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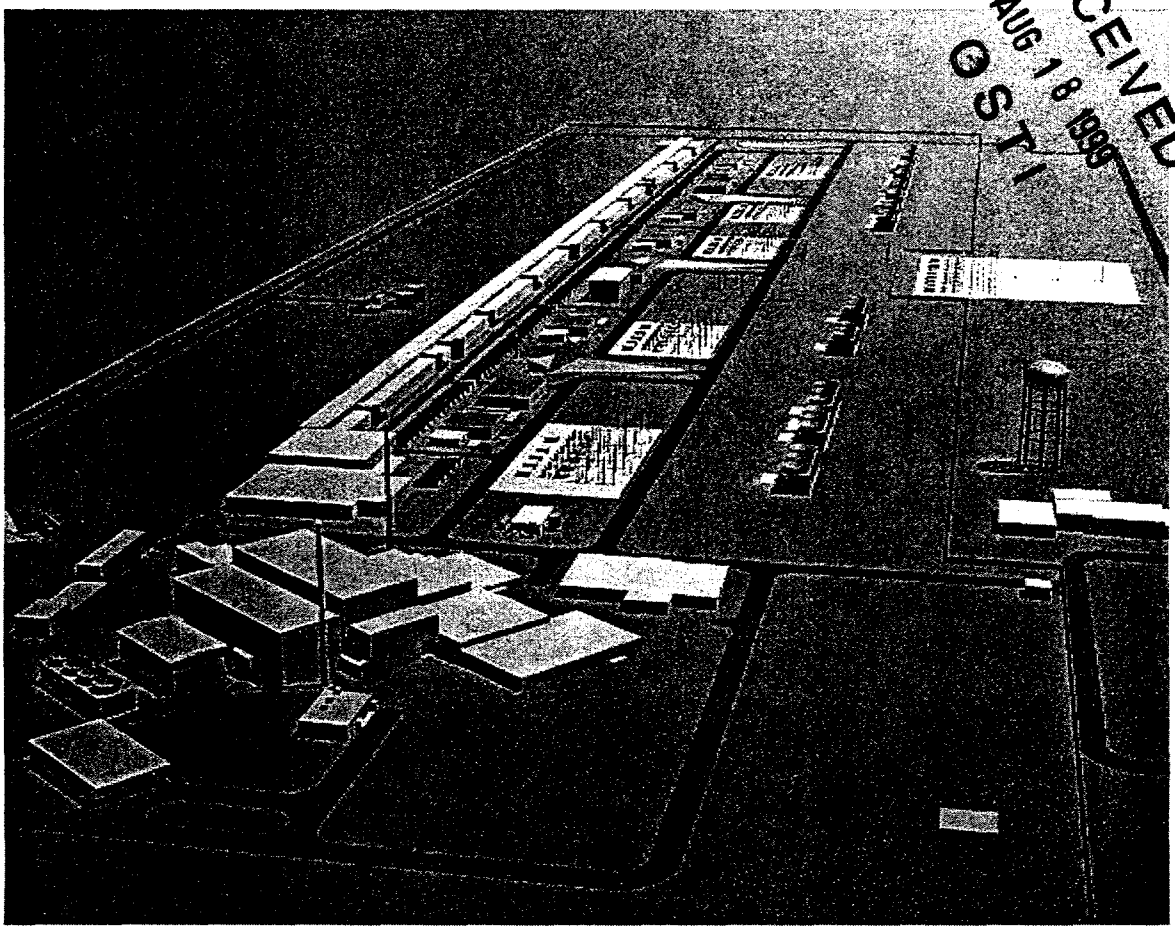
Accelerator Production of Tritium

APT-PPO-0005, Rev. 1

September 1998

Design Execution Plan



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Accelerator Production of Tritium

LIST OF EFFECTIVE PAGES

Document No.	Rev.	Document Title
APT-PPO-0005	1	Design Execution Plan

Page Number	Number of Pages	Revision
i through x	10	1
1 through 81	81	1
A-1 through A-26	26	1
B-1 through B-24	24	1
C-1 through C-19	19	1
TOTAL NUMBER OF PAGES:	**160**	**1**

PPO 4053 (8/98)

Table of Contents

List of Figures

List of Tables

Acronyms

3-D	Three Dimensional
^{3}He	Helium 3
Ac	Alternating Current
ALARA	As Low As Reasonably Achievable
AP	Acquisition Plan
APT	Accelerator Production of Tritium
BOM	Bill of Materials
BOP	Balance Of Plant
BREI/GA	Burns and Roe Enterprises, Inc./General Atomics
CAD	Computer Aided Design
CDR	Conceptual Design Report
CFDI	Complete and Final Design Information
CMP	Configuration Management Plan
CN	Change Notice
CRT	Cathode Ray Tube
DATR	Design Authority Technical Review
Dc	Direct Current
DEP	Design Execution Plan
DOE	Department Of Energy
DP60	Defense Programs
DPD	Defense Programs Division
DV&S	Design Verification and Support
ED&D	Engineering Development and Demonstration
EIS	Environmental Impact Statement
EPA	Environmental Protection Agency
EPCP	Environmental Permitting & Compliance Plan
EWD	Electrical Wiring Diagram
FAR	Federal Acquisition Regulations
FDD	Facility Design Description
GA	General Arrangement
GFE	Government Furnished Equipment
HE	High Energy
HEBT	High Energy Beam Transport
HVAC	Heating, Ventilation and Air Conditioning
I&C	Instrumentation and Control
I/O	Input/Output
ICS	Integrated Control Systems
IDR	Interdisciplinary Design Review
Kg	Kilogram
LANL	Los Alamos National Laboratory
LCC	Life Cycle Costs
LE	Low Energy
LINAC	Linear Accelerator
MCR	Main Control Room
MEL	Material Equipment List
MEV	Million Electron Volts
NEPA	National Environmental Protection Agency
NESHAP	National Emission Standards for Hazardous Air Pollutants
NPDES	National Pollution Discharge Elimination System
NPH	Natural Phenomena Hazards
O&M	Operations and Maintenance
ORR	Operational Readiness Review
OSHA	Occupational Safety and Health Administration
P&FD	Preliminary and Final Design
P&ID	Piping and Instrumentation Drawings
PDO	Program Directors Office
PDO	Project Director's Office
PDS	Plant Design System
PEP	Project Execution Plan
PEP	Project Execution Plan
PFD	Process Flow Diagram
PPO	Plant Project Office
PPP	Public Participation Plan
PSAR	Preliminary Safety Assessment Review
QA	Quality Assurance
QAPP	Quality Assurance Program Plan
RAMI	Reliability, Availability, Maintainability, Inspectability
RCRA	Resource Conservation Recovery Act
REPS	Radiation Exposure Protection Subsystem
RFP	Request For Proposal
RFQ	Request For Quotes
RMA	Reliability, Maintainability, Availability
RMPS	Radiation Monitoring and Protection System
ROD	Record of Decision
RWTS	Radioactive Waste Treatment Systems
S&S	Safeguards and Security
SAR	Safety Analysis Report
SC	Safety Class
SCDHEC	South Carolina Department Of Health and Environmental Conservation

SDD	System Design Description
SE	Systems Engineering
SEMP	Systems Engineering Management Plan
SIP	Safety Implementation Plan
SOW	Statement of Work
SRS	Savannah River Site
SS	Safety Significant
SSC	System, Structure or Component
SSC	Systems, Structures, Components
T&E	Tooling and Equipment
T/B	Target Blanket
TBBS	Target Blanket Shutdown Subsystem
TPE	Tritium Production Engineering
TPO	Technical Project Office
TSF	Tritium Separation Facility
UPS	Uninterruptible Power Supply
VECP	Value Engineering Change Proposal
WBS	Work Breakdown Structure
WMP	Waste Management Plan
WSRC	Westinghouse Savannah River Company

Design Execution Plan

1 Introduction

This Design Execution Plan (DEP) has been developed for the Accelerator Production of Tritium (APT) Project sponsored by the U. S. Department of Energy (DOE). This Plan provides a description of the APT design process beginning with the issue of the Conceptual Design Report (CDR) in April of 1997 and continuing through the end of the final design phase scheduled for September of 2001.

The DEP describes the design process for each area in the Level 2 Work Breakdown Structure (WBS) and defines a generic workflow for each product or deliverable for each system (or structure) within the scope of responsibility defined by WBS element.

1.1 Background on the APT Project

The APT Project, sponsored by DOE's Defense Programs (DOE/DP60) provides an accelerator-based system to produce tritium for the nation's stockpile of nuclear weapons. The mission of the APT program is to produce tritium by means of a fully integrated accelerator plant. The process is based on proven accelerator, target/blanket, tritium extraction, and balance of plant technologies. The APT Plant is being designed to produce 3 kilograms (nominal) per year of tritium. The Plant will be built at the Savannah River Site (SRS) and will be fully operational no later than the end of FY 2007. The APT facility is designed for a minimum lifetime of 40 years.

The APT Linear Accelerator (LINAC) is a radio frequency type LINAC consisting of cryogenic cooled superconducting cavities containing a water-cooled, room temperature low energy section. It operates at a 100% duty factor that produces a high-energy proton beam (~1700 MeV). The high-energy proton beam is directed onto a tungsten target. The incident protons generate neutrons by a spallation process. The neutrons produced in the spallation target are captured by gaseous helium-3 to produce tritium. Tritium is extracted during operation via a helium-3 stream delivered to the TSF. Product tritium is shipped from the TSF to other SRS Tritium Facilities.

Tritium is produced without the use of fissionable materials. Therefore, nuclear criticality is precluded as a consideration in both design and/or operation.

The APT facility is comprised of several facility structures which house the various systems and components protecting them and the workers from natural phenomena. These structures also provide the capability for hazardous material confinement.

1.2 Intent and Purpose of the Design Execution Plan

1.2.1 Intent

The DEP is intended to be a living document that describes the design process and is updated as the APT design progresses. As such, the major emphasis of the DEP, in its initial issue, is the preliminary design phase. It will be modified during the preliminary

design phase to provide a detailed description of the final design phase and during the final design phase modified again to provide engineering support during construction.

The design will conform to the requirements of the prime contract with DOE and the SDDs and the FDD; and will incorporate appropriate features related to process safety, RAMI, operations and maintenance, constructability and decommissioning facilitation.

1.2.2 Scope of Each Design Phase

The P&FD Phases of the APT Project will be approved by DOE. The delineation of preliminary design activities from final design activities will provide a clear indication of the status of the project and the performance of the Burns and Roe Enterprises, Inc./General Atomics Team. It will also provide DOE with an unambiguous definition of the preliminary design and the completion of appropriate portions of the final design, so that it can prepare for Critical Decision 3 (CD-3), leading to the approval for construction.

The limits of detail of the products be developed during the preliminary design phase and completed during the final design phase will be clearly identified.

1.2.2.1 Define Work Products

Work products, or deliverables, are the documents which contribute to completing a project phase and which translate the work performed into a useable format for further design construction or installation efforts. Examples of work products are: P&IDs, one line diagrams, general arrangement (GA) drawings (which further the design effort), physical piping drawings, connection diagrams and structural steel details (which support the actual construction/installation effort). Work product content, however, is a function of the project phase. This can be readily seen in the description of the work products provided in Appendix B to this plan.

1.2.3 The DEP provides the following:

- A description of the flow of work to establish consistency of work status for such items as drawings, calculations, specifications and similar other work products.
- An integration of the activities into a flow diagram which provides a logical, concise network for developing the APT design.
- A basis for training personnel by identifying the work products, demonstrating work flow to reach deliverables and integrating activities into logical sequential events.
- A definition of interface requirements for completing P&FDs based on network logic.
- A concise definition of the Peer Review Process including intra and inter discipline as well as special design reviews of work products.

1.3 Structure of the Design Execution Plan

The DEP is separated into nine major sections, with each section providing specifics as they relate to different elements and stages of the design process.

1. Section One provides an introduction to the DEP and describes the primary function of and the purpose behind such a Plan.

2. Section Two is an overview of the Preliminary and Final Design (P&FD) and related milestones, documents and the WBS structure.
3. Section Three describes the relationships between the design process and the systems engineering process.
4. Section Four defines the levels of detail required in APT documents for the P&FD phases.
5. Section Five is a discussion of the Preliminary Design Package. It includes a discipline-based description of each of the generic products of the phase such as drawings, calculations, models and others. It also describes the work processes which lead to completing each of the deliverables. These definitions and descriptions provide a sound basis for determining the status of the design process as each relates to a system, structure or component (SSC) being designed.
6. Section Six is similar to Section Five but provides a discussion of the final or detailed design phase of the APT Project. As each generic process identified in this Section is completed, the final design phase for each associated SSC ends. Any additional work on the product is considered engineering support of construction. Such support includes the procurement phase of some of the SSCs. This Section also describes the work processes associated with each of the SSC products following the final design phase. This effort is to support fabricating, manufacturing and installing all SSCs. It is typically limited to the final details necessary to conform the SSC to meet its functional requirements and spatial constraints. Although this is not part of the P&FD phase, the effort is included to provide a clear, concise and complete picture of the work involved.
7. Section Seven describes the technical database management of the APT design. The Section includes references to the Configuration Management Plan and to the change control procedures that will be invoked on the project.
8. Section Eight describes the Professional Staffing Plan for both the preliminary and the final design phases. The Section is intended to provide an overview of the Plan as it is intended to work with the design effort being performed in several locations including the Los Alamos National Laboratory (LANL), SRS and the Burns and Roe Enterprises, Inc./General Atomics home offices. It describes in general terms, the type work to be performed in each location and how the work from each location will be integrated into the total design. The details of accomplishing the design integration as well as specific resource requirements and schedules are addressed in other project documents.
9. Section Nine includes the Appendices associated with this plan.

1.4 Regulatory Drivers

1.4.1 General

Federal, state, and industrial regulations, codes, standards, and customer specifications guide the design and quality assurance activities at for the APT Project.

1.4.2 Nonreactor Nuclear

The Department of Energy (DOE) grants plant construction permits and operating licenses based on compliance with safety requirements. Plants are designed, fabricated, constructed, tested and operated with due consideration of minimum risk to the health and safety of the public and plant workers.

The minimum regulations for guiding design engineers in developing an acceptable plant design are presented in 10CFR830. The guidance for design engineers is presented in Life Cycle Asset Management Good Practice Guide, GPG-FM-010.

The minimum regulations for guiding design engineers for designing, procuring, fabricating, construction, and operating safe plants are presented in 10CFR830.120, "Quality Assurance Requirements." The requirements for the Quality Assurance Program for these activities are presented in DOE Order 5700.6C.

Additional federal regulations and industrial codes and standards (ASME/ANSI, IEEE, etc.) pertaining to APT project systems, structures, and components will be called out in design documents pertaining to those items.

1.4.3 Non-Nuclear

Regulatory and code requirements for non-nuclear work are specified in the design documents and are applicable to the extent specified for the type of work being done.

2 Overview of the Preliminary and Final Design

2.1 Major Milestones

This DEP provides direction for preparing the APT P&FD Phases of the Project. The DEP describes the work packages to be generated during the phase and establishes a path for developing the work.

Preliminary design will begin in October of 1997 (FY98) and the final design will be completed by September of 2001. The overall P&FD schedule is contained in the Integrated Project Schedule.

Table 2-1 lists the milestones, which are precursors to major Preliminary and Final Design deliverables. The dates are from the CDR issued in April 1997.

Table 2-1, Preliminary and Final Design Milestones

Begin Preliminary and Final Design	01 Oct 97
Preliminary Safety Assessment Review (PSAR)	02 Sep 98
NEPA ROD	30 Sep 98
Preliminary and Final Design Complete	28 Sep 01

2.2 Major Deliverables

The following major submittals will be generated and delivered to the Project Office during the P&FD phase:

- Preliminary Design Packages including initial SSC technical assessments and descriptions, design reports, drawings, specifications and schedule information
- Final Design Package including the detailed design information, detailed cost estimate and updated integrated schedule.

Figure 2-1, Technical Critical Hierarchy illustrates the role of the preliminary and final design packages and the development of the APT Project.

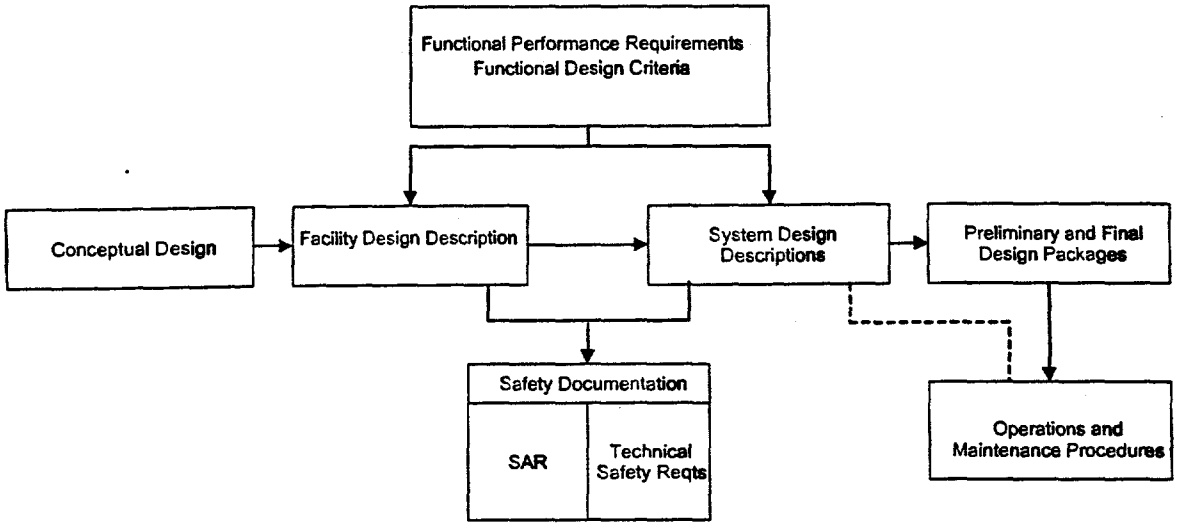

Figure 2-1, Technical Criteria Hierarchy

2.3 *Mission Statement*

The APT Project Mission as defined in the FDD, is to design and construct a tritium production facility, which can produce 3 kg of tritium per year and be fully operational by FY2007.

To achieve the APT Mission and to demonstrate the accelerator technology, the DOE has established five major project phases. The first phase, Conceptual Design, is complete. The second phase of the APT Project is Engineering Development and Demonstration Program (ED&D), which includes construction and testing of the Low Energy Demonstration Accelerator (LEDA), a comprehensive material testing and prototyping effort which is detailed in Section 2. The ED&D effort supports the final phases, which are design, construction and commissioning of a functional APT Plant. The summary level APT Project Objectives include the following:

- Produce 3kg of tritium per year.
- Ensure a 40-year design life for the plant.
- Minimize public and worker exposure to radiological hazards and materials, non-radiological toxic hazards and materials and industrial hazards by meeting all applicable DOE orders, requirements and State and Federal regulations.
- Construct the APT using technically acceptable and cost effective methods and practices.
- Design, construct and operate the APT using methods that are environmentally sound.

2.4 *Interfacing Plans*

The requirements of this Plan and the referenced documents will be incorporated into the APT Project through a series of formal programs. Plans and or procedures will be prepared which detail the requirements and the related principles and processes that are are the basis of implementing procedures. These program plans include:

- Quality Assurance
- Project Execution Plan
- Safeguards and Security
- Safety Implementation
- Systems Engineering
- Value Engineering
- Configuration Management
- Permitting
- Environmental Impact Statement Management
- Public Participation
- Waste Management
- Acquisition
- Core Technology
- Start-up/Commissioning Plan
- Test Acceptance Plan

The following sections provide a description of the other engineering processes and principles used for design, development and construction activities

2.4.1 Quality Assurance Program Plan

The Quality Assurance Program Plan (QAPP) will comply with the applicable regulations and orders contained in 10 CFR 830.120, *Quality Management* and DOE Order 5700.6C, *Quality Assurance* and will describe the Management System to be used.

2.4.2 Project Execution Plan

The Project Execution Plan (PEP) establishes the major plans, baselines and control systems employed in managing the APT Project and defines the roles and responsibilities of the major project participants.

2.4.3 Safeguards and Security Plan

The APT Project involves data and special equipment requiring safeguarding. The project itself represents a large investment of government funds in assets that must be protected. The FDD and the SDDs contain guidance regarding security-system design requirements. A Safeguards and Security Plan (S&S) Plan will be prepared during preliminary design and will be updated prior to the Operational Readiness Review (ORR).

2.4.4 Safety Implementation Plan

The purpose of the safety program is to ensure the facilities provide protection for the workers, the public, the environment and the mission investment. The Safety Implementation Plan (SIP) will be developed to define the process by which this purpose is accomplished, include preparing safety documentation following a hazard-based approach.

2.4.5 Systems Engineering Management Plan

The purpose of the Systems Engineering Management Plan (SEMP) is to ensure that the APT design is focused on meeting DOE requirements and that the design basis is documented.

2.4.6 Value Engineering Plan

The Value Engineering Plan describes a process by which improvements in the design and construction of the facility can be proposed, evaluated, and accepted by the TPO and the Government; it also includes the savings resulting from the implementing of a Value Engineering Change Proposal (VECP).

2.4.7 Configuration Management Plan

The purpose of the Configuration Management Program will be established for the APT program which will provide a system by which the technical information is documented and changes to the documents are controlled.

2.4.8 Permitting Plan

The purpose of the Environmental Permitting and Compliance Plan (EPCP) is to enumerate the environmental permits necessary for constructing and operating the APT Plant and its associated Balance of Plant (BOP) infrastructure at the SRS. The EPCP addresses all applicable Environmental Protection Agency (EPA), South Carolina Department of Health and Environmental Control (SCDHEC), and DOE rules, regulations and orders.

2.4.9 Environmental Impact Statement Management Plan

The Environmental Impact Statement (EIS) Management Plan provides the means for controlling and conducting an integrated effort to support DOE-SR in preparing the APT EIS.

2.4.10 Public Participation Plan

The purpose of the Public Participation Plan (PPP) is to ensure that meaningful and early public input is received, considered and a response provided with regard to DOE activities. The PPP identifies public participation methods that will be integrated into the development of the APT EIS.

2.4.11 Waste Management Plan

The Waste Management Plan (WMP) details the requirements and issues specific to the APT for design considerations, construction and O&M. The WMP evaluates the various waste streams that will be generated by the APT Project, addresses the key issues regarding waste stream disposition and identifies the SRS interfaces for each.

2.4.12 Pollution Prevention and Waste Minimization Plan

The purpose of the Pollution Prevention and Waste Minimization (PPWM) Plan is to ensure that design activities minimize hazardous materials use, as well as the consumption of energy, water, and other natural resources. These activities should also minimize or eliminate waste at the source and recycle, treat, or dispose of any residuals.

2.4.13 Acquisition Plan

This Acquisition Plan (AP) provides a detailed system for procuring equipment, supplies and construction services required to construct, equip, startup and commission the APT Plant.

2.4.14 Core Technology Plan

The Core Technology Plan describes the Engineering Development & Demonstration (ED&D) Program. The Program activities support conceptual, preliminary and final APT Plant design.

2.5 Other Processes

In addition to the Interface Plans there are other processes which will be integrated into the overall design process of the APT Project. The major issues are discussed in Sections 2.5.1 through 2.5.4.

2.5.1 Reliability, Availability, Maintainability, & Inspectability

A Reliability, Availability, Maintainability, and Inspectability (RAMI) Program for the APT Project will be developed based upon the DOE *Life Cycle Asset Management Good Practice Guide*, GPG-FM-004. Reliability, Maintainability, Availability (RMA) Planning will be used to establish an evaluation process to assure the Plant meets its production goals.

The process of selecting which RAMI engineering activities to employ will be accomplished through a graded approach. Historical data, estimated complexity, criticality of operation or suggested level of risk will be examined. To attain RAMI objectives, the systems assessed as most critical to the overall mission will receive greater levels of effort than those deemed less challenging.

During Preliminary Design, the top-level requirements to be established for each system will be to:

- Establish operational availability as a requirement.
- Incorporate operational availability into a formal mission statement.
- Define an operational timeline including specifications of uptime (life or annual) and downtime (life or annual).
- Analyze the realism/credibility of requirements based on O&M data from similar other facilities or systems and adjust it based on these results.

During Final APT design, development of system designs will continue. Allocations will be developed for the subtier of internal systems including:

- Allocating system downtime to major systems consistent with design reference mission.
- Expanding the design reference mission to a greater degree of detail for systems and developing those for major systems.
- Identifying underlying assumptions impacting O&M requirements including staffing and spare parts inventory.
- Analyzing the realism/credibility of requirements based on O&M data from similar other systems.
- Preparing Mean-Time-Between-Failures, Mean-Time-to-Repair, Mean-Logistics-Delay-Time and related indices.
- Completing quantification of the uncertainty and variability in reliability and availability assessments.
- The results of these allocations and evaluations will be discussed with the system/component designers and included in appropriate design documentation to assure the designs reflect RAMI requirements.

2.5.2 Constructibility and Decommissioning Facilitation

Construction viewpoints and requirements (the "constructibility" process) will be considered as a regular and routine part of design management and review for the APT Project. The principal objectives of the process is to enhance the ability to construct the facility efficiently, and to assist in meeting project requirements for safety, quality, cost and schedule. As design documents are published in various stages and revisions, construction management personnel will review the documents and offer constructibility comments. Such comments will be recorded and dispositioned in the same manner as other design review comments.

Measures to facilitate and reduce costs during decommissioning will also be considered as design documents are reviewed.

Constructibility measures and factors and decommissioning facilitation features will be considered in Value Engineering Assessments and in Engineering Trade Studies.

2.5.3 Worker Protection

The primary rules for worker safety are contained in the Occupational Safety and Health Administration (OSHA) requirements that form the bases on which all other worker safety considerations are built. Additionally, the SRS maintains a Process Safety Management Program that accounts for all the elements of the OSHA Process Safety Management Program.

Both OSHA and the Process Safety Management requirements (as incorporated into the SRS practices and procedures) will be considered.

2.5.4 Operations and Maintenance

The operations and maintenance design requirements document provides guidance for the principles of operation, facility safety philosophy, operation and control basis, and administrative aspects. It also addresses the facility maintenance philosophy and outlines

the basis for the development of procedures for surveillance, in-service inspection, preventative maintenance, and corrective maintenance.

The purpose of this document is to supply design requirements of a general nature, applicable in whole or in part to the APT. These requirements reflect knowledge and working experience of basic operations and maintenance functions. While not always linked to precise requirements, the requirements shall be applied, as practical, to all aspects of the design process. Where specific or highly detailed O&M requirements are needed relative to a specific design area, such requirements are further detailed in the respective SDDs. As part of the design evolution, the concepts and guidance in this document shall be used by the designers as input to their designs and as with any design input appropriate cost benefit analyses shall be performed.

2.6 *Work Breakdown Structure*

The APT WBS reflects the logical breakdown of work required to complete the project. It is product oriented and is the basis for all project work activities and budgeting. Each Level 2 element represents a system and all its associated work. They are established by extending project descriptions to Levels at which individual components can be identified and associated with well-defined pieces of equipment or structures. The Level 2 WBS for APT is provided in Figure 2-2.

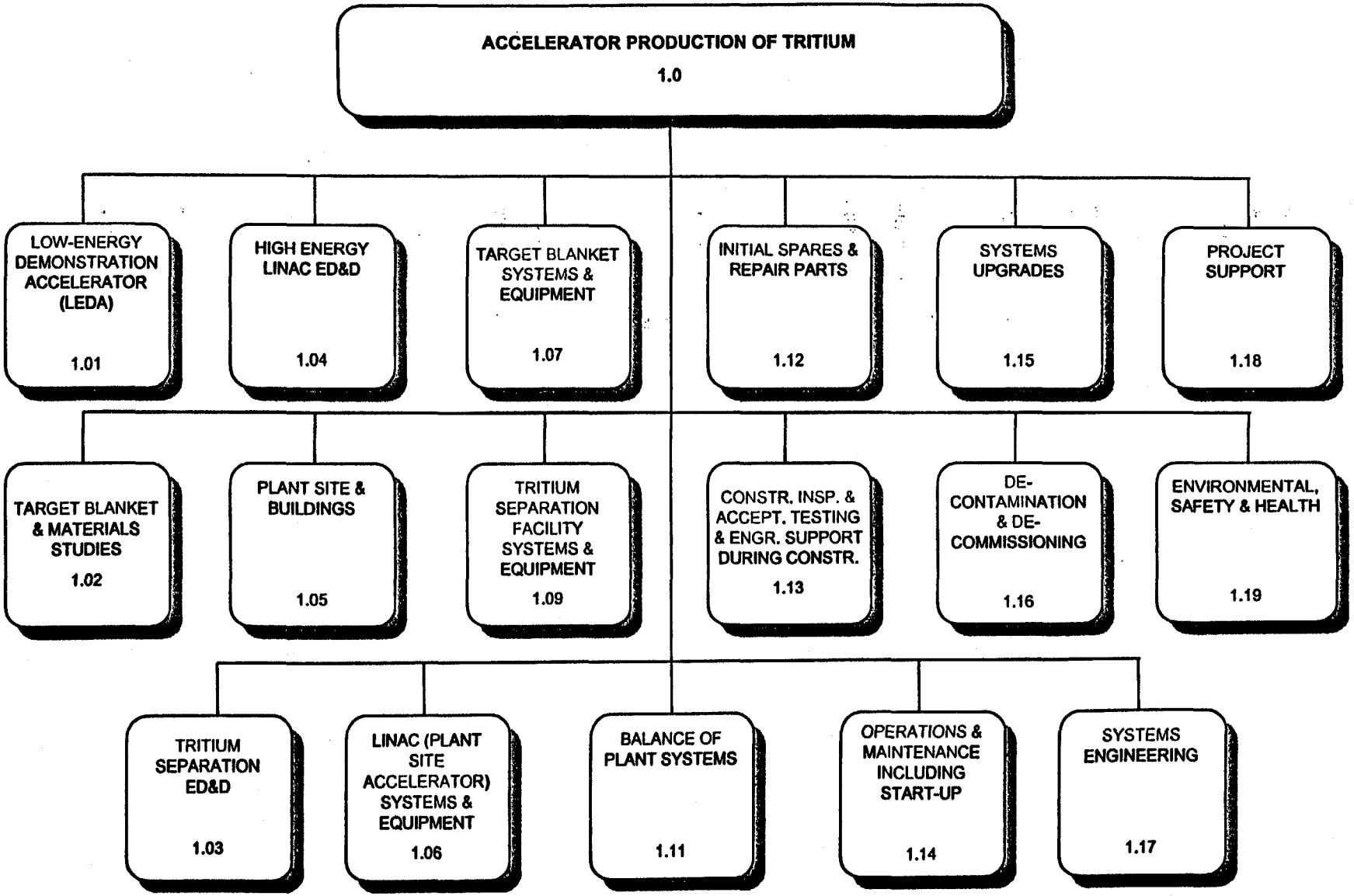

Figure 2-2, Level 2 WBS 1

3 Design Process Evolution

3.1 Systems Engineering

The objective of the Systems Engineering (SE) process is to ensure that the project delivers an integrated, and cost effective design satisfying DOE's operational mission requirements for the APT and other externally mandated requirements. The Systems Engineering process, described in this section, will be used to develop and control the configuration of the APT. This process encompasses all aspects of the preliminary and final design of the APT plant and also extends into plant construction and operation. A more detailed description of the planned Systems Engineering implementation is available in the Systems Engineering Management Plan.

3.1.1 Systems Engineering Process

The Systems Engineering process depicted in Figure 3-1 is an iterative process. It includes the following activities:

- Mission Need (Requirements Definition and Analysis) - The mission of the facility, and the top-level requirements defining and constraining mission accomplishment are clearly and quantitatively identified.
- Functional Analysis - The functions needed to accomplish the mission are completely defined. The set of functions define the mission for the individual systems, subsystems, and components. Functions are decomposed into subfunctions and related to one another, to requirements, and to the systems, subsystems, and components of the design.
- Functional Allocation - The identified functions and the defined mission are analyzed and a more detailed and precise set of requirements is derived. These requirements include performance, interface, regulatory, and design constraints. The requirements are allocated to the functions as well as to equipment and personnel.
- Design Selection - At this point either one or more design solutions are developed meeting the functions and derived requirements. Where a single design solution is arrived upon, the process proceeds to system definition. Where multiple solutions exist, systematic evaluation and optimization is performed to develop more information to allow narrowing the options to a single design selection.
- Evaluation and Optimization - Underlying the ability logically develop subfunctions, lower tiered requirements, and choose cost-effective solutions meeting these requirements are multiple engineering studies. These evaluations also serve to verify that the selected design meets the requirements of the previous process phase. Such evaluation and optimization includes alternative trade studies, cost and risk analyses, value engineering, safety analyses, human factors engineering, RAMI constructibility considerations, decommissioning facilitation measures and production assurance assessments, and other engineering specialty studies. This element of the process can also involve defining the approach and criteria for analysis and the decision process for ranking candidate solutions.

