program for laboratory-type facilities and asbestos-containing facilities. Direct system safety support for Construction-of-Facilities Projects. Manage the Problem Failure Report Program.

One position administers the PSCM Program. Verifies all modifications to pressure systems and revises all pressure systems documentation to reflect these modifications. Leads field verifications of existing and new pressure systems. Reformats existing pressure systems documentation to match the format currently being used.

### Qualifications:

Should have a bachelors degree in engineering or related field, and a minimum of two years experience working as a Lead Analyst. Should have a minimum of ten years experience in system safety engineering, configuration management or other safety related areas.

## Job Title #8: Project Configuration Management Analyst - One Position

### Duties:

This position maintains a configuration management program for flight projects at Langley Research Center (LaRC). Reviews change packages for completeness, distributes completed packages to the Configuration Control Board for review. Convenes LaRC's Configuration Control Board meetings and serves as meetings secretary. Prepares finalized change packages. Performs configuration management audits. Supports in flight project design reviews.

### Qualifications:

Should have a bachelors degree in engineering or related field and a minimum of ten years in system safety engineering, configuration management or other safety related areas.

**Job Title #9: System Safety Coordinator - One Position**

**Duties:**

This position coordinates Construction-of-Facilities Design Reviews for Langley Research Center's (LaRC's) Facilities Engineering Division. Schedules design reviews and (in conjunction with LaRC management) establishes review committees. Attends design reviews, drafts review minutes and compiles action items. Distributes meeting minutes. Distributes and tracks action items.

**Qualifications:**

Should have a bachelors degree in engineering or related field, and a minimum of five years experience working as a Senior System Safety Engineer and ten years experience in system safety engineering, configuration management or other safety related areas.

**Job Title #10: Process Control Engineer - One Position**

**Duties:**

This position develops test procedures by gathering pertinent data and parametric information necessary to complete test runs. Reviews, approves, and distributes changes to test procedures, acts as test recorder, and prepares minutes of test runs. Develops operational procedures. Develops and modifies Programmable Logic Controller (PLC) codes.

**Qualifications:**

Should have a bachelors degree in electrical or mechanical engineering or in computer science, and a minimum of five years experience in designing and starting process systems. Should have a working knowledge of analog control systems and interlock schemes. Should have PLC experience.

**Job Title #11:** **Structural Engineer - Two Positions**

**Duties:**

This position applies engineering principles and standard solutions to moderately difficult analysis problems. Uses computer solutions and recognized engineering codes to analyze structural and pressure systems. Performs stress analyses in areas where parameters are well established and fairly conventional methods can be used. Interprets results of own work and prepares reports which are reviewed for inclusion into larger project reports.

**Qualifications:**

Should have a bachelors degree in civil, materials or mechanical engineering or engineering mechanics. Should have a minimum of five years experience in design and analysis of structural and pressure systems. Shall have a minimum of two years experience in completing flexibility analyses, finite element analyses, and American Society of Mechanical Engineers, American Institute of Steel Construction and/or American Welding Society code analyses.

**Job Title #12:** **System Safety Engineer - Five Positions**

**Duties:**

This position performs Safety and Hazard Control Analyses and Risk Assessment Categorization. Evaluates facility modifications and new designs to ensure that they satisfy all safety requirements. Selects components and systems for Facility Critical Items List. Provides safety engineering support for Construction-of-Facilities Projects. Upgrades and updates Safety Analysis Reports, Operating Procedures, and drawings impacted by modifications.

**Qualifications:**

Should have a bachelors degree in electrical, civil, or mechanical engineering, or in engineering mechanics or in a related technical field. Should have a minimum of two years experience in system safety engineering, configuration management or other safety related areas.

**Job Title #13:** **Nondestructive Examination (NDE) Group Leader - One Position**

**Duties:**

This position coordinates and documents the inspections performed during structural and pressure systems recertification. Monitors visual, magnetic particle, ultrasonic, radiographic and other nondestructive examinations. Prepares and maintains databases used to document weld and inspection status. Reviews weld maps and drawings. Prepares weld profiles. Schedules support services necessary to complete system inspection and repairs. Trains inspectors in accordance with the requirements of the American Society of Nondestructive Testing (ASNT).

**Qualifications:**

Should have an associates degree in engineering technology or equivalent. Should have two years experience working as a group leader. Should have a minimum of ten years experience in inspection of pressure systems and structural weldments. Should be a certified ASNT Level III inspector in one or more disciplines. Should be an American Welding Society Certified Welding Inspector.

**Job Title #14:** **Computer-Aided-Design (CAD) Group Leader - One Position**

**Duties:**

Completes analyses, prepares conceptual layouts and eliminates interference in final installations for complex piping systems, pressure vessels, pressure components, and structural systems. Manages computer systems, workstations and networks for computer-aided-design and drafting.

**Qualifications:**

Should have an associates degree in mechanical engineering or equivalent. Should have two years experience working as a group leader. Should have a minimum of ten years experience in design, layout and detail drawing of structural and pressure systems. Should be proficient in the use of personal computers, workstations, digital scanners, optical and tape storage devices and software such as AUTOCAD, ANVIL, DOS and UNIX. Should have a minimum of five years experience in computer system operation.

**Job Title #15:** **System Safety Analyst - Six Positions**

**Duties:**

This position performs Safety and Hazard Control Analyses. Evaluates facility modifications and new designs to ensure that they satisfy all safety requirements. Updates all Safety Analysis Reports, Operating Procedures and drawings impacted by modifications. Accomplishes configuration management for laboratory-type facilities and asbestos-containing facilities. Provides systems safety support for Construction-of-Facilities Projects. Executes the Problem Failure Report Program.

This position also reviews all Pressure Systems Configuration Management (PSCM) documents for technical and format accuracy before final incorporation. Interfaces with Langley Research Center facility personnel pertaining to the incorporation and maintenance of pressure systems configuration management. Provides technical assistance relating to PSCM.

**Qualifications:**

Should have a bachelors degree, and a minimum of ten years experience in system safety engineering, configuration management or other safety related areas.

**Job Title #16:** **Technician III - Nondestructive Examination (NDE) - One Position**

**Duties:**

This position monitors, documents, interprets and verifies NDE activities such as radiographic, ultrasonic, magnetic particle, liquid penetrant and visual inspection of structural and pressure systems. Writes, develops and maintains documents such as specifications, inspection and repair procedures, training material, project schedules and safety procedures.

**Qualifications:**

Should have a high school diploma or equivalent. Should be a American Society of Nondestructive Testing Level II inspector in one or more disciplines. Should be an American Welding Society Certified Welding Inspector.

**Job Title #17:** **Senior Designer - Two Positions**

**Duties:**

Completes analyses, prepares conceptual layouts and final drawings, eliminates interferences, sizes and identifies components.

**Qualifications:**

Should have an associates degree in mechanical engineering or related discipline. Should have a minimum of two years experience directing design personnel. Should have experience in computer-aided design. Should have a minimum of ten years experience in design, layout and detail drawings of mechanical equipment and pressure systems.

**Job Title #18:** **Staff Assistant - One Position**

**Duties:**

This position assists the Contract Manager in preparing project correspondence and contract reports and in maintaining contract financial records. Maintains all personnel- and project-related records. Supervises initial typing, revision, and completion of all documentation, correspondence and reports. Interfaces with Langley Research Center personnel, vendors, and corporate personnel.

**Qualifications:**

Should have a high school diploma or equivalent. Should have a minimum of five years experience as Executive Secretary or Administrative Assistant.

**Job Title #19: Administrative Assistant - One Position**

**Duties:**

Assists System Safety Analysts in supporting Langley Research Center's Configuration Management (CM) Program. Formats and proofreads Safety Analysis Reports, Standard Operating Procedures, and Checklists. Sets up and maintains a computerized management database for documents and drawings; generates and distributes reports and letters, flow charts, and block diagrams.

**Qualifications:**

Should have a high school diploma or equivalent. Should have a minimum of five years experience in data entry utilizing database management, spreadsheet, and word processing software.

**Job Title #20: Designer - Two Positions**

**Duties:**

Prepares detailed drawings of pressure and structural systems, sizes components using design codes, and assists in making interference checks for final installation.

**Qualifications:**

Should have a high school diploma or equivalent and should have a minimum of two years of technical school training, or equivalent. Should have a minimum of five years experience in design, layout and detail drawing of mechanical equipment and piping systems. Should have a minimum of two years experience in computer-aided design procedures.

**Job Title #21:** **Technician II - Structural & Pressure Systems and Nondestructive Examination (NDE) - Three Positions**

**Duties:**

Two positions examine pressure systems and wind tunnel structural systems for the generation of recertification and configuration management documentation. Acquire necessary information on systems to accurately determine the suitability of components. Develop original field sketches of existing systems. Perform ultrasonic thickness tests, communicate with manufacturers, search catalogs and drawing files, and prepare a work package report on component status. Review documentation prepared by other technicians.

One position prepares databases using NDE inspection reports, and verifies consistency between drawings, specifications, inspection reports and radiographic film. Monitors NDE activities such as radiographic, ultrasonic, magnetic particle, liquid penetrant and visual inspection of welds and system components.

**Qualifications:**

Should have a high school diploma or equivalent, and have a minimum of five years experience in inspecting structural and pressure systems. Should be a certified ASNT Level II Inspector for visual examination.

**Job Title #22:** **Technician I - Nondestructive Examination (NDE) - One Position**

**Duties:**

This position documents NDE results. Maintains database records of inspections performed and catalogs inspection reports. Operates personal computers for managing large database systems. Reviews weld location drawings and compares with inspection data.

**Qualifications:**

Should have a high school diploma or equivalent. Should have a minimum of five years of experience in reviewing inspection documentation and managing weld data. Should have a minimum of one year of experience in use of large database systems. Should be a certified ASNT Level II Inspector in at least one discipline.

**Job Title #23:** **Technician I - Structural and Pressure Systems - Four Positions**

**Duties:**

This position examines wind tunnel structural systems and pressure systems for the generation of recertification and configuration management documentation. Acquires necessary information on standard systems to accurately determine suitability of system components. Performs ultrasonic thickness tests, communicates with manufacturers, searches catalogs and drawings files, and prepares reports defining component status.

**Qualifications:**

Should have a high school diploma or equivalent, and have a minimum of two years experience in the area of pressure and structural systems. Should have two years experience in reading blueprints.

**Job Title #24:** **Drafter I - Four Positions**

**Duties:**

This position prepares drawings and sketches of structural and pressure systems and documents their recertification status. Develops weld location drawings for use in nondestructive examination. Updates existing drawings after repairs or alterations to systems are complete.

**Qualifications:**

Should have a high school diploma or equivalent, and have a minimum of five years experience in preparing mechanical drawings and sketches. Should have a minimum of two years experience in computer-aided drafting procedures.

**Job Title #25:** **Word Processor - Two Positions**

**Duties:**

This position prepares (using word processing equipment) correspondence and reports. Manages word processing files and the Configuration Management documents.

**Qualifications:**

Should have a high school diploma or equivalent, and have a minimum of one year of word processing experience. Should have typing skills of 60 wpm and grammar skills.

**Job Title #26:** **Data Entry II - One Position**

**Duties:**

This position processes database information such as inspection reports, equipment and component lists, and records of engineering communications. Assists technicians with data collection, field verification, drawing take-offs, maintenance of procedure manuals and processing of drawings and manufacturer's catalogs.

**Qualifications:**

Should have a high school diploma or equivalent. Should have a minimum of five years of experience in data entry utilizing database management software such as Rbase 5000. Should have typing skills of 50 wpm and grammar skills.

## Job Title #27: Facility CM Program Librarian - One Position

### Duties:

This position develops procedures for controlling, identifying, and updating Supporting Facility Documents and other related documents at the 8' High Temperature Tunnel (8' HTT). Once procedures are in place, controls, identifies, updates and distributes the aforementioned documents. Operates the facility library at the 8' HTT. Files all Supporting Facility Documents in Engineering Drawing Files. Issues copies of all procedures for test runs. Maintains inventory of all library documents.

### Qualifications:

Should have a high school diploma or equivalent. Should be experienced in data entry and use of personal computers. Should have good typing, spelling and grammar skills. Should have good interpersonal skills.

## Job Title #28 Clerk - One Position

### Duties:

This position supports the Librarian by filing documentation, entering data in computer databases and storing documentation at Engineering Drawing Files. Prepares drawing cards when bringing new Configuration Controlled Drawings and Supporting Facility Documents into the Configuration Management Program. Assists the System Safety Analysts assigned to the 8' High Temperature Tunnel's Configuration Management effort.

### Qualifications:

Should have a high school diploma or equivalent. Should be experienced in data entry and use of personal computers.

# ATTACHMENT 6

# BIDDER'S LIBRARY INFORMATION

ATTACHMENT 6

INDEX OF REFERENCE DOCUMENTATION CONTAINED IN BIDDER'S LIBRARY
(1 NORTH DRYDEN STREET, BLDG. 1209, ROOM 187A)

Acquisition Regulations

| | |
|---|---|
| NHB 5103.6 | Source Evaluation Board Handbook (Includes Streamlined Acquisition Handbook) |
| NHB 9501.2 | Procedures for Contractor Reporting of Correlated Costs and Cost Performance Data (533M's and 533Q's) |

Safety Regulations

| | |
|---|---|
| LHB 1710.10 | LaRC Red Tag System |
| LHB 1710.5 | Ionizing Radiation |
| LHB 1710.12 | Potentially Hazardous Materials |
| LHB 1740.2 | Facility Safety Requirements |

Other Reference Documents

| | |
|---|---|
| LMI 5300.1 | Systems Safety, Quality, Reliability Program |

LaRC Stores Stock Catalog

Safety Analysis Report (Typical)

Standard Operating Procedures (Typical)

Laboratory Risk Evaluation (Typical)

Asbestos Configuration Management Report (Typical)

Problem/Failure Report Summary (Typical)

FENGD Design Reviews Action Item Status and Summary (Typical)

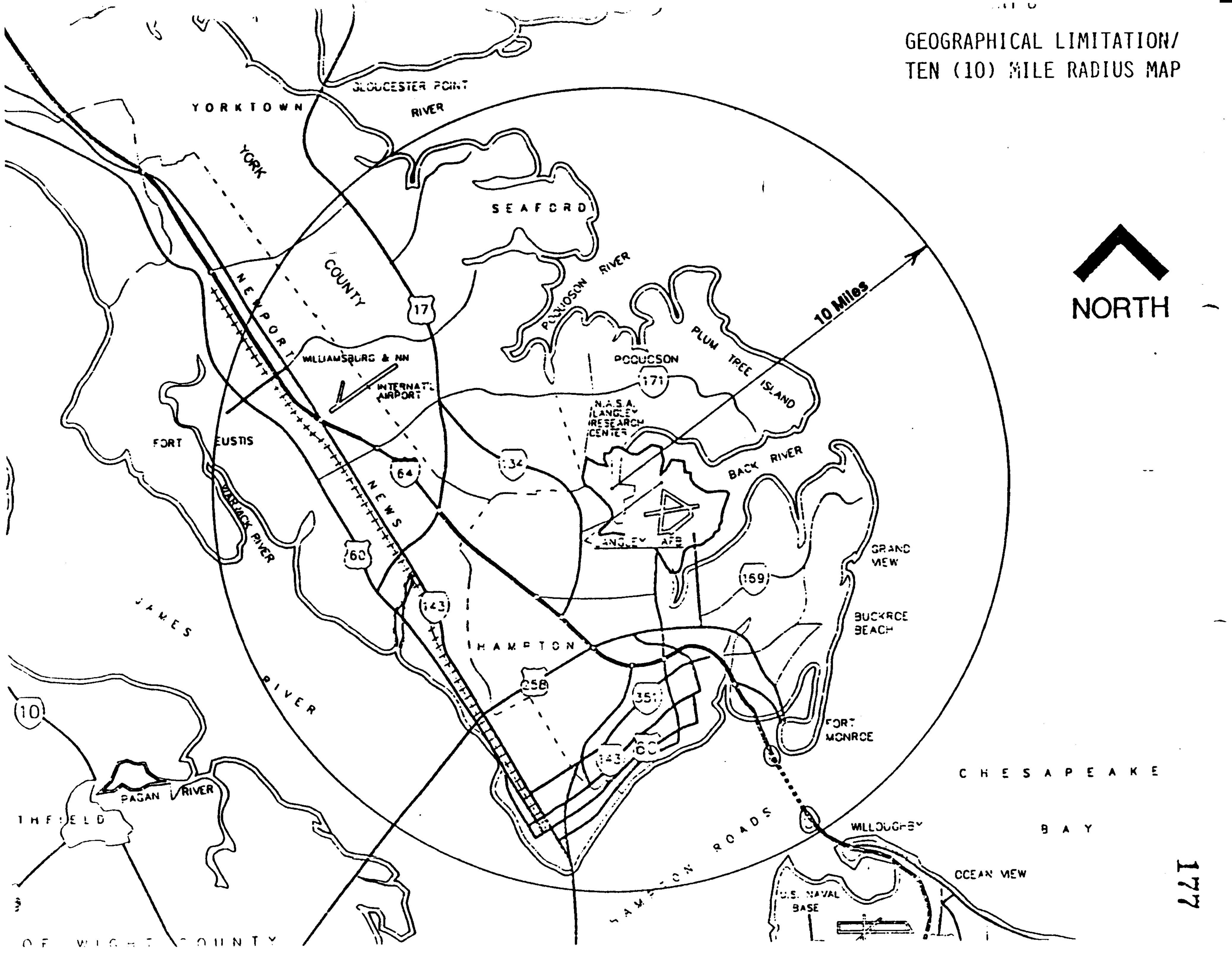
# ATTACHMENT 7

# CONTRACTOR-FURNISHED VEHICLE REQUIREMENTS

ATTACHMENT 8

GEOGRAPHICAL LIMITATION/10 MILE RADIUS MAP

GEOGRAPHICAL LIMITATION/
TEN (10) MILE RADIUS MAP



## PREFACE

This handbook, part of the Langley Safety Manual, sets forth minimum safety requirements and standards for pressurized systems within the framework of Langley Research Center safety policies and constraints. It provides professional designers and craftsmen a basis for safety and uniformity in the design, fabrication, and use of pressure vessels, piping, and associated pressure system equipment.

H. Lee Beach, Jr.
Deputy Director

DISTRIBUTION:
SDL-039, SDL-043, and SDL-054 -
LaRC Safety Manual Holders
429/Risk Management Branch, SSQRD (50 copies)
436/Facilities Engineering Division
123/Directives & Forms Management Office, ISB - MSD (10 copies)

# CONTENTS

## CONTENTS - Concluded

Chapter I

## SCOPE

This handbook contains criteria for design, fabrication, inspection, operation, and maintenance of pressure systems of the Langley Research Center (LaRC), that is, hydraulic, pneumatic, propulsion, and so forth, including new or existing, temporary or permanent pressure vessels, piping and associated equipment, and vacuum systems. Pressure vessels/systems excluded from the requirements of this handbook are given in Appendix A.

The intended application for this handbook is for permanently installed facility systems which typically remain a part of the facility for several years or more and are utilized to support more than one experimental or research project. Pressure vessels/systems for experimental systems of limited lifetime (approximately 2 years or less) can be approved by the LaRC Systems Operations Committee (SOC) (see LMI 1700.3, "The Executive Safety Board and Its Committees") and may depend on protective barriers or enclosures and remote operation to provide an acceptable degree of safety in lieu of complying with these regulations.

This handbook also applies to pressure systems on flight vehicle simulators and flight vehicles where medium weight (NSS/HP-1740.4) components can be tolerated. When the need for minimum weight can be demonstrated, flight components with lower safety factors may be used with fracture control measures as required by NSS/HP-1740.1, "NASA Aerospace Pressure Vessel Safety Standard." However, at LaRC, minimum weight systems shall be considered a deviation from this regulation and must be submitted to the Pressure Systems Committee (see LMI 1700.3) for approval.

Chapter II

# DEFINITIONS

- **Associated Pressure Systems Equipment:** Any pressurized component which is required for the utilization or operation of pressurized systems covered by these regulations

- **Codes, Standards, and Guides:** The reference to codes, standards, and guides, within the text of this handbook, includes national consensus codes, agency-wide and LaRC-wide standards which are required in design, inspection, certification, and operation of all pressure vessels and pressurized systems, both new and existing at LaRC. Codes, standards, and guides referred to in this document are available from the Fracture Mechanics Engineering Section, Structural Design Branch, Facilities Engineering Division.

- **Contractor:** Any company or organization who does work for or who supplies equipment to LaRC.

- **Designer:** Anyone authorized by the Government to perform work in accordance with standard engineering practices, codes, and LaRC safety regulations

- **Deviation:** The design, fabrication, inspection, or use of pressure vessels, piping, and associated equipment which are not in compliance with the codes listed in Chapter III, "General Policy, Codes and Standard Requirements, Supplementary Requirements by LaRC."

- **Equipment Operator:** Anyone authorized by the Government to operate, in normal use, the pressure vessels, pressure systems, piping and associated equipment covered in these regulations. Operators must be qualified by appropriate training in the operational characteristics and procedures of the equipment system that they operate.

- **Fabricator, Installer:** Anyone authorized by the Government to perform work in accordance with standard trade practices, codes, LaRC specifications, and safety regulations

- **Fluid Systems Section, Mechanical Support and Utilities Operations Branch, Operations Support Division (OSD):** Designated LaRC organization to perform work on pressure systems

- **Inspector:** Anyone authorized by the Government and/or authorized by LaRC to assure that fabricators and installers follow the scope and intent of the design specifications.

- **Pressure:**

  - **Design Pressure/Maximum Allowable Working Pressure:** This pressure shall be used in the design of a vessel for the purpose of determining the minimum permissible thickness or physical characteristics of the different parts of the vessel. When applicable, static head shall be included in the design pressure to determine the thickness of any specific part of the vessel. The pressure relief devices shall be set to initially operate at a pressure not exceeding the maximum allowable working pressure of the vessel.

- Operating Pressure: This pressure is the operating pressure of the vessel system. For pressure vessels, it should be 5 to 10% less than the maximum allowable working pressure. This avoids relief device discharging at normal operating pressure due to the manufacturer's tolerance on set pressure and allows for resetting of a safety valve after relieving overpressure. For piping systems, the relief device shall be set in accordance with the appropriate piping code (ASME/ANSI B31.3, "Petroleum Refinery Piping," or ASME/ANSI B31.1, "Power Piping.")

- **Pressure Systems Committee (PSC):** The Pressure Systems Committee is one of the committees reporting to the Executive Safety Board as set forth in LMI 1700.3, "The Executive Safety Board and Its Committees." This committee conducts reviews and provides written approval or recommends for approval to the Executive Safety Board deviations from code on pressurized systems/components; provides guidance and consulting service for safety and design of these systems; recommends, adopts, and/or interprets requirements of codes, standards, and design application for pressurized systems; and maintains an overview for developments in the field of pressure systems regarding new codes/modifications, new techniques, and improvements or applications thereof.

- **Radiographic Interpreter:** An individual trained and qualified to the ASNT SNT-TC-1A Level-II position, certified by an LaRC individual that holds a current "ASNT Level-III certification."

- **Recertification:** A verification of the pressure vessel/system suitability for continued safe service based on periodic inspection, testing, and analysis.

- **Standard Practice Engineer(s) (SPE):** The persons designated in LMI 1700.3 to review and approve the design and specifications of all pressurized ground and flight systems, and verify compliance with applicable codes, standards, and supplementary requirements of these regulations including granting of waivers of hydrotest for repairs.

- **Systems Safety, Quality and Reliability Division (SSQRD):** This division provides a point of contact between NASA Headquarters and other external organizations regarding safety matters per LMI 1700.2, "Safety Assignments," participates in formulation and implementation of safety policy, ensures safety reviews of all systems, assures a testing and certification program for specialized operators, and assists the Contracting Officer's Technical Representative in determining adequacy of contractor's safety programs.

- **Technical Project Engineer**: Anyone employed by the Government and/or authorized by LaRC to supervise and coordinate the design of pressure vessels, pressure systems, piping, and associated equipment
- **Temperature**:
  - **Maximum Design Temperature**: The maximum temperature used in the design of a vessel for the purpose of determining the minimum permissible thickness or physical characteristics of the different parts of the vessel.
  - **Minimum Design Temperature**: The minimum temperature used in the design of a vessel for the purpose of determining the physical characteristics of the different parts of the vessel

Chapter III

# GENERAL POLICY, CODES AND STANDARD REQUIREMENTS, SUPPLEMENTARY REQUIREMENTS BY LaRC

## A. General Policy

The general policy governing design, inspection and certification of new and in-service pressure vessels and systems is set forth in NMI 1710.3B (see Appendix B). Design of all pressure systems shall comply to codes, standards, and LaRC supplementary requirements to the maximum practical extent.

## B. Codes and Standard Requirements

1. American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Codes and Piping Codes.
2. National Board Inspection Code, "A Manual for Boiler and Pressure Vessel Inspectors," published by the National Board of Boiler and Pressure Vessel Inspectors.
3. American National Standards Institute (ANSI) Codes.
4. Department of Transportation, Code of Federal Regulations, Title 49, Parts 171 to 178.
5. "NASA Aerospace Pressure Vessel Safety Standards," NSS/HP-1740.1.
6. "NASA Medium Weight Pressure Vessel Standards," NSS/HP-1740.4.

## C. Supplementary Requirements by LaRC

1. Gages used in pressure systems shall meet the requirements of Federal specification GG-G-76 and as amended by LaRC (see Figure III-1, "Regulations for Pressure Gages") Gages which are critical to safe systems operations (that is, referenced in standard procedures) are to be calibrated in accordance with an established plan to ensure accurate measurement. All pressure gages must be mounted so that safety features will function. (Gages with blowout backs, for instance, must be mounted to allow blowout of back in the event of over-pressurization.) Gages shall be installed on both sides of pressure regulators to ensure proper monitoring of pressures.
2. Cast iron shall not be used for any pressures above 125 psig or where it will be subject to vibration unless approved by the SPE.
3. Seam-welded pipe and fittings are not to be used for a design pressure above 125 psig unless: (1) the seam welds are 100% radiographed; or (2) the Quality Factor as defined by the appropriate design code is utilized in determining the minimum required wall thickness of the pipe or fitting. Either alternative must be approved by the SPE.

(1) (2)

| REQUIREMENTS | SERVICE ABOVE 125 PSIG | | TYPE C SERVICE FOR 125 PSIG AND BELOW | INSTRUMENT GAGES, 0 - 30 PSIG, AND VACUUM GAGES |
|---|---|---|---|---|
| | TYPE A | TYPE B | | |
| MAXIMUM OPERATING PRESSURE | NO LIMIT | NO LIMIT | 125 PSIG | 30 PSIG |
| ALLOWABLE WORKING PRESSURE, % GAGE RANGE | 80% MAXIMUM | 60% MAXIMUM | 60% MAXIMUM | 0 - 100% |
| SAFETY CASE CONSTRUCTION (3) (6) | REQUIRED | NOT REQUIRED | NOT REQUIRED | NOT REQUIRED |
| PROOF TEST PRESSURE | 100% RANGE | 100% RANGE | 100% RANGE | 100% RANGE |
| TYPE OF TEST | DEAD WEIGHT | DEAD WEIGHT | DEAD WEIGHT OR $N_2$ | DEAD WEIGHT OR $N_2$ |
| RETEST PERIOD | EACH 5 YEARS | EACH 5 YEARS | NONE REQUIRED | NONE REQUIRED |
| LABEL FOR TEST CERTIFICATION (7) (5) | REQUIRED | REQUIRED | REQUIRED IF TESTED | REQUIRED IF TESTED |

**Flag Notes:**

(1) Bourdon tube type, nonflight applications.
(2) Gage selection shall be in compliance with these guidelines and based on the most economical choice to satisfy the reading accuracy required.
(3) Solid front, blow out entire back area; blowout plugs will not meet this requirement.
(4) Deadweight test media to be water or oil. Oil is never to be used where gages are to be used with oxygen or oxidizing agents.
(5) Certification/calibration label to include: maximum pressure, test date, and initials of personnel, and are to be made of aluminum foil with pressure sensitive adhesive on the back. The label is to be ½" x ½" and a different color for each year.
(6) Provide adequate free area for discharge where blowout back gages are used.
(7) "No Certification/Calibration Required" sticker should be applied to all devices used in general service.

**General Notes:**

a. All gages for use at or above 125 psi shall be tested to 100% of gage range.
b. Pressure gage materials shall be selected to be corrosion resistant to pressure media and surrounding environment.
c. Pressure snubbers should be used to protect gages where pulsating pressure exists.
d. Special cases should be referred to LaRC Safety Manager for recommendations.
e. Gages below 125 psi tested on request.

**WARNING:**

Gage user has responsibility for gage cleanliness and compatibility with service media

**Figure III-1.- Regulations for Pressure Gages.**

4. Inspection and hydrostatic testing of instrument piping for service above 125 psig are required to the extent necessary to assure compliance with engineering design, and with the material, fabrication, and installation.

5. All pressure piping systems (except steam piping) shall meet requirements of ASME/ANSI B31.3, "Petroleum Refinery Piping."

6. Service steam piping shall meet ASME/ANSI B and PV Code, Section I and ASME/ANSI B31.1, "Power Piping."

7. Marking, Coding and Valve Numbering

   a. Marking and Tagging - Each certified pressure vessel/system shall be marked or tagged in accordance with NMI 1710.3. Methods of identification shall not introduce notches or points of stress concentration that would reduce the operational safety of the components or system.

   b. Coding - Identification of media, flows, and color code requirements shall be as specified in LHB 1740.2, "Facility Safety Requirements" (contained in the LaRC Safety Manual). In addition, the valve numbering system shall identify media within a system as is explained in item 7.c..

   c. Valve Numbering - The valve numbering system for LaRC is designed to aid in operation and maintenance of pressurized systems. (See Appendix C for details of the valve numbering system.)

8. Code Stamping of Pressure Systems

   NASA prescribing regulation, NMI 1710.3 (see Appendix B), requires new fabrication and repairs of existing pressure vessel/systems to be in accordance with the applicable national consensus codes to the maximum practical extent. Strict compliance with some ASME codes requires stamping of the completed system. The ASME has a procedure for stamping of new pressure vessels and the National Board of Boiler and Pressure Vessel Inspectors has a procedure for repairs or alterations of existing coded pressure vessels, but no procedures exist for stamping piping system repairs or alterations to uncoded pressure vessels. The technical project engineer shall contact the LaRC Fracture Mechanics Engineering Section, Structural Design Branch, Facilities Engineering Division, early in the planning phase of projects which cannot be stamped to establish the appropriate documentation to be used. The pressure piping stamp ("PP") is used for piping inside of and up to the first valve outside of a steam boiler. Fabrication of new and repair or alteration to existing coded pressure vessel/systems shall require stamping after completion of the work in accordance with ASME or National Board procedure. All LaRC contracts which include work requiring stamping shall contain the following note:

"This solicitation involves pressure vessel(s) that require a current ASME Certificate of Authorization for use of the following stamp: "U" or "U2." The Certification shall be held by the organization performing the design, fabrication, and stamping of the pressure vessel(s). The contract award process will be greatly facilitated by submittal of the applicable Certificate of Authorization with the offeror's bid; however, early certification submittal is not required to ensure bid responsiveness. An offeror's ability to confirm that deliverable pressure vessel(s) will be code stamped as required is a matter relating to the offeror's responsibility and will be determined prior to contract award."

Possession of an ASME or National Board of Boiler and Pressure Vessel Inspectors stamp also is a means of verifying the capability of a contractor to perform high quality work on pressure vessel/systems. Therefore, to assure quality work, all contracts for pressure vessel/systems which cannot be stamped shall contain the following note:

"This solicitation involves fabrication and/or repairs to pressure systems. A current National Board or ASME Certificate of Authorization for use of any of the following stamps. "R," "U," "U2," "N," or "PP" is required to perform this fabrication and/or repairs. This certificate shall be held by the organization performing the work. This certificate shall be maintained valid and current throughout the contract performance period. The contract award process will be greatly facilitated by submittal of the applicable Certificate of Authorization with the offeror's bid; however, early certification submittal is not required to ensure bid responsiveness. An offeror's ability to confirm that the organization performing the work is a holder of any of the above stamps is a matter relating to the offeror's responsibility and will be determined prior to contract award."

9. Piping Weld Inspection

   a. All socket and branch connection welds shall be inspected and evaluated in accordance with LHB 1710.41, "Langley Research Center Standard for the Evaluation of Socket and Branch Connection Welds."

   b. Radiographic inspection of piping girth butt welds shall utilize tangential techniques only. No elliptical techniques shall be utilized.

10. CPV type union nuts subject to pressures above 3000 psig shall have vent holes and be torqued to the values listed in Appendix D.

11. Flex Hoses (except Category D fluid service as defined in ASME/ANSI B31.3)

   a. Commercial flexible hose assemblies must be tested and labeled for operating pressure by the manufacturer. Flexible hose assemblies fabricated in-house must be constructed, tested, and labeled for operating pressures by the Fluid Systems Section, Mechanical Support and Utilities Operations Branch, Operations Support Division.

b. Flex hoses shall be periodically inspected and recertified using the time intervals provided in the tables in NHB 1700.6, "Guide for Inservice Inspection of Ground-Based Pressure Vessels and Systems," Chapter 6. Periodic inspections will be external only. Recertification will require a visual internal examination in accordance with the ASME Boiler and Pressure Vessel Code, Section V. Hoses shall be tagged with inspection and recertification dates.

Before hoses can be considered unsatisfactory for use, the following factors are to be considered:

(1) Cracking or checking of the inner liner is cause for condemnation.

(2) Blistering of the outer cover is usually indicative of porosity of the inner liner.

(3) Flatness of areas over 3 inches in length is cause for condemnation.

(4) Corrosion of the wire braid is cause for condemnation.

(5) Worn, deeply scored, scratched, or badly corroded end fittings are causes for condemnation.

12. Single step hex head bushings (that is, one pipe size reduction) that have both internal and external threads shall not be used in systems with pressures above 125 psig unless approved by the SPE. All transitions of this type should be made using reducer sections.

13. Portable support equipment (except Category D fluid service as defined in ASME/ANSI B31.3), shall be periodically inspected and recertified using the time intervals provided in the tables of NHB 1700.6, "Guide for Inservice Inspection of Ground-Based Pressure Vessels and Systems," Chapter 6.

Chapter V

# CRITERIA

## A. Design

Design of all pressure systems shall comply to codes, standards, and LaRC supplementary requirements of Chapter III to the maximum practical extent.

## B. Documentation

1. Documentation for new and existing pressure vessels and systems are set forth in NHB 1700.6, "Guide for Inservice Inspection of Ground-Based Pressure Vessels and Systems," Chapter 7.

2. Radiography Film

   a. Radiographs of pressure components/equipment shall be retained by LaRC for life.

   b. The "Radiography Film" and a "Weld Joint Location Drawing" shall be sent to the configuration management contractor for storage/retention.

## C. Welding/Brazing Requirements and Certification

1. Welding/brazing operations on pressure systems, whether performed in-house or by contractors, will only be done by welders/brazers who are currently certified in accordance with ASME/ANSI B and PV Code, Section IX, "Welding and Brazing Qualifications."

2. Welding/brazing procedures and procedural qualifying test data for pressure components must be prepared and furnished in accordance with ASME/ANSI B and PV Code, Section IX, "Welding and Brazing Qualifications." Submittal of these procedures and test data are not required for code stamped systems and components.

## D. Test Requirements

All testing is to be performed using written and approved test plans and operating procedures. See NHB 1700.6, Chapter 4, for recommended nondestructive tests and inspections for pressure vessels and pressurized systems.

1. **Nondestructive Examination Requirements** - Welded joints in pressure vessels, tubes, pipes, and fittings shall be radiographically inspected when required by applicable codes. When heat treatment or stress relieving is required, the radiographic inspection shall be performed in accordance with the appropriate ASME/ANSI codes. In addition, the joint and its heat affected zone shall be MT or PT examined after heat treatment.

2. **Hydrostatic Testing** - Hydrostatic testing establishes the ability of pressure vessels, piping, and fittings to withstand the maximum pressure anticipated for the equipment. It should be conducted in accordance with the requirements of ASME/ANSI Boiler and Pressure Vessel Code VIII, Division 1 or Division 2, or ASME/ANSI B31.3, "Petroleum Refinery Piping," or B31.1, "Power Piping." All new pressure systems shall be hydrostatically tested in accordance with their design code. Repairs to existing systems shall be hydrostatically tested unless exempted by the National Board Inspection Code, Section R-308 and Supplement I, "Examples of the Repair and Alterations." Waivers of hydrostatic testing for repairs require the approval of the SPE.

   Hydrostatic testing is potentially hazardous. Adequate safety precautions are to be taken to ensure safety of personnel and equipment with regard to test procedures. After hydrostatic testing, vessels shall be dried in accordance with system requirements.

3. **Pneumatic Testing** - Pneumatic (pneumostatic) tests should only be conducted when hydrostatic testing is not feasible. A gas complying with cleanliness requirements of the pressure vessel and system will be used.

   a. A written procedure with line management approval is required for pneumatic testing and must then be approved by the Chief, Facilities Engineering Division; the Chief, Systems Safety, Quality and Reliability Division; and the Chairperson, Pressure Systems Committee.

   b. Pneumatic tests are inherently hazardous and all personnel must be excluded from the hazard zone. A hazard zone is to be established by a Facilities Engineering Division engineering analysis.

4. Hydrostatic or pneumatic testing of pressure systems used on LaRC experimental equipment, or being procured for use at LaRC, should be witnessed as follows:

   a. Pressure tests conducted elsewhere for systems to be used at LaRC should be witnessed by a representative such as the LaRC Resident Engineer, or other selected NASA personnel.

   b. Testing of pressure systems (at or away from LaRC) which are not destined to become a part of an LaRC facility system should be witnessed as determined by the responsible LaRC project manager.

5. **Pneumatic Flushing/Impulse Blowing** - Pneumatic flushing/impulse blowing is a method of cleaning debris from system lines utilizing low pressure, high velocity gas. This flushing operation is potentially dangerous. Extreme caution is to be exercised in working with this type operation. Adequate safety precautions shall be taken to ensure safety of personnel and equipment with regard to test procedures. Means shall be provided to isolate the pressure source (that is, vents, double block and

bleed valves, gages, and so forth) to provide positive verification that the system pressure is relieved and the system is safe to work on. Deflector shields should be used on all lines being blown.

## E. Analyses

Analyses shall be performed in accordance with the applicable codes. Where adequate analysis techniques do not exist, or experimental correlation with theory is inadequate, the analyses shall be supplemented by tests.

## F. Deviations

When any deviations from the criteria in Chapter V are required, the request for deviation shall be submitted in writing to the Pressure Systems Committee for appropriate action. The request for deviations shall include full justification for deviation together with supporting data and analyses. The Pressure Systems Committee will review the request and may recommend approval of the deviation to the Executive Safety Board for final approval or refer the request back to the design organization for redesign.

1. Deviations from codes and standards (Chapter IIIB) must be approved by the Pressure Systems Committee through the LaRC Executive Safety Board and these are reported to NASA Headquarters per NMI 1710.3.

2. All other deviations will be considered by the Pressure Systems Committee only and minutes of committee meetings will provide documentation of action taken.

Chapter VI

# INSPECTION AND CERTIFICATION

## A. General Requirements

1. The technical project engineer shall provide written certification that the pressure system installation is in accordance with all documentation as defined in Chapter VII.A.5, items a through d. For detail considerations necessary for pressure vessel certification, refer to Section VI of NSS/HP 1740.4.

2. All vessels, existing or new, which are certified to this standard, shall have an in-service inspection and a recertification plan developed by the technical project engineer. (See NHB 1700.6 and the Fracture Mechanics Engineering Section (FMES) for guidelines.) This plan should contain the criteria used in performing tests specified for recertification of individual pressure tests specified or recertification of individual pressure vessels and/or systems. Recertification of in-use pressure vessels and systems will be in accordance with this plan. Standard procedures are to be used to the maximum extent and will be performed to an established schedule that shows frequency of inspection and type of inspection to be performed.

## B. Process

1. The responsibilities for inspection and certification of new and in-service pressure systems are with the responsible engineers, operations personnel, designated committees, and organizations outlined below. The following explains the interrelations between the various activities displayed in Figure VI-1, "Functional Flow Chart Design, Inspection, and Certification of Pressure Vessels and Pressurized Systems."

   a. **Facility Safety Head (FSH)** - The FSH provides the focal point for inspection and certification. Requirements for in-service inspection, new pressure systems installations, or modifications to in-service pressure vessels/systems that affect this area of responsibility, must be forwarded through the FSH. There are two loops in Figure VI-1: (1) the one for in-service inspection, and (2) the one associated with new designs and changes to existing pressure systems.

   b. **Systems Engineering and Operations (SE&O)** - SE&O is to provide policy; technical support; planning by the Work Control Section, Work Control and Contracted Services Branch, Operations Support Division; and procedural assistance to perform nondestructive evaluation (NDE) that is required for in-service inspection and recertification in addition to any new NDE requirements.

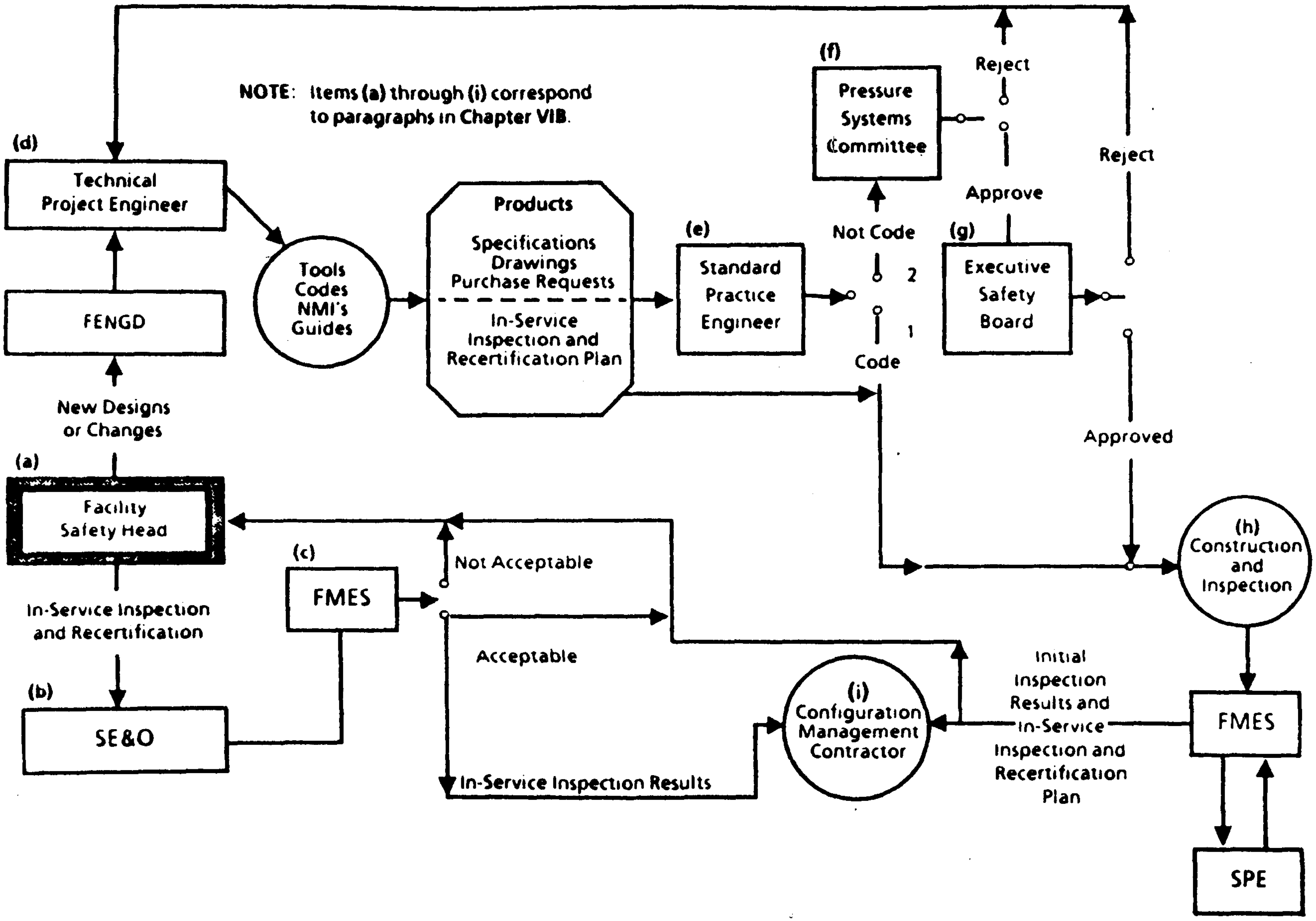



Figure VI-1.- Functional Flow Chart Design, Inspection, and Certification of Pressure Vessels and Pressurized Systems.

The Work Control Section will also maintain the schedule for in-service inspection and provide the FSH the inspection requirements for the annual maintenance program. The Facility Coordinator (FC) will provide information to the Work Control Section for establishing and maintaining the inspection schedule. (Requirements will be provided to the FC by the FSH.)

c. **Fracture Mechanics Engineering Section (FMES)**, Structural Design Branch, Facilities Engineering Division, receives in-service inspection and certification test data for analyses. The results of the analyses provide the basis for inspection dates, rerating,or derating requirements, modifications, and/or repairs. When a system is certified, the findings and an in-service inspection plan are forwarded to the FSH and the configuration management contractor for future reference and scheduling. If the system cannot be certified, this information is submitted to the FSH.

d. **Technical Project Engineer (TPE)** - Ensures that new designs, changes, or modification requirements flow from the FSH to the designer responsible for the preparation of end products such as specifications, drawings, purchase requests, and in-service inspection and recertification plan. The designer utilizes standards, codes, NMI's, and other guidelines specified by this handbook, or equivalent, in preparing the final products for purchasing and construction. Release of this information requires normal line management approval.

e. **Standard Practice Engineer (SPE)** - Reviews the output from the TPE for compliance with code requirements.

   (1) If code requirements are met, construction may commence.

   (2) If not in compliance with code requirements, the design shall be submitted to the Pressure Systems Committee. Complete analysis of the design and calculations to support approval must accompany the design package.

f. **Pressure Systems Committee** - Reviews designs that are not in accordance with code and may reject the design, returning it to the responsible designer for rework. If the committee approves the design, it is then submitted with a recommendation for final approval to the Executive Safety Board.

g. **Executive Safety Board** (see LMI 1700.3) - Approves or rejects the design and returns it to the responsible designer for rework and reprocessing through the approval cycle. Waivers, when granted, are to be reported to NASA Headquarters according to NMI 1710.3 (see Appendix B).

h. **Construction/Inspection/FMES/SPE** - During construction, inspection and associated field services may be supplied by Government or contractor personnel. The TPE provides liaison and consulting expertise. FMES provides consulting expertise on development of the In-service Inspection and Recertification Plan. On completion, data supplied from installation tests are supplied to FMES/SPE as necessary. FMES forwards the Initial Inspection Results and In-Service Inspection and Recertification Plans to the configuration management contractor.

i. **Configuration Management Contractor** - Receives data for both new and in-service pressure vessels and systems test results for updating the inspection and recertification plan from the two loops shown in Figure 2. This data will be provided to the FSH with the required schedules for future inspection and recertification.

Chapter VII

# RESPONSIBILITIES

A **Facility Safety Head (FSH)** The FSH is to

1 Ensure that the basic requirements for pressure systems of the organizational unit will fulfill the required objectives and that these requirements are clearly defined

2 Ensure that all new pressure vessels, piping, associated equipment, and all modifications thereto are approved by the Standard Practice Engineer for Pressurized Systems and/or the LaRC Formal Design Review process before commencing with site work

3 Ensure the conduct of the organizational unit's safe operation. This handbook does not relieve the FSH of this responsibility

4 Furnish a copy of this handbook to each employee of the organizational unit who performs or may be called upon to perform duties described herein. Ensure that each of these employees is familiar with and complies with the provisions of this handbook and other related LaRC safety regulations

5 Possess written verification of the following information prior to the initial operation of any pressure system

a That the design conforms to the regulations herein or that any deviations have been approved by the Pressure Systems Committee

b That the installation has been completed according to the design, specifications, drawings, and change items.

c That the Pressure Systems Committee and/or a formal design review committee has reviewed, for safety consideration, plans for construction, additions, or alterations and the initial startup and checkout procedure to be employed according to applicable prescribing LaRC instruction

d That the Committee on Potentially Hazardous Materials (see Attachment B to LMI 1700 3) has reviewed, for safety consideration, any pressure vessels, piping, and associated equipment which utilizes or employs a material that may be hazardous if not properly handled

e That the appointment of a Facility Coordinator and any necessary alternates has been made

f. That the appointment of safety operators and any necessary alternates has been made in accordance with LHB 1710.10, "Safety Clearance Procedures (Red Tag)."

g That proper safety training has been given to equipment and safety operators

NOTE Written certification of items (a) through (d) above is obtained from the **Technical Project Engineer**.

6. Complete the following prior to the scheduled operation:

   a. Review operational procedures for changes, additions, or alterations that were found necessary during the initial operational checkout.

   b Establish procedures outlining routine operational inspection and retest periods.

   c. Establish emergency operating procedures

   d Have a complete set(s) of final drawings, design specifications, design analysis manuals, and schematic drawings required for safe and proper operation

7. Maintain documentation (drawings, procedures, safety analysis, and so forth) required for safe operation of pressurized systems.

8. Provide coordination for modification, new installations, maintenance, and recertifications of pressurized systems and equipment.

9. Ensure that proper identification, labeling, color coding of components and/or system are maintained.

10 Maintain current logs, schedules, history of inspections, and recertification of facility pressure systems

11 Maintain complete documentation on pressure vessels 3 cubic feet or greater and/or working pressure in excess of 125 psig.

B. **Facility Coordinator** - The Facility Coordinator is to:

1. Assist the FSH in achieving safe operation of the building complex and research facilities.

2. Additional responsibilities of the Facility Coordinator include:

   a Initiating requests for maintenance, repairs, modification, or alterations to the facility

b. Notifying and obtaining clearance from other coordinators within the facility for any proposed work requiring utility disruption

c. Coordinating the operations procedures of equipment in the facility so that the use of common utilities does not create a safety problem

d. Maintaining a procedure for obtaining clearance for proposed work in the facility

e. Stopping any work being performed which is not in accordance with appropriate regulations, and notifying the Safety Manager

f. Controlling red tags and having an authorized safety operator attach them to electrical switches, air and fluid valves, or similar control devices when operation would cause injury or damage

C. **Safety Operator** · A safety operator (see LHB 1710 10) will provide safety clearance procedures prior to performing any work on pressure vessels and/or pressurized systems This includes the responsibilities of properly installing and removing red hold-off tags

D. **Equipment Operator** · The Equipment Operator, certified by line management, is to:

1 Be knowledgeable in all aspects of equipment to be operated.

2 Maintain logs of equipment startup, operation, and shutdown.

3. Assist in removal of pressure equipment from service and preparation for in-service inspections

E. **Technical Project Engineer (TPE)** · The TPE is to.

1 Provide for the basic pressure systems requirements specified by the FSH, retaining the responsibility for pressure systems up to and including the final systems acceptance testing. This includes the responsibility for all coordination necessary to assure compliance with these regulations by the Facility Coordinator, FSH, designer, Standard Practice Engineer, inspector, radiograph interpreter, fabricator, installer, and the appropriate committee of the Executive Safety Board (see LMI 1700 3)

2 Ensure that an inspector is assigned to inspect all new pressure vessels, piping, and associated equipment and all alterations, repairs, and additions thereto

F. **Inspector** The inspector is to

1 Ensure that the fabricator and the installer conform to the applicable portions of specifications

2. Witness all tests specified by the designer

3. Verify that test apparatus is calibrated properly before use

4. The inspector shall ensure that all nondestructive evaluation (NDE) inspection personnel performing inspections, evaluating inspection results, or interpreting radiographs shall be qualified in accordance with American Society for Non-Destructive Testing (ASNT) SNT-TC-1A "Recommended Practice for Non Destructive Testing Personnel Qualification and Certification." Personnel qualified to Level I shall be utilized only under the field supervision of a currently certified Level II or III inspector

5. Coordinate with the TPE in resolving any problems in the interpretation of specifications that involve these regulations.

6. Ensure that all radiographs of LaRC pressure systems shall be reviewed by SE&O NDE Operations Certified Radiographic Interpreter

G. **Standard Practice Engineer for Pressurized Ground Systems** - The Standard Practice Engineer for pressurized ground systems is to review and approve all new in-house designs of pressure systems or modifications to existing systems and to certify their compliance with existing codes. Any systems which do not comply with these codes are to be referred to the Pressure Systems Committee.

H. **Standard Practice Engineer for Pressurized Flight Systems** - The Standard Practice Engineer for pressurized flight systems is to examine drawings, test plans, operational procedures, checkout procedures, purchase requests, specifications, and statements of work either approving them as conforming to these regulations or directing that they be submitted to the Pressure Systems Committee

I. **Radiographic Interpreter** - The Radiographic Interpreter shall review all radiographs produced at LaRC or furnished by support contractors, equipment manufacturers, vendors, or others which pertain to pressure systems or components governed by this handbook. The interpreter shall review and interpret radiographs based on the appropriate acceptance criteria.

**Appendix A**

# SPECIAL REQUIREMENTS AND EXCLUSIONS

- **SPECIAL REQUIREMENTS**

## A. Inspection/Recertification of Cryogenic Storage Vessels and Trailers

Cryogenic storage vessels and trailers at LaRC do not require periodic recertification, but are to be visually inspected for frosting on the outer surface of the outer tank on a weekly basis When frost is visually detected, appropriate measures must be taken to reestablish the proper annulus vacuum level The annulus vacuum level is to be verified (500 microns or less) at least twice a year for cryogenic storage vessels and trailers that, by design, incorporate connections for annulus vacuum monitoring and pumping Cryogenic storage vessels and trailers of this type are provided with redundant relief protection, that is, a rupture disc and relief valve. Recertification of relief valves is to follow the guidelines stated in NHB 1700 6, "Guide for In-Service Inspection of Ground-Based Pressure Vessels and Systems " The inner tank rupture disc is to be replaced at the time of relief valve recertification

## B. Pneumatic Testing of Cryogenic Systems

Pneumatic testing of cryogenic systems in lieu of hydrostatic testing is permissible provided other approvals required by the regulation are met

- **EXCLUSIONS**

## A. Portable Air Compressors

Portable air compressors designed to operate at 125 psig or lower are excluded from the requirements of this handbook NHB 1700 6 is the basis for this exclusion

## B. Hydraulic Accumulator Type Pressure Vessels

Individual variation in both vessel design and system installation need to be considered. The pressure-volume relationship for gases that is described in NHB 1700 6 shall be used as a basis to exclude such accumulators from the requirements of this handbook, that is, the gas side volume-pressure multiple when less than 5,000 psi-cubic feet, that is, 10 cubic feet x 500 psig = 5,000 This basis shall be used for both new and existing systems at the service condition (combination) of maximum gas energy potential

## C. Hydraulic Components

Hydraulic components, covered by the National Fluid Power Association, are excluded from the requirements of this handbook However, systems in which these components are used shall be reviewed by the Standard Practice Engineer

D. **Portable Fire Extinguishers**

Portable fire extinguishers are excluded from the requirements of this handbook

E. **Refrigeration Systems**

Refrigeration systems are excluded from the requirements of this handbook These systems are covered by the American Society of Heating, Refrigeration and Air Conditioning Engineers Regulations and Manufacturers Specifications

F. **Over the Road Trailers**

Over the road trailers with pressurized components are excluded from the requirements of this handbook These trailers are covered by Department of Transportation regulations

G. **Water Systems**

Water systems operating at pressures less than 100 psi and temperatures less than 212 °F are excluded from the requirements of this handbook.

H. **Pressurized Components**

Pressurized components described in LHB 1710 15, "Wind Tunnel Model Systems Criteria," are excluded from the requirements of this handbook.

Appendix B

# NMI 1710.3, "SAFETY PROGRAM FOR PRESSURE VESSELS AND PRESSURIZED SYSTEMS"

| | |
|---|---|
| NASA MANAGEMENT INSTRUCTION | NMI 1710.3C<br>Effective Date August 26, 1991<br>Expiration Date August 26, 1996 |

Responsible Office: QS/NASA Safety Office

Subject: SAFETY PROGRAM FOR PRESSURE VESSELS AND PRESSURIZED SYSTEMS

*1. PURPOSE

NASA pressure vessels and pressurized systems (PV/S), by the very nature of their working fluids and operating parameters, create a potential hazard to the surrounding environment. This Instruction outlines NASA's program for ensuring the structural integrity of PV/S and minimizing the associated mishap potential.

*2. APPLICABILITY

This Instruction contains requirements for new and existing PV/S (including vacuum) that are used on NASA property and/or in NASA programs, regardless of owner or user. Compliance with this Instruction at contractor installations performing NASA work shall be made a contractual requirement where deemed necessary. PV/S excluded from the requirements are listed in NHB 1700.6, Guide for Inservice Inspection of Ground-Based Pressure Vessels and Systems.

*3. DEFINITIONS

The following definitions apply to this Instruction and supplement those in NHB 1700.6.

a. Flight PV/S - PV/S used for flight operations (e.g., Shuttle, payloads, aircraft, etc.) regardless of type or design safety factor.

b. Ground-Based PV/S - Any PV/S used for ground operations regardless of type or design safety factor.

c. RECERT - The NASA program for periodic certification/recertification of ground-based PV/S outlined in NHB 1700.6 that consists of the following 3 work categories:

(1) Documented identification, inspection, nondestructive examination, and analysis of PV/S.

*Changed by this revision.

(2) Repairs/modifications required to certify/recertify PV/S based on the findings of category 1. Additional nondestructive examination may be required to define the extent of needed repairs and to assure adequacy of repairs.

(3) Continuing periodic inspection, test, and maintenance of PV/S based on the results of categories 1 and 2, lessons learned, and experience.

*4. RESPONSIBILITIES

NASA Field Installation Directors and personnel under their cognizance are responsible for requirements in this Instruction pertaining to ground-based PV/S. NASA program/project managers and their personnel are responsible for flight PV/S requirements. There is a shared responsibility when flight PV/S are involved in ground operations/tests as described in paragraph 7b.

*5. GENERAL REQUIREMENTS FOR GROUND-BASED AND FLIGHT PV/S

a. All pressure vessels, pressurized components, and pressurized systems shall be designed, fabricated, installed, operated, periodically inspected, maintained, repaired, and certified/recertified in accordance with the applicable codes, standards, guides, and Federal regulations listed in Attachment A.

b. The emphasis of PV/S certification/recertification shall be on high risk areas. Efforts shall be prioritized according to the risk or hazard of potential failure using risk assessment techniques.

c. A PV/S can be recertified as safe at the original operational parameters or certified to new, reduced operational parameters. In either case, appropriate analysis, tests, examinations, repairs, modifications, and documentation shall be performed. If the PV/S is certified to new, reduced operational parameters, the new parameters shall be used as the baseline for future recertification action.

d. A system of marking and/or documentation shall be established to indicate that each PV/S is certified/recertified for use and to indicate any special constraints or instructions required for safe

*Changed by this revision.

operation of the PV/S. If a vessel/component is marked, stress concentrations or notches shall not be introduced that would compromise its integrity.

e. Documentation for each PV/S shall be prepared and revised/updated periodically. It shall identify the organization/individual responsible for the PV/S and contain, as a minimum, a PV/S description, list of available drawings/documentation, analysis results, certification requirements, unique inservice inspection requirements, and results of the most recent inspection.

f. A configuration management system shall be established to update the PV/S documentation as modifications are made. The configuration management system shall ensure that the documentation always reflects the as-built configuration of the PV/S.

g. PV/S information that would benefit other Installations/programs (e.g., failures, problems, lessons-learned, etc.) shall be forwarded to the NASA Safety Division for distribution throughout NASA.

h. PV/S brought onto NASA Installations for temporary use shall be reviewed for compliance with the technical safety requirements of this Instruction.

*6. SPECIFIC REQUIREMENTS FOR GROUND-BASED PV/S

a. An Installation Pressure Systems Manager shall be designated to direct technical efforts; approve PV/S designs, repairs, configuration changes, etc.; and act as the primary point of contact for all RECERT activities. A Pressure Systems Committee should be established. Where appropriate, the Committee should conduct reviews, recommend requirements and procedures, maintain an overview of pressure system technology, participate in RECERT activities, and provide guidance on pressure system safety to appropriate officials including the Pressure Systems Manager and safety officials.

b. RECERT shall be applied to all ground-based PV/S on a case-by-case basis. For PV/S that are to be transferred from one Installation to another, the RECERT history of that equipment shall be reviewed and

*Changed by this revision.

accepted by the receiving/responsible Installation. The shipping organization shall ensure that appropriate documentation is forwarded. If the documentation is not available or the PV/S RECERT history is not in accordance with this Instruction, the PV/S shall be certified/recertified before it is placed in service.

c. Deviations/waivers of technical requirements (codes, standards, and guides with the exception of Federal regulations) shall, as a minimum, be approved by the Pressure Systems Manager/Pressure Systems Committee with concurrence by the Installation NASA Safety Director. Approval shall be given based upon detailed analyses of the potential hazards and rationale for acceptance. Such deviations/waivers shall not exclude PV/S from RECERT. Any special RECERT requirements should be identified as part of the deviation/waiver process. For PV/S that are to be transferred from one Installation to another, associated deviations/waivers must be reviewed and accepted by the receiving/ responsible Installation. The shipping organization shall ensure that deviation/waiver files are forwarded in a timely manner to the receiving/responsible organization.

d. PV/S that require modification, rehabilitation, repair, replacement, etc., shall be approved in the same manner as any other facility project; i.e., if the level of effort is within the authority of the Center Director, the work may be approved and implemented in accordance with existing procedures; if the level of effort (cost) requires action by Headquarters, then a properly executed Facility Project-Brief Project Document, NASA Form 1509, NASA Report Control No. 10-0000-00-849, should be submitted in a timely fashion. Projects that otherwise satisfy the requirements for inclusion in the Construction of Facilities (CoF) budget should be included in the Installation's 5-year programs and be considered in the annual CoF budget cycle. Facility Project Implementation Handbook (NHB 8820.2), specifically Chapters 1 and 4, contains additional details regarding budgeting for facility projects.

e. Installations shall establish a training and certification program for high pressure systems ($\geq$ 150 psi) operators. Installations should establish a PV/S safety awareness program that periodically alerts all Installation personnel to the proper procedures for working with and around pressure systems.

f. To assure continued emphasis on the Agencywide RECERT program, Installations shall prepare and forward a NASA RECERT Status Report (NASA Report Control No. 10-0000-00-848) to the Director, Safety Division, Office of Safety and Mission Quality, by February 1 of each year. The Safety Division will distribute an annual report call letter requesting specific information needed to track the status of special interests and facilitate advocacy of program funding.

*7. SPECIFIC REQUIREMENTS FOR FLIGHT PV/S

a. Deviations/waivers that apply to flight operations shall, as a minimum, be approved by the program/project manager and the responsible NASA flight safety authority.

b. Design data, operating procedures and history, system characteristics and constraints, etc., shall be provided to cognizant Field Installation PV/S personnel to assure safe conduct of ground test, checkout, and launch operations. Deviations/waivers that apply to ground operations/tests shall, as a minimum, be approved by the program/project manager with concurrence by the Installation NASA Safety Director.

8. CANCELLATION

NMI 1710.3B dated February 23, 1982.

Administrator

DISTRIBUTION:
SDL 1

*Changed by this revision.

## PRESSURE VESSEL/SYSTEM CODES, STANDARDS, AND GUIDES

1. General Requirements

   a. "Occupational Safety and Health Standards," Occupational Safety and Health Administration (OSHA), Department of Labor (DOL), 29 CFR Part 1910.

   b. "Transportation Standards," Department of Transportation (DOT), 49 CFR.

   c. "Guide for Inservice Inspection of Ground-Based Pressure Vessels and Systems," NASA NHB 1700.6.

2. Specific Requirements

   a. "NASA Aerospace Pressure Vessel Safety Standard," NSS/HP-1740.1.

   b. "NASA Medium Weight Pressure Vessel Safety Standard," NSS/HP-1740.04.

   c. "Safety Policy and Requirements for Payloads Using the Space Transportation System," NSTS 1700.7B.

   d. "Space Shuttle Flight and Ground Systems Specification," NSTS 07700, Volume X.

   e. "Space Station Program Definition and Requirements," SSP 30000, Section 3.

   f. "Standard General Requirement for Safe Design and Operation of Pressurized Missile and Space Systems," MIL-STD-1522A.

   g. American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code.

   h. American Society of Mechanical Engineers Code for Pressure Piping, B31.

   j. American Petroleum Institute (API) Codes.

   k. National Board Inspection Code, "A Manual for Boiler and Pressure Vessel Inspectors," Current Edition, published by the National Board of Boiler and Pressure Vessel Inspectors.

   l. National Fire Protection Association (NFPA) Codes.

3. Guides

a. "Integrated Pressure Systems and Components (Portable and Installed)," United States Air Force (USAF) Technical Manual T. O. 00/25/223.

b. American Society for Testing and Materials (ASTM).

c. "Fracture Control of Metallic Pressure Vessels," NASA Special Publication (SP) 8040.

d. "Design Development Testing," NASA SP-8043.

e. "Qualification Testing," NASA SP-8044.

f. "Acceptance Testing," NASA SP-8045.

g. "Pressure Regulators, Valves, Burst Disks, etc.," NASA SP-8080.

h. "Discontinuity Stresses in Metallic Pressure Vessels," NASA SP-8083.

i. "Rocket Metal Tanks and Tank Components," NASA SP-8088.

j. "Hydrogen Safety Manual," NASA Technical Memorandum (TM) X-52454.

k. "Workbook for Estimating Effects of Accidental Explosions in Propellant Ground Handling and Transport Systems," NASA Contractor Report 3023 by Southwest Research Institute.

**Appendix C**

# VALVE NUMBERING SYSTEM

## A. Valve Numbers

1 A standard valve numbering system for all LaRC facilities has been instituted that is compatible with the computer aided maintenance system and eliminates number duplications. This system is based upon the use of seven (7) digits plus one suffix. A complete number as appears on a valve tag is as follows.

$$\underset{(a)}{\underline{xxx}} - \underset{(b)}{\underline{3xxx}}\ \underset{(c)}{\underline{x}}$$

a. The first three digits identify the building and is presented in Table C-1

b. The next four digits identify the particular device number. All valves in this example are in the 3000 series

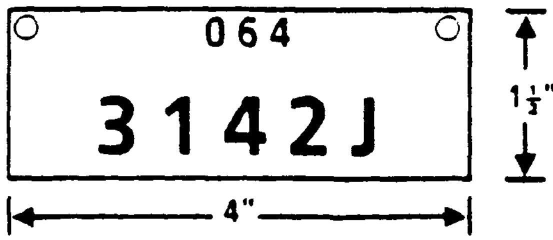
c. A suffix identifies the system in which the device is located. A current list of codes is as follows:

| Subscript | Service |
|---|---|
| A,B,C,D,E | Air |
| F | Fuel (except Hydrogen) |
| H | Hydrogen |
| J,K | Helium |
| N,M | Nitrogen |
| P | Hydraulic Fluid |
| Q | Lubricating Oil |
| R | Other Inert Material |
| S,T | Steam and Condensate |
| U,W | Water |
| V | Vacuum |
| X | Oxygen, Oxidizers |
| Y | Freon |
| Z | Fluid Combinations |

Thus, a typical valve number would appear as 064-3142 J which would identify the device as being number 3142 in the helium system in Building 1247B

2. The letter "Z" designates that more than a single fluid can be transported through the piping system. Anyone performing maintenance on a valve with this suffix, or disassembly of a system identified by this suffix, should be immediately alerted to the requirement to positively identify the system's media before maintenance or disassembly begins.

3 Tags applied to each device would appear similar to this illustration.




For operating procedures it would be sufficient to refer to the device as "thirty-one forty two jay" – the building identifier being necessary only for maintenance services

**B. Implementing Valve Numbering System**

1 The identification system will be used on all valves and valve type devices (that is, regulators) To avoid operational confusion during the transition phase, and to assure minimum impact, the following ground rules apply:

a Where possible, suffix letters providing a generic tie-in will be given priority when assigning numbers to valves in the basic operating control loop of a particular system These will be the valves normally appearing in a single standard procedure

b In building complexes where several sets of research apparatus (tunnel test sections) are serviced by common distribution or vacuum systems, no two valves will be assigned the identical number In other words, the distribution/evacuation system operating procedure would have no nomenclature ambiguities (same number and suffix with only differing identifiers)

c To minimize the impact of identification change, all valves, associated components, and particularly graphic panel identifications will bear both the old and new numbers until procedures have been demonstrated and operators are familiar with the new nomenclature This will also provide adequate lead time for procurement of new name plates and tags

d. A cross-index of old and new device numbers will be made a part of facilities baseline documentation This will enable the update of missing drawings, possibly located as result of some future drawing file purge, and will serve as an historical record The cross-index may assume the form of a drawing

e. For new facilities, or the addition or modification to existing facilities, engineering design personnel should estimate the total of valve numbers required, then request a block of numbers from the cognizant Facility Safety Head (or the Facility Safety Head's Facility Coordinator).

