

PHMC Formal Design Review Standard

Prepared for the U.S. Department of Energy
Assistant Secretary for Environmental Management

Project Hanford Management Contractor for the
U.S. Department of Energy under Contract DE-AC06-96RL13200

FLUOR.

P.O. Box 1000
Richland, Washington

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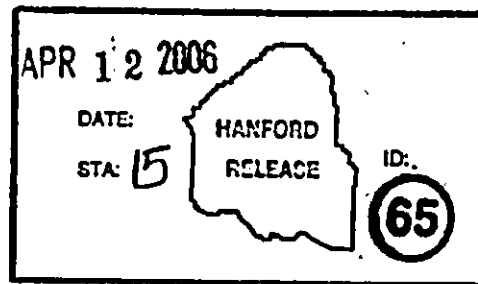
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1.0 PURPOSE

This standard establishes the expectations for the content and conduct of Project Hanford Management Contract (PHMC) formal design reviews between Fluor Hanford (FH) – the Client and the Design Agent, whether the design is produced by Fluor Hanford, Fluor Government Group, or a Contractor. This standard satisfies the design verification requirements of a formal design review as described in HNF-PRO-8336.

2.0 SCOPE

The standard is to be applied based on a graded approach established by the Design Authority and Project Management at the start of the project. This means the Design Authority and Project Management decide whether to perform a formal design review at each stage of design (30%, 60%, and 90%) based on project safety risk, complexity, and uniqueness. For example, a routine low risk project may only perform a 60% and 90% design review, while a prototype high risk project, such as sludge oxidation and grouting, would require formal reviews at each stage of design.

3.0 DESIGN MEDIA TO BE REVIEWED

In a typical design project, design media are developed in a sequential progression beginning with conceptual design (30% design), preliminary design (60% design), and final design (90% design). The level of design activity varies among the different engineering disciplines as the design progresses. Note: a 90% design is considered 100% complete by the Design Agent and includes all internal reviews and checking. Table 1 below identifies the expected level of completion of design deliverables by each discipline at each stage of the design. These design media form the data base of information that should be available for the formal design reviews at the respective stages of design completion.

4.0 FORMAL DESIGN REVIEWS

Formal design reviews consist of a systematic overall review and evaluation of a design by a committee representing all affected disciplines. The formal design review provides for verification of the design. An FH Design Review Chairman should be selected by the project, program, or department, or division manager. The Design Review Committee comprising client personnel representing the engineering disciplines and functional groups like Operations should be designated by the Design Review Chairman in conjunction with the engineering manager. Members of the Design Review Committee should have the necessary expertise to ensure that an in depth review can be performed. Neither the Design Review Chairman nor the member of the committee should be individuals who performed the original design. It is preferred the Design Review Chairman and the Design Review Committee are the same individuals for all design reviews conducted on a specific design. The formal reviews will vary in content

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depending whether they are 30%, 60%, or 90% design reviews and whether they are a general design review or a specialized P&ID or HAZOPS design review. The Design Review Chairman or his designee should facilitate the reviews.

The Design Review Chairman should schedule the review meetings far enough in advance to allow team members to review the design package and prepare for the meeting. For complex designs, a formal design review should be initiated by conducting a design review briefing to provide information on the overall scope of the design effort. The Design Review Chairman briefs the verifiers as to their assigned roles and confirms the schedule for completion.

The design review briefing should include informal discussion on functions and requirements, design philosophy, and the basic configuration on the equipment, hardware, or software, etc. The design agent responsible for the design normally presents the design including studies or analyses, such as stress analysis, seismic or other calculations, test results, interfaces, and other aspects of the design.

The following information should be provided at the briefing:

- Identification of the specific design packages(s) to be reviewed and the stage of design completion (e.g. 30%, 60% or 90%).
- An agenda for the formal design review meeting and a concise statement of the scope (part or all of the design). The agenda should include items such as fabrication adequacy, test results, procurement, and any outstanding design uncertainties.
- Copies of the Review Comment Record (RCR), site form A-6400.090.1 to be used to document individual comments. At the discretion of the Design Review Chairman, word processor versions of the RCR or other selected review/comment formats may be used to submit comments.
- Copies of the engineering documentation to be reviewed accompanied by a listing of documents.
- Other appropriate background information, including identification of design inputs like the Functional Design Requirements Document.
- List of specific assignments for each Design Review Committee member and for other personnel chosen for the meeting, date, time, and location for the meeting.
- The meeting proceedings should be documented in meeting minutes.

The Design Review Chairman should ensure that the extent of the review is adequate and appropriate for each reviewer and collectively for the overall review.