- System Definition - Based on the design selection(s) made in this process, the system is then defined with component specifications, drawings, layouts, models and/or manuals.
- Completion - Completion is reached when the system is constructed, tested, and satisfactorily demonstrated as meeting the requirements established.

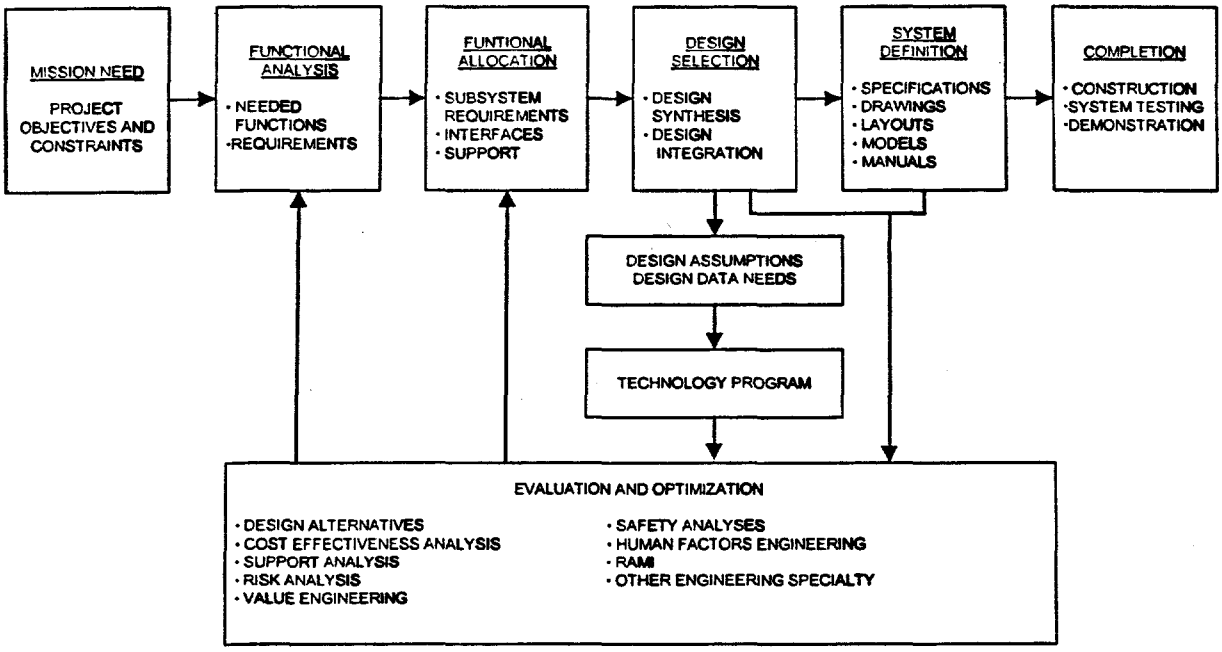

Figure 3-1, System Engineering Process

A clear and complete mission for the APT will be defined before engineering of the systems will proceed. The remaining steps of the process will then be followed starting at the top or system level and proceeding to greater levels of detail describing the APT functions, requirements and the design. In addition to these activities, the process will assure continuing system integration that result in satisfying cost, schedule, and technical performance requirements throughout the life cycle of the program. As the process activities of Figure 3-1 are performed, APT facility and system interfaces and technical baseline will be controlled consistent with risk management, configuration management, program and technical reviews.

3.1.2 Systems Integration

An important, complementary role of Systems Engineering is to ensure that the many diverse systems and components comprising the APT are compatible with one another and will work together to meet functional, performance and interface requirements. Early development of the interface definition is essential to successful integration of the system. The Systems Engineering Management Plan calls for the development of a system to system interface matrix early in the Conceptual Design phase. As the design proceeds into and through its preliminary and final design phases the plan calls for further development and maintenance of that matrix and tracking of system to system interface issues and requirements. Furthermore, the development and specification of design point and design envelope requirements will assist in ensuring that all design activity is coordinated.

System Design Descriptions (SDDs) and Interface Control Documents (ICD) will be used to identify functional, physical and performance requirements and constraints at a common boundary between two (or more) systems or components. SDDs will identify top level requirements of the interface, the specific document controlling the interface such as SDD, ICD and others, and the specific system controlling the interface. The ICD will provide more detail of the interface and support the SDD requirement. The development of ICDs will be a continuous process throughout the APT Project life cycle and will be initiated in the Conceptual Design phase of the project.

In addition to system to system interfaces, systems integration includes the application of several engineering disciplines covering multiple-system or plant-wide aspects of the plant design. These specialties will be integrated into the development effort during all design phases through their involvement in the design of the APT systems, the definition of specific design requirements and in the verification and validation technical reviews. The specialty disciplines include, but are not limited to, the following:

- Reliability, Availability, Maintainability, and Inspectability
- Production Assurance (Facility Protection)
- System Life-Cycle Cost
- Human Factors Engineering
- Safeguards and Security
- System Safety
- Regulatory Compliance
- Environmental, Socioeconomic, and Institutional
- Value Engineering

The efforts and support of the varied groups will be coordinated by Systems Integration Engineers

3.1.3 Primary Documentation

The Facility and System Design Description (FDD and SDDs) are the top-level design documents for the design of the overall facility and its constituent systems. They are also one of the major tools in implementing the Systems Engineering Management Plan (SEMP).

The FDD is the top-level design document within the project and captures the project mission, top-level functions and the requirements placed on the project by DOE and other external authorities. It also documents those requirements, developed within the project through the process described above but applying to multiple systems. It includes a summary description of the facility emphasizing overall design philosophy and how this serves to meet the top-level requirements. Within it's appendices, the FDD documents the bases and traceability of all requirements. Finally, by being the only source of defining requirements to the SDDs, the FDD serves as a control on the introduction of outside requirements into the project.

The SDD documents the specific system design requirements and describes how these requirements are satisfied by the design. It includes the design requirements and a complete description of the system design features, such as process flow paths and performance, system operating and design parameters, system arrangement, component principal design features, and system operation and maintenance and quality requirements. Implementation of the system design and related project activities, such as component procurement, proceeds only in conformance with approved SDDs.

The SDD provides the principal requirements for the components of which it is comprised. The description of system operation and maintenance in the SDD should be sufficiently explicit to confirm that the system can be operated to meets the design requirements; it also provides the basis for preparation of the plant and individual system operating procedures, maintenance procedures, cost procedures, and casualty recovery procedure. The SDD describes the required supporting services which impose design functions and requirements on interfacing systems. The SDD also identifies the required level of quality assurance, reliability of critical items, codes, and standards to be applied to system and component design, construction, testing, and operation. The SDD also provides the design basis used for preparation of safety analysis reports and technical specifications.

While the SDDs are periodically updated to describe the system design in progressively greater detail as the design evolves, it is not intended to be a historical document. Specifically, it does not trace the design alternatives that may have been considered and ultimately rejected in favor of the selected design, and it does not describe the development program that may be necessary to establish or verify the design. This essential information is captured by separate evaluation and trade studies, or program documents as appropriate to particular aspects of the design. Those reports documenting the basis for specific design decision are referenced by the SDD as a part of its design basis documentation.

3.1.3.1 Facility Design Description

The FDD provides a compendium of functional requirements and design criteria, which is applicable facility-wide or which spans multiple systems including the following:

- A top level set of functional and design requirements
- A bases for each requirement
- A summary facility description
- A summary level description of the facility systems

3.1.3.2 System Design Description Content

The SDD content is reflected in the basic document outline described below:

Summary
1.0 Functions and Design Requirements
2.0 Design Description
3.0 Operation
4.0 Setpoints, System Limitations, and Precautions
5.0 System Upsets and Recovery Procedures
6.0 Maintenance

The summary should be limited to a single page and is intended to provide the reader with the function, scope and use of the document.

3.1.3.2.1 Functions and Requirements

This section itemizes the specific functions assigned to the system and the design requirements quantifying the bounds and manner in which these functions are to be achieved.

3.1.3.2.2 Design Description

The section contains a description of the system, it's components, the system arrangement, and the system performance characteristics. The description should be of sufficient depth and appropriate focus to illustrate how the selected design satisfies the system functions and design requirements.

3.1.3.2.3 Operation

This section provides outlines of all the system operating procedures. These outlines should provide sufficient detail to ensure that the design provides for the required modes of system operation and also should provide a sufficient basis for preparation of detailed operating procedures.

3.1.3.2.4 Setpoints, System Limitations, and Precautions

This section of the SDD provides a consolidated list of system limitations, set points, and precautions that will provide a 'better understanding of system's operation, and response to casualties, and maintenance that are described in later sections of the SDD. Under operating limits the SDD should include in summary form the high and low limits for all controlled variables. The dead band and overshoot for both manual and automatic control also should be included. Appropriate limits, such as relief valve settings, maximum liquid level, etc., should be identified. The set points or nominal setting for automatic and manual controls for all anticipated operating modes should be provided.

This section also provides precautions to be observed by operations and maintenance personnel. Design precautions such as interlocks and alarms also should be included. The system status checks needed for changing see points should be defined. Where appropriate, detailed tabular lists may be included in an appendix of the SDD and referenced in this section.

3.1.3.2.5 System Upsets and Recovery Procedures

This section identifies the possible casualty events that could affect the system and the protection provided against those casualties by the system design. It also outlines the system design features and recovery procedures which will mitigate the consequences of the casualties and restore the system and facility to a known, confirmed, safe condition.

3.1.3.2.6 Maintenance

This section defines the maintenance philosophy; outlines the procedures for corrective maintenance, preventative maintenance, and in-service inspection and surveillance; and identifies interfacing systems needed to support maintenance operations. The section provides the basis for preparation of detailed maintenance procedures.

3.1.3.2.7 Appendices

In addition to the foregoing, the SDD includes Appendices containing the bases for all requirements (may be done through reference), interface requirements, a matrix of requirements traceability, instrumentation and control channel list, drawings, and an equipment list.

3.2 Design Input Requirements

3.2.1 General

Applicable design inputs, such as design bases, regulatory requirements, codes, and standards, shall be identified, documented, and their selection reviewed and approved per the design control system described in the EDP series of this manual. Changes from specified design inputs including the reasons for the changes shall be identified, approved, documented, and controlled.

The design input shall be specified on a timely basis and to the level of detail necessary to permit the design activity to be carried out in a correct manner and to provide a consistent basis for making design decisions, accomplishing design verification measures, and evaluating design changes.

3.2.2 Requirements Checklist

The design input shall include, but is not limited to, the following, where applicable:

1. Basic functions of each structure, system, and component.
2. Performance requirements such as capacity, rating, and system output.
3. Codes, standards, and regulatory requirements including the applicable issue and/or addenda (when the issue and/or addenda has been contractually established).
4. Design conditions such as pressure, temperature, fluid chemistry, and voltage.
5. Loads such as seismic, wind, thermal, and dynamic.
6. Environmental conditions anticipated during storage, construction, and operation such as pressure, temperature, humidity, corrosiveness, site elevation, wind direction, nuclear radiation, electro-magnetic radiation, and duration of exposure.
7. Interface requirements including definition of the functional and physical interfaces involving structures, systems, and components.
8. Material requirements including such items as compatibility, electrical insulation properties, protective coating, and corrosion resistance.
9. Mechanical requirements such as vibration, stress, shock, and reaction forces.
10. Structural requirements covering such items as equipment foundations and pipe supports.
11. Hydraulic requirements such as pump net positive suction heads, allowable pressure drops, and allowable fluid velocities.

12. Chemistry requirements such as provisions for sampling and limitations on water chemistry.
13. Electrical requirements such as source of power, voltage, raceway requirements, electrical insulation, and motor requirements.
14. Layout and arrangement requirements.
15. Operational requirements under various conditions, such as plant startup, normal plant operation, plant shutdown, plant emergency operation, special or infrequent operation, and system abnormal or emergency operation.
16. Instrumentation and control requirements including indicating instruments, controls, and alarms required for operation, testing, and maintenance. Other requirements such as the type of instrument, installed spares, range of measurement, and location of indication should also be included.
17. Access and administrative control requirements for plant security.
18. Redundancy, diversity, and separation requirements of structures, systems, and components.
19. Failure effects requirements of structures, systems, and components, including a definition of those events and accidents which they must be designed to withstand.
20. Test requirements including in-plant tests and the conditions under which they will be performed.
21. Accessibility, maintenance, repair, and inservice inspection requirements for the plant including the conditions under which these will be performed.
22. Personnel requirements and limitations including the qualification and number of personnel available for plant operation, maintenance, testing, and inspection, and permissible personnel radiation exposures for specified areas and conditions.
23. Transportability requirements such as size and shipping weight, limitations, and Department of Transportation regulations.
24. Fire protection or resistance requirements.
25. Handling, storage, and shipping requirements.
26. Other requirements to prevent undue risk to the health and safety of the public.
27. Materials, processes, parts, and equipment suitable for application.
28. Safety requirements for preventing personnel injury including such items as radiation hazards, restricting the use of dangerous materials, escape provisions from enclosures, and grounding of electrical systems.
29. Quality and Quality Assurance requirements.
30. Reliability requirements of structures, systems and components including their interactions which may impair functions important to safety.
31. Interface requirements between plant equipment and operation and maintenance personnel.
32. Requirements for criticality control and accountability of nuclear material.

3.3 *Preparation, Review, Approval and Issuance of Design Documents*

All Balance of Plant (BOP) drawings produced by the Plant Project Office (PPO) and participating design organizations, including their subcontractors, through all phases of the project shall be reviewed and approved in accordance with PPO-EDP-23. Non-BOP drawings shall be reviewed and approved in accordance with PPO-EDP-04, 05, 06, and 07.

3.3.1 BOP Documents

The approach and method for review and approval of all Balance of Plant drawings among the Plant Project Office (PPO) and participating design organizations, including their subcontractors, through all phases of the project is described below:

All Balance of Plant drawings will be submitted for review and approval at the following stage of completion (See Procedure PPO-EDP-23).

3.3.1.1 30% Completed Drawings (Preliminary Design)

A 30% Completed Drawing contains the design concept and format that will be used in the development of the drawing. Dimensioning, lettering, and notes would be incorporated later.

3.3.1.2 70% Completed Drawings

A 70% Completed Drawing contains a completed design, including all drafting, lettering, and notes, and is ready for checking.

3.3.1.3 95% Completed Drawings (Final Design)

A 95% Completed Drawing consists of a 70% complete drawing that has all engineering comments incorporated and has been completely checked and signed in accordance with the Design and Drafting section of the Engineering Standards. The drawing is complete except for the signature of engineering.

3.3.1.4 Approved Drawings

An Approved Drawing is one that has been Approved by Cognizant Chief Engineer/Designee.

3.3.2 TPE Documents

3.3.2.1 Design Document Review

Design document reviews shall be performed by selected technical experts from various engineering disciplines. Reviewers shall be limited to those needed to ensure the technical adequacy of the document. Line managers and engineers are responsible for ensuring that the review items include all applicable engineering disciplines and comply with the requirements listed below:

1. For information issue design documents, documented review is not required except when the document supports the Safety Analysis Report (see Exhibit 1 in PPO-EDP-04).
2. For ED&D release design documents, documented review is not required (see Exhibit 1 in PPO-EDP-05).
3. For production release design documents, objective evidence of a review and resolution of comments is required (see Exhibit 1 in PPO-EDP-06).
4. For Tooling and Equipment (T&E) release design documents, documented review is not required (see Exhibit 1 in PPO-EDP-07).

3.3.2.1.1 Independent Review

When an independent review is required, the review shall be performed by technically qualified individual(s) other than those who performed or directed the original design, but who may be from the same organization. Review and approval by the originator's immediate supervisor(s) does not qualify as an independent review.

1. For information issued design documents, an independent review is not required.
2. For ED&D released documents, an independent review is not required.
3. For production released design documents, all SC and SS classified items shall be verified by an independent review. Objective evidence of a review and resolution of comments is required for the review procedure, see PPO-EDP-06, Section 3.2.1.
4. For T&E released documents, an independent review is not required.

3.3.2.1.2 Review Methods

The reviewer's name, organization, and the review item(s) must be listed on form PPO 783, "Review Transmittal". Comments are listed on form PPO 856, "Comment/Disposition Summary", either directly or by reference to a marked-up document.

1. For information issued design documents, the review procedure is in accordance with PPO-EDP-04, Section 3.2.1.
2. For ED&D released documents, the review is combined into one cycle with the approval in accordance with PPO-EDP-05, Section 3.2.1.
3. For production released design documents, objective evidence of a review and resolution of comments is in accordance with PPO-EDP-06, Section 3.2.1.
4. For T&E released documents, the review is combined into one cycle with the approval in accordance with PPO-EDP-07, Section 3.2.1.

3.3.2.1.3 Disposition of Comments

The responsible engineer shall review and resolve comments using form PPO 856, "Comment/Disposition Summary".

3.3.2.1.4 Document Review Report

The responsible engineer shall summarize the comments, using form PPO 852, "Document Review Report", when a documented record of review is required.

3.3.2.1.5 Calculation Review Report

The reviewer's name, organization, review criteria, and comments must be on form PPO 1543, "Calculation Review Report," which is used in lieu of the Review Transmittal, Comment/Disposition Summary, and Document Review Report forms when a calculation is reviewed. The responsible engineer shall review and resolve comments on the Calculation Review Report.

3.3.2.1.6 Review Waiver of Design Documents

When a documented review is required, but it is determined that a review is not necessary, the review may be waived in accordance with PPO-EDP-06, Section 3.3.

3.3.2.2 Design Document Approvals

In order to facilitate the design process, provisions have been made for design documents that affect a limited number of systems or organizations to be approved at a lower organizational level than documents with broader application. There are five levels of approval. The criteria for determination of the approval level and the specific organization levels that must approve design documents are shown in PPO-EDP-06, Exhibit 3.

3.3.2.2.1 Approval Ground Rules

1. Additional approvals for documents to be transmitted outside the Plant Project organization for information purposes, are in accordance with PPO-PMP-04, "Controlled Communications."

2. If an independent review of a design document was conducted prior to the formal approval cycle, the independent reviewer(s) shall conduct a final review, particularly of any changes resulting from the review of others or from the approval cycle, and sign-off on the Document Review Report form, PPO 852, just prior to release of the document.

3. Approval of information issue, ED&D release, production release, and T&E release of design documents and test documents is in accordance with Procedures PPO-EDP-04, PPO-EDP-05, PPO-EDP-06, and PPO-EDP-07, respectively.

4. Certified design documents for ASME Code work shall be in accordance with Procedure PPO-EDP-06, Section 3.4 and Exhibit 2.

3.3.2.2.2 Significance of Approvals

When personnel at each organizational level approve a document, the approval signifies the following:

Engineer

The design content of the document is consistent with the controlling criteria; the document has been classified in accordance with PPO-EDP-09, "Safety and QA Classification", and identified in accordance with this procedure and Procedure PPO-CFP-03, "Design Document Identification", and the document has been prepared and reviewed per the applicable requirements of this Manual.

WBS Level 3 Manager

Agreement with the technical content of the document and, when a record of the review was required, agreement that comments were incorporated or satisfactorily resolved with reviewer and that the treatment of all comments resulting from the review is not in conflict with or would not cause additional comments from other reviewers.

WBS Level 2 Manager

Agreement that the WBS Level 3 Manager has carried out his/her responsibilities, as specified above, and agreement that the document is compatible (by virtue of proper review) with all the affected interfaces both within and outside the company.

Project Manager

Approval of use of the document for its intended project purpose as indicated by the issue/release status and the revision description; approval of the applicable funding source identification; endorsement of the technical information for use on the project; concurrence that the document complies with the latest customer functional specification, plant technical requirements, schedule, and that it meets contractual requirements; and concurrence that cost objectives have been considered.

Quality Assurance

Verification that the safety or quality assurance classification is correct; verification that applicable codes, standards, and regulatory requirements are specified and consistent with top level design documents; verification that quality characteristics are realistic and clearly stated; approval of the adequacy and cost effectiveness of quality considerations; and verification that the document meets the applicable requirements of the Quality Assurance Program Plan and the procedures of this manual.

3.3.2.3 Information Issue/Release Design Document Systems

Design documents intended for information issue, ED&D release, production release, or T&E release shall be processed for review and approval, in accordance with the following:

3.3.2.3.1 Information Issue of Design Documents

Early versions of design documents in which the information is not sufficiently complete, detailed, or final to qualify for release are information issued as described in procedure PPO-EDP-04. This allows design documents to be made available for use early in the design process in order to document the evolution of the design and to provide information flow among the various design activities. Because of the preliminary nature of the information contained, information issued design documents are limited to specific uses, which are described in PPO-EDP-04.

In order to expedite the conceptual and preliminary phases of the design process, the requirements and procedures applicable to information issue are less detailed and rigorous than those used for production release. PPO-EDP-04 is appropriate for early versions of design documents during conceptual, preliminary, or final design phases of a project.

3.3.2.3.2 ED&D Release of Design Documents

The ED&D release procedure, PPO-EDP-05, is used for research and development (ED&D) design documents that provide indirect support for design of systems and components in the areas of exploratory, experimental, and basic research. Because of the nature of the work, the requirements and procedures for ED&D release are less rigorous and detailed than those for production release. However, if an ED&D document describes work or results that will be used directly in the final design of safety class or safety significant components or systems, the documents shall be production released in accordance with PPO-EDP-06.

3.3.2.3.3 Production Release of Design Documents

Design documents for products that are complete and considered to be in final form are production released as described in procedure PPO-EDP-06.

Changes may be made in production released documents but, because of the advanced state of design represented by the document, control and documentation of the change process is more rigorous than for information issued documents. The information in production released documents can be used for design, analysis, manufacturing, construction, Design Verification and Support (DV&S) testing, installation, or purchase of product.

3.3.2.3.4 T&E Release of Design Document

The T&E release procedure, PPO-EDP-07, is used for tooling and equipment (T&E) items used in the manufacture or quality control of product items. T&E is not considered as deliverable, but it may be customer-owned. When T&E is special-designed, its design is documented by specifications and drawings which are T&E released. If deliverable, items that might otherwise fit the description of T&E must be treated as product and the associated design documents must be production released per PPO-EDP-06.

3.4 Design Document Changes

3.4.1 Change Request

Every proposed change affecting the product configuration shall be evaluated. The evaluation shall address the options of making or not making the proposed change. Additionally, the evaluation shall consider all appropriate aspects of the change on the products or systems with which the system interfaces, and on others which may be affected. These considerations should include, but not be limited to, design, performance, cost, schedule, compliance with regulatory requirements, operational effectiveness, environmental conditions, and logistics support. Changes affecting the configuration of an item (product/system/ component) shall be limited to those which are necessary, or which will offer significant benefits. These changes:

- Correct deficiencies, including safety deficiencies.
- Offer a significant improvement in performance or functionality.
- Provide pollution prevention or waste minimization benefits.
- Effect substantial capital and life cycle cost savings.
- Prevent slippage in an approved (contractual) schedule.

A formally proposed engineering change is accomplished by completing a change request (CR), form PPO 715. The change classification criteria, the Configuration Control Board (CCB) responsibility, and the procedure for processing of the CR are contained in PPO-CFP-06, *Baseline Change Control.*

The implementation of an approved CR is accomplished by a revision to the document(s) affected.

3.4.2 Change Notice

A Change Notice (CN) is a design document that alters the content of a released drawing or word document in accordance with the requirements below:

1. Change Notice Preparation

Any organization can initiate the design change. A CN, form PPO 974, must be prepared, processed for review, and approved in accordance with the requirements of PPO-EDP-06 to revise a production released design document. The use of a CN is optional for revising ED&D released and T&E released design documents and, if used, its processing is in accordance with PPO-EDP-05 and PPO-EDP-07, respectively. A CN is not used to revise a design document that has been information issued.

a) CN number identification (CN XXXXXX) shall be assigned by Configuration Management.

b) A CN shall clearly describe and provide a statement of a reason for changes to be made, including changes to improve cost, schedule, and quality standards.

2. The change shall be effected in one of the following ways:

a) Release by CN. The CN is a temporary attachment to the affected document(s). After incorporation of the change, the CN is the record of change for the document.

b) Release by Incorporation. The change is incorporated directly into the document(s) and released simultaneously with the CN. The CN is the record of change for the document.

c) Do Not Incorporate. The CN is a temporary attachment to the affected document(s) with the change being temporary or of limited applicability. For example, the modification of existing hardware items so that they will conform to a new design configuration, with the modification not being applied to new hardware items. The CN is not incorporated into the document, but it is the record of change for the

special situation. (The change as it would apply to new items is described by a separate CN, which is either released by CN or by incorporation.)

3. Revision Letters

   a) For Release by CN and Release by Incorporation Change Notices, document revision numbers advance one number on each released CN.

   b) For Do Not Incorporate Change Notices, new document revision identifiers shall not be assigned. Enter a dash in the "Next Issue" column.

3.4.3 Change Notice Limitations

As a rule, a revision must be incorporated into the affected document within 60 days of the Release of a CN. When circumstances prevent incorporation within 60 days, the responsible manager shall document in a memorandum the reason(s) for the delay, and a new incorporation time limit, and file the documenting memorandum with Configuration Management (copy to Project Management) prior to the original incorporation time limit. Any further extensions must be approved by Project Management. In any case, no more than five CNs shall be outstanding against a document at any time.

3.4.4 Change Notice Usage

A separate CN is written against each document affected by a change; however when identical or across-the-board changes are to be made to several documents, a single CN may be used to implement the change. All documents affected by the change must be listed on the CN.

3.5 Waivers

During fabrication or manufacture of a hardware item, if it is considered necessary to depart from the mandatory requirements of the drawing or specification, the fabricator may request that a waiver be authorized. As an example, a waiver relating to an alternative material or process may be requested when it is substantiated that the delivery schedule cannot be met unless the waiver is granted. The following factors are significant in evaluating the effects of a waiver: health, safety, environmental, performance, interchangeability, reliability, maintainability, durability of the item, effective use or operation, weight, dimensions, appearance (when a factor), cost, schedule, or quality.

Unless unusual circumstances exist, requests for waiver adversely affecting personnel safety shall not be approved. Requests for waivers, which would adversely affect operation or maintenance, should not be authorized as waivers, but may be processed as a design change.

All items which incorporate a known departure from requirement documents (e.g., performance or design requirement of a specification, drawing, etc.) shall not be accepted unless a waiver has been processed and approved previously as a change notice, form PPO 974, in accordance with procedure PPO-EDP-06 or as a supplier's disposition request (SDR), form PPO 2329, processed and approved in accordance with Quality Procedure PPO-QAP-10.

3.6 Deviations

Supplies or services which do not conform in all respects to the design and/or contract requirements are normally rejected. An item which through error does not conform to the drawing or specification shall not be accepted unless a nonconformance report (NR), form PPO 663, or a SDR, form PPO 2329, has been processed and approved in accordance with Quality Procedure PPO-QAP-10.

3.7 Holds

A Hold identifies a predetermined limit beyond which design/construction cannot proceed or a document cannot be released until the item or activity defined in the Hold is completed, changed, or removed. There are two types of Holds: (1) the engineering Hold and (2) the Quality Assurance Stop Work Order. All Hold information will be identified in the appropriate documentation, reported, and managed. This information will be maintained in the engineering database and reports will be issued to project and support organizations upon request.

3.7.1 Engineering Holds

Engineering Holds are those which may result from design uncertainties, changes, nonconformances, discrepancies, or other circumstances.

When an engineer decides that a change to a previously approved design will be necessary, he will review the impact of the contemplated change on the hardware, software, or construction work that is in progress. If the review indicates that immediate action is necessary to initiate an Engineering Hold to prevent unnecessary costs, the engineer will complete form PPO 2665, "Engineering Hold Order", obtain approval signatures and forward the Engineering Hold Order to Purchasing, Manufacturing, or Construction as appropriate. Engineering Holds are processed in accordance with PPO-EDP-15.

During the early phases of design development, i.e., the conceptual design phase and the preliminary design phase, when a project is publishing design documentation as information issued, engineering holds are not required. Documents which have been information issued are not complete and/or the design information contained in them has not been design-verified; therefore, they cannot have work performed to them and they are on Hold by their nature. Test documents supporting development or design verification activities will be released however, as these activities are not normally subject to engineering hold actions, but rather are intended to prevent the necessity for such actions.

3.8 Design Errors and Deficiencies

Design errors and deficiencies in approved design and design information documents (those already released for procurement, fabrication, or installation) are documented, evaluated and require corrective actions. The measures taken to revise the appropriate design documents shall be processed and documented by a change notice, form PPO 974, (see Section 3.4.2) in accordance with PPO-EDP-06, "Production Release of Design Documents". Corrective action must be processed in accordance with either Quality

Procedure PPO-QAP-16, "Corrective Action Program", or PPO-QAP-18, "Audits", as appropriate.

3.9 Design Document Formats and Contents

The format, contents, arrangement, etc. for word documents and drawings shall be in accordance with the engineering instructions for preparation of the various documents and drawings.

4 Description of Design Phases and Products

4.1 Description of Design Phases

Four main separate engineering activities are recognized for the completion of the APT Project: (1) conceptual design, (2) preliminary design, (3) final design, and (4) Engineering Support During Construction. Three additional phases are included in this DEP to account for the development of high tech equipment. They are: (1) engineering development and demonstration (ED&D), (2) design verification and support (DV&S), and (3) tooling and equipment (T&E). The first four major activities are usually phased in time and take place in the sequence listed. The next two activities are design input or support activities and can take place at any time during the conceptual, preliminary, and final design phases. The last activity supports manufacturing, inspection, and testing of a product.

4.1.1 Conceptual Design

In the conceptual phase, several design approaches to a new product or change to an existing product may be evaluated in sufficient detail to establish the general configuration and determine the technical and economic feasibility. Top level documents such as the Facility Design Description, System Design Descriptions, and Arrangement Drawings are issued during this phase to assist in the comparison of concepts and selection of the reference design.

The conceptual design phase establishes an approval base for:

1. design change control,
2. establishment of baseline project budget and schedule,
3. further optimization of product or process,
4. definition and justification for ED&D and DV&S programs, which may be initiated or continued,
5. proposal development,
6. conceptual cost estimate, Preliminary Design

Upon selection of the conceptual design, the preliminary design phase starts. In this phase the conceptual design is developed to the point that:

1. The ability of the design to satisfy the primary plant objectives for safety and performance has been confirmed.
2. Interfaces with other systems are frozen and document baseline is established.
3. A preliminary cost estimate can be generated.
4. Detailed design documents, such as design descriptions, specifications, and hardware drawings, are prepared and information issued or production released.

5. Further programs for ED&D and DV&S are initiated or continued.

4.1.2 Preliminary Design

Upon selection of the conceptual design, the preliminary design phase starts. In this phase the conceptual design is developed to the point that:

1. The ability of the design to satisfy the primary plant objectives for safety and performance has been confirmed.
2. Interfaces with other systems are frozen and document baseline is established.
3. A preliminary cost estimate can be generated.
4. Detailed design documents, such as design descriptions, specifications, and hardware drawings, are prepared and information issued or reproduction released.

4.1.3 Final Design

The final design phase includes work that is required for the procurement, fabrication, installation, testing, and operation and maintenance of the plant systems and components. In the course of final design, the preliminary design may be further refined, detailed, and frozen; and all documents required for procurement, fabrication, and installation will be generated and approved for release for construction or fabrication. Design verification of final design released documents will be accomplished prior to the start of the appropriate activity.

4.1.4 Engineering Support During Construction

Activities performed during the Engineering Support During Construction phase are focused on:

- Finalization of all awarded construction/procurement procurements
- Resolution of all contractor questions/requests made after the award of contract
- Incorporation of specific vendor information in all physical installation drawings
- Response to construction phase field questions regarding waivers from documents released as approved for construction/fabrication
- Completion of Record Drawings for all construction/installation activities documenting all approved and implemented contractor waiver requests.

This project phase will become more important as the construction and procurement phase begins. As such, additional information and guidance and direction for the ESC phase will be provided during the final design phase.

4.1.5 Additional Phases Related to Equipment Design

4.1.5.1 Research and Development

Engineering Development and Demonstration (ED&D) testing is used as a basis for developing new items or obtaining reference design data. Documentation of basic ED&D work normally does not carry a Safety or Quality Assurance classification (SQAC). ED&D documents typically provide indirect and only partial support for final design of systems or components. In future design or licensing use, the data is subjected to the level of review and approval designated for the specific system or component. For example, data from ED&D that is selected for use in final design shall be included and referenced in a design data manual or product specification document, which must be assigned the appropriate SQAC and released in accordance with project procedures controlling such information. If it is recognized that an ED&D document describes work or results that will be used directly in the final design of safety class or safety significant components or systems, it shall be designated SC or SS and be released accordingly

4.1.5.2 Design Verification and Support

Design verification and support (DV&S) consists of programs conducted for testing a prototype, model, or sample to verify and/or support a design prior to its release for production. DV&S projects are also conducted for developing analytical methods to support design work

4.1.5.3 Tooling and Equipment

Tooling and equipment (T&E) is those items used in the manufacture or quality control of product items. T&E is not considered as a deliverable, but it may be customer-owned. When T&E is special-designed, its design is documented by specifications and drawings, which are T&E released.