2. The decision to remove old valve numbers will be on a case-by-case basis for each facility under the cognizance of the Chief, Operations Support Division. This requirement is to ensure continuity of safe operation

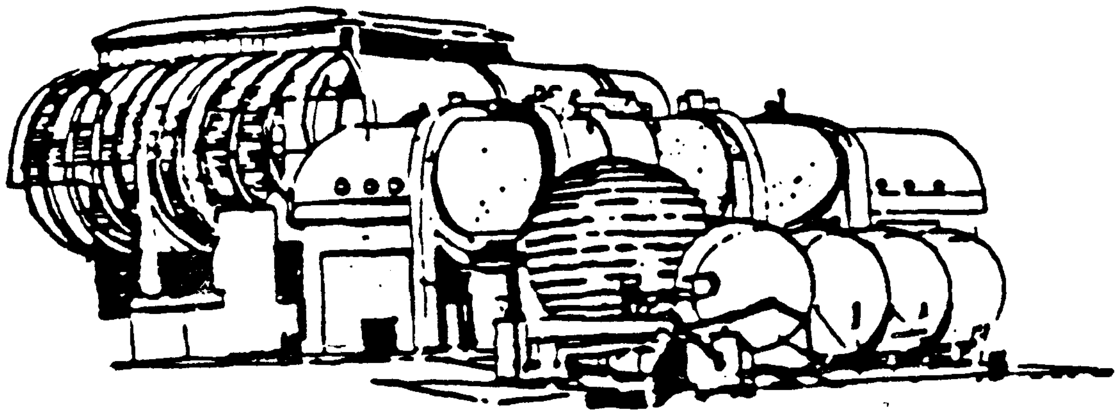
**TABLE C-1**
**BUILDING IDENTIFIERS FOR EQUIPMENT MAINTENANCE NUMBERS**

| Building Number | Identifier | Building Number | Identifier |
|---|---|---|---|
| 581 | 01 | 1155 | 78 |
| 582 | 02 | 1156 | 112 |
| 582A | 03 | 1157 | 113 |
| 583 | 04 | 1158 | 114 |
| 583A | 05 | 1159 | 115 |
| 584 | 08 | 1160 | 116 |
| 585 | 03. | 1161 | 117 |
| 640 | 09 | 1162 | 140 |
| 641 | 10 | 1163 | 25 |
| 642 | 21 | 1164 | 118 |
| 643 | 11 | 1165 | 143 |
| 644. | 15 | 1168 | 128 |
| 645 | 14 | 1169 | 132 |
| 646 | 13 | 1170 | 133 |
| 647 | 12 | 1171 | 134 |
| 648 | 19 | 1172 | 135 |
| 650 | 20 | 1173 | 136 |
| 720 | 18 | 1192 | 52 |
| 720A | 18 | 1192A,B,C,D,E | 52 |
| 720B | 18 | 1194 | 30 |
| 1120 | 149 | 1195A,B,C | 33 |
| 1146 | 22 | 1199 | 85 |
| 1147 | 82 | 1200 | 74 |
| 1148 | 23 | 1201 | 39 |
| 1149 | 24 | 1202 | 75 |
| 1151 | 35 | 1203 | 120 |
| 1152 | 26 | 1204 | 102 |
| 1153 | 79 | 1205 | 76 |
| 1154 | 83 | 1206 | 81 |

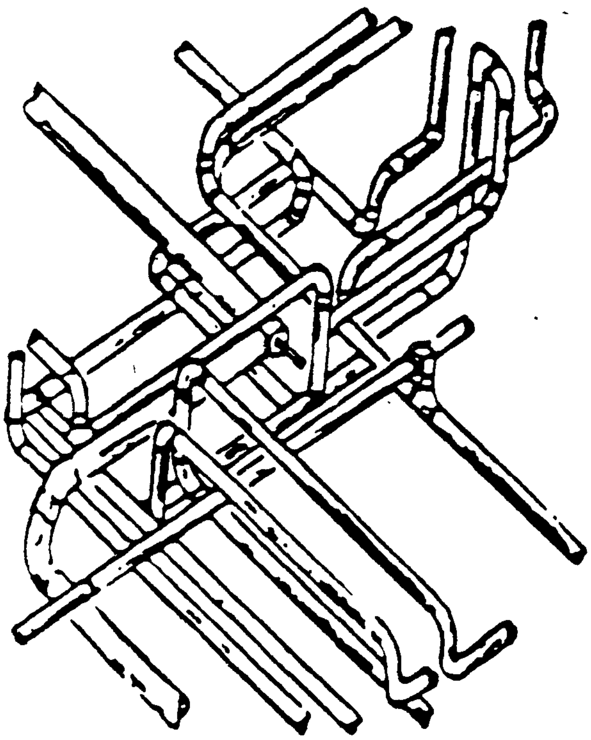
ATTACHMENT 10

LHB 1710.40
November 1988

NASA
Langley Research Center



# SAFETY REGULATIONS COVERING PRESSURIZED SYSTEMS



National Aeronautics and Space Administration

ATTACHMENT 10

NASA LANGLEY HANDBOOK (LHB) 1710.40, SAFETY REGULATIONS COVERING PRESSURIZED SYSTEMS (NOVEMBER 1988)

## IN-SERVICE REPORT FOR SAFETY DEVICES

**Operator to fill in below.**

**Safety Device No.** ______________

| | Month | Day | Year |
|---|---|---|---|
| **Date Tested** | | | |

| | Month | Day | Year |
|---|---|---|---|
| **Date Installed** | | | |

**Unit** ______________

**Location** ______________

**Insert completed form in special envelope and return to engineering department.**

(Source: American Petroleum Institute, Guide for Inspection of Refinery Equipment, Chapter XVI.)

# TEST REPORT FOR SAFETY-RELIEVING DEVICES

**Fill in this report for each device tested and send to the engineering department.**

**Date Tested**

| Month | Day | Year |
|---|---|---|
| | | |

**Device No.** ______________

**Unit** ______________

**Location** ______________

**Size**

| Inlet | Orifice | Outlet |
|---|---|---|
| | | |

**Type**

| Make | Style |
|---|---|
| | |

**Material** ______________

**Special**

| Body | Trim |
|---|---|
| | |

---

**Fill in one side only.**

***From Unit***

**Date Last Tested**

| Month | Day | Year |
|---|---|---|
| | | |

**Popped at** ______________

**Set Pressure** ______________

**Check Pressure** ______________

**New Set Pressure, If Changed** ______________

**Condition:**

- **Leaking** ______________
- **Stuck** ______________
- **Fouled** ______________
- **Corroded** ______________

**Disposition:**

- **To Unit** ______________
- **To Spare** ______________
- **To Junk** ______________

***From Spare Stock***

**Set Pressure** ______________

**Check Pressure** ______________

**Test Used:**

- **Standard** ______________
- **Dry Seat** ______________

**Tested by** ______________

(Source: American Petroleum Institute, Guide for Inspection of Refinery Equipment, Chapter XVI.)

## INSPECTION REPORT

To: ______________________ Date ______________________

______________________

Unit ______________ Equipment ______________ Service ______________

Down time ______________ Returned to Service ______________ Date of Last Inspection ______________

Reason ______________________________________________

______________________________________________

Inspection Comments ______________________________________________

______________________________________________

| | Minimum Thickness | | | |
|---|---|---|---|---|
| | Original | Last Inspection | Present | Retiring Thickness |
| Shell | | | | |
| Shell Cover | | | | |
| Channel | | | | |
| Channel Cover | | | | |
| Top Nozzle (Shell) | | | | |
| Bottom Nozzle (Shell) | | | | |
| Top Nozzle (Channel) | | | | |
| Bottom Nozzle (Channel) | | | | |
| Tubes | | | | |

Recommendations ______________________________________________

______________________________________________

Work requested by ______________________ Inspected by ______________________

cc: ______________ Signed ______________________
Chief Inspector

—Example of Inspection Report Form.

(Source: American Petroleum Institute, Guide for Inspection of Refinery Equipment, Chapter VII.)

# FORM NB-7 UNFIRED PRESSURE VESSELS

## REPORT OF INSPECTION

**Standard Form for Jurisdictions Operating Under the ASME Code**

1 DATE INSPECTED MO. DAY YEAR | CERT EXP DATE MO. YEAR | CERTIFICATE POSTED ☐ YES ☐ NO | OWNER NO. | JURISDICTION NUMBER | NAT'L BD NO ☐ OTHER NO. ☐

2 OWNER | NATURE OF BUSINESS | KIND OF INSPECTION ☐ INT ☐ EXT | CERTIFICATE INSPECTION ☐ YES ☐ NO

OWNER STREET ADDRESS NUMBER | OWNERS CITY | STATE | ZIP

3 USERS NAME – OBJECT LOCATION | SPECIFIC LOCATION IN PLANT | OBJECT LOCATION – COUNTY

USERS STREET ADDRESS NUMBER | USERS CITY | STATE | ZIP

4 TYPE ☐ AIR TANK ☐ WATER TANK ☐ OTHER ______ | YEAR BUILT | MANUFACTURER

5 USE ☐ STORAGE ☐ PROCESS ☐ HEAT EXCHANGE ☐ OTHER ______ | SIZE | PRESSURE GAGE TESTED ☐ YES ☐ NO

6 PRESSURE ALLOWED THIS INSPECTION ______ PREV INSPECTION ______ | SAFETY-RELIEF VALVES SET AT ______ | EXPLAIN IF PRESSURE CHANGED

7 IS CONDITION OF OBJECT SUCH THAT A CERTIFICATE MAY BE ISSUED? ☐ YES ☐ NO (IF NO EXPLAIN FULLY UNDER CONDITIONS) | HYDRO TEST ☐ YES ______ PSI DATE ______ ☐ NO

8 CONDITIONS: *With respect to the internal surface, describe and state location of any scale, oil or other deposits. Give location and extent of any corrosion and state whether active or inactive. State location and extent of any erosion, grooving, bulging, warping, cracking or similar condition. Report on any defective rivets, bowed, loose or broken stays. State condition of all tubes, tube ends, coils, nipples, etc. Describe any adverse conditions with respect to pressure gage, water column, gage glass, gage cocks, safety valves, etc. Report condition of setting, linings, baffles, supports, etc. Describe any major changes or repairs made since last inspection.*

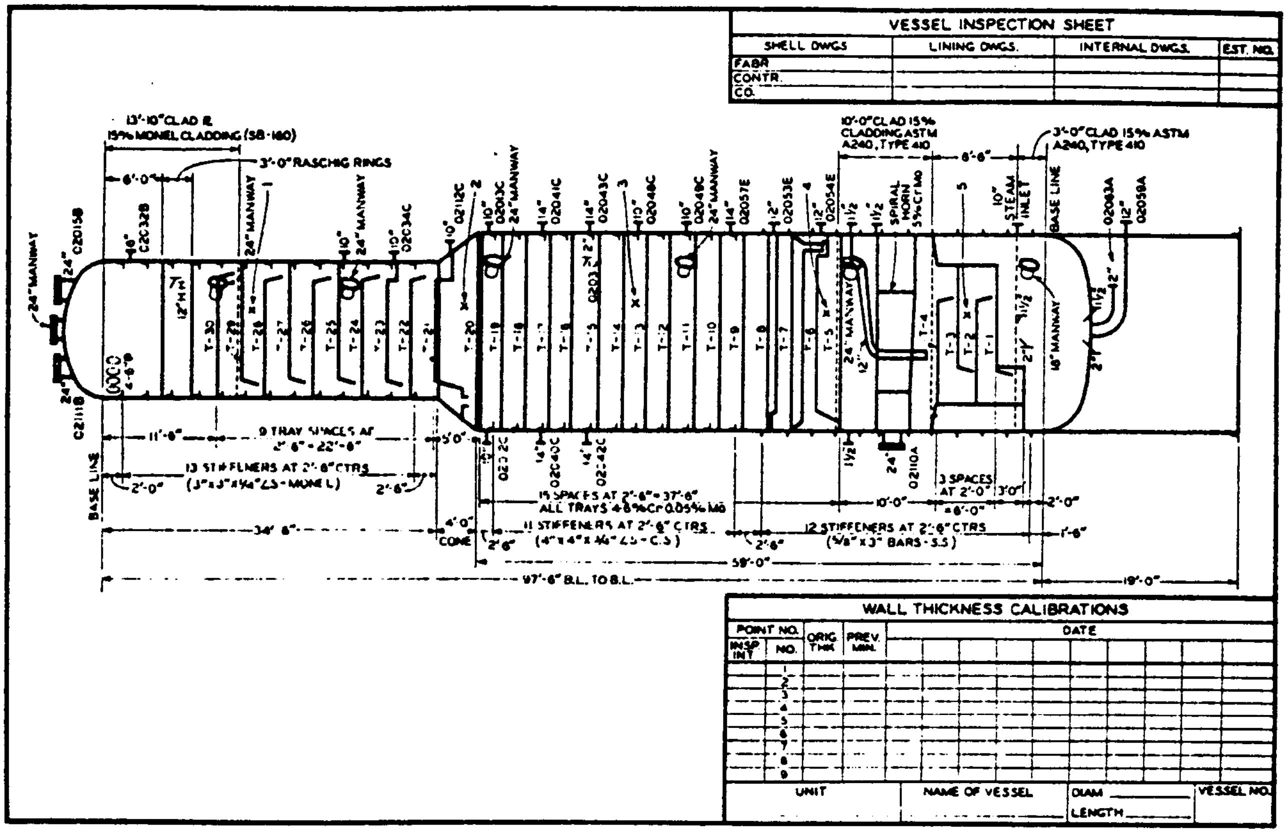
9 REQUIREMENTS *(List code violations)*

10 NAME AND TITLE OF PERSON TO WHOM REQUIREMENTS WERE EXPLAINED

I HEREBY CERTIFY THIS IS A TRUE REPORT OF MY INSPECTION

SIGNATURE OF INSPECTOR | IDENT. NO | EMPLOYED BY | IDENT. NO

(Source: National Board of Boiler and Pressure Vessel Inspectors, National Board Inspection Code, (1972)

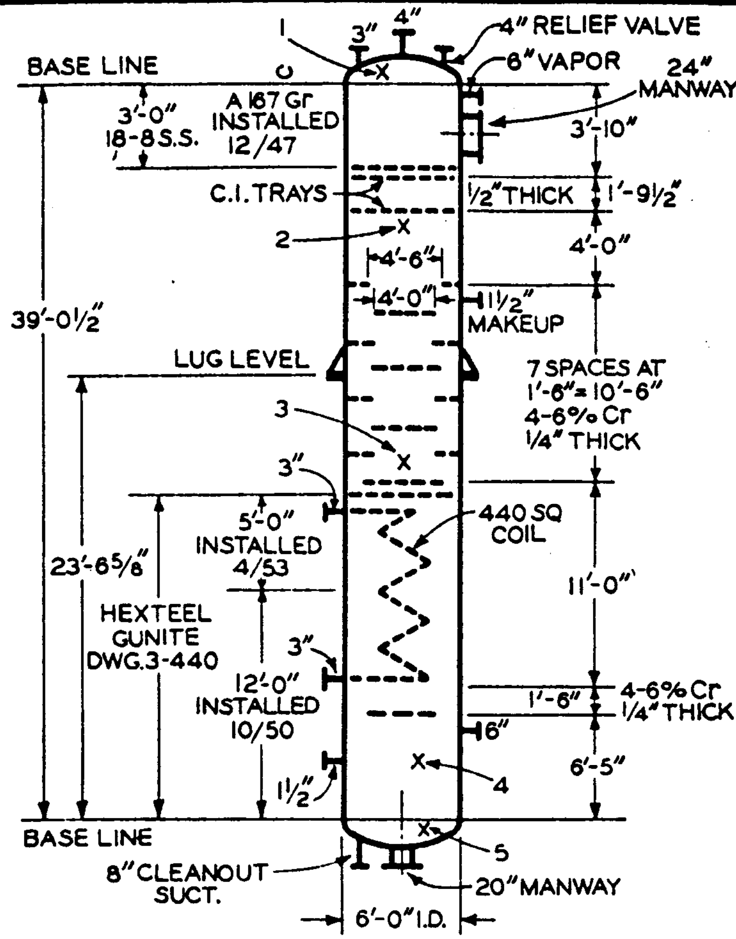



**—Another Typical Vessel Inspection Sheet for Recording Thickness Measurement to Calculate Corrosion Rate.**

(Source: American Petroleum Institute, Guide for Inspection of Refinery Equipment, Chapter VI.)

## VESSEL INSPECTION SHEET

| SHELL DWGS. | LINING DWGS. | INTERNAL DWGS. | EST. NO. |
|---|---|---|---|
| FABR. | | | |
| CONTR. | | | |
| CO. | | | |




## WALL THICKNESS CALIBRATIONS

| POINT NO. INSP. INT. | NO. | ORIG. THK. | PREV. MIN. | DATE | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | | | | | | | | | | | | |
| | 2 | | | | | | | | | | | | |
| | 3 | | | | | | | | | | | | |
| | 4 | | | | | | | | | | | | |
| | 5 | | | | | | | | | | | | |
| | 6 | | | | | | | | | | | | |
| | 7 | | | | | | | | | | | | |
| | 8 | | | | | | | | | | | | |
| | 9 | | | | | | | | | | | | |

| UNIT | NAME OF VESSEL | DIAM. ____ LENGTH ____ | VESSEL NO. |
|---|---|---|---|
| | | | |

—Typical Vessel Inspection Sheet for Recording Thickness Measurement to Calculate Corrosion Rate.

(Source: American Petroleum Institute, Guide for Inspection of Refinery Equipment. Chapter VI).

## HISTORICAL RECORD

| Date Tested | Popped | Reset | Disposition | Condition | Repairs | Remarks |
|---|---|---|---|---|---|---|

| No. | Unit | Location | Set | Test Interval |
|---|---|---|---|---|

(Source: American Pertoleum Institute, Guide for Inspection of Refinery Equipment, Chapter XVI.)

## SPECIFICATION RECORD

Make ______ Style ______

Body and Bonnet Material ______

Nozzle and Disc Material ______

Trim Material ______

*Spring Material* *Spring No.*

Carbon Steel ______

Alloy ______

Inlet ______ Outlet ______

*Size of Flange* *Size of Flange*

Orifice ______ Back Pressure ______

Spring Set Pressure ______

Relieving Pressure ______

Normal Operating Temperature ______

Remarks ______

Maintenance Engineer's Phone ______

| No. | Unit | Location |
|---|---|---|
| | | |

(Source: American Petroleum Institute, Guide for Inspection Refinery Equipment, Chapter XVI).

## PRESSURE VESSEL RECORD

Name of Unit ____________ Battery No. ____________

____________ Works Inspection and Test No. ____________ Date ____________

| | | | | |
|---|---|---|---|---|
| **NAME OF VESSEL** | | | | |
| **COMPANY VESSEL AND SKETCH NO.** | | | | |
| **OPERATING DATA** | | | | |
| Hours Under Pressure to Date | | | | |
| **SERVICE DATA** | | | | |
| Average Maximum Operating Pressure, psi | | | | |
| Average Maximum Operating Temperature, F | | | | |
| Top | | | | |
| Bottom | | | | |
| No. Trays | | | | |
| No. Baffles | | | | |
| No. Coils | | | | |
| **INSPECTION AND TEST DATA** | | | | |
| Inspector | | | | |
| Nominal ID | | | | |
| Minimum Thickness | | | | |
| Shell | | | | |
| Location | | | | |
| Top Head | | | | |
| Bottom Head | | | | |
| Joint Efficiency—Shell | | | | |
| Heads | | | | |
| Head Factor—Top | | | | |
| Bottom | | | | |
| Last Inspection | | | | |
| Inside Welds | | | | |
| Outside Welds | | | | |
| Under Insulation | | | | |
| Extent Inspection | | | | |
| Test Pressure | | | | |
| Vessel, psi | | | | |
| Coils, psi | | | | |
| Test Medium | | | | |
| Time Pressure Held—(1)+(2) | | | | |
| Maximum Allowable Operating Pressure, psi | | | | |
| Maximum Allowable Operating Temperature, F | | | | |
| Limited by | | | | |
| Working Stress, psi—Operating Temperature | | | | |
| Approved Operating Pressure, psi | | | | |
| Approved Operating Temperature, F | | | | |
| Safety Valve Setting, psi | | | | |
| **PROTECTIVE LINING DATA** | | | | |
| Drawing No. | | | | |
| Date Installed | | | | |
| Material and Type | | | | |
| Section Lined | | | | |
| Date Repaired | | | | |
| Extent of Repairs | | | | |
| Date Previous Lining Removed | | | | |
| Cause of Removal | | | | |
| **REMARKS** | | | | |

—Suggested Form for Recording the Physical Condition and Allowable Operating Conditions of All Pressure Vessels on an Operating Unit.

a-4 (Source: American Petroleum Institute, Guide for Inspection of Refinery Equipment. Chapter VI

# HEAT EXCHANGER SPECIFICATION SHEET

| | | | | |
|---|---|---|---|---|
| 1 | | | Job No. | |
| 2 | Customer | | Reference No. | |
| 3 | Address | | Proposal No. | |
| 4 | Plant Location | | Date | Rev. |
| 5 | Service of Unit | | Item No. | |
| 6 | Size Type | (Horizontal) (Vertical) Connected In | Parallel | Series |
| 7 | Surf./Unit (Gross) (Eff.) | Sq Ft; Shells/Unit | Surf./Shell (Gross) (Eff.) | Sq Ft |
| 8 | | PERFORMANCE OF ONE UNIT | | |
| 9 | Fluid Allocation | Shell Side | Tube Side | |
| 10 | Fluid Name | | | |
| 11 | Fluid Quantity, Total Lb/Hr | | | |
| 12 | Vapor (In/Out) | | | |
| 13 | Liquid | | | |
| 14 | Steam | | | |
| 15 | Water | | | |
| 16 | Noncondensable | | | |
| 17 | Temperature (In/Out) °F | | | |
| 18 | Specific Gravity | | | |
| 19 | Viscosity, Liquid Cp | | | |
| 20 | Molecular Weight, Vapor | | | |
| 21 | Molecular Weight, Noncondensable | | | |
| 22 | Specific Heat Btu/Lb°F | | | |
| 23 | Thermal Conductivity Btu Ft/Hr Sq Ft °F | | | |
| 24 | Latent Heat Btu/Lb @ °F | @ | @ | |
| 25 | Inlet Pressure Psig | | | |
| 26 | Velocity Ft/S | | | |
| 27 | Pressure Drop, Allow./Calc. Psi | / | / | |
| 28 | Fouling Resistance (Min.) | | | |
| 29 | Heat Exchanged | Btu/Hr; MTD (Corrected) | | °F |
| 30 | Transfer Rate, Service | Clean | | Btu/Hr Sq Ft °F |
| 31 | CONSTRUCTION OF ONE SHELL | | | Sketch (Bundle/Nozzle Orientation) |
| 32 | | Shell Side | Tube Side | |
| 33 | Design/Test Pressure Psig | / | / | |
| 34 | Design Temperature °F | | | |
| 35 | No. Passes per Shell | | | |
| 36 | Corrosion Allowance In. | | | |
| 37 | Connections In | | | |
| 38 | Size & Out | | | |
| 39 | Rating Intermediate | | | |
| 40 | Tube No. OD | In.; Thk (Min/Avg) | In.; Length Ft; Pitch | In. ⊲30 △60 ⊟90 ◇45 |
| 41 | Tube Type | | Material | |
| 42 | Shell ID | OD In. | Shell Cover | (Integ.) (Remov.) |
| 43 | Channel or Bonnet | | Channel Cover | |
| 44 | Tubesheet-Stationary | | Tubesheet-Floating | |
| 45 | Floating Head Cover | | Impingement Protection | |
| 46 | Baffles-Cross | Type | % Cut (Diam) (Area) Spacing: c/c | Inlet In. |
| 47 | Baffles-Long | | Seal Type | |
| 48 | Supports-Tube | U-Bend | Type | |
| 49 | Bypass Seal Arrangement | | Tube-Tubesheet Joint | |
| 50 | Expansion Joint | | Type | |
| 51 | $\rho v^2$-Inlet Nozzle | Bundle Entrance | Bundle Exit | |
| 52 | Gaskets-Shell Side | | Tube Side | |
| 53 | -Floating Head | | | |
| 54 | Code Requirements | | TEMA Class | |
| 55 | Weights/Shell-Shipping | Filled with Water | Bundle | Lb |
| 56 | Remarks | | | |
| 57 | | | | |
| 58 | | | | |
| 59 | | | | |
| 60 | | | | |
| 61 | | | | |

(Source: American Petroleum Institute, Standard 660-Heat Exchangers for Refinery Services, First Edition.)

**FORM A-3 MANUFACTURERS' TEST REPORT OF SAFETY VALVES**
As Required by the Provisions of the ASME Code Rules

1. Manufactured by ______________________ (Name and address of manufacturer)

**IDENTIFICATION OF VALVE**

2. Manufacturer's Type or Style No. ______________ Serial No. ______________
3. Inside Diameter of Valve Seat ______________ (In. (1000 ths))
4. Inlet Pipe Size ______ (In.) Outlet Pipe Size ______ (In.) Screwed or Flanged ______________
5. Inside Spring, Outside Spring (cross out one) Flat Seat, Bevel Seat (cross out one)
6. Seat Angle ______ (Deg) Material of Body ______________ of Valve Disk ______________

of Valve Seat ______________ Weight of Completely Assembled Valve ______ (Lb)

**AUTHORIZATION TEST RESULTS**

7. Type of test: By Weighed Condensation, By Flowmeter (cross out one)
8. Popping Pressure ______ (Lb per sq in. gage) Closing Pressure ______ (Lb per sq in. gage)
9. Blowdown ______ (Lb per sq in.) Relieving Capacity ______ (Lb per hr (by test))
10. Lift, at Relieving Capacity ______ (In.) Pressure during Capacity Test ______ (Lb per sq. in. gage)

Pressure in Exhaust Pipe during Capacity Test ______ (Lb per sq in. gage)

11. Fluid Used in Tests ______________ (If not saturated steam, indicate per cent moisture or molecular weight, M, if other fluid)
12. ASME Boiler Code capacity (90 per cent of test capacity) ______ (Lb per hr)

**REMARKS**

13. Place of Test ______________ Date of Test ______________
14. Does the valve chatter? ______ Does the valve stem leak? ______ Was valve stem leakage measured? ______

We certify the above data to be correct and that the relieving capacity of the safety valve conforms with the ASME Code rules and that the valve conforms to the following drawings ______________

Signed ______________ (Manufacturer) By ______________ Date ______________ 19____

Signed ______________ (Authorized Observer) Date ______________ 19____

This Form is obtainable from the ASME Order Dept., 345 E. 47th St., New York, N.Y. 10017

(Source: American Society of Mechanical Engineers, Boiler and Pressure Vessel Code. Section VIII. Division 2.)

## PRESSURE VESSEL RECORD

Name of Unit ______ Vessel Name ______

Battery No. ______ Original Item No. ______

______ Works Date ______

### HISTORY

Estimate No. ______
Order No. ______
Mfgd. By ______
Mfgrs. Serial No. ______
Mfgrs. Inspector ______
Mfgrs. Test Press. ______

Date Received ______
Date Installed ______
Company No. ______
Company Inspector ______

### DESCRIPTION

Drawing No.
Fabricators ______
Contractors ______
Company ______
Position (Vertical or Horizontal) ______
Code Constructed ______
Code ______ Year ______
Code Stamp ______
Material Specified and Grade or Type
Base ______
Lining ______
Thickness ______
Stress Relieved (Original) ______
Radiographed (Original) ______
Complete ______
Weld Intersections ______
Size—Nominal ID ______
Length Base Line to Base Line ______
Design—Pressure, psi ______
Temperature, F ______
Stress, psi ______
Maximum Allowable Operating Pressure, psi ______
Maximum Allowable Temperature, F ______
Limited by ______
Shell
Type of Construction ______
Joint Efficiency ______
Type of Support ______
Interior or Exterior Stiffeners ______
Original Thickness ______
Corrosion Allowance ______
Manways
No. ______
Size ______
Flange Rating ______
Reinforcement
Factory or Field ______

Top Head
Type: Elliptical ______ Hemispherical ______
Dished—Cr. R. ______ Kn. R. ______
Conical—Angle ______
Flat ______
Joint Efficiency ______
Original Thickness ______
Corrosion Allowance ______
Manways
No. ______
Size ______
Flange Rating ______
Reinforcement
Factory or Field ______
Bottom Head
Type: Elliptical ______ Hemispherical ______
Dished—Cr. R. ______ Kn. R. ______
Conical—Angle ______
Flat ______
Joint Efficiency ______
Original Thickness ______
Corrosion Allowance ______
Manways
No. ______
Size ______
Flange Rating ______
Reinforcement
Factory or Field ______
Nozzles
Minimum Flange Rating ______
Type Facing ______
Openings Reinforced ______
Remarks ______

NOTE: A copy of this sheet shall be prepared for each individual vessel in a unit. If new vessels are installed or any changes are made to present vessels affecting "Description" items, a new or revised copy of this sheet shall be submitted with the current inspection report.

Typical Form for a Permanent Pressure Vessel Record

(Source: American Petroleum Institute, Guide for Inspection of Refinery Equipment, Chapter VI).

# APPENDIX A

## DOCUMENTATION FORMATS

8. Pressure Test Record - The pressure test record is prepared and furnished by the manufacturer.

9. Record of Post-Weld Heat Treatment - This document is prepared by the company performing the heat treatment (when required) and is furnished by the component manufacturer. It shows rates of heating and cooling, holding temperature, and length of time at holding temperature.

10. Facsimile of Nameplate Stamping - This document is prepared by the manufacturer. It is usually a pencil rubbing of the actual nameplate as stamped.

11. Record of Impact Test - This document is furnished either by the material manufacturer of the component manufacturer, Ut should contain the applicable specification, test procedure used, and results of all tests.

12. Record of Heat Treatment - This is documentation of material heat treatment and is needed only when such heat treatment is done by, or under the control of, someone other than the material supplier. It will be a supplement to the appropriate mill test report.

702 DOCUMENTATION FOR EXISTING PRESSURE VESSELS AND SYSTEMS

1. Documentation should provide basic design and service data. A comprehensive chronological record of maintenance history, certification status, and future inservice inspection and recertification requirements is necessary for all systems throughout their service life.

2. The documentation file should contain all of the available data obtained when the system was new (See paragraph 701) plus subsequent service data as follows:

   a. The name of the component manufacturer

   b. Item number

   c. Manufacturer's serial number

   d. Model number

   e. Manufacturer's drawings and specifications

   f. Design data

3. Design Calculations - Design calculations for components such as pressure vessels, vacuum vessels, wind tunnels, and piping should include pressure, temperature, wind, seismic, deadload, and any other applicable loadings. They should specify the applicable code, standard, or other design basis.

4. Manufacturer's Data Report - Manufacturer's data reports are furnished with all components built to the rules of the ASME Boiler and Pressure Vessel Code and are illustrated in the applicable sections of this code. The equivalent for components such as pumps, compressors, valves, gages, and relief valves are data sheets, performance curves, and shop test reports (e.g., hydrostatic test, performance test, net positive suction head test, mechanical running test, relieving capacity, and calibration test.)

5. Mill Test Reports - Mill test reports are furnished by the material manufacturer for the material supplier to certify compliance with specifications. They contain information such as material manufacturer, purchaser, material specification, description of material furnished, heat number, chemical and mechanical properties, and results of test. There are instances where these are not necessary (see Par. UG-11 (a) and UG-11 (c) of Ref. 2).

6. Welding Procedure and Procedure Qualification Records - Welding procedure and procedure qualification test records are prepared and furnished by the manufacturer. They describe the welding procedure and record the test results obtained in welding procedure and welder performance qualifications and the results of examinations of welding operators. These are illustrated in the ASME Boiler and Pressure Vessel Code, Appendix II, Section IX - Welding Qualifications.

7. Record of Nondestructive Examinations - Nondestructive examinations reports are prepared by the manufacturer. When radiographic examinations are performed, the film usually remains in the possession of the manufacturer (for a period of 5 years in the case of equipment built to the ASME Boiler and Pressure Vessel Code). The minimum requirements for the reports are given in the applicable sections of Section V, Nondestructive Examination, of the ASME Boiler and Pressure Vessel Code.

8. Pressure Test Record - The pressure test record is prepared and furnished by the manufacturer.

# CHAPTER 7: DOCUMENTATION

## 700 GENERAL

1. This Chapter describes the recommended documentation for new and existing pressure vessels and systems.

2. Some documents may be unobtainable for the existing of used items. However, all documents that are obtained should be retained on file. Suggested forms for maintaining this documentation are presented in Appendix A.

## 701 DOCUMENTATION FOR NEW PRESSURE VESSELS AND SYSTEMS

1. Manufacturer's Drawings - For components such as pressure vessels, vacuum vessels, wind tunnels, piping, and expansion joints, the drawings should be either the certified shop fabrication drawings or as-built drawings. The drawings should contain the following:

   a. Manufacturer's name

   b. Date of manufacture

   c. Identification of component

   d. Configuration

   e. Dimensions and details of construction

   f. Design and operating conditions

   g. Design code or design basis

   h. Thicknesses

   i. Corrosion allowance

   j. Identification of materials and design properties

   k. Efficiency of joints

   l. Nondestructive examinations

   m. Types of tests (e.g., hydrastatic, pneumatic)

2. For components such as pumps, compressors, valves, gages, and relief devices, the drawings should be the certified outline and cross-sectional drawings showing information such as make, model number, materials of construction, and design and operating data.

TABLE 6-14

INSPECTION FOR VACUUM SYSTEM COMPONENTS

| SYSTEM COMPONENT (VALUE UNITS) | VALUE UNIT RANGE | TIME INTERVALS (YEARS) | | | | |
|---|---|---|---|---|---|---|
| | | 1 | 2 | 5 | 10 | 20 |
| VACUUM VESSELS (Capacity in Cubic Feet) | 200-15,000 | | | I | | R |
| | 15,000-100,000 | | I | | R | |
| | 100,000 & Above | I | | R | | |
| RELIEF VALVES | All | | I | | R | |

INSTRUCTIONS AND NOTES:

Volumes are water equivalent.

I - Inspection
R - Recertification

TABLE 6-13

INSPECTION FOR SYSTEM COMPONENTS CONTAINING HYDROGEN PEROXIDE (90%), NITROGEN TETROXIDE, INHIBITED RED FUMING NITRIC ACID

| SYSTEM COMPONENTS (VALUE UNITS) | VALUE UNIT RANGE | TIME INTERVALS (YEARS) | | | | |
|---|---|---|---|---|---|---|
| | | 1 | 2 | 5 | 10 | 20 |
| TANKS Capacity in liters (gallons) | Less than 37,850 (10,000) | | | I | | R |
| | 37,850 and above (10,000) | | I | | | R |
| PIPING AND COMPONENTS Pipe Diameter in centimeters (inches) | Less than 40.7 (16) | | | I | | R |
| | 40.7 and above (16) | | I | | | R |
| EXPANSION JOINTS Diameter in centimeters (inches) | Less than 40.7 (16) | | I | | R | |
| | 40.7 and above (16) | I | | R | | |
| FLEXIBLE HOSES | All | I | | R | | |
| RELIEF VALVES | All | | I | R | | |

INSTRUCTIONS AND NOTES:
Diameters are nominal

I - Inspection
R - Recertification

TABLE 6-12

INSPECTION FOR SYSTEM COMPONENTS CONTAINING FURFURYL ALCOHOL, KEROSENE (RP-1)

| SYSTEM COMPONENT (VALUE UNITS) | VALUE UNIT RANGE | TIME INTERVALS (YEARS) | | | | |
|---|---|---|---|---|---|---|
| | | 1 | 2 | 5 | 10 | 20 |
| TANKS Capacity in liters (gallons) | Less than 1,390 (380) | | | I | | |
| | 1,390-13,900 (380-3,800) | | I | R | | |
| | 13,900 and above (3,800) | I | | R | | |
| PIPING AND COMPONENTS Pipe Diameter in centimeters (inches) | Less than 25.4 (10) | | | I | | |
| | 25.4 and above (10) | | I | R | | |
| EXPANSION JOINTS | All | I | | R | | |
| RELIEF VALVES | All | | I | R | | |
| FLEXIBLE HOSES | All | I | | R | | |

INSTRUCTIONS AND NOTES:

I - Inspection
R - Recertification

TABLE 6-11

INSPECTION FOR SYSTEM COMPONENTS CONTAINING ANILINE

| SYSTEM COMPONENT (VALUE UNITS) | VALUE UNIT RANGE | TIME INTERVALS (YEARS) | | | | |
|---|---|---|---|---|---|---|
| | | 1 | 2 | 5 | 10 | 20 |
| TANKS Capacity in liters (gallons) | Less than 643.4 (170) | | | I | R | |
| | 643.4-6,433 (170-1,700) | | I | R | | |
| | 6,434 and above (1,700) | I | | R | | |
| PIPING AND COMPONENTS Pipe Diameter in cm (inches) | Less than 21.24 (6) | | | | | |
| | 21.24-50.8 (6-20) | | I | R | | |
| | 50.8 and above (20) | I | | R | | |
| FLEXIBLE HOSES | All | I | | R | | |
| RELIEF VALVES | All | | I | R | | |
| EXPANSION JOINTS | All | I | | | R | |

INSTRUCTIONS AND NOTES:

I - Inspection
R - Recertification

TABLE 6-10

INSPECTION FOR SYSTEM COMPONENTS CONTAINING MONOMETHYL HYDRAZINE, HYDRAZINE, UDMH, UDMH/HYDRAZINE

| SYSTEM COMPONENT (VALUE UNITS) | VALUE UNIT RANGE | TIME INTERVALS (YEARS) 1 | 2 | 5 | 10 | 20 |
|---|---|---|---|---|---|---|
| TANKS Capacity in liters(gallons) | Less than 378.5 (100) | | | I | R | |
| | 378.5-3,785 (100-1,000) | | I | R | | |
| | 3,785 and above (1,000) | I | | R | | |
| PIPING AND COMPONENTS Pipe Diameter in cm (inches) | Less than 12.7 (5) | | | I | R | |
| | 12.7-40.7 (5-16) | | I | R | | |
| | 40.7(16) and above | I | | R | | |
| EXPANSION JOINTS | All | I | | R | | |
| RELIEF VALVES | All | | I | R | | |
| FLEXIBLE HOSES | All | I | R | | | |

INSTRUCTIONS AND NOTES:
Diameters are nominal

I - Inspection
R - Recertification

TABLE 6-9

INSPECTION FOR SYSTEM COMPONENTS CONTAINING LIQUID FLOURINE

| SYSTEM COMPONENTS (VALUE UNITS) | VALUE UNIT RANGE | TIME INTERVALS (YEARS) | | | | |
|---|---|---|---|---|---|---|
| | | 1 | 2 | 5 | 10 | 20 |
| TANKS Capacity in liters (gallons | Less than 4,920 (1300) | | | I | | R |
| | 4,920-24,602 (1300-6500) | | I | | | R |
| | 24,602 (6500) and above | I | | | R | |
| PIPING & COMPONENTS Pipe Diameter in centimeters (inches) | Less than 21.24 (6) | | | | I | R |
| | 21.24 (6) & above | | | I | | R |
| EXPANSION JOINTS | All | I | | R | | |
| FLEXIBLE HOSES | All | I | R | | | |
| RELIEF VALVES | All | | I | R | | |

INSTURCTIONS AND NOTES:
Diameters are nominal

I - Inspection
R - Recertification

TABLE 6-8

INSPECTION FOR SYSTEM COMPONENTS CONTAINING LIQUIDS OF HYDROGEN, NATURAL GAS

| SYSTEM COMPONENT (VALUE UNITS) | VALUE UNIT RANGE | TIME INTERVALS (YEARS) | | | | |
|---|---|---|---|---|---|---|
| | | 1 | 2 | 5 | 10 | 20 |
| TANKS Capacity in liters (gallons) | Less than 4,920 (1300) | | | I | R | |
| | 4,920 - 24,602 (1300-6500) | | I I | R R | | |
| | 24,602 (6500) and above | I | | R | | |
| PIPING & COMPONENTS Pipe Diameter in centimeters (inches) | Less than 45.7(18) | | I | | R | |
| | 45.7(18) & above | I | | R | | |
| EXPANSION JOINTS | All | I | | R | | |
| RELIEF VALVES | All | | I | R | | |
| FLEXIBLE HOSES | All | I | R | | | |

INSTRUCTIONS AND NOTES:
Diameters are nominal.

I - Inspection
R - Recertification

TABLE 6-7

INSPECTION FOR SYSTEM COMPONENTS CONTAINING LIQUID OXYGEN

| SYSTEM COMPONENT (VALUE UNIT) | VALUE UNIT | TIME INTERVALS (YEARS) 1 | 2 | 5 | 10 | 20 |
|---|---|---|---|---|---|---|
| TANKS Capacity in liters (gallons) | Less than 75,700 (20,000) | | | I | | R |
| | 75,700 (20,000) and above | | I | | | R |
| PIPING & COMPONENTS Pipe Diameter in cm (inches) | Less than 61(24) | | | I | | R |
| | 61(24) and above | | I | | | R |
| EXPANSION JOINTS Diameter in cm (inches) | Less than 61(24 | | I | | R | |
| | 61(24) and above | I | | R | | |
| FLEXIBLE HOSES | All | I | R | | | |
| RELIEF VALVES | All | | I | R | | |

INSTRUCTIONS AND NOTES:
Diameters are nominal.

I - Inspection
R - Recertification

TABLE 6-6

INSPECTION FOR SYSTEM COMPONENTS CONTAINING
LIQUIDS OF ARGON, HELIUM AND NOTROGEN

| SYSTEM COMPONENT (VALUE UNITS) | VALUE UNIT RANGE | TIME INTERVALS (YEARS) | | | | |
|---|---|---|---|---|---|---|
| | | 1 | 2 | 5 | 10 | 20 |
| TANKS Capacity in liters (gallons) | Less than 189,250 (50,000) | | | I | | R |
| | 189,250 (50,000) & above | | I | | | R |
| PIPING & COMPONENTS Pipe Diameter in cm (inches) | Less than 91.4 (36) | | | I | | R |
| | 91.4 (36) & above | | I | | | R |
| EXPANSION JOINTS Diameter in cm (inches) | Less than 91.4(36) | | I | | R | |
| | 91.4 (36) & above | I | | R | | |
| FLEXIBLE HOSES | All | I | | R | | |
| RELIEF VALVES | All | | I | R | | |

INSTRUCTIONS AND NOTES:
Diameters are nominal.

I - Inspection
R - Recertification

TABLE 6-5

INSPECTION FOR SYSTEM COMPONENTS CONTAINING WATER OR NONFLAMMABLE HYDRAULIC FLUIDS

| SYSTEM COMPONENTS (VALUE UNITS) | VALUE UNIT RANGE | TIME INTERVALS (YEARS) | | | | |
|---|---|---|---|---|---|---|
| | | 1 | 2 | 5 | 10 | 20 |
| TANKS Capacity in liters (gallons) | Less than 189,250 (50,000) | | | | I | R |
| | 189,250 & above | | | I | | R |
| PIPING & COMPONENTS PIPE Diameter in cm (inches) | Less than 91.4(36) | | | | I | R |
| | 91.4(36) & above | | | I | | R |
| EXPANSION JOINTS Diameter in cm (inches) | Less than 91.4(36) | | | R | R | |
| | 91.4(36) & above | | I | R | | |
| FLEXIBLE HOSES | All | | R | | | |
| RELIEF VALVES | All | I | | R | | |

INSTRUCTIONS AND NOTES:
Diameters are nominal.

I - Inspection
R - Recertification

TABLE 6-4

INSPECTION FOR SYSTEM COMPONENTS
CONTAINING GASEOUS FLUORINE

| SYSTEM COMPONENT (VALUE UNITS) | VALUE UNIT RANGE | TIME INTERVALS (YEARS) 1 | 2 | 5 | 10 | 20 |
|---|---|---|---|---|---|---|
| PRESSURE VESSELS Pressure Times Volume in $\frac{kg}{cm^2} \bullet m^3$ $\left(\frac{lb}{in^2} \bullet ft^3\right)$ | Less than 25.8 (13,000) | | | I | | R |
| | 25.8-133(13,000 - 67,000) | | I | | R | |
| | | | | | | |
| PIPING & COMPONENTS Pressure Times Pipe Diameter Squared in $\frac{kg}{cm^2} \bullet cm^2$ $\left(\frac{lb}{in^2} \bullet in^2\right)$ | Less than 5,900 (13,000) | | | I | | R |
| | 5,900-45,400 (13,000-100,000) | | I | | R | |
| | 45,400 (100,000) and above | I | | R | | |
| EXPANSION JOINTS | All | I | | R | | |
| FLEXIBLE HOSES | All | I | R | | | |
| RELIEF VALVES | All | | I | R | | |

INSTRUCTIONS AND NOTES:
Volumes are water equivalent; diameters are nominal; pressures are gage.

I - Inspection
R - Recertification

TABLE 6-1

INSPECTION FOR SYSTEM COMPONENTS CONTAINING GASEOUS ARGON, HELIUM, NITROGEN, DRY AIR

| SYSTEM COMPONENT (VALUE UNITS) | VALUE UNIT RANGE | TIME INTERVALS (YEARS) 1 | 2 | 5 | 10 | 20 |
|---|---|---|---|---|---|---|
| PRESSURE VESSELS Pressure Times Volume in $\frac{kg}{cm^2}$ $m^3$ | Less than 10 (5,000) | | | I | | R |
| | 10 - 1,000 (5,000 - 500,000) | | I | | | R |
| | 1,000 (500,000) and above | I | | | R | |
| PIPING & COMPONENTS Pressure Times Pipe Diameter Squared in $\frac{kg}{cm^2}$ | Less than $2.27\times10^6$ (5,000,000) | | | I | | R |
| | $2.27\times10^6$ (5,000,000) and above | | I | | R | |
| EXPANSION JOINTS Pressure Times the Diameter Squared in $\frac{kg}{cm^2}$ | Less than $2.27\times10^6$ (5,000,000) | | I | | R | |
| | $2.27\times10^6$ (5,000,000) and above | I | | R | | |
| FLEXIBLE HOSES Pressure in kg per Square cm | Less than 14.05 (200 psi) | I | | R | | |
| | 14.05 (200 psi) and above | I | R | | | |
| RELIEF VALVES | All | | I | | R | |

INSTRUCTIONS AND NOTES:
Volumes are water equivalent; diameters are nominal; pressures are gage

I - Inspection
R - Recertification

FIG.4

SAMPLE INSPECTION AND RECERTIFICATION REQUIREMENTS FOR FACILITY "X"

352 kg/cm$^2$ (5000 PSI) AIR STORAGE VESSELS

| | DESCRIPTION | 1 or $N_F$=100 | 2 or $N_F$ = 200 | 5 or $N_F$=500 | 10 or $N_F$= 1,000 | 20 or $N_F$=2,000 |
|---|---|---|---|---|---|---|
| All Vessels | Complete | VE | | | VI&AET | |
| | 15.2cm (6") Nozzles | | | | UT_PT | |
| | 5.08cm (2") Nozzles | | | | UT&PT | |
| | Heads | | | | UT-Long | |
| | Heads to Cylinder Junctions | | | | RT&UT Shear | |
| | Flanges | | | | BLT | |
| | Relief Valves | | CRVT | | CRVT&VI | |
| Vessel #4 | 5.08 cm (2") Nozzle | PT | | | PT&UT | |
| Vessel #6 | Bottom Head to Cylinder Junction | | UT-Shear | | UT-Shear | |
| | Bottom Head | | UT-Long | | UT-Long | |

$N_F$ - Equivalent Full Pressure Cycles

RECERTIFICATION

UT-Long - Ultrasonic Test Unising Longitudinal Waves

UT-Shear - Ultrasonic Test Using Shear Waves

Fig. 3

SAMPLE INSPECTION AND RECERTIFICATION FOR FACILITY "X"
212 kg/ $cm^2$ (3000 PSI) AIR PIPING

| DESCRIPTION | TEST METHOD REQUIRED AT TIME INTERVALS (YEARS) 1 or $N_F$=800 | 2 or $N_F$=1600 | 5 or $N_F$=4000 | 10 or $N_F$=8000 | 20 or $N_F$=16000 |
|---|---|---|---|---|---|
| Complete System | | VI | | | VE |
| Vessel to Manifold Joints | | | | | UT–Shear |
| Manifold Exit Joints | | | UT–Shear | | UT–Shear |
| Downstream End Reducer | | | UT–Shear | | UT–Shear |
| 15.2 cm (6") Tee Weld Joints | | | | | UT–Shear |
| 15.2cm (6") Tee Inside Corners | | | | | PT |
| | | | | | RECERTIFICATION |

$N_F$ – Equivalent Full Pressure Cycles

UT–Shear – Ultrasonic Test Using Shear Waves

Fig. 2

SAMPLE INSPECTION AND RECERTIFICATION REQUIREMENTS FOR FACILITY "X" 70.4 kg/cm$^2$ (1000 PSI) WATER SYSTEM

| | TEST METHOD REQUIRED AT TIME INTERVALS (YEARS) | | | | |
|---|---|---|---|---|---|
| DESCRIPTION | 1 | 2 | 5 | 10 | 20 |
| All Piping and Components | | | VE | UT-Thick | UT-Thick |
| Elbow #24 | | UT-Thick | | | UT-Tick |
| Valve #3 | VE | | MT | | VI & MT |
| Valves 1, 2, and 4 thru 14 | | | VE | | VI |
| Water Pump "A" | VE | | | | VI |
| Relief Valve | | CRVT&VE | | VI | CRVT & VI |

UT-Thick - Ultrasonic Check for Thickness (Spot Check)

RECERTIFICATION

environment and location (e.g., buried piping.)
An engineering analysis of service life, based on actual component thickness and expected rate of thickness loss per year, is necessary for the determination of appropriate inspection and recertification intervals.

3. Proximity of Personnel - An analysis should be made of peak overpressure in occupied areas resulting from a failure and the results should be applied in the selection of inspection periods.

4. Stress analyses - Non-Destructive Examination (NDE), Materials Tests, Fracture Mechanics Evaluation, Code Evaluations, etc.- these analyses should be used to: (1) Determine the specific areas to be examined, (2) Determine the type of inspections and tests to be performed, and (3) Further develop the baseline table detail.

603 EXAMPLES

Figures 2, 3, and 4 are provided as samples of tables that could result from application of the above analyses.

conversions were made to establish value units convenient for use. Value units were modified in tables for which contents are toxic. Value units for piping were based on the energy contained in the piping for a selected distance on either side of a failure point and then modified for toxic contents.

2. Destructive potential associate with the failure of a vacuum vessel is based upon vessel implosion with reduction of pressure in the surrounding area. The hazards of this type of failure are high velocity surrounding air movement, vessel fragmentation, and possible collapse of unvented sheltering structures.

3. The component identification and the units for numerical values entered in the tables are shown in the first column. Once the appropriate table has been selected and the numerical value calculated for the component, the maximum time intervals are found in adjacent columns. As an example, in Table 6-1, a pressure vessel having a water equivalent volume of 2.83 $m^3$ (100 cubic feet) and containing dry air of 197 $kg/cm^2$ (2800 psig) would have a pressure times volume value of 558 (280,000). This example would fall on the second line of the table. It would indicate that major inspections should be made at 20-year intervals for recertification and that additional inspections should be made at 2-year intervals to maintain certification status.

## 602 DEVELOPMENT OF TABLES FOR SPECIFIC CASES

The tables in this Chapter should provide a baseline for energy considerations and assist in priority setting. Some examples of additional considerations necessary for development of specific case tables are as follows:

1. Cyclic Duty - The cognizant Pressure Systems Engineer should ensure that documentation for components in cyclic duty considers a fatigue analysis to determine the maximum number of cycles permitted and the remaining service life under the anticipated loading conditions. A fatigue analysis is required under the rules of the ASME Code, Section VIII, Division 2 (with some exceptions), and this analysis should be included in the documentation for the vessel.

2. Corrosion and Erosion - Modification of the inspection tables is necessary for reduction of wall thickness due to corrosion or erosion. Internal system or component corrosion or erosion may be caused by the contnets and/or flow characteristics. External corrosion or erosion is caused by the surrounding

# CHAPTER 6: INSPECTION TABLES

## 600 GENERAL

1. The tables presented in this Chapter should be used for format and as a baseline guide for initially selecting recertification periods and intervening periods of inspection. They are based on consideration of variations in energy levels and toxicity. They should be modified to consider cyclic duty, corrosion and erosion. Further modifications should be made to account for location with respect to proximity of personnel and equipment. The analysis conducted for determination of the areas to be examined and methods of examination may indicate that the use of equivalent full pressure cycles instead of number of years of operation, or a combination thereof, provides a more appropriate baseline for the inservice inspection and recertification program.

2. Tests, test methods and intervals used for specific systems should be based on detailed analyses and examination in the following areas and the plan should be established with consideration of the (1) potential for destruction in the event of a failure (2) possible failure modes, and (3) probability of occurrence of each:

   Stress
   Non-Destructive Examination (NDE)
   Materials Tests
   Stability (to include seismic)
   Operating Pressure and Temperature History
   Fatigue
   Fracture Mechanics (including net section stress)
   Code Evaluation

3. Results should be fully documented to clearly show how the detailed analyses and examination, when considered on an integrated basis, provide appropriate safety for the service life of the system. It should include the rationale for deviations from codes or this guide and provide support for the resulting inservice inspection and recertification plan.

## 601 CONSTRUCTION OF INSPECTION TABLES

1. Inspection tables are presented on the basis of system contents. Some possible hazards of a vessel failure are pressure shock waves, vessel fragmentation, explosion, release of flammable contents, and release of toxic or corrosive materials. The destructive potential associate with the failure of a pressure vessel was established, ranges of energy levels were selected and

# RECERTIFICATION PROCEDURE FOR INSERVICE EQUIPMENT

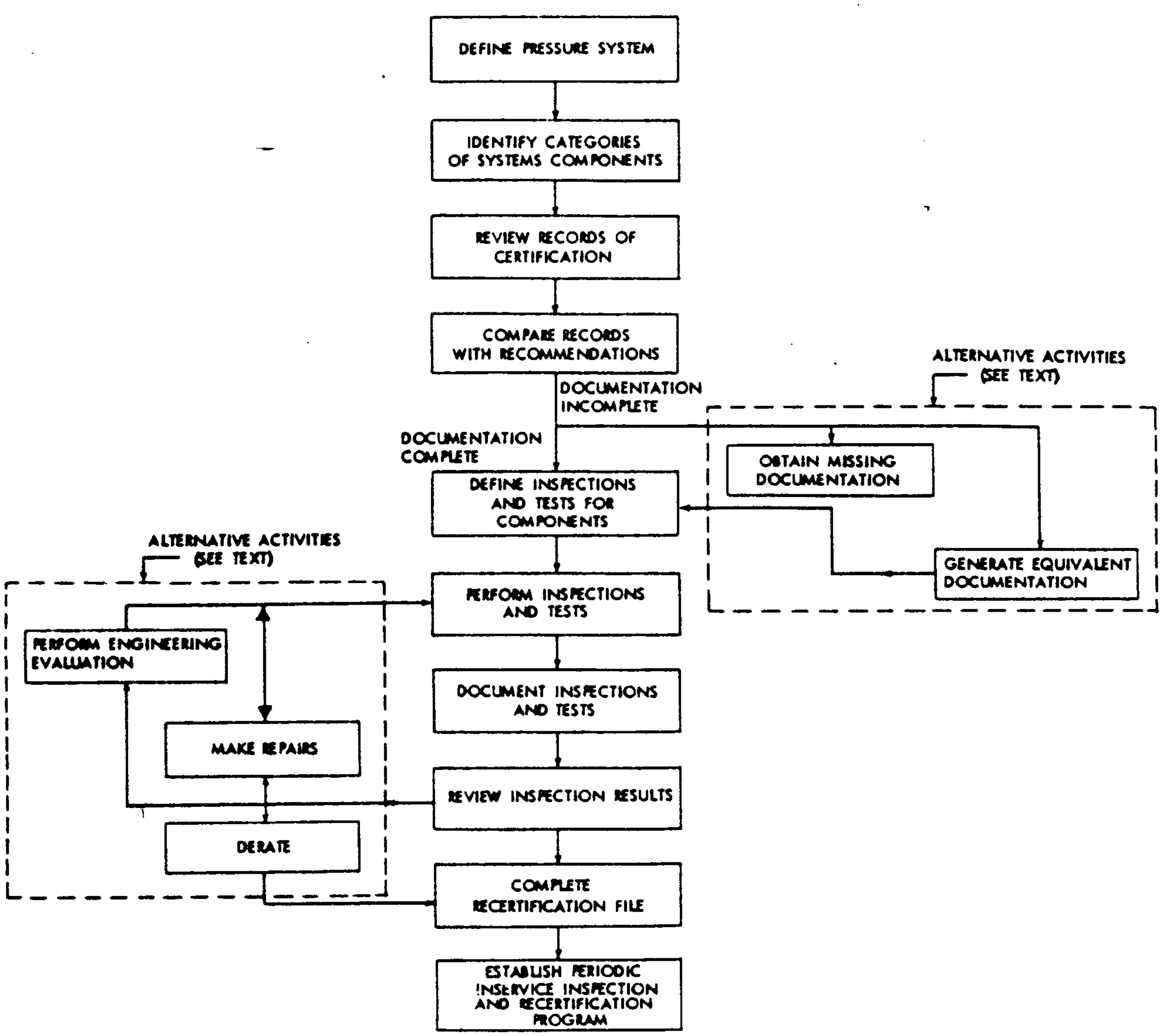



FIGURE 1

in Chapter 7. The recertified equipment should be marked or tagged to indicate date of recertification and service level and it should be indexed to the recertification data file.

m. Establish Periodic Inspection Program - Periodic inspection is necessary to ensure that a system maintains its certification status. Results of inspections and tests performed for certification should provide the base for establishment of a comprehensive inservice inspection and recertification plan. The plan should provide surveillance over critical areas to provide confidence in structural integrity between recertification periods.

## 502 USED PRESSURE VESSELS AND SYSTEMS TO BE PUT IN NEW SERVICE

When the need arises to put used systems or components into a new service, they should be recertified under the following conditions:

1. The system or component is going into service at a higher pressure or a higher or lower temperature than the original service.

2. The component has been removed from a system and stored without appropriate environmental protection.

3. The component was received from another NASA field installation, another agency, or any other source.

4. There is a change of content to the extent that a new inspection table would be used.

## 503 PRESSURE VESSELS AND SYSTEMS ON STANDBY

Vessels and systems on standby, either with or without pressure, should be treated as though in continous service and an appropriate recertification program should be maintained to meet the conditions for which it is standing by.

examinations, such as radiography, ultrasonics, and magnetic particle testing, or combinations thereof. Proof testing should be applied only when analysis has been performed that proves that data derived from the test is useful in determining the components' integrity and remaining useful life.

i. Perform Inspections and Tests - The inspections and tests determined above should be performed.

j. Document Inspections and Tests - The inspections and tests should be documented as recommended in Chapter 7.

k. Review Inspection and Test Results - The inspection and test results should be reviewed to determine if the system is qualified for recertification at the intended service. If the system is adequate for recertification, the recertification file should be completed and a periodic inservice inspection and recertification program documented for continued use. If the system cannot be recertified, there are three alternative actions that can be taken: derate, repair, or perform an engineering analysis to determine a new basis for recertification.

(1) Derate the System - The system may be derated to less severe service conditions on a permanent or temporary basis. Temporary derating will allow the system to be operated at a safe service level during the time it takes to make modifications or to develop an engineering rationale sufficient to certify the system for the original service. Completion of inspections and tests may be accomplished to certify the derated system for the lower service.

(2) Repair the System or Components - The system may be repaired and returned to a condition that can be recertified. Following the repairs, the pertinent inspections and tests should be performed and documented.

(3) Perform Engineering Analysis - An engineering evaluation may be performed to determine the service level or operating condition for which the system can be certified. When the new basis has been determined, the pertinent inspections and tests should be performed and documented.

l. Complete Recertification File - Recommendations concerning the information to be recorded and the appropriate documentation to be maintained are included

e. Documentation Complete - If the documentation is complete, proceed to define inspections and tests.

f. Documentation Incomplete - If the documentation is incomplete either of two alternative actions can be taken: obtaining missing documentation or generate equivalent documentation:

(1) Obtain Missing Documentation - Obtain the missing documentation from the manufacturer or fabricator, complete the documentation file and proceed to define inspections and tests.

(2) Generate Equivalent Documentation - Generate the equivalent of the missing documentation. Among the steps that may be necessary are:

(a) Identification of the materials used in constructing the components

(b) Measurement of the components including wall thickness

(c) Determination of weld type (to establish joint factor) and condition (inclusions and voids)

(d) Execution of an equivalent fabrication drawing

(e) Pressure testing

(f) Stress calculations

g. Analytical Procedures - the analytical procedures used may vary with the circumstances of each case, such as the age of the component, service conditions, and type of component. Consequently, each case should be considered separately.

h. Define Inspections and Tests - Inspections and tests should be defined through analysis of the documentation.

NOTE: Pressure testing is not broadly recommended because of its questionable value, the contamination problems associate with hydrostatic testing of clean systems and the hazards associate with pneumatic testing. However, there are cases where proof testing is desireable, such as when the safety of structural adequacy cannot be determined by design calculations; or when repairs, alterations, or modifications cannot be adequately examined through the use of nondestructive

# CHAPTER 5: PROCEDURES

## 500 GENERAL

This Chapter describes the recommended procedures for inservice inspection and recertification of pressure vessels and systems, including those in service, used vessels and systems being put into new service, and those on standby.

## 501 PRESSURE VESSELS AND SYSTEMS IN SERVICE

1. The procedure for recertifying pressure vessels and systems in service and defining periodic inspection is illustrated in Figure 1. The individual activities are described in the following subparagraphs:

   a. Define Pressure Systems - The system should be defined by means of a schematic that identifies, describes, and inventories each component and its location. Service parameters such as system contents, pressure, temperature, and cyclic operation should be part of the system definition. A technical and safety review of the system should be included.

   b. Identify Categories of Systems and Components - Each component within the system should be identified and placed in one of the following categories:

      Pressure Vessels (as defined in Chapter 3)
      Tanks (as defined in Chapter 3)
      Vacuum Vessels (as defined in Chapter 3)
      Flexible Hose
      Expansion Joints
      Relief Valves
      Piping and Piping System Components
        (Should include pipe, pipe fittings, valves, pumps and compressors and all other pressurized components within the system not singled out in one of the above categories.)

   c. Review Records of Certification of Each Component - All documents pertaining to the certification of the component at the time of installation should be obtained and reviewed.

   d. Compare Records With Recommendations - The actual certification documents on hand should be compared with the recommended documentation to determine whether the records are complete or incomplete. The recommendations for a complete certification documentation package are defined in Chapter 7.

Loose nuts, bolts, or other parts
Excessive vibration
Abnormal noise
Overtemperature or abnormal heat leakage
Discrepancies in gage readings
Pipe hanger condition
Flex hose anti-whip devices
Frost on vacuum jacketed lines
Obstruction in relief valve vents

Particular attention shall be directed to welds, nozzles and other discontinities.

VET A test of volumetric expansion of a pressure vessel or component to determine the stress and strain relationship. This test is performed in the same way as the standard hydrostatic test (see symbol H 150) but with additional equipment to measure the expansion of the vessel, either by displacement of water from a jacket around the vessel or by a direct expansion method in which the volume of water added to the interior of the vessel is measured.

VI Visual examination (internal) is a visual survey of the internal surfaces of the vessel or pressure system component. Where access to the interior is difficult, aids such as borescopes or fiber optics should be used to enable a thorough examination of all critical areas. Components such as valves or compressors are to be disassembled in accordance with the manufacturer's instruction manual. Examples of conditions to be observed are:

Corrosion or erosion
Mechanical wear or damage
Cracking (especially at welds and areas of known stress concentration)
Bulges or blisters
Losse bolts or other parts
Overtemperature (scaling)
Internal leakage, for instance between coolant or lubricant channels and gas flow passages.

XLT Other leakage tests such as the rate of pressure change in a sealed-off system. By closing valves to isolate different parts of the system, the leaking section can be located.

P 125 A pneumatic* test of the vessel or component to 125 percent of the maximum allowable working pressure. A gas complying with cleanliness requirements for the vessel or component will be used. Note: Test levels other than 125 percent are specified by various codes. Symbols should be keyed to the percent of working pressure, e.g., Paragraph 115 for an ASME Code, Section VIII, Division 2 pneumatic test.

SLT Leak detection using a sonic detector is applicable in pressurized systems during operations, irrespective of the types of gas in the system

ST Strain measurement tests include three different types of tests that may be used to find the yield point of the material, and hence the maximum allowable working pressure. The tests include the brittle coating test (Ref. 2, Para. UG-101 (l) ), and the strain gage method (Ref. 2, Para. UG-101 (n) ), and the displacement measurement test (Ref. 2, Para. UG-101 (o) ).

TT Thickness measurement (by methods other than ultrasonic testing, Symbol UT) refers generally to thickness measurements made by standard mechanical methods such as calipers, micrometers, and dial gages. Methods such as X-ray diffraction may also be included. Location of places where thickness checks have been made shall be documented so that measurements can be made at the same place in subsequent inspection.

UT Ultrasonic inspection is used to examine the material (including welded joints) for internal discontinuities and for thickness checks have been made shall be documented so that measurements can be made at the same place in subsequent inspections.

VE Visual examination (external) is a visual survey of the external surfaces of the vessel or other pressure system component, following a pre-arranged plan to ensure that all critical areas are included. The details of the examination will be governed by the function and design of the component. Examples of conditions to be observed are:

Corrosion (especially under insulation)
Mechanical damage
Cracking (especially at welds and areas of known stress concentration)
Bulges or blisters
Leakage

*See Page 4-2

H 150 A hydrostatic test of the vessel or component to 150 percent or the maximum allowable working pressure. Clean water with a practical minimum of dissolved or suspended solids shall be used, unless an alternative fluid is permitted by an approved written procedure. Such an alternative fluid should be nonflammable and noncontaminating to the system or component. (Caution: Compatibility of test fluid with materials of construction must be confirmed to prevent subsequent damage, such as stress corrosion cracking. Also, assurance must be obtained that all water will be removed and the system dried immediately after test.) Note: Test levels other than 150 percent are specified by various codes. Symbols should be keyed to the percent of working pressure, e.g., H 125 for an ASME Code, Section VIII, Division 2 hydrostatic test.

MLT Leak detection by helium mass spectrometer has very high sensitivity for systems filled with helium. The hood method (Ref. 1, Para. T-1060) has greater sensitivity than the sniffer method (Ref. 1, Para. T-1050). Using helium as a tracer gas, the helium mass spectrometer is also the preferred instrument for leak detection in vacuum vessels and vacuum insulating jackets.

MT Magnetic particle examination is a method for detection of cracks and other surface defects in ferromagnetic materials. It will also show discontinuities below the surface but at reduced sensitivity. For good results, the surface being examined should be free of irregularities, dirt, oil, etc. Magnetic particle examination may be performed in accordance with Reference 1, Paragraph T-751, Article 25.

PT Liquid dye penetrant examination is a widely applicable method (or group of methods) for detection of cracks and other surface defects in all types of metals. See Reference 1, Article 6 and 24, for guidance.

P 100 A pneumatic* test of the vessel or component to 100 percent of the maximum allowable working pressure. A gas complying with the cleanliness requirements of the vessel or component will be used.

* Pneumatic (also called pneumostatic) tests are potentially hazardous and all personnel must be excluded from the hazard zone, see Reference 3, Figure 5-2, "Restricted Distance for Pneumatic Testing." Pneumatic tests should be made following an approved written test procedure. For guidance in preparing for the test, see Reference 3, Section 5 (d), "Pneumatic Pressure Strength Test."

# CHAPTER 4: TEST METHODS

## 400 APPLICABILITY

The test methods applicable to pressure vessels and systems are listed in alphabetical order of the symbols used in this guide:

| Symbol | Description of Test Method |
|---|---|
| AET | Acoustic emission is a method for detecting flaw growth and relative rates of growth. |
| BLT | Leak detection by bubble test is used for pressurized systems, either during operation or under special test conditions, and is not dependent on the type of gas in the system. It can be used at pressures up to the maximum allowable working pressure; reference 1, Paragraph T-1025, permits pressures as low as 15 percent of the working pressure, or 4.22 $kg/cm^2$ (60 psi), whichever is the lower value. |
| CRVT | Certification test of the relief valve to verify the set pressure and reseating capability. Gas complying with the cleanliness requirements for the system containing the relief valve shall be used, except valves for steam service must be tested with steam, and valves intended for liquid service may be tested with water (see ref. 2, Para. UG-135.4). |
| ET | Eddy current examination is an inspection method utilizing electromagnetically induced, closed path alternating currents to evaluate material soundness. Applications of eddy current testing include metal properties, detection of cracks, voids, and inclusions. Since it has limited penetrating ability, this technique is applicable to thin materials or for surface and near surface defects in thick materials. Eddy current examination may be performed in accordance with reference 1, Article 8 and 26. |
| HLT | Leak detection by a halogen diode detector required that the vessel or system being tested must contain a gas or liquid containing one of the halogen elements (flourine, chorine, bromine, or iodine). The method may be applied to other systems by using a tracer gas; several suitable gases are listed in Reference 1, Paragraph T-1041.3. |

24. <u>Vacuum Vessel</u> - A vessel in which the internal pressure has been reduced to a level less than that of the surrounding atmosphere.