Discrepancies or design issues raised by discipline reviewers (verifiers) are itemized in RCR forms documented in the Design Review Report. All issues raised in RCRs by reviewers are to be dispositional by the design agent. If the comment is not accepted, a justification must be provided on the RCR form. In addition, the reviewer must initial his acceptance of the disposition of each of his comments, and the Design Authority needs to

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confirm proper incorporation of the comments. The DA should ask for assistance in confirming proper incorporation of comments outside of his/her field of expertise. Upon resolution of all RCR comments, each verifier completes a Design Verification Record, site form A-6003-845.

An executive summary of the design review describing the scope of the review, the major issues, disposition of issues, and design conclusions accompanied by the completed Design Verification Records (site form A-6003-845) and completed RCRs (site form A-6400.090.1) comprise the Design Review Report. The design Verification Records and the Design Review Report are approved by the Design Authority and the Engineering Manager.

5.0 TYPES OF DESIGN REVIEWS

5.1 General

A general design review should be performed at 30%, 60%, and 90% stages of design development. The design reviews are to be conducted on a graded approach based on the level of design maturity and availability of design media identified in Table 1. For example, a 30% design review would be a conceptual design review with emphasis on the relatively mature process design and initial development of mechanical, structural, instrumentation, and electrical design media. The design media listed in Table 1 should be reviewed in the manner described above. The media should be at the level of development specified in the three respective stages of design development listed in Table 1. If the design has not progressed to nor the design media is not yet developed to the respective design levels of 30%, 60%, and 90%, the formal reviews should be delayed until the design has reached the specified level of development. As the design media is reviewed comments should be recorded on the RCR forms as described above.

5.2 Piping and Instrumentation Diagram (P&ID) Review

At the 60% design review stage only, a detail P&ID review should be conducted by the design agent. The design agent should lead the review, and the design agent's engineering discipline lead engineers should be available to describe the system's design and operational control to the FH project discipline engineers. A detail line by line mark-off of every item on each P&ID should be performed as the design agent's representative describes the equipment depicted. As a minimum, the Process Flow Diagram, System Description, Equipment List, Equipment and Instrument Data Sheets, piping specification, narrative control philosophy, and functional requirements document should be available for the review. The review serves to confirm equipment consistency among the design media, explain the operation of the system, and address any ambiguities or misunderstandings of the design. Editorial comments are marked directly on the drawings with a concurring

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signature from the Design Agent's project manager and the design authority. Design holds are also marked with a cloud on the P&IDs. Other comments are noted on RCR forms for disposition as described above.

5.3 Hazard Control Decision Design Reviews

A HAZOP review should be performed at each of the three design stages between the Design Agent and FH Nuclear Safety Group. Early stages of design should start with preliminary hazards analyses. Then proceed to progressively more detail hazard reviews as the design progresses. A 60 % HAZOP must be conducted to support the Preliminary Documented Safety Analysis and a 90% design HAZOP must be conducted to support the Documented Safety Analysis. Control Design Meetings should be conducted following HAZOP meetings to discuss and agree on safety issues including safety classification of equipment. The Nuclear Safety Organization should lead HAZOP and Control Design Review with attendance by the Design Authority, Operations, Criticality (if required), Fire Protection and the Design Agent. These reviews are iterative in nature and must be revisited whenever there is any change to the design that could affect safety. The media to be reviewed includes the General Arrangement Drawings, System Description, Control Philosophy (when available), Process Flow Diagrams, and Piping and Instrumentation Diagrams.

Table 1 Project Deliverables at Three Design Points

Design Element	Conceptual Design Review (30%)	Preliminary Design Review (60%)	Final Design Review (90%)
Process Engineering	<p>Major process equipment identified, sized, and summarized on equipment list.</p> <p>Alternative processes economic evaluations complete and final selections made.</p> <p>Process flow diagrams with heat & material balance - 80% complete.</p> <p>Piping and Instrument Diagrams 1st draft with preliminary line sizing</p> <p>Process equipment data sheets complete for major equipment.</p> <p>Major equipment sizing calculations complete.</p> <p>Materials of construction specified, possibly on metallurgical flow diagram.</p>	<p>Conceptual Design review comments incorporated.</p> <p>All control parameters specified and instrument datasheets prepared.</p> <p>Process flow diagrams with heat and material balance, P&IDs, equipment data sheets, and line sizing complete.</p> <p>All other calculations complete, including electrical loads, HVAC heat loads, and utility summary.</p> <p>All safety systems components defined.</p> <p>System design description – 75% Including process description and process control philosophy.</p> <p>Preliminary RAM analysis complete</p>	<p>All work complete and checked.</p> <p>Preliminary Design review comments incorporated.</p> <p>Final RAM analysis complete and verification that plant availability meets the requirements.</p>