4.2 Level of Detail Instruction By Work Products

It is essential that the P&FD Packages contain a sufficient level of design definition at their respective levels to support an integrated technical and cost baseline.

Levels of detail for each phase are summarized through the level definitions contained in Table 4-1 through Table 4-6 and through the level definitions contained in Table 4-8 and Table 4-9 list the level of detail requirements for the P&FD phases of the APT Project.

Table 4-8. The matrices of the latter table notes different levels of detail for technically distinct areas in the APT Project depending on the associated design and/or cost risk and the type information to be provided. The scale progresses upward for each major area of documentation and analysis, eventually reaching a Level *5* which represents exhaustive analysis and detailed documentation requirements.

The Level of Detail Matrices in Table 4-8 and Table 4-9 list the level of detail requirements for the P&FD phases of the APT Project. Table 4-8 and Table 4-9 for Preliminary and Final design respectively, provide instruction for the development of the technical content of the design packages in the following areas:

- FDD/SDDs
- Trade Studies
- Drawings
- Specifications
- Supporting Calculations
- Cost Estimates

4.2.1 Facility Design Description and System Design Descriptions

This instruction applies to the system design requirements and description sections of the FDD and the SDDs. In addition to the text narrative, the instruction may involve the use of Tables, flow charts, logic diagrams, Figures, schedules and critical path charting. These guidelines may also require description of performance, supporting physics bases (technological principles), physical features, key interfaces, and validation, as applicable based on the particular section.

Table 4-1, Facility Design Descriptions and System Design Descriptions

LEVEL	Description
5	Detailed descriptions and all sections and documents are complete and approved for use. The documents reflect a complete description of the design and design basis.
4	Complete detailed description including a.) planned performance; b.) supporting physics basis (technology principles); c.) summary of supporting calculations; d.) physical features; e.) key interfaces; f.) concurrent ED&D; g.) descriptive Figures, Tables and charts; h.) impacts and sensitivities; and, I.) experimental validation, as applicable.
3	Section 1, *Functions, Performance and Design Requirements* and Section 2, *Design Descriptions*, with preliminary calculations used to size equipment and components are included in Appendix A and are complete and approved for use in the P&FD Phase.
2	Section 1, *Functions, Performance and Design Requirements* and Section 2, *Design Descriptions* are complete and approved for use in the P&FD Phase.
1	Not Applicable

4.2.2 Trade Studies

Trade studies are essential elements of the engineering process, which are required to achieve the design objectives of the APT Plant. The trade study method described in the *Good Practice Guide to Engineering Trade-Off Studies*, GPG-02, provides a structured, analytical framework for evaluating alternative architectures and designs and selecting components and approaches to tests. The GPG-02 will be the basis for the trade studies implemented during the P&FD phase of the Project. The studies consist of the following steps:

- Defining goals, objectives and values
- Identifying alternatives
- Formulating decision criteria
- Assigning weight factors to decision criteria

- Preparing utility functions
- Considering risks
- Evaluating alternatives
- Documenting results

Trade Study Reports will be controlled documents within the Configuration Management System. Additional trade studies will be performed as necessary to optimize functional performance, the reliability of life cycle costs (LCCS) availability, maintainability, inspectability and QA. The LCCs will be used as inputs to the trade studies.

Table 4-2, Trade Studies

LEVEL	Description
5	All trade studies complete, approved and information is incorporated into the final design.
4	Detailed trade studies involving final design decisions are identified.
3	Trade study recommendations are approved and the results are incorporated into the preliminary design.
2	Trade studies supporting preliminary design are complete and recommendations made.
1	Trade studies necessary to complete the preliminary design phase are identified.

4.2.3 Drawings

The design drawings will be developed in sufficient detail to meet the mission of each design phase. Table 4-3 defines the required detail. Drawings included in the P&FD include, but are not limited to:

- Site Plan, outside utilities and site improvements
- Accelerator, Target Blanket (T/B), TSF and BOP System schematics and arrangements
- General arrangement and floor plans or layouts
- Piping, ducting and cable layouts
- Process flow diagrams (PFD) if applicable, piping, mechanical and HVAC flow diagrams
- Electrical single line diagrams
- Piping and Instrument Diagrams (P&ID's)
- Process equipment and systems
- Architectural, structural and instrumentation

Table 4-3, Drawings

Level	Description
5	As-built drawings reflecting actual plant construction.
4	Installation/Construction details reflecting the incorporation of specific vendor requirements, or final design for engineered equipment which is issued and approved for construction
3	Installation/Construction drawings showing sufficient level of detail to support the procurement process are complete. Detailed drawings for engineered equipment such as field erected tanks is complete.
2	Completed P&IDs showing specific Instrument and Controls (I&C) details and equipment and pipe sizing, General Arrangement drawings showing locations of all equipment, final wall sizing drawings and details for process equipment and systems complete. Drawings for physical routing of pipe, trays and ductwork complete. HVAC Flow Diagrams and single line wiring diagrams complete including certified loads. Detailed civil, architectural and structural drawings based on final calculations complete.
1	Piping and Instrument Diagrams or Process Flow Diagrams is applicable showing the flow characteristics (temperature, flow, pressure and fluid quality) are complete. Preliminary general arrangement drawings showing major equipment locations and space allocations for pipes, trays and ductwork as well as P&IDs showing preliminary size of equipment, piping and schematic connections completed. Preliminary drawings for key equipment and systems prepared. Preliminary HVAC Flow Diagrams and single line wiring diagrams based on unconfirmed loads complete. Preliminary civil, architectural and structural drawings complete.

4.2.4 Technical Specifications

Technical Specifications are those sections of procurement documents which delineate all the technical requirements for the system or component being purchased, or the facility being constructed. Technical Specifications may include detailed drawings and are linked to drawings in their definitions of completeness.

Table 4-4, Technical Specifications

Level	Description
5	Conformed specifications are complete. No outstanding items (contractual or technical) exist. Contractor may begin work. This stage also includes any revisions to the specification reflecting unexpected field conditions.
4	Bids received, evaluated and recommendations issued.
3	Specifications are complete (technical and contractual) and issued for bid.
2	Technical specifications are complete, but do not include data sheets with specific detailed design information.
1	Specification types are identified and outline specifications are developed.

4.2.5 Supporting Calculations

Calculations may include design analyses, reduction of empirical data, simulations, results derived from use of computer models, codes or systems or complete technical research reports. Final calculations may not be parametric comparisons.

Table 4-5, Calculations

Level	Description
5	All calculations and required design verification is complete. Calculations are signed out as final.
4	Final calculations are checked and approved.
3	Calculations containing minor assumptions remain unresolved. No assumption has significant impact on design or construction.
2	Calculations containing outstanding assumptions remain unresolved. If resolved the calculation may significantly impact final design/construction.
1	Scoping calculations for preliminary equipment sizing are complete.

4.2.6 Cost Estimate

The level of required detail for cost estimates is discussed in Table 4-6.

Table 4-6, Definitions of Cost Estimate Level Detail

Level	Description
5	*Bottom-up* cost estimates based on task analysis, cost estimating guides, translation factors and quotes from suppliers for defined equipment, fabrications and others. Equipment is identified in a supporting Material and Equipment List (MEL) to a level that permits obtaining quotes from manufacturers. Special features of design and cost driving equipment and components required for functional performance are identified. Special parameters of custom and/or unique equipment and components that are to be specifically designed are identified.
4	*Bottom-up* cost estimates are based on task analysis, cost estimating guides, translation factors, and, to a limited extent, on quotes from suppliers for defined equipment, fabrications and others. Equipment supports MEL to the corresponding level.
3	Costing is based on approximate estimated quantities and estimating guides. Supplier estimates and parameters are used where practical. Aggregated and generic representations of types of equipment to be used are listed in the MEL supports.
2	Parametric costing is based on facility parameters such as square footage and use.
1	No estimate is required except for an aggregate allowance for all such items.

4.3 Design Document Definition and Functions

The documents for which this design execution plan is to be used are described in Table 4-7.

Table 4-7, Design Document Codes, Classifications, and Applications Guide

Design Document Type	Application
Plant Level Documents	
Facility Design Description	Responds to DOE and federal regulations and state and local requirements. Establishes the overall functional, performance, institutional, operational, safety, maintenance, quality assurance, and decommissioning requirements for design of the plant. Assigns or allocates these plant level requirements to the plant systems, buildings, structures, and site improvements.
	Provides an overview and orientation of the various systems, structures, and facilities which comprise the plant, with an identification of the individual systems, their boundaries and interfaces, and the SDD's prepared to cover them.
Plant Level Requirements Document	Supplements the Facility Design Description (FDD) in specifying plant level requirements to systems and buildings when they are too extensive to be included in the FDD.
Plant Level Analysis Report	Evaluates how well the plant (or multiple systems) meet certain top-level criteria and provides recommendations for remedying any deficiencies identified.
System Level Documents	
System Design Description	Comprehensive technical documents that specify pertinent design requirements and completely define the design, including operation, maintenance, and reliability of individual systems, buildings, structures, and site improvements.
Component Level Documents	
Component Design Specification	Prepared for each component addressed in System and Building Design Descriptions. Typical system-related components are vessels, pumps, heat exchangers, transformers, valves, and load centers. Typical building-related components are cranes, elevators, and general-purpose maintenance equipment.
Commodity Design Specification	Used when several components (or parts) in the plant with similar requirements, such as valves, motors, or instruments have similar design. Also used to specify technical requirements for bulk commodities such as pipe, concrete, wire and cable, raceway, etc., used directly in systems or buildings.
Specifications	
Design Specification	Describes product design such as containments, and/or handling systems, components, and appurtenances, which must meet customer or company system requirements.
Fabrication and/or Assembly Specification	Describes the work, applicable documents, quality assurance, and technical acceptance requirements for the fabrication of a product consisting of several components.
Field Assembly, Construction, Installation, and/or Checkout Specification	Describes engineering requirements of components, assemblies, and systems in support of field personnel during installation and startup of product.

Table 4-7, Design Document Codes, Classifications, and Applications Guide

Design Document Type	Application
Material Specification	Describes the minimum requirements necessary to procure, qualify, and document a material used in a product.
Packaging, Shipping, Handling, and/or Storage Specification	Defines the care and inspection of product from the time of manufacturing release to final inspection at the place of installation and use.
Process Specification	Describes a controlled operation or treatment used in the manufacture of an item.
Procurement Specification	Procurement specifications describe an item (material, equipment, or component) or generic family of items. It establishes the technical and documentation requirements supplier organization must meet.
Reports	
General Report	Presents a formal technical summary of a study, evaluation, analytical method, analysis, or operation relating to the overall project or one of its systems or components.
Calculation Report (3)	Reports the results of design calculations. Prepared to support the Issue/Release of design documents during any phase of design.
Design Report	A digest of documented information generated in support of the design which confirms that the detailed design complies fully and completely with the requirements of the design specification.
Design Verification Report	A digest of documented information generated that verifies the design and specification of a family of related items (system) or a major component.
Construction Report	Provides information which confirms and verifies the completed reactor vessel or containment and its parts comply fully and completely with the requirements of construction specification and design drawings. It includes a schedule of construction, acceptance test information, quality control records, as-built drawings, and a summary of deviations and corrective actions. The construction report is prepared by the constructor of the reactor vessel or containment.
Test Documents	
Test Specification	Defines the examinations and tests needed for ED&D purposes or to verify that a developed item conforms to the specified design requirements.
Test Plan	Prepared by the responsible organization when warranted by the magnitude and/or complexity of the test. The Test Plan describes the test facility, operational characteristics, equipment and instrumentation to be used in performing the test.
Test Procedure	Describes the step-by-step method of conducting a test to obtain data specified in a test specification.
Test Specification/ Procedure	Used on small test projects as a combined specification and procedure. See test specification and test procedure for the application of the corresponding section of a TSP.

Table 4-7, Design Document Codes, Classifications, and Applications Guide

Design Document Type	Application
Test Data Report	Prepared by the test organization to report the results upon completion of a test when these results require further evaluation by the design organization.
Test Evaluation Report	Prepared by the design organization to discuss and evaluate the test results.
Test Report	Prepared by the test organization to report the results upon completion of a test. Normally used when the design and testing organization was the same or the test results are simple and noncomplex and required no further evaluation.
Test Status Report	Prepared by the test engineer to report interim summaries of test results on a periodic basis as established in the test specification.
Computer Program Documents	
Acquired Computer Program Evaluation Report	Evaluates the adequacy of an acquired computer program and, if necessary, recommends additional validation activities.
Computer Program Manual	Provides a record of information about a computer program that is suitable for several purposes. It is used to describe the technical aspects of the program, to provide guidance for users of the program, and to provide information for a programmer to evaluate and modify the program. Normally includes user instructions, but a separate document (Users Manual) may be issued to cover users' instructions.
Computer Program User's Manual	Conveys instructions for using a computer program when they are separated from the Computer Program Manual (MCP).
Computer Program Verification/ Validation Report	Presents information to show that (1) the computer program has been verified to show it produces correct solutions for the encoded mathematical model within defined limits for each parameter employed; and (2) the encoded mathematical model has been shown to produce a valid solution to the physical problem associated with a particular application.
Computer Program Verification and Validation Specification	Contains the specification and acceptance criteria for the tasks necessary for accomplishing the verification and validation.
Programming Specification	Defines programming requirements for a computer program.
Software Design Description	Describes the architecture of the software and the algorithms used. It shall include a description of major elements as related to the requirements, a technical description, and a description of allowable or prescribed logical ranges for inputs and outputs.
Software Requirements Document	A concise description of the functional requirements of the entire external interface of the system and its environment including all hardware and software. It shall describe the external behavior of the software from a user's viewpoint, and address functionality, performance, design constraints imposed on implementation phase activities, and external interfaces.

Table 4-7, Design Document Codes, Classifications, and Applications Guide

Design Document Type	Application
Source Code Listing Document	Contains listing of all source code modules as output from the appropriate compiler or assembler. It also contains the memory load map(s), listings of procedure or command files, or any other files necessary to produce executable software.
Validation Test Specification/Procedure	Describes the computer program test requirement and provides acceptance criteria.
Validation Test Report	Documents the validation test results.
Validation Independent Evaluation Report	Documents an independent evaluation of the adequacy of validation results and the proper documentation of same.
General Word Documents	
Background File	Provides additional information that supports a design document.
Materials Design Data Manual	Compiles material property data, performance models, and assumptions regarding material properties (e.g., concrete, graphite, metal) used in product designs and analysis.
Licensing Document	Reports regarding safety analysis of a plant directed to DOE for licensing purposes including responses to DOE requests for additional information.
Operation and/or Maintenance Manual	A guide for equipment operators and servicing personnel. Also provides guidance in performing preoperational tests and may be used in training of personnel to work with the equipment.
Manual - General	A guide or set of written instructions that provides guidance to operators, servicing personnel, or other users in performing a task or tasks.
Procedure - General	A controlled document that specifies or describes how an activity is to be performed.
Diagrams	
Connection Diagram	Shows the internal and/or external circuit connections of an installation or of its component parts.
Instrumentation Diagram	Symbolically presents and functionally relates the information needed to monitor conditions, perform analysis or other special functions essential to the operation of a system.
Instrument Block (IB) Diagram	Presents the logic of instrumentation, control and electrical, processing, or digital logic systems in interconnected symbol or block form.
Piping and Instrumentation (PI) Diagram	Graphically presents the functional/physical relationship of piping and the instrumentation used in a process.
Process Flow (PF) Diagram	Summarizes the functional relationships of the unit operations and their connecting piping in a process system.
Schematic Diagram	Symbolically shows the circuit connections and functions of a specific circuit arrangement.

Table 4-7, Design Document Codes, Classifications, and Applications Guide

Design Document Type	Application
Drawings	
Altered Item Drawing	Shows modifications made to a standard commercially procured item in order to adapt it to a specific use or to a particular physical arrangement.
Building/Area Drawing	Addressed arrangements and/or structural design aspects of an entire building or a significant portion thereof (i.e., an area). Subordinate to a System Design Description for a building, structure, or site improvement.
Cable Tray Drawing	Shows detailed features such as configuration, dimensions, tolerances, etc. of the cable tray, including cables.
Component Installation/ Removal/Layout Drawing	Shows how a component is installed, removed, and stored.
Component-Level Drawing	Drawings that describe the outline, assembly, etc. of components and are subordinate to the associated Component Design Specification (CDS).
Concrete Drawing	Shows detailed features such as configuration, dimensions, tolerances, and location, etc., of the concrete pours and/or structures.
Conduit Drawing	Shows detailed features such as configuration, dimensions, tolerances, etc., of the pipe or tube conduit or conducts.
General Arrangement Drawing	A series of drawings which represent a suggested physical arrangement and layout of system equipment in a plant.
Assembly Drawing	Presents the relationship of two or more parts or subassemblies combined to form a higher order assembly.
Construction Drawing	Establishes the interrelated elements of an architectural-civil engineering design or buildings, structures, and related construction.
Detail Drawing	Shows detailed features such as configuration, dimensions, tolerances, materials, processes, surface finish, coatings, supplementary notes and references for single parts or assemblies.
Duct Support Drawing	Shows detailed features such as configuration, dimensions, tolerances, location, etc., of the duct support or supports.
Duct Support Location Drawing	Shows location of the duct hangers or supports.
Erection Drawing	Presents the procedures and operational sequence for erecting or assembling the items shown on construction drawings.
Installation Drawing	Shows the general configuration and all of the information necessary to install an item relative to its support structure or to interfacing or associated items.
Interface Control Drawing	Identifies and defines key interfaces among physically mated items.
Layout Drawing	Working drawing prepared during the conceptual or development stages of an item. Used to create detail drawings and word documents. Normally processed for information issue only.
Pipe Drawing	Shows pipe features such as configuration, dimensions, tolerances, and location of a pipe system or systems.

Table 4-7, Design Document Codes, Classifications, and Applications Guide

Design Document Type	Application
Piping Isometric Drawing	Shows piping in isometric projection but with lines parallel to the edges drawn in true length.
Piping Support Drawing	A detailed drawing of a pipe hanger or hangers and/or other support or supports.
Piping Support Location Drawing	Shows the location in the plant of the pipe hanger or pipe supports.
Plant-Level Drawing	Drawings in this category define designs involving more than one system or building. Examples include: Plot Plans, Overall Plant Flow Diagram, Plant Heat Balance and Plant Electrical One-Line Diagrams. All PDs are subordinate to the top-level design document, the FDD.
Outline Drawing	Shows critical physical and functional characteristics of an item and identifies all key interfaces with physically mated items.
Sketch Drawing	Informal drawing used to develop new concepts, to perform tolerance studies, and to analyze designs. Usually precedes the preparation of a design layout and the development of detailed drawings.
Source Control Drawing	Shows an existing commercial item which exclusively provides the performance, installation, and interchangeable characteristics required for one or more specific critical applications.
Specification Control Drawing	Depicts an existing commercial item advertised or catalogued as available as an "off-the-shelf" item or an item which is procurable on order from a specialized segment of an industry.
Steel Drawing	Shows detailed features of the I-Beams or other steel structures.
Structural Drawing	Pictorial representation of a structure or of its related elements. Delineates by means of plans, sections, or details, or a combination thereof, the design requirements set forth by the engineer.
System-Level Drawing	Drawings that address a complete system or a significant portion thereof. They are subordinate to the associated System Description. Examples include Electrical One-Line Diagrams and Pipe System Isometric Drawings.
Test Article Drawing	Prepared by the engineer or supplier to show the configuration, physical properties, etc. of the test article.
Vessel Drawing	Shows detailed pressure vessel features such as configuration, dimensions, tolerances, etc.
Lists	
Advanced List of Materials	Used to transmit design information for material procurement planning purposes in advance of the release of drawings. Prepared by the engineer for advance procurement of materials.
Parts List	A generic term including various specific lists of parts making up a system or a group of similar components, for example a valve list, a relay list, a spare parts list, or a cable tabulation

Table 4-7, Design Document Codes, Classifications, and Applications Guide

Design Document Type	Application
	Other
Change Notice	Formal, controlled description of modifications to released design documents. A released change notice permits the described modifications to be made to the affected document. The CN is a controlled document and is subject to formal draft review, approval, and release.

4.4 *Level of Detail for Preliminary & Final Design*

Table 4-8 and Table 4-9 list the level of detail requirements for the P&FD phases of the APT Project.

Table 4-8, Level of Detail Matrix - Preliminary Design

Description	Level of Detail – Preliminary Design					
	FDD/SDD	Trade Study	Drawings	Technical Specifications	Supporting Calculations	Cost Estimate
Accelerator						
Injector System	2-3	2-3	1	2	2-3	3
LE LINAC System	2-3	2-3	1	2	2-3	3
HE LINAC System	2-3	2-3	1	2	2-3	3
HEBT/Expander	2-3	2-3	1	2	2-3	3
RF System	2-3	2-3	1	2	2-3	3
Cryogenics System	2-3	2-3	1	2	2-3	3
Support Systems	2-3	2-3	1	2	2-3	3
Target/Blanket						
T/B Assembly	2-3	2-3	1	2	2-3	3
Primary Heat Removal	2-3	2-3	1	2	2-3	3
Beam Stop System	2-3	2-3	1	2	2-3	3
TSF						
Extraction	2-3	2-3	1	2	2	3
Isotope Separation	2-3	2-3	1	2	2	3
Waste Cleanup/ Containment	2-3	2-3	1	2	2	3
Process Confinement	2-3	2-3	1	2	2	3
Analytical Lab	2-3	2-3	1	2	2	3
He-3 Supply	2-3	2-3	1	2	2	3
Storage	2-3	2-3	1	2	2	3
Process Mon & Control	2-3	2-3	1	2	2	3
RadCon Mon/Crtl.	2-3	2-3	1	2	2	3
Water Detritiation.	2-3	2-3	1	2	2	3
BOP						
Power Supply System	2	2-3	1-2	2	2	3
Heat Removal System	2	2-3	1-2	2	2	3

Table 4-8, Level of Detail Matrix - Preliminary Design

Description	Level of Detail – Preliminary Design					
	FDD/SDD	Trade Study	Drawings	Technical Specifications	Supporting Calculations	Cost Estimate
HVAC System	2	2-3	1-2	2	2	3
Rad. Waste Treat.	2	2-3	1-2	2	2	3
Remote Handling	2	2-3	1-2	2	2	3
Water Treat. System	2	2-3	1-2	2	2	3
Integrated Controls	2	2-3	1-2	2	2	3
Rad Mon & Protection	2	2-3	1-2	2	2	3
Other Systems	2	2-3	1-2	2	2	3
Support Systems	2	2-3	1-2	2	1	3
Site/Buildings						
Accelerator Tunnel	2	2-3	1	2	2	3
Klystron Gallery	2	2-3	1	2	2	3
Target/Blanket Bldg.	2	2-3	1	2	2	3
TSF Bldg.	2	2-3	1	2	2	3
Control Room	2	2-3	1	2	2	3
Radwaste Facility	2	2-3	1	2	2	3
Support Facilities	2	2-3	1	2	1	3

Table 4-9, Level of Detail Matrix - Final Design

Description	Level of Detail - Final Design					
	FDD/SDD	Trade Study	Drawings	Specifications	Supporting Calculations	Cost Estimate
Accelerator						
Injector System	4	5	2-3	4	5	5
LE LINAC System	4	5	2-3	4	5	5
HE LINAC System	4	5	2-3	4	5	5
HEBT / Expander	4	5	2-3	4	5	5
RF System	4	5	2-3	4	5	5
Cryogenics System	4	5	2-3	4	5	5
Support Systems	4	5	2-3	4	5	5
Target/Blanket						
Target/Blanket Assembly	4	5	3	4	5	5
Primary Heat Removal	4	5	3	4	5	5
Beam Stop System	4	5	3	4	5	5
TSF						
Extraction	4	5	3	4	5	5
Isotope Separation	4	5	3	4	5	5
Waste Cleanup/	4	5	3	4	5	5
Process Confinement		5	3	4	5	5
Analytical Lab	4	5	3	4	5	5
He-3 Supply	4	5	3	4	5	5
Storage	4	5	3	4	5	5
Process Mon & Control	4	5	3	4	5	5
Rad Con Mon/Crtl	4	5	3	4	5	5
Water Detritiation	4	5	3	4	5	5
BOP						
Power Supply Systems	4	5	3	4	5	5
Heat Removal Systems	4	5	3	4	5	5
HVAC System	4	5	3	4	5	5
Rad. Waste Treatment	4	5	3	4	5	5
Remote Handling	4	5	3	4	5	5
Water Treatment Systems	4	5	3	4	5	5
Integrated Controls	4	5	3	4	5	5
Rad Mon & Protection	4	5	3	4	5	5
Other Systems	4	5	3	4	5	5
Support Systems	4	5	3	4	5	5
Site/Buildings						
Accelerator Tunnel	4	5	3	4	5	5
Klystron Gallery	4	5	3	4	5	5
Target/Blanket Bldg.	4	5	3	4	5	5
TSF Bldg.	4	5	3	4	5	5
Control Room	4	5	3	4	5	5
Radwaste Facility	4	5	3	4	5	5
Support Facilities	4	5	3	4	5	5

5 Preliminary Design Package

During the Preliminary Design Phase, a series of documents such as drawings, calculations, trade studies and others will be developed which will fully define the APT project sufficiently to allow for final or detailed design to begin. All trade studies will be complete and all facility modifications implementing the study recommendations will be incorporated. All equipment will be identified and located in its respective building location. All major process equipment will be designed and prepared for being detailed onto manufacturing drawings. The design of the Electrical Distribution System will be complete. All buildings will be analyzed to a point where specific reinforcement is identified and ready for being included in the final design.

All of this information is part of the Preliminary Design Package, which is the major deliverable for the Preliminary Design Phase. The Preliminary Design Package may not be completed at a single point in time. However, it will evolve and be changed as each of the contributing sections is completed. Because of the length of the ED&D Program, some of the decisions regarding the design of the accelerator components or the T/B cannot be completed as early as some of the components of the BOP Systems.

This Section describes the work flow path of the major contributors of the preliminary design and identifies in general terms the primary constituents of the Preliminary Design Package.

5.1 Balance of Plant

5.1.1 Civil Structural (WBS 1.05)

5.1.1.1 Perform Optimization Studies

All general design information which is available will be reviewed to optimize the preliminary design of the particular structure or facility for engineering, construction and cost considerations.

Studies optimizing facilities/structures are not required and can therefore be either cursory or very detailed as warranted.

5.1.1.2 Request and Receive Preliminary Design Information and Loads

The preliminary design information will be obtained from all disciplines and vendors. The information will include loads and dimensions of equipment and such things as maintenance access clearance and removal requirements used to develop the spatial and load requirements for preliminary design. These loads include live, dead, hydraulic, pressure (vacuum), thermal and dynamic.

Preliminary shielding requirements for the structures will be provided by nuclear engineering.

Reasonable estimates, supported by preliminary calculations where appropriate, will be accepted during this period.

5.1.1.3 *Perform Preliminary Calculations*

Preliminary design of structures/facilities will be performed based on loads. This will includes layouts of buildings including all major and minor dimensional requirements.

Preliminary calculations in sufficient detail to assure design adequacy of the facility and to identify potential or apparent structural problems will be performed. The calculations will also identify the adequacy of space, wall thickness and other dimensions provided in the layout. Identified significant problems will be addressed at this time. More difficult problems can be resolved during the final design phase.

5.1.1.4 *Develop General Arrangement Drawings*

Based on Preliminary Design, General Arrangement, or GA (background), drawings will be developed in conjunction with other disciplines. These drawings will be used by other disciplines to superimpose the equipment layouts and also will be used by the architectural designers for design of floor plans.

The GAs will include floor plans for each level and select building interior elevations and sections, as required to define equipment placement.

The GAs will be submitted to other disciplines for their review/comments and concurrence.

After agreement on the overall design/layout of the GAs, all detailed architectural and structural dimensions/information will be input into the three-dimensional Plant Design System (PDS) computer model of the structure and/or facility.

5.1.1.5 *Computer Modeling and Structural Analysis*

The computer structural model(s) such as *STARDYNE STADD, SAP90* and others will be used to develop and subsequently to perform computer calculations for structural design.

The computer model will be executed to "de-bug" the model and to verify the correctness of the model. Only sufficient load combinations will be executed to assure correctness of model. All individual load combinations will be applied during final analysis/design.

5.1.1.6 *Facility Design Description*

The FDD, issued at the completion of the Conceptual Design, will be upgraded to reflect all changes beginning with the CDR Phase and continuing to the Preliminary Design Phase.

5.1.1.7 *Preliminary Design Work Package*

The preliminary design work packages for Civil Structural are presented in Table 5-1 through Table 5-3. These Tables describe the work products and activities that are performed under WBS 1.05.01, through 1.05.08. The required level of detail for each work item is also described in these Tables.

5.1.2 Mechanical (WBS 1.11.02,05,07,08)

The FDD and the SDD will be used as a basis to begin design. Section 1 of the SDD contains the functions, performance requirements and design requirements while Section 2 of the SDD contains the design description. These are used as a basis to begin design. A

preliminary process flow diagram (PFD) and/or a P&ID will be developed. In a situation such as the case of the Heat Removal System, the design process leading to a P&ID will be started by a PFD. This preliminary P&ID will provide sufficient information for preliminary equipment and pipe or duct sizing to be started.

A preliminary equipment and piping or duct layout will be developed to allocate space. The preliminary PFD inputs are used to generate P&IDs and subsequently GA drawings as well as a preliminary building model.

5.1.2.1 Major Deliverables

The major deliverables for preliminary design are as follows:

- SDD Sections 1 and 2
- PFD (if applicable, for heat removal systems only)
- P&IDs
- Preliminary GA drawings (for input into the building 3-D model).

5.1.2.2 Preliminary Design Work Package

The preliminary design work packages for Mechanical are presented in Table 5-4 through Table 5-8. These Tables describe the work products and activities that are performed under WBS 1.11.02, 1.11.05, 1.11.07 and 1.11.08. The required level of detail for each work item is also described in these Tables.

5.1.3 Electrical (WBS 1.11.01)

During the preliminary design phase, the SDDs for the Electrical Systems will be used as the baseline document. Section 1 of the SDD contains the functions, performance and design requirements while Section 2 of the SDD contains the System Design Description consistent with the final CDR issued in April 1997. Similarly a Facilities Design Description document has been prepared that depicts the facilities design based on the final CDR issue. These documents will be carefully reviewed to ensure the design basis is established for all electrical engineering activities relative to the APT project SOW. As necessary, additional SDD Sections will be prepared to develop the missing design criteria elements. Such elements will typically include identifying and including applicable industry codes and standards and specific DOE Orders necessary to prepare the intended design products.

With the final CDR as the baseline, trade studies will be initiated in the selected technical areas. The trade studies will be used to assure the selected design options render most cost effective designs. The options considered will address initial capital costs as well as the operations and maintenance requirements, which meet project operating reliability goals. The results of the trade studies will establish the design approach for the preliminary design activity in the electrical area.

5.1.3.1 Electrical Design Activities

The preliminary design activity will be organized in four different technical areas which comply with the project schedule needs. These technical areas are as follows:

- Temporary construction power distribution, including early startup power
- APT main power supply distribution
- Electrical services to plant systems and facilities
- Electrical support systems

5.1.3.2 Temporary Construction Power Distribution

This design package will include a Construction Power Load List. The list will provide assessments of the electrical load demands for mobilizing site and construction activities. Based on the preliminary load data and the utility power interface requirements, preliminary designs will be developed for the construction substation design. This design will identify the high voltage interface on the utility side, and medium/low voltage distribution to support the electrical power demands for the various construction activities at the designated APT site areas. The temporary construction power requirements will also include start-up power, as necessary, before the plant permanent power is energized to support phased plant start-up and commissioning. Preliminary procurement and installation specifications will be prepared for early release of each required construction activity.

5.1.3.3 APT Main Power Distribution

The work scope for the APT Main Power Supply Distribution Center includes developing a plant-wide power distribution scheme. The scheme must cater to the electrical power needs of all systems and facilities and support all plant operating modes. All Plant Systems include the major areas of the Accelerator, the Target Blanket, the Tritium Separation Facility and all Balance of Plant Systems. This work also includes generating the following on-site power:

- Diesel generators supplying back-up power in the event of off-site power loss
- DC power supply distribution including DC stationary battery installations
- Uninterruptible Power Supply (UPS) provisions to support critical I&C loads
- Other support equipment

Extensive interface with the APT Tritium Production Engineering (LINAC, T/B, and TSF), BOP Systems and the Site and Facilities groups will be required during this phase which will involve the simultaneous collecting of accurate load data for the systems and facilities while the system design is being developed.

5.1.3.4 Electrical Services for Plant Systems and Facilities

To support the Plant Electrical System, electrically operated components and devices and feeder cables must be routed into the buildings where the components will be housed. Therefore, the preliminary issue of the GA drawings will identify the component locations, cable raceway designs, lighting design for the facilities and buildings and communication ladder diagrams. The design of the building ground loops for the equipment grounding will be initiated. These preliminary design products will support preparing the bills of material (BOM) subsequent to the development of the procurement specifications.

