

<b>FACILITIES MAINTENANCE AND ENGINEERING PROCEDURE</b>		
<b>Subject:</b>  <b>DESIGN PROCESS</b>	FMPEP-P-0350	Rev. No. 2
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### 1.0 PURPOSE

This procedure describes the essential engineering activities associated with the development and completion of the design for a project, renovation, structure, system, or subsystem. It is intended to present an overview of the complete design process, and to assist the engineering team in the understanding of that process. The satisfactory accomplishment of these activities requires a clear understanding of client needs and applicable requirements, and will result in a technically correct and cost-effective design solution utilizing a sound engineering approach.

### 2.0 GENERAL

The basic goal of the design process is to produce a design of high technical quality which meets requirements in a cost-effective and timely manner. The primary characteristics of the design process which contribute to a high quality engineered product are:

- (a) A clear definition of the objectives and customer needs.
- (b) Verification of existing field conditions
- (c) A specific plan for meeting the objectives and customer needs.
- (d) Approval or concurrence of the objectives before initiation of detailed design.
- (e) Iterations to allow refinement of the requirements.
- (f) Integration of pertinent constraints and information from similar designs, lessons learned or other design groups.
- (g) Identification of process logic and tasks requiring completion before proceeding to the next phase.
- (h) Progressive validation and acceptance of the design through a review and feedback process.
- (i) Early and specific definition and implementation of requirements and design baselines.

### 3.0 PROCEDURE

A schedule should be developed, under the direction of the Engineering Manager, Project Manager and Lead Design Engineer, for the integration of design activities into the overall engineering process.

#### 3.1 Design Process

The Engineering Manager, Project Manager and Lead Design Engineer, are responsible for managing the development of the design to assure the incorporation of requirements which reflect the client needs. Successful implementation of the design process requires planning, application of management control methods, and engineering group integration.

At the beginning of each task or design effort, the Engineering Manager, Project Manager and Lead Design Engineer should establish the management control methods necessary to achieve the objectives of the assignment.

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The design review at defined stages in the design process provide a means to assure that the design meets design requirements and that technical deficiencies or problem areas are identified and resolved. This approach provides an increasing level of confidence as the design is developed and minimizes unanticipated changes. The design reviews should occur at key points in the schedule to allow sufficient time to implement and close out items identified in the design reviews.

Design reviews should include, as applicable, reviews by staff engineers, requestors, building managers, FME shop foreman, Safety, Security, LAN office and any other party that would be affected or have an interest in the design. Design review periods should be limited to (10) working days. Design reviews should be initiated using the "Design Review Memo" illustrated in Exhibit "K".

The design process, as illustrated in Exhibit A, can be considered in three major phases:

- (a) Preliminary Design
- (b) Intermediate Design
- (c) Final Design

Exhibit B shows the process in more detail.

The overall process can be executed in a variety of ways. There are four primary scenarios, as depicted in Exhibit D. They include:

- (a) Design by A&E; installation by Contractor (Template 1)
- (b) Design inhouse; installation by Contractor (Template 2)
- (c) Design inhouse; installation inhouse by shops (Template 3)
- (d) No design required (shop assist may be needed); installation inhouse by shops (Template 4)

Exhibit C provides typical design package expectations for work performed inhouse. Typically, after the preliminary phase, there is a design review (intermediate design) at a nominal 90% stage. This is followed by the finalization of design (final design), based on the results of this review.

When design is performed by an A&E, there may be multiple reviews, depending on the scope and complexity of the project. There will be a preliminary design phase, with typically 35% and 65% reviews, followed by the final design ready for bid and then construction. If one intermediate review is performed (called 50%), the expectations of the 65% review point will likely apply. For the requirements and expectations of the A&E, refer to General Specification GS-04, A&E Expectations.

Note: The Project Manager is to perform interim evaluations and an overall performance assessment of an Architect Engineer in accordance with the FME procedure FMP-G-0065, Architect/Engineer Performance Evaluation.

### 3.1.1 Preliminary Design (Phase 1)

The purpose of the preliminary design phase is two fold. The first objective is to define the firm requirements. The requirements and their relative importance must be known. Client requirements are identified and analyzed to

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ensure that the applicable design inputs and parameters have been considered in developing conceptual solutions. Schedule requirements, budget requirement and deliverables must also be defined. Typical considerations should include, but are not limited to:

(a) Review of similar designs

(b) Applicable design criteria including:

1. System functional requirements
2. cGMP requirements
3. Site and environmental requirements
4. Fire protection and life safety requirements
5. Reliability / operability requirements
6. Compliance with codes and standards
7. Verification of existing field conditions
8. Compliance with NIH Guidelines which are found at web site <http://des.od.nih.gov/>
9. Identification of basic client needs

(c) Identification of affected and/or related design documents

(d) Reliability/availability, human factors, operations and maintenance criteria

(e) Identification of applicable construction, operations, testing, and maintenance requirements.

(f) Identification of technical, schedule and cost risks, with development of paths of resolution for the identified risk or establishment of a specific plan/procedure with milestones to mitigate potential problems.

(g) Utilization of sound engineering practices with considerations given to value engineering.

(h) Identification of long lead items.

(i) Document scope of work and deliverables.