16. Pressure Vessel - Any vessel used for the storage or handling of gas or liquid under positive pressure. Included are components of systems, such as, heat exchanger shells and drying towers and other shell structures for which the rules of the ASME Code, Section VIII would apply.

17. Proof Test - A pressure test performed to establish the maximum allowable working pressure of a vessel, system, or component thereof, (1) when the strength cannot be computed with a satisfactory assurance of accuracy, (2) when the thickness cannot be determined by means of the design rule of the applicable code or standard, or (3) when the critical flaw size to cause failure at the certified pressure cannot be identified by other nondestructive test methods. This test shall be performed in a manner equivalent to one of the methods specified in Paragraph UG-101 of the ASME Boiler and Pressure Vessel Code, Section VIII, Division 1, latest edition.

18. Recertification - The procedure by which a previously certified vessel or system, by appropriate tests, inspections, examinations, and documentation, is qualified to continue or be returned to operations at the designed pressure.

19. Recertification Period - The period of time between recertification when a certified status is maintained through documented periodic examinations and inspections to determine vessel or system condition (time between major inspections).

20. Relief Valve Set Pressure - See paragraph UG-125, Section VIII, Division 1, ASME Boiler Code and Part AR, Section VIII, Division 2, ASME Boiler Code.

21. Tank - Any vessel used for the storage or handling of liquids where the internal pressure is only a function of the liquid head or a combination of liquid head and vapor pressure.

22. Unfired Pressure Vessels and Systems - In the context for which this phrase is used in this guide it is intended to cover all pressure vessels and pressurized systems for which inservice inspection is not otherwise covered by codes and standards.

23. Vacuum System - An assembly of components under vacuum, including vessels, piping, valves, relief devices, pumps, expansion joints, gages, etc.

using nominal thickness exclusive of any allowances for corrosion or loadings other than pressure, and adjusted for any difference for static head that may exist between the part considered and the top of the vessel.

10. National Consensus Standard - Any standard, or modifications thereof, which (1) has been adopted or promulgated by a nationally recognized standards-producing organization under procedures whereby it can be determined by the Secretary of Labor or by the Assistant Secretary of Labor for Occupational Safety and Health that persons interested and affected by the standard have reached substantial agreement on its adoption, (2) was formulated in a manner that afforded an opportunity for diverse views to be considered, and (3) has been so designated by the Secretary or the Assistant Secretary, after consultation with other appropriate Federal Agencies. A standard, as used in this definition, requires conditions or activities necessary or appropriate to provide safe and healthful employment and places of employment.

11. Operating or Working Temperature - The metal temperature that will be maintained in the part of the vessel under consideration during normal operation.

12. Operating Pressure - The pressure at the top of a vessel at which it normally operates. It shall not exceed the maximum allowable working pressure.

13. Pneumatic or Pneumostatic Test - A test performed on a pressure vessel or system in which air or gas is introduced and pressurized to a designated level in a manner prescribed in the applicable code.

14. Pressure System - An assembly of components under pressure, including vessels, piping, valves, relief devices, pumps, expansion joints, gages, etc.

15. Pressure Systems Engineer - A person who has the necessary qualifications to evaluate designs with respect to code conformance and the authority to perform, or cause to be performed, the evaluation of results or any and all tests, inspections, and examinations performed on pressure systems in order to determine the next period of inspection, derating requirements, rerating requirements, modifications, repairs, etc.

# CHAPTER 3: DEFINITIONS

## 300 GENERAL

1. Certification - The documented status that qualifies a vessel or system to operate in the service for which it is intended.

2. Derated Vessel or System - A vessel or system that has been judged to be unsafe, unsuitable, or unnecessary for continued operation at its original design pressure and/or temperature limits, and has been recertified to operate at a lesser pressure and/or temperature limit range.

3. Design Pressure - The pressure used in the design of a vessel for the purpose of determining the minimum required thickness of the components of the vessel. When applicable, static head shall be added to the design pressure.

4. Design Temperature - The metal temperature used in the design of a vessel for determining the minimum required thickness of the components. Also, the metal temperature used for selecting the maximum allowable stress for the materials used in the vessel.

5. Efficiency of a Welded Joint - A numerical (decimal) quantity expressed as a multiplier of the allowable stress value used in the design of a joint.

6. Hydrostatic Test - A test performed on a pressure vessel or system in which the vessel or system is filled with a liquid (usually water) and pressurized to a designated level in a manner prescribed in the applicable code.

7. Inservice Inspection - Inspection performed after a system has been initially put into service. The system may have to be inoperative during such inspection.

8. Maximum Allowable Stress Value - The maximum unit stress permissible for a specific material used in the appropriate design formulas.

9. Maximum Allowable Working Pressure - The maximum pressure permissible at the top of a vessel in its normal operating position at the coincident operating temperature. It is the least of the values found based on calculations for every element of the vessel

of less than 2.83 cubic meters (100 cubic feet), piping, expansion joints, and valves (excluding relief) are not shown in Table 6-14, since these components represent relatively small volumes. This exclusion is based on the performance of normal routine preventive and corrective maintenance.

h. Pressure gages — Covered by: Federal Spec. AG-G-76

i. Instrumentation — Covered by: Manufacturer's installation, operation, and maintenance instructions

2. Many pressure vessels and systems in use at the NASA field installations fall into a utility category and present a minimum potential hazard. Vessels and systems used in conjunction with water heaters, space heaters, and similar general utility services utilize pressurized fluids at pressure levels and capacities that allow exclusion from this guide on the basis of performing normal routine preventive and corrective maintenance. Guidelines for such exclusions are as follows:

   a. Component exclusion limits for uncontaminated air:

      (1) Pressure vessels: Value units (pressure times volume) not greater than: 10 $\frac{kg}{cm} \cdot m^3$ (5,000 psi $\cdot$ $ft^3$) and pressures not greater than 8.8 $kg/cm^2$ (125 psig) with contents between ambient temperature and 54.4° C(130° F)

      (2) Piping and components: Value units (pressure times diameter squared) not greater than 14,500 $\frac{kg}{cm} \cdot cm^2$ (32,000 psi $\cdot$ $in^2$) and pressures not greater than 8.8 $kg/cm^2$ (125 psig) with contents between ambient temperature and 54.4° C(130° F)

   b. Component exclusion limits for water:

      (1) Tanks: Value units (capacity) not greater than 113,550 liters (30,000 gallons)

      (2) Piping and Components: Value units (diameter) not greater than 61 centimeters (24 inches)

   c. Component exclusion for Vacuum Systems:

   Because of relatively small pressure variations from atmospheric, the potential hazard of vacuum system components has been evaluated on the basis of volumetric considerations. Recertification and inspection of components such as vacuum vessels

# CHAPTER 2: EXCLUDED ITEMS

## GENERAL

1. The items listed in this Chapter are excluded from this guide because inservice inspection is covered by a national consensus standard or they do not present sufficient hazard to require other than normal routine maintenance:

| | | |
|---|---|---|
| a. | Fire extinguishers | Covered by: Federal Register Vol. 37, No. 202, Title 29 - Labor, Chapter XVII - OSHA Part 1910, Subpart L |

(1) Portable
(2) Standpipe and hose systems
(3) Automatic sprinkler system
(4) Fixed dry chemical extinguishing systems
(5) Carbon dioxide extinguishing systems
(6) Halogenated extinguishing agent systems

| | | |
|---|---|---|
| b. | Heating boilers | ASME Code, Sec. VI |
| c. | Power boilers | ASME Code, Sec. VII |
| d. | Nuclear reactor coolant systems | ASME Code, Sec. XI |
| e. | Air-Pak rescue equipment or other breathing appartus | Covered by: Federal Register Vol. 37, No. 202 Title 29 - Labor, Chapter XVII - OSHA, Part 1910, Subpart I, Sections 1910.134, .138, .139, .140 |
| f. | Mobile equipment for gases and liquids | Covered by: Department of Transportation (DOT) Regulations, Part 178 |
| g. | Heating, ventilation, air conditioning, and referigeration systems | Covered by: Manufactuers's installation operation, maintenance instructions |

# CHAPTER 1: SCOPE

## 100 PURPOSE

1. This guide includes recommendations for inservice inspection and recertification of ground based, unfired pressure vessels and all pressurized systems including those served by fired pressure vessels hereinafter referred to as pressure vessels, systems and components of systems.

2. It covers the vast array of ground based industrial and special purpose pressurized components and systems used at NASA field installations for research and development and those utility systems and components that require more than routine maintenance to insure continued structural integrity for their useful life. Through surveillance and correction of inservice deterioration, NASA will maintain a safe working environment for their own and contractor personnel, safety for the public sector and protection against loss of capital investment.

3. Items excluded from this guide, are defined in Chapter 2.

4. Coverage includes test methods, system and component categorization, recertification procedures and documentation, and inservice inspection to support and maintain certification status. Recommended documentation forms are included in Appendix A.

5. THIS GUIDE DOES NOT REPLACE EXISTING ROUTINE OPERATIONS AND MAINTENANCE INSPECTIONS. System and component checks must be made on a continuing systematic basis at the beginning of each shift, periodically during runs, weekly or at other intervals of time, based on service history and criticality. Such checks are normally visual and audible to evaluate changes related to vibration or gas leaks checks of instrumentation, etc., for indications of potential failures. Protective coatings on pressurized components must also be maintained on a continuing basis.

## LIST OF TABLES AND FIGURES

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PREFACE

Date: January 19, 1976

This guide, NHB 1700.6, is published for the purpose of establishing an outline of inservice inspection and recertification procedures for ground based, unfired pressure vessels and systems. It shall not replace the normal routine repair and maintenance programs now in effect.

Systems and components are categorized, baseline inspection and recertification time intervals are presented in tabular form, and a type and format of documentation is recommended.

It is intended that each field installation use this guide and other applicable documents to define the detailed requirements and procedures for the specific vessels and systems over which it has cognizance.

This guide is highly dependent on application by qualified pressure systems engineers and NASA-wide uniform application is dependent on good communications among the field installations.

Reuben P. Prichard Jr.
Acting Director, Safety
and Environmental Health

DISTRIBUTION
SDL 1 (SIQ)

ATTACHMENT 9

NHB 1700.6

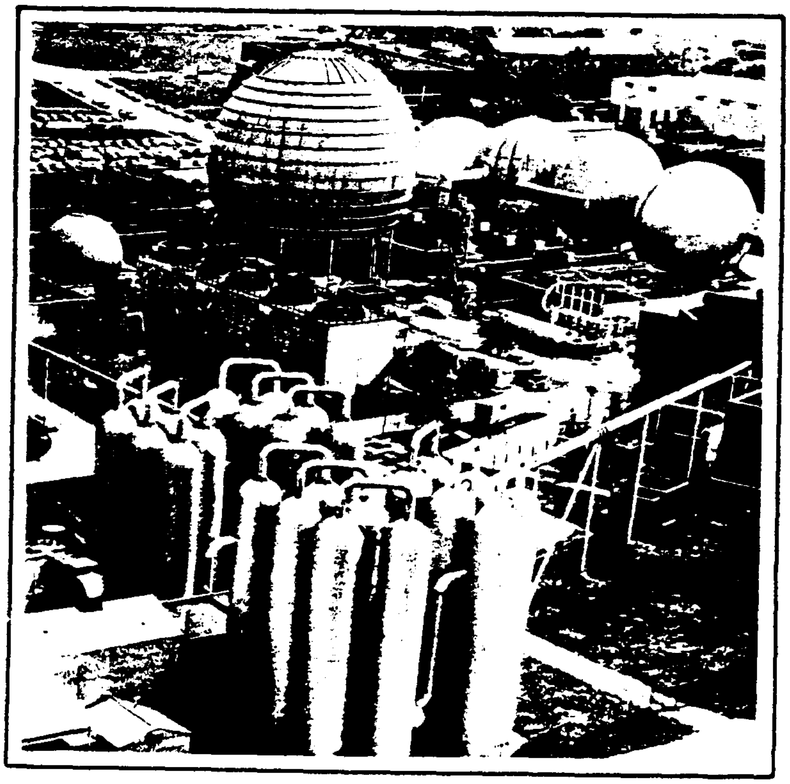
18 JANUARY 1976

# GUIDE FOR INSERVICE INSPECTION OF GROUND-BASED PRESSURE VESSELS AND SYSTEMS

NASA

National Aeronautics and Space Administration

## OFFICE OF SAFETY AND ENVIRONMENTAL HEALTH



NATIONAL AERONAUTICS AND SPACE ADMINISTRATION WASHINGTON, D.C. 20546

ATTACHMENT 9

NASA HANDBOOK (NHB) 1700.6, GUIDE FOR INSERVICE INSPECTION OF GROUND-BASED PRESSURE VESSELS AND SYSTEMS (JANUARY 18, 1976)

TABLE C-1
(Continued)

| Building Number | Identifier | Building Number | Identifier |
|---|---|---|---|
| 1207 | 69 | 1235 | 58 |
| 1208 | 97 | 1236 | 59 |
| 1209 | 125 | 1237A,B,C | 32 (Foundry) |
| 1212 | 43 | 1238A,B | 27 |
| 1212B | 43 | 1239 | 87 |
| 1212C | 43 | 1240 | 81 |
| 1213 | 42 | 1241 | 61 |
| 1215 | 41 | 1242 | 122 |
| 1218 | 36 | 1243 | 88 |
| 1218A | 36 | 1244 | 60 |
| 1219 | 37 | 1244A,B,C,D | 60 |
| 1220 | 49 | 1245 | 81 |
| 1220 | 49 | 1246 | 81 |
| 1221 | 40 | 1247A | 65 |
| 1221A,B,C,D,E | 40 | 1247B | 64 |
| 1222 | 54 | 1247C | 65 |
| 1223 | 29 | 1247D | 66 |
| 1225 | 44 | 1247E | 67 |
| 1227 | 86 | 1247F | 67 |
| 1228 | 56 | 1247H | 64 |
| 1229 | 45 | 1247G | 66 |
| 1229A | 45 | 1248 | 80 |
| 1230 | 47 | 1249 | 57 |
| 1230A,B | 47 | 1250 | 77 |
| 1231 | 46 | 1251 | 50 |
| 1232 | 55 | 1251A | 150 |
| 1232A | 53 | 1252 | 92 |
| 1233 | 34 | 1253A | 89 |
| 1234 | 22 | 1254 | 158 |

**TABLE C-1**
**(Continued)**

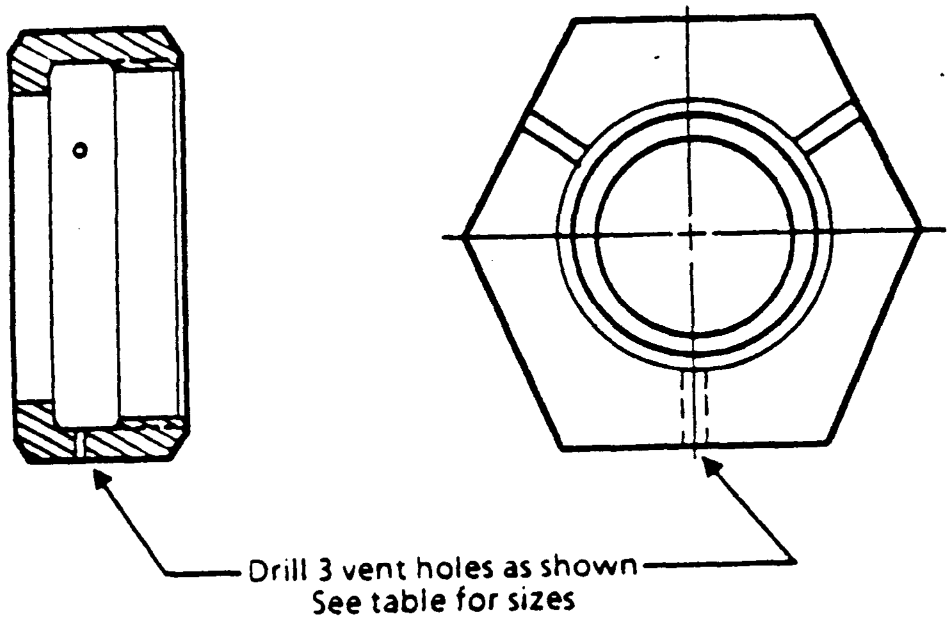
| Building Number | Identifier | Building Number | Identifier |
|---|---|---|---|
| 1255 | 137 | 1281 | 107 |
| 1256 | 63 | 1282 | 108 |
| 1257 | 51 | 1283A | 108 |
| 1258 | 51 | 1284A | 109 |
| 1259 | 51 | 1284B | 109 |
| 1260 | 51 | 1284C | 119 |
| 1261 | 124 | 1285 | 69 |
| 1262 | 68 | 1286 | 110 |
| 1263 | 48 | 1287 | 126 |
| 1264 | 151 | 1288 | 142 |
| 1265A-E | 28 | 1289 | 96 |
| 1265F | 100 | 1290 | 84 |
| 1266 | 90 | 1291 | 95 |
| 1267 | 31 | 1292 | 38 |
| 1267A | 31 | 1293A,B | 62 |
| 1267B | 31 | 1294 | [illegible] |
| 1268A,B | 70 | 1295A,B,C,D | [illegible] |
| 1270A,B | 103 | 1296 | [illegible] |
| 1271 | 104 | 1297A,B | [illegible] |
| 1272 | 105 | 1298 | 72 |
| 1273 | 106 | 1299 | 73 |
| 1273A | 106 | 1299A&E | 73 |
| 1274 | 69 | 1310 | 129 |
| 1274B | 69 | 1312 | [illegible] |
| 1275 | 69 | Plum Tree Island | 38 |
| 1276 | 107 | Link Boxes (GW) | 4 |
| 1277 | 145 | Outside Light (Poles) | 144 |
| 1278 | 107 | Relays | 146 |
| 1279 | 107 | Fire Alarm System | [illegible] |

**TABLE C-1**
**(Concluded)**

| Building Number | Identifier | Building Number | Identifier |
|---|---|---|---|
| Sprinkler System | 148 | Slings | 98 |
| Tube Type Trailers | 152 | Lifting Devices | 99 |
| Exit Lights (Battery) | 153 | Emergency Lights | 101 |
| Forklifts | 94 | | |

## CPV TYPE UNION NUT TORQUES AND VENT HOLE SIZES

| SIZE | TORQUE FT. LB. | | VENT HOLE DIAMETER |
|---|---|---|---|
| | MIN. | MAX. | |
| 1/8 | 10 | 25 | 1/16 |
| 1/4 | 10 | 25 | 1/16 |
| 3/8 | 12 | 30 | 1/16 |
| 1/2 | 15 | 40 | 3/32 |
| 3/4 | 20 | 50 | 3/32 |
| 1" | 25 | 60 | 3/32 |
| 1 1/4 | 30 | 75 | 1/8 |
| 1 1/2 | 35 | 90 | 1/8 |
| 2" | 45 | 120 | 1/8 |




NOTE Holes required when used above 3000 psi.

ATTACHMENT 11

NASA LANGLEY HANDBOOK (LHB) 1710.41, LANGLEY RESEARCH CENTER STANDARD FOR THE EVALUATION OF SOCKET AND BRANCH CONNECTION WELDS (APRIL 1989)

ATTACHMENT 11

LHB 1710.41
April 1989

NASA
Langley Research Center

# LANGLEY RESEARCH CENTER STANDARD FOR THE EVALUATION OF SOCKET AND BRANCH CONNECTION WELDS

National Aeronautics and Space Administration

# PREFACE

This handbook, part of the Langley Research Center (LaRC) Safety Manual, sets forth minimum safety requirements and standards for evaluating socket and branch connection welds within the framework of LaRC safety policies and constraints. It provides professional designers and craftsmen a basis for safety and uniformity in the design and fabrication of welded piping systems.

LHB 1710.41, dated May 1984, is rescinded and should be destroyed.

Paul F. Holloway
Deputy Director

DISTRIBUTION:
SDL-039, SDL-043, and SDL-054 - LaRC Safety Manual Holders
429/Systems Safety, Quality and Reliability Division (100 copies)
436/Facilities Engineering Division (100 copies)
397/Fabrication Division (100 copies)
123/Directives & Forms Management Office, ISB - MSD (10 copies)

## CONTENTS

## CONTENTS - Concluded

Chapter I

# SCOPE

This specification shall be utilized for the nondestructive evaluation of socket and branch connection welds at Langley Research Center (LaRC). Socket fittings include, but are not limited to, all common pipe fittings - tees, elbows, couplings, caps, flanges, unions, and valves. In addition, the exterior weld of slip-on flanges shall be inspected using this specification. Branch connections are defined as Weld-O-Let, Sock-O-Let, Thread-O-Let, or other similar commercial fittings and include modified components such as couplings.

Chapter II

# INSPECTION TECHNIQUES

Four nondestructive evaluation techniques may be utilized exclusively, or in combination, to inspect socket type and branch connection welds. These techniques are visual, radiographics, magnetic particle, and dye penetrant. Under special circumstances, other techniques (such as eddy current or ultrasonics) may be required and their application shall be guided by the appropriate sections of the American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code (B&PVC).

# VISUAL INSPECTIONS

Socket and branch connection welds shall be inspected for surface defects using visual techniques.

Visual inspections within the scope of this specification shall be restricted to the weld contour and adjacent pipe and fitting surfaces. Inspections shall be conducted in accordance with the most current editions of the American National Standard Institute (ANSI)/ASME Code B31.3, and the ASME B&PVC, Section V, Article 9, with the following modifications:

## A. Inspection Personnel

1. Inspection personnel shall be currently certified under a plan based on recommended practice SNT-TC-1A to a minimum of Level II.
2. Inspectors shall have successfully passed an eye examination, to demonstrate near distance acuity such as the J-2 letters on a standard Jaeger Test Chart, in accordance to the following schedule:
   - Under age 35, every 12 months
   - Over age 35, every 6 months

## B. Inspection Condition

Unless otherwise specified, all welds shall be contour ground and free of rust, scale, slag, or other conditions that would obscure the surface condition.

## C. Acceptance Criteria for Socket and Branch Connection Welds

1. Fillet size - weld fillets shall comply with the requirements of the current edition of ANSI B31.3. In lieu of a specified pressure design thickness "t," the nominal pipe wall thickness "Tw" shall be substituted. (See Appendix, Figures 1 and 2.)
2. Weld Surface
   a. The weld surface and adjacent base metal shall be free of cracks, incomplete fusion (IF), arc strikes, weld spatter, gouges, mishandling marks, and other sharp surface irregularities.
   b. The weld fillet shall blend uniformly into the pipe wall and fitting rim. The undercut shall not exceed the lesser of 1/32 inch or Tw/4 (Tw = nominal pipe wall thickness).
   c. Surface porosity and/or slag is not permitted.

   (See Appendix, Figures 3 through 6 for examples of these irregularities.)

3. Misalignment - unless otherwise specified, axial misalignment, between the pipe and fitting, shall not exceed 5°.

D. **Inspection Report**

Upon completion of visual inspections, the inspecting organization shall furnish a report containing, as a minimum, the following information:

1. System identification
2. Drawing number
3. Location
4. Sketch or description of each component/weld
5. Material type
6. Surface condition
7. Discrepancies noted
8. Inspector's name
9. Inspection data
10. Contract number

# RADIOGRAPHIC INSPECTIONS

Socket and branch connection weld joints shall be inspected for defects using radiographic techniques.

These radiographic inspections shall be conducted in accordance with the most current edition of the ASME B&PVC, Section V, Articles 2 and 22, as modified by the following paragraphs. Any item not specifically herein addressed will revert to the provisions of Section V.

## A. Personnel Qualifications

All inspection personnel shall be qualified in accordance with the American Society for Nondestructive Testing (ASNT) SNT-TC-1A "Recommended Practice for Nondestructive Testing Personnel Qualification and Certification." Personnel qualified to Level I shall be utilized only under the field supervision of Level II or III inspectors. In addition to the above requirement, radiographic interpreters shall have demonstrated acuity as specified under Chapter III, Paragraph A2 of this handbook and shall be familiar with weld fabrication techniques.

## B. Safety

All radiographic inspection operations conducted at LaRC shall be in accordance with applicable Nuclear Regulatory Commission (NRC) regulations and shall, in addition, be in compliance with LHB 1710.5, "Ionizing Radiation" (included in the LaRC Safety Manual).

## C. Surface Preparation

Unless otherwise specified, all welds shall be contour ground and free of surface irregularities which could mask or be confused with discontinuities.

## D. Direction of Radiation

1. Socket welds - Each socket weld exposure setup shall be aligned so as to pass the radiation central ray parallel to and in line with the socket rim. (See Appendix, Figure 7.)

2. Branch Connection Welds - Each branch connection weld exposure setup shall be aligned so as to pass the radiation central ray in a tangent to the run pipe external surface. Two views shall be imaged as follows (see Appendix, Figure 16):

   View 0 - with the central ray perpendicular to the run pipe axis

   View 1 - with the central ray offset 25-35 degrees from View 0

**NOTE:** Branch connections over 6 inches in diameter (O.D.) may require additional exposures or alternate techniques at the discretion of the NASA-NDE Radiograph Interpreter.

3. These requirements may, at the discretion of the NASA NDE Radiograph Interpreter, be relaxed to allow the simultaneous exposure of closely spaced weld joints. Three views of each weld joint taken at 60° to each other is the minimum acceptable coverage for pipe having a nominal size greater than 1 inch. For pipe having a nominal size of 1 inch or less, two views of each weld joint taken at 90° to each other is the minimum acceptable coverage. (See Appendix, Figure 7.)

E. **Shim Block Thickness, Size, Material**

1. The shim block thickness shall be established for each joint by utilizing the formula:

For socket $2T_w + R$
For Branch $2T_f + R$

where

$T_f$ = the nominal fitting single wall thickness
$T_w$ = the nominal pipe single wall thickness
R = the component of weld reinforcement measured perpendicular to the pipe axis at the fitting edge rim. (See Appendix, Figure 1 for socket welds and Figure 15 for branch connection welds.)

2. The shim block shall be of sufficient size to allow placement of a penetrameter and identification markers. Shim material shall be radiographically similar to the subject weld/pipe material.

F. **Penetrameter Selection and Essential Holes**

The penetrameter selection shall be based on the calculated shim thickness as follows:

| SHIM THICKNESS ($2T_W + R$) OR ($2T_f + R$) | PENETRAMETER | ESSENTIAL HOLE |
|---|---|---|
| 0 thru 0.375 | 10 | 4T |
| Over 0.375 thru 0.625 | 12 | 4T |
| Over 0.625 thru 0.875 | 15 | 4T |
| Over 0.875 thru 1.00 | 17 | 4T |
| Over 1.00 thru 1.50 | 25 | 2T |
| Over 1.50 thru 2.00 | 30 | 2T |
| Over 2.00 thru 2.50 | 35 | 2T |

G. **Identification Markers**

Weld numbers shall be permanently marked on each inspected joint. If the radiographic view depicts more than one weld joint, identification numbers shall be included in the image to positively identify each weld. Film printer identification techniques are prohibited. Each radiograph shall, as a minimum, have the following information permanently included in its image:

1. Weld number
2. View number
3. NASA Quality Assurance (QA) or contract number
4. Radiographic contractor identification
5. Date of exposure
6. NASA drawing number

H. **Shim Block/Penetrameter Placement**

The shim block with identification numbers and penetrameter shall be aligned parallel to the subject pipe axis with the penetrameter center adjacent to the socket rim. (See Appendix, Figure 7 for socket welds and Figure 16 for branch connection welds.)

I. **Radiographic Density**

The calculated shim thickness from Chapter IV, Paragraph E shall be utilized to determine exposure values. Film image density shall be measured through the shim block/penetrameter combination and shall equal 3.0 ± 0.5. (See Appendix, Figure 7.)

J. **Source Strength**

Unless otherwise specified, the radiation source energy shall be equal to or greater than 35 curies from IR 192 and 150 KEV for x-ray machines.

K. **Scattered Radiation**

To minimize the effect of back scatter radiation, all film cassettes shall be backed up with a minimum of 1/16-inch-thick lead sheeting. This sheeting shall be at sufficient size to completely cover the cassette and shall be covered with tape to prevent lead smearing. (See Appendix, Figure 7 for socket welds and Figure 16 for branch connection welds.)

L. **Quality of Radiographs**

All radiographs shall be free of mechanical, chemical, or other blemishes which could mask the image of any discontinuity within the area of interest. Such blemishes include, but are not limited to:

1. Fogging.
2. Processing defects such as streaks, water marks, or chemical stains.
3. Scratches, finger marks, crimps, dirt, static marks, smudges, or tears.
4. Loss of detail due to poor screen-to-film contact.
5. False indications due to defective screens or cassette faults.

M. **Geometric Unsharpness/Source-to-Film Distance**

Geometric unsharpness of the radiographic image shall not exceed 0.020 inch and the radiation source-to-film distance, unless otherwise specified by the NASA NDE Radiograph Interpreter, shall be not less than 14 inches.

N. **Acceptance Criteria for Socket and Branch Connection Welds**

1. Cracks - no cracks of any nature or extent are acceptable. (See Appendix, Figure 8.)
2. Incomplete Penetration (IP)

   a. Socket

   Definition: The failure of weld material to extend completely into and become integral with the intersection of socket rim inner diameter and cylindrical pipe wall. Incomplete penetration is not acceptable. (See Appendix, Figure 9.)

   b. Branch

   Definition: The failure of the weld material to: (a) extend completely to the inner surface of the fitting and (b) become integral with both the pipe and the fitting. (See Appendix, Figure 17.)

3. Incomplete Fusion (IF)

   Definition: An isolated, discontinuous or continuous area of no weld material fusion at the weld-socket, weld-pipe interface, or between consecutive weld passes. Incomplete fusion is not acceptable. (See Appendix, Figure 10.)

4. Pipe-to-Socket Bottom Gap (Socket Welds Only)

   A gap of 1/16 inch ± 1/32 inch shall be maintained between the pipe end and socket bottom after welding. (See Appendix, Figures 1 and 11.)

5. Porosity and Rounded Indications

   An individual porosity defect shall not exceed the lesser of Tw/3 or 1/8 inch in its greater dimensions. Adjacent indications shall be separated by a minimum Tw/2 of sound weld. The summation of diameters for aligned rounded indications shall not exceed Tw in length for any 6 Tw of weld. (See Appendix, Figure 12.)

6. Slag and Elongated Defects

   The developed length of any single slag inclusion or elongated defect shall not exceed Tw/3. Adjacent slag inclusions shall be separated by a minimum Tw/2 sound weld. The total cumulative developed length of slag inclusions and/or elongated defects shall not exceed Tw in any 6 Tw of weld. The width of a slag inclusion shall not exceed the lesser of 3/32 inch or Tw/3. Slag inclusions or elongated defects that infringe upon the root area are not acceptable to any extent. (See Appendix, Figure 13.)

7. Melt Through

   Definition: A localized area of pipe metal melting and resolidification, usually on the pipe inner diameter. Melt through shall be reviewed on an individual case basis and shall not:

   a. Reduce the nominal pipe wall thickness greater than 12-1/2%.

   b. Present unacceptable internal flow restrictions as determined by the Standard Practice Engineer.

   c. Include icicle type areas which could become dislodged. (See Appendix, Figure 14.)

8. Burn Through

   Burn through shall not reduce the nominal pipe wall thickness greater than 12-1/2%.

**O. Radiographic Technical Log and Interpretation Report**

The radiographer shall furnish, in addition to the radiographic film, a technical log and interpretation report relative to each inspected weld. The log/report shall contain, as a minimum, the following data:

1. System identification
2. Drawing number
3. Location
4. Sketch or description of each component/weld
5. Material type
6. Pipe nominal wall thickness $\underline{T_w}$ and fitting nominal wall thickness $\underline{T_f}$
7. Weld thickness $\underline{R}$
8. Shim block thickness - $\underline{2T_w + R}$ or $\underline{2T_f + R}$
9. Penetrameter size/essential hole
10. Isotope or x-ray machine, size/type/energy
11. Film type/manufacturer
12. Screen type, thickness, placement
13. Source-to-film distance
14. Exposure time/milliamp-minutes (MAM)
15. Radiographer's name
16. Inspection date
17. Discrepancies noted
18. Interpreter's name
19. Interpretation date

# MAGNETIC PARTICLE/DYE PENETRANT INSPECTIONS

Socket and branch connection weld joints shall be inspected for surface defects utilizing magnetic particle or dye penetrant techniques. When specified, this work shall be conducted in accordance with the ASME B&PVC, Section V, Articles 7 and 25, for magnetic particle and Articles 6 and 24 for dye penetrant, with the following modifications.

## A. Personnel Qualifications

Inspection personnel shall be qualified in accordance with ASNT-SNT-TC-1A. Personnel qualified to Level I shall be utilized only under the field supervision of Level II or III inspectors.

## B. Surface Conditions

Weld joint surfaces and adjacent areas (within a minimum of 1 inch on each side of weld) shall be free of any irregularities which could mask indications. Prior to inspection, these areas shall be dry and free of all paint, dirt, grease, lint, scale, welding flux, and splatter, oil or other extraneous matter that could interfere with the examination.

## C. Magnetic Particle Technique

### 1. Magnetization Method

The inspector has the option of utilizing a coil encirclement or yoke magnetization technique.

### 2. Field Adequacy

Magnetizing field adequacy shall be verified using a magnetic particle field indicator as illustrated in ASME B&PVC, Section V, Article 25. This verification shall be conducted at the beginning of each period of work or shift change and as a minimum every 4 hours during the work period.

### 3. Coverage

All surface areas of: (a) the weld and (b) the adjacent pipe and fitting material (for a minimum of 1 inch on each side of the weld) shall be 100% inspected.

## D. Dye Penetrant Technique

### 1. Dwell Time

Unless otherwise specified, dwell time shall be not less than 10 minutes.

2. Temperature

   When the surface temperature of the area to be inspected is outside of the 60° F to 125° F range, the testing procedure shall be qualified as per the requirements of ASME B&PVC, Section V, Article 6.

E. **Acceptance Criteria for Socket and Branch Connection Welds**

The following defects shall constitute rejectable conditions:

1. Cracks
2. Incomplete fusion (IF)
3. Surface open slag or porosity

F. **Inspection Report**

Upon completion of magnetic particle and/or dye penetrant inspections, the inspector shall furnish a report containing, as a minimum, the following information:

1. System identification
2. Drawing number
3. Location
4. Description or sketch of inspected item
5. Technique
   a. If dye penetrant, then include:
      (1) Penetrant type/manufacturer
      (2) Part temperature
      (3) Dwell time
      (4) Cleaning method
      (5) Development method
   b. If magnetic particle, then include:
      (1) Magnetization method
      (2) Equipment manufacturer

(3) Magnetization current (AC or DC)

(4) Magnetization current strength (amps)

(5) Power type/manufacturer

6. Discrepancies noted
7. Inspector's name
8. Date of inspection

# FIGURES

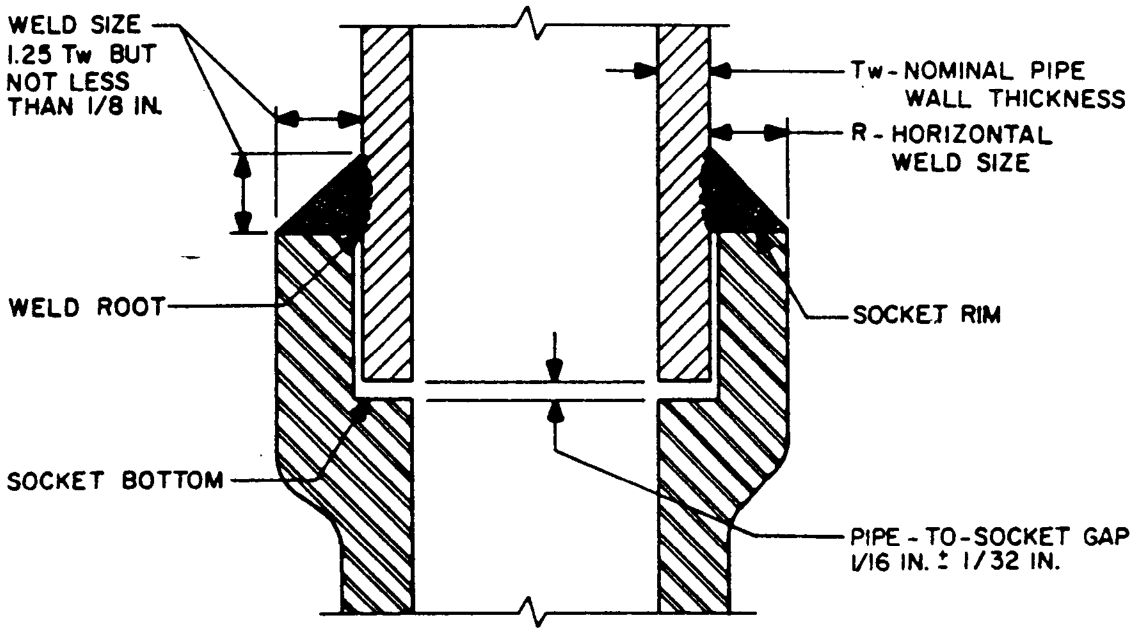
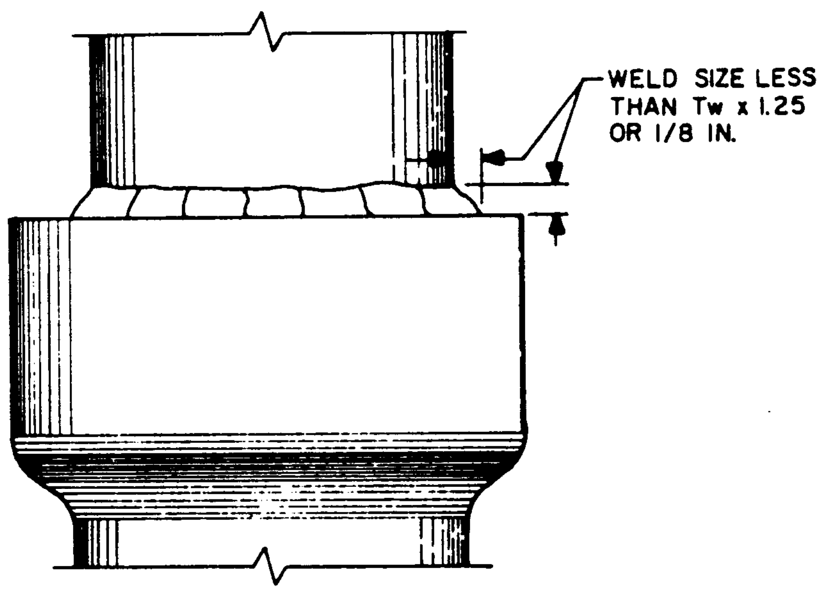



Figure 1.- Weld Nomenclature and Minimum Dimensions for Socket Weld Components Other Than Flanges.



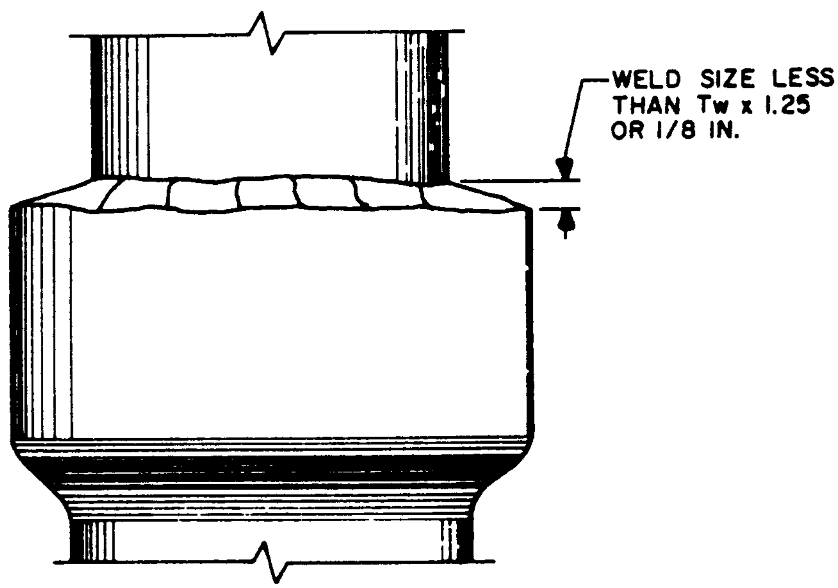




Figure 2.- Unacceptable Socket Weld Fillet Sizes for Components Other Than Flanges.

NO CRACKS PERMITTED

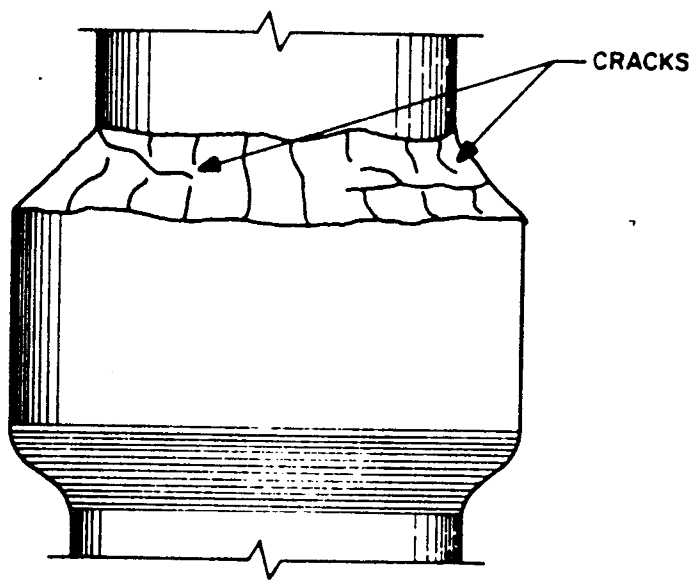



Figure 3.- Cracks.

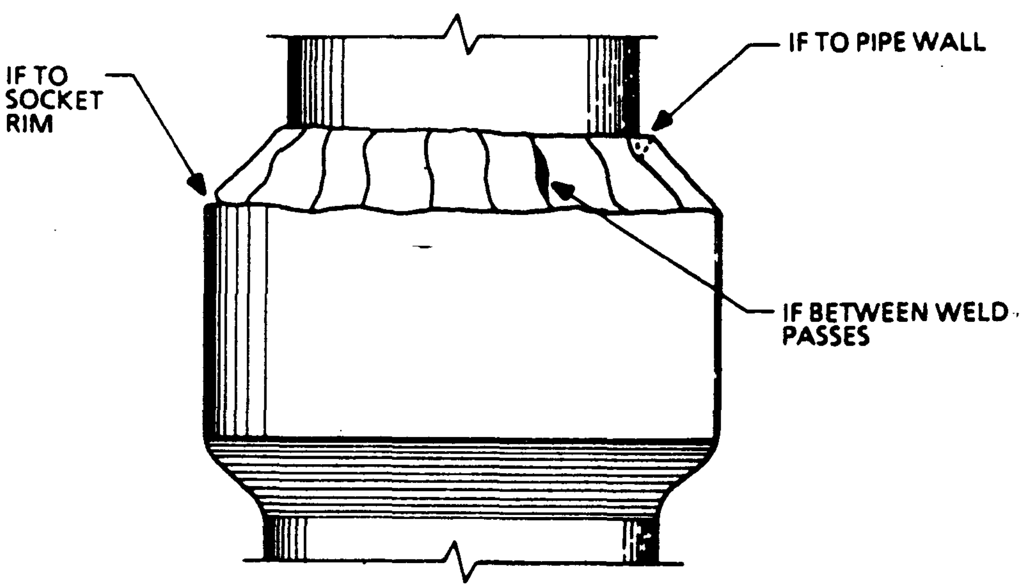



Figure 4.- Incomplete Fusion (IF).

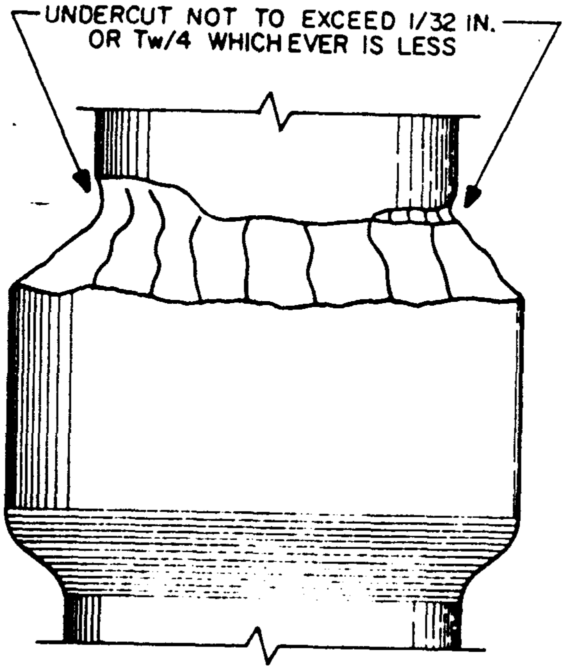



Figure 5.- Undercut.

NO SURFACE SLAG OR POROSITY PERMITTED

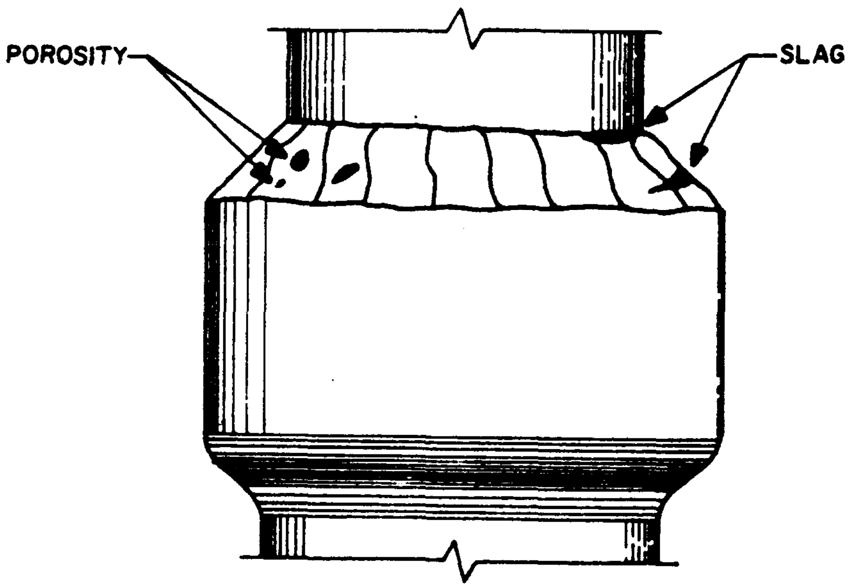



Figure 6.- Surface Slag and Porosity.

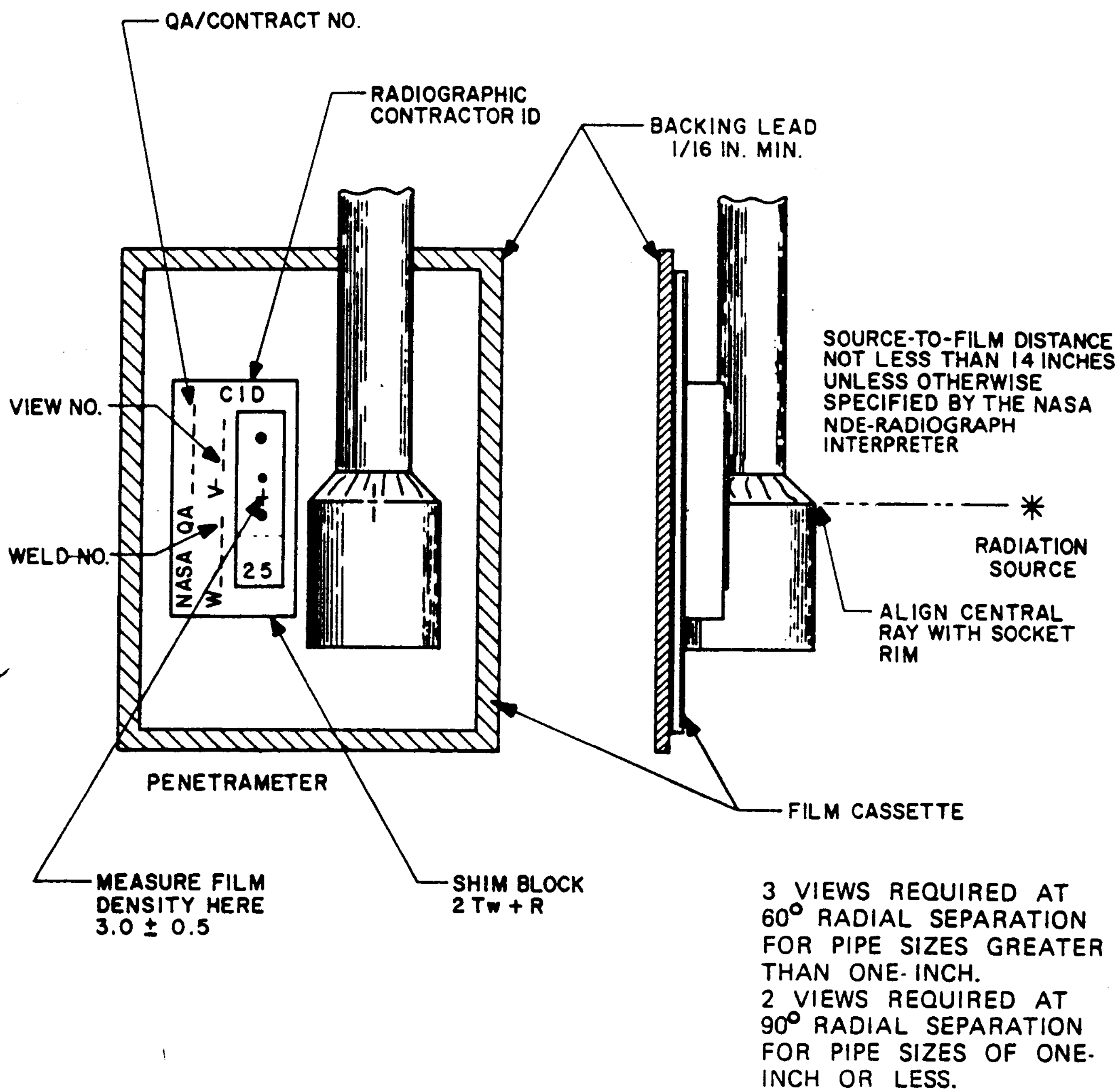



Figure 7.- Radiographic Exposure Technique (Socket).

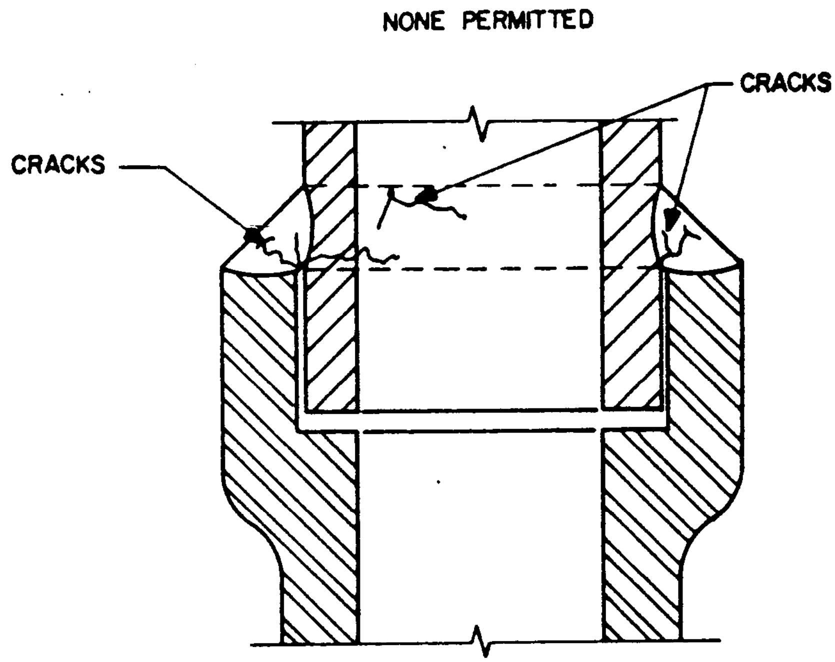



Figure 8.- Cracks.

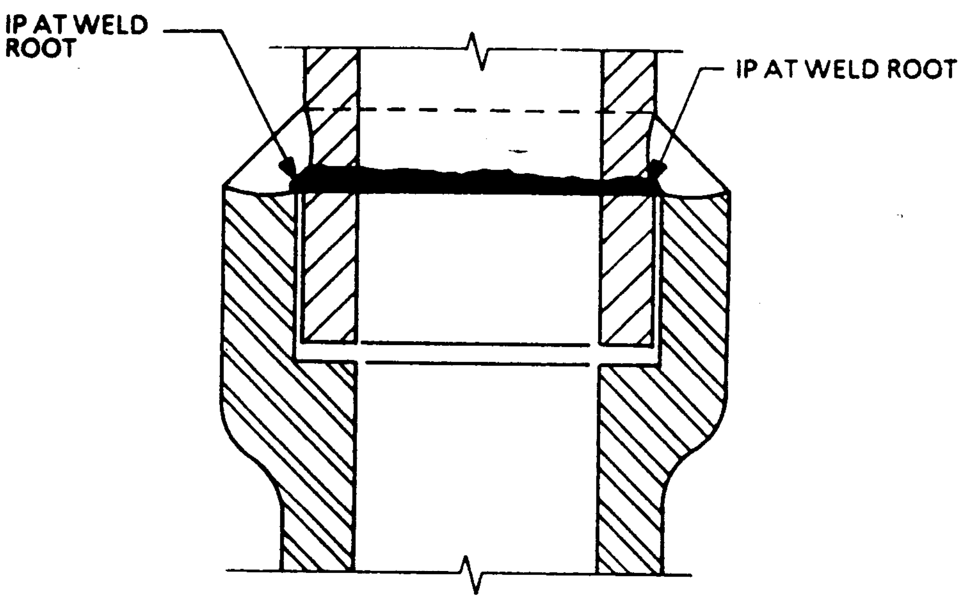



Figure 9.- Incomplete Penetration (IP).

NO IF PERMITTED

NOTE - IF IS ALSO POSSIBLE BETWEEN WELD PASSES

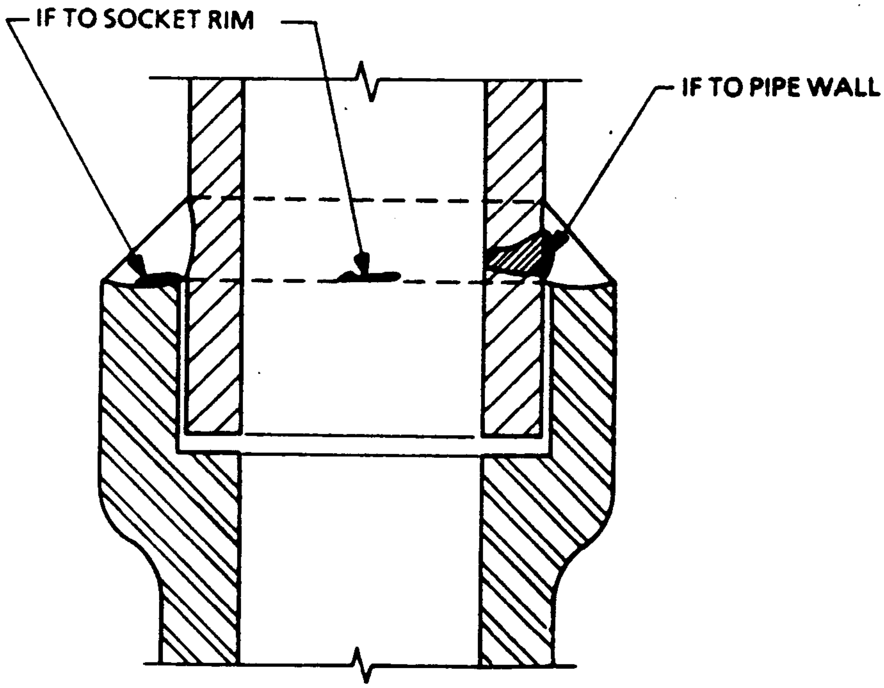



Figure 10.- Incomplete Fusion (IF).

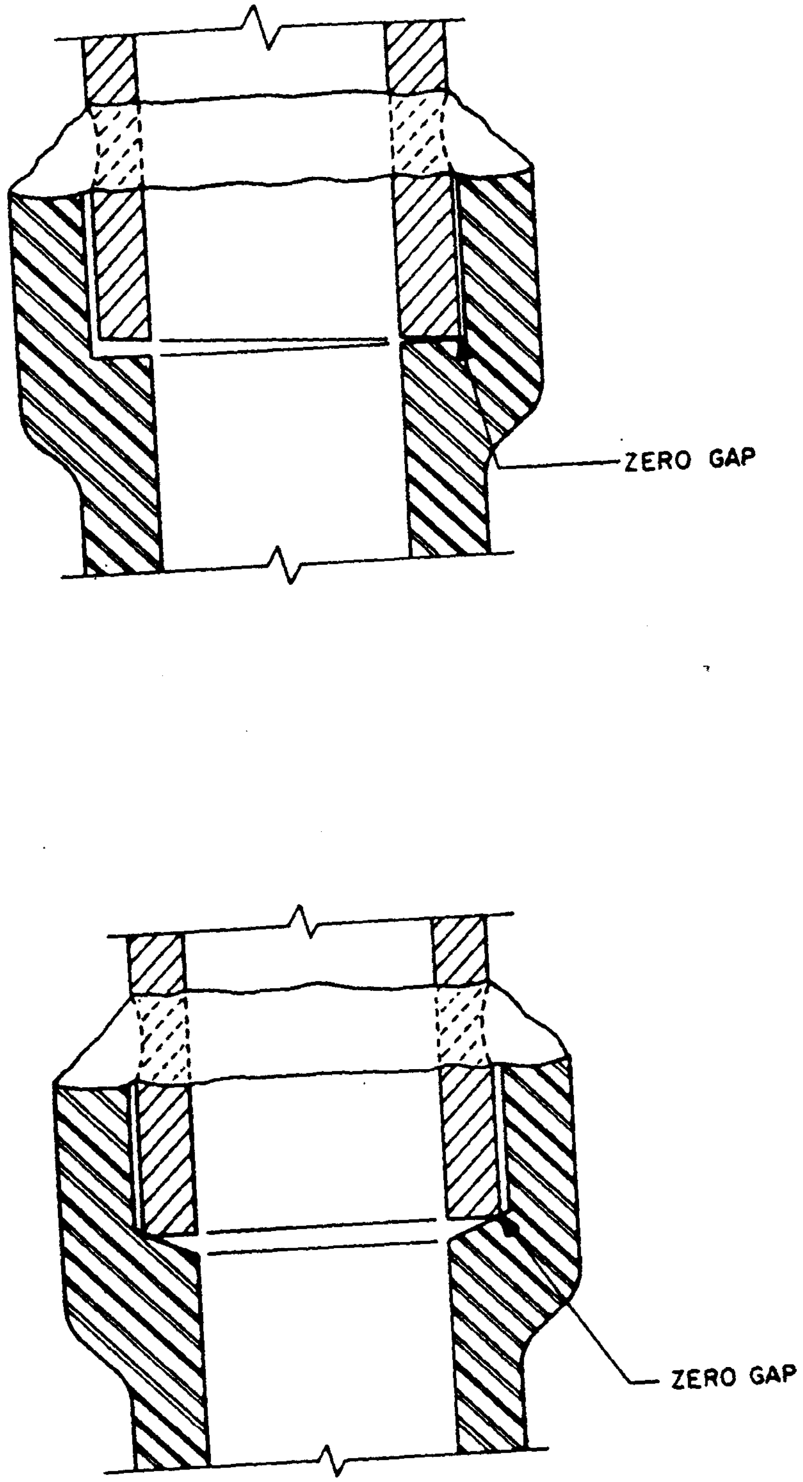



Figure 11.- Unacceptable Pipe-to-Socket Gap.

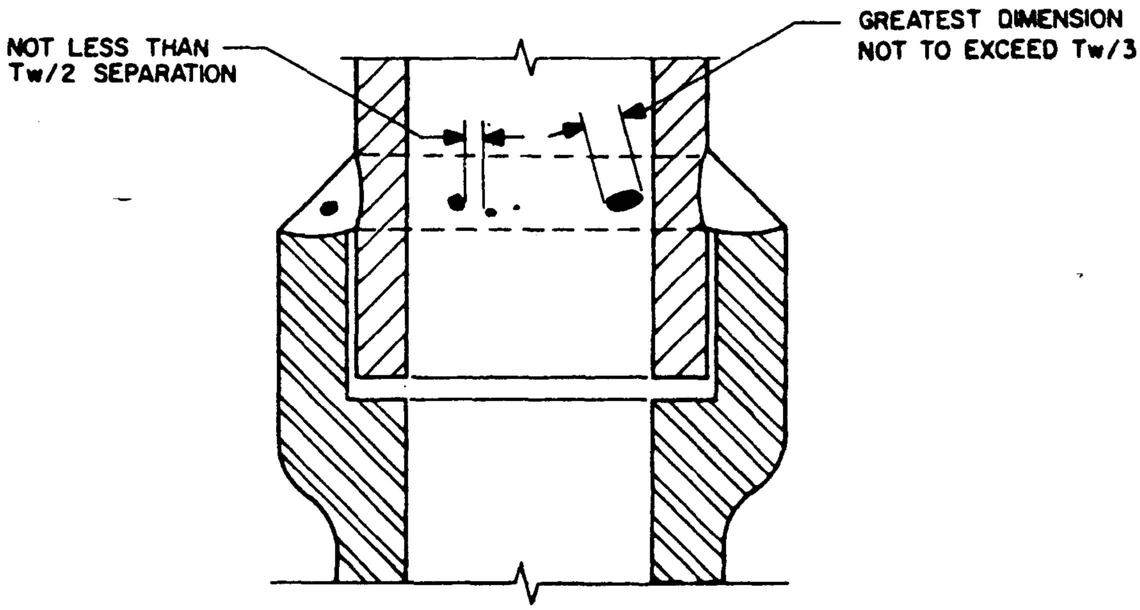



Figure 12.- Porosity and Rounded Indications.

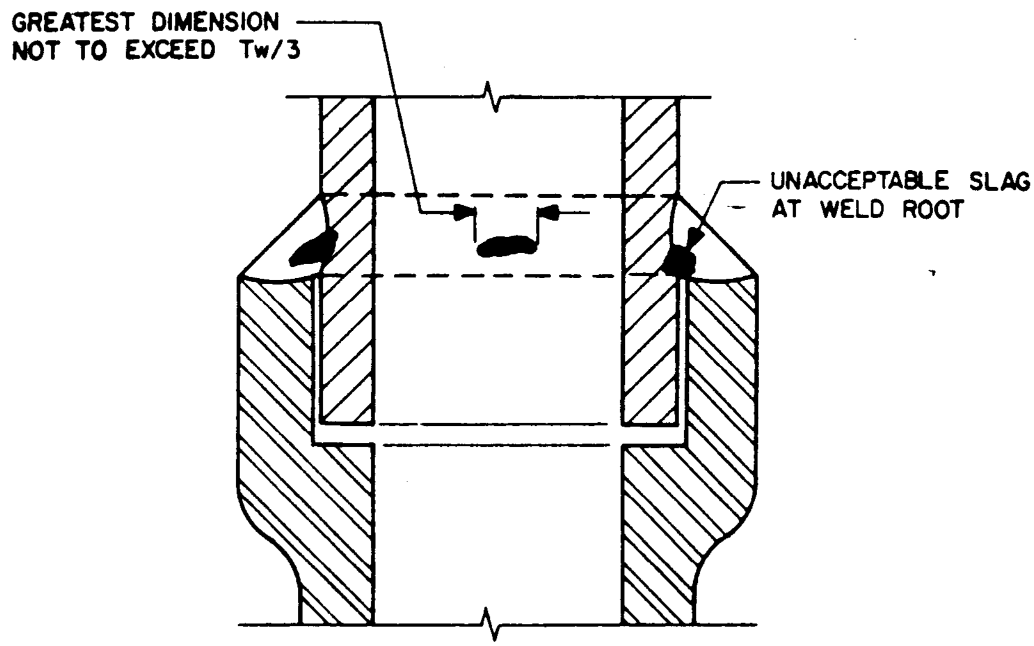



Figure 13.- Slag Inclusions.

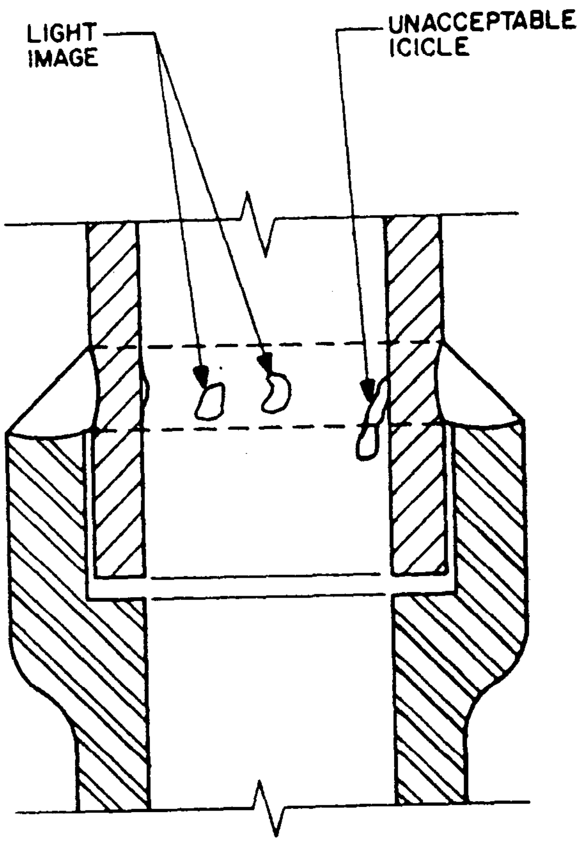



Figure 14.- Melt Through.