The various APT Plant System Design PFDs and P&IDs will be developed during this phase. The Electrical discipline will support these activities to identify electrical interfaces and electrical control requirements. These efforts will precede determining the control logic requirements of the electrical devices. Engineering effort for generating the preliminary Electrical Wiring Diagrams (EWDs) for all the electrically operated components pertaining to each system will be prepared during the later part of the preliminary design phase.

5.1.3.5 Electrical Support Services

This technical area includes engineering of the APT Plant Electrical Support Service Systems such as communications, catholic protection, grounding and lightning protection, access and security and plant lighting. In the preliminary design phase the following generic design products will be prepared to support the overall project requirements:

- System Design Descriptions and design criteria documents
- System components and standards will be selected
- Preliminary procurement specification will be prepared
- Preliminary system calculations and studies will be prepared

5.1.3.5.1 Preliminary Design Work Package

The preliminary design work packages for Electrical are presented in Table 5-9 through Table 5-12. These Tables describe the work products and activities that are performed under WBS 1.11.01. The required level of detail for each work item is also described in these Tables.

5.1.4 Instrumentation and Controls/Integrated Control Systems (WBS 1.11.03,04)

The BOP I&C WBS numbers are 1.11.03 and 1.11.04. The WBS 1.11.03 is for the Integrated Control System.

The APT Integrated Control System (ICS) will control and coordinate all aspects of plant operations ranging from the HVAC System to beam performance and production. Approximately 120,000 input and output (I/O) points will be involved in the System which will be implemented as a Digitally Distributed Control System.

The ICS is comprised of global and system specific sections. The global or common functions, which will integrate and control the APT Systems, include:

- Operator interface
- Data acquisition
- Alarm management
- Data archiving and retrieval
- Modeling and simulation
- Data distribution
- Self-checks and diagnostics
- Save and restore capabilities
- Automatic sequencing
- Closed-loop control and system tuning

- Mode control
- Timing functions
- Equipment protection including Fast Protect, Beam Permit and other interlocks.

The system-specific sections of the ICS, including I/O modules and I/O controllers (IOC) are connected to a data highway which is linked to systems within the accelerator, the T/B, the TSF, the BOP and the Main Control Room (MCR). Inputs and outputs to the ICS drops and specific system functions are included. The ICS also provides an interface for Operations, Maintenance and Engineering workstations.

WBS 1.11.04 BOP Instrumentation

The APT BOP instrumentation includes Plant Process, Safety and other Systems providing plant-wide coverage or local critical coverage. These will be integrated into the overall operation of the MCR. However, for practical or operational reasons the Systems may be operated separately from the ICS. For example, the Radiation Monitoring and Protection System (RMPS), which includes the T/B Beam Shutdown Subsystem (TBBS) and the Radiation Exposure Protection Subsystem (REPS), is separate and independent from the ICS. However, BOP instrumentation connects to the ICS in the same manner as do the devices from the T/B, LINAC or TSF.

5.1.4.1 Preliminary Design Scope

The scope for preliminary design will include preliminary SDDs, control database formats, equipment installation drawings, software requirements documents and P&IDs for Systems included in the preliminary design phase.

5.1.4.2 Preliminary Design Product Description

The SDDs will be used as a basis for design. Sections 1 and 2 will be completed. The SDDs are a sound basis from which to begin design. However, as the APT design progresses the SDD documents will be modified. The I&C Discipline will contribute to the I&C sections of SDDs for other specific plant systems.

The preliminary control database format description will form the basis for establishing the requirements for transferring sensor and process information to the ICS.

The P&IDs and Equipment Installation Drawings (EIDs) will include major process parameter measurements, control loops, shutdown logic, ICS connections and instrument tag alpha process parameter indicators. The items not included are local process measurements, instrument/loop tag numbers, pump/motor local/remote control details, detailed logic/control philosophy, alarm indication, local/remote panel designation, I/O IOC destination designation, and detailed notes and references.

The preliminary software requirements documents will contain outlines of expected performance requirements as well as functional requirements for purchased and developed control software. An outline of a software QA plan will be included.

5.1.4.3 Preliminary Design Work Package

The preliminary design work packages for I&C are presented in Table 5-13 and Table 5-14. These Tables describe the work products and activities that are performed under WBS

1.11.03 and 1.11.04. The required level of detail for each work item is also described in these Tables.

5.1.5 Nuclear (WBS 1.11.06)

Nuclear engineering is responsible for the design of the Radioactive Waste Treatment System (RWTS). The function of the RWTS is to handle, prepare, treat, temporarily store and discharge or transport APT-generated low-level radioactive solid, liquid and gaseous waste streams for disposition. The Radwaste System will serve as an intermediary between the accelerator, the T/B System, the Tritium Separation Facility, and the environment. An assumption of the RWTS design is that it will only receive waste that does have a clear path for final disposal and, that, as such will be designed to generate waste forms that will be suitable for in accordance with the SRS Waste Management Plan developed for APT.

The RWTS will be developed in compliance with regulatory requirements for the environment, safety and health. It will be designed according to As Low As Reasonably Achievable (ALARA) principles to ensure the utmost levels of radiological protection.

The design of APT will utilize information from existing accelerator/spallation experiments. Source term information will be collected from available operating accelerators and used to confirm the analytical calculations. In addition, nuclear engineering will collect data from process system design teams and vendors. This data will be used to characterize the waste streams and to determine shielding requirements.

While the final CDR is an initial baseline for the preliminary design, it is recognized that an improved understanding of the nature of the radiological source term in the early stage of the preliminary design may result in changes in the design for the RWTS. Trade Studies will be initiated in the selected technical areas to assure that the selected design options render the most cost effective designs considering the initial capital costs as well as the operations and maintenance requirements while meeting the project operational reliability goals. The results of the trade studies will be the bases for establishing the design approach for the preliminary design activity in the nuclear area.

The RWTS includes Systems to handle solid, liquid, and gaseous radioactive waste streams. Sections 5.1.5.1. through 5.1.5.3 provide brief descriptions of studies which will be performed in the Preliminary Design Phase.

5.1.5.1 Liquid Radwaste System Design Activities

The radiation source term identification will be used for characterizing the APT liquid radioactive waste to be treated and managed. Radwaste System process selection will depend on the source terms and the effluent release requirements developed in accordance with the SRS Waste Management Plan developed for APT. Shielding calculations will be performed for segregating and shielding System components. Existing liquid Radwaste processing facilities at SRS will be evaluated for potential use in treating APT radioactive liquid wastes. Methods of transporting liquid radioactive wastes to suitable SRS facilities will also be evaluated. Means for minimizing waste for the Liquid Radwaste System will be assessed including the potential to recycle and reuse liquid wastes.

5.1.5.2 *Gaseous Radwaste System Design Activities*

The gaseous Radwaste source term identification will be used for characterizing the APT gaseous radioactive waste to be treated and discharged. Process selection will depend on the source terms and effluent release requirements. A study will be performed which will consider the use of a Charcoal Delay System instead of the present three-tank concept for holdup prior to release. Shielding calculations will be performed for segregating and shielding the System components based on ALARA principles. Calculations will be performed to estimate the dose to an individual at the site boundary as a function of delay time of the waste gas.

5.1.5.3 *Solid Radwaste System Design Activities*

Source term identification will be provided for characterizing spent resin filter media and other solid waste to be treated and managed. A study will be performed which will establish which waste forms are acceptable to store and which must be disposed of. The study will also review the potential for using existing SRS Solidification Systems. In addition methods of transporting unsolidified waste to the facilities will be evaluated.

5.1.5.4 *Preliminary Design Work Package*

The preliminary design work packages for Nuclear are presented in Table 5-15. This Table describes the work products and activities that are performed under WBS 1.11.06. The required level of detail for each work item is also described in this Table.

5.2 *Tritium Production Engineering*

5.2.1 Accelerator (WBS 1.06)

The Accelerator section of the APT is comprised of a chain of different structures that accelerate a proton beam of a sufficient current to an appropriate energy, then transport and expand the beam onto the Target/Blanket, to meet the tritium production requirement of APT. The Accelerator consists of the following components or Systems:

- Low Energy (LE) LINAC
- High Energy (HE) LINAC
- High Energy Beam Transport (HEBT) and the Beam Expander
- RF Power
- Auxiliary and Cryogenic Beam Diagnostics
- I&C Systems
- Miscellaneous LINAC Support Systems.

The Low Energy LINAC is comprised of the following:

- Injector
- Radio Frequency Quadrupole (RFQ)
- Coupled-cavity drift tube LINAC (CCDTL)
- Coupled-cavity LINAC (CCL)
- LE LINAC Intertank Sections.

The HE LINAC is comprised of the Cryomodules and HE LINAC Intertank Sections.

5.2.1.1 *Preliminary Design Scope*

The Accelerator scope for preliminary design will include developing the preliminary SDDs, preliminary Installation Drawings and defining the interface points to support development of the General Arrangement Drawings.

The preliminary design tasks for the Accelerator will be to develop and integrate the preliminary designs of the Accelerator Subsystems. Top-level requirements will be reviewed and flowed down to the Subsystems. Interface points between the various Accelerator Subsystems and between the Accelerator and the T/B, BOP and ICS will be defined and coordinated. Preliminary commissioning and operating plans and integrated schedules and costs will be generated. The appropriate design reviews will be presented. Top-level requirements and interfaces will be reviewed to determine performance, reliability/availability, safety, interfaces to BOP and other APT System requirements as well as applicable SRS, DOE, industry and government regulations. Flow down of these to the Accelerator Subsystems will be coordinated. Appropriate sections of the FDD and SDDs will be updated periodically. The updates will ensure requirements are completed and maintained current and the design descriptions are updated as designs evolve. The Preliminary Installation Drawings, showing the arrangement of the technical equipment, will be developed to support the development of the General Arrangement drawings for the tunnels and the klystron gallery. They will be updated as the designs of the Accelerator technical equipment evolve.

5.2.1.2 *Preliminary Design Product Description*

The SDDs will be used as a basis for design. Sections 1 and 2 will be completed. The SDDs are a sound basis from which to begin design. However, as the Accelerator design progresses the documents will be modified to maintain the current information.

The Installation Drawings will be generated and maintained up-to-date with the design evolution and refinements. These drawings will provide the BOP with critical design requirement information concerning the technical equipment that will be required for the tunnel and gallery designs.

5.2.1.3 *Preliminary Design Work Package*

The preliminary design work packages for the Accelerator are presented in Table 5-19. This Table describes the work products and activities that are performed under WBS 1.06. The required level of detail for each work item is also described in this Table.

5.2.2 Target/Blanket (WBS 1.07)

The Target/Blanket System consists of the Target/Blanket Assembly, the associated heat removal systems, and the beamstop systems. The primary function of the Target/Blanket Assembly is to convert a high energy proton beam into a neutron source, in order to produce tritium from He-3 feedstock. The Target/Blanket heat removal systems are used to cool the Target/Blanket Assembly during normal operation and following beam shutdown. A cavity flood system is also available to provide emergency cooling following certain low-frequency design basis accidents. The beamstop systems are used during commissioning and for beam tune-up. The heat removal systems include polishing systems to maintain proper coolant chemistry.

5.2.2.1 *Preliminary Design Scope and Products*

The following activities will be performed during the preliminary design phase:

Preliminary systems level design and interface requirements will be developed and incorporated into the APT Facility Design Description Document.

A preliminary Target/Blanket System Design Description document will be prepared.

Preliminary general arrangement drawings will be prepared.

Areas for technology development will be identified and Design Data Needs (DDNs) will be prepared. Test plans to accomplish the DDNs will be reviewed and approved. A Target/Blanket System Summary Test Plan will be prepared.

A prototype manufacturing test plan will be prepared. Manufacture of prototypes will be initiated.

An operability and maintainability report will be prepared.

Input will be prepared to support the Environmental Impact Statement and Preliminary Safety Analysis Report.

Preliminary design packages, including design calculations, systems level analyses, trade studies, design drawings, and equipment lists, will be prepared for the Target/Blanket Assembly modules heat removal systems, beamstop systems, coolant polishing systems, instrumentation and control systems and target module handling machines.

Preliminary activation analyses and shielding requirements will be developed.

5.2.2.2 *Preliminary Design Work Package*

Examples of Preliminary Design Work Packages are shown in the following Tables 5-20, 5-21, and 5-22 for 3 of the 9 major systems in the Target/Blanket Systems. They are for the Target/Blanket System (WBS 1.07.01), The Cavity Vessel Systems (WBS 1.07.02), and the Heat Removal Systems (WBS 1.07.04). These Tables describe the work products and activities that are performed under WBS 1.07. The required level of detail for each work item is also described in these Tables.

5.2.3 Tritium Separation Facility (WBS 1.09)

The principal function of the Tritium Separation Facility (TSF) is to separate the high-purity tritium product from the ^{3}He-blanket gas. Secondary functions of the TSF include processing waste streams to recover tritium, to recover and purify ^{3}He for reuse and to remove radionuclides (except tritium) to levels that allow controlled release of the waste gas streams through the plant stacks. The TSF is composed of seven systems:

- Tritium Extraction System

The Tritium Extraction System separates the tritium and hydrogen produced in the blanket from the ^{3}He.

- Isotope Separation System

The Isotope Separation System separates the hydrogen isotopes into the high-purity tritium product and a stream of stackable protium.

- Waste Gas Tritium Cleanup System

The Waste Gas Tritium Cleanup System removes tritium, ^{3}He and radionuclides from waste gas streams prior to disposal.

- Process Confinement System

The Process Confinement System provides secondary confinement for all processes containing tritium.

- Analytical Laboratory System

The Analytical Laboratory System analyzes the process streams to control processes and to account for tritium.

- Tritium Storage System

The Tritium Storage System provides a storage capacity for tritium extracted in the TSF.

- 3He Supply System

The ^{3}He Supply System provides clean ^{3}He to the blanket from fresh ^{3}He and from ^{3}He recovered and purified from waste gas streams.

5.2.3.1 The TSF System Design

The design of TSF Systems will be driven by requirements from the FDD. The top-level requirements will be translated into requirements for the TSF System designs and the requirements documented in the SDDs for the seven TSF Systems. The SDDs will contain or reference all design information relative to the subject system.

Much of the technology used in the TSF has been developed and used in currently operating tritium facilities. This existing technology will be the basis for the processes used in the TSF. However, emerging tritium processing technologies have and are continuously being identified which afford the opportunity to design and build a TSF for APT which is safer, has less environmental impact and is less expensive to build and operate. These technologies are being tested for use in TSF in parallel with the APT Engineering Development and Demonstration Program (ED&D). When tests are complete, the technology to be used in carrying out specific TSF functions will be selected. The selections will be based on the results of the ED&D Program and on trade studies which will have considered a wide range of technical, safety, environmental and cost factors.

Much of the TSF processing equipment is placed in glove boxes located in both the T/B and TSF Buildings. The glove boxes prevent release of tritium to the working areas or to the environment. Process Systems in the TSF will enable this tritium and the ^{3}He to be recovered for reuse. It is planned that the Process Systems will be procured with the glove boxes already installed. This pre-installation will shift assembly work from the field to the factory and thereby reduce assembly costs and facilitate installing the process equipment in the TSF building. Accordingly, procurement specifications will contain drawings and specifications for the glove boxes, specifications for process components, P&ID diagrams for the process and requirements and Preliminary Installation drawings for the equipment to be included within the glove boxes. Various procurement strategies are planned for specialized equipment. In many cases specialized tritium process components will be built-to BREI/GA drawings and supplied to the Glove Box System vendor for installation. The

vendor will supply the glove box, install the equipment at his factory and produce as-built drawings for the equipment and glove boxes.

At the beginning of the design, the requirements for each system will be defined and documented in Section 1 of the applicable SDD with a System Description in Section 2. The TSF System document trees and a detailed design schedule will be prepared.

Additionally, during the preliminary design, work will be concentrated on preparing PFDs and preliminary P&IDs. When completed, these products will quantify the TSF external and internal process interfaces and will enable some equipment to be sized. Equipment (parts), valve and instrument lists will be compiled from the P&IDs. Preliminary arrangement drawings for the TSF and TSF Systems will be prepared. Design and trade studies will be conducted as necessary to support these activities. Priority will be given to systems which are in the T/B Building which is scheduled to be completed earlier in the project than the TSF Building.

5.2.3.2 Preliminary Design Work Package

The preliminary design work packages for the TSF are presented in Table 5-23. This Table describes the work products and activities that are performed under WBS 1.09. The required level of detail for each work item is also described in this Table.

6 Final Design Package

During the Final Design Phase, a series of documents such as drawings, calculations, trade studies and others will be developed which will fully define the APT project sufficiently to allow for construction and procurement to begin. All equipment will be identified and located in their respective building locations. All major process equipment will be designed and detailed onto manufacturing drawings. The design of the Electrical Distribution System will be complete. All buildings will be analyzed and specific reinforcement included.

All of this information is part of the Final Design Package, which is the major deliverable for the Final Design Phase. The Final Design Package may not be completed at a single point in time. For example, the final design specification and drawings to support the acquisition of equipment will be issued to support the acquisition schedule. Similarly, final specifications and drawings to support the various construction contracts will be issued to support he construction schedule.

This Section describes the work flow path of the major contributors of the final design and identifies in general terms the primary constituents of the Final Design Package.

6.1 Balance of Plant

6.1.1 Civil Structural Design

6.1.1.1 Request and Receive Final Design Information and Loads

The complete and final design information (CFDI) will be obtained from all disciplines and vendors. The CFDI will include loads and dimensions of equipment (including maintenance clearances and removal requirements). The CFDI will be used to verify and adjust the GA spatial and load requirements established in the preliminary design phase.

Structural shielding requirements will be verified and finalized by nuclear engineering.

Estimates will not be accepted at this time. If the CFDI is not available, reliably conservative, yet reasonable loads and/or spatial requirements will be utilized for the development of final design products.

The size and location of all penetrations will be finalized.

6.1.1.2 Perform Final Calculations

1. Finalize and execute all computer models.
2. Finalize all load combinations and perform analyses for all load combinations.
3. Perform final structural design of concrete or steel members.
4. Provide revised dimensions for 3-D PDS computer model.

6.1.1.3 *Perform Foundation Design*

1. Review structural design output for loads applied to the foundation (soil) subgrade.
2. Determine the adequacy of foundation materials/conditions based on the Geotechnical Design Criteria Report.
3. When foundation loads exceed the design criteria, Project Geotechnical personnel will assist in developing and evaluating design alternatives or modifications such as soil improvements, caissons, pilings or others.
4. Calculations and alternatives/modification drawings will be prepared for the changed foundation design.

6.1.1.4 *Final Design Drawings*

1. Construction drawings will be developed based on final analyses/design.
2. Excavation and Erosion Control Drawings will be prepared.
3. Based on the GA drawings, detailed design/construction drawings will be developed for architectural, structural steel and concrete.
4. The drawings will include floor plans for each level, building interior and exterior elevations, sections, schedules and details.
5. Concrete drawings will include reinforcement details which are sufficient for a contractor to use to prepare bar bending schedules.
6. Placement drawings will comply with PC-2 and PC-3 seismic requirements.

6.1.1.5 *Develop Specifications*

Specifications will be developed for each aspect of the architectural, civil and structural design. These specifications will adhere to FDD and related design criteria and accepted industry codes and standards.

6.1.1.6 *Final Facility Design Description*

Appropriate sections of the FDD document will be completed to reflect the Final Design.

6.1.1.7 *Review and Approval*

All documents, calculations, drawings, specifications and other documents will be submitted for Peer Review prior to the documents being issued for bid and/or construction.

6.1.1.8 *Final Design Work Package*

The Work Flow Diagram for Civil Structural is presented in Figure 6-1. The steps leading to the completion of the Final Design Package are depicted in this Figure.

The final design work packages for Civil Structural are presented in Table 6-1 through Table 6-3. These Tables describe the work products and activities that are performed under WBS 1.05.01-1.05.08. The required level of detail for each work item is also described in these Tables.

6.1.2 Mechanical

The final design phase will start with SDD Sections 1 & 2 being baselined to reflect all design changes developed during the preliminary design, and P&ID's released to the level of detail identified in Section 4 of this DEP. The GAs will be finalized and provided as input to the building model. All equipment, piping and or ductwork will be routed in the model and final GA and mechanical installation drawings will be issued for construction

The deliverables for final mechanical design are:

- Baselined SDD Sections 1 & 2
- Final GA drawings issued
- Final P&IDs issued
- Final Mechanical installation drawings issued (Note: These drawings may not include vendor information since the procurement process will not be complete for much equipment during the final design)
- Final equipment, valves, lines and other lists issued
- Final versions of associated drawings such as fire zones, radiation zones, equipment lay down areas and others issued.

6.1.2.1 Final Design Work Package

The Work Flow Diagram for Mechanical is presented in Figure 6-2. The steps leading to the completion of the Final Design Package are depicted in this Figure.

The final design work packages for Mechanical are presented in Table 6-4 through Table 6-8. These Tables describe the work products and activities that are performed under WBS 1.11.00, 1.11.02, 1.11.05, 1.11.07 and 1.11.08. The required level of detail for each work item is also described in these Tables.

6.1.3 Electrical Activities

The work scope for the electrical discipline for the final design phase will include preparing all documents and associated engineering tasks to support the detailed design and procurement activities for systems and facilities. These include, but are not limited to, completing relevant SDD and FDD sections, detailed design drawings for the procurement issue status, preparing and finalizing the procurement specifications, issuing the specifications for bid to the prospective vendors, receiving the bids and performing bid evaluations to select the successful vendor(s). The engineering effort for continuing the procurement process, supporting construction, preparing installation details in support of construction and supporting engineering during the test and operation phases is not included in this work scope.

The final design deliverable products will be developed by using state-of-the-art electronic design software that allows repeat activities to be automated and which thereby improves the final accuracy of the final product.

6.1.3.1 *Final Electrical Design Product Description*

During the final design phase, engineering efforts will be concentrated on integrating all the plant system final design information pertinent to generating the electrical documents. The preliminary design documents will be revised and updated as necessary to depict the final design status. Since the final products for each of the technical areas will follow the same format they are identified below by document category.

6.1.3.2 *Final Design Work Package*

The Work Flow Diagram for Electrical is presented in Figure 6-3 through Figure 6-6. The steps leading to the completion of the Final Design Package are depicted in these Figures.

The final design work packages for Electrical are presented in Table 6-9 through Table 6-12. These Tables describes the work products and activities that are performed under WBS 1.11.01. The required level of detail for each work item is also described in these Tables.

6.1.4 Instrumentation and Controls/Integrated Control Systems

6.1.4.1 *Final Instrumentation and Controls and Integrated Control System Design Scope*

The I&C scope for final design will include preparing all documents and related efforts to support design and procurement activities for systems in the final design phase. These include, but are not limited to the completed relevant SDD Sections and appendices, design documents, procurement requisitions, P&IDs and bid analyses which are ready for purchase. All documents and related efforts to support construction, installation, testing and calibration activities will be completed in the engineering construction support phase.

Preliminary designs will be reviewed and integrated. Flow of information from the ED&D programs into the ICS design will be coordinated. Interface control documents between ICS Systems and other Systems will be generated. Appropriate sections of the FDD will be updated and the SDDs reviewed periodically to maintain the design description current during the final design phase. The ICS operational scenarios will be reviewed, system limitations will be determined and the design will be reviewed for potential failures or abnormal operations with recovery sequences developed. The GA drawings of the ICS technical equipment within the plant will be generated and maintained current as the designs evolve and are finalized. Documents and information will be coordinated for the consistency and completeness necessary to procure, fabricate, assemble and test the ICS at the SRS. Global ICS software requirements will be developed and the flow down into specific system documents will be coordinated.

6.1.4.2 *Final Design Work Package*

The Work Flow Diagram for I&C/ICS is presented in Figure 6-7 through Figure 6-8. The steps leading to the completion of the Final Design Package are depicted in these Figures.

The final design work packages for I&C are presented in Table 6-13 through Table 6-14. These Tables describes the work products and activities that are performed under WBS 1.11.03-1.11.04. The required level of detail for each work item is also described in these Tables.

6.1.5 Nuclear

The Final (detail) Design will include information to support procurement and construction. During Final Design all physical drawings (piping, cable tray, conduit runs, HVAC runs) will be prepared. In addition all supports will be designed, analyzed, and interference checking will be performed. Procurement Specifications will be prepared, long lead items identified and potential vendors qualified. Final Design will be prepared in accordance with the project schedule. The design process will continue through the procurement, construction, equipment installation, and startup phases.

Operational scenarios including normal operations, upset conditions, and design basis accidents will be studied and their impact on the RWTS system and component designs assessed and incorporated. The designs will be documented in specifications and drawings, and the documentation will be collected in the SDD. The SDD will be maintained throughout the design process. After the designs are complete and the procurement packages prepared, the SDD will be updated to their final form and the RWTS design will be complete.

The deliverables for final design of the RWTS are as follows:

- SDD sections 1 & 2 baselined
- General arrangement drawings issued as revision 0
- Flow diagrams issued as revision 0
- P&IDs issued as revision 0
- Piping drawings issued as revision 0
- Duct layout drawings issued as revision 0
- Mechanical installation drawings issued as revision 0
- Final equipment, valve, line, etc. lists issued as revision 0
- Calculations

Associated drawings such as fire zone, radiation zone, equipment laydown, etc.

6.1.5.1 Final Design Work Package

The Work Flow Diagram for Nuclear is presented in Figure 6-9. The steps leading to the completion of the Final Design Package are depicted in this Figure.

The final design work packages for Nuclear are presented in Table 6-15. This Table describes the work products and activities that are performed under WBS 1.11.06. The required level of detail for each work item is also described in this Table.

6.2 Tritium Production Engineering

6.2.1 Accelerator

6.2.1.1 Accelerator Final Design Scope

The Accelerator scope for final design will include developing all documentation necessary to procure and fabricate the Accelerator Subsystems. Final documentation necessary for installing and starting up the Accelerator will be prepared.

The final design tasks of the Accelerator will lead to subsequent developing and integrating the final designs into the Accelerator Subsystems. Top-level requirements will be finalized and flowed down to the Subsystems. Interfaces between the various Accelerator Subsystems and between the Accelerator and T/B, BOP and ICS will be coordinated and finalized. Final commissioning and operational plans, integrated schedules and costs for fabrication, installation and start up will be generated. Appropriate final design reviews will be completed. Pertinent Sections of the FDD and SDDs will be updated to reflect the final requirements and design. The Installation Drawings showing the arrangement of the technical equipment will be updated to reflect the final design of the Accelerator technical equipment and to support the development of the final General Arrangement drawings. Documents and information will be developed and coordinated for the consistency and completeness necessary to procure, fabricate, assemble and start up the Accelerator at SRS.

6.2.1.2 Final Design Products

The final design products from the Accelerator scope of work include:

- Issue as Rev 0 complete SDDs including all Sections and Appendices.
- Issue as Rev 0 final Installation Drawings
- Issue as Rev 0 all documentation appropriate and necessary for fabricating, installing and starting-up of the Accelerator.
- Issue as Rev 0 appropriate ready-for-issue bid packages.

6.2.1.3 Final Design Work Package

The Work Flow Diagram for the Accelerator is presented in Figure 6-10. The steps leading to the completion of the Final Design Package are depicted in this Figure.

The final design work packages for Nuclear are presented in Table 6-19. This Table describes the work products and activities that are performed under WBS 1.06. The required level of detail for each work item is also described in this Table.

6.2.2 Target/Blanket

6.2.2.1 Target/Blanket Overview

The Target/Blanket System consists of the Target/Blanket Assembly, the associated heat removal systems, and the beamstop systems. The primary function of the Target/Blanket Assembly is to convert a high energy proton beam into a neutron source, in order to produce tritium from He-3 feedstock. The Target/Blanket heat removal systems are used to cool the Target/Blanket Assembly during the normal operation and following beam shutdown. A cavity flood system is also available to provide emergency cooling following certain low-frequency design basis accidents. The beamstop systems are used during commissioning and for beam tune-up. The heat removal systems include polishing systems to maintain proper coolant chemistry.

6.2.2.2 *Final Design Scope and Products*

Design work planned and initiated during the preliminary design phase will be completed:

Systems level design and interface requirements, systems design descriptions, and general arrangement drawings will be finalized.

Status and final reports for prototype manufacture and testing will be prepared.

Final design packages will be issued.

Vendor qualification requirements will be prepared, design specifications will be prepared for vendors, and vendors will be selected to complete the design of certain components and systems.

Examples of Final Design products are shown in the following Table 6-16, 6-17, and 6-18 for 3 of the 9 major systems in the Target/Blanket Systems. They are for the Target/Blanket System (WBS 1.07.01), The Cavity Vessel System (WBS 1.07.02), and the Heat Removal Systems (WBS 1.07.04).

6.2.2.3 *Final Design Work Package*

The systems compressing the Target/Blanket Assembly Work Flow Diagram is presented in Figure 6-11, parallels the design logic for the mechanical systems shown in Figure 6-2.

The final design work packages for T/B are presented in Table 6-20. These Tables describes the work products and activities that are performed under WBS 1.07. The required level of detail for each work item is also described in these Tables.

6.2.3 Tritium Separation Facility

During final design, the PFD and P&IDs will be completed and the Installation Drawings for the TSF Systems will be finished.

Operational scenarios including normal operations, upset conditions and design basis accidents will be studied. The impact of such conditions on the TSF System and its component designs will be assessed and incorporated.

As ED&D results become available, process technologies will be selected and process equipment designed. The designs will be documented in specifications and drawings and the documentation will be collected in the appropriate SDDs.

As the design progresses, the BOP Interfaces will be defined in drawings and other documents on a schedule which is compatible with the requirements of the BOP Systems.

As required, potential vendors will be contacted and TSF requirements discussed and compared to the industrial capabilities. From this industry information, decisions on the final procurement strategy will be developed. As the component and system designs are completed, procurement specifications structured to produce competitive vendor responses will be prepared.

The SDD will be maintained throughout the design process. After the designs are complete and the procurement packages prepared, the SDDs will be updated to their final form and the TSF design will be complete.

6.2.3.1 *Final Design Work Package*

The Work Flow Diagram for the TSF is presented in Figure 6-12. The steps leading to the completion of the Final Design Package are depicted in this Figure.

The final design work packages for the TSF are presented in Table 6-21. This Table describes the work products and activities that are performed under WBS 1.09. The required level of detail for each work item is also described in this Table.