(j) Develop budget and cost estimates (upon sufficient design) for performance monitoring.

The second objective of Phase 1 is to define the Preliminary Design. This may require several iterations to assure that all requirements have been identified and potential solutions have been developed. Each iteration should provide a clearer and more complete statement of the design requirements. See Exhibit C, "Preliminary Design Phase" and use sections as appropriate.

### 3.1.2 Intermediate Design (Phase 2)

The major focus of the intermediate design phase is the development, in more detail, of the design concept of the project. These intermediate designs typically involve application of concurrent engineering techniques including coordination among all engineering disciplines for compliance with design requirements, constructability, cost-effectiveness, and compatibility with schedule requirements. See Exhibit C, "Intermediate Design Phase" and use sections as appropriate.

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### 3.1.3 Final Design (Phase 3)

The selected intermediate design from Phase 2 is developed into the final design using the following as appropriate:

- (a) Walkdowns
- (b) Design reviews
- (c) Design calculations
- (d) Drawings
- (e) Specifications
- (f) Purchase Requests
- (g) Vendor data
- (h) Design Change Notice (DCN)
- (i) Test procedures
- (k) Construction/Subcontract Plan
- (l) Detailed cost estimates

See Exhibit C, “Final Design Phase” and use sections as appropriate. Control of the appropriate design process activities will assure that the developed final design still adheres to the requirements previously established in the Preliminary and Intermediate Design Phases.

### 3.2 Specific Requirements

At the beginning of a project, the team is to use the Facility Design Checklist (Exhibit E) to aid in determining the scope of the project. This checklist is intended to be used to ask questions of the customer and of the design team to identify as completely as possible the various elements of the project. Similarly, the Safety & Environmental Questionnaire (Exhibit F) is to be completed and submitted to EHS. This will aid in their understanding of the scope and support their ability to provide a thorough and meaningful review of the design.

At the early stages of the project, to support the conceptual estimate and the subsequent design requirements, the guidelines of Exhibit G are to be used to determine the proper code application, occupancy classification, egress, and fire suppression requirements.

If, at any point during the design, it is determined that a deviation from the NIH Guidelines is needed, such deviation must be requested, in writing, from NCI (Authority Having Jurisdiction, AHJ), using Exhibit H.

At the nominal 15% design point, the team must develop a preliminary engineering estimate, using the guidelines of Exhibit I, Preliminary Engineering Estimate Template and Guidelines.

During the design, the requirements of the Uniform Federal Accessibility Standards and Rehabilitation Act of 1973 should be applied as explained in the design criteria of Exhibit J.

The design review process is to utilize design review meetings that are planned and well executed. The design material to be reviewed is to be distributed according to schedule so as to give the reviewers sufficient time to perform a thorough review. This is typically at least 10 working days. The lead engineer has the responsibility

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to orchestrate the review. Refer to procedure FMEP-P-0325, Design Review. Distribution and scheduling is to use the Design Review Request memo, Exhibit K.

During the design, care should be taken to identify changes to functional as well as physical drawings and documents. This is to include such functional documents as control diagrams, flow diagrams, sequence of operations diagrams, and electrical single lines. Additionally, the effect on documents such as site maps and chiller plant site drawings, to name a few, must be considered, and changes noted. The purpose is to keep both functional and physical drawings/ documents current to reflect the as-built condition. The affect on the facility floor plans should also be addressed and changes identified, so that the periodic issuance of these drawings by Space Management will be accurate.

When the design is completed, NCI acceptance is to be obtained using the Design Acceptance letter of Exhibit L. Fiscal approval package is to be developed for NCI approval, and should be coordinated with the design acceptance. For projects to be implemented inhouse by the shops, the design deliverables are to be transmitted to the shops, using Exhibit M, for their estimation, fiscal approval package development, and subsequent completion. For projects that will be implemented by a Contractor, the fiscal approval package will be initiated using Exhibit N.

At the conclusion of the project, Lessons Learned must be addressed before closeout is allowed. Refer to Lessons Learned procedure FMEP-G- 0070.

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FMEP-P-0350 Exhibits

- Exhibit A - Design Process Phases (1 Page)
- Exhibit B - Design Process Details (1 Page)
- Exhibit C - Typical Design Package Contents For Each Phase Of Design (Inhouse) (25 Pages)
- Exhibit D – Process Senarios (4 Pages)
- Exhibit E – Facility Design Checklist (10 Pages)
- Exhibit F – Safety & Environmental Questionnaire (4 Pages)
- Exhibit G – Fire Protection Guidelines (11 Pages)
- Exhibit H – Request for Exemption from NIH Guidelines (1 Page)
- Exhibit I - Preliminary Engineering Estimate Template and Guidelines (6 Pages)
- Exhibit J – Criteria for Applying Uniform Federal Accessibility Standards and Rehabilitation Act 1973 (1 Page)
- Exhibit K – Design Review Request Memo (2 Pages)
- Exhibit L – Request letter for NCI Design Acceptance (1 Page)
- Exhibit M – Letter transmitting design to shops for estimation and fiscal approval package development (1 Page)
- Exhibit N – Letter initiating fiscal approval package for projects to be implemented by Contractor (1 Page)