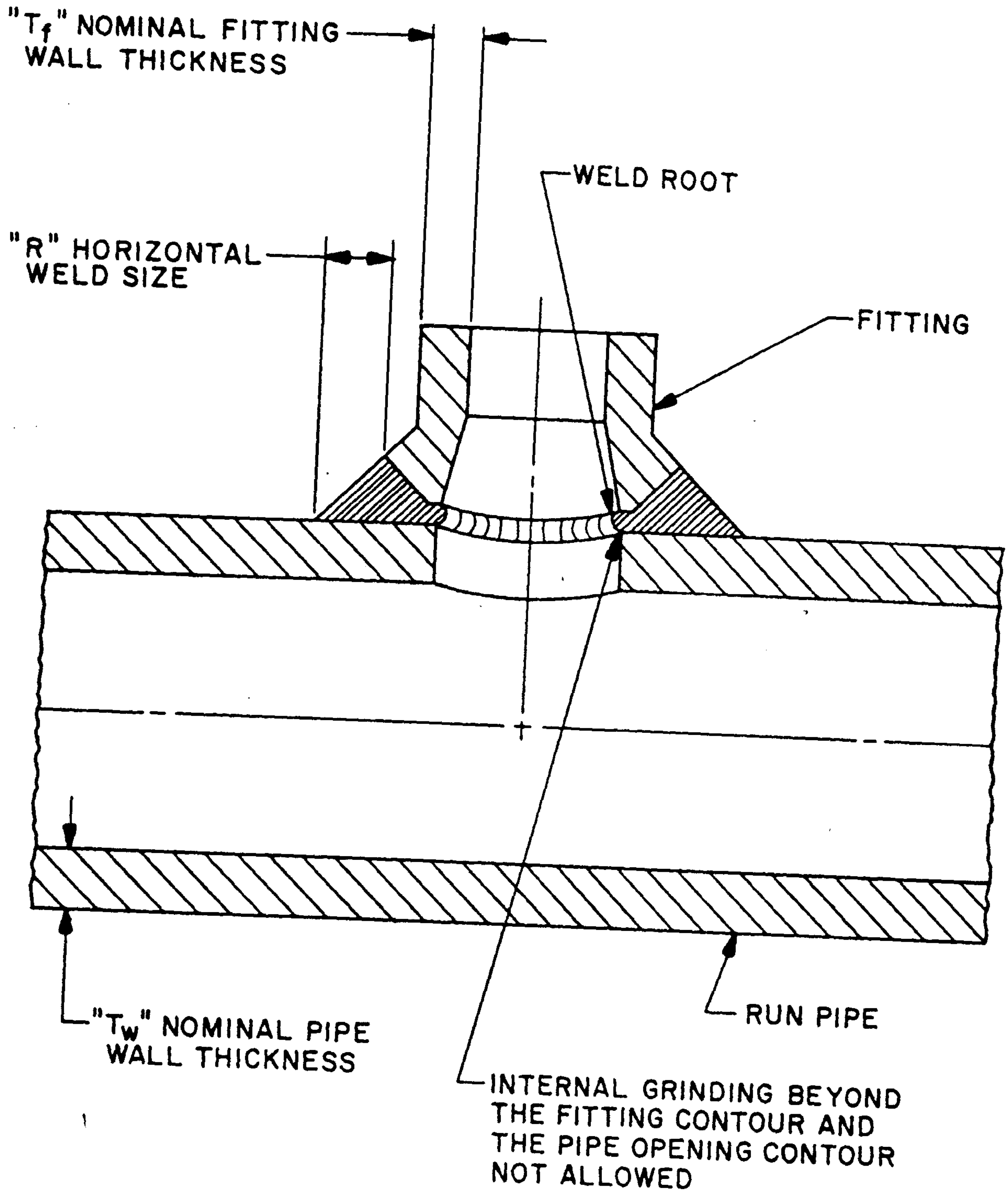
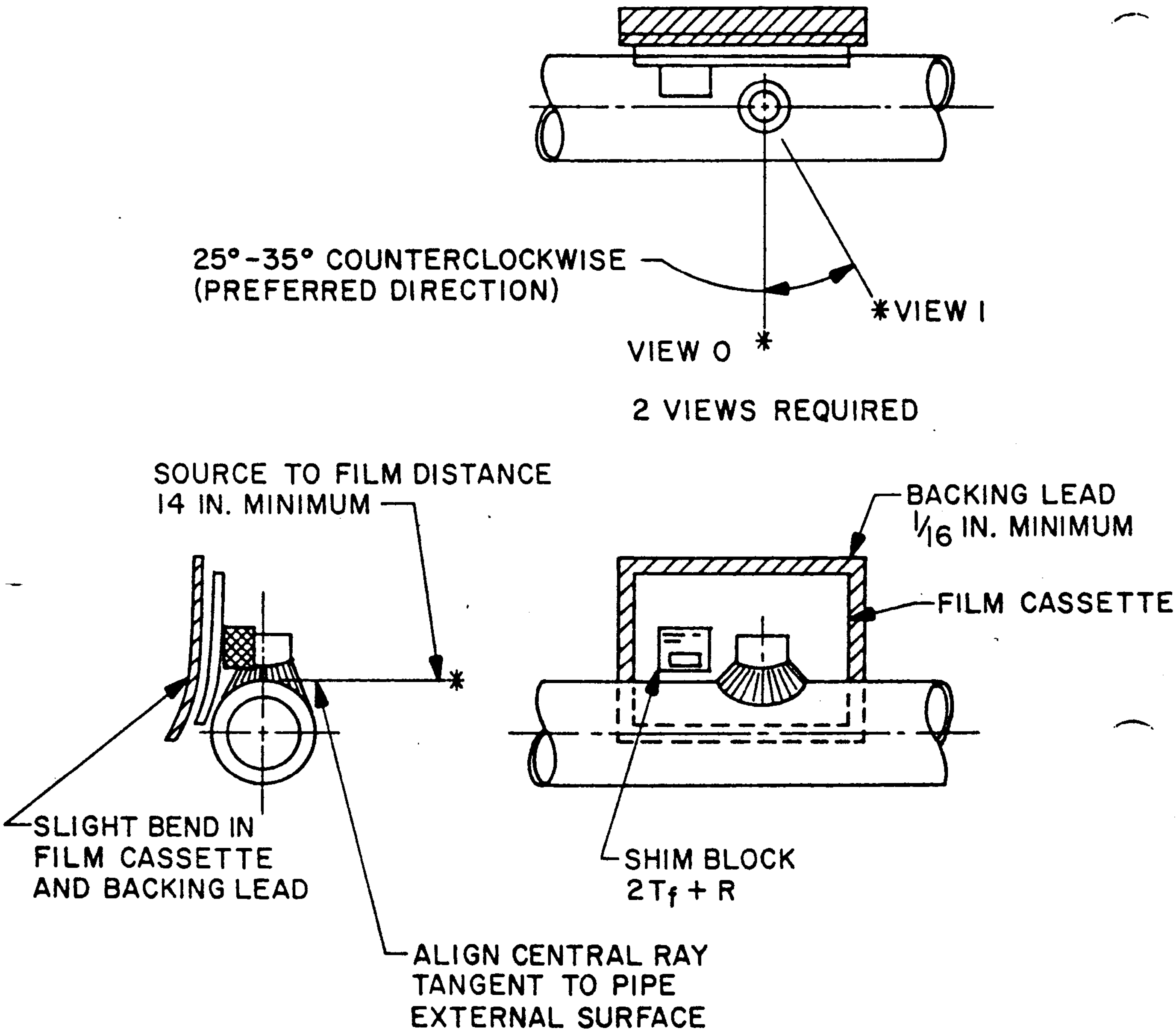



Figure 15.- Weld Nomenclature and Minimum Dimensions for Branch Connection Welds.




NOTE

BRANCH CONNECTIONS OVER 6 INCHES DIAMETER (O.D.) MAY REQUIRE ADDITIONAL EXPOSURES OR ALTERNATE TECHNIQUES AT THE DISCRETION OF THE NASA NDE RADIOGRAPH INTERPRETER

Figure 16.- Radiographic Exposure Technique (Branch).

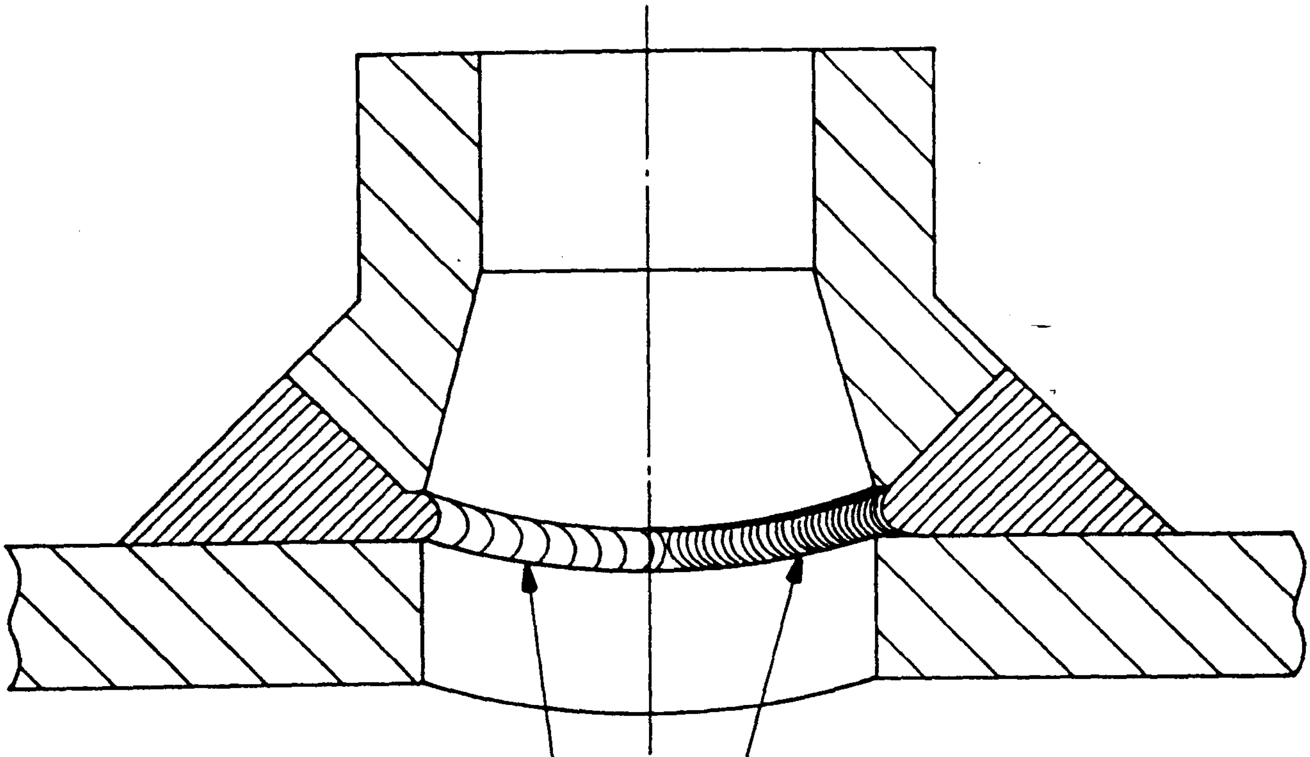



Figure 17.- Incomplete Penetration (Branch).

ATTACHMENT 12

NASA LANGLEY HANDBOOK (LHB) 1740.4, FACILITY SYSTEM SAFETY ANALYSIS AND CONFIGURATION MANAGEMENT (MARCH 1992)

ATTACHMENT 12

LHB 1740.4
March 1992

NASA
Langley Research Center

# FACILITY SYSTEM SAFETY ANALYSIS AND CONFIGURATION MANAGEMENT

National Aeronautics and Space Administration

# PREFACE

This handbook sets forth policy and responsibilities for the System Safety Program as it applies to Langley Research Center research facilities. It defines and implements the requirements of the Facility System Safety Analysis and Configuration Management Program. It is provided to assist Government personnel in performing their responsibilities for this program and to define the contractor's participation in the Configuration Management Program.

LHB 1740.4, dated May 1991, is superseded and should be destroyed.

H. Lee Beach, Jr.
Deputy Director

DISTRIBUTION:
SDL 040, SDL 043, SDL 410, SDL 411, and SDL 412
429/Systems Safety, Quality and Reliability Division (150 copies)
123/Directives & Forms Management Office, ISB - MSD (10 copies)

CONTENTS

CONTENTS - Concluded

# THE LaRC FACILITY SYSTEM SAFETY PROGRAM

## 1.1 INTRODUCTION

### 1.1.1 Application

The LaRC Facility System Safety Program exists to ensure the safe and continuous operation of selected LaRC facilities. As a part of that program, a number of research facilities have undergone a Facility System Safety Analysis. Each of those facilities has been assigned a unique Effort Code (EC) number. These numbers appear on documentation associated with the facilities and are listed in Figure 1-1, "Effort Code Summary."

### 1.1.2 Objective

The key provision of the Facility System Safety Program stipulates **that an initial Systems Safety Analysis be conducted for each facility, that a baseline for controlled documents be established, and that these analyses and documents be kept current by an active Configuration Management (CM) Program.** These analyses and the continuous update provided by the CM Program provide procedural and risk information to operating personnel while recording and maintaining the current status of supporting documentation, equipment, and services within those facilities.

## 1.2 SCOPE

The LaRC Research Facilities and Laboratory Configuration Management Programs consist of three separate programs with two subprograms under Facility Configuration Management:

a. Facility Configuration Management

  (1) Pressure Systems Configuration Management

  (2) Software Configuration Management

b. Laboratory Configuration Management

c. Asbestos Configuration Management

Details on Facility System Safety Analysis and the Configuration Management Programs may be found as described below.

**Chapter 2** provides details of the **Facility System Safety Analysis** process. **Chapter 3** provides guidance on the program to upgrade existing safety

| Effort Code | Facility Title | Facility No. | Street Address |
|---|---|---|---|
| 01 | West Area High Pressure Air System | 1247E | 7E East Reid St. |
| 02 | Hypersonic $CF_4$ Tunnel | 1275 | 20 Lewis Loop |
| 03 | 8-Foot High Temperature Tunnel | 1265 | 10 East Reid St. |
| 04 | 1- x 3-Foot High Enthalpy Aerothermal Tunnel | 1265 | 10 East Reid St. |
| 05 | Hypersonic Blowdown Tunnels | 1247D | 1D East Reid St. |
| 07 | Hypersonic $N_2$ Tunnel | 1247 | 1B East Reid St. |
| 12 | Entry Structures Facility | 1267 | 6 East Reid St. |
| 13 | Visual Motion Simulator | 1268A | 24 West Taylor St. |
| 14 | Drive Control | 1241 | 9 West Taylor St. |
| 16 | 31-Inch Mach 10 Tunnel | 1251A | 16A Victory St. |
| 17 | 15-Inch Mach 6 High Temperature Tunnel | 1251A | 16A Victory St. |
| 18 | Transonic Dynamics Tunnel | 648 | 648 Dodd Blvd. |
| 19 | 14- x 22-Foot Subsonic Tunnel | 1212C | 17C West Taylor St. |
| 21 | 16-Foot Transonic Tunnel | 1146 | 11 West Taylor St. |
| 22 | Aircraft Noise Reduction Laboratory | 1208 | 2 North Dryden St. |
| 23 | Hypersonic Materials Test Apparatus | 1148 | 8 West Taylor St. |
| 24 | Unitary Wind Tunnel | 1251 | 16 Victory St. |
| 25 | Scramjet Test Facility | 1247B | 1B East Reid St. |
| 26 | High Reynolds No. Helium Tunnel Complex | 1247H | 2H East Marvin St. |
| 27 | High Reynolds No. Helium Recovery System | 1247B | 1B East Reid St. |
| 28 | Hypersonic Helium Tunnel Facility | 1247B | 1B East Reid St. |
| 29 | Aircraft Landing Dynamics Facility | 1257-1262 | 2 West Bush Rd. |
| 30 | HPB Ceramic Heated Combustion Facility | 1263 | 15 North Marvin St. |
| 31 | Vortex Research Facility | 720B | 720B Back River Rd. |
| 33 | Impact Dynamics Research Facility | 1297 | 12 West Bush Rd. |
| 34 | 0.3-Meter Transonic Cryogenic Tunnel | 1242 | 7 West Taylor St. |
| 35 | Anechoic Noise Facility | 1218A | 3A South Wright St. |
| 36 | Jet Noise Apparatus | 1221A | 12A Langley Blvd. |
| 37 | Thermal Acoustic Fatigue Apparatus | 1221A | 12A Langley Blvd. |
| 38 | East Area High Pressure Air System | 646/582 | 582A Thornell Ave. |
| 39 | 8-Foot Transonic Pressure Tunnel | 640 | 640 Thornell Ave. |
| 40 | Low Turbulence Pressure Tunnel | 582A | 582A Thornell Ave. |
| 42 | 6- x 28-Inch Transonic Tunnel | 583 | 583 Plum St. |
| 43 | 6- x 19-Inch Transonic Tunnel | 585 | 585 Thompson St. |
| 50 | Vacuum Sphere Control and 60-Foot Space Simulator | 1295 | 2 South Warner St. |
| 52 | High Speed 7 x 10 Foot Tunnel | 1212B | 17B West Taylor St. |
| 58 | Impact and Projectile Range | 1275 | 20 Lewis Loop |
| 59 | Chemical Kinetic Shock Tube | 1275 | 20 Lewis Loop |
| 60 | 30- x 60-Foot Tunnel | 643 | 643 Thornell Ave. |
| 61 | 12-Foot Low Speed Tunnel | 644 | 644 Andrews St. |
| 62 | 20-Foot Vertical Spin Tunnel | 645 | 645 Andrews St. |
| 64 | DC-9 Simulator | 1220 | 1 South Wright St. |
| 65 | Visual Landing Display System | 1220 | 1 South Wright St. |
| 66 | Differential Maneuvering Simulator | 1268A | 24 West Taylor St. |
| 67 | General Purpose Fighter Simulator | 1220 | 1 South Wright St. |
| 68 | General Aviation Simulator | 1268A | 24 West Taylor St. |
| 69 | 7-Inch High Temperature Tunnel | 1264 | 17 North Marvin St. |
| 71 | Vitiated Heater, Test Cell #2 | 1221 | 12 Langley Blvd. |
| 80 | Combustion and Mixing Research Apparatus, Test Cell #1 | 1221 | 12 Langley Blvd. |
| 84 | Hangar Water Deluge System | 1244 | 6 East Taylor St. |
| 85 | Hevi-Duty Brazing Vacuum Furnace | 1232A | 6A Langley Blvd. |
| 86 | 16-Meter Thermal Vacuum Chamber | 1293B | 4B West Taylor St. |
| 88 | Autoclave | 647 | 647 Andrews St. |
| 89 | Autoclaves | 1267A | 6A East Reid St. |
| 91 | Composite Shop Autoclave | 1238B | 3B East Durand St. |
| 92 | Hypersonic Helium Tunnel Recovery System | 1247B | 1B East Reid St. |
| 93 | Transport Systems Research Vehicle (TSRV) | 1268B | 13 Langley Blvd. |
| 97 | Space Systems Structures Research Lab | 1293A | 6A West Taylor St. |
| 98 | Steam Distribution System | 1215 | 14 West Taylor St. |
| 99 | National Transonic Facility (NTF) | 1236 | 5 West Taylor St. |

**Figure 1-1.- Effort Code Summary.**

analyses to a more thorough and updated standard. Chapter 4 covers the Facility Configuration Management (CM) Program. Chapter 5 addresses the Pressure Systems Configuration Management (PSCM) Program. Chapter 6 addresses Software Configuration Management. Chapter 7 addresses the Laboratory Risk Evaluation Program (LREP). Chapter 8 addresses the Asbestos Configuration Management Program.

## 1.3 DEFINITIONS

The glossary in the Appendix lists and defines the terms unique to the Facility System Safety Program.

# FACILITY SYSTEM SAFETY ANALYSIS

## 2.1 GENERAL

A **Facility Systems Safety Analysis** is a systematic approach toward: (1) identifying credible hazards associated with the operation of a facility, (2) defining the risk in terms of severity and probability, (3) assessing the controls for those hazards, and (4) making recommendations toward reduction of the probability of occurrence, if appropriate. Such an analysis must be accomplished prior to the start of research activities at any new facility or prior to any existing facility being brought into the Configuration Management (CM) Program. The overall responsibility for the conduct of the Facility Systems Safety Analysis lies with the **Facility Assurance Section (FAS), Risk Management Branch (RMB), Systems Safety, Quality and Reliability Division (SSQRD)**. The analysis itself, however, is a group effort conducted by a Facility Team. This team includes the:

a. Facility Safety Head (FSH).

b. Facility Coordinator (FC).

c. Facilities Configuration Coordinator (FCC) from the Facilities Engineering Division (FENGD).

d. Safety Manager (Head, RMB, SSQRD).

e. Designated Safety Engineer, FAS, SSQRD.

f. Designated Systems Safety Engineer from the CM contractor.

The completed analysis is documented in the **Safety Analysis Report** (SAR). This document, along with the **Standard Operating Procedures** (SOP's), designated **engineering drawings**, and other documents identified by the Facility Team, are listed in the **Configuration Controlled Document** (CCD) section of the **Facility Baseline List** (FBL). These documents, and the FBL which lists them, are maintained under the CM Program. The FSH leads the Facility Team and has final approval of all CCD's. Changes to CCD's are initiated by a NASA Langley Form 127, "Change Notification Sheet (CNS)." The Facility Team meets annually to review the previous year's activities and plan for the future.

## 2.2 PLANNING

Approximately 60 days prior to the initiation of a Facility System Safety Analysis, the assigned Safety Engineer in SSQRD will notify the responsible FSH. The FSH, with the assistance of the facility staff and technicians, will assemble and provide to SSQRD all existing documentation which reflects the "as-is" facility hardware. These documents include:

a. Facility Resumé.

b. Facility Engineering Drawings (red-lined if necessary).

c. Standard Operating Procedures.

d. Maintenance Plan.

e. Vendor Manuals.

f. Checklists.

g. Engineering Reports/Analyses.

h. Any other item that may be of value toward the System Safety Analysis; such as:

    (1) Operational Logs.

    (2) Failure Mode Histories.

    (3) Specific areas of concern.

## 2.3 EXECUTION

The assembled documents will be reviewed by the FSH, FC, and the Safety Engineer in FAS, SSQRD to initiate the Facility System Safety Analysis. These documents will form the foundation of the SSQRD Safety Engineer's formal analysis of the facility's hazards and other conditions appropriate to the issue of safety. The end products of this effort will be the:

a. Standard Operating Procedures (SOP's)/Checklists.

b. Safety Analysis Report (SAR).

c. Facility Baseline List (FBL).

d. Other special items as appropriate.

Details on these end items and inclusion of engineering drawings into the Facility CM Program follow.

### 2.3.1 Standard Operating Procedures (SOP's)/Checklists

#### 2.3.1.1 SOP Guidelines

SOP's are detailed, written, formal instructions for **qualified operators** to be routinely followed at a designated facility. Some guidelines to be used in their preparation are:

a. SOP's must provide for a **complete cycle** of operation (dormant to run to dormant). This cycle is normally presented in three separate SOP sections: **Pre-Operational (PRE-OP) Procedures, Operational (OP) Procedures, and Post-Operational (POST-OP) Procedures.**

b. SOP's for the complete cycle must be **demonstrated for and approved by the Facility Team** prior to being included in the CM Program.

c. Initially, **dry runs will be performed** to avoid unnecessary exposure to hazards.

d. SOP's will alert operators of potential unexpected events. These alerts are expressed in three distinct categories:

    (1) A **NOTE** is a general instruction to the operator concerning the **specific order that procedures must follow**. It alerts the operator to potential undesired results of a minor nature (that is, failure to comply would invalidate previous actions) and provides explanatory information.

    (2) A **CAUTION** alerts the operator that the sequence which follows could cause **equipment damage** if not executed properly.

    (3) A **WARNING** alerts the operator that the sequence which follows could cause **personnel injury** if not executed properly.

e. Red-lined copies of the SOP's will be corrected and submitted to the Facility Team for approval.

f. SOP's may include date/sign-off sheets that can be used for documentation of the day-to-day operation of the facility.

### 2.3.1.2 Checklist Guidelines

Checklists are abbreviated versions of SOP's which are intended to provide less-detailed instructions for routine, day-to-day operation of a facility by the **most experienced of operator personnel**. Prior to their use, they must be demonstrated, approved, and included in the CM Program. This process is identical to that followed in the development and acceptance of SOP's. Some guidelines to be used in their preparation are:

a. A Checklist may cover an entire cycle of operation or any part thereof; however, it must be clearly labeled as to what it covers.

b. A Checklist may be of a "check off" or "sign off" nature; or, simply a sequential listing of steps to be taken without the need to check/sign items off.

c. A Checklist is often reproduced within the facility and a copy used for each operational run. In such cases, the entire Checklist must be reproduced and no part of the original omitted.

The FSH and/or FC will use approved SOP's/Checklists in training for operator qualification/certification.

Facility complexity and operational risks will dictate the requirement for the degree of structured operations which are to be controlled by hand-held procedures and/or Checklists.

### 2.3.1.3 SOP/Checklist Development

Development of SOP's and Checklists is achieved by following the planned sequence of activities as listed below:

a. The FSH and FC develop an appropriate Work Breakdown Structure (WBS) of facility operations, Sequential Flow Charts, and first-draft Procedures/Checklists.

b. The Facility Team reviews and approves the WBS and accompanying Sequential Flow Chart with emphasis on identifying mission- and safety-critical events on the first draft of the SOP/Checklists.

c. The FSH and FC demonstrate, for the Facility Team, the resulting second-draft SOP/Checklists.

d. The Facility Team approves and accepts the final SOP/Checklists.

e. The FSH and Safety Manager approve the final SOP's/Checklists and these documents are incorporated into the CM Program.

### 2.3.1.4 SOP/Checklist Organization

SOP's/Checklists are divided into two sections: **Forematter** and **Text**.

a. The **Forematter** consists of the following:

(1) The Title Page contains the SOP/Checklist title, the name of the facility for which the document was completed, and the facility number [illegible]

(2) The **Revision Record** reflects all SOP/Checklist document changes and states who prepared, reviewed, and accepted those changes. The "Prepared By" column is signed by the Configuration Management or Safety Engineer who prepared the change. The "Reviewed By" column is signed by designated reviewing authority. The "Reviewed By Safety Manager" column is signed by the Head, RMB, SSQRD. Finally, the "FSH Cognizance" column is signed by the responsible FSH.

(3) The **List of Page Revisions** enumerates each page in the document and the current revision letter of each page.

(4) A **General Introduction** page addresses the purpose, personnel, support and safety services, equipment, initial conditions, and reference drawings appropriate to the procedures/checklist being presented.

b. The **Text** section begins immediately following the forematter and consists of a Sequence Flow Chart, which shows the normal safe order in which the procedures (Pre-operations, Operations, and Post-Operations) can be executed, and the actual, step-by-step procedures/checklist.

### 2.3.2 Safety Analysis Reports (SAR's)

#### 2.3.2.1 General

A **Safety Analysis Report** (SAR) formally documents the **Facility System Safety Analysis** for a given facility. A SAR is initially developed in a structured sequence of planned activities as follows:

a. A designated Safety Engineer from SSQRD compiles an initial **System Definition** which includes the **Facility Description**, a **System Block Diagram**, and a **Preliminary Hazard Analysis.**

b. The Facility Team reviews and comments on the initial product.

c. The designated Safety Engineer conducts a **Hazard Control Analysis** (HCA).

d. The designated Safety Engineer prepares a **Critical Items List** (CIL).

e. The FSH reviews and comments on the developed documents.

f. The Facility Team reviews the developed documents and the FSH response. This is followed by their approval and acceptance of the SAR.

g. The Safety Manager and the FSH approve the SAR and it is incorporated into the CM Program.

The SAR will be maintained by the CM contractor in conjunction with the FSH and Safety Manager. Any facility change will be considered for possible SAR impact. It is critical that all parties involved maintain close communication in analyzing hardware or procedural changes and update the SAR as expeditiously as possible.

### 2.3.2.2 SAR Organization

The SAR is divided into three main sections: **Forematter**, **Text**, and **Appendixes**. The Text is further subdivided into subsections common to all facilities; although, on a case-by-case basis, additional special-item subsections (for example, a CIL) can be added if directed by the Facility Team. The common subsections are the **Introduction**, the **Facility Description** (which includes a **Facility Block Diagram**), and the **Safety Analysis Summary**. The following is a discussion of each section/subsection.

a. The **Forematter** section consists of the **Title Page**, **Revision Record**, **List of Page Revisions**, and **Table of Contents**.

   (1) The **Title Page** contains the report title, the name of the facility for which the report was completed, the facility number in which the facility is housed, and the Effort Code (EC) associated with the facility.

   (2) The **Revision Record** reflects all SAR document changes and states who prepared, reviewed, and accepted the report/changes, and the date issued. The "Prepared By" column is signed by the Safety Engineer who prepared the report/change. The "Reviewed By" column is signed by designated reviewing authority. The "Reviewed By Safety Manager" column is signed by the Safety Manager, SSQRD. Finally, the "FSH Cognizance" column is signed by the responsible FSH.

   (3) The **List of Page Revisions** enumerates each page in the report and the current revision letter of each page.

   (4) The **Table of Contents** lists the major subsections of the SAR and the page number on which each begins.

b. The Text section of the SAR consists of the **Introduction**, the **Facility Description**, and the **Safety Analysis Summary**.

   (1) The **Introduction** identifies the facility, states the purpose and philosophy of the analysis, and explains the **Risk Assessment** logic.

(2) The **Facility Description** is a brief overview of the subject facility which lists the major facility capabilities, the nature of research conducted, the subsystems, and any special facility feature appropriate to the safety analysis. It also includes a **Facility Block Diagram** which shows the general relationships among the various subsystems.

(3) The **Safety Analysis Summary** is the heart of the SAR. It contains **General Observations and Recommendations** which address those **Hazards/Undesired Events** that are general in scope (primarily resulting from facility familiarity) as opposed to **Hazards/Undesired Events** specific to a particular subsystem revealed by the analysis. Every entry in both this subsection and the following one, **Tabular Summary**, will be assigned **an alpha-numeric Risk Level** in accordance with the philosophy and guidelines established by this handbook (see paragraph 2.3.2.5) and the SAR **Introduction**. The **Tabular Summary** subsection lists and discusses the identified **Undesired Events** and the associated risks are assessed. The discussion appears in this section in an abbreviated format only.

c. The **Appendixes** of the SAR provide the more detailed discussion of the Hazards, Undesired Events, and Risk Assessments. There is normally a separate Appendix for each major subsystem identified on the **Facility Block Diagram**. The Appendixes are keyed to the Tabular Summary subsection of the Safety Analysis Summary. The Appendixes provide **much greater definition** of the facility's situation in that the Undesired Events associated with each of these subsystems are addressed in detail.

d. Where applicable, SAR's shall include a Critical Items List (CIL). **A Critical Item is any item, the single order failure of which, would likely result in death or damage to equipment/ property equal to or greater than $1.0M**. Typical examples of Critical Items include: interlocks, safety devices, high energy components, and biological/environmental impact components. A Critical Item must have the design analyses, inservice inspection/preventive maintenance procedures, installation procedures, and nondestructive testing required to establish and maintain an acceptable probability-of-occurrence risk category. The requirement for design calculations can be waived for Critical Items which are proprietary or part of a company's standard product line providing that: (1) the item has been designed to industry consensus codes, (2) a history of acceptable operations of the same or similar products is available, and (3) the use is in compliance with the manufacturer's ratings and recommended applications. Examples of proprietary items that may meet the design waiver criteria are large rotating machinery for wind-tunnel compressor or drive systems. Critical Items listed in the SAR's shall be tracked throughout their lifetime for compliance with design, maintenance, and inspection requirements. Pressure components that are standard product lines and built to national consensus codes or standards, are by definition not considered Critical Items. However, these items shall be covered under the Center's Pressure System Recertification Program to assure system integrity.

### 2.3.2.3 SAR Preparation

a. **General**.- A SAR is prepared by a Safety Engineer under the direction of SSQRD. The Safety Engineer is assisted by the other members of the Facility Team. The following definitions are provided toward ensuring a uniform understanding of the terms related to SAR preparation:

   (1) **Hazard**--A condition which has the **potential** to result in damage to equipment and/or personnel injury/death.

   (2) **Undesired Event**--An event (or series of events) which **unleashes the potential** inherent in a hazard; and, either directly or indirectly, results in damage and/or personnel injury/death.

   (3) **Cause**--The stimulus or triggering **mechanism/act which precipitates** the Undesired Event/Accident.

   (4) **Effect**--The **consequence of the Undesired Event/Accident** in terms of equipment damage and/or personnel injury/death.

b. **Phases**.- The phases of SAR preparation are as follows (see **Figure 2-1**, "SAR Preparation Flow Sequence"):

   (1) The **System Definition Phase.** The Safety Engineer uses facility-provided documentation to define the system. In this phase, the facility is described and the facility is divided into manageable operational **subsystems**. Examples of operational **subsystems** are: high pressure air, vacuum, model injection, cooling water, test section, nitrogen, hydrogen, and so forth. How these subsystems are identified in any given facility depends on the desires of the Safety Engineer in organizing the SAR to cover every aspect of the facility. For example, in one instance, the model injection component may be a separate subsystem; whereas, in another instance, it may be included as part of the test section subsystem. The important thing is to ensure that all components are considered so that they may all be given due consideration. Also at this time, a **Facility Block Diagram** is generated to show the interrelationships among the chosen subsystems.

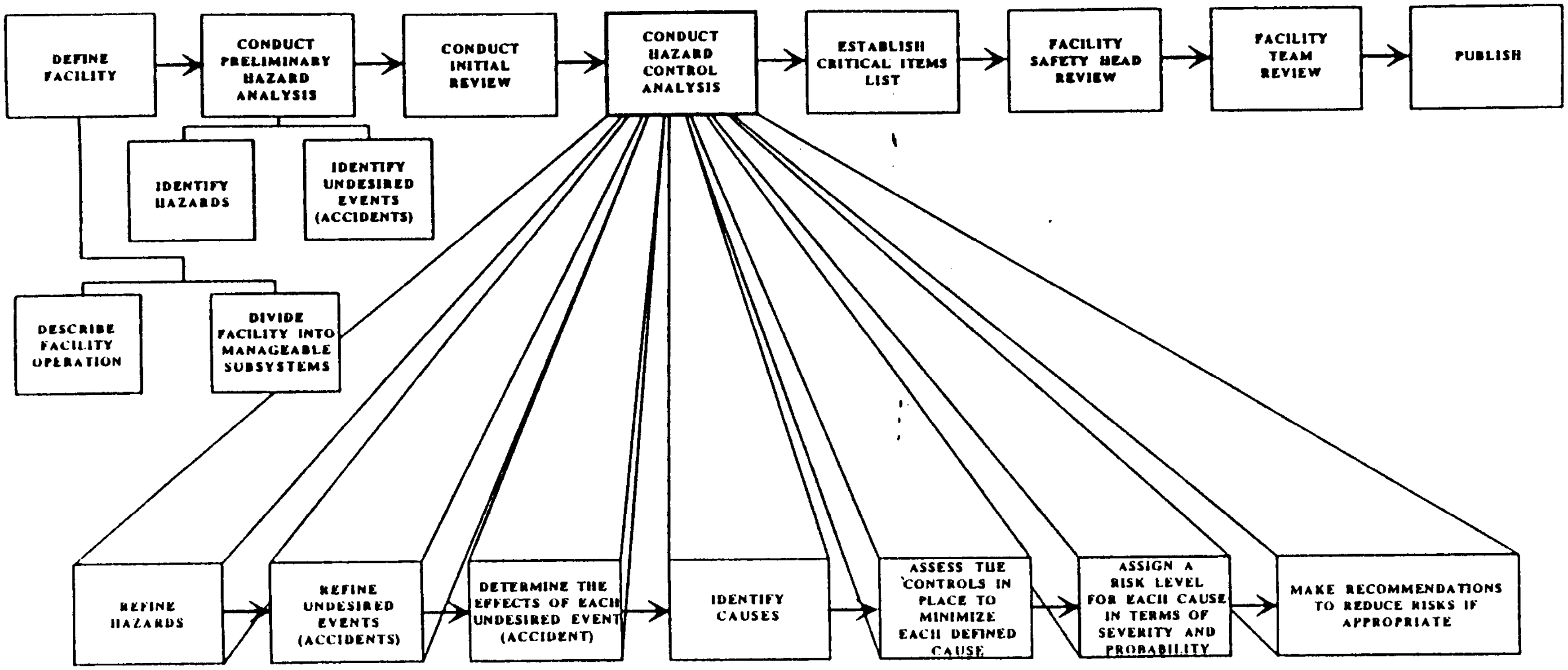



Figure 2-1.- SAR Preparation Flow Sequence.

(2) **The Preliminary Hazard Analysis Phase-. A Preliminary Hazard Analysis** is conducted to **identify all of the possible Hazards and the Undesired Events (Accidents) which could result from those Hazards.** (This action represents an initial assessment; and, the Hazards and Undesired Events/Accidents established here could be expanded as the assessment progresses.) There may be one or more Hazards in each of the subsystems. Upon completion of this phase, copies of the products are sent to the Facility Team for review and clarification of the facility Hazards and Undesired Events/Accidents.

(3) **The Facility Team Review Phase.**- The Facility Team reviews the System Definition and Preliminary Hazard Analysis products and provides the Safety Engineer additional information and comments as appropriate.

(4) **The Hazard Control Analysis Phase.**- With input from the Facility Team, the Safety Engineer now performs a **Hazard Control Analysis (HCA).** The HCA is the heart of the SAR. It ensures that a deductive approach is taken in the assessment of the safety implications of the facility and documents that thought process. The approach which shall be taken in the HCA is reflected in the lower portion of the flow chart in **Figure 2-1**.

(5) **The Critical Items Generation Phase.**- With the subsystems, Hazards, and Undesired Events defined, the Safety Engineer now prepares a CIL guided by the definition in paragraph 2.3.2.2d. Interlocks or other hazard controls, analyses, drawings, maintenance, installation, and in-service inspection procedures are identified, as required, for each Critical Item.

(6) **The Facility Safety Head Review Phase.**- The FSH now conducts a thorough and independent review of all documentation.

(7) **The Facility Team Review Phase.**- The remaining members of the Facility Team are assembled by the FSH for a final review, approval, and acceptance of the SAR.

(8) **The Publication Phase.**- After all of the issues are resolved and the SAR is prepared in final format, it is formally approved by the Safety Manager and FSH; and, it may be incorporated into the CM Program.

### 2.3.2.4 The Analysis

a. The analysis begins with a detailed exploration of each of the identified **Hazards** (an example of one might be hot surfaces).

b. Considering that **Hazard**, the analyst establishes **what event(s) could occur** that would result in the Hazard causing damage/injury/death (for example, personnel in contact with hot surfaces). Those events become the **Undesired Events (Accidents)**. There could be multiple Undesired Events resulting from each identified Hazard.

c. The analyst then establishes the **Effects of each Undesired Event** in terms of damage/injury/death (for example, serious injury to personnel). When numerous effects result, only the most severe need be noted.

d. From this point, the analyst establishes **what could cause those Undesired Events** to occur and these findings become the **Causes** (for example, personnel error). **There could be multiple causes for the same Undesired Event.**

e. To determine the facility's ability to sustain the catastrophe, the analyst must then **Assess the Safety Features and Procedures** in force which would, either directly or indirectly, minimize the probability of the occurrence of each Cause. If the Cause(s) can be minimized, the Undesired Event will not likely occur; therefore, **an Assessment is made for each individual Cause. Those Assessments must take the form of an investigation of the design and operation of the facility for each individual Cause.** Operational Procedures and facility drawings must be consulted to determine how the Hazard is contained and how daily operations are managed toward minimizing the probability of Undesired Events.

f. The next step in the analysis is the **Risk Assessment**. (Due to the length of this subject, it is discussed separately below in **paragraph 2.3.2.5, "Risk Assessment.") An individual Risk Assessment is made and assigned for each of the previously identified Causes.**

g. If an assigned **Risk Assessment** is unacceptable, **Recommendations** are made which, if implemented, would reduce that **Risk Assessment** to acceptable limits. (See paragraph 2.3.2.5.3a, b, and c regarding acceptability of Risks.) These **Recommendations** normally take the form of additional Safety Features/Devices, Design Changes, or changes in Operating Procedures.

h. **Summary**.- Undesired Events, Causes, and **Effects** should be confined to "credible" as opposed to "conceivable" happenings.

Their credibility is important in that it will ensure that the effort expended on the safety analysis is justified. They should reflect only those things that could reasonably be expected to occur.

2.3.2.5 Risk Assessment

The Undesired Events identified for each subsystem and the results of the detailed HCA are covered in detail in the Appendixes of the SAR and summarized in the Tabular Summaries. An alpha-numeric Risk Level, based on both Severity and Probability of Occurrence, is derived and assigned to each Undesired Event. The following paragraphs address how those alpha-numeric Risk Levels and the resulting Risk Assessment Codes (RAC's) are derived. (Also see Figure 3-2, "Current Risk Assessment Matrix.")

2.3.2.5.1 Severity Category

Severity is assigned assuming the Undesired Event will occur. Worst possible results are assumed with no consideration being given to abatement techniques incorporated in the system design or to the use of procedures. The Severity Category provides a relative measure of the worst possible consequences resulting from personnel error, environmental conditions, design inadequacies, procedural deficiencies, and subsystem or component failure/malfunction. These Categories are:

a. Category I - Catastrophic - May cause death, permanent disability, hospitalization of five or more people, and/or system/ equipment damage in excess of $250,000. (Type A or B Mishap)

b. Category II - Critical - May cause lost time injury or illness, and/or system/equipment damage between $25,000 and $250,000. (Type C Mishap)

c. Category III - Marginal - May cause minor injury or illness, and/or system/equipment damage between $500 and $25,000. (Reportable Incident)

d. Category IV - Negligible - Will not result in injury, occupational illness, or system/equipment damage in excess of $500. (Non-Reportable Incident)

2.3.2.5.2 Probability of Occurrence Level

Probability of Occurrence Level provides a measure of system safety by evaluating the system design in conjunction with abatement techniques, inspections, tests, and operating procedures. The Probability of Occurrence Level is the probability that a failure will occur sometime during the planned life of the system. The probability level is qualitatively based upon engineering judgment with appropriate guidelines. Those guidelines are:

a. **Level A - Frequent** - This is the level assigned when neither a safety feature nor approved procedures exist to prevent the Undesired Event.

b. **Level B - Occasional** - This is the level assigned when a safety feature does not exist to prevent the Undesired Event; but, the use of approved procedures should prevent the Undesired Event.

c. **Level C - Possible** - This is the level assigned when approved procedures do not exist to prevent the Undesired Event; but, an existing safety feature should prevent the Undesired Event.

d. **Level D - Remote** - This is the level assigned when both a safety feature and approved procedures, or two independent safety features, exist which, collectively, should prevent the Undesired Event.

**2.3.2.5.3 Establishing a Risk Assessment Code (RAC)**

Using the **Categories** and **Levels** described above, the information provided by the facility for the analysis, and on-site inspection techniques, the Safety Engineer conducts the analysis to determine the risks associated with each of the listed Undesired Events. This process will result in each **Undesired Event** being analyzed with respect to each credible **Cause**. Also, each of the Undesired Events will be shown to have an **Effect**. Each of the listed **Causes** is then assigned its own unique **Risk Level** (for example, IA, IIB, IIIC, and so forth). Applied to the two-dimensional matrix (see Chapter 3, Figure 3-2, "Current Risk Assessment Matrix), these **Risk Levels** translate into one of three **Risk Assessment Codes** (**RAC's**): **RAC 1**, **RAC 2**, or **RAC 3**. They are pattern-coded on the matrix to distinguish each from the other. **RAC 1's** include blocks IA, IB, IC, IIA, IIB, and IIIA. **RAC 2's** include blocks IIC, IIIB, and IVA. All other blocks are **RAC 3**. The implication of a given RAC is explained in the following paragraphs.

a. **RAC 1's for new facilities**, and those associated with a major Construction of Facilities (CoF) in existing facilities, are of major safety concern and **require corrective action before the facility can operate. RAC 1's for existing facilities not** undergoing a major CoF are also of major safety concern and **require an abatement plan approved by the Safety Manager. This abatement plan must be developed by facility personnel and approved by the Safety Manager within 30 days of either (1) publication of this document (for existing RAC 1's), or (2) knowledge of a new RAC 1's existence (for any RAC 1's assigned in the future). Failure to meet this requirement could result in facility shutdown.**

b. **RAC 2's for new facilities**, and those associated with a major CoF in existing facilities, are also of concern and require special attention. The FSH of the facility in question, with Safety Manager concurrence, shall by letter, **inform the Program Director** who oversees the facility of the nature of the RAC 2's and request approval to conduct operations. Operations shall not begin in that facility until the Program Director, with the concurrence of the Integrated Systems Review (ISR) Chairperson, has responded by letter authorizing such action. **RAC 2's for existing facilities not** undergoing a major CoF require no such approval; however, plans and programs to correct them as time and resources permit are considered sound management practice.

c. **RAC 3's are of an acceptable risk level.**

### 2.3.3 Engineering Drawings

#### 2.3.3.1 General

Engineering drawings which are brought into the CM Program are designated and maintained as Configuration Controlled Documents (CCD's). These drawings have been singled out by facility, safety, and engineering personnel as especially important to the facilities' safe and continuous operation. These drawings are listed in the **CCD section** of the **Facility Baseline List** (FBL) and represent the known configuration of the facilities they depict. Other drawings may be designated as **Supporting Facility Documents (SFD's)** and listed in the SFD section of the FBL. (See paragraph 2.3.4.2.)

#### 2.3.3.2 Criteria for Designating Drawings as CCD's

The criteria for selecting and incorporating new engineering drawings into the FBL as CCD's are listed below. The drawing must be:

a. Necessary for the safe operation of the facility.

b. Able to support the independent safety analysis of the operating systems.

c. Usable for system troubleshooting.

d. Suitable for engineering change design.

The CM Contracting Officer's Technical Representative (COTR) has the responsibility for resolving any differences of opinion and making final decisions regarding the disposition of all drawings chosen for inclusion in the CM Program. (See LHB 7320.1, "Engineering Drawing System," for more detailed guidance on LaRC drawing format, approval, and control.)

### 2.3.3.3 Drawing Documentation Requirements

All engineering drawings currently in the CM Program have either been field verified (FV) or are in need of field verification. No new drawing may be brought into the program (added to the CCD section of the FBL) unless it is first field verified. The field verification process is a hands-on verification of the validity of the drawing conducted by facility, SSQRD, Operations Support Division (OSD), or Contractor personnel. A drawing which has been field verified will display a "FIELD VERIFIED" statement authenticating that action. That statement will be signed by the person attesting to the field verification. It will further be signed and dated as approved by the Technical Project Engineer (TPE), FSH, or some other responsible person. A sample of this statement is as follows:

**FACILITY BASELINE DRAWING**
**FIELD VERIFIED BY:** ____________________
**APPROVED BY:** ____________________
**LATEST DATE:** ____________________

Some drawings exist which display a "WARNING! UNVERIFIED" statement alerting the user that they are not field verified. A sample of that statement is as follows:

**WARNING!**
**UNVERIFIED**

**All drawings which are currently in the CM Program and not field verified are the subject of an ongoing field verification effort by facility and OSD personnel as time and resources permit.**

### 2.3.3.4 Changes to Drawings

When drawings in the CM Program require change, the drawing shall be red-lined by the technician actually making the hardware change. Proper red-lining techniques are to *add* new items in green ink or black ink highlighted in yellow marker and *delete* existing items by marking over them in red ink. Drawings so red-lined shall be forwarded through channels on a Change Notification Sheet (CNS) and reviewed by Engineering and the Safety Office. When approved, the originals of the drawings will be modified by the CM contractor and new WORKING MASTER copies provided to the facility.

**2.3.3.5 Working Masters**

For each drawing listed on the FBL as a CCD drawing, the facility is provided with a current revision of the drawing marked WORKING MASTER in red color. The intent of this procedure is to identify the drawing as a copy of the current configuration of the facility as described by the drawing which is recorded on the Master retained in Engineering Drawing Files. These drawings should be kept in a central location in the facility and closely controlled to ensure availability to facility personnel for reference to correct facility configuration. Each time a CCD drawing is revised, a new WORKING MASTER of the revised drawing is provided to the facility. The CM contractor is assigned the responsibility for the preparation of the revised drawings and distribution to the appropriate facility/facilities in accordance with the CM Program.

There are a number of CCD drawings which detail systems that affect more than one facility. When a drawing affects more than one EC, each of the affected EC's will be listed on the CCD sticker applied to the drawings. In addition, each of the affected EC facilities will receive a drawing marked WORKING MASTER. In this manner, each EC facility can maintain a complete file of WORKING MASTER drawings which reflect up-to-date configuration. However, this results in more than one drawing marked WORKING MASTER. It is conceivable that one facility may have modified a system, including the red-lining of the affected drawings, without the knowledge of the other facility having custody of the same WORKING MASTER drawing. Expeditious revision of the appropriate drawings and distribution of current WORKING MASTERS will alleviate this perturbation in the CM drawing program in the most part. To preclude the adverse impact of using a WORKING MASTER drawing which is in the process of revision by another custodian of the same drawing, contact the other custodian and inquire as to the drawing status and get the information regarding the revision if under revision.

Adherence to the following additional guidelines will promote proper accountability and use of WORKING MASTER drawings:

a. A WORKING MASTER drawing **should always reflect the true (as-built) configuration** of the facility which it represents.

b. Proposed changes to a facility which impact on a CCD drawing should be red-lined on a separate copy of the affected drawing; not the WORKING MASTER.

c. Changes which reflect "as-built" configurations should be marked on the WORKING MASTER of each affected CCD drawing.

d. The current WORKING MASTER (or a copy) should always be present at the facility.

### 2.3.4 Facility Baseline List (FBL)

The FBL, although not in itself a CCD, lists the documents pertinent to a given facility that are CCD and under the management of the CM Program. The documents listed in the FBL are selected during the initial phase of the Facility Systems Safety Analysis and each must be approved by the FSH and Facility Team. They normally include the SAR, the SOP's and/or Checklists, any Recertification documents, and the key facility engineering drawings. Each must be complete, accurate, and current. The CM contractor is responsible for actually creating and maintaining the FBL once the documents to be listed therein have been identified. The following paragraphs describe the format of an FBL and present an explanation of its sections.

#### 2.3.4.1 The Change Control Record

The FBL Change Control Record is a five-column form used to record all actions taken to revise a CCD document listed in the FBL. Its heading includes the name and number of the facility, and the EC which has been assigned to the facility. The columns (left to right) are:

a. DATE--The date that the change is actually made in the FBL pages affected.

b. CNS NO.(s)--The CNS number which initiated the change followed by a brief description of what the change was about.

c. REPLACEMENT PAGES--The pages of the FBL that were actually altered in making the change.

d. REV.--The new (current) revision of the FBL. The letters I, O, Q, S, X, and Z are not to be used. When Y is the last revision used, the next sequence shall be AA through AY (then, BA through BY, and so forth).

e. CM ENGINEER--The name of the contractor CM Engineer who is executing the change. Prior to publication and distribution of the new pages, the CM Engineer shall sign the form over his/her typed name.

### 2.3.4.2 The Listings

The Listings of the FBL are contained in two sections: the CCD's section and the SFD's section. These sections are distinguishable by the different titles of the forms and the number of columns. Both sections are paginated in one sequence starting with 1 on the first page of the CCD's section and ending on the last page of the SFD's section.

a. The three-column CCD form includes:

   (1) **DOCUMENT NUMBER**--The number of the document (that is, drawing, SAR, or Procedure number). Drawing shall be listed first, in numerical sequence for ease of reference, followed by the SAR, the Procedures and/or Checklists; then, any other document which has been designated as CCD.

   (2) **REV.**--The current (active) revision letter(s) of the drawing or other document listed in column 1. Again, the letters I, O, Q, S, X, and Z are not used.

   (3) **DESCRIPTION**--The title of each of the drawings and documents listed in column 1.

b. The two-column SFD form includes:

   (1) The same **Document Number** column as does the three-column CCD form and its purpose is the same (see paragraph 2.3.4.2a(1) above). Normally the only documents listed in the SFD section are drawings.

   (2) The middle (**REV.**) column does not exist on this form since the revisions of SFD drawing are not recorded.

   (3) The second column on this form is the **DESCRIPTION** column and serves the same purpose as the **DESCRIPTION** column on the three-column CCD form (see paragraph 2.3.4.2a(3) above).

## 2.3.5 Other Document Maintenance Requirements

### 2.3.5.1 Filing Systems

The CM Program affects three file systems: **Engineering Drawing Files (EDF), CM Contractor files, and Research Facility files.** Document maintenance consists of the timely updating of CCD drawings and other supporting documents (SOP's, SAR's, and so forth), keeping historical records, and keeping "originals" (reproducible masters) on file. Document records will be maintained by each file system as indicated:

a. **Engineering Drawing Files (EDF).** EDF is the repository for all original configuration controlled drawings and for the microfilmed historical records of configuration controlled drawings and other CCD's (see LHB 7320.1 for details). EDF will microfilm the original CCD's and all subsequent changes in order to preserve these historical records. Only the CM contractor is permitted to withdraw CCD original drawings from EDF (see paragraph 2.3.5.1b below). Analyses, drawings, and nondestructive engineering information for systems which have been recertified or identified on the CIL will also be stored in EDF.

b. **CM Contractor Files.** The CM contractor will maintain and store the originals (reproducibles) of all SOP's, SAR's, and other CCD documentation (except drawings). As changes are approved and made to these documents, the CM contractor will ensure that all interested parties receive updated pages as appropriate. The facility will be given a WORKING MASTER copy of all CCD revisions once they are created by the CM contractor. The CM contractor will have on hand only those CCD original drawings to be modified as directed by an approved CNS. Original drawings will be changed by the CM contractor in accordance with the red-lined drawings accompanied by an approved CNS. The CNS will be handled in accordance with the Change Control Flow Chart (see Figure 4-3). After the original CCD drawing is changed, it will be initialed by the person who prepared the red-line, a Facilities Engineering Division (FENGD) representative, and the FSH. All changes are considered to have been "Field Verified" upon sign-off by cognizant personnel. The CM contractor will provide appropriate copies to the interested parties and return the original of the drawing to EDF.

c. **Research Facility Files.** Each research facility EC will maintain its own current WORKING MASTER filing system of CCD's. Updates to these documents will be provided by the CM contractor; but, the facilities must ensure that updates are properly posted and centrally stored so as to be of use when needed.

### 2.3.5.2 Supporting Facility Documents (SFD's)

These documents shall be red-lined by facility personnel and changed as necessary to support facility operations. SFD drawings may be revised through the Facilities Configuration Coordinator (FCC) at FENGD. Since SFD's are not CCD, they are not serviced by the CM contractor.

## 2.4 LaRC INTERLOCK PHILOSOPHY

### 2.4.1 General

The mission of LaRC is to conduct meaningful, leading-edge research in the fields of aeronautical and aerospace technology. In order to conduct such research, large power sources, pressurized gases, vacuums, hazardous materials, heavy machinery, and many other potentially dangerous conditions, procedures are necessary. The requirement to integrate safety into such an operation is paramount toward protecting the community, operating personnel, equipment, and the environment. **LaRC's cornerstone strategy to achieve the required level of safety is the Interlock Philosophy.** The philosophy is enunciated in the following paragraphs:

a. A credible single order failure that can jeopardize personnel or major equipment requires an interlock or protective device to prevent its occurrence.

b. The safety interlock or protective device must be independent of the failure mode and cannot be compromised by occurrence of the credible single order failure.

c. When an independent safety interlock or device cannot be provided due to the utilization of a common component or path, then an independent component and/or path may be necessary (for example, hardwired backup of a software safety interlock or device).

d. The safety interlock or device, unless it is verified automatically during startup (as a permissive), should be periodically verified for proper operation. Period of performance will be established by the safety analysis and specified in the SAR.

e. Safety interlocks and devices, either software or hardware, must be under configuration control at the project level both before and during shakedown. Commencing at the Operational Readiness Review (ORR), these safety interlocks and devices will come under LaRC configuration management in accordance with Chapter 4 of this handbook. At no time will program changes be made while the facility is on line. Forcing of safety interlocks or devices during facility operation (temporary changes to complete a run or troubleshoot a problem) must be in accordance with an approved procedure and have the permission of the FSH or a designated alternate.

f. Failures of catastrophic proportions will be identified by the facility safety analysis and redundant safety interlocks or devices provided. Each situation will be assessed individually in the safety analysis as these potential failures are identified.

Protective measures will be established by the Safety Manager to assure consistency throughout the Center.

### 2.4.2 Techniques

The above philosophy must be pursued regardless of the type of process control or complexity of the research facility. Several techniques are used to achieve these aims, yet permit the necessary research to be accomplished. These techniques are discussed in the following paragraphs, in order of effectiveness, beginning with the most effective.

a. **Design**. The first line of safety is in the initial design of a research facility. Safety and interlock policies must be of equal and simultaneous consideration with research aims in the initial design phase of a facility. It is at this point that the best, and the most cost effective, safeguards can be incorporated into the system.

b. **Engineered Safety Features**. Once a facility is constructed, additional safety margins can best be attained by ad hoc, engineered safety features. Such devices become an integral, permanent part of the facility and its routine operation. Like design features above, they are most likely passive in nature and require no special action to cause them to be effective.

c. **Safety Devices**. Adjunct devices, which are provided for operating personnel, can also enhance safety. Such devices (protective goggles, hard hats, safety bars, and so forth) are effective; however, they require a conscious act on the part of the operator to become useful. Although they may appear cost effective, their effectiveness is moot if they are not employed.

d. **Warning Devices**. Visual and audible means to alert personnel to hazards are also very economical. They are not, however, and should never be considered as barriers. Many of the techniques in the previous paragraphs are barriers. The term barriers implies that such devices **prevent** the occurrence of Undesired Events. Warning devices are effective only when personnel are aware of them in sufficient time to react; and do, in fact, react.

e. **Procedures/Training**. The introduction of the human element into a perfectly designed and controlled hardware system brings with it a potential for unexpected results. The only way to ensure that the occurrences of these operator errors are minimized is through the use of a thorough training program and the use of properly written, verified, and controlled SOP's. If operator training and procedure compliance are to be completely effective in lowering the probability of an Undesired Event to an acceptable level, they must be coupled with some, if not all, of the abatement techniques listed in paragraphs 2.4.2a through 2.4.2d above.

Chapter 3

# SYSTEM SAFETY ANALYSIS UPGRADE

## 3.1 PROGRAM SUMMARY

System Safety Analyses have been performed at a number of LaRC facilities as part of the LaRC Safety Program. These analyses provided information on operational risks in the facilities and are the foundations of the SAR's, SOP's, and Checklists now in existence. Since these initial System Safety Analyses were completed, many have been **upgraded** into a format which provides greater definition in the area of assessment of the risks involved. These **upgrades** were accomplished in an attempt to apply the latest risk assessment techniques and safety philosophy to the process. Since many of the earlier versions still exist, paragraphs 3.1.1 and 3.1.2 below are provided to give insight into their meaning. Paragraph 3.1.3 below describes the current approach.

### 3.1.1 The Initial Convention

The **Initial Convention** used in the assessment of risks was a straight-forward, one-dimensional, rank-ordering of the risks under which any one of six Risk Assessment Classification ratings could be assigned to any one Effect of any one Undesired Event. The Risk Assessment Classifications in the initial convention were:

a. I--Possible serious or fatal injury to the public or to test subjects.

b. II--Possible serious or fatal injury to test facility personnel.

c. III--Possible damage to major equipment.

d. IV--Terminated or delayed operations.

e. V--Nuisance failure.

f. N/A--Nonapplicable.

That Risk Assessment Classification convention still exists in many of the SAR's. Those SAR's are still valid; but, will be the subject of an **upgrade** action in the future. The severity of the classifications under this convention can best be understood by considering that **all assessments of I, II, or III should be of concern in the daily operation of the facility and action should be underway to reduce them to IV, V, or N/A.**

### 3.1.2 The Interim Convention

Also still in existence at some facilities is an **Interim Convention** which was the first attempt to achieve a more meaningful approach to Facility System Safety Analyses. This was the first use of a two-dimensional matrix in which **Severity Categories** (Categories I-IV) **and Probability of Occurrence Levels** (Levels A-D were used to achieve a basic Risk Assessment Code (RAC) of 1, 2, or 3. It was during this period that these basic RAC levels were established. The two-dimensional matrix used in this **Interim Convention** is shown in **Figure 3-1, "Interim Risk Assessment Matrix." A RAC** level was determined by establishing the **Severity Category** through application of the stated definitions of each Undesired Event situation; then, determining the **Probability of Occurrence Level** by applying other definitions which are based upon the facility's physical and procedural status. Those assessments falling into the three (black) blocks in the extreme upper left corner of the matrix were considered to be the most severe (RAC 1). As with the **Initial Convention**, SAR's in the **Interim Convention** format are still valid. They, too, will be the subject of a Safety Office **upgrade** action as time permits.

### 3.1.3 The Current Convention

**Figure 3-2, "Current Risk Assessment Matrix,"** shows the most recent approach used by Safety Engineers to **upgrade existing SAR's**. This approach would also be used to **create a new SAR**. The basic RAC levels (1, 2, and 3) remain the same as developed in the **Interim Convention**, as does the method used to determine them; however, the black area encompassing the "most severe" category (**RAC** 1) has been expanded to six blocks, the definitions of the **Severity Categories** have been further refined, and the definition of Probability of Occurrence Level D has been expanded. **RAC's** are divided into these three groups based on the class of deficiency (see NHB 1700.1(V1-A), "Basic Safety Manual"). The method for developing a SAR under this convention is presented, in detail, in Chapter 2, paragraph 2.3.2, "Safety Analysis Reports."

**HAZARD SEVERITY**

The Hazard Severity Category provides a relative measure of the worst possible consequences resulting from personnel error, environmental conditions, design inadequacies, procedural deficiencies, subsystem or component failure or malfunction as follows

**CATEGORY I · CATASTROPHIC**

May cause death, system loss, or major equipment loss

**CATEGORY II · CRITICAL**

May cause severe injury, severe occupational illness, major system damage, or major equipment damage

**CATEGORY III · MARGINAL**

May cause minor injury, minor occupational illness, minor system damage, or minor equipment damage

**CATEGORY IV · NEGLIGIBLE**

Will not result in injury, occupational illness, system damage, or equipment damage

**HAZARD PROBABILITY**

The probability that a hazard will occur during the planned life expectancy of the system. The probability level is quantitative based on engineering judgment with appropriate guidelines as follows

**LEVEL A · FREQUENT**

Level assigned when neither safety features nor approved procedures exist to prevent the undesired event from occurring

**LEVEL B · OCCASIONAL**

Level assigned when safety features do not exist to prevent the undesired event from occurring, but the use of approved procedures should prevent the undesired event from occurring

**LEVEL C · POSSIBLE**

Level assigned when approved procedures do not exist to prevent the undesired event from occurring, but existing safety features should prevent the undesired event from occurring

**LEVEL D · REMOTE**

Level assigned when both safety features and approved procedures exist which should prevent the undesired event from occurring

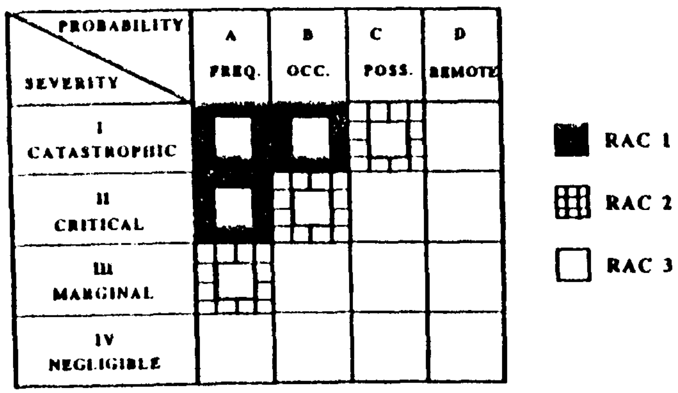



Figure 3-1. Interim Risk Assessment Matrix.

**HAZARD SEVERITY**

The Hazard Severity Category provides a relative measure of the worst possible consequences resulting from personnel error, environmental conditions, design inadequacies, procedural deficiencies, and subsystem or component failure/malfunction, with no consideration being given to abatement techniques

**CATEGORY I · CATASTROPHIC**

May cause death, permanent disability, hospitalization of five or more people, and or system or equipment damage in excess of $250,000 (Type A or B mishap)

**CATEGORY II · CRITICAL**

May cause lost time injury or illness, and or system/equipment damage between $25,000 and $250,000 (Type C mishap)

**CATEGORY III · MARGINAL**

May cause minor injury or illness, or system/equipment damage between $500 and $25,000 (Reportable incident)

**CATEGORY IV · NEGLIGIBLE**

Will not result in injury, occupational illness, or system/equipment damage greater than $500 (Nonreportable incident)

**HAZARD PROBABILITY**

The probability that a hazard will occur during the planned life expectancy of the system. The probability level is quantitative based on engineering judgment with appropriate guidelines as follows

**LEVEL A · FREQUENT**

Level assigned when neither a safety feature nor approved procedures exist to prevent the undesired event from occurring

**LEVEL B · OCCASIONAL**

Level assigned when a safety feature does not exist to prevent the undesired event from occurring, but the use of approved procedures should prevent the undesired event from occurring

**LEVEL C · POSSIBLE**

Level assigned when approved procedures do not exist to prevent the undesired event from occurring, but an existing safety feature should prevent the undesired event from occurring

**LEVEL D · REMOTE**

Level assigned when both a safety feature and approved procedures, or two independent safety features exist which collectively, should prevent the undesired event from occurring

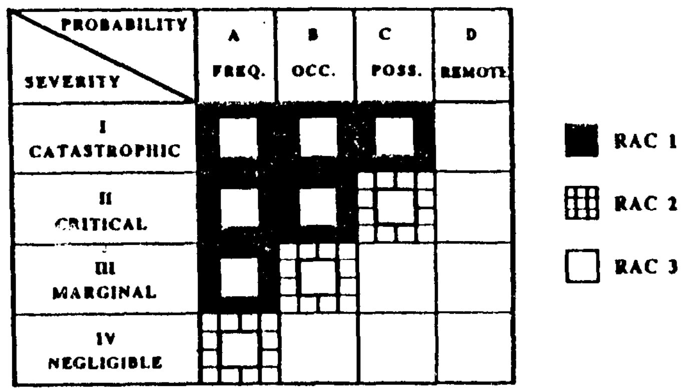



Figure 3-2.- Current Risk Assessment Matrix.

Chapter 4

# FACILITY CONFIGURATION MANAGEMENT (CM) PROGRAM

## 4.1 PROGRAM SUMMARY

The LaRC **Facility Configuration Management (CM) Program** covers 60 research facilities (referred to as Effort Codes (EC's) in the context of CM). They are listed in Chapter 1, Figure 1-1, "Effort Code Summary." These EC's represent 70 research activities. CM implies the **control and continuous updating of documents** listed in the FBL and includes continuous systems safety analysis to assess the impact of change. It is important that any change to facility hardware and/or procedures be processed through this **Change Control System**. A support contractor provides continuous update of the documents for each facility in the CM Program. These documents include:

a. **Safety Analysis Reports (SAR's)** in which hazards and potential undesired events have been identified and the methods for their control have been analyzed to assure that the system does not expose personnel or equipment to unacceptable risks due to credible single point failure.

b. **Standard Operating Procedures (SOP's)/Checklists** in which detailed operation sequences are provided to safely operate the facilities.

c. **Configuration Controlled Document (CCD) engineering drawings** as listed in the FBL.

d. **Pressure Systems Documents** in which is recorded the database generated during the Inservice Inspection/Recertification effort. (NOTE: The Pressure Systems Configuration Management Program is now a separate, distinct entity from the Facility CM Program (and supporting documents). However, as the program matures, it is envisioned that the Pressure System Documents will become a part of the Facility CM Program. See Chapter 5 for a description of the Pressure System Configuration Management Program.)

## 4.2 CHANGE CONTROL

### 4.2.1 General

Basic to any change control in a CM Program is the notification of the change to the affected parties, verification that no protective measures have been degraded or defeated, and that no new hazards have been introduced. These requirements are satisfied at NASA LaRC through the use of either of two forms:

a. NASA Langley Form 127, "Change Notification Sheet (CNS)." (See Figure 4-1.)

## CHANGE NOTIFICATION SHEET

| FACILITY NUMBER | ORIGINATOR | EXTENSION | DATE |
|---|---|---|---|
| FACILITY NAME | | | EFFORT CODE |
| DESCRIPTION OF CHANGE | | | |

**SAMPLE**

**FACILITY BASELINE LIST (FBL) DOCUMENTS AFFECTED:**

| DOCUMENT NUMBER | CURRENT REVISION | TITLE | Maintained | |
|---|---|---|---|---|
| | | | CCD | SFD |
| | | | | |

### APPROVALS

| HEAD, FACILITY ASSURANCE SECTION, SSORD | DATE | FACILITY COORDINATOR | DATE |
|---|---|---|---|
| FACILITIES CONFIGURATION COORDINATOR | DATE | FACILITY SAFETY HEAD | DATE |

| DOES THIS CHANGE AFFECT SAFETY? ☐ YES ☐ NO | CHANGE VERIFIED | CNS INCORPORATED | CHANGE NUMBER |
|---|---|---|---|
| CRITICAL ITEMS LIST AFFECTED? ☐ YES ☐ NO | CM CONTRACTOR DATE | CM CONTRACTOR DATE | SHEET OF |

NASA Langley Form 127 (Rev. Jan. 1992) Previous editions may be used Prescribing Document: LHB 1740.4

Figure 4-1.- Change Notification Sheet (CNS).

b. NASA Langley Form 184, "Problem/Failure Report (PFR)." (See Figure 4-2.)

The CNS and PFR, when required, will be processed in accordance with the directions in Figure 4-3, "Change Control Flow Chart." The Facilities Configuration Coordinator (FCC) and the Head, FAS, SSQRD, must approve the CNS prior to any hardware changes which affect any CCD document in any NASA LaRC facility which is covered under the CM Program. A safety and/or third party review will be conducted for all modifications except those that are strictly administrative in nature. Prior to change implementation, all planned configuration modifications will be reviewed, concurred in, and approved by the Head, FAS, SSQRD, the FCC, and in some cases, also the Facility Engineer. After the modification has been completed, the CM contractor will update the affected documents (drawings, procedures, checklists, and/or SAR's) in accordance with submitted red-lines and analyses, and make distribution of the new documentation to all interested parties.

### 4.2.2 Methods of Change

Modifications to facilities at NASA LaRC under the CM Program may be initiated by any one of four methods. The method selected depends upon the complexity and magnitude of the anticipated change. These four methods are:

a. **Administrative Change.** Facility modifications which are simply administrative in nature and do not affect safety may be implemented without a CNS, PFR, or other approval. An example of such changes is the replacement of a mechanical or electrical component with a like device (valve, meter, and so forth).

b. **Change Requiring LaRC Facility Engineer Review.** Facility changes resulting from a problem or failure that does not affect FBL documents should be reported and reviewed via NASA Langley Form 184. (See LHB 1740.2, "Facility Safety Requirements.")

c. **Minor Change not Requiring Design Review.** For those facility modifications affecting FBL documents and not requiring the Design Review process, a CNS is initiated (normally by the FC) and submitted, with red-lined documents supporting the change, to the Head, FAS, SSQRD, and FCC for approval. Detailed procedures documenting the fabrication and nondestructive examination processes for modifications of Critical Items will be provided by FENGD. The final red-lined "as built" documents and field verified drawings are submitted to the CM contractor for review and document update.

**PROBLEM/FAILURE REPORT**

**See Instructions on Reverse**

SERIAL NUMBER

**PART I - EMPLOYEE**

FACILITY NUMBER

FACILITY NAME

DATE PROBLEM/FAILURE OCCURRED

SYSTEM/COMPONENT IDENTIFICATION (Include Inventory No., Model No., Serial No., etc.)