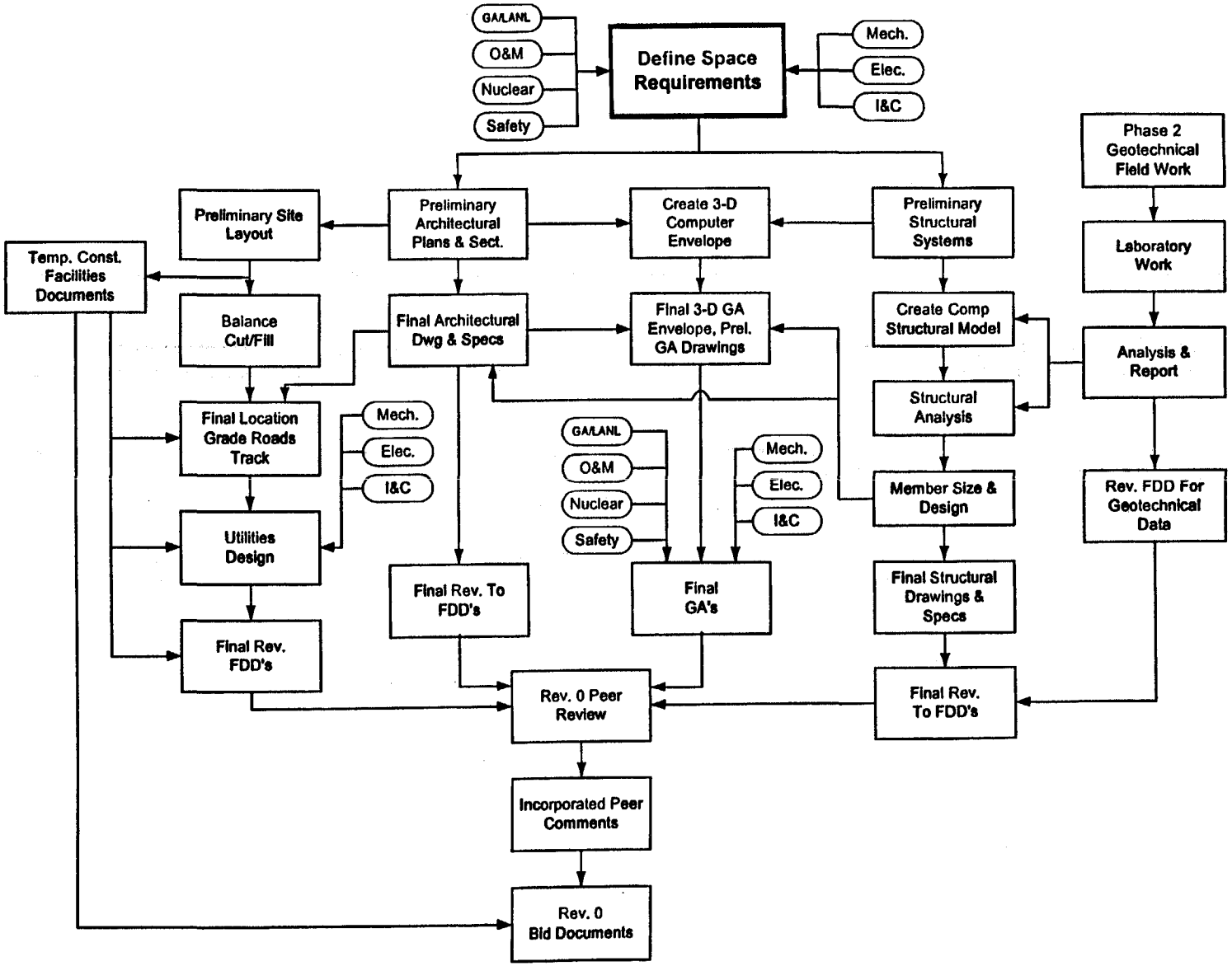

Figure 6-1, Civil Structural Work Flow Diagram

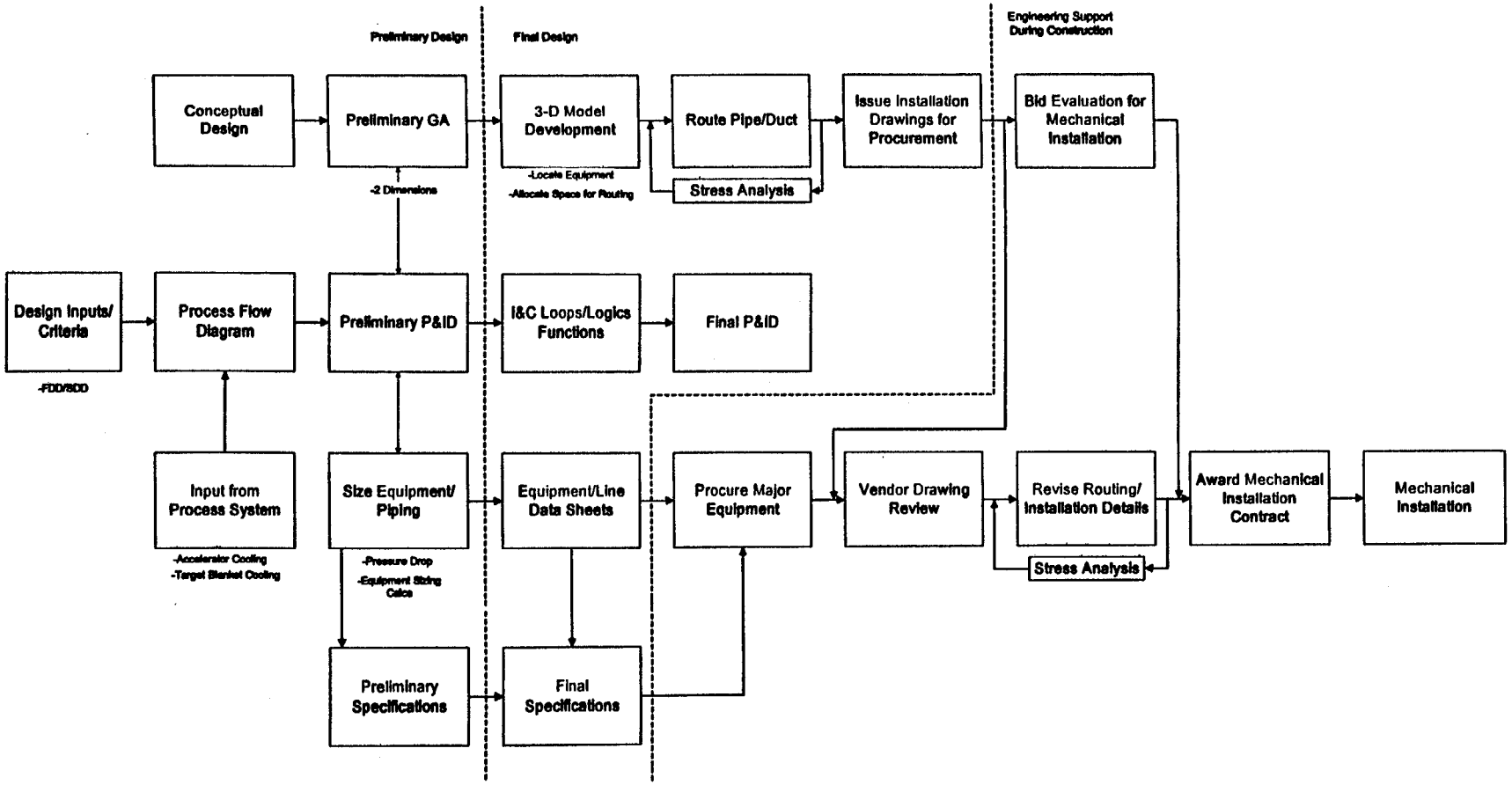

Figure 6-2, Mechanical Work Flow Diagram

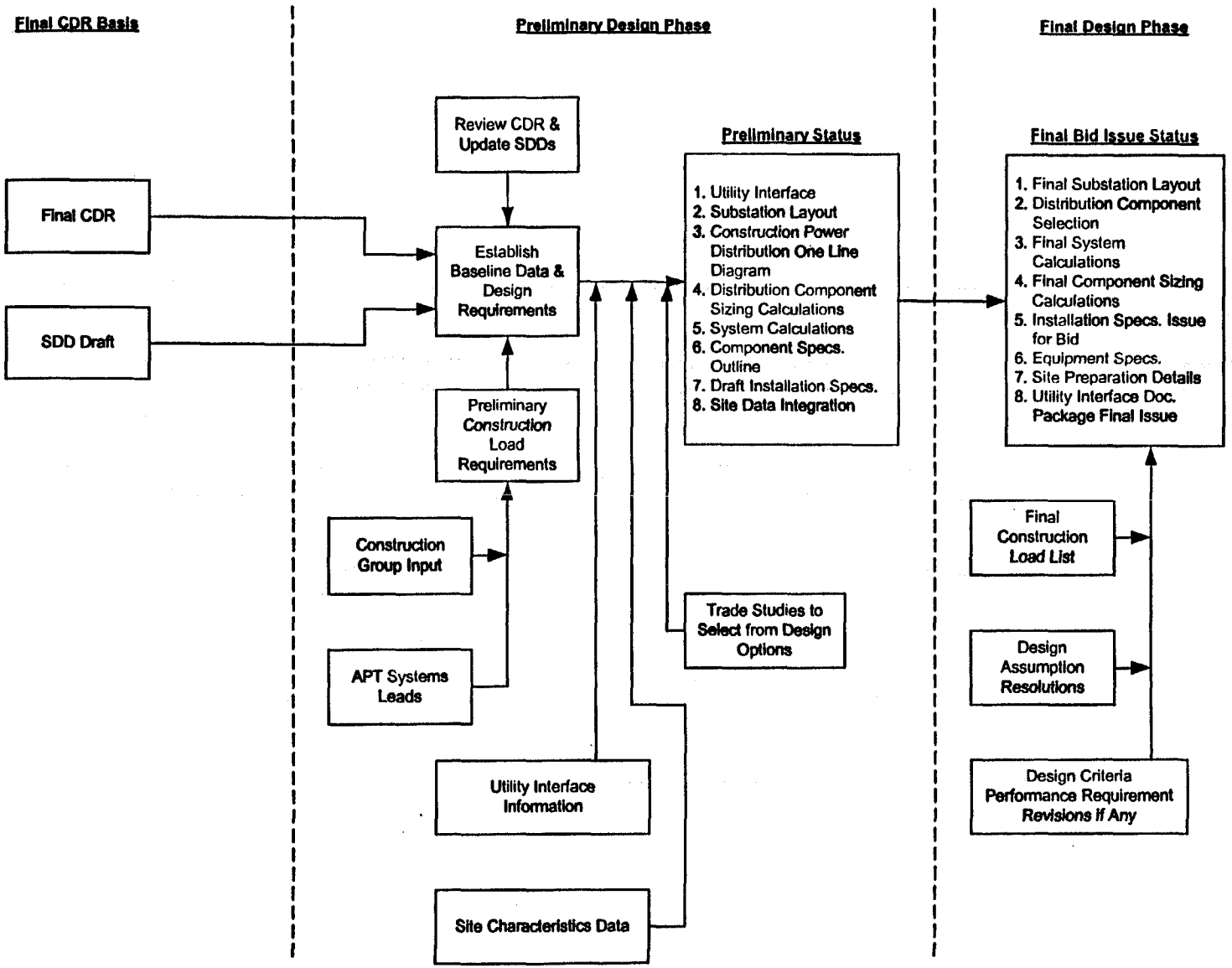

Figure 6-3, Electrical Work Flow Diagram Construction Power Distribution

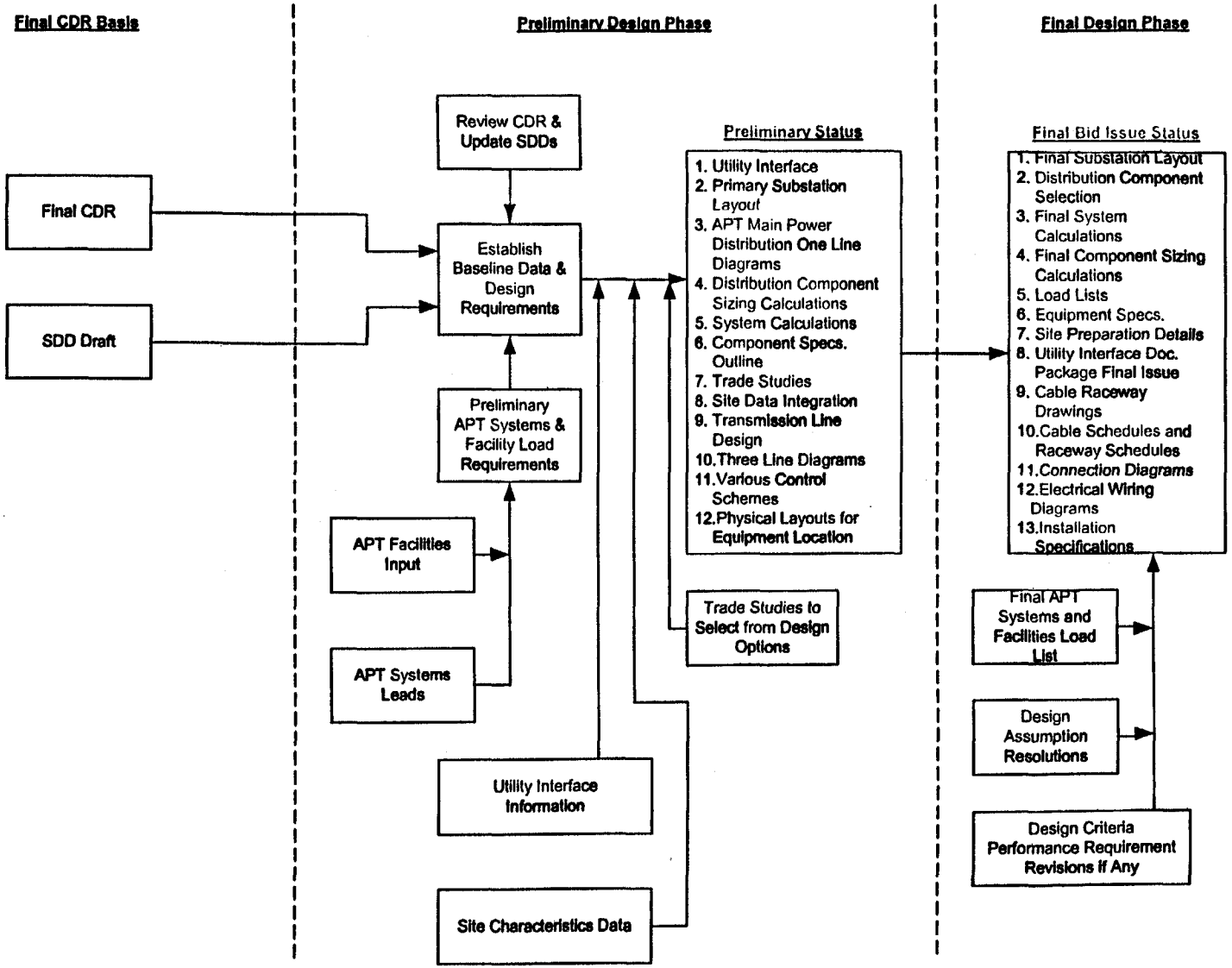

Figure 6-4, Electrical Work Flow Diagram APT Main Power Distribution

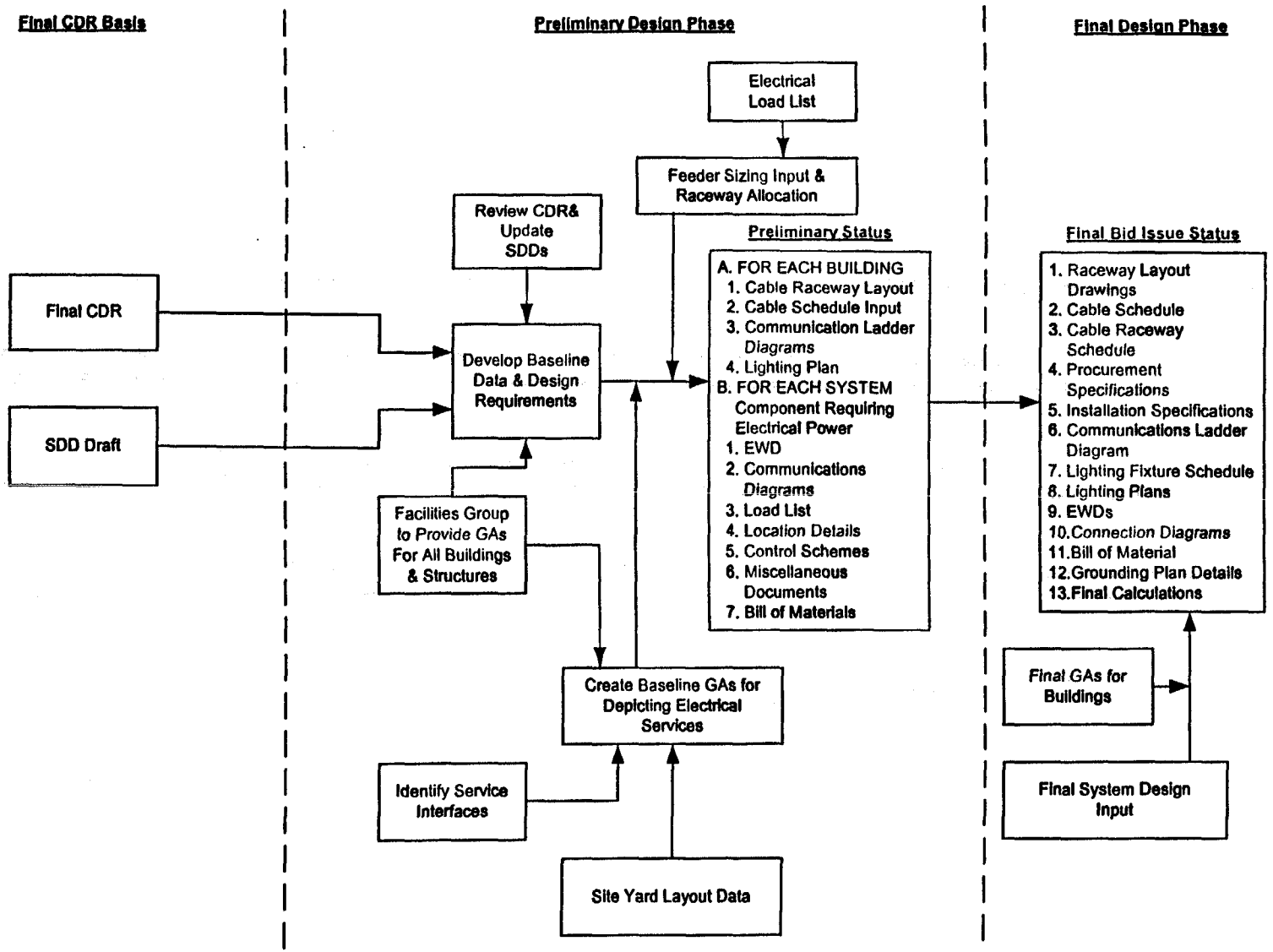

Figure 6-5, Electrical Work Flow Diagram Electrical Services to Plant Systems and Facilities