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Design Element	Conceptual Design Review (30%)	Preliminary Design Review (60%)	Final Design Review (90%)
	<p>Process system description, draft</p> <p>Utility requirements estimated – 60%</p> <p>Estimated process equip. heat loads to HVAC.</p> <p>Waste streams identification</p> <p>Reliability, Availability, and Maintainability (RAM) parameters identified for key systems.</p> <p>Deliverables for Safety Systems Identification:</p> <ol style="list-style-type: none"> 1. Failure Modes and Effects Analysis (FMEA) at a systems level. 2. Preliminary HazOp Analysis 3. Preliminary safety SSCs identified. 	<p>Estimate and classification of waste streams.</p> <p>Deliverables for Safety Systems Identification:</p> <ol style="list-style-type: none"> 1. FMEA complete 2. HazOp analysis complete 3. All safety SSCs identified 	
Architectural	<p>Concept sketches complete, including materials of construction, color schemes, etc.</p> <p>Plans – 85% complete except notes, dimensions, and sections.</p> <p>Sections – 70%</p> <p>Elevations – 70%</p> <p>Details – 40%</p> <p>Schedules – 70%</p> <p>Construction specifications – 30%</p>	<p>Conceptual Design review comments incorporated.</p> <p>Plans – 95% complete except notes, dimensions, and sections.</p> <p>Sections – 95%</p> <p>Elevations – 95%</p> <p>Details – 60%</p> <p>Schedules – 95%</p> <p>Construction specifications – 90%</p>	<p>All work complete and checked.</p> <p>Preliminary Design review comments incorporated.</p>
Civil	<p>Grading plan – 90%</p> <p>Drainage plan – 90%</p> <p>Site plan with utilities – 90%</p> <p>Typical road section.</p> <p>Geotechnical evaluation.</p> <p>Calculations – 75%</p> <p>Construction specifications – 30%</p>	<p>Conceptual Design review comments incorporated.</p> <p>Grading, drainage, paving, and site plans – 95%</p> <p>Sections and details – 75%</p> <p>Calculations – 90%</p> <p>Construction specifications – 90%</p>	<p>All work complete and checked.</p> <p>Preliminary Design review comments incorporated.</p>
Structural	<p>Calculations – 65% to match architectural and facility progress.</p>	<p>Conceptual Design review comments incorporated.</p>	<p>All work complete and checked.</p> <p>Preliminary Design review comments</p>

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Design Element	Conceptual Design Review (30%)	Preliminary Design Review (60%)	Final Design Review (90%)
	<p>Drawings should show basic framing system, plan, sections, and some details.</p> <p>Structural calculations 65% complete</p>	<p>Calculations substantially complete, including check.</p>	<p>incorporated.</p>
Environmental Control	<p>Calculations – 70%</p> <p>Permitting strategies documented.</p> <p>Waste streams evaluation</p>	<p>Conceptual Design review comments incorporated.</p> <p>Permitting strategies shared with the environmental enforcement agency and feed back is obtained.</p> <p>Complete calculations.</p>	<p>All work complete and checked.</p> <p>Preliminary Design review comments incorporated.</p> <p>Permitting strategies approved by the environmental enforcement agency.</p> <p>All disciplines cross-checked for interface (documented).</p>
HVAC	<p>HVAC flow diagram (PFD) 1st draft</p> <p>HVAC mechanical flow diagram (MFD) or P&ID 1st draft</p> <p>Control philosophy 1st draft</p> <p>Preliminary heating and cooling loads</p> <p>Preliminary Life-cycle cost analysis</p> <p>Identification of applicable codes and standards</p> <p>Preliminary equipment list</p> <p>System description and control philosophy draft</p> <p>Establish basis for design</p>	<p>Conceptual Design review comments incorporated.</p> <p>Final HVAC flow diagram (PFD)</p> <p>Final MFD or P&ID.</p> <p>Heating and cooling calculations – 80%</p> <p>Preliminary duct routing drawings</p> <p>Confinement zone drawings</p> <p>Establish facility space requirements</p> <p>Final equipment list complete</p>	<p>All work complete and checked.</p> <p>Preliminary Design review comments incorporated.</p> <p>Air balance plan</p>