PROBLEM/FAILURE DESCRIPTION AND PROBABLE CAUSE

**SAMPLE**

ORIGINATED BY (Employee Name)

DATE

**PART II - ACTION BY FACILITY COORDINATOR AND FACILITY SAFETY HEAD**

DISPOSITION AND RATIONALE

CORRECTIVE ACTION (Complete as applicable)

☐ WORK ORDER, NO. ______

☐ FACILITY ENGINEERING REVIEW (FER)

☐ CHANGE NOTIFICATION SHEET, NO. ______

☐ SOFTWARE CHANGE

ACTION ASSIGNED TO

DATE ASSIGNED

FACILITY COORDINATOR (Signature)

DATE

FACILITY SAFETY HEAD CONCURRENCE (Signature)

DATE

**PART III - VERIFICATION/CLOSURE**

DESCRIPTION OF CORRECTIVE ACTION IMPLEMENTED

ACTION VERIFIED BY (Signature)

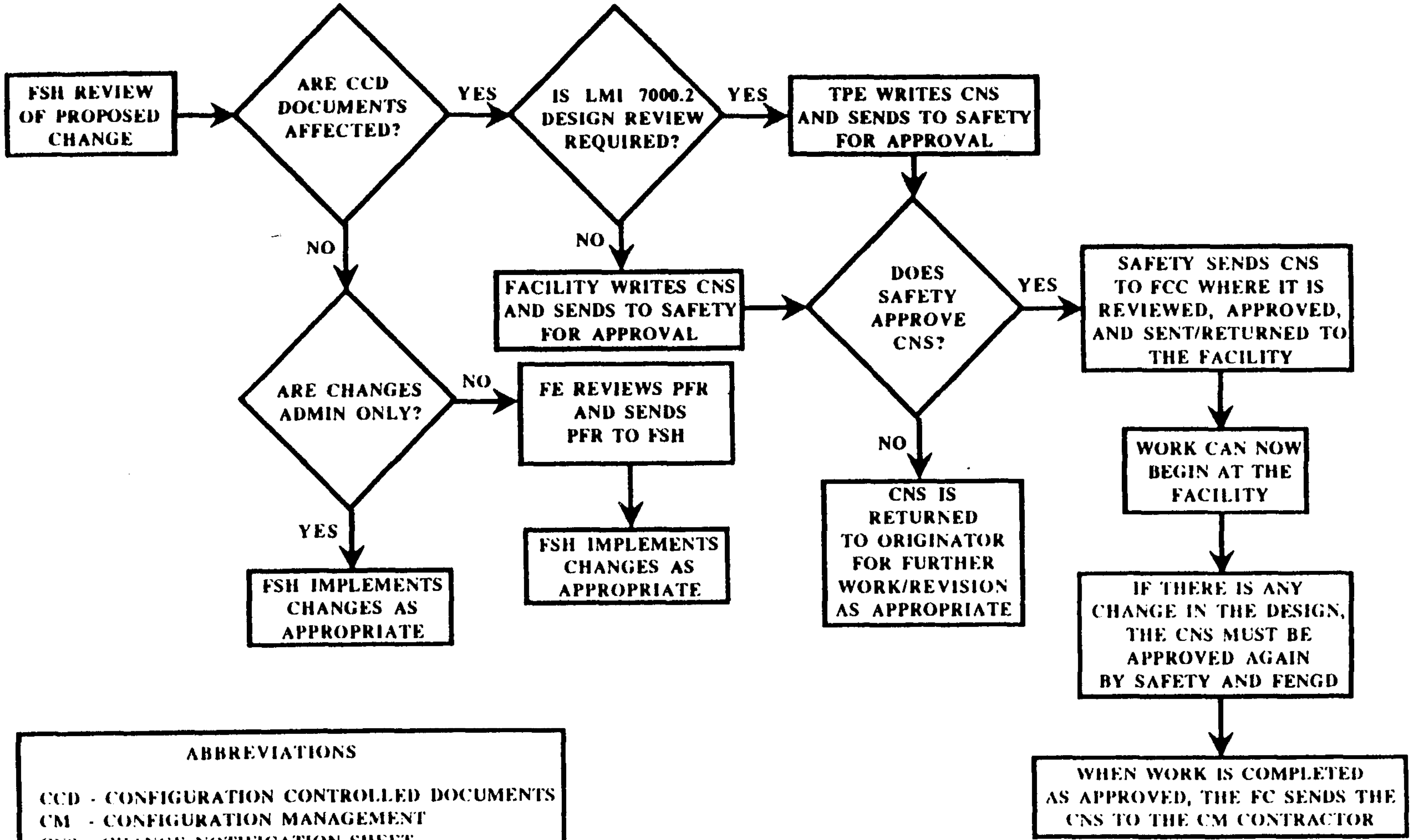
DATE VERIFIED

ACCEPTED BY (Facility Coordinator Signature & Date)

CONCURRED BY (Facility Safety Head Signature & Date)

NASA Langley Form 184 (Rev. Jan. 1992) Previous editions may be used Prescribing Documents LHB 1740.2 and 1740.4

Figure 4-2.- Problem/Failure Report (PFR).




**ABBREVIATIONS**

CCD - CONFIGURATION CONTROLLED DOCUMENTS
CM - CONFIGURATION MANAGEMENT
CNS - CHANGE NOTIFICATION SHEET
FC - FACILITY COORDINATOR
FCC - FACILITIES CONFIGURATION COORDINATOR
FE - LaRC FACILITY ENGINEER
FENGD- FACILITIES ENGINEERING DIVISION
FSH - FACILITY SAFETY HEAD
PFR - PROBLEM/FAILURE REPORT
TPE - TECHNICAL PROJECT ENGINEER

Figure 4-3. Change Control Flow Chart.

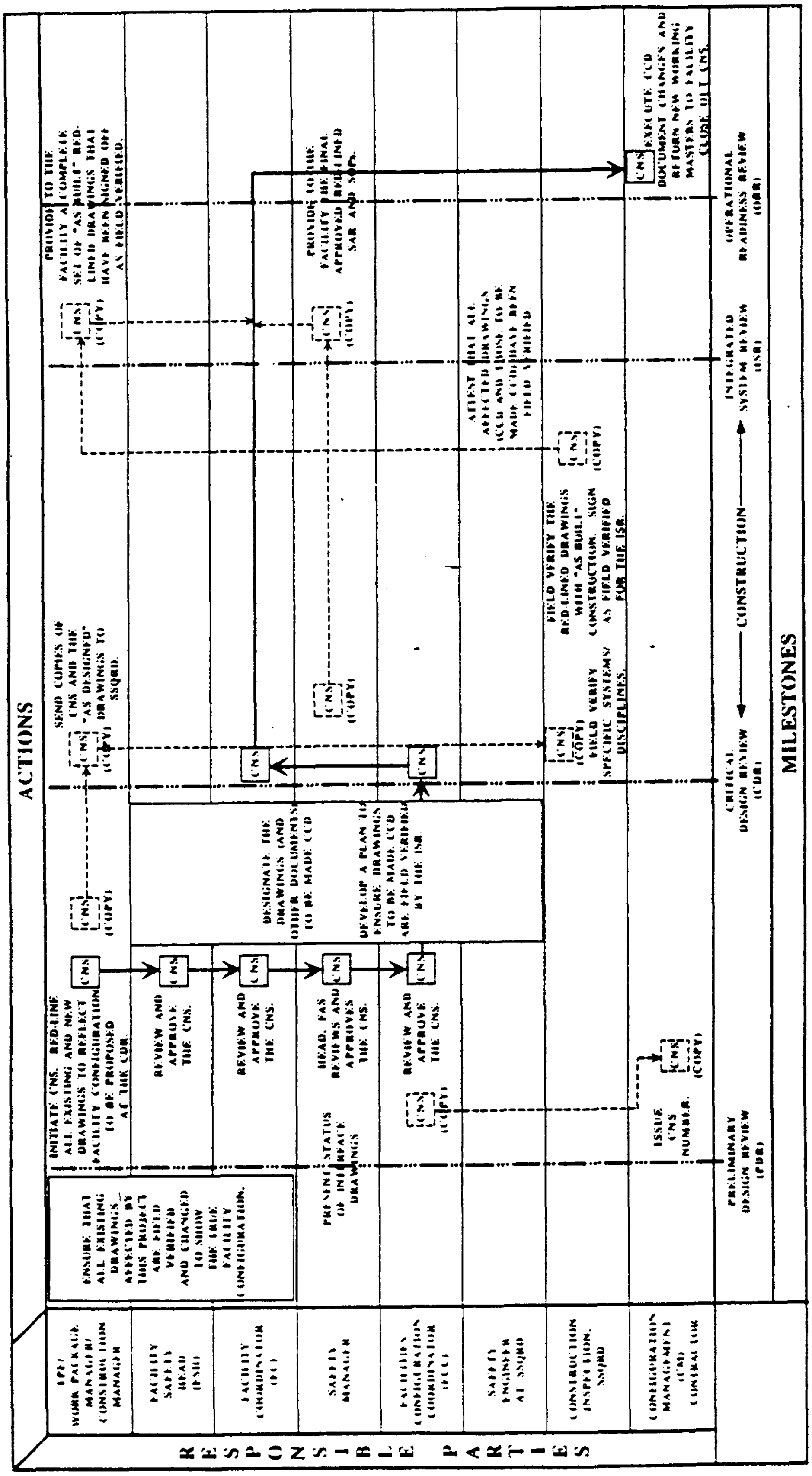



Figure 4-4.- Change Control by Design Review Process

# PRESSURE SYSTEMS CONFIGURATION MANAGEMENT (PSCM)

## 5.1 PROGRAM SUMMARY

Pressure Systems Configuration Management (PSCM) uses the databases generated during Inservice Inspections to produce Configuration Controlled Documents (CCD's) for each system analyzed and documented. These databases are comprised of recertification status sheets (component listings) and computer-aided design (CAD)-produced isometric drawings of high-energy systems. New high-energy systems installed in facilities which are already in the PSCM Program will be added to the program. The resulting CCD's and subsequent changes thereto shall be approved and maintained in accordance with Chapter 4 of this handbook. Engineering and research facility personnel are required to report proposed changes using NASA Langley Form 127, "Change Notification Sheet (CNS)." A Safety and/or third-party engineering review will be conducted for all changes affecting the database. After a change has been approved, and the hardware work has been completed, the CM contractor will field check the changes and update the affected CM documents. All changes to be incorporated in these Pressure Systems Documents (PSD's) will be appropriately red-lined in coordination with engineering and facility personnel, and Pressure Systems will be an agenda item at the annual CM meetings when appropriate. PSD's are useful to engineering and research facility personnel in preparing design changes and during maintenance, repairs, and system inspection. Also, they will be the primary documents used to facilitate future Recertification efforts. High energy systems for the various LaRC facilities will be incorporated into the PSCM Program in order of criticality as resources permit. (See NMI 1710.3, "Design, Inspection, and Certification of Pressure Vessels and Pressurized Systems," for more details.)

## 5.2 PRODUCTS

The products of this program are CCD's called PSD's. Each document consists of:

a. Title Page--Identifies the document as a PSD, gives the facility number and name (if relevant), the system name and designation, and the PSCM document number.

b. PSCM Revision Record--Reflects the approval of the initial issue and all subsequent changes.

c. List of Page Revisions--Lists every page in the document and the current revision letter of each page.

d. Table of Contents.

e. Introduction--Discusses the development, purpose, and uses of PSCM.

f. Definition of Symbols.

g. Key to Recertification Sheets (Component Inventories).

h. System Description.

i. CAD drawing followed by the Recertification Status Sheets.

j. Footnotes.

k. Document Reference Sheet.

# SOFTWARE CONFIGURATION MANAGEMENT

## 6.1 GENERAL

The introduction of **Automated Control Systems** into NASA LaRC research facilities has generated the need for configuration control of the resulting software at these facilities A **Software Configuration Management (SWCM) Program** to provide regulatory guidance for this documentation is being developed for implementation.

## 6.2 PROGRAM OVERVIEW

As the SWCM Program is implemented in a facility, coordination is required in order to ensure that the software brought under configuration control retains its quality over time. Research facilities having Automated Control Systems will initially have their existing software "**baselined.**" This will, in effect, formalize the existing software as a specific **VERSION** (probably Version 1.0). Subsequent changes must be closely controlled and approved by a **Facility Software Change Control Panel** (FSCCP). Both the initial software packages, and subsequent changes to be reviewed and approved by this panel, will be initiated by the Facility Safety Head (FSH) of the affected research facility by use of a **Software Change Request** (SCR). The FSCCP members will normally include, but may not be limited to, the FSH, the Facility Coordinator (FC), an SSQRD representative, and a FENGD representative (usually the **Facility Automation Engineer** (FAE)).

Upon approval by the FSCCP, the change will be implemented by using the existing CNS process (see Chapter 4, paragraph 4.2.2c) in the established CM Program. The approved change will be made to a copy of the existing (current) Version of the software by appropriate software maintenance personnel. Once the change is made, tested, and verified, it will be subjected to an **Independent Validation and Verification** (IVV). Upon successful completion of the IVV process, the new Version will be established and implemented. This new Version (for example, Version 1.1) will become the active one and the old Version (for example, Version 1.0) will be retained in archive for possible future reference or reimplementation, if necessary. In this regard, up to three past Versions will be maintained in archive to support the current Version.

# LABORATORY RISK EVALUATION PROGRAM (LREP)

## 7.1 PROGRAM SUMMARY

The Laboratory Risk Evaluation Program (LREP) program objectives are to:

a. Establish a separate Configuration Management (CM) Program for Laboratories at NASA LaRC which are not currently under the existing CM Program, nor are they covered under Safety Permit.

b. Increase safety awareness at the operator level at those facilities.

c. Enhance the capability of SSQRD in monitoring the safety aspects of Laboratory operations and assisting in the resolution of unsafe practices.

Over 120 laboratories have been identified as candidates for this program. The LREP will be implemented for each of these laboratories in order of criticality as funding is obtained.

## 7.2 PRODUCTS

The products of this program are Risk Evaluations and Operating Procedures for each of the identified laboratories. These documents become Configuration Controlled Documents (CCD's) and are established as a separate CM Program. As in the existing CM Program, laboratory management personnel shall take the steps necessary to correct any RAC 1 and/or RAC 2 Risk Assessments revealed in the documented Risk Evaluations (see Chapter 2, paragraph 2.3.2.5.3a and b).

### 7.2.1 Risk Evaluations (RE's)

The term Risk Evaluation was established to identify the Safety Analysis efforts associated with the LREP directive. It was intended to differentiate clearly between the LREP analysis and the full-scale Safety Analysis Report (SAR) normally associated with the existing CM Program. The Risk Evaluations, although in a similar format, are not the product of a full-scale Hazard Control Analysis (HCA). They also do not reflect the detailed analysis of electrical and mechanical engineering drawings, the confirmation of interlocks, or other efforts normally included in the conduct of a SAR. Risk Evaluations are subjective analyses of the effectiveness of the operating procedures relative to safety considerations. The evaluations are made based on the data from manufacturers' handbooks, discussions with operator and maintenance personnel, visual inspections, maintenance factors, and a comparative analysis of existing procedures. A Risk Evaluation consists of:

a. **Title Page**--Identifies the document as an LREP product, gives the name of the Laboratory, the unique identifying number, and the facility number in which the Laboratory is located. (The unique identifying number is a combination of the facility number and the order in which the Risk Evaluations were done in that facility; that is 1148-1, 1148-2, and so forth).

b. **LREP Revision Record**--Reflects the approval signatures for the initial issue and all Risk Evaluation changes at the direction of the approving authority.

c. **List of Page Revisions**--Enumerates every page in the document and the current revision letter of each page.

d. **Table of Contents.**

e. **Introduction**--Provides the purpose and philosophy of the analysis and explains the RAC logic.

f. **Laboratory Description**--Gives a brief overview of the Laboratory, lists major capabilities, and discusses the nature of research which can be conducted. This section also includes a Facility Block Diagram of the Laboratory being evaluated.

g. **Risk Evaluation**--Provides the complete assessment of the Laboratory's operational environment. It includes General Observations and General Recommendations which address the existing conditions in a broad fashion. More specific hazards are addressed in the following section, "Tabular Summary."

h. **Tabular Summary**--Column 1 enumerates each **Identified Hazard**. In the second column, marked "**Risk Evaluation**," the analyst describes the Undesired Event, the potential causes and effects, what is presently in place to prevent its occurrence, and what other safety devices and/or procedures might further preclude the event. Following this, the analyst assigns a **Hazard Level** (which is derived from the standard Risk Assessment Matrix discussed in Chapter 2, paragraph 2.3.2.5.3), and proposes **Recommendations** which, if implemented, should reduce the assigned Hazard Levels.

### 7.2.2 Standard Operating Procedures (SOP's)

Many of the Laboratories to be evaluated in the LREP effort have procedures in place and are using them in day-to-day operations. In those cases, the existing procedures are simply put into CM format, demonstrated, and returned to the laboratory without significant change. CM-unique techniques such as the [illegible] circling of NOTES, CAUTIONS, and WARNINGS are incorporated to bring the document to standard format. For those laboratories which have no procedures, initial drafts are prepared and demonstrated prior to being incorporated. The format for procedures is identical to that of Risk Evaluations in the first three pages (Title Page, LREP Revision Record, and List of Page Revisions). Page iv is a general opening page addressing the Purpose, Personnel, Support and Safety Services, and Initial Conditions appropriate to the procedures which follow. The procedures may be numbered in one continuous sequence; or, they may be divided into Pre-Operational, Operational, and Post-Operational sections as dictated by the complexity of the Laboratory. The unique identifying number for procedures is derived simply by adding a "P" to the identifying number of the Risk Evaluation which the procedures support (that is, 1148-1P, 1148-2P, and so forth).

## 7.3 LREP CHANGES

Changes to LREP documents are accomplished in a similar manner as those in the Facility CM Program. In lieu of a Change Notification Sheet (CNS), LREP changes are initiated with a NASA Langley Form 129, "Change in Laboratory Equipment/Procedures (CLEP)," (see Figure 7-1). This form is similar to the CNS form. The one major difference is that it does not require the signature of the Facilities Configuration Coordinator (FCC). The final recipient of the CLEP form, and the action attached to it, is the CM contractor. Changes will be made to the original documents and copies of revised pages will be distributed in a manner similar to the existing CM Program.

| CHANGE IN LABORATORY EQUIPMENT/PROCEDURES (CLEP) | | | | |
|---|---|---|---|---|
| FACILITY NUMBER | ORIGINATOR | MAIL STOP | EXTENSION | DATE |
| FACILITY NAME | | | CHANGE NUMBER | SHEET OF |
| DESCRIPTION OF CHANGE | | | | |

SAMPLE

LABORATORY DOCUMENT TO BE AFFECTED

| DOCUMENT NUMBER | CURRENT REVISION | TITLE |
|---|---|---|
| | | |

APPROVALS

| | |
|---|---|
| FACILITY COORDINATOR | DATE |
| FACILITY SAFETY HEAD | DATE |
| HEAD, FACILITY ASSURANCE SECTION, SSORD | DATE |

ACTION

| CHANGE VERIFIED | CLEP INCORPORATED |
|---|---|
| CM CONTRACTOR DATE | CM CONTRACTOR DATE |

NASA Langley Form 129 (Jan. 1992) Prescribing Document LHB 1740

Figure 7-1.- Change in Laboratory Equipment/Procedures (CLEP) Form

# ASBESTOS CONFIGURATION MANAGEMENT

## 8.1 PROGRAM SUMMARY

The Asbestos Configuration Management Program (ACMP) was implemented on October 1, 1991. The program objectives are to:

a. Establish a program that will enable the Center to comply with the myriad of clean air emission regulations established by the Environmental Protection Agency (EPA), the Occupational Safety and Health Administration (OSHA), and the Commonwealth of Virginia.

b. Increase safety awareness and minimize the risk of asbestos exposure to personnel.

c. Institute controls to prevent the release of asbestos fibers, restrict future asbestos use, and develop surveillance and control of known existing asbestos applications in Center facilities.

Over 250 facilities have been identified to participate in this program. Each facility was inspected to identify friable and nonfriable asbestos-containing building material (ACBM) and written inspection reports were provided to the FSH's. These reports are on file at the facilities and are the baseline documents for this program.

## 8.2 PRODUCT

The product of this program is the Asbestos Configuration Controlled Document. The purpose of the document is to permit facility personnel, especially the FSH and FC, proper surveillance and control of existing asbestos applications. If hazards are found to exist, prompt and effective action should be taken to eliminate the hazards. The document consists of:

a. **Title Page**--Identifies the document as the configuration controlled document, identifies the facility by number and name, and identifies the current document revision.

b. **Revision Record**--Reflects the approval signatures for the initial issue and all subsequent changes at the direction of the approving authority.

c. **List of Page Revisions**--Enumerates each page in the document and the current revision letter of each page.

d. **Table of Contents.**

e. **Introduction**--Provides the purpose and philosophy of the document.

f. **Facility Asbestos Summary**--Describes in narrative form the asbestos status of the facility.

g. **Facility Diagram**--Depicts the actual location of positive samples where asbestos is located in the facility.

## 8.3 ASBESTOS CONFIGURATION MANAGEMENT CHANGES

Change to ACMP documentation are accomplished by use of **NASA Langley Form 128, "Asbestos Configuration Management Program (ACMP) Change Sheet"** (see Figure 8-1). The form is initiated by the FC/FSH and approved by the Head, Safety Management Section (SMS), SSQRD, and FENGD. The final recipient of the form, and the action attached to it, is the CM contractor. Changes will be made to the original document and copies of revised pages will be distributed to the FSH, SSQRD, FENGD, and OSD.

# ASBESTOS CONFIGURATION MANAGEMENT PROGRAM (ACMP) CHANGE SHEET

| FACILITY NUMBER | ORIGINATOR | MAIL STOP | EXTENSION | DATE |
|---|---|---|---|---|
| FACILITY NAME | | | CHANGE NUMBER | SHEET OF |

DESCRIPTION OF CHANGE

SAMPLE

## ASBESTOS DOCUMENT TO BE AFFECTED

| DOCUMENT NUMBER | CURRENT REVISION | TITLE |
|---|---|---|
| | | |

## APPROVALS

| | |
|---|---|
| FACILITY COORDINATOR | DATE |
| FACILITY SAFETY HEAD | DATE |
| HEAD, SAFETY MANAGEMENT SECTION, SSCRD | DATE |
| FENGD | DATE |

## ACTION

| CHANGE VERIFIED | CHANGE INCORPORATED |
|---|---|
| CM CONTRACTOR DATE | CM CONTRACTOR DATE |

NASA Langley Form 128 (Jan. 1992) Prescribing Document LHB ...

Figure 8-1.- Asbestos Configuration Management Program (ACMP) Change Sheet Form

# GLOSSARY OF KEY TERMS

The following list defines key terms used in this handbook:

**Asbestos Configuration Management Program (ACMP)**--A program designed to ensure NASA Langley Research Center (LaRC) compliance with asbestos-related EPA, OSHA, and Commonwealth of Virginia clean air emission regulations.

**Asbestos Configuration Management Program (ACMP) Change Sheet**--NASA Langley Form 128 prepared by LaRC personnel and processed by contractor personnel. It is used to record changes in the asbestos status of Center facilities covered under the Asbestos Configuration Management Program.

**Cause**--The stimulus or triggering mechanism/act which precipitates the Undesired Event.

**Change in Laboratory Equipment/Procedures (CLEP)**--NASA Langley Form 129 prepared by LaRC personnel and processed by contractor personnel. It is used to record all changes made to Configuration Controlled Documents (CCD's) in the Laboratory Risk Evaluation Program (LREP).

**Change Notification Sheet (CNS)**--NASA Langley Form 127 prepared by LaRC personnel and processed by contractor personnel. It is used to record all changes to be made to Facility Baseline List (FBL)-listed (CCD) documents.

**Checklist**--An abbreviated set of written instructions for operating a facility. Checklists are derived from Standard Operating Procedures (SOP's) and contain sufficient detail to enable safe operations by the most experienced operator personnel. Checklists are controlled under the CM Program.

**CM Contractor**--The CM Contractor is the Nonpersonal Service Contractor which supports the LaRC Facility Configuration Management Program.

**CM Update**--The process of reviewing and documenting changes on a continuing basis. During this process, the reproducible masters (originals) are revised to incorporate the changes as shown on red-lined documents. Revisions are initiated and tracked by the use of the CNS.

**Configuration Controlled Documents (CCD's)**--Those facility baseline documents that are considered critical to describing how a facility is configured, how it is to be operated, and what risks are associated with its operation. As such, CCD's are revised only through a formal change process under the Configuration Management (CM) Program. Examples of CCD's include, but are not limited to, Safety Analysis Reports (SAR's), SOP's and Checklists, certain Pressure System Documents, and selected Engineering Drawings.

**Configuration Management (CM)**--A discipline which establishes a baseline for facilities, selects technical and administrative documents, and exercises administrative control of all changes to that baseline.

**Critical Items List (CIL)**--A **Critical Item** is any item, the single order failure of which, would likely result in death or damage to equipment/property equal to or greater than $1.0M.

**Effect**--The consequence of an Undesired Event/Accident in terms of equipment damage and/or personnel injury/death.

**Effort Code (EC)** - A preassigned two-digit number that identifies a specific facility or group of facilities in the CM Program. For the life of the facility, all CCD's will bear this number regardless of any facility name changes and/or hardware modifications.

**Facility Assurance Section (FAS)**--A section in the Risk Management Branch, SSQRD, which is assigned primary responsibility for the management and execution of the CM Program and the development of Facility System Safety Analyses. The Head, FAS, SSQRD, approves all CNS's prior to any CM facility hardware changes involving CCD documentation.

**Facility Baseline List (FBL)**--A list of documents which are pertinent to the safety of day-to-day operations, system safety analysis, and planning for system modifications of a facility under the CM Program. These documents are selected for each facility during the initial phase of the System Safety Analysis. All selected facility documentation will be listed in the FBL. The SAR, the SOP's, and the Checklists are included in this listing. All design analyses referenced in the CIL are included in the FBL as Supporting Facility Documents (SFD's). All engineering drawings will be listed in numerical order and all CCD's will be shown with the latest revision. Facility drawings will be further subdivided into the CCD and SFD sections of the FBL.

**Facility Configuration Coordinator (FCC)**--An individual appointed from the Facilities Engineering Division (FENGD) who coordinates FENGD support to the LaRC System Safety Program. The FCC is responsible for the drawing upgrade associated with the System Safety Analysis effort and drawing updates for the CM Program. The FCC also approves all CNS's prior to any CM facility hardware changes which affect CCD documentation.

**Facility Coordinator (FC) (see LMI 1700.2, "Safety Assignments")**--An individual appointed to coordinate the overall day-to-day operations of an LaRC facility. This individual uses assigned facility personnel, and additional support personnel, as available, to accomplish requirements of this handbook.

**Facility Resumé**--A document maintained by each major facility which is operated by the Operations Support Division (OSD). It contains information required for safe operations. Data includes drawings, operating and emergency procedures, operators' certification, and requirements for the control of unique hazards. The FC is responsible for this document.

**Facility Safety Head (FSH) (see LMI 1700.2)**--An appointed individual who is responsible for providing team direction, obtaining required support from knowledgeable research personnel, and approving all Configuration Controlled Documentation affecting the facility.

**Facility System Safety Analysis**--An analysis throughout all phases of the facility's life cycle involving the identification and control of hazards and the assessment of risks in operating that facility.

**Facility Team**--Personnel assigned to a particular LaRC facility during the initial Systems Safety Analysis or the Upgrade effort. The team is composed of the FSH, FC, FCC, Safety Manager, Safety Engineer assigned to the System Safety effort, and the CM Contractor when needed.

**Field Verified (or Field Verification)**--The process by which the accuracy of a CCD or any other drawing is verified. That accuracy is attested to by affixing a "Field Verified" statement, signed by the person doing the verification, and signed and dated by the Project Engineer, FSH, or other responsible person.

**Hazard**--A condition which has the potential to result in damage to equipment and/or personnel injury/death.

**Laboratory Risk Evaluation Program (LREP)**--A program designed to provide Risk Evaluations (RE's) and SOP's to selected laboratories at LaRC which were not previously in the CM Program and not covered with a Safety Permit.

**LaRC Facility Engineer (FE)**--The engineer assigned by FENGD to review, provide recommendations, and approve research facility repairs and/or work.

**Pressure Systems Configuration Management (PSCM)**--A program to continuously update the Inservice Inspection/Recertification effort. The PSCM contractor establishes an accurate database for high-pressure systems, publishes a Pressure Systems Document on each system inspected, and maintains that document through the existing CM Program.

**Problem/Failure Report (PFR)**--NASA Langley Form 184 which reports on the inability of a system, subsystem, component, part, or material to perform in accordance with specifications, functional test, or operational procedure requirements or expectations. (See LHB 1740.2, "Facility Safety Requirements.")

**Red-Lining**--The process of identifying changes on facility documentation. Deletions to be made are lined through with red markings; additions are shown in green, or in black with yellow highlighting. Red-lining of drawings may indicate proposed changes, or changes to show the "as is" condition.

**Research Facility (Facility)**--A ground-based apparatus or equipment directly associated with research operations, and sufficiently complex or hazardous to warrant special safety analysis and control.

**Risk Evaluation (RE)**--A limited Safety Analysis done under the authority of the Laboratory Risk Evaluation Program (LREP). It is not a full-scale Safety Analysis Report (SAR).

**Safety Analysis Report (SAR)**--A report under the control of the CM Program which documents the formal Facility System Safety Analysis of a particular research facility.

**Safety Engineer**--A representative of the Facility Assurance Section (FAS), Risk Management Branch (RMB), Systems Safety, Quality and Reliability Division (SSQRD), who performs an initial Facility System Safety Analysis, and/or an Upgrade of an existing one, and supports the CM activity for a particular facility.

**Safety Management Section**--A section in the Risk Management Branch, SSQRD, which is assigned primary responsibility for the Center's Institutional Environmental Health Program.

**Safety Manager**--The Branch Head, Risk Management Branch, SSQRD. This individual reviews and approves all System Safety Analyses and reviews all changes to the SAR's, SOP's, and Checklists under the CM Program.

**Single Point Failure**--Those discrete system elements and/or interfaces, the malfunction/failure of which, taken individually, would cause failure of the system.

**Standard Operating Procedures (SOP's)**--Detailed, written, step-by-step instructions to be routinely followed in operating a facility. SOP's contain all information considered pertinent to safe and efficient operation of the facility. SOP's are the source documents for Operational Checklists and are the basis, in part, for the facility Hazard Control Analysis. SOP's may also be used for training operator personnel. SOP's are under the control of the CM Program.

**Supporting Facility Documents (SFD's)**--Those documents, identified in the SFD section of the FBL which are considered as part of the baseline documentation; but, do not meet the criteria for CCD's. They include design analyses and vendor manuals, maintenance procedures, construction drawings, conduit routing, panel board schedules, change control records, test data, structural inservice inspection plans, and detailed component drawings.

**Technical Project Engineer (TPE)**--The engineer assigned by FENGD to manage repairs, rework, or modifications to an existing research facility or construction of a new facility.

**Undesired Event**--An event (or series of events) which unleashes the potential inherent in a hazard; and, either directly or indirectly, results in damage and/or personnel injury/death.

**Undesired Events List**--A listing in the SAR of system failures/malfunctions derived from the preliminary hazard analysis which could, if not adequately controlled, result in personnel injury, unacceptable equipment/facility damage, and/or loss of productivity.

**Upgrade**--The process of revising an existing SAR, which was initially published under a now-outdated convention, to reflect the latest in assessment techniques and safety philosophy.

**Working Masters**--Copies of the latest-revision CCD's (SAR's, SOP's, drawings, and so forth) which are stamped "**WORKING MASTER**" in red and kept at the facility. These documents are prepared by and provided to the facility by the CM contractor. WORKING MASTER drawings also show, in the CCD block, which facilities (by Effort Code number) consider the drawing to be critical to their operation.

ATTACHMENT 13

NASA LANGLEY MANAGEMENT INSTRUCTION (LMI) 7000.2, REVIEW PROGRAM FOR LANGLEY RESEARCH CENTER (LaRC) CONSTRUCTION OF FACILITIES (CoF) PROJECTS
(JUNE 25, 1991)

NASA
National Aeronautics and
Space Administration

Langley Research Center
# MANAGEMENT MANUAL

LMI 7000.2

June 25, 1991

**SUBJECT:** Review Program for Langley Research Center (LaRC) Construction of Facilities (CoF) Projects

**SUMMARY**

This instruction sets forth the applicability, criteria, policy, and procedures for review of CoF Projects under Langley Research Center (LaRC) management.

**APPLICABILITY**

This instruction applies to the following CoF projects:

- All Major Discrete Projects.
- Any Minor Program Projects with elements of unusual or potentially high risk.

Selection of those Minor Program Projects to be reviewed under this instruction will be made by the Chief, Facilities Engineering Division (FENGD), with the concurrence of the Deputy Director for Systems Engineering and Operations. The number and format of Design Reviews for all CoF projects not covered by this instruction will be established by the Chief, FENGD.

**CRITERIA**

The criteria stated herein are minimum requirements for a third-party review of the technical and management aspects of LaRC's CoF projects. The requirements of this instruction do not supersede other reviews imposed by NASA Headquarters, or replace the scientific and technical reviews conducted by LaRC organizations or committees such as:

- Institutional Review Board Reviews (see LMI 7100.8).
- The Executive Safety Board and Its Committees' Reviews (see LMI 1700.3).
- Technical Merit and Feasibility Reviews.
- Routine Line Organization Reviews.

**POLICY**

This Center will conduct the following sequential set of reviews for CoF projects covered by this instruction.

1. Conceptual Design Review (CoDR).

2. Preliminary Design Review (PDR).

3. Critical Design Review (CDR).

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**POLICY (Continued)**

4. Integrated System Review (ISR).

5. Operational Readiness Review (ORR).

This policy and set of reviews may be altered by the Director for Systems Engineering and Operations, as appropriate, to meet unique project requirements.

**REVIEW OBJECTIVES**

The primary objective of the above reviews is to enhance the probability of success of LaRC CoF projects. This will be achieved using the cumulative knowledge of a team of engineers and scientists who have been selected for their experience with the particular systems and functions involved. These reviews are advisory in nature and do not relieve the LaRC organization to which the project is assigned of the responsibility for the success of the project.

The reviews will be technically oriented and proper consideration is to be given to constraints operating on the project - particularly those involving primary technical objectives, program costs, and schedules.

**GENERAL REQUIREMENTS**

| Item | Responsibility |
|---|---|
| Special Reviews | The Chairperson of each review or the cognizant LaRC Program Director may also establish other special reviews to supplement the above reviews. |
| Support | LaRC Program Directors are to support the above reviews by furnishing senior personnel experienced in the required technical disciplines as requested. |
| | The Chairperson of each review is to organize each panel and draw support from NASA Headquarters, other Centers, industry, or other Federal agencies when applicable. |
| Scheduling | The Project/Program Manager, or equivalent, is responsible for contacting the designated chairperson to request and set a desired review date that allows sufficient time for orderly preparation. A tentative agenda, with allotted times and a designated Action Item Coordinator, will accompany this request. The Action Item Coordinator will be responsible for administratively tracking and routing all documentation necessary for closure of the review action items. |

**GENERAL REQUIREMENTS (Continued)**

| Item | Responsibility |
|---|---|
| Notification | Notification of a review is initiated by interoffice letter from the review chairperson to appropriate distribution which includes:<br>• Review objectives.<br>• Date, time, and place.<br>• Committee members.<br>• Action Item Coordinator.<br>• Tentative agenda with allotted times. |
| Review Material | All review material is to be distributed by review initiator to all panel members at least 10 days prior to the scheduled review date. |
| Action Items | Issues and questions which cannot be readily addressed at the review shall be documented on SE&O Organizational Form N-330, "Request for Action," (RFA) forms (available from the Systems Safety, Quality and Reliability Division (SSQRD)), and assigned to an appropriate individual for closure. The Review Panel will screen all submitted RFA's at the end of the review for completeness, elimination, or consolidation, as appropriate. The Project/Program Manager, in conjunction with the Design Review Chairperson, will assign action item responsibilities and due dates on the RFA forms. |
| Action Item Closure | Action Item (AI) assignees shall send responses to the AI Coordinator for logging and routing by the specified due date. Closure requires concurrence by the RFA originator and approval by the review chairperson. An information copy of the tentative closure will be sent to all Review Panel members. Closure will become final unless it is challenged by a panel member within 10 working days. A copy of all final accepted closures is to be sent to SSQRD. The cognizant Division Chief of the RFA assignees is responsible for assuring that all action items are closed in a timely manner. |
| Minutes | Minutes of each review, including action items, are to be distributed by the secretary to the Panel members, appropriate Division Chiefs and Program Directors, and the Correspondence and Records Management Section (C&RMS), Management Support Division (MSD), within 10 days of review completion. |

## REVIEW DESCRIPTIONS

| Review Type | Function |
|---|---|
| • **Conceptual Design Review (CoDR)** | |

**Conceptual Design Review (CoDR)**

### Objective (CoDR)

The objective of the CoDR is to assure the adequacy of the conceptual design to meet the functional design requirements and to provide a sound basis for a final design. The CoDR will normally be scheduled at 90 percent completion of the Preliminary Engineering Report (PER) (see NMI 7330.2).

See Attachment A for a sample CoDR agenda.

### Membership

Chairperson: Deputy Director for Systems Engineering and Operations or designated alternate
Secretary: Appointed by the Chairperson
Members: LaRC Safety Manager or designated alternate
Facility Safety Head
Facility Coordinator
Cognizant Research Project Representative

At least five technical representatives from supporting line organizations as deemed appropriate by the Chairperson

**Preliminary Design Review (PDR)**

### Objective (PDR)

The objective of the PDR is to validate the adequacy of the intended final design approaches as related to the facility functional requirements according to applicable policies, design criteria, standards stated in NHB 7320.1, and other applicable National Codes. The PDR will normally be scheduled when the final design is approximately 30 percent complete.

See Attachment B for a sample PDR agenda.

**Membership** - See CoDR.

**REVIEW DESCRIPTIONS (Continued)**

| Review Type | Function |
|---|---|
| • **Critical Design Review (CDR)** | <u>Objective (CDR)</u> |

The objective of the CDR is to validate the facility specification for the procurement and construction of the detailed design. The CDR is to ensure the final design and planning have been reviewed and that sufficient data have been presented according to the applicable policies, design criteria, standards stated in LHB 7320.1, and other applicable National Codes. The CDR will normally be scheduled when the final design is approximately 90 percent complete but prior to the initiation of the acquisition/construction phase.

See Attachment C for a sample CDR agenda.

After the CDR and closure of resulting action items, line management will coordinate detailed drawing and specification reviews. Upon successful completion of these reviews, the responsible Project/Program Manager will provide a written statement to the CDR chairperson with copies to panel members.

<u>Membership</u> - See CoDR

• **Integrated Systems Review (ISR)**

<u>Objective (ISR)</u>

The objective of the ISR is to validate the quality and configuration of the facility, confirm that it is capable of performing properly under expected operational environments, and assess that facility operational objectives will be achieved. The ISR will normally be scheduled when the construction and systems level acceptance testing is approximately complete but prior to initiation of integrated systems testing.

See Attachment D for a sample ISR agenda.

<u>Membership</u>

| | |
|---|---|
| Chairperson: | Deputy Director for Systems Engineering and Operations or designated alternate |
| Secretary: | Appointed by the Chairperson |
| Members: | Division Chief responsible for facility |
| | Chief, SSQRD or designated alternate |
| | Facility Safety Head |



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## REVIEW DESCRIPTIONS

| Review Type | Function |
| --- | --- |
| • **Integrated Systems Review (ISR) (Continued)** | Members: Facility Coordinator<br>Chairperson, Systems Operations Committee (see LMI 1700.3)<br><br>At least five technical personnel selected by the Chairperson, preferably from the previous design review panels<br><br>**Action**<br><br>The Chairperson is to provide a written statement to the cognizant Program Director certifying it is acceptable to initiate system level checkout and test programs. All board members will receive a copy of this written statement. |
| • **Operational Readiness Review (ORR)** | **Objective (ORR)**<br><br>The objective of the ORR is to provide a comprehensive assessment of the facility, equipment, test articles, operational procedures, and staffing to assure the overall readiness and operation of the facility or systems.<br><br>The ORR will normally be scheduled when the integrated system level test program is completed but prior to initial research operation of the facility.<br><br>See Attachment E for a sample ORR agenda.<br><br>**Membership**<br><br>Chairperson: Program Director responsible for facility<br>Secretary: Appointed by the Chairperson<br>Members: Chairperson, ISR<br>Chairperson, Systems Operations Committee (see LMI 1700.3)<br>Chief, SSQRD or designated alternate<br>Facility Safety Head<br>Facility Coordinator<br><br>At least three technical personnel selected by the Chairperson |

## REVIEW DESCRIPTIONS

| Review Type | Function |
|---|---|
| • **Operational Readiness Review (ORR) (Continued)** | <u>Action</u><br><br>After the ORR, the Chairperson, and an appointed committee to include at least three ORR members, will conduct a final "walk through" of the new/modified facility to:<br><br>- Certify that the facility is operational.<br>- List all observed safety and quality assurance deficiencies.<br>- Verify that all prior corrective actions have been incorporated.<br><br>The Chairperson is to provide a written statement to the LaRC Deputy Director certifying that the facility is acceptable and recommending that the facility be declared operational. All panel members will receive a copy of this written statement. |

## REFERENCES

NHB 7320.1, "Facilities Engineering Handbook"

NMI 7330.1, "Delegation of Authority - Approval Authorities for Facility Projects"

NMI 8800.9, "Intergovernmental Review of National Aeronautics and Space Administration Programs and Activities"

NMI 8800.12, "Coordination of Construction, Maintenance, Operations, and Management of NASA Facilities Programs"

NHB 8820.2, "Facility Project Implementation Handbook"

NASA Software Management and Assurance Program (SMAP) Information System Life-Cycle and Documentation Standards Release 4.3"

LMI 1700.1, "Safety Program"

LMI 1700.2, "Safety Assignments"

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National Aeronautics and Space Administration

MANAGEMENT MANUAL



**REFERENCES (Continued)**

LMI 1700.3, "The Executive Safety Board and Its Committees"

LHB 1740.4, "Facility System Safety Analysis and Configuration Management"

**RECISION**

LMI 7000.2, dated May 26, 1981, T.S. 1139.

Paul F. Holloway
Paul F. Holloway
Deputy Director

Attachments A-E

Attachment A to LMI 7000.2

# CONCEPTUAL DESIGN REVIEW (CoDR)
## Sample Agenda

I. INTRODUCTION
- Scope of Review
- Status of Conceptual Design (percent complete, earlier studies, and so forth)
- Agenda

II. PROJECT OVERVIEW
- Research/Programmatic Requirements and Project Justification
- New Capability/Performance Desired
- Project Scope
  - CoF Funded Portion
  - R&D Funded Portion

III. DESIGN REQUIREMENTS/CONSTRAINTS
- Historic Preservation
- Interfaces
- Functional
- Siting
- Special Systems or Equipment
- Safety, Reliability, and Quality Assurance (SR&QA)
- Security
- Utilities
- Design Codes/Criteria
- Operations and Maintenance
- Design Loads/Environment
- Geometric Lines
- Hardware/Software
- Environmental Impact
- Requirement Changes Since Publication of Facility Requirements Document

IV. CONCEPTUAL DESIGN
- Project Description (major elements/components)
- Site Description
- Architectural Concept
- Foundation/Structural/Mechanical/Electrical Concepts and Analyses
- Evaluation of Options
- Operations and Maintenance Considerations
- Design of Special Systems or Equipment
- Needed Additional Studies/Tests/Analyses
- Summary of How Design Tentatively Meets Requirements
- Areas of Design Concern/Uncertainty

V. SAFETY AND QUALITY ASSURANCE
- Facility Energy Source Checklist
- Preliminary Hazards List
- Preliminary Critical Items List (CIL)
- Status of As-Built Reference Interface Drawings
- Special Construction Inspection Requirements
- Design Safety Considerations

VI. COST
- Baseline Estimate for Preliminary Engineering Report (PER) Funding
- Design/Construction Cost Estimates
  - Breakdown of Major Cost Elements
  - Element Cost Ranges/Uncertainties and Potential for Growth
  - Significant Cost Drivers
  - Potential Areas for Descoping or Bid Alternatives
  - Potential Areas for Design - Furnish and Install Procurement
- Overall Cost Assessment and Uncertainties/Concerns

VII. SCHEDULE
- Project Level (with rationale)
- Major Element or Work Package Level
- Schedule Uncertainties/Concerns

VIII. SUMMARY

Attachment B to LMI 7000.2

**PRELIMINARY DESIGN REVIEW (PDR)**
**Sample Agenda**

I. INTRODUCTION
- Scope of Review
- Status of Design
- Status of Action Items
- Agenda

II. PROJECT OVERVIEW
- Project Justification Background
- New Capability/Performance Desired
- Project Scope
  - CoF Funded Portion
  - R&D Funded Portion

III. PROJECT MANAGEMENT
- Work Breakdown Structure
- Management Structure/Organization
- Roles and Responsibilities
- Project Controls and Status Reporting
- Documentation Plans and Status of End Items
  - Management Plan
  - Standard Operating Procedures (SOP)
  - Safety, Reliability, and Quality Assurance (SR&QA) Plan
  - Safety Analysis Report (SAR)
  - Inspection Plan
  - Maintenance and In-Service Inspection Plan/Procedures
  - Design Criteria Document
  - Interface Requirements Document
  - Configuration Control Plan
  - Hazard Analyses and Critical Items List (CIL)
  - CIL Installation Procedures
  - Operational Checkout Plan/Procedures
  - Software Management and Assurance Program (SMAP) Plans
  - Design Analyses

IV. DESIGN REQUIREMENTS/CONSTRAINTS
- System Interfaces
  - Between Work Package
  - With Existing Facility
- Elements of Interface Requirements Document
- Elements of Design Criteria Document
  - Software Requirements List
  - Programmatic Requirements/Objectives List
  - Engineering Requirements List
  - Design Load Environments List



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V. PRELIMINARY DESIGN
- Preliminary Design Concept Drawings
- Block Diagrams and Schematics
- Design Approach and Supporting Analyses
  - Architectural
  - Structural
  - Mechanical
  - Electrical
  - Controls and Associated Software
- Tradeoff Studies
- Areas of Technical Uncertainty/Risk
- Design Verification Test Results/Plans
- Performance Analyses
- Status Summary of Design Compliance with Design Criteria and Interface Requirements Document

VI. SAFETY, RELIABILITY, AND QUALITY ASSURANCE
- Overview of SR&QA Approach During Design/Acquisition/Construction/Checkout
- Systems Safety Features Included in Design (interlocks, stops, and so forth)
- Hazard Analyses Results and Preliminary Critical Item List (CIL)
- Implementation of SR&QA Plan
- Field Verification Status of Interface Drawings to be Referenced in Acquisition Package
- Potential Revisions and Additions to Existing Facilities Baseline List (FBL)
- Areas of Concern or Uncertainty

VII. COST
- Baseline PER Cost Estimate
- Current Cost Estimate and Rationale for any Cost Variations
- Cost Concerns/Uncertainties (design or construction)

VIII. SCHEDULE
- Project Level
- Work Package Level
- Status of Design Tasks Against Plan
- Schedule Concerns/Uncertainties (design or construction)

IX. SUMMARY

Attachment C to LMI 7000.2

**CRITICAL DESIGN REVIEW (CDR)**
**Sample Agenda**

I. INTRODUCTION
- Scope of Review
- Status of Design
- Status of Action Items
- Agenda

II. PROJECT OVERVIEW
- Project Justification Background
- New Capability/Performance Expected
- Project Scope
  - CoF Funded Portion
  - R&D Funded Portion

III. PROJECT MANAGEMENT
- Management Structure/Organization
- Documentation Status
- Overview of Acquisition Plan
- Acquisition Package(s) Status

IV. DESIGN REQUIREMENTS/CONSTRAINTS
- System Interfaces
  - Work Packages
  - Existing Facility
- Elements of Interface Requirements Document
- Elements of Design Criteria Document

V. FINAL DESIGN
- Final Design Concept Drawings
- Block Diagrams and Schematics
- Design Details and Supporting Analyses
  - Architectural/Structural/Mechanical/Electrical
  - Controls and Associated Software
- Performance Analyses
- Maintainability, Repairability, and Operability
- Producibility and Manufacturing Readiness
- Human Engineering
- Mock-ups, Breadboards, and/or Prototype Hardware
- Design Verification Test Results
- Summary of Design Compliance with Elements of Design Criteria and Interface Requirements Documents
- Areas of Technical Uncertainty/Risk

VI. SAFETY, RELIABILITY, AND QUALITY ASSURANCE

- Status of Safety, Reliability, and Quality Assurance (SR&QA) Activities
- Verification Status of Interface Reference Drawings
- Status of Facility Baseline List Drawings
- Independent Reviews of Drawings and Analyses
- Hazard Analyses and Updated Critical Item List (CIL)
- CIL As-Built Assurance Plan
- Systems Safety Features Included in Design
- Overall SR&QA Assessment and Areas of Concern/Uncertainty

VII. COST

- Baseline PER Cost Estimate
- Current Cost Estimate and Rationale for Changes from PDR
- Cost Concerns/Uncertainties

VIII. SCHEDULE

- Project Level
- Work Package Level
- Design Completion and Preparation of Procurement Package
- Procurement Cycle
- Schedule Concerns/Uncertainties

IX. SUMMARY

Attachment D to LMI 7000.2

# INTEGRATED SYSTEMS REVIEW (ISR)
## Sample Agenda

I. INTRODUCTION
- Objective and Scope of Review
- Agenda

II. PROJECT OVERVIEW
- Programmatic Requirements
- Description of Construction Project and Functional Operation of Facility
- Top Level Schedule and Status
- Summary of Prior Reviews of All Types
- Status of Open Action Items from Design Reviews

III. CONSTRUCTION
- Overview and Overall Status of Construction
- Detailed Discussion of Facility Components/Systems/Controls
  - Brief Description of Specifications by Which Item was Procured/Constructed
  - Changes in the CDR Design (including field changes) and the Independent Reviewing Body for Each
  - Summary of all Qualification, Proof, and/or Acceptance Testing Performed and Results
  - Summary of As-Built Compliance with Contractual Requirements
- Status of Construction Contract(s) and Contract Submittals (including as-built drawings)
- Concern, Limitations, and Potential Problem Areas

IV. DOCUMENTATION
- Overall Documentation Required (documentation tree)
  - Design Related
  - Safety, Reliability, and Quality Assurance (SR&QA) Related
  - Construction Related
  - Test Related
  - Management Related
- Status Summary

V. FACILITY SHAKEDOWN
- Overview of Objectives
- Management Structure/Organization, Roles, and Responsibilities
- Operating Personnel Readiness (includes training and certification)
- Field Verification Status of Facility Baseline List (FBL) As-Built Drawings
- Details of Shakedown Plan
  - Tasks
  - Operating Procedures (Standard and Test Unique)
  - Configuration Management Procedures
  - Test Instrumentation and Data Reduction
  - Schedule
- Areas of Concern/Uncertainty

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VI. SAFETY, RELIABILITY, AND QUALITY ASSURANCE

- Overview of Facility Safety Program, Special Studies, and Safety Reviews
- Safety Analysis Report/Operational Hazard Analyses (including Software and Shakedown Unique Configurations and Operations)
- Critical Item List (CIL)
- Critical Interlocks
- Quality Assurance/Inspection Utilized and any Deviations Accepted (general items, critical items, and critical interlocks)
- Status of Open Items from Safety/Hazard Analysis Reviews
- Overall SR&QA Assessment and Areas of Concern/Uncertainty

VII. SUMMARY ASSESSMENT OF READINESS FOR INTEGRATED SYSTEMS TESTING

- Hardware
- Software
- Personnel
- Open Items
- Concerns

# OPERATIONAL READINESS REVIEW (ORR)
## Typical Agenda

I. INTRODUCTION
- Objective and Scope of Review
- Agenda

II. PROJECT OVERVIEW
- Research Requirements
- Project Scope and Status Summary
- Top Level Schedule and Summary
- Status of Open Action Items from Prior Formal Reviews

III. INTEGRATED SYSTEMS TESTING
- Test Results Against Plan
- Verification of Critical Interlocks
- Resolution of Problems/Failures
- Configuration Changes
  - Documentation
  - Hardware
  - Software
- Summary of Overall Project Compliance with Requirements

IV. DOCUMENTATION
- Status of Overall Project Documentation Against Requirements
- Archival Responsibilities and Status

V. OPERATIONS PROCEDURES
- Roles and Responsibilities
- Typical Sequence of Events and Verification of Standard Operating Procedures (SOP)
- Emergency Procedures

VI. SAFETY, RELIABILITY, AND QUALITY ASSURANCE
- Safety Analysis Changes Since ISR
- Safety Compliance Verification
- Personnel Training and Certification
- Quality Assurance and Compliance with Specifications
- Configuration Management
- Open Items

VII. SUMMARY ASSESSMENT OF OPERATIONAL READINESS
- Hardware
- Software
- Personnel
- Procedures/Documentation
- Open Items

ATTACHMENT 14

NASA LANGLEY MANAGEMENT INSTRUCTION (LMI) 7120.1, AERONAUTIC AND SPACE FLIGHT PROJECTS AND EXPERIMENTS REVIEW PROGRAM (OCTOBER 21, 1980)

National Aeronautics and Space Administration

Langley Research Center

# MANAGEMENT MANUAL

LMI 7120.1

October 21, 1980



SUBJECT: Aeronautic and Space Flight Projects and Experiments Review Program

REF: NMI 7121.1, "Planning and Approval of Major Research and Development Projects"
NHB 7121.4, "Guidelines for Project Planning"
LMI 1710.1, "Human Factors Research, Man-Rating Requirements, and Committee Review Procedures"
LHB 7121.1, "Project Management"

SUMMARY

This instruction sets forth the criteria, policy, and procedures for review of aeronautic and space flight projects and experiments under the management of this Center and flight experiments included as a part of a mission managed external to this Center.

CRITERIA

The criteria stated herein are minimum requirements that will permit total visibility by a third-party review committee of the technical and management aspects of Langley Research Center's (LaRC) flight projects and experiments. The requirements of this instruction do not supersede other reviews imposed by NASA Headquarters, other Centers, or other LaRC reviews.

POLICY

This Center will conduct the following sequential set of reviews for flight projects and experiments:

- Design Reviews
  - Conceptual Design Review (CoDR)
  - Preliminary Design Review (PDR)
  - Critical Design Review (CDR)
- Preshipment Readiness Review
- Preflight Review
- Postflight Review

This policy may be altered by the cognizant Program Director to meet unique requirements.

GENERAL

The above reviews are advisory in nature and do not relieve LaRC personnel of the responsibility for the success of the project or mission.

Special Reviews

The Chairperson of each review, or the cognizant Program Director, may also establish other special reviews to supplement the above reviews.

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Support

All LaRC Program Directors are to support the above reviews. They are to furnish senior personnel, experienced in the required technical disciplines, as requested.

The Chairperson of each review shall organize the Committee and draw support from other Centers or Federal Agencies as required.

Review Deviations

Deviations from the review policies established in this instruction may be made only with the approval of the cognizant Program Director.

Review Objectives

The primary objective of the above reviews is to enhance the probability of success of LaRC flight missions. This will be achieved by utilizing the cumulative knowledge and skills of the team of engineers and scientists who have been selected for their experience with particular systems and functions.

The reviews will be technically oriented, however, proper consideration is to be given to operating constraints — particularly those involving primary mission objectives and program costs and schedules.

NASA Headquarters Participation in Reviews

The Project Manager, or equivalent, is to insure that personnel from the appropriate NASA Headquarters Program Office are informed of review date and, to the extent practicable, arrange for reviews to be scheduled to allow NASA Headquarters' participation.

PROCEDURES

Design Reviews

General

There are three levels of design reviews which are to be phased into the project/mission schedule at appropriate times. New designs are to include all three reviews; namely:

- Conceptual Design Review (CoDR) — In some cases this review may be eliminated if the concept has been demonstrated and only minor changes are necessary.
- Preliminary Design Review (PDR)
- Critical Design Review (CDR)

Design Reviews (Continued)

General

- Membership

| | |
|---|---|
| Chairperson: | Assistant Director for Systems Engineering and Operations or designated representative |
| Secretary: | Appointed by the Chairperson |
| Members: | Representative, Systems Safety, Quality and Reliability Office |
| | At least five representatives from supporting line organizations as deemed appropriate by the Chairperson. |

- Reviews

The Project Manager, or equivalent, is responsible for notifying the Chairperson of a review within sufficient time so as to permit an orderly preparation of the review.

- Minutes

Minutes of each review are to be distributed to committee members and appropriate Division Chiefs and Program Directors.

Minutes are to be made a part of project/mission files.

- Action

The Project Manager, or equivalent, is responsible for insuring that appropriate action items, comments, and recommendations resulting from a review, also any open action items, are appropriately discussed at the next review.

FUNCTION

CoDR

The objective of the CoDR is to present the scientific requirements and examine the proposed design approach to accomplish these requirements by examining, completing, and presenting the:

Design Reviews

FUNCTION

CoDR (Continued)

- initial design
- trade-off studies
- alternate configurations
- selection of critical parts
- preliminary analyses
- definition of environments
- interface requirements
- Government Supplied Equipment (GSE)
- project planning
- software approach, etc.

so that the design can be examined at the conceptual level with confidence.

The CoDR will normally be scheduled at a time which will permit assessment as noted above and prior to the start of development testing.

PDR

The objective of the PDR is to examine in detail the baseline project/mission design being planned for manufacture and qualifications, validate the design approaches as related to project/mission requirements, and cover such items as:

- mechanical design layouts
- circuit designs
- design analyses
- performance analyses
- results of development testing
- GSE requirements
- manufacturing and qualification test planning
- status of reliability, quality assurance, and systems safety programs
- status of planning for data retrieval, analysis, and publication

The PDR will normally be scheduled at the completion of the preliminary design and prior to the fabrication of qualification hardware.

CDR

The objective of the CDR is to examine details of the final design and mission, verify the final plans, design, fabrication plans, and flight acceptance test planning as related to project/mission requirements, and cover such items as:

Design Reviews

CDR (Continued)

FUNCTION

- updated final design and analyses
- qualification test and calibration test results
- functional and performance test results
- reliability, quality assurance, and safety programs
- a review of the plans for data retrieval, analysis, and publication

The CDR will normally be scheduled at the completion of the qualification test program.

At the conclusion of the CDR, the review committee should have confidence that they have reviewed the final design and planning, that sufficient data has been presented to demonstrate the design is compatible with the total flight system, and the project/mission will be accomplished within cost and schedule constraints.

Preshipment Readiness Review

The objective of the Preshipment Readiness Review is to inspect flight hardware, make final review of project/mission plans, concentrate on results of acceptance testing, and cover such items as:

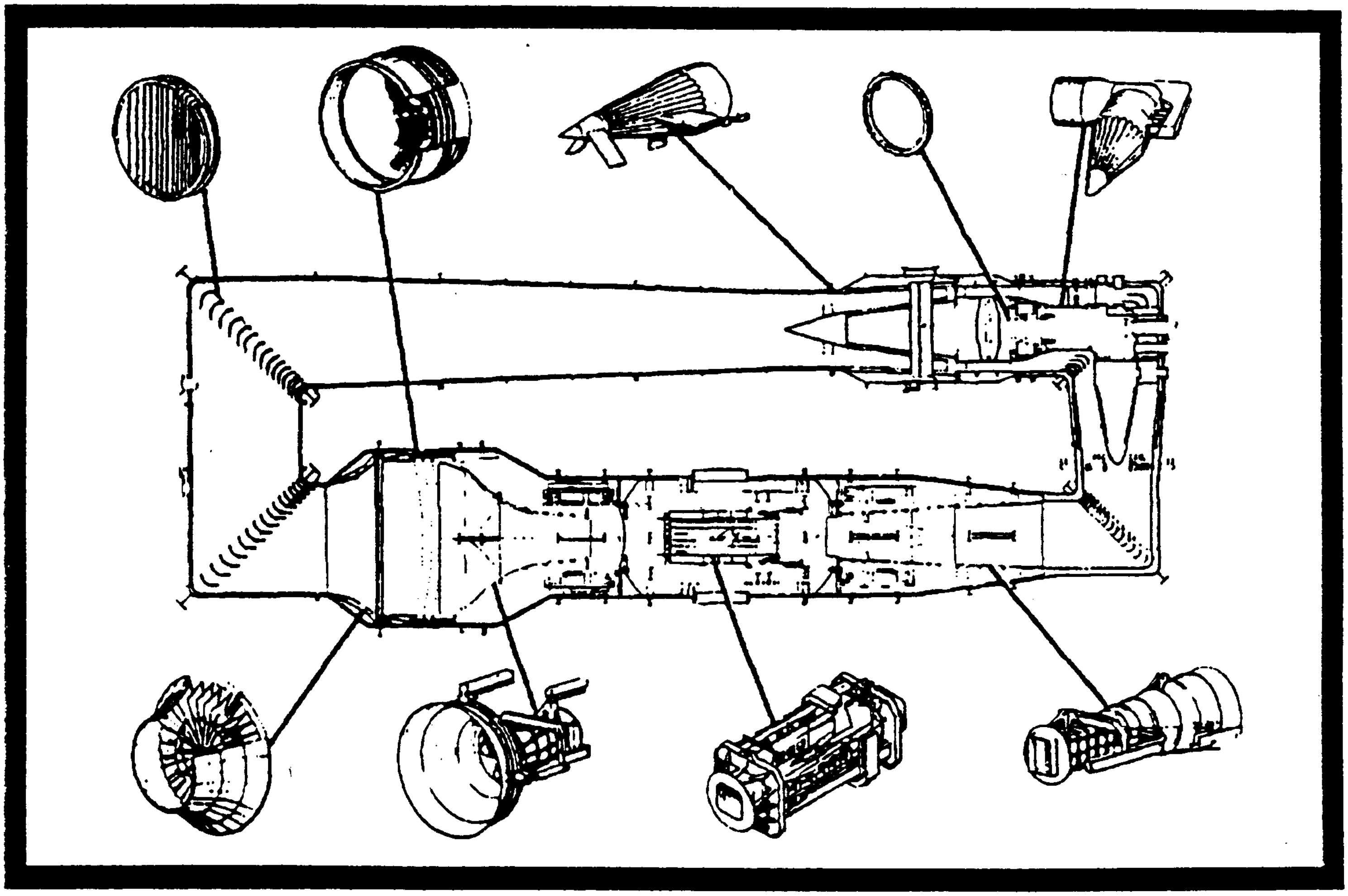
- validating the quality of the hardware
- confirming that the hardware is flightworthy and will perform properly under the simulated flight environment
- assessing that the mission objectives will be met
- compliance with mission requirements and specifications
- refurbishment and recalibration plans (when required)
- shipping and storage plans
- confirmation of compatibility with all interface, weather protection, and contamination control plans
- all failures or anomalies during test
- status of safety and reliability analyses and verification of compliance with documentation requirements

ATTACHMENT 15

LANGLEY GUIDANCE (NFM-1C), GUIDE FOR THE CERTIFICATION/RECERTIFICATION OF WIND TUNNEL STRUCTURAL SYSTEMS (FEBRUARY 1993)

ATTACHMENT 15

# Guide For The Certification/Recertification Of Wind Tunnel Structural Systems



NFM-1C, FEBRUARY 1993

# CERTIFICATION/RECERTIFICATION OF WIND TUNNEL STRUCTURAL SYSTEMS

## PREFACE

This guide sets forth criteria for the certification/recertification of the wind tunnel internal structural systems at Langley Research Center (LaRC). This document is intended to prevent wind tunnel damage or injury due to structural failure of wind tunnel components. Procedures for certification are established, allowable stresses are specified, and a type and format of documentation is prescribed. The inservice inspection specified in the recertification procedure shall not replace the normal routine repair and maintenance programs already in effect. The requirements in this document are to be used in the certification/recertification of the wind tunnels to the extent established by LaRC.

## 1.0 APPLICABILITY AND IMPLEMENTATION

### 1.1 Introduction and Scope

This guide contains criteria for the certification/recertification of the wind tunnel structural systems at Langley Research Center (LaRC). The established criteria are intended to prevent structural/component loss and/or potential facility damage. This guide does not apply either to pressure vessels and systems which are covered by NASA Langley Handbook LHB 1710.40 or to Wind-Tunnel Model Systems which are covered by NASA Langley Handbook LHB 1710.15.

### 1.2 Applicability and Excluded Items

The requirements in this document or portions thereof are mandatory for all new and existing wind tunnel internal structural systems, except for wind tunnel structural components or sub-components that are isolated, protected, contained or restrained in such a manner that the maximum destructive failure could not be harmful to people and/or facilities and equipment.

### 1.3 Definitions

a. Wind Tunnel Structural System: Any wind tunnel structural components or sub-components internal to the tunnel envelope whose failure could result in facility damage or personnel injury.

b. Highly Stressed Areas: An area whose maximum stresses, when compared to allowable stresses, result in a margin of safety against failure of 0.05 or less, and said failure can result in structural system loss and/or facility damage.

c. Structural System Certification: LaRC's Recertification Officer shall recertify wind tunnel structural systems when they satisfy the requirements of this guide.

d. Recertification: The verification of the structural system certification.

e. Recertification Plan: The plan established to verify and maintain the continuous certification of the wind tunnel structural systems. The plan shall provide for (a) the location and/or generation of all required analyses, (b) the nondestructive examination of welds and highly stressed areas, and (c) the surveillance of highly stressed areas to provide confidence in their structural integrity.

f. Design Pressure: The maximum pressure which can occur at the portion of the tunnel which is being analyzed.

g. Design Temperature: The maximum and minimum temperatures which can occur at the portion of the tunnel being analyzed.

Temperatures effects shall include both transient and steady-state thermal analysis where applicable.

h. Inservice Inspection: Inspection performed after a system has been initially put into service.

i. Structural Systems Engineer: Person(s) designated to review and approve the safety of design for the wind tunnel structural systems. Structural systems engineering responsibilities may be assigned to a contractor.

j. Structural Systems Report: The wind tunnel structural analyses, tests, inspection results, future inspection plan and recommendations in documented format.

k. Nondestructive Examination (NDE): Inspection and examination of components by various nondestructive methods to determine the presence of nonconformities or to monitor known nonconformities.

**1.4 Responsibilities**

LaRC's Recertification Officer is responsible for the implementation of all requirements of this guide.

**2.0 CERTIFICATION/RECERTIFICATION PROCEDURES**

**2.1 General Description**

This chapter describes the procedures for certification/recertification for wind tunnel structural systems.

**2.2 New Systems**

New wind tunnel systems shall be certified prior to operation. The procedures for certifying a wind tunnel structural system shall be in accordance with the design acceptance criteria specified in this guide or otherwise specified by FENGD. Reviews shall be conducted to certify that all new wind tunnel systems are functional and meet the criteria set forth in this guide. FENGD may require a formal engineering review of all new systems for compliance with this document.

**2.3 Systems In Service**

All existing tunnel structural systems shall be recertified for operation. The certification/recertification shall also be addressed when any internal component is modified so that the documentation remains current. The procedure for recertifying wind tunnel structural systems and defining periodic inspection is illustrated in Figure 1. The individual activities are described in the following subparagraphs:

a. Specify wind tunnel facility: The name and location of t wind tunnel shall be specified.

b. Define system and operating conditions: The wind tunnel syst and operating parameters such as test medium, pressur temperature, and cyclic operation shall be determined.

c. Identify system components: The wind tunnel components a sub-components shall be identified by means of schematics th identify, describe, and inventory each component and i location.

d. Determine loads for each component: The maximum loads whi can occur on each structural component shall be determined a specified.

e. Review existing analysis and any certification documentatic All existing design analyses shall be obtained and reviewed f verification and completeness of design as per the requiremer of Sections 3.0 and 4.0.

f. Provide a complete analysis: In the event that the analysis not complete or does not exist, a complete analysis shall provided. In evaluating stresses and fatigue life, t analytical procedures as defined in Sections 3.0 and 4.0, a the Appendix shall be used.

g. Establish alternate design requirements: In cases wh alternate design criteria and analysis methods (for examp elastic-plastic analysis, non-linear analysis, altered safe factors, or proof testing) are used to ensure the safe oper tion of the system, sufficient explanation and detail shall provided. When the analysis utilizes alternate design criter or analysis methods, FENGD may direct use of further inspect criteria upon the subject component to ensure safety.