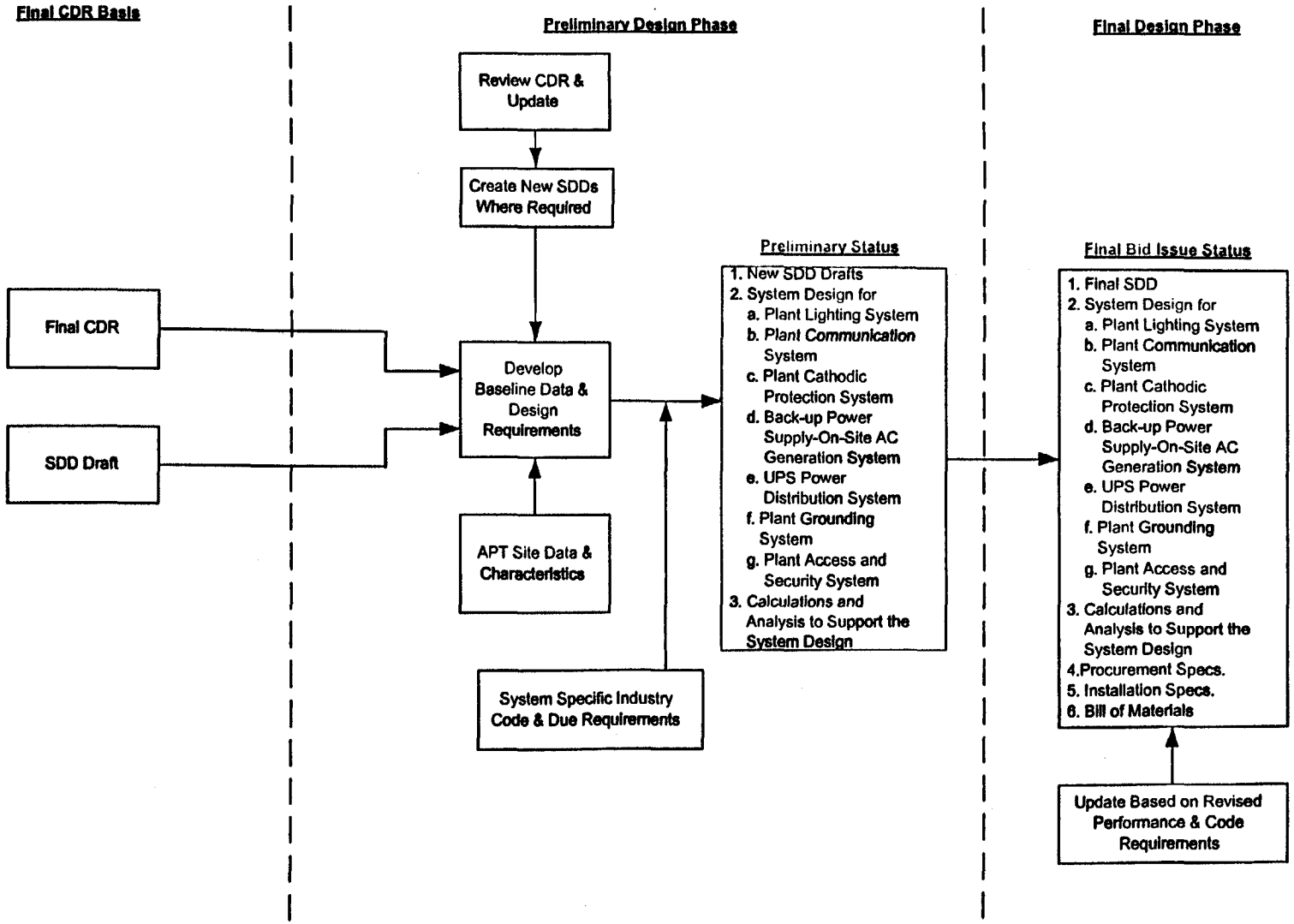

Figure 6-6, Electrical Work Flow Diagram Electric Support Systems

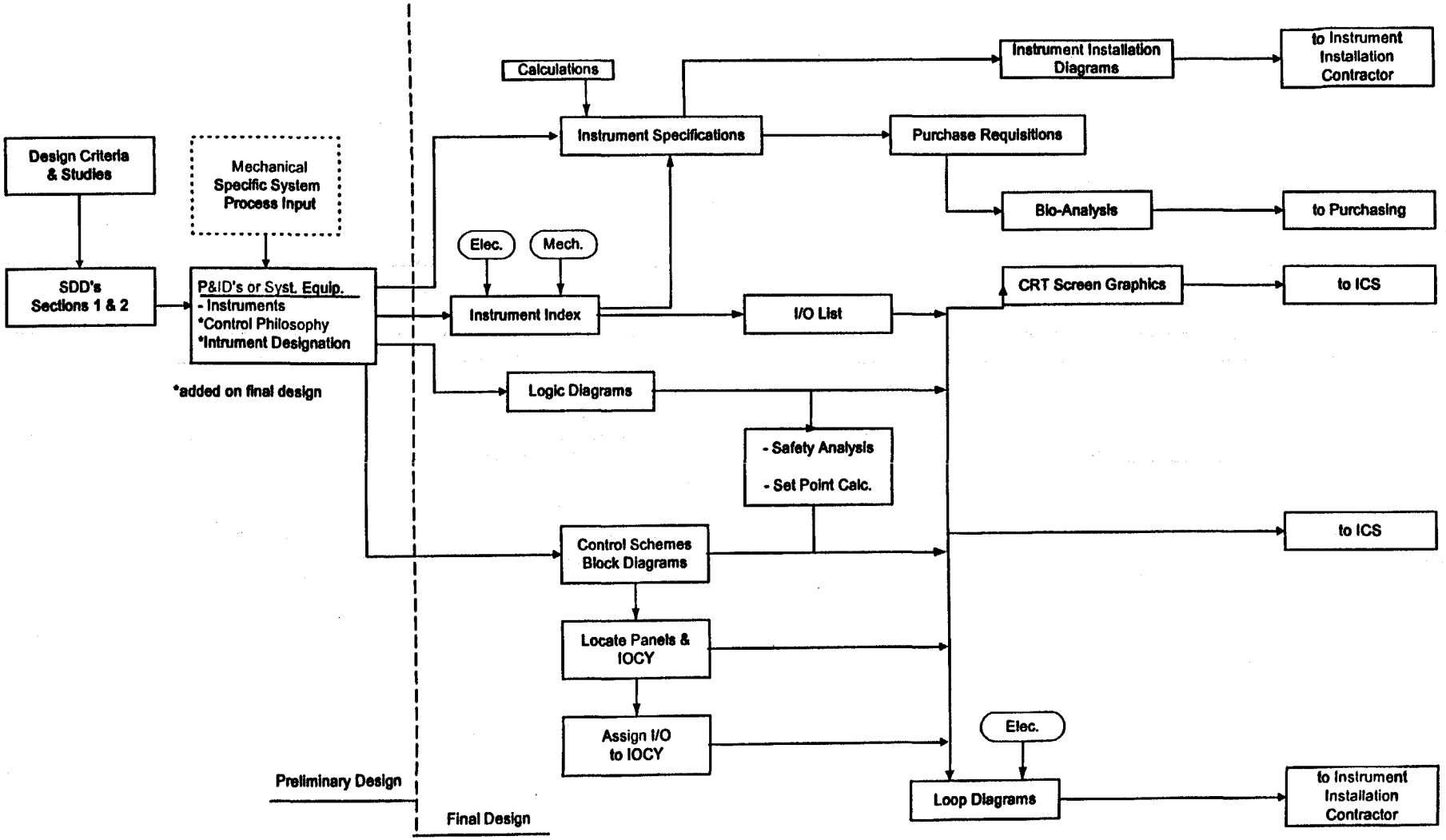

Figure 6-7, I&C Work Flow

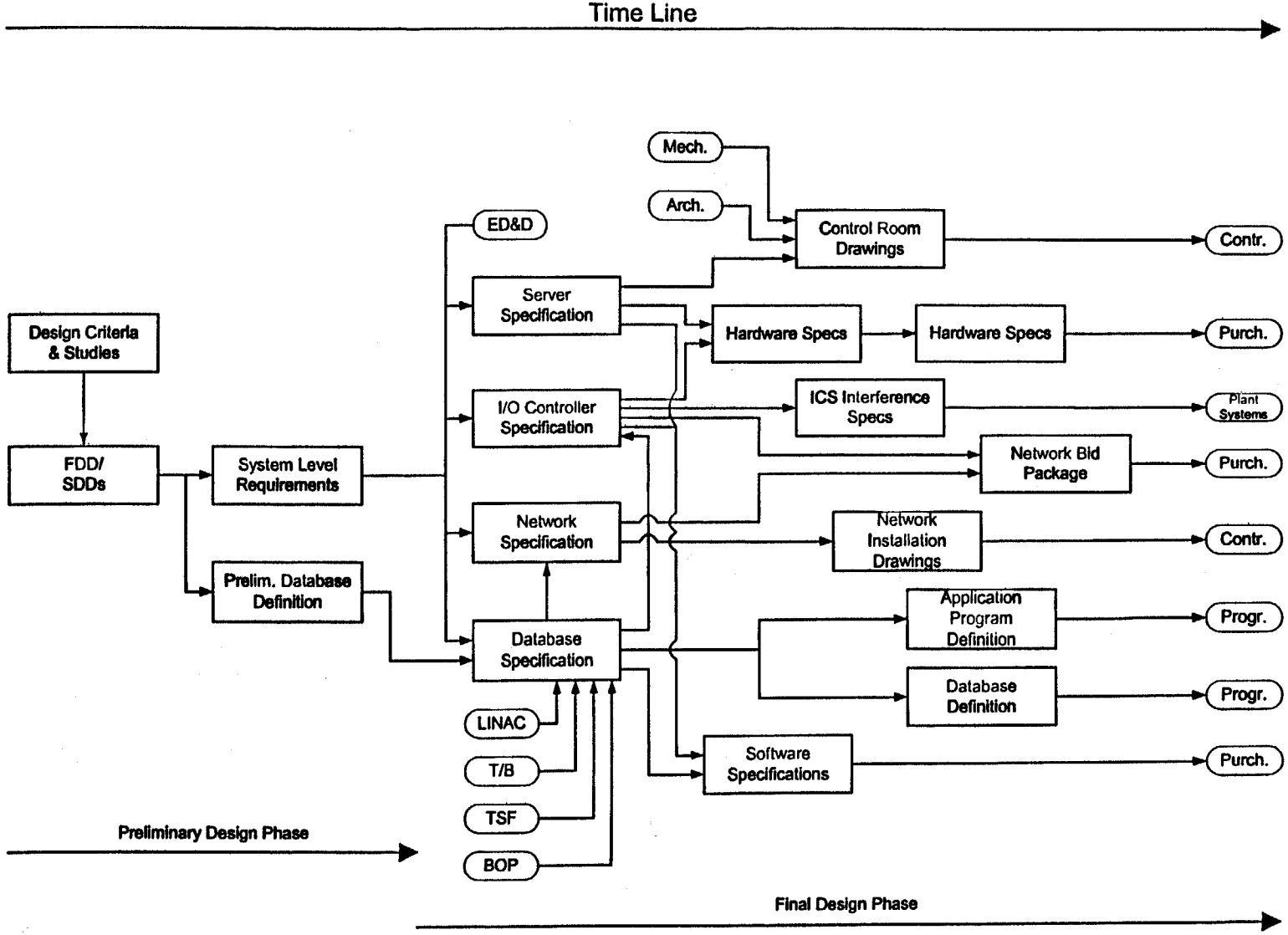

Figure 6-8, ICS Work Flow Diagram

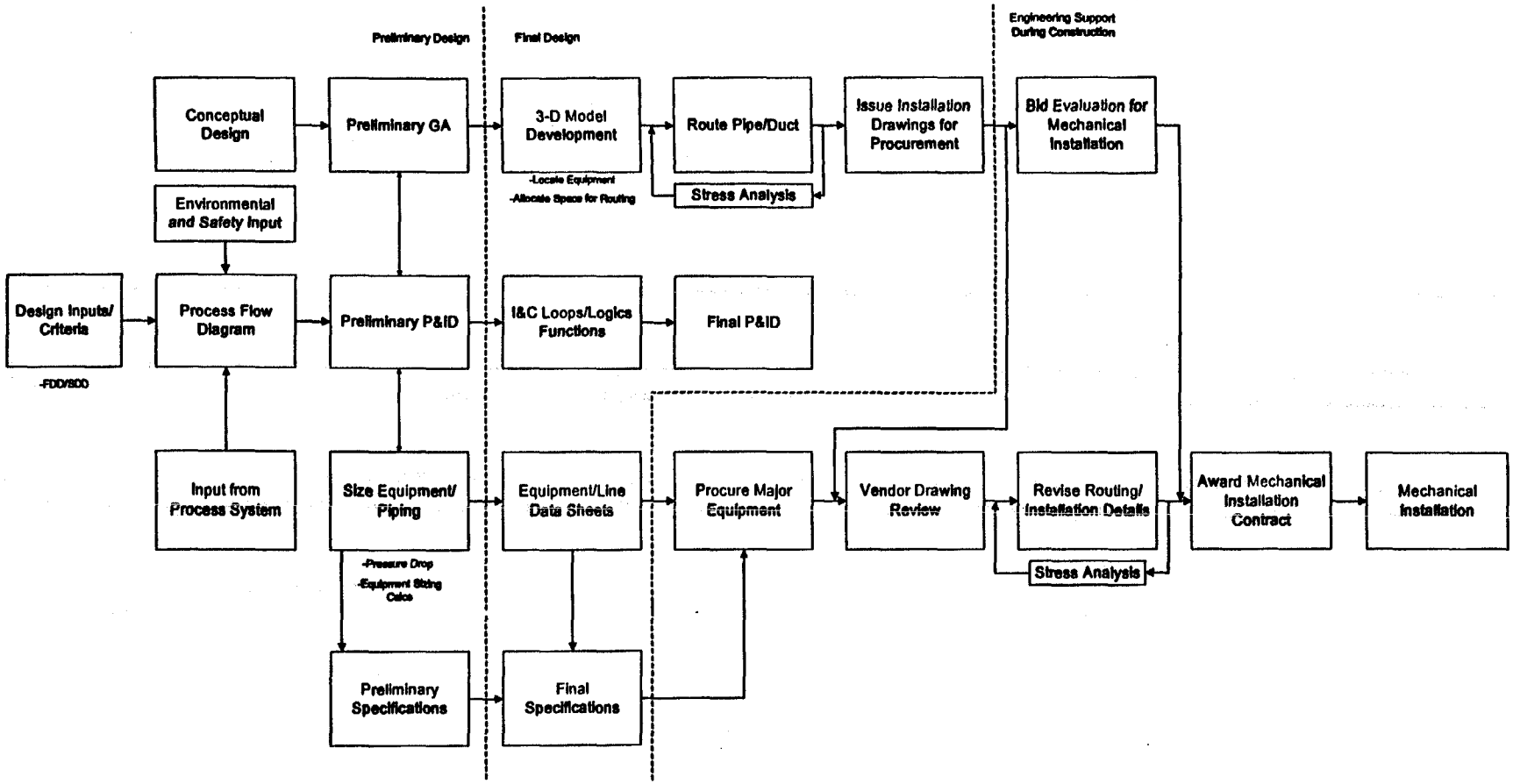

Figure 6-9, Nuclear/Radwaste Work Flow Diagram

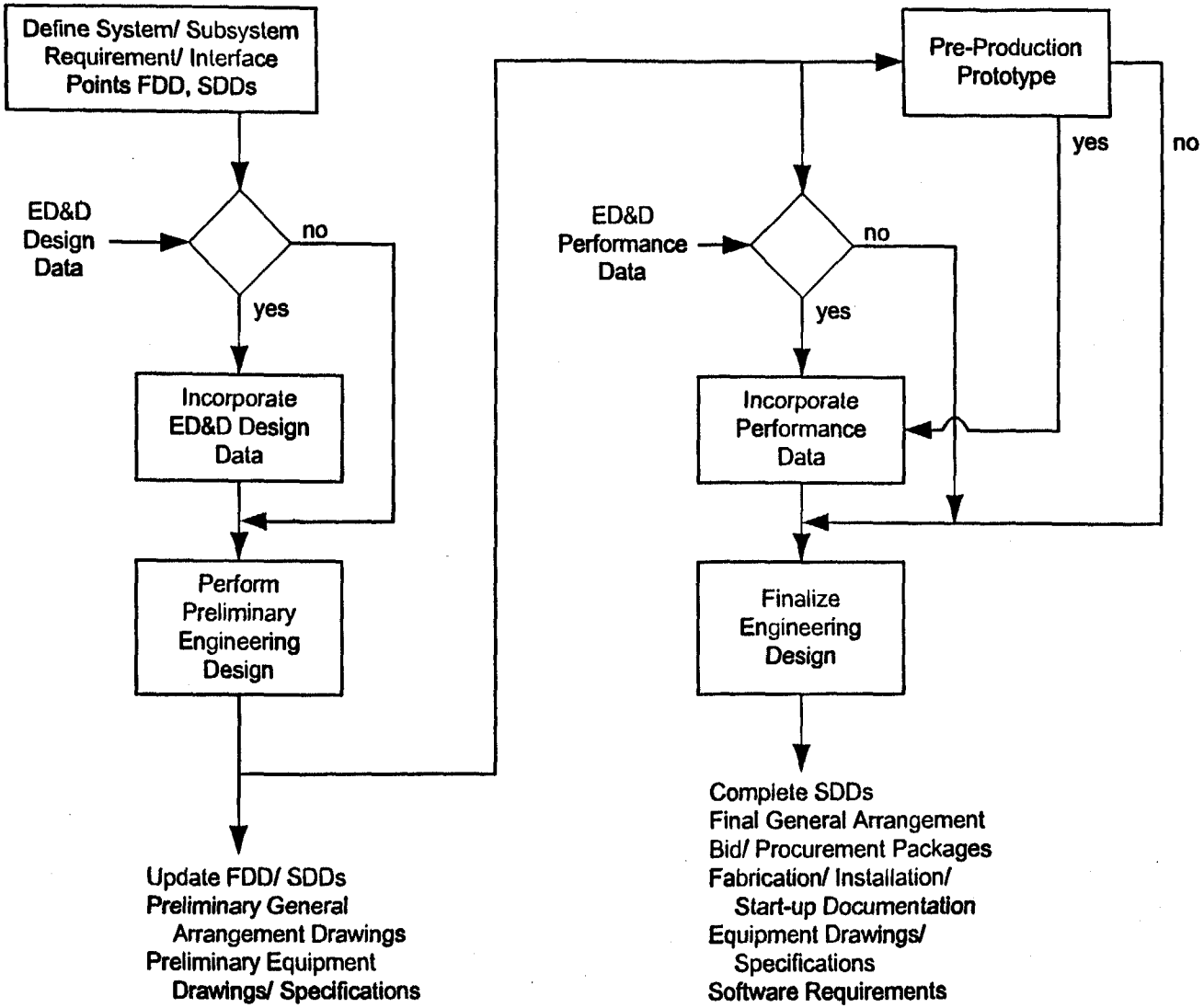

Figure 6-10, Accelerator Work Flow Diagram

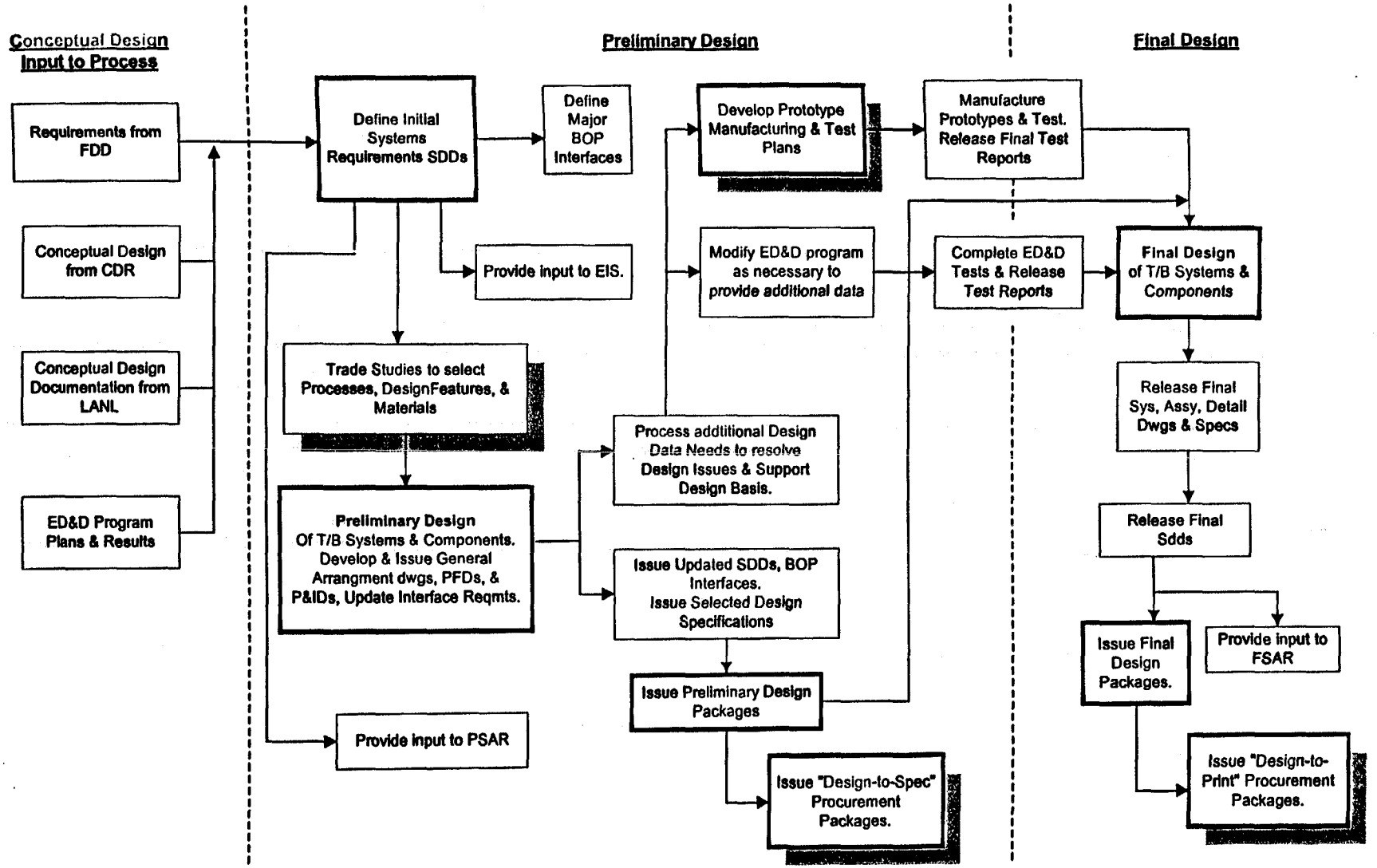

Figure 6-11, Target/Blanket System Work/Product Flow Diagram

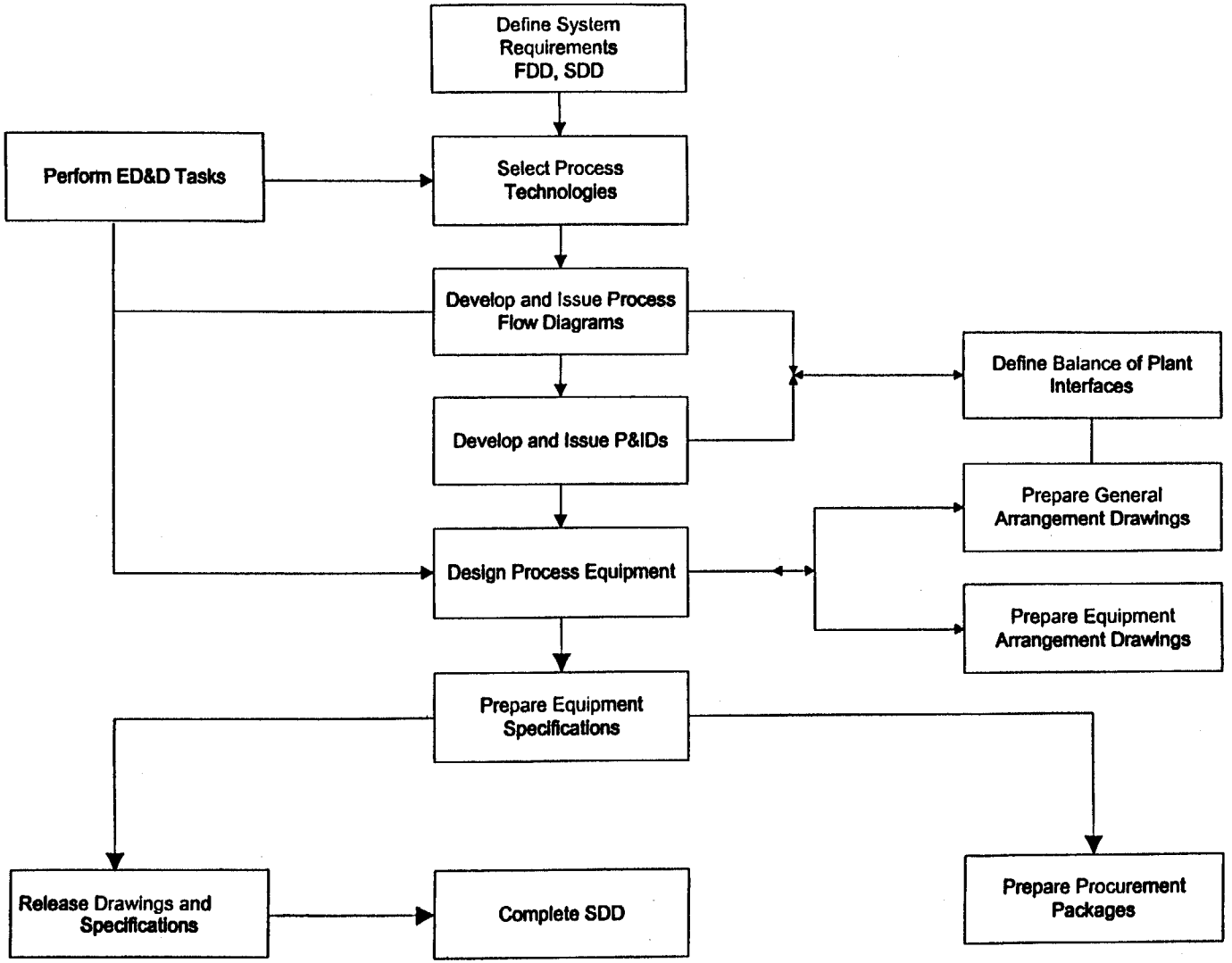

Figure 6-12, Tritium Separation Facility Work Flow Diagram

7 Technical Baseline Management

7.1 Configuration Management

The Configuration Management Plan (CMP) establishes the requirements and responsibilities of a configuration management program by which approved technical baselines are identified, controlled, documented and verified. The Plan is intended to ensure the APT Plant physical configuration is properly reflected and documented. This includes structures, systems and components. The Plan also provides the basis for correct interface, both physical and functional. The process will be applied in a selective, graded manner based on the health, safety, environmental and programmatic levels of importance of the systems, components and other products.

The APT Configuration Management Plan defines the requirements for an integrated process that will provide the following:

- Identification - Identifying and documenting the technical baseline, including the physical and functional characteristics of structures, systems, components, computer software and other project products.
- Document Control - Identifying and controlling the documents which define the technical baseline, including providing routine and change distribution, storing and safekeeping.
- Technical Change Control - Providing a systematic method of managing proposed changes to the approved technical baseline and ensuring the changes are correctly identified, reviewed, evaluated for impact, documented, implemented and closed out.
- Data Management - Establishing the system for recording, statusing and disseminating the project documentation including providing status reports of current configuration, technical documentation and other baselined products. The System also includes describing all proposed and approved changes to baselined products throughout the life cycle of the item.
- Verification - Verifying the configuration conforms to the technical baseline, that all approved changes have been properly incorporated into the baseline, that the as-built configuration conforms to the baseline, and that the elements of the CM Program are in accordance with approved plans and procedures.

7.2 Design Verification

Design Verification Reviews will be performed during the review and approval process for Technical Baseline documents. Such reviews are also required periodically to support key design decisions.

Design verification is a planned process for substantiating the adequacy of design in support of intended uses. All analytical methods, systems, structures, assemblies, components, fuels, processes, and design characteristics are subject to some degree of verification. The nature and extent of the verification depends on the importance of the item to public safety, defense in depth, or worker safety; similarity to other proven designs; sophistication within the state-of-the-art; degree of standardization; and design complexity.

The design of items that are identified as critical to performance, could risk the health and safety of the public, or could endanger workers must be verified to a preapproved plan.

The design may be verified by either:

a) Reviewing and evaluating the draft design documents and calculations individually or as a package of functional or system-related word documents and drawings which may be issued or released or released or still in the draft stage. (See Note 1.)

b) Confirming the mathematical basis of the design by alternate techniques. (See Note 1.)

c) Arranging to operate or test an approved prototype, model, or sample item. (See Notes 1 and 2.)

d) A practical combination of the above methods.

Note 1: In the case of SC or SS classified systems, components, structures, processes, etc., design verification must be objectively performed by technically qualified individuals who were independent of the design or calculation work; that is, they did not originate, direct, supervise, or significantly contribute to the design or the design calculations.

Note 2: A DV&S Project may be applicable.

7.3 Project Reviews

As identified in the CMP, the APT Project must perform consistency assessments. There must be consistency between the physical plant requirements as specified in the baseline requirements of the FDD and subordinate SDDs as well as the physical plant as defined in the baseline design documentation. Both types of reviews are intended to ascertain whether the system of controls is appropriate to ensure the plant is being designed and will be built to meet established requirements.

7.3.1 Design Authority Technical Reviews

The DATRs are performed on all Technical Baseline documents, both at initial approval and on the review and approval of amendments or superseding documents. The DATR is to be performed by the Design Authority or it's documented designate. The DATR includes review for:

- Technical accuracy and completeness based on the scope of the document being reviewed.
- Collateral impact against approved or pending Technical Baseline documents.
- Compliance to FDDs and SDDs section 1 and 2.

In situations of revised design or performance requirements, the DATR includes a collateral impact review. This ensures all Technical Baseline documents affected by added, deleted and/or modified requirements are reviewed. Subsequent impacts resulting from the change are initiated and tracked to approval. Periodic reviews, coordinated by the Design Authority, are scheduled to provide verification of complete and accurate design documentation in the Technical Baseline. These reviews are typically in support of key decisions and other milestones authorized by the PDO.

7.3.2 Technical Work Group and Peer Reviews

Technical Work Groups can be chartered by the Design Authority to provide a comprehensive review of technical completeness, accuracy, and appropriate application of technology in key areas. Technical Work Groups can be included in the formal interdisciplinary review (IDR) process for proposed new Technical Baseline documents and for proposed revisions in accordance with the Group Charter. Comments submitted by these Work Groups receive a formal response and disposition by the Design Authority or its designee prior to the new or revised document being approved and/or released.

The Engineering function may also establish Technical Work Groups for specific key areas. The comments from these Groups must also receive formal response and disposition. Similarly, the Engineering function may request a peer IDR at specific stages of the design effort. This type review should include interface functions and systems.

7.3.3 Review Focus

The depth and intensity of each review will be commensurate with the importance the subject being addressed with respect to project success. Greater attention will be directed to those areas that are:

- Critical to technical performance
- Safety related
- Major cost drivers
- Complex, in design, operation or maintainability
- Deviations from past designs or established practice
- On the schedule critical path
- Experiencing technical difficulties

Independent calculations or verifications will be performed to the extent practical for areas being assessed. In addition to the technical, cost and schedule aspects, the P&FD will be reviewed extensively for M&O adequacy. A series of reviews by a multi-departmental team is planned. The team will be directed by an APT Project team member experienced in O&M.

7.3.4 Reviewer Selection

The reviews will be performed by senior professionals who maintain a high level of technical or managerial expertise. The reviewers will typically be selected from organizations maintaining geographic and/or administrative independence from the organization performing the design effort. Unbiased review is thereby possible.

7.3.5 Review Timing

Schedules for the reviews will be identified early in the P&FD phase of design. Each design must be at a point in its evolution so that adequate information is developed and ready to be reviewed.

8 Staffing

8.1 Project Staffing

Burns and Roe Enterprises, Inc. and General Atomics will staff the APT Project in a manner to meet the P&FD requirements of the project schedule for construction. Figure 8-1 displays the current anticipated staffing. This project staffing meets currently identified DOE budget estimates for the next two years. Specific staffing requirements will be identified after the total integrated project schedule is developed and the schedule for producing deliverables to support construction is finalized.

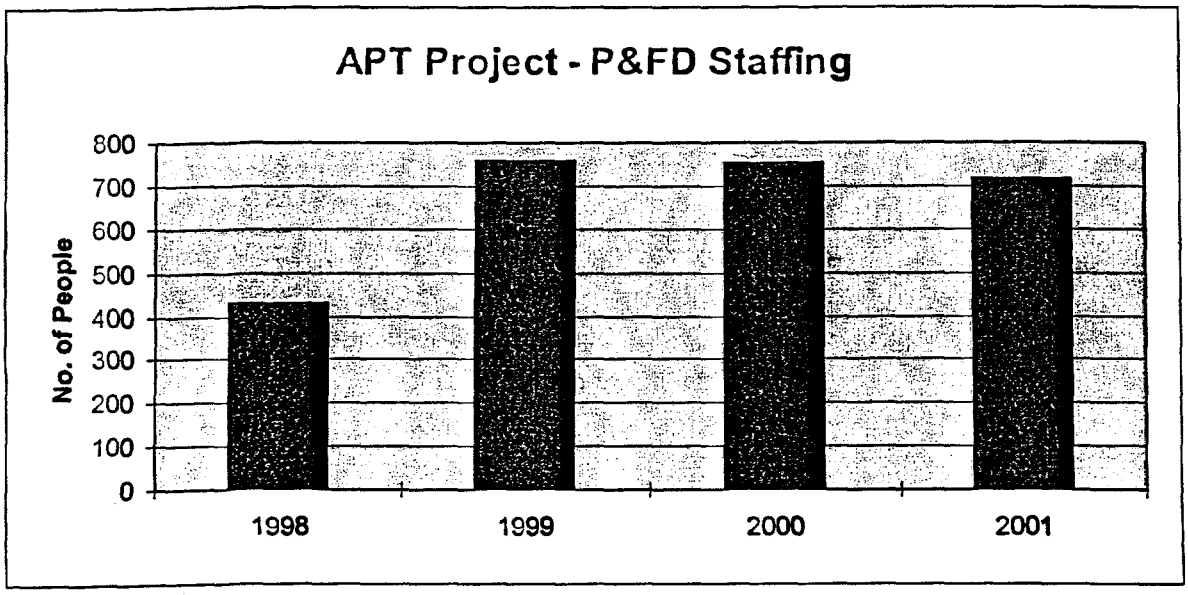

Figure 8-1, APT Project - P&FD Staffing

8.2 Location of Work Force

At present, it is expected the APT P&FD work will be performed in four locations:

- Los Alamos, New Mexico
- Savannah River Site and Aiken, South Carolina
- Oradell, New Jersey
- La Jolla, California

The first two locations correspond to where the bulk of the BREI/GA project work on the APT will be performed. The BOP and facilities and structures work will, for the most part, be performed in the Savannah River Site area, the area where the APT Facility will ultimately be constructed. Work on development and final design of the Accelerator and T/B Systems will be performed in the Los Alamos area. This work area for the accelerator and target/blanket is selected based on its proximity to the LANL professional staff, most of whom are closely associated with the APT Project and who are most familiar with the design concepts now being developed. At present, no decision has been made as to where

the bulk of the tritium separation work will occur, but is now assumed to be performed in the Los Alamos area.

The Oradell, NJ and La Jolla, CA locations correspond to the home offices of Burns and Roe Enterprises, Inc. and General Atomics respectively. The resources in these offices will be used to perform work that is not specifically associated with SRS, LANL or the actual hardware development efforts on the project. For example, the non-critical structures of the APT project may be designed at the BREI home office. Similarly, technical sections of procurement specifications may be prepared in Oradell. A significant segment of the software development for controlling the Accelerator and T/B Systems may be performed in the GA La Jolla office. Figure 8-2 depicts the current estimated project staffing by location and year for the duration of the P&FD Phases.

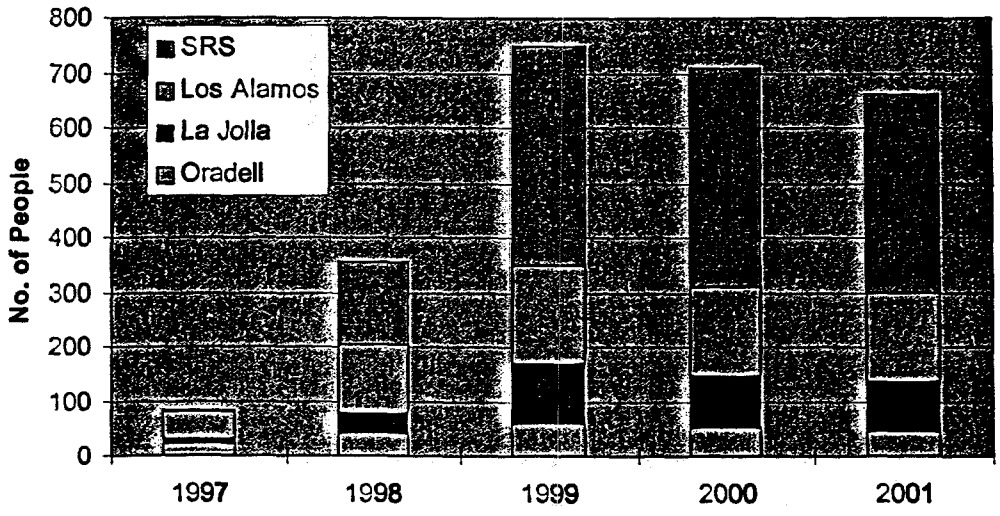

Figure 8-2, APT Project - P&FD Staffing by Work Location

8.3 Work Performance Locations

Appendix C identifies the specific locations where work will be performed for each WBS Level 2 area for each year in the current P&FD Schedule. These locations may change as the total integrated project schedule is completed and the resulting P&FD Schedule is modified.

Appendix A, Description of Preliminary Design Work Packages

Table 5-1, Preliminary Design Work Package - Plant Site & Yardwork

Facility/System: Plant Site & Yardwork **WBS** 1.05.01

Item	Description	Interface/ Precursor	Comments/Limits of Design Phase
Temporary Construction Facilities	Prepare construction drawings for preliminary site work and facilities to be used during construction.		Prepare drawings and construction bid packages for site clearing, grubbing, excavation, grading and drainage, sedimentation control, etc. to support initial site preparation. Prepare drawings and construction bid packages for temporary construction roads, offices, parking, laydown areas, and temporary construction utilities, such as water, sanitary, electricity, temporary fencing, etc.
Preliminary Site Layout	Prepare preliminary site layout drawings, details and sections.	Adjustments will be incorporated, as required, based on Project Site detail changes.	Preliminary site layout drawings will include all buildings, structures, facilities, roads, parking lots, railroads, fencing, site utilities, etc. Additionally, sections and details will be included as necessary for preliminary design.
Geotechnical Investigation	Award contract package for site geotechnical investigation, Phase 2. Analyze data and prepare Geotechnical Report.		Award a contract for soil borings, sampling and laboratory and field testing. This work is necessary to determine site geotechnical design parameters and criteria, such as bearing capacity and settlement.
Calculations	Perform preliminary calculations as needed to support Geotechnical Report and as required for temporary construction sitework.		Generally, detailed or final calculations will not be performed during this phase of preliminary layout and design. Computer graphic software will be utilized for site layout and will be used to verify/check dimensional values. Occasional preliminary calculations will be performed to verify design/space allocations, as required. Any special, preliminary calculations will be performed as needed to support the design effort.

Table 5-2, Preliminary Design Work Package - Target/Blanket and Accelerator

Facility/System: Target/Blanket and Accelerator **WBS** 1.05.02 and 1.05.03

Item	Description	Interface/ Precursor	Comments/Limits of Design Phase
General Arrangements (GAs)	Prepare General Arrangement background drawings, plans, sections and details.	Input changes from all parties.	Prepare preliminary design drawings of each building or facility to be used by all disciplines as background drawings for detailing structural, architectural, equipment, electrical and piping layouts. These drawings will be the basis for the preliminary structural analyses, construction details of the building, and 3-D model envelope.
Calculations	Develop preliminary Computer model of building or structure. Perform preliminary calculations in preparation for Final Calculations. Review/evaluate computer model based on preliminary output.	Obtain agreements from all parties related to physical dimensions. Agreements from all parties involved in the building/structure design is required *prior to full* commitment to the Final calculations.	Develop the computer model(s) that will be required to perform the structural analyses needed for the design of the building/structure. Structural design criteria will be prepared along with preliminary structural computer models. Lead sheets will define design criteria, codes and standards, load combinations and design conditions. Preliminary computer models will be developed and seismic design will be evaluated at a basic level. Preliminary computer calculations will be performed in order to verify the integrity and correctness of the model. Final execution computer calculations (i.e., Final Calcs.) will not be performed during the Preliminary Phase. Review computer structural analyses and verify adequacy of the model.
Facility Design Description (FDD)	Modify FDD.	Input from all other parties.	Perform an editorial update of the FDD in order to reflect changes which have occurred during the preliminary design.
3-D Model Input	Develop preliminary 3-D computer model for the building.	Based on input from all other parties.	Develop the preliminary 3-D computer model envelope as a tool that will be used by other disciplines to input equipment, maintenance, piping and electrical space allocations/requirements within the building.

Table 5-3, Preliminary Design Work Packages - Support Buildings & Structures

Facility/System: Support Buildings & Structures **WBS** 1.05..04,.05,.06,.07,.08

Item	Description	Interface/ Precursors	Comments/Limits of Design Phase
General Arrangements (GAs)	Prepare General Arrangement background drawings, plans, sections and details.	Input changes from all parties.	Prepare preliminary design drawings of each building or facility to be used by all disciplines as background drawings for detailing structural, architectural, equipment, electrical and piping layouts. The drawings will be the basis for preliminary structural analyses, construction details of the building, and 3-D model envelope.
Calculations	Develop preliminary Computer model of building or structure. Perform preliminary calculations in preparation for Final Calculations. Review/evaluate computer model based on preliminaryl output.	Obtain agreements related to physical dimensions. Agreements from all parties involved in the building/structure design is required prior to full commitment to the Final calculations.	Develop the computer model(s) that will be required to perform the structural analyses needed for the design of the building/structure. Structural design criteria will be prepared and preliminary structural computer models. Define codes & standards, load combinations and design conditions. Preliminary computer models will be developed and seismic design will be evaluated at a basic level. Preliminary computer calculations will be performed in order to verify the integrity and correctness of the model. Final calculations will not be performed during the Preliminary Design Phase. Review computer structural analyses and verify the adequacy of the model.
Facility Design Description (FDD)	Modify FDD.	Input from all other parties.	Perform an editorial update of the FDD in order to reflect changes which have occurred during the preliminary design.
3-D Model Input	Develop preliminary 3-D computer model for the building.	Based on input from all other parties.	Develop the preliminary 3-D computer model envelope as a tool that will be used by other disciplines to input equipment, maintenance, piping and electrical space allocations/requirements within the building.

Table 5-4, Preliminary Design Work Packages - General Specifications

Facility/System: General Specifications **WBS** 1.11.00

Items	Description	Interface/ Precursor	Comments/Limits for Design Phase
Procurement Specifications	Procurement Specifications for all mechanical equipment, piping, valves, packaged skids, etc..		Data sheets for the Procurement Specifications will be prepared during final design. This activity also covers bid review during final design

Table 5-5, Preliminary Design Work Packages - Heat Removal Systems

Facility/System: Heat Removal Systems **WBS** 1.11.02

Items	Description	Interface/ Precursor	Comments/Limits for Design Phase
Process Flow Diagram	A drawing used to identify key process parameters at various points in the systems, such as temperature, pressure, flow, etc.)		Will be developed for heat rejection systems only. Necessary to support equipment sizing. Will precede completion of the system P&ID
P&IDs	Includes equipment and schematic flow paths including line and valve classifications, sizes and process information. Used to develop preliminary line lists, valve lists, etc.		Will use existing P&IDs developed in Conceptual Design as a starting point. Drawings will be modified to reflect changes to Conceptual Design developed prior to and during Preliminary Design. Both I&C and Electrical provide input to the P&IDs is the form of process control information and equipment control information
Calculations	Preliminary equipment and piping sizing calculations. Used for space allocation.	Primary and Secondary heat loads and cooling requirements.	Requires all heating and cooling loads in order to identify equipment, pipe and cooling tower sizes
	Preliminary Pressure Drop Calculations		Used to develop pipe size and properties (wall thickness, material, OD, etc.)
SDD	Modify Sections 1 and 2 as required.		Add any new functional requirements, applicable codes and standards and specific design criteria that have been identified prior to and during Preliminary Design (examples include, but are not limited to, number of pumps, valves, heat exchangers, type of equipment, etc.) and has not already been included as part of conceptual design
General Arrangement Drawings	Locate all sized equipment and allow for pipe routing.		Building 3-D model developed by CSA. Mechanical group identifies space requirements, then locates specific equipment including O&M envelop and approximates pipe routing space allocation.

Table 5-6, Preliminary Design Work Packages - Misc. Support Systems

Facility/System: Misc. Support Systems **WBS** 1.11.05

Items	Description	Interface/ Precursor	Comments/Limits for Design Phase
P&IDs	Includes equipment and schematic flow paths including equipment and pipe, sizes and process information. Used to develop preliminary line lists, valve lists, etc.		Will use existing P&IDs developed in Conceptual Design as a starting point. Drawings will be modified to reflect changes to Conceptual Design developed prior to and during Preliminary Design. Both I&C and Electrical provide input to the P&IDs is the form of process control information and equipment control information.
Calculations	Preliminary equipment and duct sizing calculations. Used for space allocation.	.	Requires all in-house system requirements in order to identify equipment, packages equipment, and piping sizes.
	Preliminary pipe pressure drop calculations		Used to develop pipe size .
SDD	Modify Sections 1 and 2 as required.		Add any new functional requirements, applicable codes and standards and specific design criteria that have been identified prior to and during Preliminary Design (examples include, but are not limited to, number of pumps, tanks, type of equipment, etc.) and has not already been included as part of conceptual design.
General Arrangement Drawings	Locate all sized equipment and allow for pipe routing.		Building 3-D model developed by CSA. Mechanical group identifies space requirements, then locates specific equipment including O&M envelop and approximates pipe routing space allocation.

Table 5-7, Preliminary Design Work Packages - BOP Water Treatment Systems

Facility/System: **BOP Water Treatment Systems** **WBS** **1.11.07**

Items	Description	Interface/ Precursor	Comments/Limits for Design Phase
P&IDs	Includes equipment and schematic flow paths including equipment and pipe, sizes and process information. Used to develop preliminary line lists, valve lists, etc.		Will use existing P&IDs developed in Conceptual Design as a starting point. Drawings will be modified to reflect changes to Conceptual Design developed prior to and during Preliminary Design. Both I&C and Electrical provide input to the P&IDs is the form of process control information and equipment control information.
Calculations	Preliminary equipment and pipe sizing calculations. Used for space allocation.		Requires all in-house treated water requirements in order to identify packaged equipment and pipe sizes.
	Preliminary pipe pressure drop calculations		Used to develop pipe size.
SDD	Modify Sections 1 and 2 as required.		Add any new functional requirements, applicable codes and standards and specific design criteria that have been identified prior to and during Preliminary Design (examples include, but are not limited to, number of pumps, tanks, type of equipment, etc.) and has not already been included as part of conceptual design.
General Arrangement Drawings	Locate all sized equipment and allow for pipe routing.		Building 3-D model developed by CSA. Mechanical group identifies space requirements, then locates specific equipment including O&M envelop and approximates pipe routing space allocation.

Table 5-8, Preliminary Design Work Packages - HVAC Systems

Facility/System: HVAC Systems **WBS** 1.11.08

Items	Description	Interface/ Precursor	Comments/Limits for Design Phase
P&IDs and Flow Diagrams	Includes equipment and schematic flow paths including duct and damper classifications, sizes and process information. Used to develop preliminary duct lists, damper lists, etc.		Will use existing P&IDs developed in Conceptual Design as a starting point. Drawings will be modified to reflect changes to Conceptual Design developed prior to and during Preliminary Design. Both I&C and Electrical provide input to the P&IDs is the form of process control information and equipment control information.
Calculations	Preliminary equipment and duct sizing calculations (space allocation).		Requires all heating and cooling loads in order to identify equipment, duct and cooling tower sizes.
	Preliminary duct pressure drop calculations		Used to develop duct size.
SDD	Modify Sections 1 and 2 as required.		Add any new functional requirements, applicable codes and standards and specific design criteria that have been identified prior to and during Preliminary Design (examples include, but are not limited to, number of fans, coolers, dampers, type of equipment, etc.) and has not already been included as part of conceptual design.
General Arrangement Drawings	Locate all sized equipment and allow for duct routing.		Building 3-D model developed by CSA. Mechanical group identifies space requirements, then locates specific equipment including O&M envelop and approximates duct routing space allocation.

Table 5-9, Balance of Plant Electrical System Design - Temporary Construction Power Distribution

1. Temporary Construction Power Distribution: **WBS 1.11.01**

Item	Description	Interface/ Precursor	Comments/Limits for Design Phase
Draft System Design Document [SDD] : Update to Prelim. status	As a part of the Final CDR issue, a draft SDD was developed to document the subject system design basis. Update of this design basis will document the revised system design performance needs or new code/industry standard requirements during prelim design phase.	Identify Code/ Standards changes, or, design performance changes post CDR issue. Missing criteria identification during draft SDD review.	Review the draft SDD to assure that all the necessary criteria for the construction power design work is included, add the missing requirements and cods/standards.
Trade Studies	In selected technical areas, trade Studies are conducted to evaluate design options and determine approach to render optimum design.	Review the Final CDR design and develop potential options in the technical areas where cost cutting opportunities may be apparent.	Trade Studies will be limited to those technical topics that are likely to reduce the overall system cost without compromising the performance requirements.
Construction Power Load List	Provides concise listing of the power demands, including load characteristics and locations, to be fed from the Temporary Construction Power source.	Construction Group and APT System Leads to compile load requirements data for systems under their cognizance.	preliminary construction power load list will identify the total APT site needs during the site mobilization, initial construction and portions of startup loads until the main power distribution is made available.
Construction Power One Line Diagram	This document defines the power distribution scheme including off-site power interface with Utility, distribution component ratings and circuit protection requirements.	Completion of the preliminary Construction Power Load List, Trade Studies to optimize design approach, and the related electrical systems calculations	A preliminary design of the One Line Diagram will define the power flow at various distribution voltages, system component sizes, distribution switchgear arrangements and the load feeder information. The document will also show the Utility interface details.

Table 5-9 (cont.), Balance of Plant Electrical System Design - Temporary Construction Power Distribution

1. Temporary Construction Power Distribution: WBS 1.11.01

Item	Description	Interface/ Precursor	Comments/Limits for Design Phase
Construction Power Substation Layout Drawing	This drawing provides the physical layout of the substation including the equipment arrangement.	Completion of the preliminary One Line Diagram.	The drawing will include overall substation component layout and the overall dimensional details to define space allocations, based on typical equipment sizes.
System Calculations	Using approved software, system analysis is performed to determine the component requirements and ensure the selections support safe design for normal and abnormal operating conditions.	Completion of the preliminary One Line Diagram	Perform preliminary calculations to support preparation of the design as well as determining component characteristics for the procurement specifications.
Procurement Specifications	This document defines the component parameters and functional characteristics to allow vendor bid preparation.	Completion of the preliminary One Line Diagram	Prepare a draft procurement specification document for each of the major component type based on the preliminary design information.
Installation Specification	This document defines the Construction Power Substation installation requirements including expected performance, functions and quality assurance needs.	Completion of the preliminary One Line Diagram	Prepare a draft installation specification document based on the preliminary design information.

Table 5-10, Balance of Plant Electrical System Design - APT Main Power Distribution

2. APT Main Power Distribution: **WBS 1.11.01**

Item	Description	Interface/ Precursor	Comments/Limits for Design Phase
Draft System Design Document [SDD] : Update to Prelim. status	As a part of the Final CDR issue, a draft SDD was developed to document the subject system design basis. Update of this design basis will document the revised system design performance needs or new code/industry standard requirements during prelim design phase.	Identify Code/ Standards changes, or, design performance changes post CDR issue. Missing criteria identification during draft SDD review.	Review the draft SDD to assure that all the necessary criteria for the APT Main Power distribution design work is included, add the missing requirements and cods/standards.
Trade Studies	In selected technical areas, trade Studies are conducted to evaluate design options and determine approach to render optimum design.	Review the Final CDR design and develop potential options in the technical areas where cost cutting opportunities may be apparent.	Trade Studies will be limited to those technical topics that are likely to reduce the overall system cost without compromising the performance requirements.
APT Main Power Load List	Provides concise listing of the power demands, including load characteristics and locations, to be fed from the APT Main Power source.	APT Facilities and APT System Leads to compile load requirements data for systems under their cognizance.	A preliminary 'APT Main Power Load List' will identify the total APT site power needs during plant normal and abnormal operating conditions.
APT Main Power One Line Diagram	This document defines the power distribution scheme including off-site power interface with Utility, distribution component ratings and circuit protection requirements.	Completion of the preliminary APT Main Power Load List, Trade Studies to optimize design approach, and the related electrical systems calculations	A preliminary design of the One Line Diagram will define the power flow at various distribution voltages, system component sizes, distribution switchgear arrangements and the load feeder information. The document will also show the Utility interface details.
APT Main Power Protection Relay Diagram	This document provides the protection equipment design details that assures maximum distribution availability, and protection of loads and circuit distribution components against electrical faults.	Completion of the preliminary One Line Diagrams, and distribution system circuit co-ordination studies.	This document will define the circuit breaker and other distribution component sizing information to support the preliminary APT Main Power distribution design.

Table 5-10 (cont.), Balance of Plant Electrical System Design - APT Main Power Distribution

2. APT Main Power Distribution: WBS 1.11.01 Sheet 2 of 2

Item	Description	Interface/ Precursor	Comments/Limits for Design Phase
APT Main Power Substation Layout Drawings	These drawings provides the physical layout of the primary substations including the equipment arrangement.	Completion of the preliminary One Line Diagram.	The drawing will include overall substation component layout and the overall dimensional details to define space allocations, based on typical equipment sizes.
System Calculations	Using approved software, system analysis is performed to determine the component requirements and ensure the selections support safe design for normal and abnormal operating conditions.	Completion of the preliminary One Line Diagram	Perform preliminary calculations to support preparation of the design as well as determining component characteristics for the procurement specifications.
Procurement Specifications	This document defines the component parameters and functional characteristics to allow vendor bid preparation.	Completion of the preliminary One Line Diagram	Prepare a draft procurement specification document for each of the major component type based on the preliminary design information.
Installation Specification	This document defines the APT Main Power primary Substation installation requirements including expected performance, functions and quality assurance needs.	Completion of the preliminary One Line Diagram	Prepare a draft installation specification document based on the preliminary design information.

Table 5-11, Balance of Plant Electrical System Design - Electrical Services to Plant Facilities and Systems

3. Electrical Services to Plant Facilities and Systems: WBS 1.11.01, 1.11.02, 1.11.05 AND 1.05.XX

Item	Description	Interface/ Precursor	Comments/Limits for Design Phase
System Electrical Wiring Diagrams (EWD)	EWDs define the electrical connections to each plant system component that is electrically operated .	Systems Leads to define component control requirements.	Preliminary EWDs will identify the control scheme, conductor requirements, and interconnections, however, the termination details may be missing.
Communication Ladder Diagrams	For each facility, the communication points are defined on these documents	Availability of the facility General Arrangement (GA) drawings.	Preliminary communication ladder diagrams will identify the communication equipment locations and interconnections. The termination details may be missing.
Lighting Plans	These drawings show the lighting distribution layout including the fixture locations.	Availability of the facility General Arrangement (GA) drawings, and Prelim. lighting calculations	Based on preliminary GA, the lighting plans will identify the prelim. fixture locations and circuit assignments.
Raceway Layout Drawings	For each facility, these documents identify the raceway locations.	Availability of the facility General Arrangement (GA) drawings.	Preliminary raceway drawings will show the tentative tray/conduit routing data based on the preliminary equipment locations.
Cable Interconnection Diagrams	These documents show the interconnection details between various power source and associated subdistribution or load equipment.	Overall system design	Preliminary cable interconnection diagrams may not include termination details.
Cable/Raceway Schedules	This document identifies individual circuit cabling and overal cable type/length info.	Overall system design	Prelim Cable/raceway schedule reflects the preliminary system design status.

Table 5-12, Balance of Plant Electrical System Design - Electrical Support Systems

4. Electrical Support Systems: **WBS 1.11.01**

[Plant Lighting System; Plant Communication System; Plant Cathodic Protection System; Back-up Power Supply System; UPS Distr. System; Plant Grounding & Lightning Protection System; and Plant Access and Security System.]

Item	Description	Interface/ Precursor	Comments/Limits for Design Phase
Draft System Design Documents	New SDDs need to be prepared for the electrical support systems to address the required design issues for completing the APT facility design.		Preliminary SDDs will identify the design and code requirements for the electrical support systems.
System Specifications	For each electrical support system, an overall specification will define the procurement scope.	Availability of the facility General Arrangement (GAs) drawings.	Preliminary specifications will outline the tentative system supply scope.
System Specific Calculations	System calculations, when required, provide the component sizing basis.	Availability of the facility General Arrangement (GAs) drawings.	Based on preliminary GAs, the system calculations provide the preliminary component sizing information
Raceway Layout Drawings	For each facility, these documents identify the raceway locations.	Availability of the facility General Arrangement (Gas) drawings.	Preliminary raceway drawings will show the tentative tray/conduit routing data based on the preliminary equipment locations.
Cable Interconnection Diagrams	These documents show the interconnection details between various power source and associated subdistribution or load equipment.	Overall system design	Preliminary cable interconnection diagrams may not include termination details.

Table 5-13, Preliminary Design Work Packages - Balance of Plant I&C

Facility/System: Balance of Plant I&C **WBS** 1.11.03

Item	Description	Interface/ Precursor	Comments/Limits for Design Phase
P&IDs	Includes major process measurements, control loops, shutdown philosophy, ICS connections, and instrument process identifiers (i.e. PI, TI, LI, FI, etc.).		Will use preliminary P&IDs developed similar to Conceptual Design as a stating point. I&C will not include local process measurements, instrument/loop tag numbers, pump/motor local/remote control details, detailed control philosophy, alarm indication, local/remote panel designation, and detailed notes and references.
SDD	Modify Sections 1 and 2		Add new functional requirements, identify all applicable codes and standards, including specific design criteria that has not already been included as part of conceptual design.
Preliminary Control System Block Diagram	Depicts the control system in simplified block format.		Shows and defines all the significant elements of the control system including the method and type of connectivity. Gives an overall general view of the control system to allow discussion, comment and evaluation of overall control philosophy.
Preliminary Instrument Index Format	This document will serve to list all instruments and relate them to other parameters and documents.		Shows information columns taken from the global data base and several standard report formats to be used. Dummy instrument tags of generic types and related information will be added for examples.
Preliminary Control Database Format Description	Standardizes methods and format requirements for transferring sensor and process information to/from ICS.		Collects sensor and control requirements from all plant areas. Identify common and specific attributes of control system I/O. Preliminary to, but not including, control system database specification.
Preliminary Software Requirements	Outlines expected performance requirements and functionality. Includes software QA plan.		Identify need and initial performance requirements for control software, machine operating systems and applications purchased or developed in-house. Preliminary to final software requirements documentation.

Table 5-14, Preliminary Design Work Packages - Plant Wide I&C Systems & Equipment

Facility/System: Plant Wide I&C Systems & Equipment **WBS** 1.11.04

Item	Description	Interface/ Precursor	Comments/Limits for Design Phase
P&IDs	Includes major process measurements, control loops, shutdown philosophy, ICS connections, and instrument process identifiers (i.e. such as PI, TI, LI, FI, etc.).		Will use preliminary P&IDs developed similar to Conceptual Design as a starting point. I&C will not include local process measurements, instrument/loop tag numbers, pump/motor local/remote control details, detailed control philosophy, alarm indication, local/remote panel designation, and detailed notes and references.
SDD	Modify Sections 1 and 2		Add new functional requirements, identify all applicable codes and standards, including specific design criteria that has not already been included as part of conceptual design
Preliminary Control System Block Diagram	Depicts the control system in simplified block format.		Shows and defines all the significant elements of the control system including the method and type of connectivity. Gives an overall general view of the control system to allow discussion, comment and evaluation of overall control philosophy.
Preliminary Instrument Location Plans.	Shows in plan the preliminary location of the sensors and control panels.		Uses the GA with preliminary major equipment and piping shown.
Preliminary Instrument Index Format	This document will serve to list all instruments and relate them to other parameters and documents.		Shows information columns taken from the global data base and several standard report formats to be used. Dummy instrument tags of generic types and related information will be added for examples.

Table 5-15, Preliminary Design Work Packages - Radwaste Systems

Facility/System: Radwaste Systems **WBS** 1.11.06

Items	Description	Interface/ Precursor	Comments/Limits for Design Phase
Source Terms	A description of each waste stream including quantity, chemical characteristics, and nuclear characteristics.	Data collected from process system design teams and vendors. and other accelerators.	Source Term Identification for each waste stream based on normal operation and occasional occurrences; quantity-flowrate (gpm); total dissolved solids-chemical concentration (ppm);undissolved solids-particle size (microns); nuclear characteristics-isotope concentration (uci/gm).
Design Development Study	A study to evaluate various alternatives		Design Development Studies will be prepared to evaluate various process alternatives and the selection of processing equipment.
Process Flow Diagram	A drawing used to identify key process parameters at various points in the systems, such as temperature, pressure, flow, etc.)		Will be developed for liquid, gaseous, and solid radwaste systems. Necessary to support equipment sizing. Will precede completion of the system P&ID.
P&IDs	Includes equipment and schematic flow paths including line and valve classifications, sizes and process information. Used to develop preliminary line lists, valve lists, etc.		Will use existing P&IDs developed in Conceptual Design as a starting point. Drawings will be modified to reflect changes to Conceptual Design developed prior to and during Preliminary Design. Both I&C and Electrical provide input to the P&IDs in the form of process control and equipment control information.
Calculations	Preliminary equipment and piping sizing calculations. Used for space allocation.		Requires all heating and cooling loads in order to identify equipment and pipe sizes.
	Preliminary Pressure Drop Calculations. Preliminary shielding calculations.		Used to develop pipe size and properties (wall thickness, material, OD, etc.). Used to develop shield wall thicknesses and locate equipment to facilitate maintenance and enhance radiological protection.
SDD	Modify Sections 1 and 2 as required.		Add any new functional requirements, applicable codes, standards and specific design criteria that have been identified prior to and during Preliminary Design (examples include, but are not limited to, number of pumps, valves, heat exchangers, type of equipment, etc.) and has not already been included as part of conceptual design.
General Arrangement Drawings	Locate all sized equipment and allow for pipe routing.		Building 3-D model developed by CSA. Mechanical group identifies space requirements, then locates specific equipment including O&M envelop and approximates pipe routing space allocation.

Table 5-16, Preliminary Design Work Packages - Target/Blanket System

Facility/System: Target/Blanket System **WBS** 1.07.01

Items	Description	Interface/ Precursor	Comments/Limits for Design Phase
Trade study Report	Used to select configuration, material, and manufacturing process.		Initiates prelim design phase with basic engineering information to select the major features of system/component design. Necessary to support equipment sizing.
P&IDs	Includes equipment and schematic flow paths including line and valve classifications, sizes and process information. Used to develop preliminary line lists, valve lists, etc.		Will use existing P&IDs developed in Conceptual Design as a starting point. Drawings will be modified to reflect changes to Conceptual Design developed prior to and during Preliminary Design. Both I&C and Electrical provide input to the P&ID's is the form of process control information and equipment control information
Calculations	Preliminary equipment and piping sizing calculations. Used for space allocation.	.	Requires all heating and cooling loads in order to identify equipment and manifold sizes. Required coolant flow rates and dynamic response used in systems and stress analyses.
	Preliminary Pressure Drop Calculations		Used to develop manifold size and properties (wall thickness, material, OD, etc.)
SDD	Modify Sections 1 and 2 as required.		Add any new functional requirements, applicable codes and standards and specific design criteria that have been identified prior to and during Preliminary and has not already been included as part of conceptual design
General Arrangement Drawings	Locate all equipment, show coolant pipe routing, structural support locations.		Develop 3-D model to identify space requirements, then locates specific equipment including O&M envelop and approximates pipe routing space allocation.
Prototype Mfg and Test Report	Needed for FOAK equipment to assure that equipment can be manufactured, and will meet O&M requirements		Best to complete before final design starts to assure successful operation of components in system.

Table 5-17, Preliminary Design Work Packages - Cavity Vessel System

Facility/System: Cavity Vessel System **WBS** 1.07.02

Items	Description	Interface/ Precursor	Comments/Limits for Design Phase
Trade study Report	Used to select configuration, material, and manufacturing process.		Initiates prelim design phase with basic engineering information to select the major features of system/component design. Necessary to support equipment sizing.
Process Flow Diagram	A drawing used to identify key process parameters at various points in the systems, such as temperature, pressure, flow, etc.)	.	Will be developed for Atmosphere Control system. Necessary to support equipment sizing. Will precede completion of the system P&ID
P&IDs	Includes equipment and schematic flow paths including line and valve classifications, sizes and process information. Used to develop preliminary line lists, valve lists, etc.		Will use existing P&IDs developed in Conceptual Design as a starting point. Drawings will be modified to reflect changes to Conceptual Design developed prior to and during Preliminary Design. Both I&C and Electrical provide input to the P&ID's is the form of process control information and equipment control information
Calculations	Preliminary equipment, vessel and piping sizing calculations to ASME criteria	Primary heat loads, cooling, pressure, and Dynamic Loads requirements.	Requires all heating, cooling and mechanical loads in order to identify equipment, vessel, and pipe sizes
SDD	Modify Sections 1 and 2 as required.		Add any new functional requirements, applicable codes and standards and specific design criteria that have been identified prior to and during Preliminary Design and has not already been included as part of conceptual design
General Arrangement Drawings	Locate all sized components, equipment and allow for pipe routing.		Developing 3-D model to identify space requirements, then locates specific equipment including O&M envelop and approximates pipe routing space allocation.
Prototype Mfg and Test	Needed for FOAK equipment to assure that equipment can be manufactured, and will meet O&M requirements		Prototyping only applies to the design of Fluid flow jumpers and specialized remote handling equipment

Table 5-18, Preliminary Design Work Packages - Heat Removal Systems

Facility/System: Heat Removal Systems **WBS** 1.07.04

Items	Description	Interface/ Precursor	Comments/Limits for Design Phase
Trade study Report	Used to select configuration that meets both safety and normal operation requirements.		Initiates prelim design phase with basic engineering information to select the major features of system/component design. Necessary to determine layout of system.
Process Flow Diagram	A drawing used to identify key process parameters at various points in the systems, such as temperature, pressure, flow, etc.)		Will be developed for heat rejection systems only. Necessary to support equipment sizing. Will precede completion of the system P&ID
P&IDs	Includes equipment and schematic flow paths including line and valve classifications, sizes and process information. Used to develop preliminary line lists, valve lists, etc.		Will use existing P&IDs developed in Conceptual Design as a starting point. Drawings will be modified to reflect changes to Conceptual Design developed prior to and during Preliminary Design. Both I&C and Electrical provide input to the P&ID's is the form of process control information and equipment control information
Calculations	Preliminary equipment and piping sizing calculations. Used for space allocation.	Heat loads and cooling requirements from Target and blanket systems.	Requires all heating and cooling requirements from target, blankets, Reflectors, window, and cavity flood system.
	Preliminary system pressure pressure drop calculations		Used to develop pipe size and properties (wall thickness, material, OD, etc.)
SDD	Modify Sections 1 and 2 as required.		Add any new functional requirements, applicable codes and standards and specific design criteria that have been identified prior to and during Preliminary Design (examples include, but are not limited to, number of pumps, valves, heat exchangers, type of equipment, etc.) and has not already been included as part of conceptual design
General Arrangement Drawings	Locate all sized equipment and allow for pipe routing.		Develop 3-D model to identify space requirements, then locates specific equipment including O&M envelop and approximates pipe routing space allocation.

Table 5-19, Preliminary Design Work Packages - Accelerator

Facility/System: Accelerator **WBS** 1.06

Items	Description	Interface/ Precursor	Comments/Limits for Design Phase
Process Flow Diagram	A drawing used to identify key process parameters at various points in the systems, such as temperature, pressure, flow, etc.)	.	Will be developed for applicable Linac subsystems. Necessary to support equipment sizing. Will precede completion of the system P&ID
P&IDs	Includes equipment and schematic flow paths including line and valve classifications, sizes and process information. Used to develop preliminary line lists, valve lists, etc.		In the Preliminary Design, P&IDs will show process connectivity, major equipment, major valves, principal control loops where applicable. Equipment and line sizing will not be complete.
Calculations	Trade-off calcs for technical equip. design selections; preliminary equip. design and sizing calcs. Used to size piping and prepare equip. arrgmts.		Equipment sizing and weights, heat loads, and electrical loads will be preliminary.
Preliminary Equipment Drawings/Specification	Specifications for common Linac technical equipment such as valves, pumps, vacuum instruments; preliminary drawings or specifications for specialized equipment.		Equipment drawings or specifications will be not be complete, but developed sufficiently to provide necessary preliminary design information to the other APT systems
SDDs	Modify Sections 1 and 2 as required.		Add any new functional requirements, applicable codes and standards and specific design criteria that have been identified subsequent to the Conceptual Design Report. Update system design descriptions appropriately to describe the Preliminary refinements from that of the Conceptual Design.
General Arrangement Drawings	Locate all sized technical equipment and allow for cooling and cryogenic pipe routing.		Preliminary technical equipment and piping layouts in the Linac tunnel and gallery; services required in the tunnel and gallery will be included on general arrangement drawings appropriate for preliminary definition of building floor space; building height will be included.

Table 5-20, Preliminary Design Work Packages - Target/Blanket System

Facility/System Target/Blanket System **WBS** 1.07.01

Items	Description	Interface/ Precursor	Comments/Limits for Design Phase
Trade study Report	Used to select configuration, material, and manufacturing process.		Initiates prelim design phase with basic engineering information to select the major features of system/component design. Necessary to support equipment sizing.
P&IDs	Includes equipment and schematic flow paths including line and valve classifications, sizes and process information. Used to develop preliminary line lists, valve lists, etc.		Will use existing P&IDs developed in Conceptual Design as a starting point. Drawings will be modified to reflect changes to Conceptual Design developed prior to and during Preliminary Design. Both I&C and Electrical provide input to the P&ID's is the form of process control information and equipment control information
Calculations	Preliminary equipment and piping sizing calculations. Used for space allocation.	.	Requires all heating and cooling loads in order to identify equipment and manifold sizes. Required coolant flow rates and dynamic response used in systems and stress analyses.
	Preliminary Pressure Drop Calculations		Used to develop manifold size and properties (wall thickness, material, OD, etc.)
SDD	Modify Sections 1 and 2 as required.		Add any new functional requirements, applicable codes and standards and specific design criteria that have been identified prior to and during Preliminary and has not already been included as part of conceptual design
General Arrangement Drawings	Locate all equipment, show coolant pipe routing, structural support locations.		Develop 3-D model to identify space requirements, then locates specific equipment including O&M envelop and approximates pipe routing space allocation.
Prototype Mfg and Test Report	*Needed for FOAK equipment to assure* that equipment can be manufactured, and will meet O&M requirements		Best to complete before final design starts to assure successful operation of components in system.

Table 5-21, Preliminary Design Work Packages - Cavity Vessel System

Facility/System Cavity Vessel System **WBS** 1.07.02

Items	Description	Interface/ Precursor	Comments/Limits for Design Phase
Trade study Report	Used to select configuration, material, and manufacturing process.		Initiates prelim design phase with basic engineering information to select the major features of system/component design. Necessary to support equipment sizing.
Process Flow Diagram	A drawing used to identify key process parameters at various points in the systems, such as temperature, pressure, flow, etc.)	.	Will be developed for Atmosphere Control system. Necessary to support equipment sizing. Will precede completion of the system P&ID
P&IDs	Includes equipment and schematic flow paths including line and valve classifications, sizes and process information. Used to develop preliminary line lists, valve lists, etc.		Will use existing P&IDs developed in Conceptual Design as a starting point. Drawings will be modified to reflect changes to Conceptual Design developed prior to and during Preliminary Design. Both I&C and Electrical provide input to the P&ID's is the form of process control information and equipment control information
Calculations	Preliminary equipment, vessel and piping sizing calculations to ASME criteria	Primary heat loads, cooling, pressure, and Dynamic Load reqts.	Requires all heating, cooling and mechanical loads in order to identify equipment, vessel, and pipe sizes
SDD	Modify Sections 1 and 2 as required.		Add any new functional requirements, applicable codes and standards and specific design criteria that have been identified prior to and during Preliminary Design and has not already been included as part of conceptual design
General Arrangement Drawings	Locate all sized components, equipment and allow for pipe routing.		Developing 3-D model to identify space requirements, then locates specific equipment including O&M envelop and approximates pipe routing space allocation.
Prototype Mfg and Test	Needed for FOAK equipment to assure that it can be manufactured, and will meet O&M requirements		Prototyping only applies to the design of Fluid flow jumpers and specialized remote handling equipment

Table 5-22, Preliminary Design Work Packages - Heat Removal Systems

Facility/System Heat Removal Systems **WBS** 1.07.04

Items	Description	Interface/ Precursor	Comments/Limits for Design Phase
Trade study Report	Used to select configuration that meets both safety and normal operation requirements.		Initiates prelim design phase with basic engineering information to select the major features of system/component design. Necessary to determine layout of system.
Process Flow Diagram	A drawing used to identify key process parameters at various points in the systems, such as temperature, pressure, flow, etc.)	.	Will be developed for heat rejection systems only. Necessary to support equipment sizing. Will precede completion of the system P&ID
P&IDs	Includes equipment and schematic flow paths including line and valve classifications, sizes and process information. Used to develop preliminary line lists, valve lists, etc.		Use existing P&IDs developed in Conceptual Design as a starting point. Drawings will be modified to reflect changes to Conceptual Design developed prior to and during Preliminary Design. Both I&C and Electrical provide input to the P&ID's is the form of process control and equipment control information
Calculations	Preliminary equipment and piping sizing calculations. Used for space allocation.	Heat loads & cooling requirements from Target/blanket systems.	Requires all heating and cooling requirements from target, blankets, Reflectors, window, and cavity flood system.
	Preliminary system pressure pressure drop calculations		Used to develop pipe size and properties (wall thickness, material, OD, etc.)
SDD	Modify Sections 1 and 2 as required.		Add any new functional requirements, applicable codes and standards and specific design criteria identified prior to/during Preliminary Design and has not already been included as part of conceptual design
General Arrangement Drawings	Locate all sized equipment and allow for pipe routing.		Develop 3-D model to identify space requirements, then locates specific equipment including O&M envelop and approximates pipe routing space allocation.

Table 5-23, Preliminary Design Work Packages - Tritium Separation Facility

Facility/System: Tritium Separation Facility **WBS** 1.09

Items	Description	Interface/ Precursor	Comments/Limits for Design Phase
Process Flow Diagram	Presents process mass and energy balances. Used to identify key process parameters at various points in the systems, such as temperature, press. flow, stream composition, etc.	Heat loads, temperature and pressure distributions, stream composition changes, etc. .	Will be developed for all process systems except the Analytical Lab and the Tritium Storage System. Necessary to support equipment sizing. Will precede completion of the system P&ID
P&IDs	Presents equipment and schematic flow paths including line and valve classifications and sizes, process and control info. Used to develop preliminary line lists, valve lists, etc.	Process connectivity, process parts, control loops, process part sizing, etc.	No P&IDs were prepared for the Conceptual Design Report. In the Preliminary Design, P&IDs will show process connectivity, major equipment, major valves, principal control loops. Equipment and line sizing and control functions will not be complete.
Calculations	Trade-off calculations to select process technology, to perform preliminary equipment design and sizing. Sizing used to determine equipment arrangements and balance of plant requirements.	.	Equipment sizing, heat loads, arrangements, and electrical loads will be preliminary.
Preliminary Equipment Specification	Specifications for common equipment such as valves, tanks, vacuum systems, instruments and preliminary specifications for certain equipment.		Equipment specifications will not be complete and will be limited to equipment not defined by a major ED&D programs.
SDD	Modify Sections 1 and 2 as required.	Collects baseline design information	Add any new functional requirements, applicable codes and standards, and specific design criteria that have been identified subsequent to the Conceptual Design Report. Tables quantifying flows, stream compositions, heat loads, equipment sizes, etc. will be added to the system descriptions.
General Arrangement Drawings	Locate all sized equipment and allow for pipe routing and other services required by the process.	System spatial requirements	Equipment and piping layout, services required in the TSF building will be included on general arrangement drawings appropriate for preliminary definition of building floor space, building height will be included.

Appendix B, Description of Final Design Work Packages

Table 6-1, Final Design Work Package - Yard Work

Facility/System: Yard Work **WBS** 1.05.01

Item	Description	Interface/ Precursor	Comments/Limits of Design Phase
Drawings	Drawings needed for bid and construction of all final civil electrical mechanical and environmental yard elements.		Drawings for the final grading ,road and paving configuration below and above ground utilities installation ,site lighting, and drainage, fencing and communication systems, as required for bid and construction.
Specifications	Specifications required for bid and construction	.	Specifications for materials and installation methods as needed for bid and construction.
Calculations	Calculations for sizing and geometric positioning for all site elements		Calculations to be a combination of hand and computer generated as needed. Final grading to use Inter graph Inroads system.
FDD	FDD'S will be finalized and become the record for the design.		

Table 6-2, Final Design Work Packages - T/B, Accelerator & Klystron

Facility/System: T/B, Accelerator & Klystron **WBS** 1.05.02,.03

Item	Description	Interface/ Precursor	Comments/Limits of Design/Phase
Drawings	Drawings needed for bid and construction of the T/B building, Accelerator Tunnel, Injector, Beam stop, and Klystron Gallery	Final space, power, and heat removal, and shielding requirements from all parties	Drawings for the final structure, architecture ,power and lighting, HVAC, fire protection, plumbing systems, and Shielding as needed for bid and construction, including line lists ,material equipment lists data sheets, P&IDs, communication ladder diagrams, and one line diagrams.
Specifications	Specifications required for bid and construction	.	Specifications for materials and installation methods as needed for bid and construction.
Calculations	Calculations as required for all element sizing. All calculations checked and approved.		Calculations to be a combination of hand and computer generated as needed. Calculations to include computer seismic and dynamic analysis, load and flow losses, settlement, thermal, and NPH impacts.
FDD	Final revisions to FDD'S to reflect final design.	Input from Electrical, Mechanical, Nuclear, I&C and O&M	FDD's become record document defining the design.
General Arrangements (GAs)	Final general arrangement drawings showing all equipment	Input from all systems.	General arrangement drawings consists of plans and sections as needed to define the location of all equipment , equipment service access, and removal spaces for servicing.

Table 6-3, Final Design Work Packages - Support Buildings & Structures

Facility/System: Support Buildings & Structures **WBS** 1.05.04,.05,.06,.07,.08

Item	Description	Interface/ Precursor	Comments/Limits of Design Phase
Drawings	Drawings needed for bid and construction of the miscellaneous support buildings and structures.	Final space, power, and heat removal, and shielding requirements from all parties	Drawings for the final structure, architecture ,power and lighting, HVAC, fire protection, plumbing systems, and shielding as needed for bid and construction, including line lists ,material equipment lists, data sheets ,P & Ids ,communication ladder diagrams , and one line diagrams.
Specifications	Specifications required for bid and construction.	.	Specifications for materials and installation methods as needed for bid and construction.
Calculations	Calculations as required for all element sizing. All calculations checked and approved.		Calculations to be a combination of hand and computer generated as needed. Calculations to include computer analysis, load and flow losses, settlement, thermal, and NPH impacts.
FDD	Final revisions to FDD'S to reflect final design.	Input from Electrical, Mechanical, Nuclear, I&C and O&M	FDD'S become record document defining the design.
General Arrangements (GAs)	Final general arrangement drawings showing all equipment in the mechanical and electrical buildings ,TSF, Rad Waste And demin Water Buildings	Input from all systems.	General arrangement drawings consists of plans and sections as needed to define the location of all equipment , equipment service access and removal spaces for servicing.

Table 6-4, Final Design Work Packages - General Specifications

Facility/System: General Specifications **WBS** 1.11.00

Items	Description	Interface/ Precursor	Comments/Limits for Design Phase
Purchase Requisitions	This document is a transmittal from Engineering to Purchasing identifying the quantity & tag no's. of required instrumentation or control system components to be purchased from the selected vendor.		Vendors will be determined through appropriate bid format and analysis.
Database, control, system and application software specifications	Comprehensive design descriptions and performance/testing requirements for all APT control software.		Documents are ready to be included in bid packages to vendors or to be passed to prime or subcontract programming staff.
Procurement Specifications	Procurement Specifications for all mechanical equipment, piping, valves, packaged skids, etc..		Data sheets for the Procurement Specifications will be prepared during final design. This activity also covers bid review during final design

Table 6-5, Final Design Work Packages - Heat Removal Systems

Facility/System: Heat Removal Systems **WBS** 1.11.02

Items	Description	Interface/ Precursor	Comments/Limits for Design Phase
Process Flow Diagram	A drawing used to identify key process parameters at various points in the systems, such as temperature, pressure, flow, etc.)	.	Will be developed for heat rejection systems only. Issued as Rev 0 for start of final design.
P&IDs	Includes equipment and schematic flow paths including line and valve classifications, sizes and process information. Used to develop final line lists, valve lists, etc.		Issued as Rev 0 for start of final design. Contains all information required to prepare final equipment sizing, line sizing and lists. Final lists will be issued to support construction.
Calculations	Final equipment and piping sizing calculations.	Primary and Secondary heat loads and cooling requirements.	Calculations will be finalized and put through a formal review and approval cycle.
	Final Pressure Drop Calculations		Calculations will be finalized and put through a formal review and approval cycle.
SDD	Issue all Sections of the SDD		The SDD will be issued with all section completed
General Arrangement Drawings	All general arrangements will be updated with Rev 0 P&ID information and input provided to the 3D building model		Building 3-D model developed by CSA. Mechanical group identifies space requirements, then locates specific equipment including O&M envelop and pipe routing space allocation.
Mechanical Installation Drawings	Mechanical will route all piping in 3D Model . Electrical and I&C will locate electrical and I&C equipment		Mechanical installation drawings will be issued as Rev 0 to support construction. Information not available from vendor drawing review will be issued at a later date under a Construction Support work package.

Table 6-6, Final Design Work Packages - Misc. Support Systems

Facility/System: Misc. Support Systems **WBS** 1.11.05

Items	Description	Interface/ Precursor	Comments/Limits for Design Phase
P&IDs	Includes equipment and schematic flow paths including equipment and pipe, sizes and process information. Used to develop final line lists, valve lists, etc.		Issued as Rev 0 for start of final design. Contains all information required to prepare final equipment sizing, line sizing and lists. Final lists will be issued to support construction.
Calculations	Preliminary equipment and duct sizing calculations. .	.	Calculations will be finalized and put through a formal review and approval cycle.
	Final pipe pressure drop calculations		Calculations will be finalized and put through a formal review and approval cycle.
SDD	Issue all sections of the SDD		The SDD will be issued with all sections completed.
General Arrangement Drawings	All general arrangements will be updated with Rev 0 P&ID information and input provided to the #d building model		Building 3-D model developed by CSA. Mechanical group identifies space requirements, then locates specific equipment including O&M envelop and approximates pipe routing space allocation.
Mechanical Installation Drawings	Mechanical will route all piping in 3D Model. Electrical and I&C will locate electrical and I&C equipment		Mechanical installation drawings will be issued as Rev 0 to support construction. Information not available from vendor drawing review will be issued at a later date under a Construction Support work package.

Table 6-7, Final Design Work Packages - BOP Water Treatment Systems

Facility/System: BOP Water Treatment Systems **WBS** 1.11.07

Items	Description	Interface/ Precursor	Comments/Limits for Design Phase
P&IDs	Includes equipment and schematic flow paths including equipment and pipe, sizes and process information. Used to develop final line lists, valve lists, etc.		Issued as Rev 0 for start of final design. Contains all information required to prepare final equipment sizing, line sizing and lists. Final lists will be issued to support construction.
Calculations	Final equipment and pipe sizing calculations.	.	Calculations will be finalized and put through a formal review and approval cycle.
	Final pipe pressure drop calculations		Calculations will be finalized and put through a formal review and approval cycle.
SDD	Issue all sections of the SDD		The SDD will be issued with all sections completed.
General Arrangement Drawings	All general arrangements will be updated with Rev 0 P&ID information and input provided to the 3D building model		Building 3-D model developed by CSA. Mechanical group identifies space requirements, then locates specific equipment including O&M envelop and approximates pipe routing space allocation.
Mechanical Installation Drawings	Mechanical will route all piping in 3D Model. Electrical and I&C will locate electrical and I&C equipment		Mechanical installation drawings will be issued as Rev 0 to support construction. Information not available from vendor drawing review will be issued at a later date under a Construction Support work package.

Table 6-8, Final Design Work Packages - HVAC Systems

Facility/System: HVAC Systems **WBS** 1.11.08

Items	Description	Interface/ Precursor	Comments/Limits for Design Phase
P&IDs	Includes equipment and schematic flow paths including duct and damper classifications, sizes and process information. Used to develop final duct lists, damper lists, etc.		Issued as Rev 0 for start of final design. Contains all information required to prepare final equipment sizing, line sizing and lists. Final lists will be issued to support construction.
Calculations	Final equipment and duct sizing calculations.	.	Calculations will be finalized and put through a formal review and approval cycle.
	Final duct pressure drop calculations		Calculations will be finalized and put through a formal review and approval cycle.
SDD	Issue all sections of the SDD		The SDD will be issued with all sections completed.
General Arrangement Drawings	All general arranges will be updated with Rev 0 P&ID information and input provided to the 3D building model.		Building 3-D model developed by CSA. Mechanical group identifies space requirements, then locates specific equipment including O&M envelop and approximates duct routing space allocation.
Mechanical Installation Drawings	Mechanical will route all piping in 3D Model. Electrical and I&C will locate electrical and I&C equipment		Mechanical installation drawings will be issued as Rev 0 to support construction. Information not available from vendor drawing review will be issued at a later date under a Construction Support work package.

Table 6-9, Balance of Plant Electrical System Design - Temporary Construction Power Distribution

1. Temporary Construction Power Distribution: **WBS 1.11.01** **Sheet 1 of 2**

Item	Description	Interface/ Precursor	Comments/Limits for Design Phase
Prelim. System Design Document [SDD] : Update to final status	Final SDD will document the system design performance and DOE orders/ code/industry standard requirements during prelim design phase.	Identify Code/ Standards changes, or, design performance changes post preliminary SDD issue.	Review the preliminary SDD to assure that all the necessary criteria for the construction power design work is included, add the missing requirements and cods/standards. Issue final SDD
Trade Studies	In selected technical areas, trade Studies are conducted to evaluate design options and determine approach to render optimum design.		No activity during this phase.
Construction Power Load List	Provides concise listing of the power demands, including load characteristics and locations, to be fed from the Temporary Construction Power source.	Construction Group and APT System Leads to finalize load requirements data for systems under their cognizance.	A final construction power load list will identify the total APT site needs during the site mobilization, initial construction and portions of startup loads until the main power distribution is made available. This document will be the basis of final design.
Construction Power One Line Diagram	This document defines the power distribution scheme including off-site power interface with Utility, distribution component ratings and circuit protection requirements.	Completion of the final Construction Power Load List, Trade Studies to optimize design approach, and the related electrical systems calculations	This document will define the circuit breaker and other distribution component sizing information to support the final power distribution design.
Construction Power Protection Relay Diagram	This document provides the protection equipment design details that assures maximum distribution availability, and protection of loads and circuit distribution components against electrical faults.	Completion of the final One Line Diagrams, and distribution system circuit co-ordination studies.	This document will define the circuit breaker and other distribution component sizing information to support the final power distribution design.

Table 6-9 (cont.), Balance of Plant Electrical System Design - Temporary Construction Power Distribution

1. Temporary Construction Power Distribution: **WBS 1.11.01** **Sheet 2 of 2**

Item	Description	Interface/ Precursor	Comments/Limits for Design Phase
Construction Power Substation Layout Drawing	This drawing provides the physical layout of the substation including the equipment arrangement.	Completion of the final One Line Diagram.	The drawing will include overall substation component layout and the overall dimensional details to define space allocations, based on selected equipment sizes.
System Calculations	Using approved software, system analysis is performed to determine the component requirements and ensure the selections support safe design for normal and abnormal operating conditions.	Completion of the final One Line Diagram	Perform final calculations to support preparation of the design as well as determining component characteristics for the procurement specifications.
Procurement Specifications	This document defines the component parameters and functional characteristics to allow vendor bid preparation.	Completion of the final One Line Diagram	Prepare a final procurement specification document for each of the major component type based on the final design information.
Installation Specification	This document defines the Construction Power Substation installation requirements including expected performance, functions and quality assurance needs.	Completion of the final One Line Diagram	Prepare a final installation specification document based on the final design information.

Table 6-10, Balance of Plant Electrical System Design - APT Main Power Distribution

2. APT Main Power Distribution: **WBS 1.11.01** **Sheet 1 of 2**

Item	Description	Interface/ Precursor	Comments/Limits for Design Phase
Prelim. System Design Document [SDD] : Update to final status	Final SDD will document the system design performance and DOE orders/ code/industry standard requirements during prelim design phase.	Identify Code/ Standards changes, or, design performance changes post preliminary SDD issue..	Review the preliminary SDD to assure that all the necessary criteria for the construction power design work is included, add the missing requirements and cods/standards. Issue final SDD
Trade Studies	In selected technical areas, trade Studies are conducted to evaluate design options and determine approach to render optimum design.		No activity during this phase.
APT Main Power Load List	Provides concise listing of the power demands, including load characteristics and locations, to be fed from the APT Main Power source.	APT Facilities and APT System Leads to finalize load requirements data for systems under their cognizance.	A final construction power load list will identify the total APT site needs during the site mobilization, initial construction and portions of startup loads until the main power distribution is made available. This document will be the basis of final design.
APT Main Power One Line Diagram	This document defines the power distribution scheme including off-site power interface with Utility, distribution component ratings and circuit protection requirements.	Completion of the final APT Main Power Load List, Trade Studies to optimize design approach, and the related electrical systems calculations	This document will define the circuit breaker and other distribution component sizing information to support the final power distribution design.
APT Main Power Protection Relay Diagram	This document provides the protection equipment design details that assures maximum distribution availability, and protection of loads and circuit distribution components against electrical faults.	Completion of the final One Line Diagrams, and distribution system circuit co-ordination studies.	This document will define the circuit breaker and other distribution component sizing information to support the final power distribution design.

Table 6-10 (cont.), Balance of Plant Electrical System Design - APT Main Power Distribution

2. APT Main Power Distribution: **WBS 1.11.01** **Sheet 2 of 2**

Item	Description	Interface/ Precursor	Comments/Limits for Design Phase
APT Main Power Substation Layout Drawings	These drawings provide the physical layout of the primary substations including the equipment arrangement.	Completion of the final One Line Diagram.	The drawing will include overall substation component layout and the overall dimensional details to define space allocations, based on selected equipment sizes.
System Calculations	Using approved software, system analysis is performed to determine the component requirements and ensure the selections support safe design for normal and abnormal operating conditions.	Completion of the final One Line Diagram	Perform final calculations to support preparation of the design as well as determining component characteristics for the procurement specifications.
Procurement Specifications	This document defines the component parameters and functional characteristics to allow vendor bid preparation.	Completion of the final One Line Diagram	Prepare a final procurement specification document for each of the major component type based on the final design information.
Installation Specification	This document defines the APT Main Power Substation installation requirements including expected performance, functions and quality assurance needs.	Completion of the final One Line Diagram	Prepare a final installation specification document based on the final design information.

Table 6-11, Balance of Plant Electrical System Design - Electrical Services to Plant Facilities and Systems

3. Electrical Services to Plant Facilities and Systems: WBS 1.11.01, 1.11.02, 1.11.05 AND 1.05.XX

Item	Description	Interface/ Precursor	Comments/Limits for Design Phase
System Electrical Wiring Diagrams (EWD)	EWDs define the electrical connections to each plant system component that is electrically operated .	Systems Leads to define component control requirements.	Final EWDs will identify the control scheme, conductor requirements, and interconnections, including the termination details.
Communication Ladder Diagrams	For each facility, the communication points are defined on these documents	Availability of the facility General Arrangement (GA) drawings.	Final communication ladder diagrams will identify the communication equipment locations and interconnections, including the termination details.
Lighting Plans	These drawings show the lighting distribution layout including the fixture locations.	Availability of the facility General Arrangement (GA) drawings, and Prelim. lighting calculations	Based on final GAs, the lighting plans will identify the fixture locations and circuit assignments.
Raceway Layout Drawings	For each facility, these documents identify the raceway locations.	Availability of the facility General Arrangement (GA) drawings.	Final raceway drawings will show the tray/conduit routing data based on the final equipment locations.
Cable Interconnection Diagrams	These documents show the interconnection details between various power source and associated subdistribution or load equipment.	Overall system design	Final cable interconnection diagrams will include termination details.
Cable/Raceway Schedules	This document identifies individual circuit cabling and overal cable type/length info.	Overall system design	Final Cable/raceway schedule reflects the final system design status.

Table 6-12, Balance of Plant Electrical System Design - Electrical Support Systems

4. Electrical Support Systems: **WBS 1.11.01**

[Plant Lighting System; Plant Communication System; Plant Cathodic Protection System; Back-up Power Supply System; UPS Distr. System; Plant Grounding & Lightning Protection System; and Plant Access and Security System.]

Item	Description	Interface/ Precursor	Comments/Limits for Design Phase
Final System Design Documents	New SDDs need to be prepared for the electrical support systems to address the required design issues for completing the APT facility design.		Final SDDs will identify the design and code requirements for the electrical support systems.
System Specifications	For each electrical support system, an overall specification will define the procurement scope.	Availability of the facility General Arrangement (GAs) drawings.	Final specifications will outline the system supply scope.
System Specific Calculations	System calculations, when required, provide the component sizing basis.	Availability of the facility General Arrangement (GAs) drawings.	Based on final GAs, the system calculations will provide the component sizing information
Raceway Layout Drawings	For each facility, these documents identify the raceway locations.	Availability of the facility General Arrangement (GAs) drawings.	Final raceway drawings will show the tray/conduit routing data based on the final equipment locations.
Cable Interconnection Diagrams	These documents show the interconnection details between various power source and associated subdistribution or load equipment.	Overall system design	Final cable interconnection diagrams will include termination details.

Table 6-13, Final Design Work Packages - Balance of Plant I&C

Facility/System: Balance of Plant I&C **WBS** 1.11.03

Item	Description	Interface/ Precursor	Comments/Limits for Design Phase
P&IDs	A drawing used to identify all instrument process parameters measured and the control philosophy thereof.		The P&IDs will include the required process parameter measurements, control loops, shutdown logic, instrument tag alpha process parameter indication and tag number, local process measurements, local/remote control details, detailed logic/control philosophy, alarm indication, local/remote panel designation, I/O IOC destination designation and detailed notes and references.
SDD	The SDDs will be used as a basis for design.		All sections and appendices will be completed keeping in mind that as the APT design progresses this document will grow and may be modified. I&C will contribute to sections of SDDs for the other specific plant systems.
Control System Block Diagram	Depicts the control system in simplified block format.		Shows and defines all the all elements of the control system including the method of connectivity and types of devices. Gives an overall general view of the control system to allow an understanding of overall system control philosophy.
Instrument Location Plans	Shows in plan the location and identification of all the sensors and control panels and wiring runs.		Uses the General Arrangement with equipment and piping shown.
Instrument Index	This document serves to list all instruments and relate them to other parameters and documents.		This document includes a list of all instrument tags with related information taken from the global database and set up in several standard report formats.
Logic Diagrams	These diagrams are a graphical representation of the discreet logic necessary for interlocking and alarming control systems.		It will be developed in an electronic mode which can be directly down loaded to the intended IOC.
Specifications/Data Sheets	This combination of documents details all of the process, material, performance, and design information required to purchase instrumentation, control system networks, and ICS control hardware.		All documents and related efforts to support construction, installation, testing and calibration activities will be completed in the engineering construction support phase.(i.e. such as Loop Diagrams, Screen Graphics, Instrumentation. Installation Details and etc.)

Table 6-14, Final Design Work Packages - Plant Wide I&C Systems & Equipment

Facility/System: Plant Wide I&C Systems & Equipment **WBS** 1.11.04

Item	Description	Interface/ Precursor	Comments/Limits for Design Phase
P&IDs	A drawing used to identify all instrument process parameters measured and the control philosophy thereof.		The P&IDs will include process parameter measurements, control loops, shutdown logic, instrument tag alpha process parameter indication , tag numbers, local process measurements, local/remote control details and panel designation, detailed logic/control philosophy, alarm indication, I/O IOC destination designation, and detailed notes and references.
SDD	The SDDs will be used as a basis for design.		All sections and appendices will be completed keeping that the SDD is a living document. I&C will contribute to sections of SDDs for the other specific plant systems.
Control System Block Diagram	Depicts the control system in simplified block format.		Shows and defines all the all elements of the control system including the method and type of connectivity. Gives an overall general view of the control system and control philosophy.
Instrument Location Plans.	Location and identification of all the sensors, control panels and wiring runs.		Uses the GA with equipment and piping shown.
Instrument Index	This document serves to list all instruments and relate them to other parameters and documents.		This document includes a list of all instrument tags with related information taken from the global database and set up in several standard report formats.
Logic Diagrams	Graphical representation of the discreet logic necessary for interlocking and alarming control systems.		It will be developed in an electronic mode which can be directly down loaded to the intended IOC.
Specifications/Data Sheets	Detail the process, material, performance, and design info. required to purchase instr., control systems., networks, and ICS control hardware.		
Calculations	Calcs aid in sizing and selecting instruments in respect to the process reqmts. Also to account for instrument error and drift in safety related inst.		Instruments to be calculated would include but not be limited to Head type level devices or flowmeters such as orifice plates, venturies, nozzles, weirs, flumes and differential. press. level detectors; modulating control valves; and safety related set points.
Loop Diagrams	Shows the complete control loop from sensor to final control element. Identification is made of electrical and pneumatic connections and all pertinent information needed to completely test and trouble shoot each control loop.		Fieldbus technology is rapidly taking form in the data communication area. A study is now being done to determine its effect on the composition of this traditional instrumentation document.
Installation Details	These documents show the details of instrument installation including hardware type, size, material, quantity and location of all off line instruments.		Inline, into-line, or into-vessel instruments are not usually included except if there is a pneumatic connection or if it is an unusual installation situation.

Table 6-15, Final Design Work Packages - Radwaste Systems

Facility/System: Radwaste Systems **WBS** 1.11.06

Items	Description	Interface/ Precursor	Comments/Limits for Design Phase
Source Terms	A description of each waste stream including quantity, chemical characteristics, and nuclear characteristics.		Source Term Identification for each waste stream based on normal operation and occasional occurrences; quantity-flowrate (gpm); total dissolved solids-chemical concentration (ppm); undissolved solids-particle size (microns); nuclear characteristics-isotope concentration (uci/gm).
Design Development Study	A study to evaluate various alternatives		The result of the Design Development Studies will be incorporated in the Flow Diagram and P&ID's for final design.
Process Flow Diagram	A drawing used to identify key process parameters at various points in the systems, such as temperature, pressure, flow, etc.)		Will be developed for liquid, gaseous, and solid radwaste systems. Issued as Rev. 0 for start of final design.
P&ID's	Includes equipment and schematic flow paths including line and valve classifications, sizes and process information. Used to develop final line lists, valve lists, etc.		Issued as Rev. 0 for start of final design. Contains all information required to prepare final equipment sizing, line sizing and lists. Final lists will be issued to support construction.
Calculations	Final equipment and piping sizing calculations. Final Pressure Drop Calculations. Final shielding calculations.		Calculations will be finalized and put through a formal review and approval cycle.
SDD	Complete Sections 1 and 2.		Final Design (includes, but not limited to, number of pumps, valves, heat exchangers, and type of process equipment).
General Arrangement Drawings	All general arrangements will be updated with Rev. 0 P&ID information and input provided to the 3D building model.		Building 3-D model developed by CSA. Nuclear identifies space requirements, then locates specific equipment including O&M envelop and approximates pipe routing space allocation.
Mechanical Installation Drawings	Mechanical will route all piping in 3D Model. Electrical and I&C will locate electrical and I&C equipment.		Mechanical installation drawings will be issued as Rev. 0 to support construction. Information not available from vendor drawing review will be issued at a later date under a Construction Support work package.
Procurement Specification	Specification will be prepared to purchase all radwaste systems and equipment from prequalified vendor.		The actual procurement and the incorporation of vendor drawings into the design will occur during the construction phase.

Table 6-16, Final Design Work Packages - Target/Blanket Systems

Facility/System: Target/Blanket Systems **WBS** 1.07.01

Items	Description	Interface/ Precursor	Comments/Limits for Design Phase
P&IDs	Includes equipment and schematic flow paths including line and valve classifications, sizes and process information. Used to develop final line lists, valve lists, etc.		Issued as Rev 0 for start of final design. Contains all information required to prepare final equipment sizing, line sizing and lists. Final lists will be issued to support construction.
Calculations	Final equipment and piping sizing calculations. Seismic and Dynamic analyses finalized	Final heat loads and cooling requirements from Target and blankets.	Calculations will be finalized and put through a formal review and approval cycle.
	Final Pressure Drop Calculations		Calculations will be finalized and put through a formal review and approval cycle.
SDD	Issue all Sections of the SDD		The SDD will be issued with all section completed
General Arrangement Drawings	All general arrangements will be updated with Rev 0 P&ID information and input provided to the 3D systems model		Produce 3-D model drawing to finalize space requirements, and locates specific equipment including O&M envelop and pipe routing space allocation.
Mechanical Installation Drawings	Locate all equipment and piping in 3D Model . Finalize location I&C equipment		Mechanical installation drawings will be issued as Rev 0 to support construction. Information not available from vendor drawing review will be issued at a later date under a Construction Support work package.

Table 6-17, Final Design Work Packages - Cavity Vessel Systems

Facility/System: Cavity Vessel Systems **WBS** 1.07.02

Items	Description	Interface/ Precursor	Comments/Limits for Design Phase
Process Flow Diagram	A drawing used to identify key process parameters at various points in the systems, such as temperature, pressure, flow, etc.)	.	Will be developed for heat rejection systems only. Issued as Rev 0 for start of final design.
P&IDs	Includes equipment and schematic flow paths including line and valve classifications, sizes and process information. Used to develop final line lists, valve lists, etc.		Issued as Rev 0 for start of final design. Contains all information required to prepare final equipment sizing, line sizing and lists. Final lists will be issued to support construction.
Calculations	Final equipment and piping sizing calculations to ASME criteria.	Final heat loads, cooling, pressure, and dynamic loads requirements from Target and blankets.	Calculations will be finalized and put through a formal review and approval cycle. ASME Design Report will be produced
SDD	Issue all Sections of the SDD		The SDD will be issued with all section completed
General Arrangement Drawings	All general arrangements will be updated with Rev 0 P&ID information and input provided to the 3D systems model		Produce 3-D model drawing to finalize space requirements, and locates specific equipment including O&M envelop and pipe routing space allocation.
Mechanical Installation Drawings	Finalize routing of all piping in 3D Model . Electrical and I&C will locate electrical and I&C equipment		Mechanical installation drawings will be issued as Rev 0 to support construction. Information not available from vendor drawing review will be issued at a later date under a Construction Support work package.

Table 6-18, Final Design Work Packages - Heat Removal Systems

Facility/System: Heat Removal Systems **WBS** 1.07.04

Items	Description	Interface/ Precursor	Comments/Limits for Design Phase
Process Flow Diagram	A drawing used to identify key process parameters at various points in the systems, such as temperature, pressure, flow, etc.)	.	Will be developed for heat rejection systems only. Issued as Rev 0 for start of final design.
P&IDs	Includes equipment and schematic flow paths including line and valve classifications, sizes and process information. Used to develop final line lists, valve lists, etc.		Issued as Rev 0 for start of final design. Contains all information required to prepare final equipment sizing, line sizing and lists. Final lists will be issued to support construction.
Calculations	Final equipment and piping sizing calculations.	Final heat loads and cooling requirements from Target and blankets.	Calculations will be finalized and put through a formal review and approval cycle.
	Final Pressure Drop Calculations		Calculations will be finalized and put through a formal review and approval cycle.
SDD	**Issue all Sections of the SDD**		**The SDD will be issued with all section completed**
General Arrangement Drawings	All general arrangements will be updated with Rev 0 P&ID information and input provided to the 3D building model		Produce 3-D model drawing to finalize space requirements, and locates specific equipment including O&M envelop and pipe routing space allocation.
Mechanical Installation Drawings	Mechanical will route all piping in 3D Model . Electrical and I&C will locate electrical and I&C equipment		Mechanical installation drawings will be issued as Rev 0 to support construction. Information not available from vendor drawing review will be issued at a later date under a Construction Support work package.

Table 6-19, Final Design Work Packages - Accelerator

Facility/System: Accelerator **WBS** 1.06

Items	Description	Interface/ Precursor	Comments/Limits for Design Phase
Process Flow Diagram	A drawing used to identify key process parameters at various points in the systems, such as temperature, pressure, flow, etc.)	.	Will be developed for cooling and cryogenic systems only. Issued as Rev 0 for start of final design.
P&IDs	Includes equipment and schematic flow paths including line and valve classifications, sizes and process information. Used to develop final line lists, valve lists, etc.		Issued as Rev 0 for start of final design. Contains all information required to prepare final equipment sizing, line sizing and lists. Final lists will be issued to support construction.
Equipment Design Drawings/Specifications	Specifications for common Linac technical equipment such as valves, pumps, vacuum instruments; preliminary drawings or specifications for specialized equipment		Technical equipment drawings or specifications will be completed to allow for the procurement or fabrication of the equipment
Software Requirements	Control process and display input to the Integrated Control System for proper control and monitoring of accelerator		Software requirements developed in sufficient detail to allow development of the software for control and monitoring of the Linac by the Integrated Control System
Calculations	Final equipment design and sizing calculations.		Calculations will be finalized and put through a formal review and approval cycle.
SDD	Update all Sections of the SDD		The SDD will be issued with all sections completed
General Arrangement Drawings	Locate all sized technical equipment and allow for cooling and cryogenic pipe routing.		Identifies final technical equipment layouts and space requirements including O&M envelop and pipe and electrical conduit routing space allocation.
Procurement Packages	Packages with drawing/specifications and other appropriate information, such as QA, to procure the equipment		Ready to begin the procurement process
Fabrication, Installation, Start up and Commissioning Schedules & Plans	Schedules and plans that describe and coordinated activities to fabricate, install, start up and commission the Linac		Schedules and plans will be developed to a sufficient level to begin the construction of the Linac

Table 6-20, Final Design Work Packages - Target/Blanket

Facility/System: Target/Blanket **WBS** 1.07

Items	Description	Interface/ Precursor	Comments/Limits for Design Phase
P&IDs	Includes equipment and schematic flow paths including line and valve classifications, sizes and process information. Used to develop final line lists, valve lists, etc.		Issued as Rev 0 for start of final design. Contains all information required to prepare final equipment sizing, line sizing and lists. Final lists will be issued to support construction.
Calculations	Final equipment and piping sizing calculations. Seismic and Dynamic analyses finalized	Final heat loads and cooling requirements from Target and blankets.	Calculations will be finalized and put through a formal review and approval cycle.
	Final Pressure Drop Calculations		Calculations will be finalized and put through a formal review and approval cycle.
SDD	Issue all Sections of the SDD		The SDD will be issued with all section completed
General Arrangement Drawings	All general arrangements will be updated with Rev 0 P&ID information and input provided to the 3D systems model		Produce 3-D model drawing to finalize space requirements, and locates specific equipment including O&M envelop and pipe routing space allocation.
Mechanical Installation Drawings	Locate all equipment and piping in 3D Model . Finalize location I&C equipment		Mechanical installation drawings will be issued as Rev 0 to support construction. Information not available from vendor drawing review will be issued at a later date under a Construction Support work package.

Table 6-21, Final Design Work Packages - Tritium Separation Facility

Facility/System: Tritium Separation Facility **WBS** 1.09

Items	Description	Interface/ Precursor	Comments/Limits for Design Phase
Process Flow Diagram	Presents process mass and energy balances. Used to identify key process parameters at various points in the systems, such as temperature, pressure, flow, stream composition, etc.)	Heat loads, temperature and pressure distributions, stream composition changes, etc. .	Will be developed for all process systems except the Analytical Lab and the Tritium Storage System. Necessary to support system design and equipment sizing.
P&IDs	Presents equipment and schematic flow paths including line and valve classifications and sizes, process and control information. Used to develop preliminary line lists, valve lists, etc.	Process connectivity, process parts, control loops, process part sizing, etc.	Equipment, instrumentation, control information complete and drawings issued for construction.
Equipment, Valve, Line and Instrument Lists	These lists are taken from the P&IDs and constitute a full set of items with their appropriate APT identification numbers traceable to the drawings and to the installed equipment.	Number and type of parts and unique identification number for each part	Lists will be complete and fully consistent with the drawing packages.
Detailed Process Equipment Design Drawings	Drawings present design information necessary to fabricate and assemble specialty process equipment.	Information needed to fabricate and assemble process equipment.	Drawings reviewed and approved for construction.
Equipment Specifications	When needed, supplies supplementary requirements for specialty process and mechanical equipment needed in the TSF.	Detailed requirements needed to fabricate and assemble process equipment	Specifications reviewed and approved for construction.
Process Equipment Arrangement Drawings	Provides process equipment arrangement details needed by a vendor to design and assemble a process system. Is part of the procurement specifications.	With P&IDs and Specifications, supplies information needed by a vendor to assemble parts into an operable, maintainable system	Drawings approved for construction. Includes (with P&IDs and Specifications) sufficient detail for vendor to perform a detailed design of the equipment arrangement, assemble the system in glove boxes or other configurations, and prepare detailed, as-build drawings of the completed system.
Electrical Single Line Drawings	Number and types of electrical loads.	Information needed by balance of plant to design the electrical supply and distribution system.	Drawings will be approved for construction.

Appendix C, Staffing Plan by Work Breakdown Structure, Year and Location

WBS 1.05 Balance of Plant

Equivalent Full Time Employees

	FY 98	FY 99	FY 00	FY 01
Home Office	23	35	23	10
LANL	3	3	1	1
SRS	19	46	50	25
Total	45	84	74	36

Work Description

Home Office

FY 98	Perform preliminary design for site layout, T/B, Accelerator, Klystron Gallery and Security Bldg, and the Injector bldg. Perform Geotechnical analysis, develop seismic models for the T/B and accelerator.
FY 99	Execute the final design for the Tunnel, Klystron Gallery and the Injector bldg. to meet the third quater construction start for the tunnel. Execute the seismic analysis for the T/B building.
FY 00	Preliminary and final design of the Administration and training buildings. Miscellaneous dynamic seismic analysis.
FY 01	.Preliminary and final design of the Access control and the Operations buildings.

SRS Area

FY 98	Perform the Site civil design for temporary and final construction including all underground utilities, roads and construction services. Also supervise the geotechnical field and lab work.
FY 99	.Complete Site road and rail spur design and final grading, final design of the T/B building, sewer lift station, fire pump house and water tank foundations.
FY 00	Complete T/B building design, Beam stop, Pipe racks, Rad waste. Begin design of the TSF, Klystron Remanufacturing, Cryo Module remanufacturing, and final designs for the Electrical ,Mechanical equipment bldgs, and cooling tower basins.
FY 01	Final designs for the T/B Hx, Warehouse, Maintenance bldg, Backup power, Stacks, and Cryo plant enclosures.

LANL Area

FY 98	Preliminary design coordination with LANL for the Accelerator, Injector bldg, T/B and Klystron Gallery.
FY 99	Preliminary design coordination with LANL for Beam stop, Demin water, Administration and Training building designs. Review of Accelerator final design with LANL
FY 00	Coordinate preliminary design for the Klystron remanufacturing and Cryo module remanufacturing buildings, review of final T/B design with LANL.
FY 01	Coodinate Cryo plant configurations and general review of miscellaneous designs with LANL.

WBS 1.06 Linac

Equivalent Full Time Employees

	FY 98	FY 99	FY 00	FY 01
Home Office	32	72	72	42
LANL	42	63	53	26
SRS	0	0	0	0
Total	74	135	125	68

Work Description

Home Office

FY 98	Component trade studies
FY 99	Component design and drawing preparation
FY 00	Component design and drawings and preparation of bid packages
FY 01	Completion of component designs and preparation of bid packages

SRS Area

FY 98	No Activity
FY 99	No Activity
FY 00	No activity
FY 01	No activity

LANL Area

FY 98	Accelerator design integration; incorporation of ED&D generated data into APT accelerator design; subsystem trade studies; development of preliminary equipment layouts and General Arrangement Drawings; development of start up and commissioning plan update requirements and design descriptions in SDDs (System Design Descriptions)
FY 99	Accelerator design integration; incorporation of ED&D generated data into APT accelerator design; subsystem preliminary design; refine equipment layouts and General Arrangement Drawings; refinement of start up/commissioning plans: analyze Accelerator normal/abnormal operating conditions; development of cost/schedule for fabrication, installation, and start up and commissioning
FY 00	Accelerator design integration; incorporation of ED&D generated data into APT accelerator design; subsystem preliminary and final design; refine equipment layouts and General Arrangement Drawings; refinement of start up/commissioning plans; analyze Accelerator normal/abnormal operating conditions; development of cost/schedule for fabrication, installation, and start up and commissioning
FY 01	Accelerator final design integration; incorporation of final ED&D data into APT accelerator design; complete subsystem final design finalize General Arrangement Drawings; finalize start up and commissioning plans; finalize cost/schedule for fabrication, installatic and start up/commissioning; complete Design Reports for all components; prepare operating and maintenance information for all Accelerator systems: complete System Description Documents for all Accelerator systems.

WBS 1.07 Target/Blanket Systems

Equivalent Full Time Employees

	FY 98	FY 99	FY 00	FY 01
Home Office	26	50	46	21
LANL	39	39	39	23
SRS	2	4	10	20
Total	67	93	95	64

Work Description

Home Office

FY 98	Conduct preliminary design of Target Module Handling Machine Robotics System, Cavity Vessel, Beam Stops, and External Shielding. Initiate final design, and Heat Removal Systems. Develop instrumentation requirements. Develop design requirements. Conduct design trade studies. