U.S. Department of Energy, Office of River Protection

ORP Design Oversight Report

Waste Treatment and Immobilization Plant Instrument Procurement and Installation

February 2005

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U.S. Department of Energy
Office of River Protection
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Executive Summary

This design oversight assessment evaluated the Bechtel National Inc. (BNI) processes for procurement, installation and testing of instruments and instrument equipment for the Waste Treatment and Immobilization Plant (WTP). The general status of procurement and scheduling was also considered.

BNI provided a presentation and review materials that addressed:

- INtools Instrument Database for tracking instrument procurements and installations
- Status and planning for instrument procurements and material receipt and storage
- Work processes and planning for instrument installations, inspections and testing
- General schedules

The information provided addressed satisfactorily all the design oversight assessment objectives and lines of inquiry.

BNI has adopted a procedure driven approach for procuring and installing instruments that appears to be effective and efficient. The BNI methodology will also accommodate a smooth transition from construction to plant startup, commissioning and testing.

In this limited review, there appear to be no vulnerabilities with the BNI Control and Instrumentation (C&I) process for procuring and installing instruments or with its implementation by the Bechtel C&I staff.

Recommendations to ORP Management:

BNI plans to perform instrument component testing on each instrument installed. DOE personnel, within the WTP engineering division, will be fully engaged in overseeing both the instrument installations and associated inspections and testing as these activities are accomplished. Instrument testing is a significant area of oversight that ORP line management must assure through formality in order to accommodate and demonstrate effective plant startup readiness. This will be achieved by surveillance and oversight written reports specific to instrument installation and/or testing.

Introduction and Background

In November 2004, a Design Oversight Assessment was performed on the Integrated Control Network (ICN). A few of the lines of inquiry for that assessment concerned the hardware and instrument installations. However, the assessment overall was largely limited to ICN software development and the ICN architecture, and the details regarding instrument procurement and installation were not considered.

This present assessment, as follow-on to the November 2004 ICN review, was intended to address more fully the processes connected with instrument procurement, installation and testing. The goal of the assessment was to understand the BNI approach, methodology, practice and

progress for ensuring the WTP is appropriately outfitted with the necessary plant instruments and controls.

Scope

This assessment evaluated the BNI methodology and processes for procuring instruments and instrument equipment, performing instrument installations and field testing. In addition, brief consideration was given to maintenance and scheduling. This assessment did not evaluate the BNI Control and Instrument (C&I) design or the design methodology by which instruments are selected. Specific assessment objectives and lines of inquiry are listed blow.

1. Obtain a general status on instrument specifications, procurements and subcontracts.

   - What field instruments have been purchased to date, bulk procurements or otherwise?
   - What procurements are yet planned?
   - What vendors have been awarded contracts or are being considered?
   - What instrument specifications have been issued?
   - Obtain a list of pertinent MRs.
   - Obtain an Intools printout of instruments sorted by facility, system, and type.

2. Understand the process and planning for field instrument installation and testing.

   - Describe the process and planning for field instrument installation.
   - Will subcontractors perform the field installation work?
   - What are the interfaces between engineering and construction/installers?
   - How will field testing be performed when the instruments are installed?

3. Understand the philosophy associated with instrument maintainability and spares.

   - Describe the philosophy and planning associated with instrument maintainability and instrument spares.

4. Gain further insight into the ICN general schedule.

   - Obtain a detailed schedule (level 4 or lower) of the I&C work and deliverables (software and hardware), including installation of instruments, (or templates/fragnets/hammock)

Approach

This assessment involved a presentation by BNI engineering staff, discussion and document reviews.

The assessment objectives and lines of inquiry listed above were provided to BNI and in response they provided a presentation agenda listed below. The presentation was held on December 15, 2004.

Database Centered Design Process

Instrument Procurement

-Awarded Contracts
-Instrument Quantities
-Instrument Procurement Strategies (Racks, Jumpers and In-line)

Instrument Installation

-Interface between Engineering & Construction
-Installation Work Planning Process
-Work Process for Installation

Instrument Field Testing and Maintenance

-Who will perform instrument field testing?
-What testing will be performed?
-Testing Strategy
-Transition from Startup to Preventative Maintenance
-Spare Parts Strategy for Instrumentation

Schedule

Document Reviews

The following documents were also reviewed.

24590-WTP-3PS-JQ08-T0001, *Engineering Specification for Construction and Installation of Controls and Instrumentation*

24590-WTP-3PS-JQ07-T0001, *Engineering Specification for Instrumentation for Package Systems*

Discussion

INtools Instrument Database

Bechtel's successful management of the huge WTP instrumentation effort depends largely on the utilization of an effective instrument database.

All engineering documentation relevant to instrument selection, procurement, installation, testing and calibration is coordinated through a central database called the *INtools Instrument Database.* The kinds of information provided as input to INtools includes process data, design information from P&IDs, V&IDs, MHDs, calculations etc., equipment specifications, vendor data, facility and instrument installation details. The key outputs from INtools include **Instrument Index Reports**, termination strip reports, specifications for Material Requisitions (MRs), and tracking systems. The key tracking systems include TEAMworks and SETROUTE.

TEAMWorks is Bechtel's construction management tracking system used for equipment and materials. TEAMWorks uses tagged components from design engineering and procurement status data for construction work packaging and materials management. It also adds installation status data that is shared with other applications for progress reporting.

SETROUTE® is Bechtel's corporate cable, raceway and wiring tracking system used for design, procurement, and component installation and field control of electrical cables, raceways, equipment, terminations, jumpers and cable routes.

The **INtools Instrument Index Report** provides the following information (by facility):

- Tag number
- Instrument type
- Reference drawing and revision
- Safety classification and quality level
- Seismic category
- Location, room number, equipment number, rack/enclosure number, etc.

Bechtel has developed Standard Instrument Installation Details for both domestic and international work and custom installation details for the WTP project. The Instrument Index Report lists the appropriate installation details. Modifications or changes to these installation details are made in accordance with WTP procedure: 24590-WTP-GPP-CON-3103, *Field Change Requests (FCR's) Field Change Notices (FCN's)*

The following discussion presents information that addresses the assessment objectives listed above. Reference will be made as necessary to the INtools database products.

1. Obtain a general status on instrument specifications, procurements and subcontracts.

- What field instruments have been purchased to date, bulk procurements or otherwise?
- What procurements are yet planned?
- What vendors have been awarded contracts or are being considered?
- What instrument specifications have been issued?
- Provide a list of pertinent MRs.
- Provide an Intools printout of instruments sorted by facility, system, and type.

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BNI purchases instruments for the WTP through several area discipline groups called MFATs (Multi-Facility Acquisition Teams). The MFAT groups and the estimated instrument quantities to be purchased through each MFAT are listed in Table 1 below.

Table 1

MFAT Area	Quantity
Control and Instrumentation (C&I)	**7546**
Electrical	232
Fire Protection	35
HVAC	822
Mechanical Handling	3411
Mechanical Systems	7536
Melter	334
Plant Design	1461
Sub-total	**3831**
Grand Total	**21377**

Note: Since the C&I group provided the data for this review, only the C&I procurements are discussed.

C&I will procure its 7,546 instruments through 71 Material Requisitions. These MRs are listed below.

- For Instruments: 15 Material Requisitions.
- For In-line Instruments: 26 Material Requisitions
- For Instrument Bulks: 7 Material Requisitions.
- For Racks and Enclosures: 8 Material Requisitions
- For ICN and PPJ: 2 Material Requisitions
- For Special Systems: 11 Material Requisitions
- For Control System Emulator: 2 Material Requisitions.

As of December 1, 2004, 536 instrument items have been purchased through 43 of the 71 MRs.

At the time of the BNI presentation (December 15, 2004), 5 additional MRs for 2004 were still planned to be awarded. 21 MRs are planned to be awarded in 2005 and 2 are planned for 2006.

The instrument procurements also support requirements for instruments installed on racks, jumpers for instruments installed in hot cells requiring remote handling features and radiation tolerance, and in-line instruments.

Racks

Since 75% of the instruments will be installed on racks, these instruments are purchased and then shipped to awarded rack manufacturer(s) for installation in racks prior to shipment to site. Purchase order releases for rack mounted instruments are scheduled taking into account the instrument fabrication time and the required-at-fabricator date as a deliverable target date. Purchase order releases are also scheduled to meet required-on-site (ROS) dates.

Racks and instruments are fabricated in multiple releases as follows.

- Rack fabrication is scheduled not to exceed supplier shop loading capacity.
- Fabrication is scheduled to minimize warehousing on site.
- Racks released for fabrication as of DEC-1-2004: 23 CM.
- Racks scheduled for release to fabrication for DECEMBER: 35 CM.
- First racks required on site: 22-AUG-2005 (10 racks).

Jumpers

Procurement of instrumentation is also scheduled to support process jumper fabrication. Instruments are procured, fabricated and shipped to jumper manufacturer(s) to support assembly of pre-fabricated jumper spools.

Material requisitions supporting instruments installed in process jumpers are listed as follows.

24590-CM-MRA-JT08-00001 Thermowells

24590-QL-MRA-JF08-00002 Magmeters >4"

24590-QL-MRA-JF08-00003 Magmeters <6"

24590-QL-MRA-JP02-00001 Pressure & Temp Transmitters

24590-QL-MRA-JT08-00001 Thermowells

24590-QL-MRA-JV01-00002 Control Valves

24590-QL-MRA-JV01-00003 Control Valves

In-line Instruments

Procurement of in-line instruments support required on site dates (ROS). In-line instruments require an early procurement effort to support construction schedules. There are 26 material requisitions supporting instruments installed in-lines

Vendors

The INtools Instrument Index provides a listing of the vendors who have received contracts for providing specified instruments. BNI provided ORP with a full Instrument Index listing on CD.

Material Receipt, Storage and Control

Instrument receipt is made in accordance with WTP procedure: 24590-WTP-GPP-MGT-013 *Acceptance of Procured Material.* Consistent with this procedure, BNI utilizes a document called the Material Acceptance Plan (MAP) for ensuring all attributes and/or activities required for

quality acceptance of procured material are established. The MAP also defines how each designated functional organization performs its assigned responsibilities and documents quality acceptance of procured material during the material receiving process.

Storage requirements for instruments and instrument equipment will be in accordance with manufacturer's recommendations and/or WTP procedure 24590-WTP-GPP-CON-6201, *Equipment Preservation and Maintenance*

2. Understand the process and planning for field instrument installation and testing.

- What are the interfaces between engineering and construction/installers?
- Describe the process and planning for field instrument installation.
- Will subcontractors perform the field installation work?
- How will field testing be performed when the instruments are installed?

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Interfaces

The interface between engineering and construction occurs through the following personnel.

- Responsible Field Engineer (RFE)
- Resident Engineer
- Construction Coordinator
- Responsible Superintendent (RS)
- Quality Control Engineer (QCE)

The RFE has the primary responsibility for review of all design drawings for quantity takeoffs and manages quantity tracking, field material requisitions, and technical issues.
The RFE also performs inspections to ensure that the installation is in compliance with applicable design documents, codes, standards and project specifications.

The Resident Engineer is a member of design engineering and is resident in the field to aid in quick resolution of issues as they arise.

The Construction Coordinator is the construction representative located with engineering, to act as the liaison between construction and other members of the project team. The construction coordinator participates in design development and constructability reviews.

The RS is responsible for supervision and coordination of craft labor, tools, equipment and work permits required to make installations in accordance with applicable design drawings, project specifications, and safety requirements and oversees the quality of the work being performed. Also, the RS, after material issuance from the warehouse, will organize and control the storage of the materials and equipment until just prior to the time of installation.

The QCE is responsible for reviewing construction records for proper grading, per 24590-WTP-GPP-CON-7107, *Construction Quality Control Program.*

Work Planning

A general overview of Bechtel's Instrument Installation Work Planning Process is provided in Figure 1. In this process BNI utilizes the two data tracking systems, *TEAMworks* and *SETROUTE* to schedule and coordinate materials, tools, and craft personnel for the installation. BNI also utilizes another tracking program called *PunchWorks*, which is Bechtel's Standard Application Program (BSAP) used to track action items and manage work and punch-list items.

Pre-Planning

The Responsible Field Engineer (RFE) and the Responsible Superintendent (RS) review the design drawings and *TEAMWorks* to identify construction issues and to confirm bulk quantities. A review is also conducted to identify other discipline commodities that need to be installed to support instrument installation activities. The RS also determines any special rigging requirements for large instrument racks, instrument shelters, and vendor package skids.

Preparation

The RS in conjunction with the RFE determine the field work plan and prepare a schedule based on material delivery dates, manpower availability, and project schedule requirements. Construction work packages are also prepared according to specfic procedures. WTP procedures 24590-WTP-GPP-CON-1201, *Construction Work Packages* and 24590-WTP-GPP-CON-3105, *Construction Work Packages Special Instructions*, are used by the RFE as needed and agreed upon with the RS.

Work Planning Highlights

The RS makes arrangements for safety and work permits, and obtains design drawings, vendor drawings, vendor instructions, and other documentation required to complete the work.

The design drawings issued by engineering or equipment vendors represents the scope of work to be performed and shows the instruments to be installed. Typical specifications and drawings utilized when installing instruments are:

- Instrument location drawings (Bechtel standard & project specific)
- Instrumentation installation and piping specifications
- Instrumentation detail drawings
- Piping isometric drawings
- Hook up drawings (process and pneumatic)
- Instrument index (with appropriate details)
- P&IDs
- Instrument wiring diagrams and schematics
- Vendor drawings and vendor instructions

- Data sheets
- Construction specification

Tagged instruments and major equipment purchases for packaged instrumentation systems are identified and detailed in the project specifications, data sheets and drawings as presented earlier. Procurement of these items is coordinated by the design engineer along with the purchasing department (MFAT), and/or provided by the Equipment Supplier.

The RFE and the RS review the design drawings. Installations are made as shown on the design drawings and details, unless otherwise approved. A Field Change Request (FCR) will be issued to document any deviation from the design drawings.

Prior to the start of work, the RFE and the RS will perform a complete field walk in order to identify design conflicts and field interferences that may be encountered. Also, any safety concerns relative to instrumentation installation practices and device accessibility for maintenance are identified and addressed.

Instrument installation control and accountability is assured with the use of Instrument Installation Cards produced through *Teamwork's* or *SETROUTE*. The RFE ensures the installation cards are issued to the RS or (sub) contractor for specific areas in the work plan. The RS or (sub) contractor installs instruments using the installation cards and the design drawings. The RS ensures the instrument card is updated as each instrument and the instrument commodities are installed.

General Instrument Installation Considerations

All in-line mounted instruments such as control valves and pressure relief valves are shown on the piping isometrics along with the taps for all off-line field-mounted instruments. In most cases, the in-line instruments will be installed with the piping, temporarily removed as required for flushing and hydro testing, and then reinstalled. Flow orifices and flow elements are normally held out until the last minute and installed as directed by the client or the startup group.

Field mounted instruments, which are shipped loose, must be individually mounted on an instrument stand or by an approved method as listed on the installation details drawings. All installations must be installed per the instrument installation details referenced in the instrumentation index. After instruments are mounted, process pneumatic tubing and electrical conduit will be connected in accordance with the instrument installation detail drawings and electrical installation procedures. Special consideration will be given when evaluating installations in and around energized equipment and equipment lockout/tagout practices will be performed in accordance with WTP procedure 24590-WTP-GPP-SIND-008, *System and Equipment Safety Lockout/Tagout*.

Figure 2 shows the details involved in the entire work process for instrument installation.

After instrument installation is complete, all covers and gaskets, are installed in order to keep out moisture and debris and to protect the instruments from harsh weather conditions.

Completed instrument cards are turned in and logged into the *TEAMWorks* or *SETROUTE®*) database by the RFE or trained designee.

Inspections

As the field work progresses and instruments are installed, both the RS and the RFE monitor installations to assure they are installed in accordance with the latest drawings and specifications. The following is a general list the RFE will use in performing a check of all new instruments and instrumentation systems:

a. Installed instrument matches the Instrument Data Sheet
b. Correct material, size, type, and function for the installation
c. Properly mounted/attached using correct details
d. All manufacturers' requirements have been met
e. Correct elevation and correct orientation
f. Correct hardware used
g. All packaging and shipping blocks removed
h. Ensure flexible connection/expansion loops at instrument
i. Flexible hoses installed to manufacturer's specification (flow and bend radii)
j. Conduit installation to the instrument allows for easy removal from the process for maintenance
k. Properly tagged/ID tags installed
l. Not blocking access to walkways, manways, or other equipment
m. Grounding, bonding, shielding and jumpers installed
n. Tubing runs are properly sloped and supported
o. All fittings and ferrules are the correct type and connections are made up in accordance with manufacturer's specifications or applicable standard work practices
p. Verify the nameplate is correct, legible, and permanently attached
q. Confirm grouting on instrument stands
r. Verify all welds are correct per drawings and specs
s. Clean and free of debris
t. All air piping is properly supported
u. All taps and root valves are accessible and properly oriented
v. Final installation is acceptable for safe maintenance and operations considerations
w. Correct instrument installation details have been used

Once the installation has been completed, a final inspection of each instrument is performed by the RFE to ensure the installation has been completed according to drawings, codes, and specifications.

As part of the final inspection, the RFE generates a list of open instrument punchlist items. The punchlist items are entered into the *PunchWorks* database (or equivalent) with responsible individuals and completion dates provided for each of them. *PunchWorks* tracks each item until it has been completed.

Performance of Instrument Installation

Bechtel performs all field work associated with instrument installation and instrument rack and jumper installations. Subcontractors will not perform instrument installations. Typically BNI purchases instruments for rack mounting and has them shipped to an awarded rack manufacturer for installation in racks prior to shipment to the site. Some instruments are also installed with jumpers and a process similar to that for rack mounted instruments is followed. BNI ensures that other discipline commodities needed to install instruments are completed prior to actual instrument installation. These other commodities include foundations, footings, embeds, underground utilities, platforms, plates, etc. that may be installed under subcontract work.

Testing

The Startup group will perform instrument installation testing and calibration as part of the Component Testing associated with each of the WTP systems. Craft personnel under the direction of a Startup Testing Lead will perform component testing activities. The testing activities are scheduled in the L4 startup sequence according to system and will be performed either before or after system turnover from construction depending on the testing requirements. Component Testing will be completed prior to the completion of Systems Testing

Instrument Component Testing ensures that instruments are ready to support System Testing and will verify that instruments are installed correctly, located properly, and that instruments are functional. For smart devices (instruments with microprocessors and network communications capability), the device firmware version will be verified for system testing later. Verification of loop function through the control room operator displays (HMIs) (as applicable) will also be performed as well as instrument calibration.

The calibration strategy will include a graded approach to ensure that the testing effort is consistent with the instrument's significance to project success. Instrument calibration testing will typically be performed after installation. Generally, instruments are being procured with certified calibration by the vendors. Thus, calibration testing will mainly be "calibration checks" to ensure that vendor calibration has not been compromised by shipping or installation. Instruments not provided with vendor calibration certificates will be field or shop calibrated.

In many cases, component testing may require Integrated Control Network (ICN) support depending upon the specific instrument and system. The systems required for ICN startup are generally designed for standalone operation. These systems include mainly the electrical systems (MVE, LVE, DCE, UPE, etc.). Portions of Component as well as System Testing will be completed before ICN startup. After the ICN is available, loop function through the operator control room screens (HMIs) must be checked for all instruments monitored through the ICN.

After the ICN system testing is performed, Foundation Fieldbus (FFB) Components will be tested. The FFB instruments are generally used for remote sensing and control elements. Device firmware configuration is also required as part of the testing to ensure proper communication with the ICN. The device configuration will be overwritten by software downloaded from the ICN upon device connection and will be consistent with the device firmware version verified

during previous component testing activities. The FFB device's network node address is required as part of the configuration and cannot be set until it is connected with the ICN. Testing of the device through the HMIs will also be required.

Component testing for Profibus devices will include both local and ICN connection testing. Profibus devices are generally used for electrical distribution and control equipment as well as for interface with foreign vendor packages. These devices generally require local connection in order to download configuration (and sometimes calibration settings) prior to connection to the ICN. Profibus devices, like FFB devices, require connection to the ICN in order to check for correct node addressing and for performing loop testing through the HMIs for remotely displayed instrument indications.

Serial device testing is focused on local device function and configuration with ICN interface for remote monitoring. Serial communication devices are generally used for a few specific non-process instruments and for remote monitoring and control of electrical switchgear equipment. For these devices, all configuration is performed locally and ICN connection is only required for checking network interface features. However, loop testing through the HMIs is required for remotely displayed indications and remote control where applicable.

Conventional I/O devices, such as 4-20 mA, discrete I/O, etc., may be tested before or after ICN availability. These devices are generally used for discrete position sensing for mechanical handling equipment and process sensors for safety equipment and do not require ICN or control system connection for initial calibration check. Testing includes loop checks for verifying that devices are connected to the proper I/O points and have proper scaling. Safety loop functions are explicitly tested.

Once required the required calibration, testing and checking are complete the equipment will be transferred to the care, custody, and control of Startup or the Client as required by contract.

Equipment documentation will be listed in a turnover package that is completed in accordance with Procedure 24590-WTP-GPP-CON-1601

3. Understand the philosophy associated with instrument maintainability and spares.

- Describe the philosophy and planning associated with instrument maintainability and instrument spares.

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Upon completion of Startup Testing, the responsibility for instrument maintenance will be transferred to Commissioning and Testing (C&T) Maintenance. Prior to this transfer, engineering will populate the Intools Database with all project instruments including those within vendor packages. Calibration information will be drawn from Intools to populate an instrument calibration database that will be used for initial and subsequent calibration activities. Details of the calibration program, including instrument accuracies, M&TE accuracies,

calibration frequencies, and graded the approach criteria will be determined as the supporting programs are developed.

The "graded approach" to maintaining instrument calibration and the frequency of performing calibration checks is applied to three major categories depending on plant or process risk. These are described below.

- Project critical – SIS Loop, Clean Air permit components, process critical, and other instruments that could pose significant personnel, environmental, or project risk in the case of undetected malfunction will receive the highest level of maintenance including routine calibration checks leading to calibration or replacement as needed to ensure proper function.

- Routine monitoring and control – Instruments used for normal equipment and process control functions will receive routine periodic maintenance including scheduled re-calibration or replacement as required for proper system function to ensure a high degree of assurance of proper function.

- Infrequent monitoring or control – Instruments used for infrequent or non-essential functions will receive routine maintenance or calibration before use as appropriate to support specific tasks.

The instrument spare parts program is currently under development, but the following features are anticipated:

- Instruments found defective will be replaced in-kind. On-site repair is unlikely.

- Instrument spares will be stocked or available on short notice as necessary to minimize project risk and expense according to the following criteria:

  - Lead times for delivery of replacements
  - Vendor recommendations
  - Operating experience
  - System availability requirements
  - RAMI data
  - Item cost

4. Gain further insight into the ICN general schedule.

- ➢ Obtain a detailed schedule (level 4 or lower) of the I&C work and deliverables (software and hardware), including installation of instruments, (or templates/fragnets/hammock)

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The BNI scheduling of instrument procurement, installation, and testing activities was briefly discussed in the presentation. Figures 3 and 4 provide typical fragnets involved in the detailed

schedule development. These schedules are consistent with Level 4 schedules and schedules from other presentations which are easily obtainable.

Figure 1 - Instrument Installation Work Planning Process

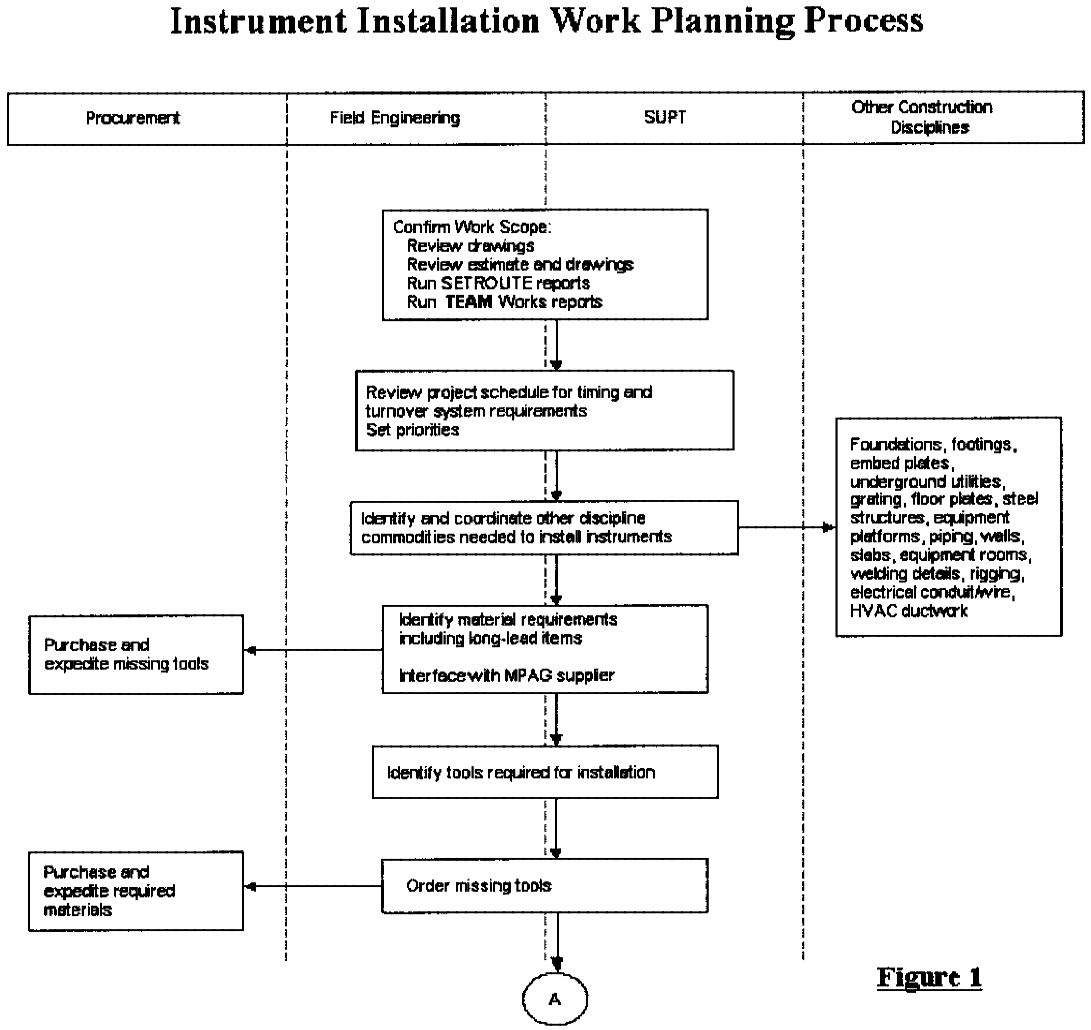


Figure 1

Instrument Installation Work Planning Process (Cont.)

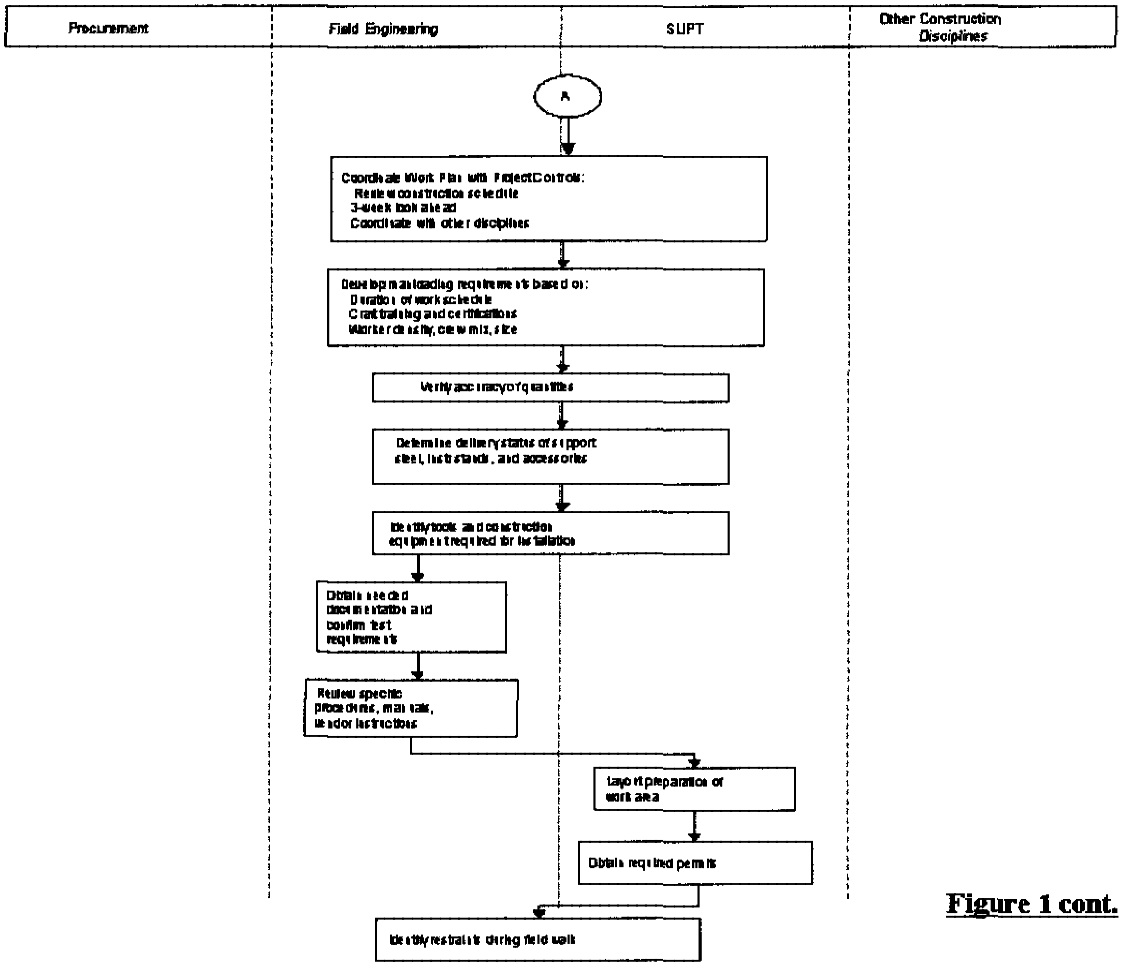


Figure 1 cont.

Figure 2 - Work Process for Instrumentation Installation

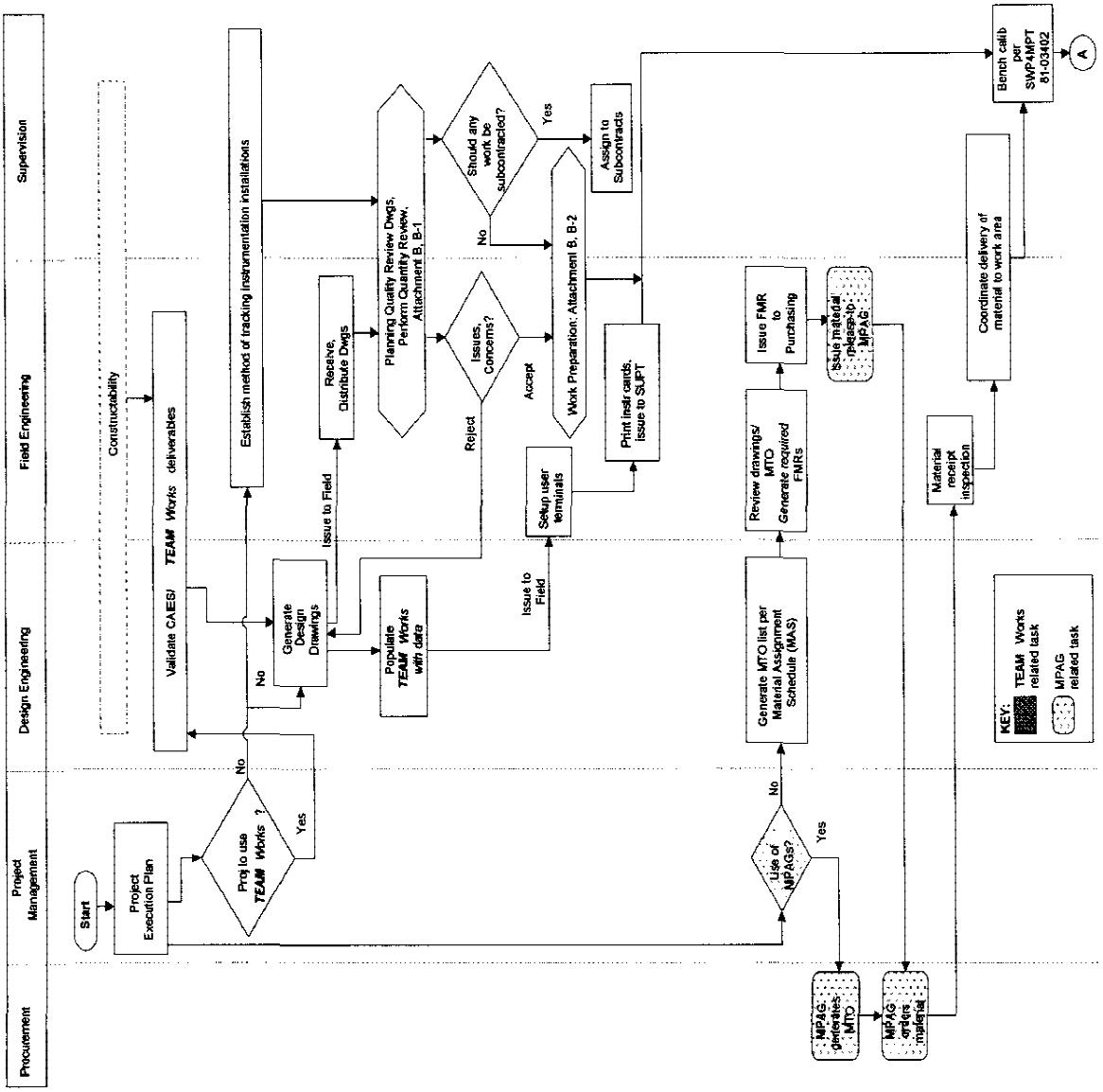


Figure 2 - Work Process for Instrumentation Installation

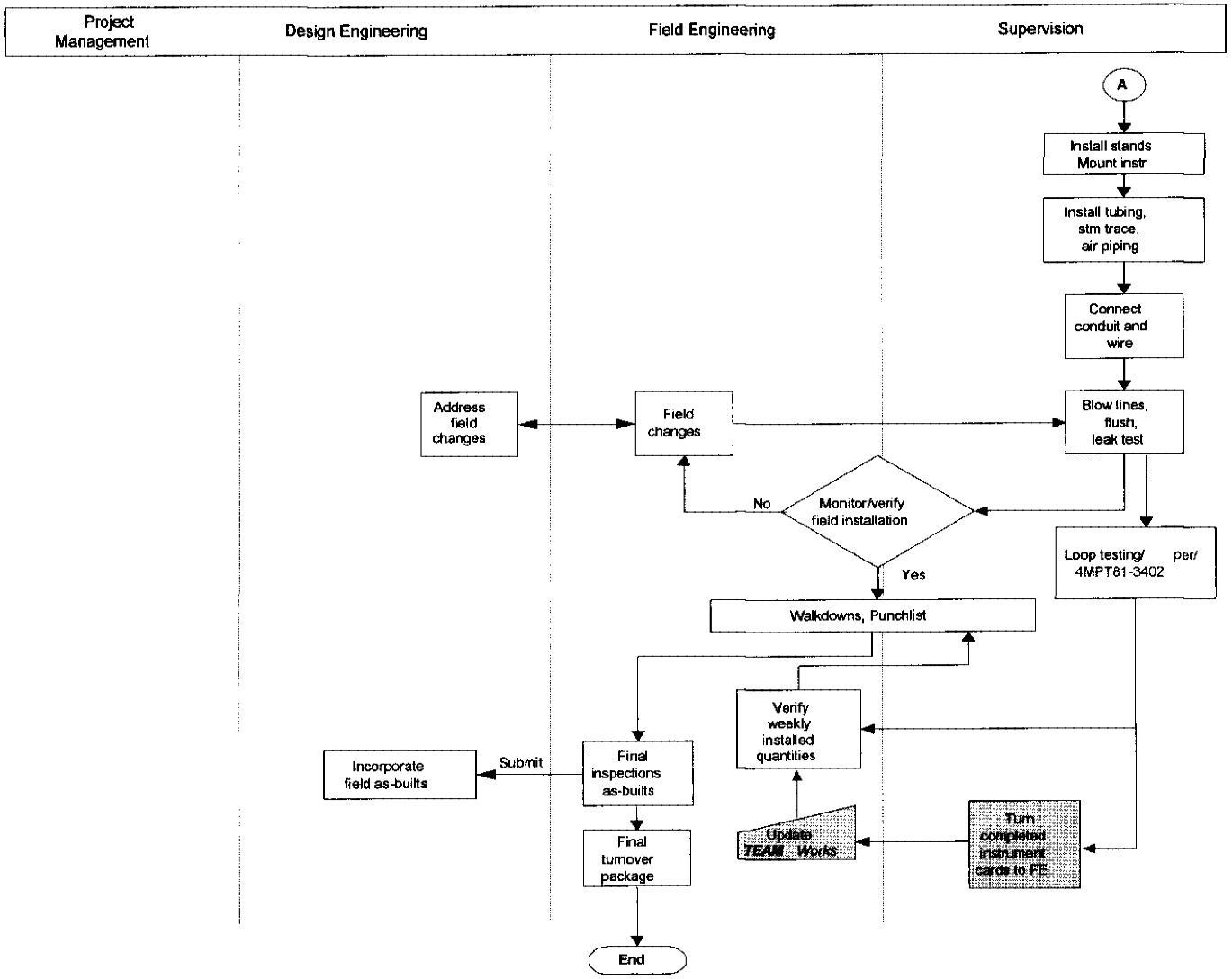


Figure 3 - C&I Software Development Fragnet

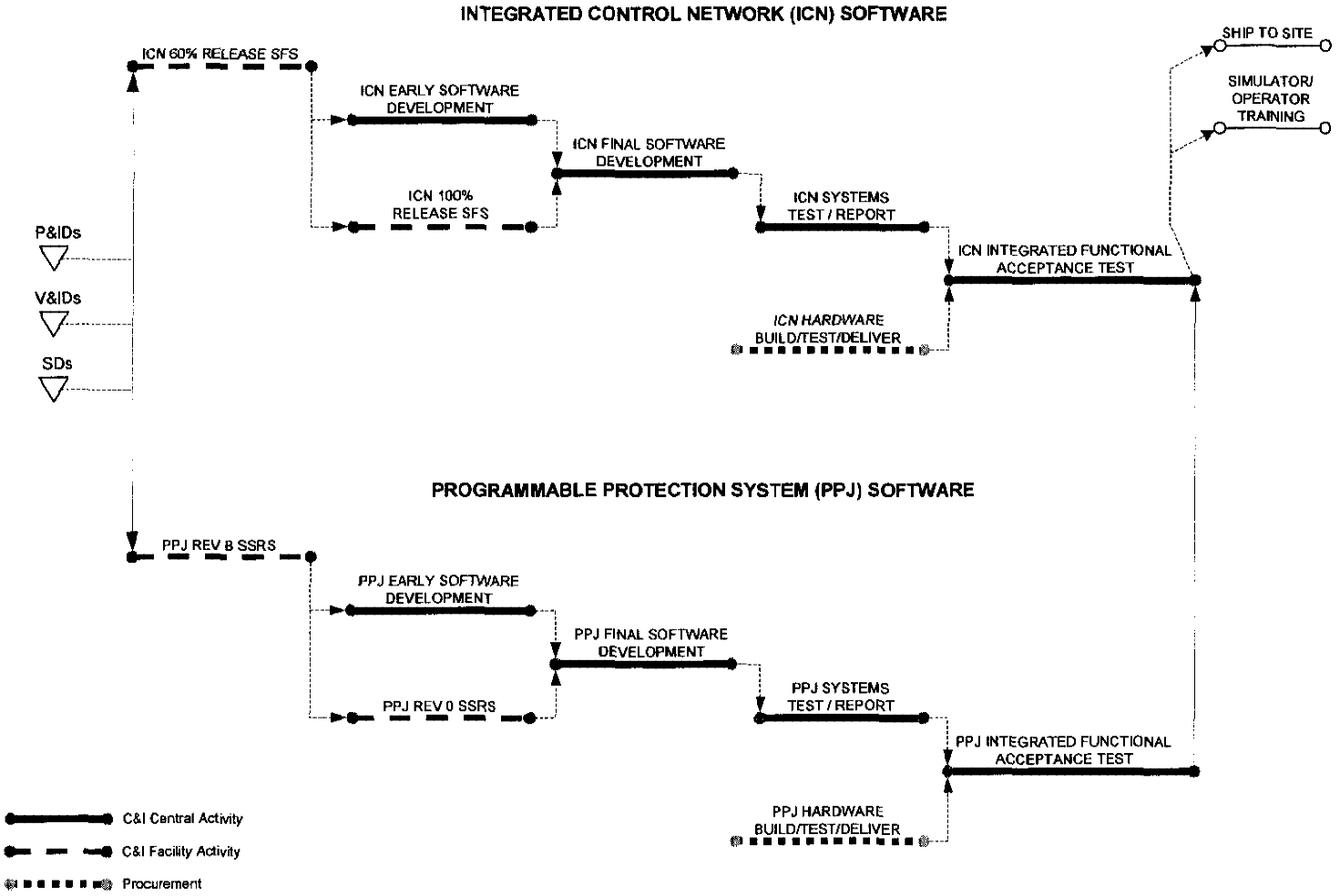
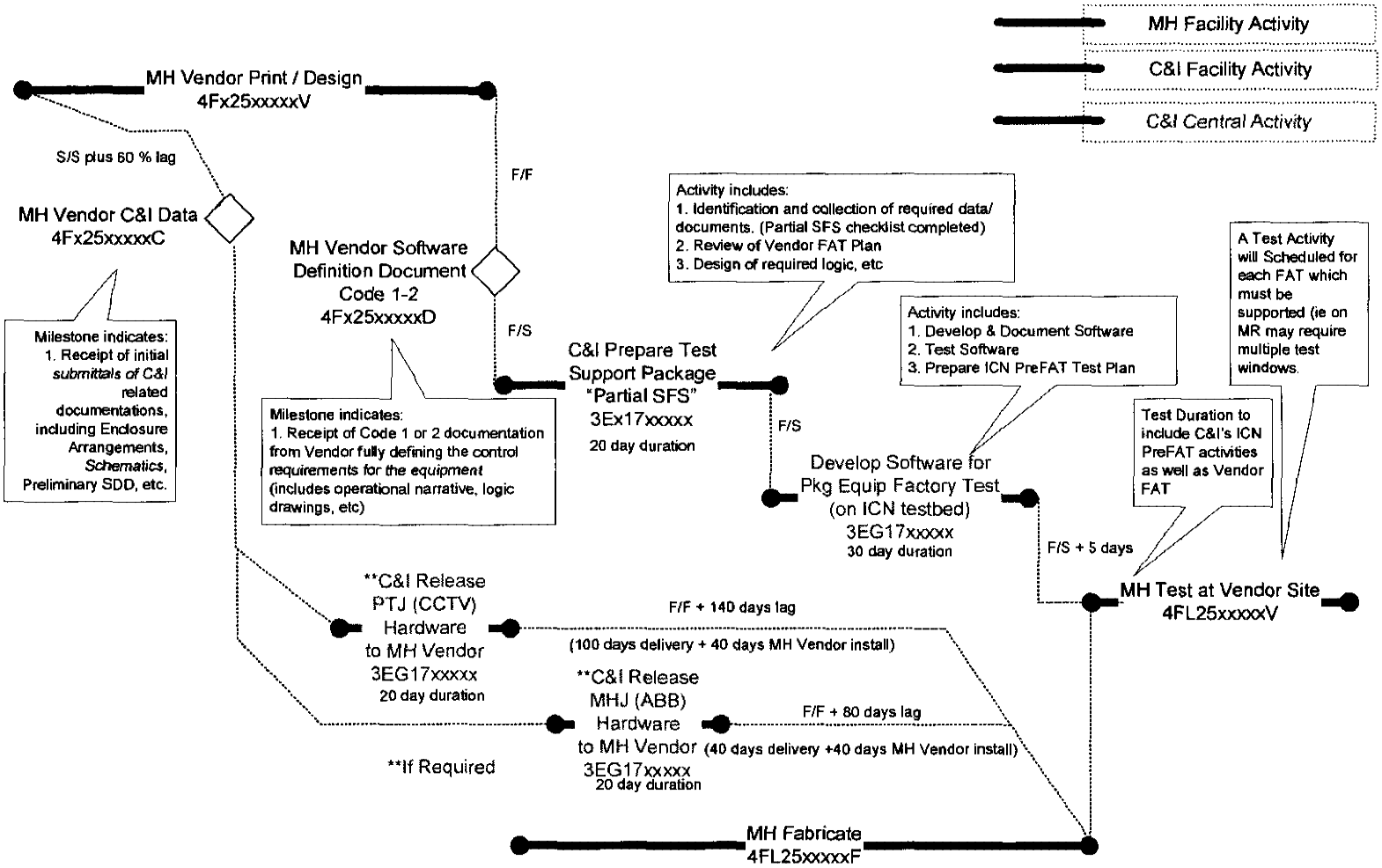


Figure 4 - Mechanical Handling ICN Development



Record Note for document number D-05-DESIGN-011:

Please scan the attached original document, "US Department of Energy, Office of River Protection Design Oversight Report: Waste Treatment and Immobilization Plant Instrument Procurement and Installation," into RMIS and list ML Ramsay as the originator.

A summary of this report was sent to BNI in letter number 05-WED-016.

bcc:
Ramsay, ML

Thank you