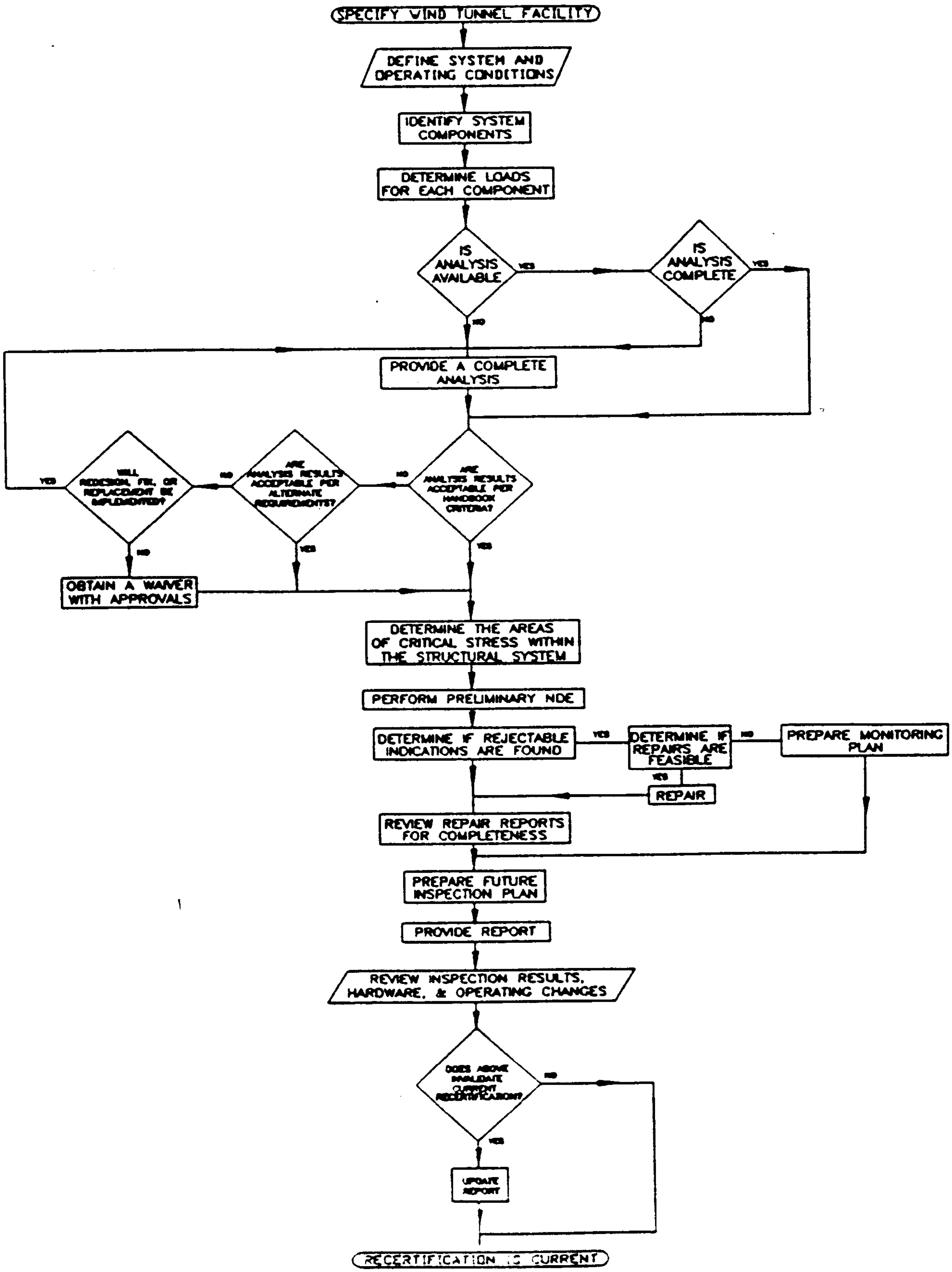
h. Determine highly stressed areas: The results of the analy and the areas of high stress shall be identified and summari in the structural systems report.

i. Perform NDE:

(1) All welds shall be visually examined in accordance w the requirements of the applicable American Weld Society Code, e.g. ANSI/AWS D1.1 for steel structures ANSI/AWS D1.2 for aluminum structures.

(2) All high stressed areas and 10±½% of all welds shall examined using one of the following nondestruct examination methods: radiographic, ultrasonic, penetrant, magnetic particle, eddy current, or visu LaRC's Recertification Officer shall specify the welds be inspected and the nondestructive examination method be used. In performing these examinations, the procedu and acceptance criteria in the applicable American Weld Society Code shall apply.

**Figure 1:** <u>**Recertification Procedure Flow Chart for Structural Systems**</u>



## 3.0 DESIGN AND ANALYSIS

### 3.1 General

The design of the wind tunnel structural components shall be in accordance with the criteria set forth in this section.

### 3.2 Standards

Unless otherwise specified, applicable provisions of the following standards, codes, or handbooks are acceptable:

American National Standards Institute (ANSI)

American Institute of Steel Construction (AISC)

American Society for Testing Materials (ASTM)

American Welding Society (AWS)

American Society for Nondestructive Testing (ASNT)

American Society of Mechanical Engineers (ASME)

National Electric Code (NEC)

National Design Specification for Stress Grade Lumber (NDSSGL)

Society of Automotive Engineers (SAE)

LaRC Safety Regulations Covering Pressurized Systems (LHB 1710.40)

National Bureau of Standards (NBS)

Aerospace Structural Metals Handbook - Department of Defense (DOD)

Advance Composite Design Guide - DOD/NASA

Unless identified by date, the edition - including addenda and code cases - in effect at the start of recertification shall apply.

### 3.3 Design Loads

a. The design pressures and temperatures shall be established by research personnel and shall be included in the structural systems report (see Section 4.0).

b. The loading conditions used for each component design shall include where applicable: dead loads, centrifugal, aerodynamic and thermal loads for the extremes of the test conditions, and design cycle life requirements. Worst case combinations of loading conditions shall also be considered.

## 3.4 Material Properties

a. Standards: Material Properties (mechanical and other) shall be determined using the latest issue of recognized standards, or, when necessary, experimental test data.

b. Adjustments: All material properties, design criteria, and allowable stresses shall be suitably adjusted for operational temperature, pressure, heat affected zones from welding or machining, stress corrosion, and any other environmental effects which may be present during the period the material is under stress.

c. Material Properties Verification: When material properties cannot be determined because of material uncertainty or lack of documentation for a known material, worst case properties of like materials may be used, or properties may be determined by testing. For cryogenic applications, particular care shall be given to the determination of strength and Charpy V-notch properties.

d. Galling: Galling shall be considered in evaluating faying surfaces.

e. Toughness: For all applications requiring high material toughness, the Charpy V-notch impact strength properties ($C_{VN}$) set forth below are required (except for specific materials as noted in paragraph 3.4e(2)).

(1) Impact Strength: The following Charpy V-notch ($C_{VN}$) impact strength values are required for carbon and low alloy steels (including welds, heat affected, and base materials):

| Specified Minimum Material Tensile Strength | Average ($C_{VN}$) for Three Specimens, (ft-lb) | Minimum ($C_{VN}$) for Any Specimen, (ft-lb) |
|---|---|---|
| ≤65 ksi | 13 | 10 |
| >65 & ≤75 ksi | 15 | 12 |
| >75 & <95 ksi | 20 | 15 |
| ≥95 ksi | Lateral Expansion ≥ 0.015 inches | |

(2) Exceptions: Materials which (1) do not undergo a marked drop in impact resistance at cryogenic temperatures, and (2) meet the requirement of sections 3.4a through 3.4d may be used without meeting the $C_{VN}$ requirements. These

materials are as follows: aluminum alloys, copper and copper alloys, nickel and nickel alloys, austenitic stainless steels, and composite materials.

f. Cryogenic Applications: In analyzing materials for cryogenic applications, special consideration must be given to low temperature embrittlement, coefficient of thermal expansion, and dimensional stability. Such considerations must be given not only to primary (load carrying) structural materials but also to solders, brazes, fillers, and so forth.

(1) Cryogenic Materials Data Sources: Suggested sources of information on materials which have been characterized and evaluated for cryogenic use are as follows:

- Materials for Cryogenic Wind Tunnel Testing. National Bureau of Standards Report, NBSIR 79-1624, May 1990.

- Cryogenic Materials Data Handbook. Volumes I and II. Technical Documentary Report, AFML-TDR-64-280 (Rev. 1970)

- Handbook on Materials for Superconducting Machinery. Metals and Ceramics Information Agency Report, MCIC-HB-04, November 1974.

### 3.5 Allowable Stresses

a. General: The allowable stress criteria for materials given in this section are based on well established design practices. Three methods are provided for establishing stress design allowables. Methods 1 and 1A are based on conventional, conservative approaches which can be employed where structural design optimization is not a factor, and minimum analysis effort is desired. Method 2 is a systematic approach which can yield a more optimal structural design. Individual structural components or subsystems can be designed to the allowables of either Methods 1, 1A or 2.

b. Method 1: For standard handbook analysis at temperatures below the creep range, the allowable combined stress (axial plus bending) shall be the smaller of the values of one-quarter (1/4) of the minimum ultimate strength or two-thirds (2/3) of the minimum yield strength of the material at temperature. This corresponds to a safety factor of 4 on ultimate or 1.5 on yield, respectively. In this method, the combined stress to be compared to the allowable shall be calculated for worst combined load cases (mechanical plus thermal) and include stress concentration effects. In the absence of shear strength data, maximum allowable shear stress for all combined loads shall be taken as one-third (1/3) of the minimum yield strength at temperature. The maximum allowable bearing stress shall be equal to the yield strength at temperature.

c. Method 1A: In certain cases a variation on the allowables of Method 1 is acceptable. Method 1A is intended to address situations where the allowables of Method 1 cannot be met when stress concentration effects are included in areas where the stress state is well defined (for example, a perforated plate loaded in bending). In such cases, a highly localized stress cannot result in collapse of the structure but rather becomes a concern in terms of localized distortion and crack initiation which could lead to fatigue failure. In such cases, the allowables of Method 1 may be used without including the stress concentration effect. However, the stress concentration effect along with other fatigue reduction factors must be applied, and a fatigue or fracture mechanics analysis shall be performed per section 3.6c or 3.6d, respectively.

d. Method 2: This method may used when the system cannot be certified/recertified to the allowables of Methods 1 or 1A. However, in order to design to the allowables in this section, the stress state in the structure must be well understood with a high level of confidence. Closed-form solutions and standard handbook calculations will in many cases suffice. However, for highly indeterminate complex structures, a more in-depth analysis will be required using state-of-the-art structural analysis codes employing finite element or finite difference techniques.

   (1) Terminology for Method 2:

      (a) Combined Principle Stress Intensity: The combined principle stress intensity is defined as twice the maximum shear stress and is the difference between the algebraically largest principle stress and the algebraically smallest principle stress at a given point.

      (b) Normal Stress: The stress normal to the plane of reference.

      (c) Shear Stress: The stress tangent to the plane of reference.

      (d) Membrane Stress: The component of normal stress which is uniformly distributed and is equal to the average value of stress across the thickness of the section under consideration.

      (e) Primary Stress: The stress (normal or shear) which is necessary to satisfy the simple laws of equilibrium of external and internal loads. A thermal stress is not a primary stress. Examples of primary stresses are: general membrane stress (axial force divided by gross cross-sectional area of a structural element) and bending stress (bending moment divided by the section modulus of a structural member).

(f) Secondary Stress: The stress (normal or shear) developed by constraints or by the self-constraint of a structure. Examples of secondary stresses are: general thermal stress and bending stress at a gross structural discontinuity (sudden changes in geometry which affect a relatively large portion of the component).

(g) Incremental Peak Stress: Incremental peak stress is defined as the increment added to the stress at a point to give the total peak stress in areas of stress concentrations or local thermal stresses. The basic characteristic of a peak stress is that it does not cause any noticeable distortion and is objectionable only as a possible source of a fatigue crack or a brittle fracture.

(h) Thermal Stress: Thermal stress is a self-balancing stress produced by a nonuniform distribution of temperature, by boundary conditions, or by differing coefficients of thermal expansion. Two types of thermal stresses are considered: general thermal stress associated with distortion of the structure in which it occurs, and local thermal stress associated with almost complete suppression of the differential expansion/contraction and thus produces virtually no distortions.

(i) Stress Cycle: Stress cycle is a condition in which the alternating stress difference goes from an initial value through an algebraic maximum value and an algebraic minimum value and then returns to the initial value. A single operational cycle may result in one or more stress cycles.

(2) Calculation of Combined Stress Intensity: At the point on the structure which is being investigated, choose an orthogonal set of coordinates (i,j,k). The stress components in these directions are then designated $\sigma_i$, $\sigma_j$, $\sigma_k$ for normal stresses and $\tau_{ij}$, $\tau_{jk}$, $\tau_{ki}$, for shear stresses.

Calculate the stress components for each type of loading to which the part will be subjected and assign each set of stress values to one of, or a group of, the following categories:

(a) Primary membrane stresses, $\sigma_m$

(b) Primary bending stress, $\sigma_b$

(c) Secondary stress, $\sigma_g$

(d) Incremental peak stress, [illegible]

Translate the stress components in the [i,j,k] (may be rectangular, cylindrical, or spherical coordinates) directions into principle stresses $\sigma_1$, $\sigma_2$, $\sigma_3$. Next calculate the value of the stress difference $\sigma_{12}$, $\sigma_{23}$, and $\sigma_{31}$ from the relations:

$$\sigma_{12} = (\sigma_1 - \sigma_2)$$
$$\sigma_{23} = (\sigma_2 - \sigma_3)$$
$$\sigma_{31} = (\sigma_3 - \sigma_1)$$

NOTE: For a biaxial state of stress $\sigma_3 = 0$.

The combined stress intensity S is the largest absolute value of $\sigma_{12}$, $\sigma_{23}$, $\sigma_{31}$.

(3) Stress Intensity Allowables:

(a) Primary Membrane Stress Intensity, $\sigma_m$, shall not exceed the allowable membrane stress, $S_m$. $S_m$ shall be the smaller of:

2/3 $S_y$@temperature
2/3 $S_y$@70°F
1/3 $S_u$@temperature
1/3 $S_u$@70°F

(b) Primary membrane plus primary bending stress intensity for solid rectangular cross sections shall not exceed 1.5 times $S_m$:

$$\sigma_m + \sigma_b \leq 1.5\ S_m$$

Primary membrane plus primary bending stress intensity over the gross section of non-rectangular or hollow cross sections (including rolled shapes) shall not exceed $S_m$:

$$\sigma_m + \sigma_b \leq S_m$$

(c) Primary plus secondary stress intensity shall not exceed 3.0 times $S_m$:

$$\sigma_m + \sigma_b + \sigma_s \leq 3.0\ S_m$$

(d) Primary plus secondary plus peak stress intensity shall be evaluated by Fatigue Analysis (Section 3.6c).

(4) Other allowables:

(a) The algebraic sum of the three principal stresses shall not exceed 4.0 times $S_m$:

$$\sigma_1 + \sigma_2 + \sigma_3 \leq 4.0\ S_m$$

(b) Bearing stress shall be less than or equal to $S_y$.

(c) Pure primary shear stress shall be less than or equal to $0.6S_m$. (Shape factors which are applied to calculate maximum transverse shear stress at the centroids of cross sections do not apply to pure shear stress calculations). Typical components which undergo pure shear include keys, bolt and nut threads, and shear pins.

(5) Stress Allowables For Composites

(a) General: Allowable stresses and stress intensities will generally be in accordance with the above requirements. The yield or ultimate strength of the composite material shall be taken from test data for the particular lay-up. When test data is not available, the stresses in each ply of the laminate shall be calculated and compared with the allowables for the ply material.

(b) Shear: Because of the complexity of shear loadings in composite materials, a safety factor of 2 on the as-built ultimate shear strength, both interlaminar and laminar, is required.

## 3.6 Structural Analysis/Design

a. Stress Analysis: A stress analysis is required as a part of the structural systems report. It shall be complete and sufficiently comprehensive so as to require no further explanation.

b. Thermal Analysis: Sufficient analyses shall be performed to examine thermal stresses and distortions for steady-state and transient conditions.

c. Fatigue Analysis: The provisions of this section apply to components that are subjected to cyclic loadings to the extent that fatigue is a credible failure mode. The fatigue analysis is performed on the premise that no flaws or cracks initially exist in the structure. Appendix A is provided as a guide for performing fatigue design analysis and for determining the remaining fatigue life in a component.

d. Fracture Analysis: Fracture mechanics analysis may be used to evaluate known flaws. The fracture analysis may preclude the fatigue analysis as the basis for design life calculations.

e. Design Life: The design life requirements for the fatigue and/or fracture analysis for structural components and the sources shall be referenced. In cases where the projected load-cycle/design life requirement is not well defined, the following approximations shall be used:

(1) Peak Load Cycles: The estimated [illegible] component will experience [illegible]

conditions over its life shall be multiplied by 1.5. This number shall be the primary design life-cycle requirement.

(2) Unsteady Oscillating Loads: Unless otherwise known, the assumed maximum peak unsteady load shall be 25 percent of the steady loads at a random frequency. Unsteady aerodynamic loads shall be considered when flow conditions may result in unsteady perturbations produced by such phenomena as shedding vortices, varying separation or stall zones, inlet turbulent intensities, number of guide vanes per revolution of rotor, etc. These unsteady loads may be of either random or known frequencies.

f. Creep: Creep shall be considered when material temperatures exceed 1/2 of their melting temperatures (temperatures are on the absolute scale).

g. Mechanical Connections

(1) Structural Joints:

(a) Welded Joints: All welded joints shall be designed and fabricated in compliance with AWS.

(b) Bolted Joints: All bolted joints shall be designed and analyzed for the loads specified in paragraph 3.3 and for a clamping force of 1.5 times the maximum separating force. Bolted joints may be friction or bearing type. If a bolted joint is the bearing type, no shear loads shall be transmitted through the threaded portion of the bolt. Shear loads may also be transmitted by keys, pins, or shoulders.

(2) Fasteners:

(a) Preload: Fasteners shall be designed for a maximum preload not to exceed ⅔ of the bolt materials' yield strengths.

(b) Thread Engagement: Thread engagement shall be designed to develop strength equivalent to the bolt ultimate strength. The design shall consider both the parent and the insert material.

(c) Retention: Bolts in critical applications must be secured by mechanical systems (locking-tab washers, locking inserts, interference threadforms safety wiring, jam nuts, and so forth) and/or approved chemical locking systems.

h. Stability

(1) Buckling: The allowable compressive stress/load in columns and skins shall not exceed one-half (1/2) of the

critical buckling stress/load calculated using the proper slenderness ratio.

(2) Aerodynamic stability: The stability of the structural components shall be analyzed to ensure that undesirable events such as divergence and flutter do not create unstable conditions.

(a) Divergence: The allowable dynamic pressure causing divergence shall not exceed one-half (1/2) of the actual dynamic pressure on the component. This requirement is also satisfied if the ratio of the increase in normal force on the component to angle of attack of the flow does not exceed 1/2 of the support system restoring force generated by such an angle change (change in force / change in angle of attack).

(b) Flutter: The structural components shall be sufficiently designed to avoid flutter. A factor of safety of 2 shall be applied to the dynamic pressure when calculating the aerodynamic forcing functions causing flutter.

i. Dynamic Analysis

(1) General: The special requirements set forth in this section apply to systems which have rotating parts, such as fans and rotors, or systems to which dynamic loadings are applied.

(2) Analysis: Equivalent G factor, real eigenvalue, transient response, frequency response, or random response analyses shall be performed if required to determine the structural adequacy of the system.

## 4.0 DOCUMENTATION

### 4.1 General

A Structural Systems Report shall be prepared for all wind tunnels structural systems at LaRC. This report will present analyses and related inspection results which reflect the current safety status of the wind tunnel structural systems.

### 4.2 Contents

The structural systems report shall contain 1) a main body describing the facility, and summarizing all results and recommendations 2) appendices which include status sheets showing the certification/recertification status for each major system or component, and 3) attachments including component analyses background information and related NDE results. The appendices and attachments shall be capable of standing alone. As a minimum, the report shall contain:

a. Main body

(1) Record of Revisions Page

(2) Table of Contents (including a list of appendices and attachments).

(3) Introduction

(4) Facility Description: A description of the facility including system contents and service conditions such as aerodynamic pressure, temperature, cyclic operations, flow characteristics, etc.

(5) Executive Summary: The executive summary shall consist of the significant results used in the certification/recertification process. This contains the findings, recommendations, and future inspection plan.

(a) Findings: Any deviations to the requirements of this guide or unacceptable conditions revealed by the analysis which restrict full certification/recertification shall be reported.

(b) Recommendations: Any recommendations for disposing of the deficiencies shall be stated.

(c) Future Inspection Requirements: The future nondestructive examination requirements shall be established based on the highly stressed areas. A drawing showing the type of NDE and years of future inspection shall be developed.

(6) Recertification Approach: A general description of the procedure followed to recertify the facility shall be provided.

(7) Status Sheet Key/Definitions: This section shall designate the definitions and/or keys used in the status sheets which are contained in the appendices.

b. Appendices: An appendix shall accompany each sub-system described in the facility. Each appendix shall contain two main listings: (1) a list of the non-complying components and suggested recommendations, and (2) a list containing the status of all components.

(1) Non-complying components: This listing identifies the components which do not meet the recertification requirements within this guide. The following information shall be included:

(a) Drawing number showing the location of the component

(b) Item number of component

(c) Description of component

(d) Actual component stress

(e) Allowable component stress

(f) Problem description

(g) Recommendation

(2) Status Summary: This listing summarizes the status of all components. The list shall contain brief descriptions of the following categories:

(a) Drawing and item number.

(b) Component description

(c) Material

(d) Installation date of component

(e) Inspection date of component

(f) Maximum actual stress

(g) Maximum allowable stress (or equivalent)

(h) Margins of safety. Margin of safety shall be calculated as:

$$M.S. = \left(\frac{Allowable\ Stress}{Actual\ Stress}\right) - 1$$

or similarly when levels other than stress are being compared.

(i) Footnotes which may be added to further clarify component information.

(j) References specifying the recertification details contained within the attachments.

(k) Recommendation for each component. The component is either recertified/certified, recommended for removal, repair, monitoring or derating.

c. Attachments: The attachments shall provide background information of the recertification. The attachments shall specify the following:

(1) Component or System Definition and Description: This shall include as-built drawing numbers and sketches for the system or component. These drawings and/or sketches shall describe the system and/or component design and location. A supplementary narrative description may be included as needed.

(2) Materials: The material properties adjusted for operating conditions.

(3) Allowables: The allowable stress levels for each stress classification at the applicable temperature.

(4) Loading Conditions: A description of all non-negligible loads imposed on the component. If loads are derived from analysis, the analysis shall be presented or referenced here. Examples of loading conditions are dead (gravity) loads, thermal loads, aerodynamic loads, and mechanical loads.

(5) Assumptions: A description of assumptions used in the analysis which affect the final results.

(6) Method of Analysis: A description of the methods used in the structural analysis.

(7) Stress Analysis: A clear, detailed, and structured analysis shall be presented. References to equations which are not common knowledge shall be given. The analysis shall be complete and self-contained. Existing analyses may be referenced and not presented in detail if no changes to the analysis are required. This section may be further subdivided to reflect individual types of analyses such as buckling, thermal, fatigue, fracture mechanics, static and dynamic.

(a) The stress analysis shall show whether allowable stresses are exceeded for the worst load case(s).

(b) Each detailed analysis section shall contain a description of the components, a sketch showing forces and moments acting on the part (free body diagram) and statements of assumptions, approximations, section and physical properties, type and heat treat condition of the materials, and pertinent drawing numbers.

(c) The general equations and their sources shall be given before substitution of numerical values.

(d) Where applicable, finite element analyses documentation shall include computer generated plot(s) of the finite element model(s), descriptions of loads and boundary conditions, tabular or graphical summary of stress data, and name of structural code used. Validation of finite element model(s) is required by either closed form solution approximations or other evidence which shows high confidence in the finite element model(s) such as equilibrium checks, convergency, accuracy of solution, and so forth.

(8) Waivers, change notification sheets, and other supporting documents.

(9) Results of NDE

(10) References: Books, papers, analyses, reports, drawings, letters and any other reference material used in the development of the report.

## 5.0 QUALITY ASSURANCE

### 5.1 Introduction

This chapter provides the detailed quality assurance criteria for the recertification of wind tunnel internal structural systems at LaRC. These criteria are intended to ensure that the as-built wind tunnel structural system hardware meets the criteria specified within this guide.

### 5.2 Recertification Plan

FENGD is responsible for creating and maintaining a recertification plan. This plan shall provide methods for monitoring the inservice inspection results and resolving discrepant items. The recertification plan shall also track revisions to hardware or operating conditions which might affect the certification. Each change and/or inspection shall be reviewed by the structural systems engineer to determine if the change meets the requirements of this guide. The results of inservice inspection coupled with the review of revisions and changes will ensure that the structural systems are continuously certified. The recertification plan monitors any change in the structural system by keeping track of the following records:

a. Operational history (including but not limited to: exposure to temperature in excess of design, exposure to operation in excess of maximum operating design parameters, change in location).

b. Records of modifications or repairs.

c. Records of inspections and tests performed on the system.

d. Date of last inspection.

e. Waivers

**5.3 Deviations**

Two types of deviations from this guide may occur. The first deviation being a design which does not meet the requirements or alternate design requirements established in this guide, and the second from an unfavorable condition found during the inservice inspection. Deviation requests for component design and inservice inspections will be handled in the following manner.

When an inspection or review of component analysis reveals evidence of deviations from the criteria in this guide, the discrepancy must be processed in accordance with the provisions of this paragraph.

a. Documentation - A deficiency noted by the inservice inspection or design analysis must be documented and reported to FENGD for disposition. Deficiencies must be recorded in the structural systems report.

b. Disposition - FENGD shall coordinate the corrective action or otherwise dispose of the deficiency. The disposition may consist of additional engineering analysis, repair, modification, derating, additional tests, or inspections.

(1) Additional Engineering Analysis - Additional engineering evaluation may be performed using more realistic assumptions and/or sophisticated methods to certify/recertify the system for the original operating conditions. When the new basis has been determined, the appropriate inspections and tests must be performed and documented.

(2) Derating - A system or component may be derated to less severe service conditions on a permanent or temporary basis. Temporary derating allows the system to be operated at a safe service level during the time it takes to make modifications or to develop the engineering rationale required to certify/recertify the system for permanent service.

(3) Repairs or Modifications - The system or component may be repaired or modified and returned to a condition that can be recertified. Appropriate inspections and tests must be performed and documented.

(4) Additional Inspection or Retests - A discrepant item may be monitored closely to obtain additional data for evaluation.

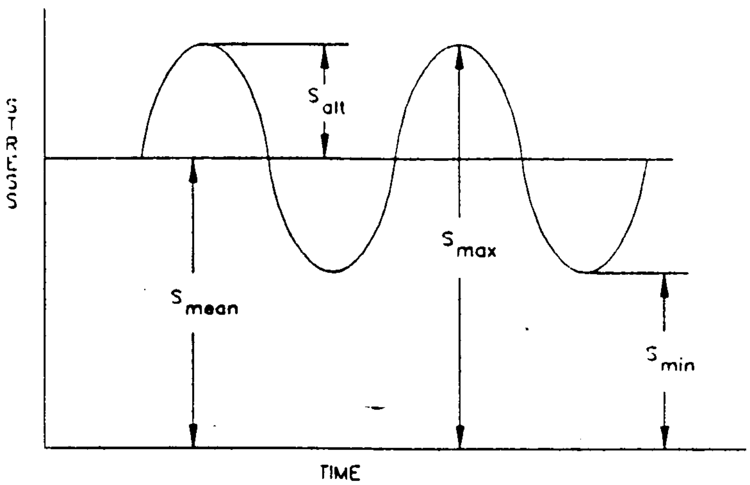
c. Waivers - Waivers must be [illegible] when a deviant item disclosed by an inherent design [illegible] or inservice inspection is to remain in [illegible]. The [illegible] and any supporting evidence [illegible] FENGD for disposition.

Each waiver must be documented and be included in the structural systems report.

## APPENDIX A: FATIGUE ANALYSIS

### A.1 Definitions

The figure below shows a typical stress cycle:




where: $S_{min}$ = minimum stress
$S_{max}$ = maximum stress
$S_{mean}$ = mean stress
= $(S_{max}+S_{min})/2$
$S_{alt}$ = alternating stress
= $(S_{max}-S_{min})/2$

The following are definitions pertaining to fatigue analysis:

n = actual number of stress cycles of a load case
N = allowable number of stress cycles from the fatigue curve
u = usage factor of a specific load case = the fraction of a component's fatigue life which has been exhausted
= n/N
U = the total usage factor = the summation of all load case usage factors and shall be less than or equal to 1.0.
$\sigma_i$ = principal stress
$S_{ij}$ = stress difference range = $\sigma_i - \sigma_j$
$S_{ij\ adj}$ = stress difference range adjusted to incorporate the difference of modulus of elasticity of the actual material to that of the fatigue curve
= $S_{ij} \times (E_{curve}/E_{actual})$
$S_{alt}$ = 1/2 of the adjusted stress difference range
= $(1/2) \times S_{ij} \times (E_{curve}/E_{actual})$

### A.2 Fatigue Curve

Fatigue (S-N) data for the material at test temperature shall be used. Whenever applicable, the fatigue curves (S-N curves) in Section VIII, Division 2, Appendix 5 of the ASME Boiler and Pressure Vessel Code shall be used in the fatigue analyses. When the fatigue curves in Section VIII, Division 2 are not applicable, the baseline S-N data shall be located through a search of the technical literature. These data shall then be adjusted as described in the document "Criteria of the ASME Boiler and Pressure Vessel Code for Design by Analysis in Sections III and VIII,

**A.5 Example**

A component fabricated from carbon steel is subjected to the following load cases of cyclic stress at 70°F:

| Load Case | No. of Cycles | $\sigma_x$ | $\sigma_y$ | $\sigma_z$ | $\tau_{xy}$ | $\tau_{yz}$ | $\tau_{zx}$ |
|---|---|---|---|---|---|---|---|
| 1 | 10000 | 30000 | 15000 | 1000 | 5000 | 0 | 0 |
| 2 | 5000 | 2000 | -1000 | 2000 | 1000 | -1000 | -1000 |
| 3 | 1000 | -20000 | 5000 | -5000 | 2000 | -2000 | -2000 |

First, the principal stresses are calculated and ordered consistently by direction. Then the stress differences are calculated:

| Load Case | No. of Cycles | $\sigma_1$ | $\sigma_2$ | $\sigma_3$ | $S_{12}$ | $S_{23}$ | $S_{31}$ |
|---|---|---|---|---|---|---|---|
| 1 | 10000 | 31514 | 13486 | 1000 | 18028 | 12486 | -30514 |
| 2 | 5000 | 3450 | -1450 | 1000 | 4900 | -2450 | -2450 |
| 3 | 1000 | -20380 | 5600 | -5220 | -25980 | 10820 | 15160 |

Figure 5-110.1 from the 1989 ASME Boiler and Pressure Vessel Code, Section VIII, Division 2, Appendix 5, is used as the S - N curve for the carbon steel. E of the curve is 30 x $10^6$ psi. E of the material at 70°F is 29.5 x $10^6$ psi.

Combine $S_{12}$'s and the number of cycles, calculate $S_{alt}$ = $(1/2)(S_{12})(E_{curve}/E_{analysis})$ find N from the fatigue curve, and calculate the usage:

| Combined Cases | No. of Cycles (n) | Combined $S_{12}$ | $S_{alt}$ | Allowable No. of Cycles (N) | Usage Factor (u=n/N) |
|---|---|---|---|---|---|
| 1-3 | 1000 | 44008 | 22377 | 50000 | 0.02 |
| 1-0[1] | 9000 | 18028 | 9167 | $\infty^2$ | 0 |
| 2-0[1] | 5000 | 4900 | 2491 | $\infty^2$ | 0 |
| | | | | | $U = \Sigma u$ <br> $= 0.02$ |

Notes: 1) Load case 0 indicates that no loadcase superposition has occurred.
2) Infinite number of cycles indicates that the alternating stress is below the endurance limit.

Division 2" to develop the required fatigue curves. This document is available from the Fracture Mechanics Engineering Section, FENGD or from the ASME.

## A.3 Stress Concentration Factors

Appropriate stress concentration factors shall be applied to stresses in areas of local structural discontinuities before principal stresses are calculated.

## A.4 Application

Considering the general case of a component subjected to multiple cyclic loading conditions over its life, the following method of cumulative damage (Miner's Rule) shall be used to determine the components structural adequacy from a fatigue viewpoint:

1. For each loading condition of n number of stress cycles, the principal stresses and their respective directional cosines shall be calculated.
2. The principal stresses in each direction for each load case shall then be ordered, $\sigma_1$, $\sigma_2$, $\sigma_3$. The ordering by direction shall be consistent between load cases.
3. The stress difference ranges shall then be calculated: $S_{12} = \sigma_1 - \sigma_2$, $S_{23} = \sigma_2 - \sigma_3$, and $S_{31} = \sigma_3 - \sigma_1$.
4. The $S_{12}$'s from all load cases shall be tabulated. Likewise, the $S_{23}$'s and $S_{31}$'s shall also be separately tabulated.
5. Stress differences in the same direction and the number of cycles shall be superpositioned if the resulting combined range is greater than the individual stress difference ranges. (The example in the next section illustrates this).
6. The alternating stress shall be calculated as 1/2 of the stress difference range multiplied by the ratio of the modulus of elasticity of the fatigue curve to the actual modulus of elasticity of the material.
7. Using an appropriate fatigue (S-N) curve, the allowable number of cycles (N) corresponding to the alternating stress shall be determined.
8. The usage factor, u, is calculated as the ratio of the actual number of cycles, n, to the allowable number of cycles, N.
9. For each of the three stress difference ranges, the total usage factor is the summation of the individual u's and shall not exceed 1.0.

Likewise for $S_{23}$:

| Combined Cases | No. of Cycles (n) | Combined $S_{23}$ | $S_{alt}$ | Allowable No. of Cycles (N) | Usage Factor (u=n/N) |
|---|---|---|---|---|---|
| 1-2 | 5000 | 14936 | 7595 | $\infty^2$ | 0 |
| $1-0^1$ | 5000 | 12486 | 6349 | $\infty^2$ | 0 |
| $3-0^1$ | 1000 | 10820 | 5502 | $\infty^2$ | 0 |

Notes: 1) Load case 0 indicates that no loadcase superposition has occurred.
2) Infinite number of cycles indicates that the alternating stress is below the endurance limit.

$U = \Sigma u$
$= 0.0$

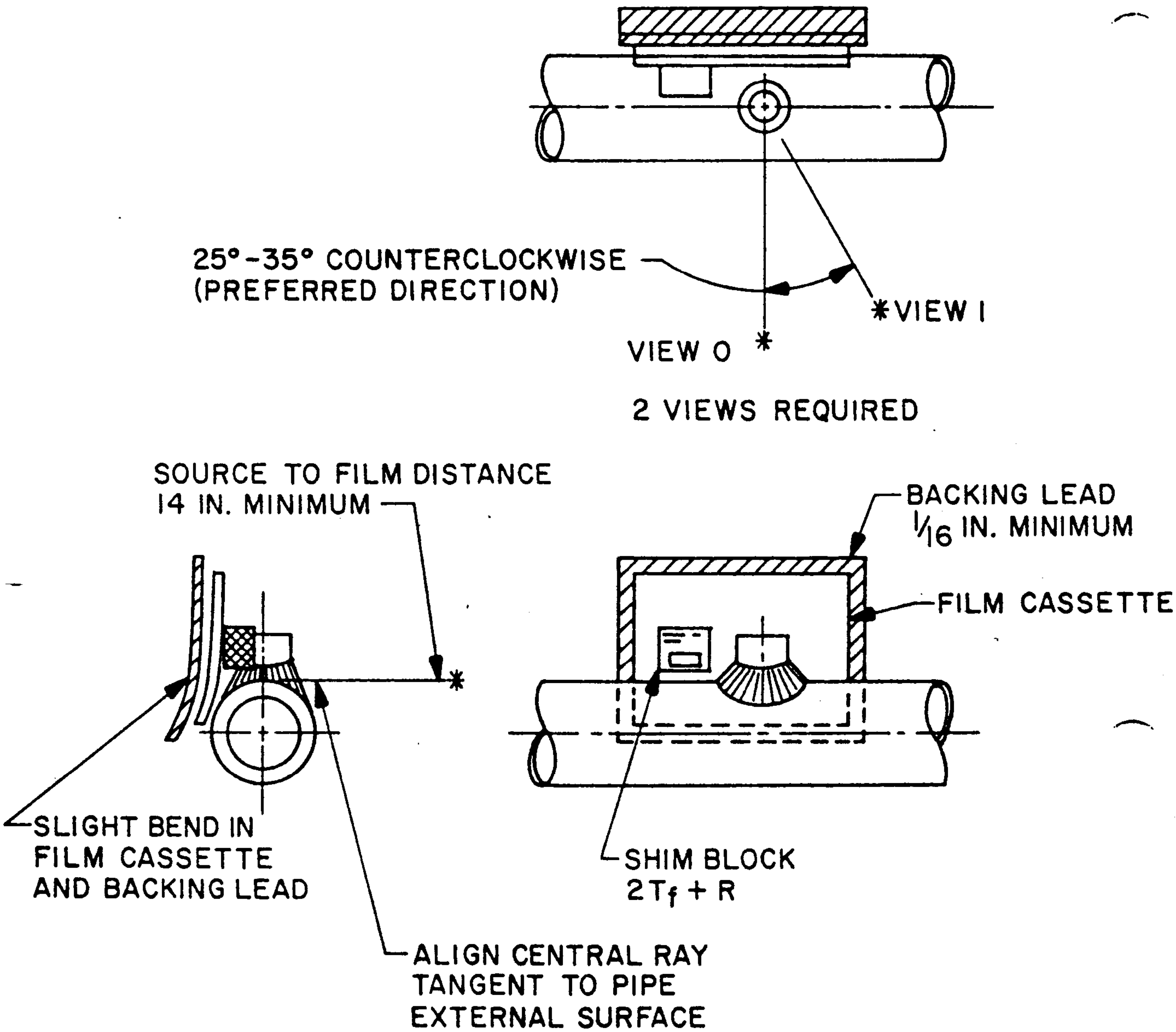
Likewise for $S_{31}$:

| Combined Cases | No. of Cycles (n) | Combined $S_{31}$ | $S_{alt}$ | Allowable No. of Cycles (N) | Usage Factor (u=n/N) |
|---|---|---|---|---|---|
| 3-1 | 1000 | 45674 | 23224 | 50000 | 0.02 |
| $0^1-1$ | 9000 | 30514 | 15516 | 200000 | 0.045 |
| $0^1-2$ | 5000 | 2450 | 1246 | $\infty^2$ | 0 |

Notes: 1) Load case 0 indicates that no load case superposition has occurred.
2) Infinite number of cycles indicates that the alternating stress is below the endurance limit.

$U = \Sigma u$
$= 0.065$

Since each total usage factor is less than 1.0, the component is structurally acceptable from a fatigue viewpoint.




NOTE

BRANCH CONNECTIONS OVER 6 INCHES DIAMETER (O.D.) MAY REQUIRE ADDITIONAL EXPOSURES OR ALTERNATE TECHNIQUES AT THE DISCRETION OF THE NASA NDE RADIOGRAPH INTERPRETER

Figure 16.- Radiographic Exposure Technique (Branch).

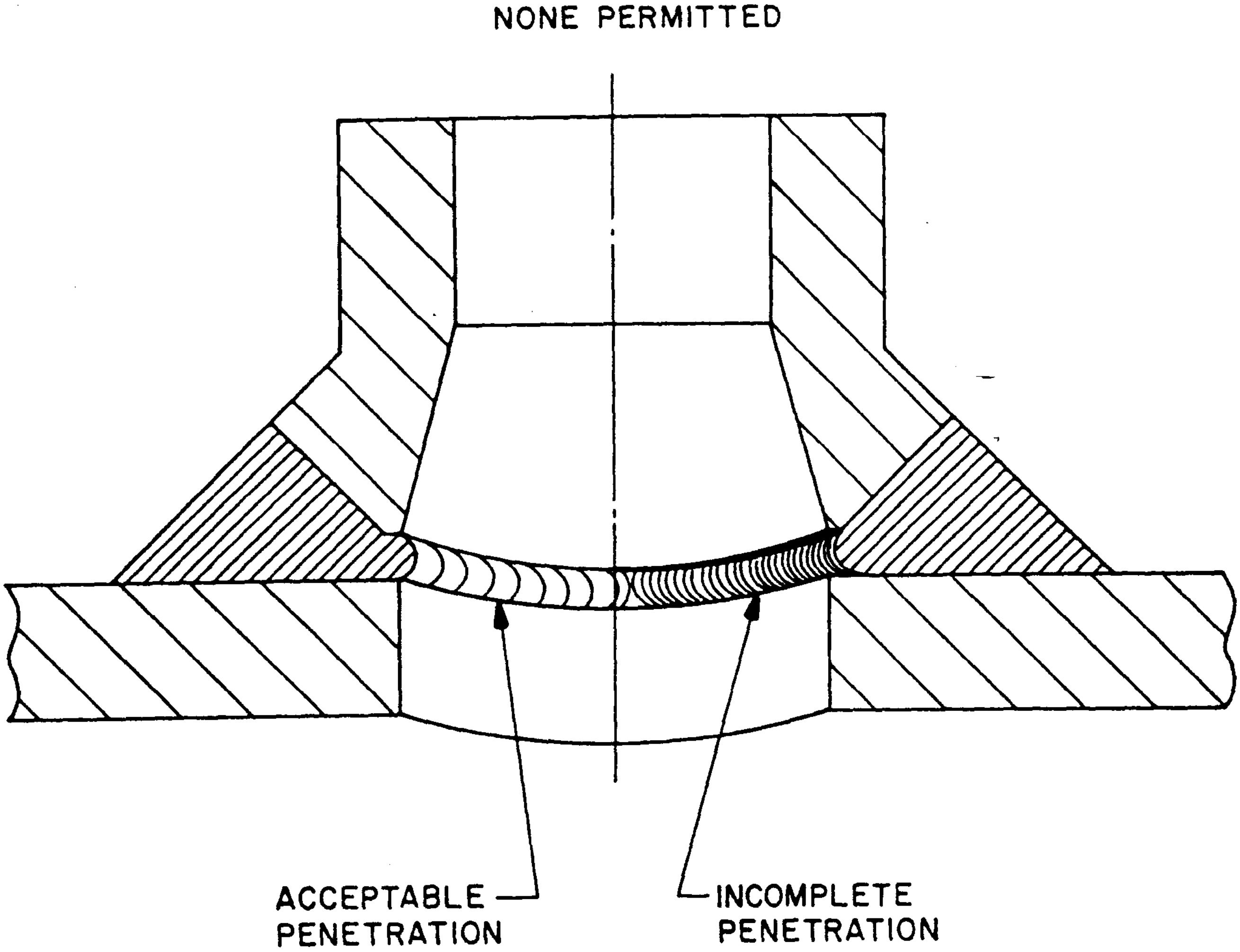



Figure 17.- Incomplete Penetration (Branch).

ATTACHMENT 12

NASA LANGLEY HANDBOOK (LHB) 1740.4, FACILITY SYSTEM SAFETY ANALYSIS AND CONFIGURATION MANAGEMENT (MARCH 1992)

ATTACHMENT 12

LHB 1740.4
March 1992

NASA
Langley Research Center

# FACILITY SYSTEM SAFETY ANALYSIS AND CONFIGURATION MANAGEMENT

National Aeronautics and Space Administration

# PREFACE

This handbook sets forth policy and responsibilities for the System Safety Program as it applies to Langley Research Center research facilities. It defines and implements the requirements of the Facility System Safety Analysis and Configuration Management Program. It is provided to assist Government personnel in performing their responsibilities for this program and to define the contractor's participation in the Configuration Management Program.

LHB 1740.4, dated May 1991, is superseded and should be destroyed.

H. Lee Beach, Jr.
Deputy Director

DISTRIBUTION:
SDL 040, SDL 043, SDL 410, SDL 411, and SDL 412
429/Systems Safety, Quality and Reliability Division (150 copies)
123/Directives & Forms Management Office, ISB - MSD (10 copies)

CONTENTS

CONTENTS - Concluded

# THE LaRC FACILITY SYSTEM SAFETY PROGRAM

## 1.1 INTRODUCTION

### 1.1.1 Application

The LaRC **Facility System Safety Program** exists to ensure the safe and continuous operation of selected LaRC facilities. As a part of that program, a number of research facilities have undergone a **Facility System Safety Analysis**. Each of those facilities has been assigned a unique **Effort Code** (EC) number. These numbers appear on documentation associated with the facilities and are listed in Figure 1-1, "Effort Code Summary."

### 1.1.2 Objective

The key provision of the Facility System Safety Program stipulates **that an initial Systems Safety Analysis be conducted for each facility, that a baseline for controlled documents be established, and that these analyses and documents be kept current by an active Configuration Management (CM) Program**. These analyses and the continuous update provided by the CM Program provide procedural and risk information to operating personnel while recording and maintaining the current status of supporting documentation, equipment, and services within those facilities.

## 1.2 SCOPE

The LaRC Research Facilities and Laboratory Configuration Management Programs consist of three separate programs with two subprograms under Facility Configuration Management:

a. Facility Configuration Management

   (1) Pressure Systems Configuration Management

   (2) Software Configuration Management

b. Laboratory Configuration Management

c. Asbestos Configuration Management

Details on Facility System Safety Analysis and the Configuration Management Programs may be found as described below.

**Chapter 2** provides details of the **Facility System Safety Analysis** process. **Chapter 3** provides guidance on the program to upgrade existing safety

| Effort Code | Facility Title | Facility No. | Street Address |
|---|---|---|---|
| 01 | West Area High Pressure Air System | 1247E | 7E East Reid St. |
| 02 | Hypersonic $CF_4$ Tunnel | 1275 | 20 Lewis Loop |
| 03 | 8-Foot High Temperature Tunnel | 1265 | 10 East Reid St. |
| 04 | 1- x 3-Foot High Enthalpy Aerothermal Tunnel | 1265 | 10 East Reid St. |
| 05 | Hypersonic Blowdown Tunnels | 1247D | 1D East Reid St. |
| 07 | Hypersonic $N_2$ Tunnel | 1247 | 1B East Reid St. |
| 12 | Entry Structures Facility | 1267 | 6 East Reid St. |
| 13 | Visual Motion Simulator | 1268A | 24 West Taylor St. |
| 14 | Drive Control | 1241 | 9 West Taylor St. |
| 16 | 31-Inch Mach 10 Tunnel | 1251A | 16A Victory St. |
| 17 | 15-Inch Mach 6 High Temperature Tunnel | 1251A | 16A Victory St. |
| 18 | Transonic Dynamics Tunnel | 648 | 648 Dodd Blvd. |
| 19 | 14- x 22-Foot Subsonic Tunnel | 1212C | 17C West Taylor St. |
| 21 | 16-Foot Transonic Tunnel | 1146 | 11 West Taylor St. |
| 22 | Aircraft Noise Reduction Laboratory | 1208 | 2 North Dryden St. |
| 23 | Hypersonic Materials Test Apparatus | 1148 | 8 West Taylor St. |
| 24 | Unitary Wind Tunnel | 1251 | 16 Victory St. |
| 25 | Scramjet Test Facility | 1247B | 1B East Reid St. |
| 26 | High Reynolds No. Helium Tunnel Complex | 1247H | 2H East Marvin St. |
| 27 | High Reynolds No. Helium Recovery System | 1247B | 1B East Reid St. |
| 28 | Hypersonic Helium Tunnel Facility | 1247B | 1B East Reid St. |
| 29 | Aircraft Landing Dynamics Facility | 1257-1262 | 2 West Bush Rd. |
| 30 | HPB Ceramic Heated Combustion Facility | 1263 | 15 North Marvin St. |
| 31 | Vortex Research Facility | 720B | 720B Back River Rd. |
| 33 | Impact Dynamics Research Facility | 1297 | 12 West Bush Rd. |
| 34 | 0.3-Meter Transonic Cryogenic Tunnel | 1242 | 7 West Taylor St. |
| 35 | Anechoic Noise Facility | 1218A | 3A South Wright St. |
| 36 | Jet Noise Apparatus | 1221A | 12A Langley Blvd. |
| 37 | Thermal Acoustic Fatigue Apparatus | 1221A | 12A Langley Blvd. |
| 38 | East Area High Pressure Air System | 646/582 | 582A Thornell Ave. |
| 39 | 8-Foot Transonic Pressure Tunnel | 640 | 640 Thornell Ave. |
| 40 | Low Turbulence Pressure Tunnel | 582A | 582A Thornell Ave. |
| 42 | 6- x 28-Inch Transonic Tunnel | 583 | 583 Plum St. |
| 43 | 6- x 19-Inch Transonic Tunnel | 585 | 585 Thompson St. |
| 50 | Vacuum Sphere Control and 60-Foot Space Simulator | 1295 | 2 South Warner St. |
| 52 | High Speed 7 x 10 Foot Tunnel | 1212B | 17B West Taylor St. |
| 58 | Impact and Projectile Range | 1275 | 20 Lewis Loop |
| 59 | Chemical Kinetic Shock Tube | 1275 | 20 Lewis Loop |
| 60 | 30- x 60-Foot Tunnel | 643 | 643 Thornell Ave. |
| 61 | 12-Foot Low Speed Tunnel | 644 | 644 Andrews St. |
| 62 | 20-Foot Vertical Spin Tunnel | 645 | 645 Andrews St. |
| 64 | DC-9 Simulator | 1220 | 1 South Wright St. |
| 65 | Visual Landing Display System | 1220 | 1 South Wright St. |
| 66 | Differential Maneuvering Simulator | 1268A | 24 West Taylor St. |
| 67 | General Purpose Fighter Simulator | 1220 | 1 South Wright St. |
| 68 | General Aviation Simulator | 1268A | 24 West Taylor St. |
| 69 | 7-Inch High Temperature Tunnel | 1264 | 17 North Marvin St. |
| 71 | Vitiated Heater, Test Cell #2 | 1221 | 12 Langley Blvd. |
| 80 | Combustion and Mixing Research Apparatus, Test Cell #1 | 1221 | 12 Langley Blvd. |
| 84 | Hangar Water Deluge System | 1244 | 6 East Taylor St. |
| 85 | Hevi-Duty Brazing Vacuum Furnace | 1232A | 6A Langley Blvd. |
| 86 | 16-Meter Thermal Vacuum Chamber | 1293B | 4B West Taylor St. |
| 88 | Autoclave | 647 | 647 Andrews St. |
| 89 | Autoclaves | 1267A | 6A East Reid St. |
| 91 | Composite Shop Autoclave | 1238B | 3B East Durand St. |
| 92 | Hypersonic Helium Tunnel Recovery System | 1247B | 1B East Reid St. |
| 93 | Transport Systems Research Vehicle (TSRV) | 1268B | 13 Langley Blvd. |
| 97 | Space Systems Structures Research Lab | 1293A | 6A West Taylor St. |
| 98 | Steam Distribution System | 1215 | 14 West Taylor St. |
| 99 | National Transonic Facility (NTF) | 1236 | 5 West Taylor St. |

**Figure 1-1.- Effort Code Summary.**

analyses to a more thorough and updated standard. Chapter 4 covers the Facility Configuration Management (CM) Program. Chapter 5 addresses the Pressure Systems Configuration Management (PSCM) Program. Chapter 6 addresses Software Configuration Management. Chapter 7 addresses the Laboratory Risk Evaluation Program (LREP). Chapter 8 addresses the Asbestos Configuration Management Program.

## 1.3 DEFINITIONS

The glossary in the Appendix lists and defines the terms unique to the Facility System Safety Program.

# FACILITY SYSTEM SAFETY ANALYSIS

## 2.1 GENERAL

A **Facility Systems Safety Analysis** is a systematic approach toward: (1) identifying credible hazards associated with the operation of a facility, (2) defining the risk in terms of severity and probability, (3) assessing the controls for those hazards, and (4) making recommendations toward reduction of the probability of occurrence, if appropriate. Such an analysis must be accomplished prior to the start of research activities at any new facility or prior to any existing facility being brought into the Configuration Management (CM) Program. The overall responsibility for the conduct of the Facility Systems Safety Analysis lies with the **Facility Assurance Section (FAS), Risk Management Branch (RMB), Systems Safety, Quality and Reliability Division (SSQRD).** The analysis itself, however, is a group effort conducted by a Facility Team. This team includes the:

a. Facility Safety Head (FSH).

b. Facility Coordinator (FC).

c. Facilities Configuration Coordinator (FCC) from the Facilities Engineering Division (FENGD).

d. Safety Manager (Head, RMB, SSQRD).

e. Designated Safety Engineer, FAS, SSQRD.

f. Designated Systems Safety Engineer from the CM contractor.

The completed analysis is documented in the **Safety Analysis Report** (SAR). This document, along with the **Standard Operating Procedures (SOP's)**, designated **engineering drawings**, and other documents identified by the Facility Team, are listed in the **Configuration Controlled Document** (CCD) section of the **Facility Baseline List** (FBL). These documents, and the FBL which lists them, are maintained under the CM Program. The FSH leads the Facility Team and has final approval of all CCD's. Changes to CCD's are initiated by a NASA Langley Form 127, "Change Notification Sheet (CNS)." The Facility Team meets annually to review the previous year's activities and plan for the future.

## 2.2 PLANNING

Approximately 60 days prior to the initiation of a Facility System Safety Analysis, the assigned Safety Engineer in SSQRD will notify the responsible FSH. The FSH, with the assistance of the facility staff and technicians, will assemble and provide to SSQRD all existing documentation which reflects the "as-is" facility hardware. These documents include:

a. Facility Resumé.

b. Facility Engineering Drawings (red-lined if necessary).

c. Standard Operating Procedures.

d. Maintenance Plan.

e. Vendor Manuals.

f. Checklists.

g. Engineering Reports/Analyses.

h. Any other item that may be of value toward the System Safety Analysis; such as:

  (1) Operational Logs.

  (2) Failure Mode Histories.

  (3) Specific areas of concern.

## 2.3 EXECUTION

The assembled documents will be reviewed by the FSH, FC, and the Safety Engineer in FAS, SSQRD to initiate the Facility System Safety Analysis. These documents will form the foundation of the SSQRD Safety Engineer's formal analysis of the facility's hazards and other conditions appropriate to the issue of safety. The end products of this effort will be the:

a. Standard Operating Procedures (SOP's)/Checklists.

b. Safety Analysis Report (SAR).

c. Facility Baseline List (FBL).

d. Other special items as appropriate.

Details on these end items and inclusion of engineering drawings into the Facility CM Program follow.

### 2.3.1 Standard Operating Procedures (SOP's)/Checklists

#### 2.3.1.1 SOP Guidelines

SOP's are detailed, written, formal instructions for **qualified operators** to be routinely followed at a designated facility. Some guidelines to be used in their preparation are:

a. SOP's must provide for a **complete cycle** of operation (dormant to run to dormant). This cycle is normally presented in three separate SOP sections: **Pre-Operational (PRE-OP) Procedures, Operational (OP) Procedures, and Post-Operational (POST-OP) Procedures.**

b. SOP's for the complete cycle must be **demonstrated for and approved by the Facility Team** prior to being included in the CM Program.

c. Initially, **dry runs will be performed** to avoid unnecessary exposure to hazards.

d. SOP's will alert operators of potential unexpected events. These alerts are expressed in three distinct categories:

   (1) A **NOTE** is a general instruction to the operator concerning the **specific order that procedures must follow**. It alerts the operator to potential undesired results of a minor nature (that is, failure to comply would invalidate previous actions) and provides explanatory information.

   (2) A **CAUTION** alerts the operator that the sequence which follows could cause **equipment damage** if not executed properly.

   (3) A **WARNING** alerts the operator that the sequence which follows could cause **personnel injury** if not executed properly.

e. Red-lined copies of the SOP's will be corrected and submitted to the Facility Team for approval.

f. SOP's may include date/sign-off sheets that can be used for documentation of the day-to-day operation of the facility.

### 2.3.1.2 Checklist Guidelines

Checklists are abbreviated versions of SOP's which are intended to provide less-detailed instructions for routine, day-to-day operation of a facility by the **most experienced of operator personnel**. Prior to their use, they must be demonstrated, approved, and included in the CM Program. This process is identical to that followed in the development and acceptance of SOP's. Some guidelines to be used in their preparation are:

a. A Checklist may cover an entire cycle of operation or any part thereof; however, it must be clearly labeled as to what it covers.

b. A Checklist may be of a "check off" or "sign off" nature; or, simply a sequential listing of steps to be taken without the need to check/sign items off.

c. A Checklist is often reproduced within the facility and a copy used for each operational run. In such cases, the entire Checklist must be reproduced and no part of the original omitted.

The FSH and/or FC will use approved SOP's/Checklists in training for operator qualification/certification.

Facility complexity and operational risks will dictate the requirement for the degree of structured operations which are to be controlled by hand-held procedures and/or Checklists.

### 2.3.1.3 SOP/Checklist Development

Development of SOP's and Checklists is achieved by following the planned sequence of activities as listed below:

a. The FSH and FC develop an appropriate Work Breakdown Structure (WBS) of facility operations, Sequential Flow Charts, and first-draft Procedures/Checklists.

b. The Facility Team reviews and approves the WBS and accompanying Sequential Flow Chart with emphasis on identifying mission- and safety-critical events on the first draft of the SOP/Checklists.

c. The FSH and FC demonstrate, for the Facility Team, the resulting second-draft SOP/Checklists.

d. The Facility Team approves and accepts the final SOP/Checklists.

e. The FSH and Safety Manager approve the final SOP's/Checklists and these documents are incorporated into the CM Program.

### 2.3.1.4 SOP/Checklist Organization

SOP's/Checklists are divided into two sections: **Forematter** and **Text**.

a. The **Forematter** consists of the following:

(1) The Title Page contains the SOP/Checklist title, the name of the facility for which the document was completed, and the facility number in which the facility is housed

(2) The **Revision Record** reflects all SOP/Checklist document changes and states who prepared, reviewed, and accepted those changes. The "Prepared By" column is signed by the Configuration Management or Safety Engineer who prepared the change. The "Reviewed By" column is signed by designated reviewing authority. The "Reviewed By Safety Manager" column is signed by the Head, RMB, SSQRD. Finally, the "FSH Cognizance" column is signed by the responsible FSH.

(3) The **List of Page Revisions** enumerates each page in the document and the current revision letter of each page.

(4) A **General Introduction** page addresses the purpose, personnel, support and safety services, equipment, initial conditions, and reference drawings appropriate to the procedures/checklist being presented.

b. The **Text** section begins immediately following the forematter and consists of a Sequence Flow Chart, which shows the normal safe order in which the procedures (Pre-operations, Operations, and Post-Operations) can be executed, and the actual, step-by-step procedures/checklist.

### 2.3.2 Safety Analysis Reports (SAR's)

#### 2.3.2.1 General

A **Safety Analysis Report** (SAR) formally documents the **Facility System Safety Analysis** for a given facility. A SAR is initially developed in a structured sequence of planned activities as follows:

a. A designated Safety Engineer from SSQRD compiles an initial **System Definition** which includes the **Facility Description**, a **System Block Diagram**, and a **Preliminary Hazard Analysis**.

b. The Facility Team reviews and comments on the initial product.

c. The designated Safety Engineer conducts a **Hazard Control Analysis** (HCA).

d. The designated Safety Engineer prepares a **Critical Items List** (CIL).

e. The FSH reviews and comments on the developed documents.

f. The Facility Team reviews the developed documents and the FSH response. This is followed by their approval and acceptance of the SAR.

g. The Safety Manager and the FSH approve the SAR and it is incorporated into the CM Program.

The SAR will be maintained by the CM contractor in conjunction with the FSH and Safety Manager. Any facility change will be considered for possible SAR impact. It is critical that all parties involved maintain close communication in analyzing hardware or procedural changes and update the SAR as expeditiously as possible.

2.3.2.2 SAR Organization

The SAR is divided into three main sections: **Forematter**, **Text**, and **Appendixes**. The Text is further subdivided into subsections common to all facilities; although, on a case-by-case basis, additional special-item subsections (for example, a CIL) can be added if directed by the Facility Team. The common subsections are the **Introduction**, the **Facility Description** (which includes a **Facility Block Diagram**), and the **Safety Analysis Summary**. The following is a discussion of each section/subsection.

a. The **Forematter** section consists of the **Title Page**, **Revision Record**, **List of Page Revisions**, and **Table of Contents**.

(1) The **Title Page** contains the report title, the name of the facility for which the report was completed, the facility number in which the facility is housed, and the Effort Code (EC) associated with the facility.

(2) The **Revision Record** reflects all SAR document changes and states who prepared, reviewed, and accepted the report/changes, and the date issued. The "Prepared By" column is signed by the Safety Engineer who prepared the report/change. The "Reviewed By" column is signed by designated reviewing authority. The "Reviewed By Safety Manager" column is signed by the Safety Manager, SSQRD. Finally, the "FSH Cognizance" column is signed by the responsible FSH.

(3) The **List of Page Revisions** enumerates each page in the report and the current revision letter of each page.

(4) The **Table of Contents** lists the major subsections of the SAR and the page number on which each begins.

b. The Text section of the SAR consists of the **Introduction**, the **Facility Description**, and the **Safety Analysis Summary**.

(1) The **Introduction** identifies the facility, states the purpose and philosophy of the analysis, and explains the **Risk Assessment** logic.

(2) The **Facility Description** is a brief overview of the subject facility which lists the major facility capabilities, the nature of research conducted, the subsystems, and any special facility feature appropriate to the safety analysis. It also includes a **Facility Block Diagram** which shows the general relationships among the various subsystems.

(3) The **Safety Analysis Summary** is the heart of the SAR. It contains **General Observations and Recommendations** which address those **Hazards/Undesired Events** that are general in scope (primarily resulting from facility familiarity) as opposed to **Hazards/Undesired Events** specific to a particular subsystem revealed by the analysis. Every entry in both this subsection and the following one, **Tabular Summary**, will be assigned **an alpha-numeric Risk Level** in accordance with the philosophy and guidelines established by this handbook (see paragraph 2.3.2.5) and the SAR **Introduction**. The **Tabular Summary** subsection lists and discusses the identified **Undesired Events** and the associated risks are assessed. The discussion appears in this section in an abbreviated format only.

c. The **Appendixes** of the SAR provide the more detailed discussion of the Hazards, Undesired Events, and Risk Assessments. There is normally a separate Appendix for each major subsystem identified on the **Facility Block Diagram**. The Appendixes are keyed to the Tabular Summary subsection of the Safety Analysis Summary. The Appendixes provide **much greater definition** of the facility's situation in that the Undesired Events associated with each of these subsystems are addressed in detail.

d. Where applicable, SAR's shall include a Critical Items List (CIL). **A Critical Item is any item, the single order failure of which, would likely result in death or damage to equipment/ property equal to or greater than $1.0M**. Typical examples of Critical Items include: interlocks, safety devices, high energy components, and biological/environmental impact components. A Critical Item must have the design analyses, inservice inspection/preventive maintenance procedures, installation procedures, and nondestructive testing required to establish and maintain an acceptable probability-of-occurrence risk category. The requirement for design calculations can be waived for Critical Items which are proprietary or part of a company's standard product line providing that: (1) the item has been designed to industry consensus codes, (2) a history of acceptable operations of the same or similar products is available, and (3) the use is in compliance with the manufacturer's ratings and recommended applications. Examples of proprietary items that may meet the design waiver criteria are large rotating machinery for wind-tunnel compressor or drive systems. Critical Items listed in the SAR's shall be tracked throughout their lifetime for compliance with design, maintenance, and inspection requirements. Pressure components that are standard product lines and built to national consensus codes or standards, are by definition not considered Critical Items. However, these items shall be covered under the Center's Pressure System Recertification Program to assure system integrity.

### 2.3.2.3 SAR Preparation

a. **General**.- A SAR is prepared by a Safety Engineer under the direction of SSQRD. The Safety Engineer is assisted by the other members of the Facility Team. The following definitions are provided toward ensuring a uniform understanding of the terms related to SAR preparation:

(1) **Hazard**--A condition which has the **potential** to result in damage to equipment and/or personnel injury/death.

(2) **Undesired Event**--An event (or series of events) which **unleashes the potential** inherent in a hazard; and, either directly or indirectly, results in damage and/or personnel injury/death.

(3) **Cause**--The stimulus or triggering **mechanism/act which precipitates** the Undesired Event/Accident.

(4) **Effect**--The **consequence of the Undesired Event/Accident** in terms of equipment damage and/or personnel injury/death.

b. **Phases**.- The phases of SAR preparation are as follows (see **Figure 2-1**, "SAR Preparation Flow Sequence"):

(1) The **System Definition Phase.** The Safety Engineer uses facility-provided documentation to define the system. In this phase, the facility is described and the facility is divided into manageable operational **subsystems**. Examples of operational **subsystems** are: high pressure air, vacuum, model injection, cooling water, test section, nitrogen, hydrogen, and so forth. How these subsystems are identified in any given facility depends on the desires of the Safety Engineer in organizing the SAR to cover every aspect of the facility. For example, in one instance, the model injection component may be a separate subsystem; whereas, in another instance, it may be included as part of the test section subsystem. The important thing is to ensure that all components are considered so that they may all be given due consideration. Also at this time, a Facility **Block Diagram** is generated to show the interrelationships among the chosen subsystems.

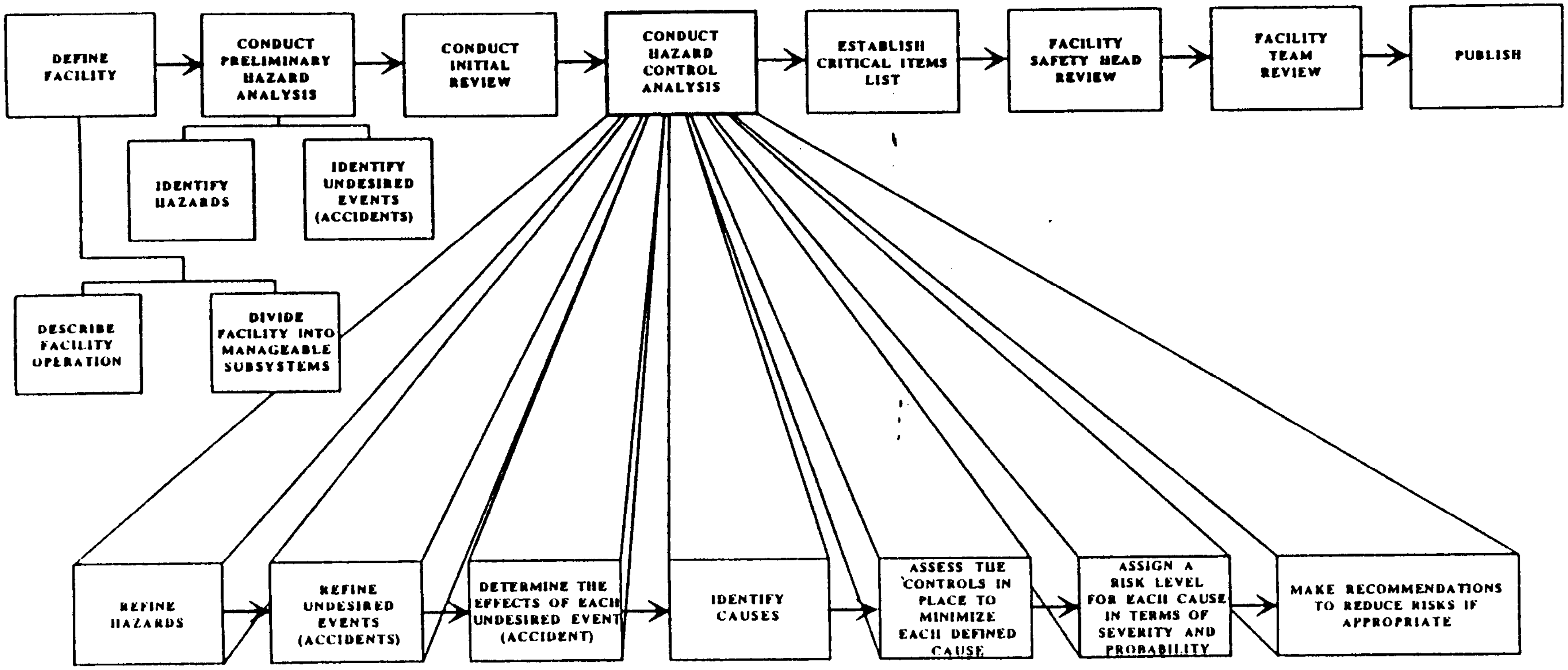



Figure 2-1. - SAR Preparation Flow Sequence.



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(2) **The Preliminary Hazard Analysis Phase-.** A Preliminary Hazard Analysis is conducted to identify all of the possible Hazards and the Undesired Events (Accidents) which could result from those Hazards. (This action represents an initial assessment; and, the Hazards and Undesired Events/Accidents established here could be expanded as the assessment progresses.) There may be one or more Hazards in each of the subsystems. Upon completion of this phase, copies of the products are sent to the Facility Team for review and clarification of the facility Hazards and Undesired Events/Accidents.

(3) **The Facility Team Review Phase.-** The Facility Team reviews the System Definition and Preliminary Hazard Analysis products and provides the Safety Engineer additional information and comments as appropriate.

(4) **The Hazard Control Analysis Phase.-** With input from the Facility Team, the Safety Engineer now performs a **Hazard Control Analysis (HCA).** The HCA is the heart of the SAR. It ensures that a deductive approach is taken in the assessment of the safety implications of the facility and documents that thought process. The approach which shall be taken in the HCA is reflected in the lower portion of the flow chart in **Figure 2-1**.