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Design Element	Conceptual Design Review (30%)	Preliminary Design Review (60%)	Final Design Review (90%)
Facility Layout	<p>Preliminary General Arrangement and Space Allocation drawings showing all major mechanical and HVAC equipment</p> <p>Preliminary Control Room Arrangement drawings</p> <p>Preliminary Radiation Zone drawings</p> <p>Preliminary demolition drawings</p>	<p>Conceptual Design review comments incorporated.</p> <p>Detailed General Arrangement, Space Allocation, and Control Room arrangement drawings showing all mechanical and HVAC equipment and key electrical and control systems panels</p> <p>Final demolition drawings complete</p>	<p>All work complete and checked</p> <p>Preliminary Design review comments incorporated</p>
Piping	<p>Pipe support, stress, etc. calculations – 30%</p> <p>Schematics showing major components; general arrangements; space allocation; and flow patterns of each system - 60%</p> <p>General arrangement drawing showing all major equipment.</p> <p>3D model started</p> <p>Piping specifications started</p>	<p>Conceptual Design review comments incorporated.</p> <p>Piping specifications – preliminary draft complete</p> <p>3D model 60% complete</p> <p>Piping Plans – 80%</p> <p>Piping Elevation – 60%</p> <p>Piping Details – 60%</p> <p>Piping Schedules – 80%</p> <p>Completed piping calculations.</p> <p>General arrangement drawing complete (plan view).</p> <p>Testing requirements – 90%</p> <p>Underground piping drawings.</p> <p>Line list</p>	<p>All work complete and checked</p> <p>Preliminary Design review comments incorporated.</p>
Electrical	<p>Initial start of one-line diagram, legend, notes.</p> <p>Electrical load summary</p> <p>Complete floor plans showing preliminary layout of lighting and receptacles; location of major power distribution equipment such as switchgear, motor control centers, panel boards; location of major process equipment, motors, pumps, control panels, etc.; preliminary layout of telecommunications and alarm equipment such as PA system, fire alarm, intrusion alarm, telephone, computer outlets, etc.</p>	<p>Conceptual Design review comments incorporated.</p> <p>One-line diagrams – complete</p> <p>Schematic and wiring diagrams – 60%</p> <p>Panel schedules and details – 60%</p> <p>Lighting and receptacles, controls and general details – 60%</p> <p>Final layout of electrical distribution system including all branch circuits, home runs, switchgear, and motor control center details – 60%</p>	<p>All work complete and checked.</p> <p>Preliminary Design review comments incorporated.</p>

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	<p>Outside distribution plans showing preliminary routing of utility services.</p> <p>Demolition sketches – complete</p> <p>Electrical calculations.</p> <p>Procurement/performance and construction specifications – 30%</p>	<p>Grounding plans and details – 60%</p> <p>Lightning protection design</p> <p>Outside distribution plans – complete</p> <p>Final layout of telecommunications and alarm equipment including tie-ins to existing circuits – complete</p> <p>Electrical calculations – complete</p> <p>Equipment specifications – 90%</p> <p>Electrical testing requirements – 90%</p> <p>Cathodic protection – 60%</p> <p>Procurement/performance and construction specifications - 90%</p>	
<p>Instrumentation & Controls (e.g., Monitoring and Control Systems)</p>	<p>Monitoring and Control System F&R Document – provides I&C, MCS baseline design requirements.</p> <p>Control system architecture, as required (defines control strategy, fully, semi, or automation or manual controls requirements, data communication protocols, and data storage and retrieval, HMI/PLC architectures).</p> <p>Software Quality Assurance Plan, as required.</p> <p>Computer or data acquisitions specification draft. Design calculations.</p> <p>Procurement/performance and construction specifications – 30%</p>	<p>Conceptual Design review comments incorporated.</p> <p>Instrument equipment list</p> <p>Control room layout and general instrumentation system field layout.</p> <p>Control logic narratives</p> <p>Control and computer panel.</p> <p>Instrument specifications and sizing calculations, including data sheets.</p> <p>Interconnections – tubing and cabling.</p> <p>Software requirements specification (computer and data acquisition specifications) as required.</p> <p>Software verification and validation test procedure, as required.</p> <p>Software I/O tag and address listing, as required.</p> <p>HMI interface screens, as required. Set points document, O&M manual.</p> <p>Interface subsystems procurement specifications.</p> <p>First milestone review comments incorporated.</p>	<p>All work complete and checked.</p> <p>Preliminary Design review comments incorporated.</p> <p>HMI, PLC, communication, and data system software programming ready for initial testing, as required.</p> <p>Integrated testing (hardware, software, firmware, electrical wiring, sensors, interlocks, etc.), and software V&V report, as required.</p> <p>Software design descriptions, as required.</p> <p>Instrumentation installation details.</p> <p>Control loop diagrams.</p>

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		Procurement/performance and construction specifications – 90% I&C testing requirements – 90%	
Mechanical	General arrangement drawing Equipment layout drawings – 90% Equipment assembly drawings – 40% Equipment detail drawings – 20% Equipment Calculations – 40% Tabulation of equipment, material, services – 80% Identification of long-lead procurement items. Construction specifications – 30% Preliminary Operation and Maintenance Plan (for high-radiation, remote operation or maintenance facilities)	Conceptual Design review comments incorporated. Equipment layouts complete. Equipment assemblies – 60% Equipment details – 40% Equipment Calculations – 90% Equipment installation drawings – 30% Mechanical equipment list. Identify work and schedule to complete drawings. Construction specifications – 90% Equipment testing requirements – 90% Equipment procurement specifications Final Operation and Maintenance Plan (for high-radiation, remote operation or maintenance facilities)	All work completed and checked. Preliminary Design review comments incorporated.
Project Controls / Cost Estimating	Work breakdown structure (WBS) complete. Basis for cost estimate complete. Project construction work plan by participant complete. Project schedule for design, equipment, procurement, and construction work complete and in usable detail. Construction craft and crew rates complete. Miscellaneous costs, indirect costs, job factors, construction support activity, and other factors that have a cost impact on project construction	Conceptual Design review comments incorporated. Miscellaneous cost determinants complete. Cost code system complete. Architectural, structural, and civil cost estimate complete. Electrical, instrumentation, piping, and environmental control cost estimates 90% complete. Deviations from budget estimate identified and rationalized.	Title II cost estimate in final form with only minor items needed to complete. Preliminary Design review comments incorporated.

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	<p>work are 95% complete.</p> <p>Determine contingency and escalation, if any, to be applied.</p> <p>Determine base cost data.</p> <p>Cost Code System 95% complete.</p> <p>Architectural, structural, and civil cost estimate in proper form and 95% complete.</p> <p>Electrical, instrumentation, piping, and environmental control bills of material up-to-date with design status and priced out in proper form.</p> <p>Computerization of cost estimate, when required, up-to-date with current status of design engineering.</p> <p>Title I cost estimate complete.</p>	<p>All unit prices established.</p>	
<p>Construction</p>	<p>Conduct a documented site walk down to confirm current status, if required.</p> <p>Constructability review.</p>	<p>Conceptual Design review comments incorporated.</p> <p>Constructability review.</p> <p>Review for safety or operating hazards involving construction.</p> <p>Review for construction methods, construction economics, and accessibility.</p> <p>Review feasibility of recommended work assignment (CMP) or fixed-price contract and special equipment procurement by FH</p> <p>Prepare construction specification per CSI.</p>	<p>Review for safety, etc. (see item under 60% reviews).</p> <p>Preliminary Design review comments incorporated.</p> <p>Completeness of total design as needed for contracting purposes.</p> <p>Review for errors, ambiguities, omissions, clarity, and interferences.</p> <p>Review for operational phase (ensure that work specified will provide minimum interferences and conflicts with operating group during construction).</p> <p>Review construction methods, openings sized appropriately for access, etc., for adequacy and practicability.</p> <p>Review for start of preparation of special conditions and review procurement plans.</p> <p>Review definitions of and availability of government-furnished items (also provide for proper identification, storage, and release to contractor in an orderly manner).</p>

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			Review for storage facilities, rest rooms, security boundaries, temporary electrical, utility services, and parking as related directly to the contractor's activities.
Operations and Maintenance	Operational concept agreed to and checked against the P&IDs Operability review	Conceptual Design review comments incorporated. Operational and maintenance concepts final. Operability / Maintainability review Maintenance procedures identified Operating procedures identified	All vendor information required for operations is identified and presented. Preliminary Design review comments incorporated. Maintenance procedures forms ready for validation. Operating procedures ready for validation.
Nuclear & Radiation Safety	ALARA Plan, complete Preliminary Radiation Zone Map	Nuclear safety analyses, including source terms, shielding, criticality, etc. Hazard Analysis, complete Preliminary Documented Safety Analysis (PDSA) and Technical Safety Requirements (TSR) ALARA Report Final Radiation Zone Map	All work completed and checked. Preliminary Design review comments incorporated. Final DSA and TSRs
Project Management	Conceptual Design Report Functional Design Criteria issued Software verification complete Design Verification Plan	Preliminary Design Report Test Plan with acceptance criteria Functional Design Criteria updated	Functional Design Criteria compliance matrix Authorization Basis compliance matrix

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