(5) **The Critical Items Generation Phase.-** With the subsystems, Hazards, and Undesired Events defined, the Safety Engineer now prepares a CIL guided by the definition in paragraph 2.3.2.2d. Interlocks or other hazard controls, analyses, drawings, maintenance, installation, and in-service inspection procedures are identified, as required, for each Critical Item.

(6) **The Facility Safety Head Review Phase.-** The FSH now conducts a thorough and independent review of all documentation.

(7) **The Facility Team Review Phase.-** The remaining members of the Facility Team are assembled by the FSH for a final review, approval, and acceptance of the SAR.

(8) **The Publication Phase.-** After all of the issues are resolved and the SAR is prepared in final format, it is formally approved by the Safety Manager and FSH; and, it may be incorporated into the CM Program.

### 2.3.2.4 The Analysis

a. The analysis begins with a detailed exploration of each of the identified **Hazards** (an example of one might be hot surfaces).

b. Considering that **Hazard**, the analyst establishes **what event(s) could occur** that would result in the Hazard causing damage/injury/death (for example, personnel in contact with hot surfaces). Those events become the **Undesired Events (Accidents)**. There could be multiple Undesired Events resulting from each identified Hazard.

c. The analyst then establishes the **Effects of each Undesired Event** in terms of damage/injury/death (for example, serious injury to personnel). When numerous effects result, only the most severe need be noted.

d. From this point, the analyst establishes **what could cause those Undesired Events** to occur and these findings become the **Causes** (for example, personnel error). **There could be multiple causes for the same Undesired Event.**

e. To determine the facility's ability to sustain the catastrophe, the analyst must then **Assess the Safety Features and Procedures** in force which would, either directly or indirectly, minimize the probability of the occurrence of each Cause. If the Cause(s) can be minimized, the Undesired Event will not likely occur; therefore, **an Assessment is made for each individual Cause. Those Assessments must take the form of an investigation of the design and operation of the facility for each individual Cause.** Operational Procedures and facility drawings must be consulted to determine how the Hazard is contained and how daily operations are managed toward minimizing the probability of Undesired Events.

f. The next step in the analysis is the **Risk Assessment.** (Due to the length of this subject, it is discussed separately below in **paragraph 2.3.2.5, "Risk Assessment.")** **An individual Risk Assessment is made and assigned for each of the previously identified Causes.**

g. If an assigned **Risk Assessment** is unacceptable, **Recommendations** are made which, if implemented, would reduce that **Risk Assessment** to acceptable limits. (See paragraph 2.3.2.5.3a, b, and c regarding acceptability of Risks.) These **Recommendations** normally take the form of additional Safety Features/Devices, Design Changes, or changes in Operating Procedures.

h. **Summary.**- Undesired Events, Causes, and **Effects** should be confined to "credible" as opposed to "conceivable" happenings.

Their credibility is important in that it will ensure that the effort expended on the safety analysis is justified. They should reflect only those things that could reasonably be expected to occur.

2.3.2.5 Risk Assessment

The Undesired Events identified for each subsystem and the results of the detailed HCA are covered in detail in the Appendixes of the SAR and summarized in the Tabular Summaries. An alpha-numeric Risk Level, based on both Severity and Probability of Occurrence, is derived and assigned to each Undesired Event. The following paragraphs address how those alpha-numeric Risk Levels and the resulting Risk Assessment Codes (RAC's) are derived. (Also see Figure 3-2, "Current Risk Assessment Matrix.")

2.3.2.5.1 Severity Category

Severity is assigned assuming the Undesired Event will occur. Worst possible results are assumed with no consideration being given to abatement techniques incorporated in the system design or to the use of procedures. The Severity Category provides a relative measure of the worst possible consequences resulting from personnel error, environmental conditions, design inadequacies, procedural deficiencies, and subsystem or component failure/malfunction. These Categories are:

a. Category I - Catastrophic - May cause death, permanent disability, hospitalization of five or more people, and/or system/ equipment damage in excess of $250,000. (Type A or B Mishap)

b. Category II - Critical - May cause lost time injury or illness, and/or system/equipment damage between $25,000 and $250,000. (Type C Mishap)

c. Category III - Marginal - May cause minor injury or illness, and/or system/equipment damage between $500 and $25,000. (Reportable Incident)

d. Category IV - Negligible - Will not result in injury, occupational illness, or system/equipment damage in excess of $500. (Non-Reportable Incident)

2.3.2.5.2 Probability of Occurrence Level

Probability of Occurrence Level provides a measure of system safety by evaluating the system design in conjunction with abatement techniques, inspections, tests, and operating procedures. The Probability of Occurrence Level is the probability that a failure will occur sometime during the planned life of the system. The probability level is qualitatively based upon engineering judgment with appropriate guidelines. Those guidelines are:

a. **Level A - Frequent** - This is the level assigned when neither a safety feature nor approved procedures exist to prevent the Undesired Event.

b. **Level B - Occasional** - This is the level assigned when a safety feature does not exist to prevent the Undesired Event; but, the use of approved procedures should prevent the Undesired Event.

c. **Level C - Possible** - This is the level assigned when approved procedures do not exist to prevent the Undesired Event; but, an existing safety feature should prevent the Undesired Event.

d. **Level D - Remote** - This is the level assigned when both a safety feature and approved procedures, or two independent safety features, exist which, collectively, should prevent the Undesired Event.

**2.3.2.5.3 Establishing a Risk Assessment Code (RAC)**

Using the **Categories** and **Levels** described above, the information provided by the facility for the analysis, and on-site inspection techniques, the Safety Engineer conducts the analysis to determine the risks associated with each of the listed Undesired Events. This process will result in each **Undesired Event** being analyzed with respect to each credible **Cause**. Also, each of the Undesired Events will be shown to have an **Effect**. Each of the listed **Causes** is then assigned its own unique **Risk Level** (for example, IA, IIB, IIIC, and so forth). Applied to the two-dimensional matrix (see Chapter 3, Figure 3-2, "Current Risk Assessment Matrix), these **Risk Levels** translate into one of three **Risk Assessment Codes** (**RAC's**): **RAC 1**, **RAC 2**, or **RAC 3**. They are pattern-coded on the matrix to distinguish each from the other. **RAC 1's** include blocks IA, IB, IC, IIA, IIB, and IIIA. **RAC 2's** include blocks IIC, IIIB, and IVA. All other blocks are **RAC 3**. The implication of a given **RAC** is explained in the following paragraphs.

a. **RAC 1's for new facilities**, and those associated with a major Construction of Facilities (CoF) in existing facilities, are of major safety concern and **require corrective action before the facility can operate. RAC 1's for existing facilities not** undergoing a major CoF are also of major safety concern and **require an abatement plan approved by the Safety Manager. This abatement plan must be developed by facility personnel and approved by the Safety Manager within 30 days of either (1) publication of this document (for existing RAC 1's), or (2) knowledge of a new RAC 1's existence (for any RAC 1's assigned in the future). Failure to meet this requirement could result in facility shutdown.**

b. **RAC 2's for new facilities**, and those associated with a major CoF in existing facilities, are also of concern and require special attention. The FSH of the facility in question, with Safety Manager concurrence, shall by letter, **inform the Program Director** who oversees the facility of the nature of the RAC 2's and request approval to conduct operations. Operations shall not begin in that facility until the Program Director, with the concurrence of the Integrated Systems Review (ISR) Chairperson, has responded by letter authorizing such action. **RAC 2's for existing facilities not** undergoing a major CoF require no such approval; however, plans and programs to correct them as time and resources permit are considered sound management practice.

c. **RAC 3's are of an acceptable risk level.**

### 2.3.3 Engineering Drawings

#### 2.3.3.1 General

Engineering drawings which are brought into the CM Program are designated and maintained as Configuration Controlled Documents (CCD's). These drawings have been singled out by facility, safety, and engineering personnel as especially important to the facilities' safe and continuous operation. These drawings are listed in the **CCD section** of the **Facility Baseline List** (FBL) and represent the known configuration of the facilities they depict. Other drawings may be designated as **Supporting Facility Documents (SFD's)** and listed in the SFD section of the FBL. (See paragraph 2.3.4.2.)

#### 2.3.3.2 Criteria for Designating Drawings as CCD's

The criteria for selecting and incorporating new engineering drawings into the FBL as CCD's are listed below. The drawing must be:

a. Necessary for the safe operation of the facility.

b. Able to support the independent safety analysis of the operating systems.

c. Usable for system troubleshooting.

d. Suitable for engineering change design.

The CM Contracting Officer's Technical Representative (COTR) has the responsibility for resolving any differences of opinion and making final decisions regarding the disposition of all drawings chosen for inclusion in the CM Program. (See LHB 7320.1, "Engineering Drawing System," for more detailed guidance on LaRC drawing format, approval, and control.)

### 2.3.3.3 Drawing Documentation Requirements

All engineering drawings currently in the CM Program have either been field verified (FV) or are in need of field verification. No new drawing may be brought into the program (added to the CCD section of the FBL) unless it is first field verified. The field verification process is a hands-on verification of the validity of the drawing conducted by facility, SSQRD, Operations Support Division (OSD), or Contractor personnel. A drawing which has been field verified will display a "FIELD VERIFIED" statement authenticating that action. That statement will be signed by the person attesting to the field verification. It will further be signed and dated as approved by the Technical Project Engineer (TPE), FSH, or some other responsible person. A sample of this statement is as follows:

**FACILITY BASELINE DRAWING**
**FIELD VERIFIED BY:** ____________________
**APPROVED BY:** ____________________
**LATEST DATE:** ____________________

Some drawings exist which display a "WARNING! UNVERIFIED" statement alerting the user that they are not field verified. A sample of that statement is as follows:

**WARNING!**
**UNVERIFIED**

**All drawings which are currently in the CM Program and not field verified are the subject of an ongoing field verification effort by facility and OSD personnel as time and resources permit.**

### 2.3.3.4 Changes to Drawings

When drawings in the CM Program require change, the drawing shall be red-lined by the technician actually making the hardware change. Proper red-lining techniques are to *add* new items in green ink or black ink highlighted in yellow marker and *delete* existing items by marking over them in red ink. Drawings so red-lined shall be forwarded through channels on a Change Notification Sheet (CNS) and reviewed by Engineering and the Safety Office. When approved, the originals of the drawings will be modified by the CM contractor and new WORKING MASTER copies provided to the facility.

### 2.3.3.5 Working Masters

For each drawing listed on the FBL as a CCD drawing, the facility is provided with a current revision of the drawing marked WORKING MASTER in red color. The intent of this procedure is to identify the drawing as a copy of the current configuration of the facility as described by the drawing which is recorded on the Master retained in Engineering Drawing Files. These drawings should be kept in a central location in the facility and closely controlled to ensure availability to facility personnel for reference to correct facility configuration. Each time a CCD drawing is revised, a new WORKING MASTER of the revised drawing is provided to the facility. The CM contractor is assigned the responsibility for the preparation of the revised drawings and distribution to the appropriate facility/facilities in accordance with the CM Program.

There are a number of CCD drawings which detail systems that affect more than one facility. When a drawing affects more than one EC, each of the affected EC's will be listed on the CCD sticker applied to the drawings. In addition, each of the affected EC facilities will receive a drawing marked WORKING MASTER. In this manner, each EC facility can maintain a complete file of WORKING MASTER drawings which reflect up-to-date configuration. However, this results in more than one drawing marked WORKING MASTER. It is conceivable that one facility may have modified a system, including the red-lining of the affected drawings, without the knowledge of the other facility having custody of the same WORKING MASTER drawing. Expeditious revision of the appropriate drawings and distribution of current WORKING MASTERS will alleviate this perturbation in the CM drawing program in the most part. To preclude the adverse impact of using a WORKING MASTER drawing which is in the process of revision by another custodian of the same drawing, contact the other custodian and inquire as to the drawing status and get the information regarding the revision if under revision.

Adherence to the following additional guidelines will promote proper accountability and use of WORKING MASTER drawings:

a. A WORKING MASTER drawing **should always reflect the true (as-built) configuration** of the facility which it represents.

b. Proposed changes to a facility which impact on a CCD drawing should be red-lined on a separate copy of the affected drawing; not the WORKING MASTER.

c. Changes which reflect "as-built" configurations should be marked on the WORKING MASTER of each affected CCD drawing.

d. The current WORKING MASTER (or a copy) should always be present at the facility.

### 2.3.4 Facility Baseline List (FBL)

The FBL, although not in itself a CCD, lists the documents pertinent to a given facility that are CCD and under the management of the CM Program. The documents listed in the FBL are selected during the initial phase of the Facility Systems Safety Analysis and each must be approved by the FSH and Facility Team. They normally include the SAR, the SOP's and/or Checklists, any Recertification documents, and the key facility engineering drawings. Each must be complete, accurate, and current. The CM contractor is responsible for actually creating and maintaining the FBL once the documents to be listed therein have been identified. The following paragraphs describe the format of an FBL and present an explanation of its sections.

#### 2.3.4.1 The Change Control Record

The FBL Change Control Record is a five-column form used to record all actions taken to revise a CCD document listed in the FBL. Its heading includes the name and number of the facility, and the EC which has been assigned to the facility. The columns (left to right) are:

a. DATE--The date that the change is actually made in the FBL pages affected.

b. CNS NO.(s)--The CNS number which initiated the change followed by a brief description of what the change was about.

c. REPLACEMENT PAGES--The pages of the FBL that were actually altered in making the change.

d. REV.--The new (current) revision of the FBL. The letters I, O, Q, S, X, and Z are not to be used. When Y is the last revision used, the next sequence shall be AA through AY (then, BA through BY, and so forth).

e. CM ENGINEER--The name of the contractor CM Engineer who is executing the change. Prior to publication and distribution of the new pages, the CM Engineer shall sign the form over his/her typed name.

2.3.4.2 The Listings

The Listings of the FBL are contained in two sections: the CCD's section and the SFD's section. These sections are distinguishable by the different titles of the forms and the number of columns. Both sections are paginated in one sequence starting with 1 on the first page of the CCD's section and ending on the last page of the SFD's section.

a. The three-column CCD form includes:

(1) DOCUMENT NUMBER--The number of the document (that is, drawing, SAR, or Procedure number). Drawing shall be listed first, in numerical sequence for ease of reference, followed by the SAR, the Procedures and/or Checklists; then, any other document which has been designated as CCD.

(2) REV.--The current (active) revision letter(s) of the drawing or other document listed in column 1. Again, the letters I, O, Q, S, X, and Z are not used.

(3) DESCRIPTION--The title of each of the drawings and documents listed in column 1.

b. The two-column SFD form includes:

(1) The same **Document Number** column as does the three-column CCD form and its purpose is the same (see paragraph 2.3.4.2a(1) above). Normally the only documents listed in the SFD section are drawings.

(2) The middle (REV.) column does not exist on this form since the revisions of SFD drawing are not recorded.

(3) The second column on this form is the DESCRIPTION column and serves the same purpose as the DESCRIPTION column on the three-column CCD form (see paragraph 2.3.4.2a(3) above).

2.3.5 Other Document Maintenance Requirements

2.3.5.1 Filing Systems

The CM Program affects three file systems: **Engineering Drawing Files (EDF), CM Contractor files, and Research Facility files.** Document maintenance consists of the timely updating of CCD drawings and other supporting documents (SOP's, SAR's, and so forth), keeping historical records, and keeping "originals" (reproducible masters) on file. Document records will be maintained by each file system as indicated:

a. **Engineering Drawing Files** (EDF). EDF is the repository for all original configuration controlled drawings and for the microfilmed historical records of configuration controlled drawings and other CCD's (see LHB 7320.1 for details). EDF will microfilm the original CCD's and all subsequent changes in order to preserve these historical records. Only the CM contractor is permitted to withdraw CCD original drawings from EDF (see paragraph 2.3.5.1b below). Analyses, drawings, and nondestructive engineering information for systems which have been recertified or identified on the CIL will also be stored in EDF.

b. **CM Contractor Files.** The CM contractor will maintain and store the originals (reproducibles) of all SOP's, SAR's, and other CCD documentation (except drawings). As changes are approved and made to these documents, the CM contractor will ensure that all interested parties receive updated pages as appropriate. The facility will be given a WORKING MASTER copy of all CCD revisions once they are created by the CM contractor. The CM contractor will have on hand only those CCD original drawings to be modified as directed by an approved CNS. Original drawings will be changed by the CM contractor in accordance with the red-lined drawings accompanied by an approved CNS. The CNS will be handled in accordance with the Change Control Flow Chart (see Figure 4-3). After the original CCD drawing is changed, it will be initialed by the person who prepared the red-line, a Facilities Engineering Division (FENGD) representative, and the FSH. All changes are considered to have been "Field Verified" upon sign-off by cognizant personnel. The CM contractor will provide appropriate copies to the interested parties and return the original of the drawing to EDF.

c. **Research Facility Files.** Each research facility EC will maintain its own current WORKING MASTER filing system of CCD's. Updates to these documents will be provided by the CM contractor; but, the facilities must ensure that updates are properly posted and centrally stored so as to be of use when needed.

### 2.3.5.2 Supporting Facility Documents (SFD's)

These documents shall be red-lined by facility personnel and changed as necessary to support facility operations. SFD drawings may be revised through the Facilities Configuration Coordinator (FCC) at FENGD. Since SFD's are not CCD, they are not serviced by the CM contractor.

## 2.4 LaRC INTERLOCK PHILOSOPHY

### 2.4.1 General

The mission of LaRC is to conduct meaningful, leading-edge research in the fields of aeronautical and aerospace technology. In order to conduct such research, large power sources, pressurized gases, vacuums, hazardous materials, heavy machinery, and many other potentially dangerous conditions, procedures are necessary. The requirement to integrate safety into such an operation is paramount toward protecting the community, operating personnel, equipment, and the environment. **LaRC's cornerstone strategy to achieve the required level of safety is the Interlock Philosophy.** The philosophy is enunciated in the following paragraphs:

a. A credible single order failure that can jeopardize personnel or major equipment requires an interlock or protective device to prevent its occurrence.

b. The safety interlock or protective device must be independent of the failure mode and cannot be compromised by occurrence of the credible single order failure.

c. When an independent safety interlock or device cannot be provided due to the utilization of a common component or path, then an independent component and/or path may be necessary (for example, hardwired backup of a software safety interlock or device).

d. The safety interlock or device, unless it is verified automatically during startup (as a permissive), should be periodically verified for proper operation. Period of performance will be established by the safety analysis and specified in the SAR.

e. Safety interlocks and devices, either software or hardware, must be under configuration control at the project level both before and during shakedown. Commencing at the Operational Readiness Review (ORR), these safety interlocks and devices will come under LaRC configuration management in accordance with Chapter 4 of this handbook. At no time will program changes be made while the facility is on line. Forcing of safety interlocks or devices during facility operation (temporary changes to complete a run or troubleshoot a problem) must be in accordance with an approved procedure and have the permission of the FSH or a designated alternate.

f. Failures of catastrophic proportions will be identified by the facility safety analysis and redundant safety interlocks or devices provided. Each situation will be assessed individually in the safety analysis as these potential failures are identified.

Protective measures will be established by the Safety Manager to assure consistency throughout the Center.

### 2.4.2 Techniques

The above philosophy must be pursued regardless of the type of process control or complexity of the research facility. Several techniques are used to achieve these aims, yet permit the necessary research to be accomplished. These techniques are discussed in the following paragraphs, in order of effectiveness, beginning with the most effective.

a. **Design**. The first line of safety is in the initial design of a research facility. Safety and interlock policies must be of equal and simultaneous consideration with research aims in the initial design phase of a facility. It is at this point that the best, and the most cost effective, safeguards can be incorporated into the system.

b. **Engineered Safety Features**. Once a facility is constructed, additional safety margins can best be attained by ad hoc, engineered safety features. Such devices become an integral, permanent part of the facility and its routine operation. Like design features above, they are most likely passive in nature and require no special action to cause them to be effective.

c. **Safety Devices**. Adjunct devices, which are provided for operating personnel, can also enhance safety. Such devices (protective goggles, hard hats, safety bars, and so forth) are effective; however, they require a conscious act on the part of the operator to become useful. Although they may appear cost effective, their effectiveness is moot if they are not employed.

d. **Warning Devices**. Visual and audible means to alert personnel to hazards are also very economical. They are not, however, and should never be considered as barriers. Many of the techniques in the previous paragraphs are barriers. The term barriers implies that such devices **prevent** the occurrence of Undesired Events. Warning devices are effective only when personnel are aware of them in sufficient time to react; and do, in fact, react.

e. **Procedures/Training**. The introduction of the human element into a perfectly designed and controlled hardware system brings with it a potential for unexpected results. The only way to ensure that the occurrences of these operator errors are minimized is through the use of a thorough training program and the use of properly written, verified, and controlled SOP's. If operator training and procedure compliance are to be completely effective in lowering the probability of an Undesired Event to an acceptable level, they must be coupled with some, if not all, of the abatement techniques listed in paragraphs 2.4.2a through 2.4.2d above.

Chapter 3

# SYSTEM SAFETY ANALYSIS UPGRADE

## 3.1 PROGRAM SUMMARY

System Safety Analyses have been performed at a number of LaRC facilities as part of the LaRC Safety Program. These analyses provided information on operational risks in the facilities and are the foundations of the SAR's, SOP's, and Checklists now in existence. Since these initial System Safety Analyses were completed, many have been **upgraded** into a format which provides greater definition in the area of assessment of the risks involved. These **upgrades** were accomplished in an attempt to apply the latest risk assessment techniques and safety philosophy to the process. Since many of the earlier versions still exist, paragraphs 3.1.1 and 3.1.2 below are provided to give insight into their meaning. Paragraph 3.1.3 below describes the current approach.

### 3.1.1 The Initial Convention

The **Initial Convention** used in the assessment of risks was a straight-forward, one-dimensional, rank-ordering of the risks under which any one of six Risk Assessment Classification ratings could be assigned to any one Effect of any one Undesired Event. The Risk Assessment Classifications in the initial convention were:

a. I--Possible serious or fatal injury to the public or to test subjects.

b. II--Possible serious or fatal injury to test facility personnel.

c. III--Possible damage to major equipment.

d. IV--Terminated or delayed operations.

e. V--Nuisance failure.

f. N/A--Nonapplicable.

That Risk Assessment Classification convention still exists in many of the SAR's. Those SAR's are still valid; but, will be the subject of an **upgrade** action in the future. The severity of the classifications under this convention can best be understood by considering that all assessments of I, II, or III should be of concern in the daily operation of the facility and action should be underway to reduce them to IV, V, or N/A.

### 3.1.2 The Interim Convention

Also still in existence at some facilities is an **Interim Convention** which was the first attempt to achieve a more meaningful approach to Facility System Safety Analyses. This was the first use of a two-dimensional matrix in which **Severity Categories** (Categories I-IV) **and Probability of Occurrence Levels** (Levels A-D were used to achieve a basic Risk Assessment Code (RAC) of 1, 2, or 3. It was during this period that these basic RAC levels were established. The two-dimensional matrix used in this **Interim Convention** is shown in **Figure 3-1, "Interim Risk Assessment Matrix." A RAC** level was determined by establishing the **Severity Category** through application of the stated definitions of each Undesired Event situation; then, determining the **Probability of Occurrence Level** by applying other definitions which are based upon the facility's physical and procedural status. Those assessments falling into the three (black) blocks in the extreme upper left corner of the matrix were considered to be the most severe (RAC 1). As with the **Initial Convention**, SAR's in the **Interim Convention** format are still valid. They, too, will be the subject of a Safety Office **upgrade** action as time permits.

### 3.1.3 The Current Convention

**Figure 3-2, "Current Risk Assessment Matrix,"** shows the most recent approach used by Safety Engineers to **upgrade existing SAR's**. This approach would also be used to **create a new SAR**. The basic RAC levels (1, 2, and 3) remain the same as developed in the **Interim Convention**, as does the method used to determine them; however, the black area encompassing the "most severe" category (**RAC** 1) has been expanded to six blocks, the definitions of the **Severity Categories** have been further refined, and the definition of Probability of Occurrence Level D has been expanded. **RAC's** are divided into these three groups based on the class of deficiency (see NHB 1700.1(V1-A), "Basic Safety Manual"). The method for developing a SAR under this convention is presented, in detail, in Chapter 2, paragraph 2.3.2, "Safety Analysis Reports."

## HAZARD SEVERITY

The Hazard Severity Category provides a relative measure of the worst possible consequences resulting from personnel error, environmental conditions, design inadequacies, procedural deficiencies, subsystem or component failure or malfunction as follows

**CATEGORY I - CATASTROPHIC**

May cause death, system loss, or major equipment loss

**CATEGORY II - CRITICAL**

May cause severe injury, severe occupational illness, major system damage, or major equipment damage

**CATEGORY III - MARGINAL**

May cause minor injury, minor occupational illness, minor system damage, or minor equipment damage

**CATEGORY IV - NEGLIGIBLE**

Will not result in injury, occupational illness, system damage, or equipment damage

## HAZARD PROBABILITY

The probability that a hazard will occur during the planned life expectancy of the system. The probability level is quantitative based on engineering judgment with appropriate guidelines as follows

**LEVEL A - FREQUENT**

Level assigned when neither safety features nor approved procedures exist to prevent the undesired event from occurring

**LEVEL B - OCCASIONAL**

Level assigned when safety features do not exist to prevent the undesired event from occurring, but the use of approved procedures should prevent the undesired event from occurring

**LEVEL C - POSSIBLE**

Level assigned when approved procedures do not exist to prevent the undesired event from occurring, but existing safety features should prevent the undesired event from occurring

**LEVEL D - REMOTE**

Level assigned when both safety features and approved procedures exist which should prevent the undesired event from occurring

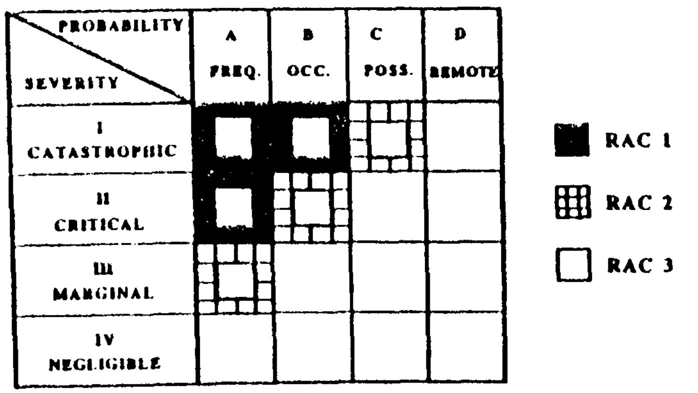



Figure 3-1. Interim Risk Assessment Matrix.

## HAZARD SEVERITY

The Hazard Severity Category provides a relative measure of the worst possible consequences resulting from personnel error, environmental conditions, design inadequacies, procedural deficiencies, and subsystem or component failure/malfunction, with no consideration being given to abatement techniques

**CATEGORY I - CATASTROPHIC**

May cause death, permanent disability, hospitalization of five or more people, and or system or equipment damage in excess of $250,000 (Type A or B mishap)

**CATEGORY II - CRITICAL**

May cause lost time injury or illness, and or system/equipment damage between $25,000 and $250,000 (Type C mishap)

**CATEGORY III - MARGINAL**

May cause minor injury or illness, or system/equipment damage between $500 and $25,000 (Reportable incident)

**CATEGORY IV - NEGLIGIBLE**

Will not result in injury, occupational illness, or system/equipment damage greater than $500 (Nonreportable incident)

## HAZARD PROBABILITY

The probability that a hazard will occur during the planned life expectancy of the system. The probability level is quantitative based on engineering judgment with appropriate guidelines as follows

**LEVEL A - FREQUENT**

Level assigned when neither a safety feature nor approved procedures exist to prevent the undesired event from occurring

**LEVEL B - OCCASIONAL**

Level assigned when a safety feature does not exist to prevent the undesired event from occurring, but the use of approved procedures should prevent the undesired event from occurring

**LEVEL C - POSSIBLE**

Level assigned when approved procedures do not exist to prevent the undesired event from occurring, but an existing safety feature should prevent the undesired event from occurring

**LEVEL D - REMOTE**

Level assigned when both a safety feature and approved procedures, or two independent safety features exist which collectively, should prevent the undesired event from occurring

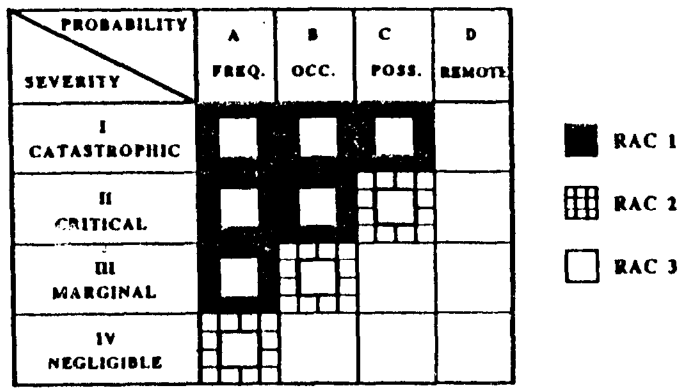



Figure 3-2.- Current Risk Assessment Matrix.

Chapter 4

# FACILITY CONFIGURATION MANAGEMENT (CM) PROGRAM

## 4.1 PROGRAM SUMMARY

The LaRC **Facility Configuration Management (CM) Program** covers 60 research facilities (referred to as Effort Codes (EC's) in the context of CM). They are listed in Chapter 1, Figure 1-1, "Effort Code Summary." These EC's represent 70 research activities. CM implies the **control and continuous updating of documents** listed in the FBL and includes continuous systems safety analysis to assess the impact of change. It is important that any change to facility hardware and/or procedures be processed through this **Change Control System**. A support contractor provides continuous update of the documents for each facility in the CM Program. These documents include:

a. **Safety Analysis Reports (SAR's)** in which hazards and potential undesired events have been identified and the methods for their control have been analyzed to assure that the system does not expose personnel or equipment to unacceptable risks due to credible single point failure.

b. **Standard Operating Procedures (SOP's)/Checklists** in which detailed operation sequences are provided to safely operate the facilities.

c. **Configuration Controlled Document (CCD) engineering drawings** as listed in the FBL.

d. **Pressure Systems Documents** in which is recorded the database generated during the Inservice Inspection/Recertification effort. (NOTE: The Pressure Systems Configuration Management Program is now a separate, distinct entity from the Facility CM Program (and supporting documents). However, as the program matures, it is envisioned that the Pressure System Documents will become a part of the Facility CM Program. See Chapter 5 for a description of the Pressure System Configuration Management Program.)

## 4.2 CHANGE CONTROL

### 4.2.1 General

Basic to any change control in a CM Program is the notification of the change to the affected parties, verification that no protective measures have been degraded or defeated, and that no new hazards have been introduced. These requirements are satisfied at NASA LaRC through the use of either of two forms:

a. NASA Langley Form 127, "Change Notification Sheet (CNS)." (See Figure 4-1.)

## CHANGE NOTIFICATION SHEET

| FACILITY NUMBER | ORIGINATOR | EXTENSION | DATE |
|---|---|---|---|
| FACILITY NAME | | | EFFORT CODE |

DESCRIPTION OF CHANGE

**SAMPLE**

**FACILITY BASELINE LIST (FBL) DOCUMENTS AFFECTED:**

| DOCUMENT NUMBER | CURRENT REVISION | TITLE | Maintained | |
|---|---|---|---|---|
| | | | CCD | SFD |
| | | | | |

### APPROVALS

| HEAD, FACILITY ASSURANCE SECTION, SSORD | DATE | FACILITY COORDINATOR | DATE |
|---|---|---|---|
| FACILITIES CONFIGURATION COORDINATOR | DATE | FACILITY SAFETY HEAD | DATE |

| DOES THIS CHANGE AFFECT SAFETY? ☐ YES ☐ NO | CHANGE VERIFIED | CNS INCORPORATED | CHANGE NUMBER |
|---|---|---|---|
| CRITICAL ITEMS LIST AFFECTED? ☐ YES ☐ NO | CM CONTRACTOR DATE | CM CONTRACTOR DATE | SHEET OF |

NASA Langley Form 127 (Rev. Jan. 1992) Previous editions may be used Prescribing Document LHB 1740.4

Figure 4-1.- Change Notification Sheet (CNS).

b. NASA Langley Form 184, "Problem/Failure Report (PFR)." (See Figure 4-2.)

The CNS and PFR, when required, will be processed in accordance with the directions in Figure 4-3, "Change Control Flow Chart." The Facilities Configuration Coordinator (FCC) and the Head, FAS, SSQRD, must approve the CNS prior to any hardware changes which affect any CCD document in any NASA LaRC facility which is covered under the CM Program. A safety and/or third party review will be conducted for all modifications except those that are strictly administrative in nature. Prior to change implementation, all planned configuration modifications will be reviewed, concurred in, and approved by the Head, FAS, SSQRD, the FCC, and in some cases, also the Facility Engineer. After the modification has been completed, the CM contractor will update the affected documents (drawings, procedures, checklists, and/or SAR's) in accordance with submitted red-lines and analyses, and make distribution of the new documentation to all interested parties.

### 4.2.2 Methods of Change

Modifications to facilities at NASA LaRC under the CM Program may be initiated by any one of four methods. The method selected depends upon the complexity and magnitude of the anticipated change. These four methods are:

a. **Administrative Change.** Facility modifications which are simply administrative in nature and do not affect safety may be implemented without a CNS, PFR, or other approval. An example of such changes is the replacement of a mechanical or electrical component with a like device (valve, meter, and so forth).

b. **Change Requiring LaRC Facility Engineer Review.** Facility changes resulting from a problem or failure that does not affect FBL documents should be reported and reviewed via NASA Langley Form 184. (See LHB 1740.2, "Facility Safety Requirements.")

c. **Minor Change not Requiring Design Review.** For those facility modifications affecting FBL documents and not requiring the Design Review process, a CNS is initiated (normally by the FC) and submitted, with red-lined documents supporting the change, to the Head, FAS, SSQRD, and FCC for approval. Detailed procedures documenting the fabrication and nondestructive examination processes for modifications of Critical Items will be provided by FENGD. The final red-lined "as built" documents and field verified drawings are submitted to the CM contractor for review and document update.

| PROBLEM/FAILURE REPORT<br>See Instructions on Reverse | | | SERIAL NUMBER |
|---|---|---|---|

**PART I - EMPLOYEE**

| FACILITY NUMBER | FACILITY NAME | DATE PROBLEM/FAILURE OCCURRED |
|---|---|---|

SYSTEM/COMPONENT IDENTIFICATION (Include Inventory No., Model No., Serial No., etc.)

PROBLEM/FAILURE DESCRIPTION AND PROBABLE CAUSE

**SAMPLE**

| ORIGINATED BY (Employee Name) | DATE |
|---|---|

**PART II - ACTION BY FACILITY COORDINATOR AND FACILITY SAFETY HEAD**

DISPOSITION AND RATIONALE

CORRECTIVE ACTION (Complete as applicable)

- ☐ FACILITY ENGINEERING REVIEW (FER)
- ☐ WORK ORDER, NO. ________________
- ☐ CHANGE NOTIFICATION SHEET, NO. ________________
- ☐ SOFTWARE CHANGE

| ACTION ASSIGNED TO | DATE ASSIGNED |
|---|---|

| FACILITY COORDINATOR (Signature) | DATE | FACILITY SAFETY HEAD CONCURRENCE (Signature) | DATE |
|---|---|---|---|

**PART III - VERIFICATION/CLOSURE**

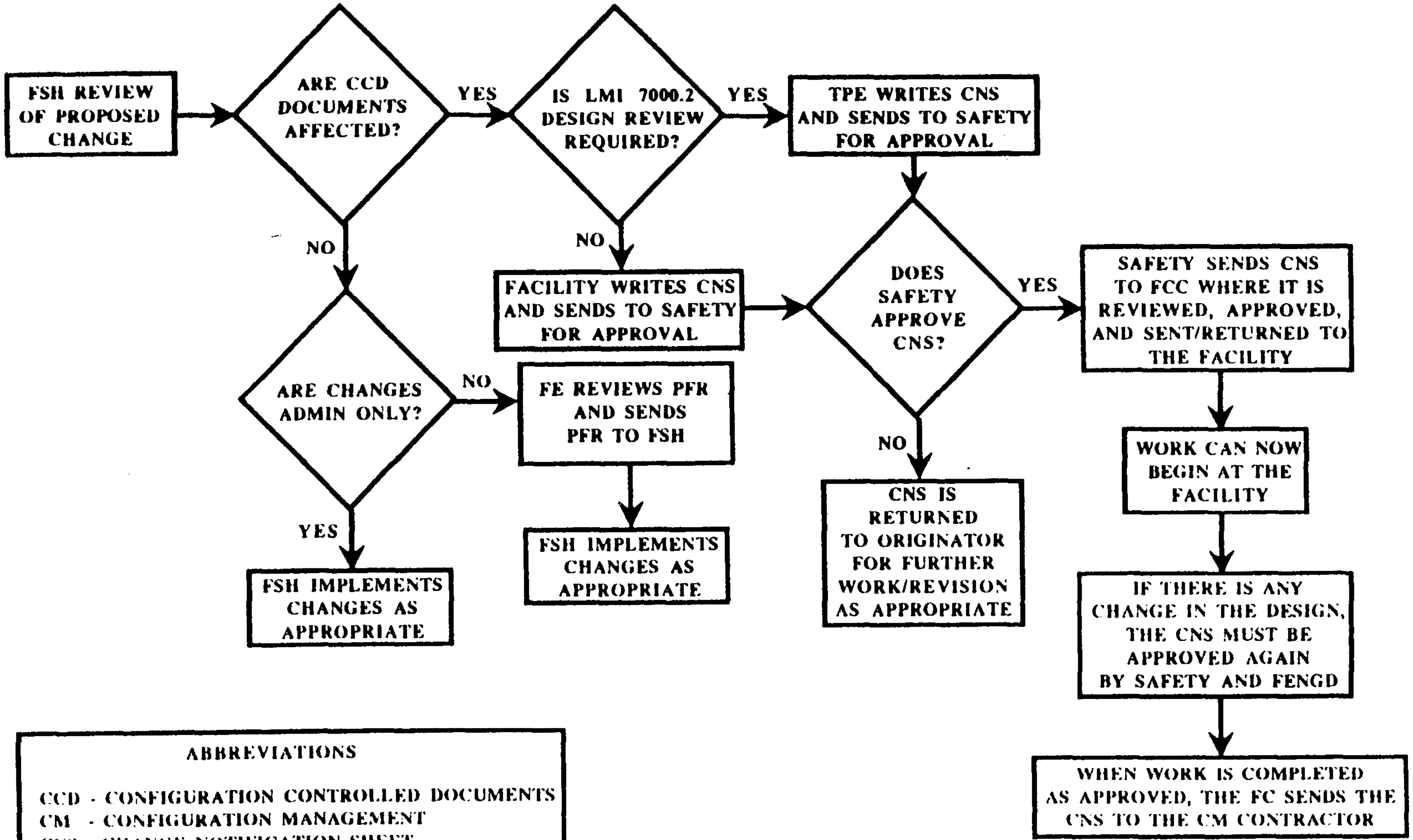
DESCRIPTION OF CORRECTIVE ACTION IMPLEMENTED

| ACTION VERIFIED BY (Signature) | DATE VERIFIED |
|---|---|

| ACCEPTED BY (Facility Coordinator Signature & Date) | CONCURRED BY (Facility Safety Head Signature & Date) |
|---|---|

NASA Langley Form 184 (Rev. Jan. 1992) Previous editions may be used Prescribing Documents LHB 1740.2 and 1740.4

Figure 4-2.- Problem/Failure Report (PFR).




**ABBREVIATIONS**

CCD - CONFIGURATION CONTROLLED DOCUMENTS
CM - CONFIGURATION MANAGEMENT
CNS - CHANGE NOTIFICATION SHEET
FC - FACILITY COORDINATOR
FCC - FACILITIES CONFIGURATION COORDINATOR
FE - LaRC FACILITY ENGINEER
FENGD- FACILITIES ENGINEERING DIVISION
FSH - FACILITY SAFETY HEAD
PFR - PROBLEM/FAILURE REPORT
TPE - TECHNICAL PROJECT ENGINEER

Figure 4-3. Change Control Flow Chart.



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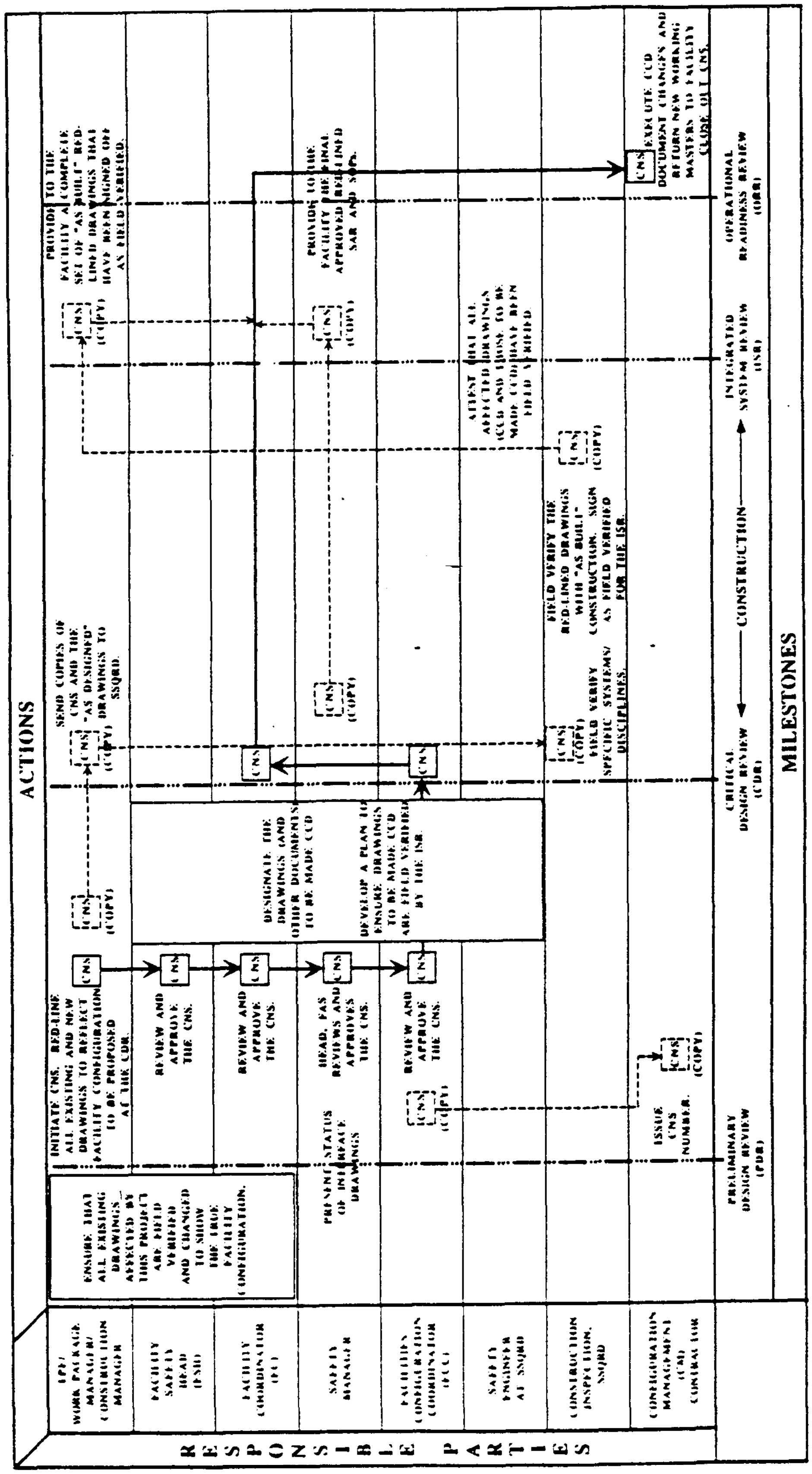


Figure 4-4.- Change Control by Design Review Process

# PRESSURE SYSTEMS CONFIGURATION MANAGEMENT (PSCM)

## 5.1 PROGRAM SUMMARY

Pressure Systems Configuration Management (PSCM) uses the databases generated during Inservice Inspections to produce Configuration Controlled Documents (CCD's) for each system analyzed and documented. These databases are comprised of recertification status sheets (component listings) and computer-aided design (CAD)-produced isometric drawings of high-energy systems. New high-energy systems installed in facilities which are already in the PSCM Program will be added to the program. The resulting CCD's and subsequent changes thereto shall be approved and maintained in accordance with Chapter 4 of this handbook. Engineering and research facility personnel are required to report proposed changes using NASA Langley Form 127, "Change Notification Sheet (CNS)." A Safety and/or third-party engineering review will be conducted for all changes affecting the database. After a change has been approved, and the hardware work has been completed, the CM contractor will field check the changes and update the affected CM documents. All changes to be incorporated in these Pressure Systems Documents (PSD's) will be appropriately red-lined in coordination with engineering and facility personnel, and Pressure Systems will be an agenda item at the annual CM meetings when appropriate. PSD's are useful to engineering and research facility personnel in preparing design changes and during maintenance, repairs, and system inspection. Also, they will be the primary documents used to facilitate future Recertification efforts. High energy systems for the various LaRC facilities will be incorporated into the PSCM Program in order of criticality as resources permit. (See NMI 1710.3, "Design, Inspection, and Certification of Pressure Vessels and Pressurized Systems," for more details.)

## 5.2 PRODUCTS

The products of this program are CCD's called PSD's. Each document consists of:

a. Title Page--Identifies the document as a PSD, gives the facility number and name (if relevant), the system name and designation, and the PSCM document number.

b. PSCM Revision Record--Reflects the approval of the initial issue and all subsequent changes.

c. List of Page Revisions--Lists every page in the document and the current revision letter of each page.

d. Table of Contents.

e. Introduction--Discusses the development, purpose, and uses of PSCM.

f. Definition of Symbols.

g. Key to Recertification Sheets (Component Inventories).

h. System Description.

i. CAD drawing followed by the Recertification Status Sheets.

j. Footnotes.

k. Document Reference Sheet.

Chapter 6

# SOFTWARE CONFIGURATION MANAGEMENT

## 6.1 GENERAL

The introduction of **Automated Control Systems** into NASA LaRC research facilities has generated the need for configuration control of the resulting software at these facilities A **Software Configuration Management (SWCM) Program** to provide regulatory guidance for this documentation is being developed for implementation.

## 6.2 PROGRAM OVERVIEW

As the SWCM Program is implemented in a facility, coordination is required in order to ensure that the software brought under configuration control retains its quality over time. Research facilities having Automated Control Systems will initially have their existing software "**baselined.**" This will, in effect, formalize the existing software as a specific **VERSION** (probably Version 1.0). Subsequent changes must be closely controlled and approved by a **Facility Software Change Control Panel** (FSCCP). Both the initial software packages, and subsequent changes to be reviewed and approved by this panel, will be initiated by the Facility Safety Head (FSH) of the affected research facility by use of a **Software Change Request** (SCR). The FSCCP members will normally include, but may not be limited to, the FSH, the Facility Coordinator (FC), an SSQRD representative, and a FENGD representative (usually the **Facility Automation Engineer** (FAE)).

Upon approval by the FSCCP, the change will be implemented by using the existing CNS process (see Chapter 4, paragraph 4.2.2c) in the established CM Program. The approved change will be made to a copy of the existing (current) Version of the software by appropriate software maintenance personnel. Once the change is made, tested, and verified, it will be subjected to an **Independent Validation and Verification** (IVV). Upon successful completion of the IVV process, the new Version will be established and implemented. This new Version (for example, Version 1.1) will become the active one and the old Version (for example, Version 1.0) will be retained in archive for possible future reference or reimplementation, if necessary. In this regard, up to three past Versions will be maintained in archive to support the current Version.

# LABORATORY RISK EVALUATION PROGRAM (LREP)

## 7.1 PROGRAM SUMMARY

The Laboratory Risk Evaluation Program (LREP) program objectives are to:

a. Establish a separate Configuration Management (CM) Program for Laboratories at NASA LaRC which are not currently under the existing CM Program, nor are they covered under Safety Permit.

b. Increase safety awareness at the operator level at those facilities.

c. Enhance the capability of SSQRD in monitoring the safety aspects of Laboratory operations and assisting in the resolution of unsafe practices.

Over 120 laboratories have been identified as candidates for this program. The LREP will be implemented for each of these laboratories in order of criticality as funding is obtained.

## 7.2 PRODUCTS

The products of this program are Risk Evaluations and Operating Procedures for each of the identified laboratories. These documents become Configuration Controlled Documents (CCD's) and are established as a separate CM Program. As in the existing CM Program, laboratory management personnel shall take the steps necessary to correct any RAC 1 and/or RAC 2 Risk Assessments revealed in the documented Risk Evaluations (see Chapter 2, paragraph 2.3.2.5.3a and b).

### 7.2.1 Risk Evaluations (RE's)

The term Risk Evaluation was established to identify the Safety Analysis efforts associated with the LREP directive. It was intended to differentiate clearly between the LREP analysis and the full-scale Safety Analysis Report (SAR) normally associated with the existing CM Program. The Risk Evaluations, although in a similar format, are not the product of a full-scale Hazard Control Analysis (HCA). They also do not reflect the detailed analysis of electrical and mechanical engineering drawings, the confirmation of interlocks, or other efforts normally included in the conduct of a SAR. Risk Evaluations are subjective analyses of the effectiveness of the operating procedures relative to safety considerations. The evaluations are made based on the data from manufacturers' handbooks, discussions with operator and maintenance personnel, visual inspections, maintenance factors, and a comparative analysis of existing procedures. A Risk Evaluation consists of:

a. **Title Page**--Identifies the document as an LREP product, gives the name of the Laboratory, the unique identifying number, and the facility number in which the Laboratory is located. (The unique identifying number is a combination of the facility number and the order in which the Risk Evaluations were done in that facility; that is 1148-1, 1148-2, and so forth).

b. **LREP Revision Record**--Reflects the approval signatures for the initial issue and all Risk Evaluation changes at the direction of the approving authority.

c. **List of Page Revisions**--Enumerates every page in the document and the current revision letter of each page.

d. **Table of Contents.**

e. **Introduction**--Provides the purpose and philosophy of the analysis and explains the RAC logic.

f. **Laboratory Description**--Gives a brief overview of the Laboratory, lists major capabilities, and discusses the nature of research which can be conducted. This section also includes a Facility Block Diagram of the Laboratory being evaluated.

g. **Risk Evaluation**--Provides the complete assessment of the Laboratory's operational environment. It includes General Observations and General Recommendations which address the existing conditions in a broad fashion. More specific hazards are addressed in the following section, "Tabular Summary."

h. **Tabular Summary**--Column 1 enumerates each **Identified Hazard**. In the second column, marked "**Risk Evaluation**," the analyst describes the Undesired Event, the potential causes and effects, what is presently in place to prevent its occurrence, and what other safety devices and/or procedures might further preclude the event. Following this, the analyst assigns a **Hazard Level** (which is derived from the standard Risk Assessment Matrix discussed in Chapter 2, paragraph 2.3.2.5.3), and proposes **Recommendations** which, if implemented, should reduce the assigned Hazard Levels.

### 7.2.2 Standard Operating Procedures (SOP's)

Many of the Laboratories to be evaluated in the LREP effort have procedures in place and are using them in day-to-day operations. In those cases, the existing procedures are simply put into CM format, demonstrated, and returned to the laboratory without significant change. CM-unique techniques such as the [illegible] circling of NOTES, CAUTIONS, and WARNINGS are incorporated to bring the document to standard format. For those laboratories which have no procedures, initial drafts are prepared and demonstrated prior to being incorporated. The format for procedures is identical to that of Risk Evaluations in the first three pages (Title Page, LREP Revision Record, and List of Page Revisions). Page iv is a general opening page addressing the Purpose, Personnel, Support and Safety Services, and Initial Conditions appropriate to the procedures which follow. The procedures may be numbered in one continuous sequence; or, they may be divided into Pre-Operational, Operational, and Post-Operational sections as dictated by the complexity of the Laboratory. The unique identifying number for procedures is derived simply by adding a "P" to the identifying number of the Risk Evaluation which the procedures support (that is, 1148-1P, 1148-2P, and so forth).

## 7.3 LREP CHANGES

Changes to LREP documents are accomplished in a similar manner as those in the Facility CM Program. In lieu of a Change Notification Sheet (CNS), LREP changes are initiated with a NASA Langley Form 129, "Change in Laboratory Equipment/Procedures (CLEP)," (see Figure 7-1). This form is similar to the CNS form. The one major difference is that it does not require the signature of the Facilities Configuration Coordinator (FCC). The final recipient of the CLEP form, and the action attached to it, is the CM contractor. Changes will be made to the original documents and copies of revised pages will be distributed in a manner similar to the existing CM Program.

| CHANGE IN LABORATORY EQUIPMENT/PROCEDURES (CLEP) | | | | |
|---|---|---|---|---|
| FACILITY NUMBER | ORIGINATOR | MAIL STOP | EXTENSION | DATE |
| FACILITY NAME | | | CHANGE NUMBER | SHEET OF |
| DESCRIPTION OF CHANGE | | | | |

**SAMPLE**

| LABORATORY DOCUMENT TO BE AFFECTED | | |
|---|---|---|
| DOCUMENT NUMBER | CURRENT REVISION | TITLE |
| | | |

| APPROVALS | |
|---|---|
| FACILITY COORDINATOR | DATE |
| FACILITY SAFETY HEAD | DATE |
| HEAD, FACILITY ASSURANCE SECTION, SSORD | DATE |

| ACTION | |
|---|---|
| CHANGE VERIFIED<br>CM CONTRACTOR DATE | CLEP INCORPORATED<br>CM CONTRACTOR DATE |

NASA Langley Form 129 (Jan. 1992) Prescribing Document LHB 1740

Figure 7-1.- Change in Laboratory Equipment/Procedures (CLEP) Form

# ASBESTOS CONFIGURATION MANAGEMENT

## 8.1 PROGRAM SUMMARY

The Asbestos Configuration Management Program (ACMP) was implemented on October 1, 1991. The program objectives are to:

a. Establish a program that will enable the Center to comply with the myriad of clean air emission regulations established by the Environmental Protection Agency (EPA), the Occupational Safety and Health Administration (OSHA), and the Commonwealth of Virginia.

b. Increase safety awareness and minimize the risk of asbestos exposure to personnel.

c. Institute controls to prevent the release of asbestos fibers, restrict future asbestos use, and develop surveillance and control of known existing asbestos applications in Center facilities.

Over 250 facilities have been identified to participate in this program. Each facility was inspected to identify friable and nonfriable asbestos-containing building material (ACBM) and written inspection reports were provided to the FSH's. These reports are on file at the facilities and are the baseline documents for this program.

## 8.2 PRODUCT

The product of this program is the Asbestos Configuration Controlled Document. The purpose of the document is to permit facility personnel, especially the FSH and FC, proper surveillance and control of existing asbestos applications. If hazards are found to exist, prompt and effective action should be taken to eliminate the hazards. The document consists of:

a. **Title Page**--Identifies the document as the configuration controlled document, identifies the facility by number and name, and identifies the current document revision.

b. **Revision Record**--Reflects the approval signatures for the initial issue and all subsequent changes at the direction of the approving authority.

c. **List of Page Revisions**--Enumerates each page in the document and the current revision letter of each page.

d. **Table of Contents.**

e. **Introduction**--Provides the purpose and philosophy of the document.

f. **Facility Asbestos Summary**--Describes in narrative form the asbestos status of the facility.

g. **Facility Diagram**--Depicts the actual location of positive samples where asbestos is located in the facility.

## 8.3 ASBESTOS CONFIGURATION MANAGEMENT CHANGES

Change to ACMP documentation are accomplished by use of **NASA Langley Form 128, "Asbestos Configuration Management Program (ACMP) Change Sheet"** (see Figure 8-1). The form is initiated by the FC/FSH and approved by the Head, Safety Management Section (SMS), SSQRD, and FENGD. The final recipient of the form, and the action attached to it, is the CM contractor. Changes will be made to the original document and copies of revised pages will be distributed to the FSH, SSQRD, FENGD, and OSD.

# ASBESTOS CONFIGURATION MANAGEMENT PROGRAM (ACMP) CHANGE SHEET

| FACILITY NUMBER | ORIGINATOR | MAIL STOP | EXTENSION | DATE |
|---|---|---|---|---|
| FACILITY NAME | | | CHANGE NUMBER | SHEET OF |

DESCRIPTION OF CHANGE

**SAMPLE**

## ASBESTOS DOCUMENT TO BE AFFECTED

| DOCUMENT NUMBER | CURRENT REVISION | TITLE |
|---|---|---|
| | | |

## APPROVALS

| | |
|---|---|
| FACILITY COORDINATOR | DATE |
| FACILITY SAFETY HEAD | DATE |
| HEAD, SAFETY MANAGEMENT SECTION, SSCRD | DATE |
| FENGD | DATE |

## ACTION

| CHANGE VERIFIED | CHANGE INCORPORATED |
|---|---|
| CM CONTRACTOR DATE | CM CONTRACTOR DATE |

NASA Langley Form 128 (Jan. 1992) Prescribing Document LHB ...

Figure 8-1.- Asbestos Configuration Management Program (ACMP) Change Sheet Form

# GLOSSARY OF KEY TERMS

The following list defines key terms used in this handbook:

**Asbestos Configuration Management Program (ACMP)**--A program designed to ensure NASA Langley Research Center (LaRC) compliance with asbestos-related EPA, OSHA, and Commonwealth of Virginia clean air emission regulations.

**Asbestos Configuration Management Program (ACMP) Change Sheet**--NASA Langley Form 128 prepared by LaRC personnel and processed by contractor personnel. It is used to record changes in the asbestos status of Center facilities covered under the Asbestos Configuration Management Program.

**Cause**--The stimulus or triggering mechanism/act which precipitates the Undesired Event.

**Change in Laboratory Equipment/Procedures (CLEP)**--NASA Langley Form 129 prepared by LaRC personnel and processed by contractor personnel. It is used to record all changes made to Configuration Controlled Documents (CCD's) in the Laboratory Risk Evaluation Program (LREP).

**Change Notification Sheet (CNS)**--NASA Langley Form 127 prepared by LaRC personnel and processed by contractor personnel. It is used to record all changes to be made to Facility Baseline List (FBL)-listed (CCD) documents.

**Checklist**--An abbreviated set of written instructions for operating a facility. Checklists are derived from Standard Operating Procedures (SOP's) and contain sufficient detail to enable safe operations by the most experienced operator personnel. Checklists are controlled under the CM Program.

**CM Contractor**--The CM Contractor is the Nonpersonal Service Contractor which supports the LaRC Facility Configuration Management Program.

**CM Update**--The process of reviewing and documenting changes on a continuing basis. During this process, the reproducible masters (originals) are revised to incorporate the changes as shown on red-lined documents. Revisions are initiated and tracked by the use of the CNS.

**Configuration Controlled Documents (CCD's)**--Those facility baseline documents that are considered critical to describing how a facility is configured, how it is to be operated, and what risks are associated with its operation. As such, CCD's are revised only through a formal change process under the Configuration Management (CM) Program. Examples of CCD's include, but are not limited to, Safety Analysis Reports (SAR's), SOP's and Checklists, certain Pressure System Documents, and selected Engineering Drawings.

**Configuration Management** (CM)--A discipline which establishes a baseline for facilities, selects technical and administrative documents, and exercises administrative control of all changes to that baseline.

**Critical Items List** (CIL)--A **Critical Item** is any item, the single order failure of which, would likely result in death or damage to equipment/property equal to or greater than $1.0M.

**Effect**--The consequence of an Undesired Event/Accident in terms of equipment damage and/or personnel injury/death.

**Effort Code** (EC) - A preassigned two-digit number that identifies a specific facility or group of facilities in the CM Program. For the life of the facility, all CCD's will bear this number regardless of any facility name changes and/or hardware modifications.

**Facility Assurance Section** (FAS)--A section in the Risk Management Branch, SSQRD, which is assigned primary responsibility for the management and execution of the CM Program and the development of Facility System Safety Analyses. The Head, FAS, SSQRD, approves all CNS's prior to any CM facility hardware changes involving CCD documentation.

**Facility Baseline List** (FBL)--A list of documents which are pertinent to the safety of day-to-day operations, system safety analysis, and planning for system modifications of a facility under the CM Program. These documents are selected for each facility during the initial phase of the System Safety Analysis. All selected facility documentation will be listed in the FBL. The SAR, the SOP's, and the Checklists are included in this listing. All design analyses referenced in the CIL are included in the FBL as Supporting Facility Documents (SFD's). All engineering drawings will be listed in numerical order and all CCD's will be shown with the latest revision. Facility drawings will be further subdivided into the CCD and SFD sections of the FBL.

**Facility Configuration Coordinator** (FCC)--An individual appointed from the Facilities Engineering Division (FENGD) who coordinates FENGD support to the LaRC System Safety Program. The FCC is responsible for the drawing upgrade associated with the System Safety Analysis effort and drawing updates for the CM Program. The FCC also approves all CNS's prior to any CM facility hardware changes which affect CCD documentation.

**Facility Coordinator** (FC) (**see LMI 1700.2, "Safety Assignments"**)--An individual appointed to coordinate the overall day-to-day operations of an LaRC facility. This individual uses assigned facility personnel, and additional support personnel, as available, to accomplish requirements of this handbook.

**Facility Resumé**--A document maintained by each major facility which is operated by the Operations Support Division (OSD). It contains information required for safe operations. Data includes drawings, operating and emergency procedures, operators' certification, and requirements for the control of unique hazards. The FC is responsible for this document.

**Facility Safety Head (FSH) (see LMI 1700.2)**--An appointed individual who is responsible for providing team direction, obtaining required support from knowledgeable research personnel, and approving all Configuration Controlled Documentation affecting the facility.

**Facility System Safety Analysis**--An analysis throughout all phases of the facility's life cycle involving the identification and control of hazards and the assessment of risks in operating that facility.

**Facility Team**--Personnel assigned to a particular LaRC facility during the initial Systems Safety Analysis or the Upgrade effort. The team is composed of the FSH, FC, FCC, Safety Manager, Safety Engineer assigned to the System Safety effort, and the CM Contractor when needed.

**Field Verified (or Field Verification)**--The process by which the accuracy of a CCD or any other drawing is verified. That accuracy is attested to by affixing a "Field Verified" statement, signed by the person doing the verification, and signed and dated by the Project Engineer, FSH, or other responsible person.

**Hazard**--A condition which has the potential to result in damage to equipment and/or personnel injury/death.

**Laboratory Risk Evaluation Program (LREP)**--A program designed to provide Risk Evaluations (RE's) and SOP's to selected laboratories at LaRC which were not previously in the CM Program and not covered with a Safety Permit.

**LaRC Facility Engineer (FE)**--The engineer assigned by FENGD to review, provide recommendations, and approve research facility repairs and/or work.

**Pressure Systems Configuration Management (PSCM)**--A program to continuously update the Inservice Inspection/Recertification effort. The PSCM contractor establishes an accurate database for high-pressure systems, publishes a Pressure Systems Document on each system inspected, and maintains that document through the existing CM Program.

**Problem/Failure Report (PFR)**--NASA Langley Form 184 which reports on the inability of a system, subsystem, component, part, or material to perform in accordance with specifications, functional test, or operational procedure requirements or expectations. (See LHB 1740.2, "Facility Safety Requirements.")

**Red-Lining**--The process of identifying changes on facility documentation. Deletions to be made are lined through with red markings; additions are shown in green, or in black with yellow highlighting. Red-lining of drawings may indicate proposed changes, or changes to show the "as is" condition.

**Research Facility (Facility)**--A ground-based apparatus or equipment directly associated with research operations, and sufficiently complex or hazardous to warrant special safety analysis and control.

**Risk Evaluation (RE)**--A limited Safety Analysis done under the authority of the Laboratory Risk Evaluation Program (LREP). It is not a full-scale Safety Analysis Report (SAR).

**Safety Analysis Report (SAR)**--A report under the control of the CM Program which documents the formal Facility System Safety Analysis of a particular research facility.

**Safety Engineer**--A representative of the Facility Assurance Section (FAS), Risk Management Branch (RMB), Systems Safety, Quality and Reliability Division (SSQRD), who performs an initial Facility System Safety Analysis, and/or an Upgrade of an existing one, and supports the CM activity for a particular facility.

**Safety Management Section**--A section in the Risk Management Branch, SSQRD, which is assigned primary responsibility for the Center's Institutional Environmental Health Program.

**Safety Manager**--The Branch Head, Risk Management Branch, SSQRD. This individual reviews and approves all System Safety Analyses and reviews all changes to the SAR's, SOP's, and Checklists under the CM Program.

**Single Point Failure**--Those discrete system elements and/or interfaces, the malfunction/failure of which, taken individually, would cause failure of the system.

**Standard Operating Procedures (SOP's)**--Detailed, written, step-by-step instructions to be routinely followed in operating a facility. SOP's contain all information considered pertinent to safe and efficient operation of the facility. SOP's are the source documents for Operational Checklists and are the basis, in part, for the facility Hazard Control Analysis. SOP's may also be used for training operator personnel. SOP's are under the control of the CM Program.

**Supporting Facility Documents (SFD's)**--Those documents, identified in the SFD section of the FBL which are considered as part of the baseline documentation; but, do not meet the criteria for CCD's. They include design analyses and vendor manuals, maintenance procedures, construction drawings, conduit routing, panel board schedules, change control records, test data, structural inservice inspection plans, and detailed component drawings.

**Technical Project Engineer (TPE)**--The engineer assigned by FENGD to manage repairs, rework, or modifications to an existing research facility or construction of a new facility.

**Undesired Event**--An event (or series of events) which unleashes the potential inherent in a hazard; and, either directly or indirectly, results in damage and/or personnel injury/death.

**Undesired Events List**--A listing in the SAR of system failures/malfunctions derived from the preliminary hazard analysis which could, if not adequately controlled, result in personnel injury, unacceptable equipment/facility damage, and/or loss of productivity.

**Upgrade**--The process of revising an existing SAR, which was initially published under a now-outdated convention, to reflect the latest in assessment techniques and safety philosophy.

**Working Masters**--Copies of the latest-revision CCD's (SAR's, SOP's, drawings, and so forth) which are stamped "WORKING MASTER" in red and kept at the facility. These documents are prepared by and provided to the facility by the CM contractor. WORKING MASTER drawings also show, in the CCD block, which facilities (by Effort Code number) consider the drawing to be critical to their operation.

ATTACHMENT 13

NASA LANGLEY MANAGEMENT INSTRUCTION (LMI) 7000.2, REVIEW PROGRAM FOR LANGLEY RESEARCH CENTER (LaRC) CONSTRUCTION OF FACILITIES (CoF) PROJECTS (JUNE 25, 1991)

NASA
National Aeronautics and Space Administration

Langley Research Center

# MANAGEMENT MANUAL

LMI 7000.2

June 25, 1991

SUBJECT: Review Program for Langley Research Center (LaRC) Construction of Facilities (CoF) Projects

**SUMMARY**

This instruction sets forth the applicability, criteria, policy, and procedures for review of CoF Projects under Langley Research Center (LaRC) management.

**APPLICABILITY**

This instruction applies to the following CoF projects:

- All Major Discrete Projects.
- Any Minor Program Projects with elements of unusual or potentially high risk.

Selection of those Minor Program Projects to be reviewed under this instruction will be made by the Chief, Facilities Engineering Division (FENGD), with the concurrence of the Deputy Director for Systems Engineering and Operations. The number and format of Design Reviews for all CoF projects not covered by this instruction will be established by the Chief, FENGD.

**CRITERIA**

The criteria stated herein are minimum requirements for a third-party review of the technical and management aspects of LaRC's CoF projects. The requirements of this instruction do not supersede other reviews imposed by NASA Headquarters, or replace the scientific and technical reviews conducted by LaRC organizations or committees such as:

- Institutional Review Board Reviews (see LMI 7100.8).
- The Executive Safety Board and Its Committees' Reviews (see LMI 1700.3).
- Technical Merit and Feasibility Reviews.
- Routine Line Organization Reviews.

**POLICY**

This Center will conduct the following sequential set of reviews for CoF projects covered by this instruction.

1. Conceptual Design Review (CoDR).

2. Preliminary Design Review (PDR).

3. Critical Design Review (CDR).

→

**POLICY (Continued)**

4. Integrated System Review (ISR).

5. Operational Readiness Review (ORR).

This policy and set of reviews may be altered by the Director for Systems Engineering and Operations, as appropriate, to meet unique project requirements.

**REVIEW OBJECTIVES**

The primary objective of the above reviews is to enhance the probability of success of LaRC CoF projects. This will be achieved using the cumulative knowledge of a team of engineers and scientists who have been selected for their experience with the particular systems and functions involved. These reviews are advisory in nature and do not relieve the LaRC organization to which the project is assigned of the responsibility for the success of the project.

The reviews will be technically oriented and proper consideration is to be given to constraints operating on the project - particularly those involving primary technical objectives, program costs, and schedules.

**GENERAL REQUIREMENTS**

| Item | Responsibility |
|---|---|
| Special Reviews | The Chairperson of each review or the cognizant LaRC Program Director may also establish other special reviews to supplement the above reviews. |
| Support | LaRC Program Directors are to support the above reviews by furnishing senior personnel experienced in the required technical disciplines as requested. |
| | The Chairperson of each review is to organize each panel and draw support from NASA Headquarters, other Centers, industry, or other Federal agencies when applicable. |
| Scheduling | The Project/Program Manager, or equivalent, is responsible for contacting the designated chairperson to request and set a desired review date that allows sufficient time for orderly preparation. A tentative agenda, with allotted times and a designated Action Item Coordinator, will accompany this request. The Action Item Coordinator will be responsible for administratively tracking and routing all documentation necessary for closure of the review action items. |

## GENERAL REQUIREMENTS (Continued)

| Item | Responsibility |
|---|---|
| Notification | Notification of a review is initiated by interoffice letter from the review chairperson to appropriate distribution which includes:<br>• Review objectives.<br>• Date, time, and place.<br>• Committee members.<br>• Action Item Coordinator.<br>• Tentative agenda with allotted times. |
| Review Material | All review material is to be distributed by review initiator to all panel members at least 10 days prior to the scheduled review date. |
| Action Items | Issues and questions which cannot be readily addressed at the review shall be documented on SE&O Organizational Form N-330, "Request for Action," (RFA) forms (available from the Systems Safety, Quality and Reliability Division (SSQRD)), and assigned to an appropriate individual for closure. The Review Panel will screen all submitted RFA's at the end of the review for completeness, elimination, or consolidation, as appropriate. The Project/Program Manager, in conjunction with the Design Review Chairperson, will assign action item responsibilities and due dates on the RFA forms. |
| Action Item Closure | Action Item (AI) assignees shall send responses to the AI Coordinator for logging and routing by the specified due date. Closure requires concurrence by the RFA originator and approval by the review chairperson. An information copy of the tentative closure will be sent to all Review Panel members. Closure will become final unless it is challenged by a panel member within 10 working days. A copy of all final accepted closures is to be sent to SSQRD. The cognizant Division Chief of the RFA assignees is responsible for assuring that all action items are closed in a timely manner. |
| Minutes | Minutes of each review, including action items, are to be distributed by the secretary to the Panel members, appropriate Division Chiefs and Program Directors, and the Correspondence and Records Management Section (C&RMS), Management Support Division (MSD), within 10 days of review completion. |

## REVIEW DESCRIPTIONS

| Review Type | Function |
|---|---|
| • **Conceptual Design Review (CoDR)** | **Objective (CoDR)** |

The objective of the CoDR is to assure the adequacy of the conceptual design to meet the functional design requirements and to provide a sound basis for a final design. The CoDR will normally be scheduled at 90 percent completion of the Preliminary Engineering Report (PER) (see NMI 7330.2).

See Attachment A for a sample CoDR agenda.

**Membership**

Chairperson: Deputy Director for Systems Engineering and Operations or designated alternate
Secretary: Appointed by the Chairperson
Members: LaRC Safety Manager or designated alternate
Facility Safety Head
Facility Coordinator
Cognizant Research Project Representative

At least five technical representatives from supporting line organizations as deemed appropriate by the Chairperson

• **Preliminary Design Review (PDR)**

**Objective (PDR)**

The objective of the PDR is to validate the adequacy of the intended final design approaches as related to the facility functional requirements according to applicable policies, design criteria, standards stated in NHB 7320.1, and other applicable National Codes. The PDR will normally be scheduled when the final design is approximately 30 percent complete.

See Attachment B for a sample PDR agenda.

**Membership** - See CoDR.

**REVIEW DESCRIPTIONS (Continued)**

| Review Type | Function |
|---|---|
| • **Critical Design Review (CDR)** | <u>**Objective (CDR)**</u><br><br>The objective of the CDR is to validate the facility specification for the procurement and construction of the detailed design. The CDR is to ensure the final design and planning have been reviewed and that sufficient data have been presented according to the applicable policies, design criteria, standards stated in LHB 7320.1, and other applicable National Codes. The CDR will normally be scheduled when the final design is approximately 90 percent complete but prior to the initiation of the acquisition/construction phase.<br><br>See Attachment C for a sample CDR agenda.<br><br>After the CDR and closure of resulting action items, line management will coordinate detailed drawing and specification reviews. Upon successful completion of these reviews, the responsible Project/Program Manager will provide a written statement to the CDR chairperson with copies to panel members.<br><br><u>**Membership**</u> - See CoDR |
| • **Integrated Systems Review (ISR)** | <u>**Objective (ISR)**</u><br><br>The objective of the ISR is to validate the quality and configuration of the facility, confirm that it is capable of performing properly under expected operational environments, and assess that facility operational objectives will be achieved. The ISR will normally be scheduled when the construction and systems level acceptance testing is approximately complete but prior to initiation of integrated systems testing.<br><br>See Attachment D for a sample ISR agenda.<br><br><u>**Membership**</u><br><br>Chairperson: Deputy Director for Systems Engineering and Operations or designated alternate<br>Secretary: Appointed by the Chairperson<br>Members: Division Chief responsible for facility<br>Chief, SSQRD or designated alternate<br>Facility Safety Head |

## REVIEW DESCRIPTIONS

| Review Type | Function | |
|---|---|---|
| • **Integrated Systems Review (ISR) (Continued)** | Members: | Facility Coordinator<br>Chairperson, Systems Operations Committee (see LMI 1700.3)<br><br>At least five technical personnel selected by the Chairperson, preferably from the previous design review panels |

**Action**

The Chairperson is to provide a written statement to the cognizant Program Director certifying it is acceptable to initiate system level checkout and test programs. All board members will receive a copy of this written statement.

• **Operational Readiness Review (ORR)**

**Objective (ORR)**

The objective of the ORR is to provide a comprehensive assessment of the facility, equipment, test articles, operational procedures, and staffing to assure the overall readiness and operation of the facility or systems.

The ORR will normally be scheduled when the integrated system level test program is completed but prior to initial research operation of the facility.

See Attachment E for a sample ORR agenda.

**Membership**

| | |
|---|---|
| Chairperson: | Program Director responsible for facility |
| Secretary: | Appointed by the Chairperson |
| Members: | Chairperson, ISR<br>Chairperson, Systems Operations Committee (see LMI 1700.3)<br>Chief, SSQRD or designated alternate<br>Facility Safety Head<br>Facility Coordinator<br><br>At least three technical personnel selected by the Chairperson |

## REVIEW DESCRIPTIONS

| Review Type | Function |
|---|---|
| • **Operational Readiness Review (ORR) (Continued)** | <u>Action</u><br><br>After the ORR, the Chairperson, and an appointed committee to include at least three ORR members, will conduct a final "walk through" of the new/modified facility to:<br><br>- Certify that the facility is operational.<br>- List all observed safety and quality assurance deficiencies.<br>- Verify that all prior corrective actions have been incorporated.<br><br>The Chairperson is to provide a written statement to the LaRC Deputy Director certifying that the facility is acceptable and recommending that the facility be declared operational. All panel members will receive a copy of this written statement. |

## REFERENCES

NHB 7320.1, "Facilities Engineering Handbook"

NMI 7330.1, "Delegation of Authority - Approval Authorities for Facility Projects"

NMI 8800.9, "Intergovernmental Review of National Aeronautics and Space Administration Programs and Activities"

NMI 8800.12, "Coordination of Construction, Maintenance, Operations, and Management of NASA Facilities Programs"

NHB 8820.2, "Facility Project Implementation Handbook"

NASA Software Management and Assurance Program (SMAP) Information System Life-Cycle and Documentation Standards Release 4.3"

LMI 1700.1, "Safety Program"

LMI 1700.2, "Safety Assignments"

**NASA** National Aeronautics and Space Administration

**Langley Research Center**

**MANAGEMENT MANUAL**



**REFERENCES (Continued)**

LMI 1700.3, "The Executive Safety Board and Its Committees"

LHB 1740.4, "Facility System Safety Analysis and Configuration Management"

**RECISION**

LMI 7000.2, dated May 26, 1981, T.S. 1139.

Paul F. Holloway
Deputy Director

Attachments A-E

Attachment A to LMI 7000.2

# CONCEPTUAL DESIGN REVIEW (CoDR)
## Sample Agenda

I. INTRODUCTION
- Scope of Review
- Status of Conceptual Design (percent complete, earlier studies, and so forth)
- Agenda

II. PROJECT OVERVIEW
- Research/Programmatic Requirements and Project Justification
- New Capability/Performance Desired
- Project Scope
  - CoF Funded Portion
  - R&D Funded Portion

III. DESIGN REQUIREMENTS/CONSTRAINTS
- Historic Preservation
- Interfaces
- Functional
- Siting
- Special Systems or Equipment
- Safety, Reliability, and Quality Assurance (SR&QA)
- Security
- Utilities
- Design Codes/Criteria
- Operations and Maintenance
- Design Loads/Environment
- Geometric Lines
- Hardware/Software
- Environmental Impact
- Requirement Changes Since Publication of Facility Requirements Document

IV. CONCEPTUAL DESIGN
- Project Description (major elements/components)
- Site Description
- Architectural Concept
- Foundation/Structural/Mechanical/Electrical Concepts and Analyses
- Evaluation of Options
- Operations and Maintenance Considerations
- Design of Special Systems or Equipment
- Needed Additional Studies/Tests/Analyses
- Summary of How Design Tentatively Meets Requirements
- Areas of Design Concern/Uncertainty

V. SAFETY AND QUALITY ASSURANCE
- Facility Energy Source Checklist
- Preliminary Hazards List
- Preliminary Critical Items List (CIL)
- Status of As-Built Reference Interface Drawings
- Special Construction Inspection Requirements
- Design Safety Considerations

VI. COST
- Baseline Estimate for Preliminary Engineering Report (PER) Funding
- Design/Construction Cost Estimates
  - Breakdown of Major Cost Elements
  - Element Cost Ranges/Uncertainties and Potential for Growth
  - Significant Cost Drivers
  - Potential Areas for Descoping or Bid Alternatives
  - Potential Areas for Design - Furnish and Install Procurement
- Overall Cost Assessment and Uncertainties/Concerns

VII. SCHEDULE
- Project Level (with rationale)
- Major Element or Work Package Level
- Schedule Uncertainties/Concerns

VIII. SUMMARY

## PRELIMINARY DESIGN REVIEW (PDR)
## Sample Agenda

I. **INTRODUCTION**
- Scope of Review
- Status of Design
- Status of Action Items
- Agenda

II. **PROJECT OVERVIEW**
- Project Justification Background
- New Capability/Performance Desired
- Project Scope
  - CoF Funded Portion
  - R&D Funded Portion

III. **PROJECT MANAGEMENT**
- Work Breakdown Structure
- Management Structure/Organization
- Roles and Responsibilities
- Project Controls and Status Reporting
- Documentation Plans and Status of End Items
  - Management Plan
  - Standard Operating Procedures (SOP)
  - Safety, Reliability, and Quality Assurance (SR&QA) Plan
  - Safety Analysis Report (SAR)
  - Inspection Plan
  - Maintenance and In-Service Inspection Plan/Procedures
  - Design Criteria Document
  - Interface Requirements Document
  - Configuration Control Plan
  - Hazard Analyses and Critical Items List (CIL)
  - CIL Installation Procedures
  - Operational Checkout Plan/Procedures
  - Software Management and Assurance Program (SMAP) Plans
  - Design Analyses

IV. **DESIGN REQUIREMENTS/CONSTRAINTS**
- System Interfaces
  - Between Work Package
  - With Existing Facility
- Elements of Interface Requirements Document
- Elements of Design Criteria Document
  - Software Requirements List
  - Programmatic Requirements/Objectives List
  - Engineering Requirements List
  - Design Load Environments List



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V. PRELIMINARY DESIGN
- Preliminary Design Concept Drawings
- Block Diagrams and Schematics
- Design Approach and Supporting Analyses
  - Architectural
  - Structural
  - Mechanical
  - Electrical
  - Controls and Associated Software
- Tradeoff Studies
- Areas of Technical Uncertainty/Risk
- Design Verification Test Results/Plans
- Performance Analyses
- Status Summary of Design Compliance with Design Criteria and Interface Requirements Document

VI. SAFETY, RELIABILITY, AND QUALITY ASSURANCE
- Overview of SR&QA Approach During Design/Acquisition/Construction/ Checkout
- Systems Safety Features Included in Design (interlocks, stops, and so forth)
- Hazard Analyses Results and Preliminary Critical Item List (CIL)
- Implementation of SR&QA Plan
- Field Verification Status of Interface Drawings to be Referenced in Acquisition Package
- Potential Revisions and Additions to Existing Facilities Baseline List (FBL)
- Areas of Concern or Uncertainty

VII. COST
- Baseline PER Cost Estimate
- Current Cost Estimate and Rationale for any Cost Variations
- Cost Concerns/Uncertainties (design or construction)

VIII. SCHEDULE
- Project Level
- Work Package Level
- Status of Design Tasks Against Plan
- Schedule Concerns/Uncertainties (design or construction)

IX. SUMMARY

Attachment C to LMI 7000.2

# CRITICAL DESIGN REVIEW (CDR)
## Sample Agenda

I. INTRODUCTION
- Scope of Review
- Status of Design
- Status of Action Items
- Agenda

II. PROJECT OVERVIEW
- Project Justification Background
- New Capability/Performance Expected
- Project Scope
  - CoF Funded Portion
  - R&D Funded Portion

III. PROJECT MANAGEMENT
- Management Structure/Organization
- Documentation Status
- Overview of Acquisition Plan
- Acquisition Package(s) Status

IV. DESIGN REQUIREMENTS/CONSTRAINTS
- System Interfaces
  - Work Packages
  - Existing Facility
- Elements of Interface Requirements Document
- Elements of Design Criteria Document

V. FINAL DESIGN
- Final Design Concept Drawings
- Block Diagrams and Schematics
- Design Details and Supporting Analyses
  - Architectural/Structural/Mechanical/Electrical
  - Controls and Associated Software
- Performance Analyses
- Maintainability, Repairability, and Operability
- Producibility and Manufacturing Readiness
- Human Engineering
- Mock-ups, Breadboards, and/or Prototype Hardware
- Design Verification Test Results
- Summary of Design Compliance with Elements of Design Criteria and Interface Requirements Documents
- Areas of Technical Uncertainty/Risk

VI. SAFETY, RELIABILITY, AND QUALITY ASSURANCE

- Status of Safety, Reliability, and Quality Assurance (SR&QA) Activities
- Verification Status of Interface Reference Drawings
- Status of Facility Baseline List Drawings
- Independent Reviews of Drawings and Analyses
- Hazard Analyses and Updated Critical Item List (CIL)
- CIL As-Built Assurance Plan
- Systems Safety Features Included in Design
- Overall SR&QA Assessment and Areas of Concern/Uncertainty

VII. COST

- Baseline PER Cost Estimate
- Current Cost Estimate and Rationale for Changes from PDR
- Cost Concerns/Uncertainties

VIII. SCHEDULE

- Project Level
- Work Package Level
- Design Completion and Preparation of Procurement Package
- Procurement Cycle
- Schedule Concerns/Uncertainties

IX. SUMMARY

Attachment D to LMI 7000.2

# INTEGRATED SYSTEMS REVIEW (ISR)
## Sample Agenda

I. INTRODUCTION
- Objective and Scope of Review
- Agenda

II. PROJECT OVERVIEW
- Programmatic Requirements
- Description of Construction Project and Functional Operation of Facility
- Top Level Schedule and Status
- Summary of Prior Reviews of All Types
- Status of Open Action Items from Design Reviews

III. CONSTRUCTION
- Overview and Overall Status of Construction
- Detailed Discussion of Facility Components/Systems/Controls
  - Brief Description of Specifications by Which Item was Procured/Constructed
  - Changes in the CDR Design (including field changes) and the Independent Reviewing Body for Each
  - Summary of all Qualification, Proof, and/or Acceptance Testing Performed and Results
  - Summary of As-Built Compliance with Contractual Requirements
- Status of Construction Contract(s) and Contract Submittals (including as-built drawings)
- Concern, Limitations, and Potential Problem Areas

IV. DOCUMENTATION
- Overall Documentation Required (documentation tree)
  - Design Related
  - Safety, Reliability, and Quality Assurance (SR&QA) Related
  - Construction Related
  - Test Related
  - Management Related
- Status Summary

V. FACILITY SHAKEDOWN
- Overview of Objectives
- Management Structure/Organization, Roles, and Responsibilities
- Operating Personnel Readiness (includes training and certification)
- Field Verification Status of Facility Baseline List (FBL) As-Built Drawings
- Details of Shakedown Plan
  - Tasks
  - Operating Procedures (Standard and Test Unique)
  - Configuration Management Procedures
  - Test Instrumentation and Data Reduction
  - Schedule
- Areas of Concern/Uncertainty

→

VI. SAFETY, RELIABILITY, AND QUALITY ASSURANCE

- Overview of Facility Safety Program, Special Studies, and Safety Reviews
- Safety Analysis Report/Operational Hazard Analyses (including Software and Shakedown Unique Configurations and Operations)
- Critical Item List (CIL)
- Critical Interlocks
- Quality Assurance/Inspection Utilized and any Deviations Accepted (general items, critical items, and critical interlocks)
- Status of Open Items from Safety/Hazard Analysis Reviews
- Overall SR&QA Assessment and Areas of Concern/Uncertainty

VII. SUMMARY ASSESSMENT OF READINESS FOR INTEGRATED SYSTEMS TESTING

- Hardware
- Software
- Personnel
- Open Items
- Concerns

# OPERATIONAL READINESS REVIEW (ORR)
## Typical Agenda

I. INTRODUCTION
- Objective and Scope of Review
- Agenda

II. PROJECT OVERVIEW
- Research Requirements
- Project Scope and Status Summary
- Top Level Schedule and Summary
- Status of Open Action Items from Prior Formal Reviews

III. INTEGRATED SYSTEMS TESTING
- Test Results Against Plan
- Verification of Critical Interlocks
- Resolution of Problems/Failures
- Configuration Changes
  - Documentation
  - Hardware
  - Software
- Summary of Overall Project Compliance with Requirements

IV. DOCUMENTATION
- Status of Overall Project Documentation Against Requirements
- Archival Responsibilities and Status

V. OPERATIONS PROCEDURES
- Roles and Responsibilities
- Typical Sequence of Events and Verification of Standard Operating Procedures (SOP)
- Emergency Procedures

VI. SAFETY, RELIABILITY, AND QUALITY ASSURANCE
- Safety Analysis Changes Since ISR
- Safety Compliance Verification
- Personnel Training and Certification
- Quality Assurance and Compliance with Specifications
- Configuration Management
- Open Items

VII. SUMMARY ASSESSMENT OF OPERATIONAL READINESS
- Hardware
- Software
- Personnel
- Procedures/Documentation
- Open Items

ATTACHMENT 14

NASA LANGLEY MANAGEMENT INSTRUCTION (LMI) 7120.1, AERONAUTIC AND SPACE FLIGHT PROJECTS AND EXPERIMENTS REVIEW PROGRAM (OCTOBER 21, 1980)

National Aeronautics and Space Administration

# Langley Research Center MANAGEMENT MANUAL



LMI 7120.1

October 21, 1980

SUBJECT: Aeronautic and Space Flight Projects and Experiments Review Program

REF: NMI 7121.1, "Planning and Approval of Major Research and Development Projects"
NHB 7121.4, "Guidelines for Project Planning"
LMI 1710.1, "Human Factors Research, Man-Rating Requirements, and Committee Review Procedures"
LHB 7121.1, "Project Management"

SUMMARY

This instruction sets forth the criteria, policy, and procedures for review of aeronautic and space flight projects and experiments under the management of this Center and flight experiments included as a part of a mission managed external to this Center.

CRITERIA

The criteria stated herein are minimum requirements that will permit total visibility by a third-party review committee of the technical and management aspects of Langley Research Center's (LaRC) flight projects and experiments. The requirements of this instruction do not supersede other reviews imposed by NASA Headquarters, other Centers, or other LaRC reviews.

POLICY

This Center will conduct the following sequential set of reviews for flight projects and experiments:

- Design Reviews
  - Conceptual Design Review (CoDR)
  - Preliminary Design Review (PDR)
  - Critical Design Review (CDR)
- Preshipment Readiness Review
- Preflight Review
- Postflight Review

This policy may be altered by the cognizant Program Director to meet unique requirements.

GENERAL

The above reviews are advisory in nature and do not relieve LaRC personnel of the responsibility for the success of the project or mission.

Special Reviews

The Chairperson of each review, or the cognizant Program Director, may also establish other special reviews to supplement the above reviews.

Support

All LaRC Program Directors are to support the above reviews. They are to furnish senior personnel, experienced in the required technical disciplines, as requested.

The Chairperson of each review shall organize the Committee and draw support from other Centers or Federal Agencies as required.

Review Deviations

Deviations from the review policies established in this instruction may be made only with the approval of the cognizant Program Director.

Review Objectives

The primary objective of the above reviews is to enhance the probability of success of LaRC flight missions. This will be achieved by utilizing the cumulative knowledge and skills of the team of engineers and scientists who have been selected for their experience with particular systems and functions.

The reviews will be technically oriented, however, proper consideration is to be given to operating constraints — particularly those involving primary mission objectives and program costs and schedules.

NASA Headquarters Participation in Reviews

The Project Manager, or equivalent, is to insure that personnel from the appropriate NASA Headquarters Program Office are informed of review date and, to the extent practicable, arrange for reviews to be scheduled to allow NASA Headquarters' participation.

PROCEDURES

Design Reviews

General

There are three levels of design reviews which are to be phased into the project/mission schedule at appropriate times. New designs are to include all three reviews; namely:

- Conceptual Design Review (CoDR) — In some cases this review may be eliminated if the concept has been demonstrated and only minor changes are necessary.
- Preliminary Design Review (PDR)
- Critical Design Review (CDR)

Design Reviews
(Continued)

General

- Membership

| | |
|---|---|
| Chairperson: | Assistant Director for Systems Engineering and Operations or designated representative |
| Secretary: | Appointed by the Chairperson |
| Members: | Representative, Systems Safety, Quality and Reliability Office |
| | At least five representatives from supporting line organizations as deemed appropriate by the Chairperson. |

- Reviews

The Project Manager, or equivalent, is responsible for notifying the Chairperson of a review within sufficient time so as to permit an orderly preparation of the review.

- Minutes

Minutes of each review are to be distributed to committee members and appropriate Division Chiefs and Program Directors.

Minutes are to be made a part of project/mission files.

- Action

The Project Manager, or equivalent, is responsible for insuring that appropriate action items, comments, and recommendations resulting from a review, also any open action items, are appropriately discussed at the next review.

FUNCTION

CoDR

The objective of the CoDR is to present the scientific requirements and examine the proposed design approach to accomplish these requirements by examining, completing, and presenting the:

Design Reviews

FUNCTION

CoDR (Continued)

- initial design
- trade-off studies
- alternate configurations
- selection of critical parts
- preliminary analyses
- definition of environments
- interface requirements
- Government Supplied Equipment (GSE)
- project planning
- software approach, etc.

so that the design can be examined at the conceptual level with confidence.

The CoDR will normally be scheduled at a time which will permit assessment as noted above and prior to the start of development testing.

PDR

The objective of the PDR is to examine in detail the baseline project/mission design being planned for manufacture and qualifications, validate the design approaches as related to project/mission requirements, and cover such items as:

- mechanical design layouts
- circuit designs
- design analyses
- performance analyses
- results of development testing
- GSE requirements
- manufacturing and qualification test planning
- status of reliability, quality assurance, and systems safety programs
- status of planning for data retrieval, analysis, and publication

The PDR will normally be scheduled at the completion of the preliminary design and prior to the fabrication of qualification hardware.

CDR

The objective of the CDR is to examine details of the final design and mission, verify the final plans, design, fabrication plans, and flight acceptance test planning as related to project/mission requirements, and cover such items as:

Design Reviews

CDR (Continued)

FUNCTION

- updated final design and analyses
- qualification test and calibration test results
- functional and performance test results
- reliability, quality assurance, and safety programs
- a review of the plans for data retrieval, analysis, and publication

The CDR will normally be scheduled at the completion of the qualification test program.

At the conclusion of the CDR, the review committee should have confidence that they have reviewed the final design and planning, that sufficient data has been presented to demonstrate the design is compatible with the total flight system, and the project/mission will be accomplished within cost and schedule constraints.

Preshipment Readiness Review

The objective of the Preshipment Readiness Review is to inspect flight hardware, make final review of project/mission plans, concentrate on results of acceptance testing, and cover such items as:

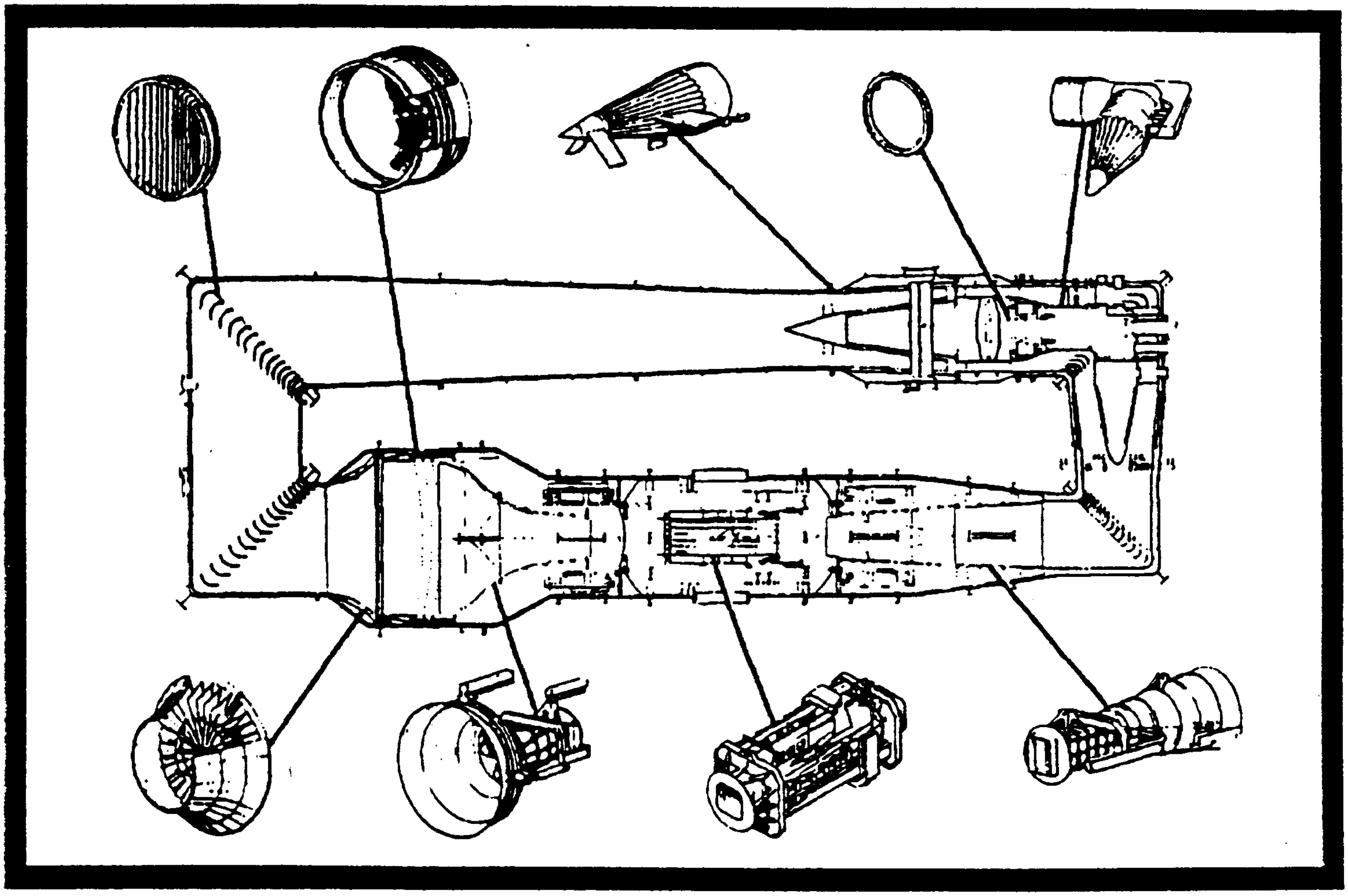
- validating the quality of the hardware
- confirming that the hardware is flightworthy and will perform properly under the simulated flight environment
- assessing that the mission objectives will be met
- compliance with mission requirements and specifications
- refurbishment and recalibration plans (when required)
- shipping and storage plans
- confirmation of compatibility with all interface, weather protection, and contamination control plans
- all failures or anomalies during test
- status of safety and reliability analyses and verification of compliance with documentation requirements

ATTACHMENT 15

LANGLEY GUIDANCE (NFM-1C), GUIDE FOR THE CERTIFICATION/RECERTIFICATION OF WIND TUNNEL STRUCTURAL SYSTEMS (FEBRUARY 1993)

ATTACHMENT 15

# Guide For The Certification/Recertification Of Wind Tunnel Structural Systems



NFM-1C, FEBRUARY 1993

CERTIFICATION/RECERTIFICATION
OF WIND TUNNEL STRUCTURAL SYSTEMS

## PREFACE

This guide sets forth criteria for the certification/recertification of the wind tunnel internal structural systems at Langley Research Center (LaRC). This document is intended to prevent wind tunnel damage or injury due to structural failure of wind tunnel components. Procedures for certification are established, allowable stresses are specified, and a type and format of documentation is prescribed. The inservice inspection specified in the recertification procedure shall not replace the normal routine repair and maintenance programs already in effect. The requirements in this document are to be used in the certification/recertification of the wind tunnels to the extent established by LaRC.

# 1.0 APPLICABILITY AND IMPLEMENTATION

## 1.1 Introduction and Scope

This guide contains criteria for the certification/recertification of the wind tunnel structural systems at Langley Research Center (LaRC). The established criteria are intended to prevent structural/component loss and/or potential facility damage. This guide does not apply either to pressure vessels and systems which are covered by NASA Langley Handbook LHB 1710.40 or to Wind-Tunnel Model Systems which are covered by NASA Langley Handbook LHB 1710.15.

## 1.2 Applicability and Excluded Items

The requirements in this document or portions thereof are mandatory for all new and existing wind tunnel internal structural systems, except for wind tunnel structural components or sub-components that are isolated, protected, contained or restrained in such a manner that the maximum destructive failure could not be harmful to people and/or facilities and equipment.

## 1.3 Definitions

a. Wind Tunnel Structural System: Any wind tunnel structural components or sub-components internal to the tunnel envelope whose failure could result in facility damage or personnel injury.

b. Highly Stressed Areas: An area whose maximum stresses, when compared to allowable stresses, result in a margin of safety against failure of 0.05 or less, and said failure can result in structural system loss and/or facility damage.

c. Structural System Certification: LaRC's Recertification Officer shall recertify wind tunnel structural systems when they satisfy the requirements of this guide.

d. Recertification: The verification of the structural system certification.

e. Recertification Plan: The plan established to verify and maintain the continuous certification of the wind tunnel structural systems. The plan shall provide for (a) the location and/or generation of all required analyses, (b) the nondestructive examination of welds and highly stressed areas, and (c) the surveillance of highly stressed areas to provide confidence in their structural integrity.

f. Design Pressure: The maximum pressure which can occur at the portion of the tunnel which is being analyzed.

g. Design Temperature: The maximum and minimum temperatures which can occur at the portion of the tunnel being analyzed.

Temperatures effects shall include both transient and steady-state thermal analysis where applicable.

h. Inservice Inspection: Inspection performed after a system has been initially put into service.

i. Structural Systems Engineer: Person(s) designated to review and approve the safety of design for the wind tunnel structural systems. Structural systems engineering responsibilities may be assigned to a contractor.

j. Structural Systems Report: The wind tunnel structural analyses, tests, inspection results, future inspection plan and recommendations in documented format.

k. Nondestructive Examination (NDE): Inspection and examination of components by various nondestructive methods to determine the presence of nonconformities or to monitor known nonconformities.

### 1.4 Responsibilities

LaRC's Recertification Officer is responsible for the implementation of all requirements of this guide.

## 2.0 CERTIFICATION/RECERTIFICATION PROCEDURES

### 2.1 General Description

This chapter describes the procedures for certification/recertification for wind tunnel structural systems.

### 2.2 New Systems

New wind tunnel systems shall be certified prior to operation. The procedures for certifying a wind tunnel structural system shall be in accordance with the design acceptance criteria specified in this guide or otherwise specified by FENGD. Reviews shall be conducted to certify that all new wind tunnel systems are functional and meet the criteria set forth in this guide. FENGD may require a formal engineering review of all new systems for compliance with this document.

### 2.3 Systems In Service

All existing tunnel structural systems shall be recertified for operation. The certification/recertification shall also be addressed when any internal component is modified so that the documentation remains current. The procedure for recertifying wind tunnel structural systems and defining periodic inspection is illustrated in Figure 1. The individual activities are described in the following subparagraphs:

a. Specify wind tunnel facility: The name and location of t wind tunnel shall be specified.

b. Define system and operating conditions: The wind tunnel syst and operating parameters such as test medium, pressur temperature, and cyclic operation shall be determined.

c. Identify system components: The wind tunnel components a sub-components shall be identified by means of schematics th identify, describe, and inventory each component and i location.

d. Determine loads for each component: The maximum loads whi can occur on each structural component shall be determined a specified.

e. Review existing analysis and any certification documentatic All existing design analyses shall be obtained and reviewed f verification and completeness of design as per the requiremer of Sections 3.0 and 4.0.

f. Provide a complete analysis: In the event that the analysis not complete or does not exist, a complete analysis shall provided. In evaluating stresses and fatigue life, t analytical procedures as defined in Sections 3.0 and 4.0, a the Appendix shall be used.

g. Establish alternate design requirements: In cases wh alternate design criteria and analysis methods (for examp elastic-plastic analysis, non-linear analysis, altered safe factors, or proof testing) are used to ensure the safe oper tion of the system, sufficient explanation and detail shall provided. When the analysis utilizes alternate design criter or analysis methods, FENGD may direct use of further inspect criteria upon the subject component to ensure safety.

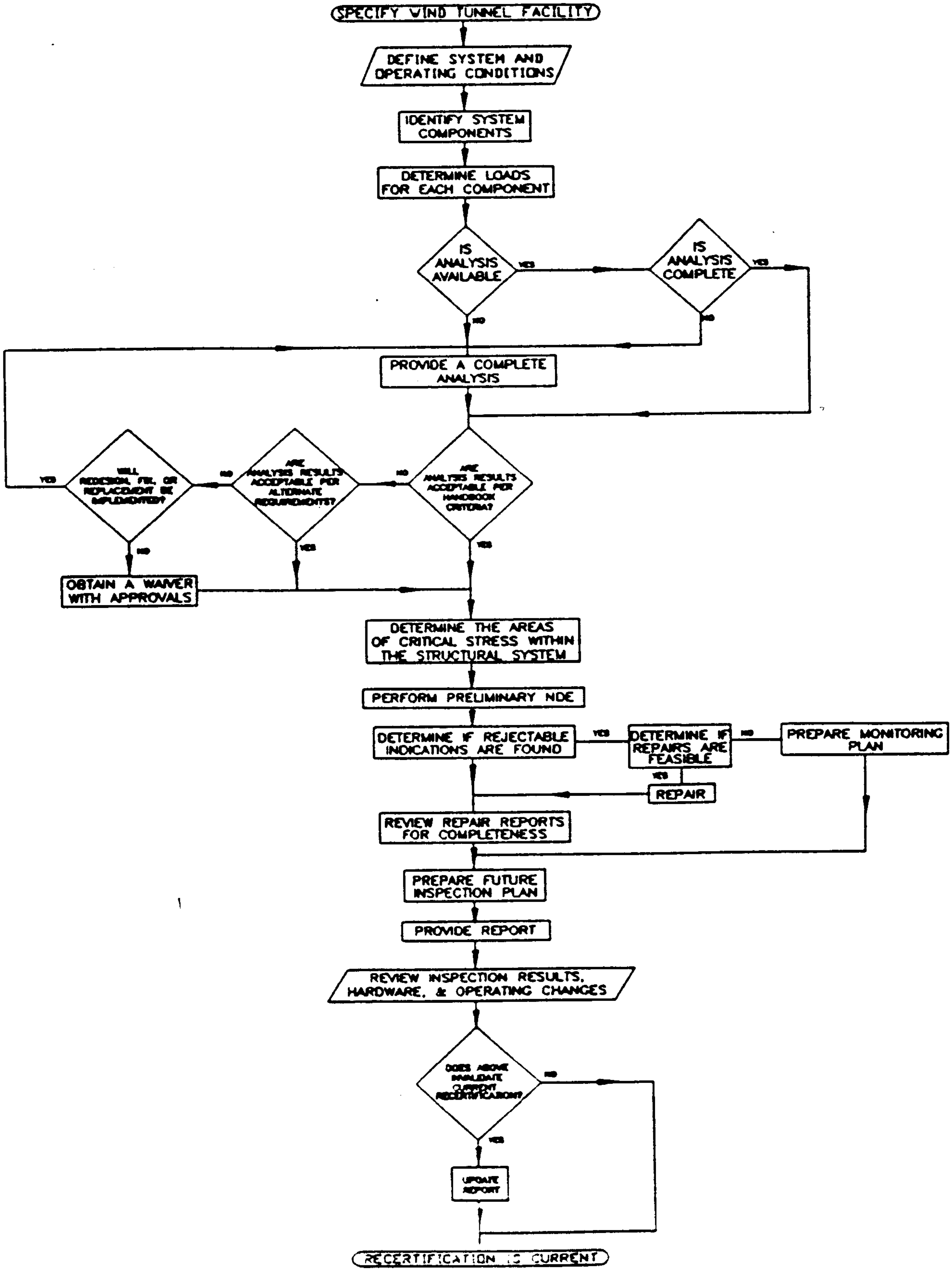
h. Determine highly stressed areas: The results of the analy and the areas of high stress shall be identified and summari in the structural systems report.

i. Perform NDE:

(1) All welds shall be visually examined in accordance w the requirements of the applicable American Weld Society Code, e.g. ANSI/AWS D1.1 for steel structures ANSI/AWS D1.2 for aluminum structures.

(2) All high stressed areas and 10±½% of all welds shall examined using one of the following nondestruct examination methods: radiographic, ultrasonic, penetrant, magnetic particle, eddy current, or visu LaRC's Recertification Officer shall specify the welds be inspected and the nondestructive examination method be used. In performing these examinations, the procedu and acceptance criteria in the applicable American Weld Society Code shall apply.

Figure 1: Recertification Procedure Flow Chart for Structural Systems



## 3.0 DESIGN AND ANALYSIS

### 3.1 General

The design of the wind tunnel structural components shall be in accordance with the criteria set forth in this section.

### 3.2 Standards

Unless otherwise specified, applicable provisions of the following standards, codes, or handbooks are acceptable:

American National Standards Institute (ANSI)

American Institute of Steel Construction (AISC)

American Society for Testing Materials (ASTM)

American Welding Society (AWS)

American Society for Nondestructive Testing (ASNT)

American Society of Mechanical Engineers (ASME)

National Electric Code (NEC)

National Design Specification for Stress Grade Lumber (NDSSGL)

Society of Automotive Engineers (SAE)

LaRC Safety Regulations Covering Pressurized Systems (LHB 1710.40)

National Bureau of Standards (NBS)

Aerospace Structural Metals Handbook - Department of Defense (DOD)

Advance Composite Design Guide - DOD/NASA

Unless identified by date, the edition - including addenda and code cases - in effect at the start of recertification shall apply.

### 3.3 Design Loads

a. The design pressures and temperatures shall be established by research personnel and shall be included in the structural systems report (see Section 4.0).

b. The loading conditions used for each component design shall include where applicable: dead loads, centrifugal, aerodynamic and thermal loads for the extremes of the test conditions, and design cycle life requirements. Worst case combinations of loading conditions shall also be considered.

## 3.4 Material Properties

a. Standards: Material Properties (mechanical and other) shall be determined using the latest issue of recognized standards, or, when necessary, experimental test data.

b. Adjustments: All material properties, design criteria, and allowable stresses shall be suitably adjusted for operational temperature, pressure, heat affected zones from welding or machining, stress corrosion, and any other environmental effects which may be present during the period the material is under stress.

c. Material Properties Verification: When material properties cannot be determined because of material uncertainty or lack of documentation for a known material, worst case properties of like materials may be used, or properties may be determined by testing. For cryogenic applications, particular care shall be given to the determination of strength and Charpy V-notch properties.

d. Galling: Galling shall be considered in evaluating faying surfaces.

e. Toughness: For all applications requiring high material toughness, the Charpy V-notch impact strength properties ($C_{VN}$) set forth below are required (except for specific materials as noted in paragraph 3.4e(2)).

(1) Impact Strength: The following Charpy V-notch ($C_{VN}$) impact strength values are required for carbon and low alloy steels (including welds, heat affected, and base materials):

| Specified Minimum Material Tensile Strength | Average ($C_{VN}$) for Three Specimens, (ft-lb) | Minimum ($C_{VN}$) for Any Specimen, (ft-lb) |
|---|---|---|
| ≤65 ksi | 13 | 10 |
| >65 & ≤75 ksi | 15 | 12 |
| >75 & <95 ksi | 20 | 15 |
| ≥95 ksi | Lateral Expansion ≥ 0.015 inches | |

(2) Exceptions: Materials which (1) do not undergo a marked drop in impact resistance at cryogenic temperatures, and (2) meet the requirement of sections 3.4a through 3.4d may be used without meeting the $C_{VN}$ requirements. These

materials are as follows: aluminum alloys, copper and copper alloys, nickel and nickel alloys, austenitic stainless steels, and composite materials.

f. Cryogenic Applications: In analyzing materials for cryogenic applications, special consideration must be given to low temperature embrittlement, coefficient of thermal expansion, and dimensional stability. Such considerations must be given not only to primary (load carrying) structural materials but also to solders, brazes, fillers, and so forth.

(1) Cryogenic Materials Data Sources: Suggested sources of information on materials which have been characterized and evaluated for cryogenic use are as follows:

- Materials for Cryogenic Wind Tunnel Testing. National Bureau of Standards Report, NBSIR 79-1624, May 1990.

- Cryogenic Materials Data Handbook. Volumes I and II. Technical Documentary Report, AFML-TDR-64-280 (Rev. 1970)

- Handbook on Materials for Superconducting Machinery. Metals and Ceramics Information Agency Report, MCIC-HB-04, November 1974.

### 3.5 Allowable Stresses

a. General: The allowable stress criteria for materials given in this section are based on well established design practices. Three methods are provided for establishing stress design allowables. Methods 1 and 1A are based on conventional, conservative approaches which can be employed where structural design optimization is not a factor, and minimum analysis effort is desired. Method 2 is a systematic approach which can yield a more optimal structural design. Individual structural components or subsystems can be designed to the allowables of either Methods 1, 1A or 2.

b. Method 1: For standard handbook analysis at temperatures below the creep range, the allowable combined stress (axial plus bending) shall be the smaller of the values of one-quarter (1/4) of the minimum ultimate strength or two-thirds (2/3) of the minimum yield strength of the material at temperature. This corresponds to a safety factor of 4 on ultimate or 1.5 on yield, respectively. In this method, the combined stress to be compared to the allowable shall be calculated for worst combined load cases (mechanical plus thermal) and include stress concentration effects. In the absence of shear strength data, maximum allowable shear stress for all combined loads shall be taken as one-third (1/3) of the minimum yield strength at temperature. The maximum allowable bearing stress shall be equal to the yield strength at temperature

c. Method 1A: In certain cases a variation on the allowables of Method 1 is acceptable. Method 1A is intended to address situations where the allowables of Method 1 cannot be met when stress concentration effects are included in areas where the stress state is well defined (for example, a perforated plate loaded in bending). In such cases, a highly localized stress cannot result in collapse of the structure but rather becomes a concern in terms of localized distortion and crack initiation which could lead to fatigue failure. In such cases, the allowables of Method 1 may be used without including the stress concentration effect. However, the stress concentration effect along with other fatigue reduction factors must be applied, and a fatigue or fracture mechanics analysis shall be performed per section 3.6c or 3.6d, respectively.

d. Method 2: This method may used when the system cannot be certified/recertified to the allowables of Methods 1 or 1A. However, in order to design to the allowables in this section, the stress state in the structure must be well understood with a high level of confidence. Closed-form solutions and standard handbook calculations will in many cases suffice. However, for highly indeterminate complex structures, a more in-depth analysis will be required using state-of-the-art structural analysis codes employing finite element or finite difference techniques.

(1) Terminology for Method 2:

(a) Combined Principle Stress Intensity: The combined principle stress intensity is defined as twice the maximum shear stress and is the difference between the algebraically largest principle stress and the algebraically smallest principle stress at a given point.

(b) Normal Stress: The stress normal to the plane of reference.

(c) Shear Stress: The stress tangent to the plane of reference.

(d) Membrane Stress: The component of normal stress which is uniformly distributed and is equal to the average value of stress across the thickness of the section under consideration.

(e) Primary Stress: The stress (normal or shear) which is necessary to satisfy the simple laws of equilibrium of external and internal loads. A thermal stress is not a primary stress. Examples of primary stresses are: general membrane stress (axial force divided by gross cross-sectional area of a structural element and bending stress (bending moment divided by the section modulus of a structural member).

(f) Secondary Stress: The stress (normal or shear) developed by constraints or by the self-constraint of a structure. Examples of secondary stresses are: general thermal stress and bending stress at a gross structural discontinuity (sudden changes in geometry which affect a relatively large portion of the component).

(g) Incremental Peak Stress: Incremental peak stress is defined as the increment added to the stress at a point to give the total peak stress in areas of stress concentrations or local thermal stresses. The basic characteristic of a peak stress is that it does not cause any noticeable distortion and is objectionable only as a possible source of a fatigue crack or a brittle fracture.

(h) Thermal Stress: Thermal stress is a self-balancing stress produced by a nonuniform distribution of temperature, by boundary conditions, or by differing coefficients of thermal expansion. Two types of thermal stresses are considered: general thermal stress associated with distortion of the structure in which it occurs, and local thermal stress associated with almost complete suppression of the differential expansion/contraction and thus produces virtually no distortions.

(i) Stress Cycle: Stress cycle is a condition in which the alternating stress difference goes from an initial value through an algebraic maximum value and an algebraic minimum value and then returns to the initial value. A single operational cycle may result in one or more stress cycles.

(2) Calculation of Combined Stress Intensity: At the point on the structure which is being investigated, choose an orthogonal set of coordinates (i,j,k). The stress components in these directions are then designated $\sigma_i$, $\sigma_j$, $\sigma_k$ for normal stresses and $\tau_{ij}$, $\tau_{jk}$, $\tau_{ki}$, for shear stresses.

Calculate the stress components for each type of loading to which the part will be subjected and assign each set of stress values to one of, or a group of, the following categories:

(a) Primary membrane stresses, $\sigma_m$

(b) Primary bending stress, $\sigma_b$

(c) Secondary stress, $\sigma_g$

(d) Incremental peak stress, $\sigma_{.}$

Translate the stress components in the [i,j,k] (may be rectangular, cylindrical, or spherical coordinates) directions into principle stresses $\sigma_1$, $\sigma_2$, $\sigma_3$. Next calculate the value of the stress difference $\sigma_{12}$, $\sigma_{23}$, and $\sigma_{31}$ from the relations:

$$\sigma_{12} = (\sigma_1 - \sigma_2)$$
$$\sigma_{23} = (\sigma_2 - \sigma_3)$$
$$\sigma_{31} = (\sigma_3 - \sigma_1)$$

NOTE: For a biaxial state of stress $\sigma_3 = 0$.

The combined stress intensity S is the largest absolute value of $\sigma_{12}$, $\sigma_{23}$, $\sigma_{31}$.

(3) Stress Intensity Allowables:

(a) Primary Membrane Stress Intensity, $\sigma_m$, shall not exceed the allowable membrane stress, $S_m$. $S_m$ shall be the smaller of:

2/3 $S_y$@temperature
2/3 $S_y$@70°F
1/3 $S_u$@temperature
1/3 $S_u$@70°F

(b) Primary membrane plus primary bending stress intensity for solid rectangular cross sections shall not exceed 1.5 times $S_m$:

$$\sigma_m + \sigma_b \leq 1.5\ S_m$$

Primary membrane plus primary bending stress intensity over the gross section of non-rectangular or hollow cross sections (including rolled shapes) shall not exceed $S_m$:

$$\sigma_m + \sigma_b \leq S_m$$

(c) Primary plus secondary stress intensity shall not exceed 3.0 times $S_m$:

$$\sigma_m + \sigma_b + \sigma_s \leq 3.0\ S_m$$

(d) Primary plus secondary plus peak stress intensity shall be evaluated by Fatigue Analysis (Section 3.6c).

(4) Other allowables:

(a) The algebraic sum of the three principal stresses shall not exceed 4.0 times $S_m$:

$$\sigma_1 + \sigma_2 + \sigma_3 \leq 4.0\ S_m$$

(b) Bearing stress shall be less than or equal to $S_y$.

(c) Pure primary shear stress shall be less than or equal to $0.6S_m$. (Shape factors which are applied to calculate maximum transverse shear stress at the centroids of cross sections do not apply to pure shear stress calculations). Typical components which undergo pure shear include keys, bolt and nut threads, and shear pins.

(5) Stress Allowables For Composites

(a) General: Allowable stresses and stress intensities will generally be in accordance with the above requirements. The yield or ultimate strength of the composite material shall be taken from test data for the particular lay-up. When test data is not available, the stresses in each ply of the laminate shall be calculated and compared with the allowables for the ply material.

(b) Shear: Because of the complexity of shear loadings in composite materials, a safety factor of 2 on the as-built ultimate shear strength, both interlaminar and laminar, is required.

## 3.6 Structural Analysis/Design

a. Stress Analysis: A stress analysis is required as a part of the structural systems report. It shall be complete and sufficiently comprehensive so as to require no further explanation.

b. Thermal Analysis: Sufficient analyses shall be performed to examine thermal stresses and distortions for steady-state and transient conditions.

c. Fatigue Analysis: The provisions of this section apply to components that are subjected to cyclic loadings to the extent that fatigue is a credible failure mode. The fatigue analysis is performed on the premise that no flaws or cracks initially exist in the structure. Appendix A is provided as a guide for performing fatigue design analysis and for determining the remaining fatigue life in a component.

d. Fracture Analysis: Fracture mechanics analysis may be used to evaluate known flaws. The fracture analysis may preclude the fatigue analysis as the basis for design life calculations.

e. Design Life: The design life requirements for the fatigue and/or fracture analysis for structural components and the sources shall be referenced. In cases where the projected load-cycle/design life requirement is not well defined, the following approximations shall be used:

(1) Peak Load Cycles: The estimated [illegible] component will experience [illegible]

conditions over its life shall be multiplied by 1.5. This number shall be the primary design life-cycle requirement.

(2) Unsteady Oscillating Loads: Unless otherwise known, the assumed maximum peak unsteady load shall be 25 percent of the steady loads at a random frequency. Unsteady aerodynamic loads shall be considered when flow conditions may result in unsteady perturbations produced by such phenomena as shedding vortices, varying separation or stall zones, inlet turbulent intensities, number of guide vanes per revolution of rotor, etc. These unsteady loads may be of either random or known frequencies.

f. Creep: Creep shall be considered when material temperatures exceed 1/2 of their melting temperatures (temperatures are on the absolute scale).

g. Mechanical Connections

(1) Structural Joints:

(a) Welded Joints: All welded joints shall be designed and fabricated in compliance with AWS.

(b) Bolted Joints: All bolted joints shall be designed and analyzed for the loads specified in paragraph 3.3 and for a clamping force of 1.5 times the maximum separating force. Bolted joints may be friction or bearing type. If a bolted joint is the bearing type, no shear loads shall be transmitted through the threaded portion of the bolt. Shear loads may also be transmitted by keys, pins, or shoulders.

(2) Fasteners:

(a) Preload: Fasteners shall be designed for a maximum preload not to exceed ⅔ of the bolt materials' yield strengths.

(b) Thread Engagement: Thread engagement shall be designed to develop strength equivalent to the bolt ultimate strength. The design shall consider both the parent and the insert material.

(c) Retention: Bolts in critical applications must be secured by mechanical systems (locking-tab washers, locking inserts, interference threadforms safety wiring, jam nuts, and so forth) and/or approved chemical locking systems.

h. Stability

(1) Buckling: The allowable compressive stress/load in columns and skins shall not exceed one-half (1/2) of the

critical buckling stress/load calculated using the proper slenderness ratio.

(2) Aerodynamic stability: The stability of the structural components shall be analyzed to ensure that undesirable events such as divergence and flutter do not create unstable conditions.

(a) Divergence: The allowable dynamic pressure causing divergence shall not exceed one-half (1/2) of the actual dynamic pressure on the component. This requirement is also satisfied if the ratio of the increase in normal force on the component to angle of attack of the flow does not exceed 1/2 of the support system restoring force generated by such an angle change (change in force / change in angle of attack).

(b) Flutter: The structural components shall be sufficiently designed to avoid flutter. A factor of safety of 2 shall be applied to the dynamic pressure when calculating the aerodynamic forcing functions causing flutter.

i. Dynamic Analysis

(1) General: The special requirements set forth in this section apply to systems which have rotating parts, such as fans and rotors, or systems to which dynamic loadings are applied.

(2) Analysis: Equivalent G factor, real eigenvalue, transient response, frequency response, or random response analyses shall be performed if required to determine the structural adequacy of the system.

## 4.0 DOCUMENTATION

### 4.1 General

A Structural Systems Report shall be prepared for all wind tunnels structural systems at LaRC. This report will present analyses and related inspection results which reflect the current safety status of the wind tunnel structural systems.

### 4.2 Contents

The structural systems report shall contain 1) a main body describing the facility, and summarizing all results and recommendations 2) appendices which include status sheets showing the certification/recertification status for each major system or component, and 3) attachments including component analyses background information and related [illegible] attachments shall be capable of standing alone. As a minimum, the report shall contain:

a. Main body

(1) Record of Revisions Page

(2) Table of Contents (including a list of appendices and attachments).

(3) Introduction

(4) Facility Description: A description of the facility including system contents and service conditions such as aerodynamic pressure, temperature, cyclic operations, flow characteristics, etc.

(5) Executive Summary: The executive summary shall consist of the significant results used in the certification/recertification process. This contains the findings, recommendations, and future inspection plan.

(a) Findings: Any deviations to the requirements of this guide or unacceptable conditions revealed by the analysis which restrict full certification/recertification shall be reported.

(b) Recommendations: Any recommendations for disposing of the deficiencies shall be stated.

(c) Future Inspection Requirements: The future nondestructive examination requirements shall be established based on the highly stressed areas. A drawing showing the type of NDE and years of future inspection shall be developed.

(6) Recertification Approach: A general description of the procedure followed to recertify the facility shall be provided.

(7) Status Sheet Key/Definitions: This section shall designate the definitions and/or keys used in the status sheets which are contained in the appendices.

b. Appendices: An appendix shall accompany each sub-system described in the facility. Each appendix shall contain two main listings: (1) a list of the non-complying components and suggested recommendations, and (2) a list containing the status of all components.

(1) Non-complying components: This listing identifies the components which do not meet the recertification requirements within this guide. The following information shall be included:

(a) Drawing number showing the location of the component

(b) Item number of component

(c) Description of component

(d) Actual component stress

(e) Allowable component stress

(f) Problem description

(g) Recommendation

(2) Status Summary: This listing summarizes the status of all components. The list shall contain brief descriptions of the following categories:

(a) Drawing and item number.

(b) Component description

(c) Material

(d) Installation date of component

(e) Inspection date of component

(f) Maximum actual stress

(g) Maximum allowable stress (or equivalent)

(h) Margins of safety. Margin of safety shall be calculated as:

$$M.S. = \left(\frac{Allowable\ Stress}{Actual\ Stress}\right) - 1$$

or similarly when levels other than stress are being compared.

(i) Footnotes which may be added to further clarify component information.

(j) References specifying the recertification details contained within the attachments.

(k) Recommendation for each component. The component is either recertified/certified, recommended for removal, repair, monitoring or derating.

c. Attachments: The attachments shall provide background information of the recertification. The attachments shall specify the following:

(1) Component or System Definition and Description: This shall include as-built drawing numbers and sketches for the system or component. These drawings and/or sketches shall describe the system and/or component design and location. A supplementary narrative description may be included as needed.

(2) Materials: The material properties adjusted for operating conditions.

(3) Allowables: The allowable stress levels for each stress classification at the applicable temperature.

(4) Loading Conditions: A description of all non-negligible loads imposed on the component. If loads are derived from analysis, the analysis shall be presented or referenced here. Examples of loading conditions are dead (gravity) loads, thermal loads, aerodynamic loads, and mechanical loads.

(5) Assumptions: A description of assumptions used in the analysis which affect the final results.

(6) Method of Analysis: A description of the methods used in the structural analysis.

(7) Stress Analysis: A clear, detailed, and structured analysis shall be presented. References to equations which are not common knowledge shall be given. The analysis shall be complete and self-contained. Existing analyses may be referenced and not presented in detail if no changes to the analysis are required. This section may be further subdivided to reflect individual types of analyses such as buckling, thermal, fatigue, fracture mechanics, static and dynamic.

(a) The stress analysis shall show whether allowable stresses are exceeded for the worst load case(s).

(b) Each detailed analysis section shall contain a description of the components, a sketch showing forces and moments acting on the part (free body diagram) and statements of assumptions, approximations, section and physical properties, type and heat treat condition of the materials, and pertinent drawing numbers.

(c) The general equations and their sources shall be given before substitution of numerical values.

(d) Where applicable, finite element analyses documentation shall include computer generated plot(s) of the finite element model(s), descriptions of loads and boundary conditions, tabular or graphical summary of stress data, and name of structural code used. Validation of finite element model(s) is required by either closed form solution approximations or other evidence which shows high confidence in the finite element model(s) such as equilibrium checks, convergency, accuracy of solution, and so forth.

(8) Waivers, change notification sheets, and other supporting documents.

(9) Results of NDE

(10) References: Books, papers, analyses, reports, drawings, letters and any other reference material used in the development of the report.

## 5.0 QUALITY ASSURANCE

### 5.1 Introduction

This chapter provides the detailed quality assurance criteria for the recertification of wind tunnel internal structural systems at LaRC. These criteria are intended to ensure that the as-built wind tunnel structural system hardware meets the criteria specified within this guide.

### 5.2 Recertification Plan

FENGD is responsible for creating and maintaining a recertification plan. This plan shall provide methods for monitoring the inservice inspection results and resolving discrepant items. The recertification plan shall also track revisions to hardware or operating conditions which might affect the certification. Each change and/or inspection shall be reviewed by the structural systems engineer to determine if the change meets the requirements of this guide. The results of inservice inspection coupled with the review of revisions and changes will ensure that the structural systems are continuously certified. The recertification plan monitors any change in the structural system by keeping track of the following records:

a. Operational history (including but not limited to: exposure to temperature in excess of design, exposure to operation in excess of maximum operating design parameters, change in location).

b. Records of modifications or repairs.

c. Records of inspections and tests performed on the system.

d. Date of last inspection.

e. Waivers

## 5.3 Deviations

Two types of deviations from this guide may occur. The first deviation being a design which does not meet the requirements or alternate design requirements established in this guide, and the second from an unfavorable condition found during the inservice inspection. Deviation requests for component design and inservice inspections will be handled in the following manner.

When an inspection or review of component analysis reveals evidence of deviations from the criteria in this guide, the discrepancy must be processed in accordance with the provisions of this paragraph.

a. Documentation - A deficiency noted by the inservice inspection or design analysis must be documented and reported to FENGD for disposition. Deficiencies must be recorded in the structural systems report.

b. Disposition - FENGD shall coordinate the corrective action or otherwise dispose of the deficiency. The disposition may consist of additional engineering analysis, repair, modification, derating, additional tests, or inspections.

(1) Additional Engineering Analysis - Additional engineering evaluation may be performed using more realistic assumptions and/or sophisticated methods to certify/recertify the system for the original operating conditions. When the new basis has been determined, the appropriate inspections and tests must be performed and documented.

(2) Derating - A system or component may be derated to less severe service conditions on a permanent or temporary basis. Temporary derating allows the system to be operated at a safe service level during the time it takes to make modifications or to develop the engineering rationale required to certify/recertify the system for permanent service.

(3) Repairs or Modifications - The system or component may be repaired or modified and returned to a condition that can be recertified. Appropriate inspections and tests must be performed and documented.

(4) Additional Inspection or Retests - A discrepant item may be monitored closely to obtain additional data for evaluation.

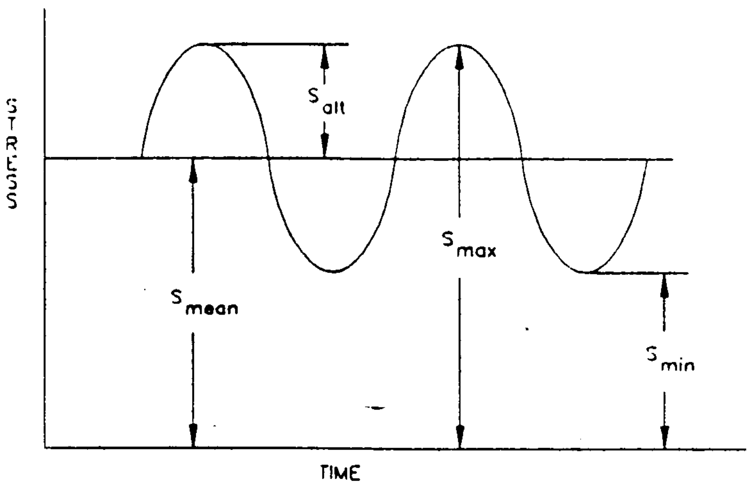
c. Waivers - Waivers must be [illegible] when a deviant item disclosed by an inherent [illegible] inservice inspection is to remain in [illegible]. The [illegible] and any supporting evidence [illegible] for disposition.

Each waiver must be documented and be included in the structural systems report.

## APPENDIX A: FATIGUE ANALYSIS

### A.1 Definitions

The figure below shows a typical stress cycle:




where: $S_{min}$ = minimum stress
$S_{max}$ = maximum stress
$S_{mean}$ = mean stress = $(S_{max}+S_{min})/2$
$S_{alt}$ = alternating stress = $(S_{max}-S_{min})/2$

The following are definitions pertaining to fatigue analysis:

$n$ = actual number of stress cycles of a load case
$N$ = allowable number of stress cycles from the fatigue curve
$u$ = usage factor of a specific load case = the fraction of a component's fatigue life which has been exhausted
= $n/N$
$U$ = the total usage factor = the summation of all load case usage factors and shall be less than or equal to 1.0.
$\sigma_i$ = principal stress
$S_{ij}$ = stress difference range = $\sigma_i - \sigma_j$
$S_{ij\ adj}$ = stress difference range adjusted to incorporate the difference of modulus of elasticity of the actual material to that of the fatigue curve
= $S_{ij} \times (E_{curve}/E_{actual})$
$S_{alt}$ = 1/2 of the adjusted stress difference range
= $(1/2) \times S_{ij} \times (E_{curve}/E_{actual})$

### A.2 Fatigue Curve

Fatigue (S-N) data for the material at test temperature shall be used. Whenever applicable, the fatigue curves (S-N curves) in Section VIII, Division 2, Appendix 5 of the ASME Boiler and Pressure Vessel Code shall be used in the fatigue analyses. When the fatigue curves in Section VIII, Division 2 are not applicable, the baseline S-N data shall be located through a search of the technical literature. These data shall then be adjusted as described in the document "Criteria of the ASME Boiler and Pressure Vessel Code for Design by Analysis in Sections III and VIII,

## A.5 Example

A component fabricated from carbon steel is subjected to the following load cases of cyclic stress at 70°F:

| Load Case | No. of Cycles | $\sigma_x$ | $\sigma_y$ | $\sigma_z$ | $\tau_{xy}$ | $\tau_{yz}$ | $\tau_{zx}$ |
|---|---|---|---|---|---|---|---|
| 1 | 10000 | 30000 | 15000 | 1000 | 5000 | 0 | 0 |
| 2 | 5000 | 2000 | -1000 | 2000 | 1000 | -1000 | -1000 |
| 3 | 1000 | -20000 | 5000 | -5000 | 2000 | -2000 | -2000 |

First, the principal stresses are calculated and ordered consistently by direction. Then the stress differences are calculated:

| Load Case | No. of Cycles | $\sigma_1$ | $\sigma_2$ | $\sigma_3$ | $S_{12}$ | $S_{23}$ | $S_{31}$ |
|---|---|---|---|---|---|---|---|
| 1 | 10000 | 31514 | 13486 | 1000 | 18028 | 12486 | -30514 |
| 2 | 5000 | 3450 | -1450 | 1000 | 4900 | -2450 | -2450 |
| 3 | 1000 | -20380 | 5600 | -5220 | -25980 | 10820 | 15160 |

Figure 5-110.1 from the 1989 ASME Boiler and Pressure Vessel Code, Section VIII, Division 2, Appendix 5, is used as the S - N curve for the carbon steel. E of the curve is 30 x $10^6$ psi. E of the material at 70°F is 29.5 x $10^6$ psi.

Combine $S_{12}$'s and the number of cycles, calculate $S_{alt} = (1/2)(S_{12})(E_{curve}/E_{analysis})$ find N from the fatigue curve, and calculate the usage:

| Combined Cases | No. of Cycles (n) | Combined $S_{12}$ | $S_{alt}$ | Allowable No. of Cycles (N) | Usage Factor (u=n/N) |
|---|---|---|---|---|---|
| 1-3 | 1000 | 44008 | 22377 | 50000 | 0.02 |
| 1-0[1] | 9000 | 18028 | 9167 | $\infty^2$ | 0 |
| 2-0[1] | 5000 | 4900 | 2491 | $\infty^2$ | 0 |

Notes: 1) Load case 0 indicates that no loadcase superposition has occurred.
2) Infinite number of cycles indicates that the alternating stress is below the endurance limit.

$U = \Sigma u = 0.02$

Division 2" to develop the required fatigue curves. This document is available from the Fracture Mechanics Engineering Section, FENGD or from the ASME.

### A.3 Stress Concentration Factors

Appropriate stress concentration factors shall be applied to stresses in areas of local structural discontinuities before principal stresses are calculated.

### A.4 Application

Considering the general case of a component subjected to multiple cyclic loading conditions over its life, the following method of cumulative damage (Miner's Rule) shall be used to determine the components structural adequacy from a fatigue viewpoint:

1. For each loading condition of n number of stress cycles, the principal stresses and their respective directional cosines shall be calculated.
2. The principal stresses in each direction for each load case shall then be ordered, $\sigma_1$, $\sigma_2$, $\sigma_3$. The ordering by direction shall be consistent between load cases.
3. The stress difference ranges shall then be calculated: $S_{12} = \sigma_1 - \sigma_2$, $S_{23} = \sigma_2 - \sigma_3$, and $S_{31} = \sigma_3 - \sigma_1$.
4. The $S_{12}$'s from all load cases shall be tabulated. Likewise, the $S_{23}$'s and $S_{31}$'s shall also be separately tabulated.
5. Stress differences in the same direction and the number of cycles shall be superpositioned if the resulting combined range is greater than the individual stress difference ranges. (The example in the next section illustrates this).
6. The alternating stress shall be calculated as 1/2 of the stress difference range multiplied by the ratio of the modulus of elasticity of the fatigue curve to the actual modulus of elasticity of the material.
7. Using an appropriate fatigue (S-N) curve, the allowable number of cycles (N) corresponding to the alternating stress shall be determined.
8. The usage factor, u, is calculated as the ratio of the actual number of cycles, n, to the allowable number of cycles, N.
9. For each of the three stress difference ranges, the total usage factor is the summation of the individual u's and shall not exceed 1.0.

Likewise for $S_{23}$:

| Combined Cases | No. of Cycles (n) | Combined $S_{23}$ | $S_{alt}$ | Allowable No. of Cycles (N) | Usage Factor (u=n/N) |
|---|---|---|---|---|---|
| 1-2 | 5000 | 14936 | 7595 | $\infty^2$ | 0 |
| $1-0^1$ | 5000 | 12486 | 6349 | $\infty^2$ | 0 |
| $3-0^1$ | 1000 | 10820 | 5502 | $\infty^2$ | 0 |

Notes: 1) Load case 0 indicates that no loadcase superposition has occurred.
2) Infinite number of cycles indicates that the alternating stress is below the endurance limit.

$U = \Sigma u$
$= 0.0$

Likewise for $S_{31}$:

| Combined Cases | No. of Cycles (n) | Combined $S_{31}$ | $S_{alt}$ | Allowable No. of Cycles (N) | Usage Factor (u=n/N) |
|---|---|---|---|---|---|
| 3-1 | 1000 | 45674 | 23224 | 50000 | 0.02 |
| $0^1-1$ | 9000 | 30514 | 15516 | 200000 | 0.045 |
| $0^1-2$ | 5000 | 2450 | 1246 | $\infty^2$ | 0 |

Notes: 1) Load case 0 indicates that no load case superposition has occurred.
2) Infinite number of cycles indicates that the alternating stress is below the endurance limit.

$U = \Sigma u$
$= 0.065$

Since each total usage factor is less than 1.0, the component is structurally acceptable from a fatigue viewpoint.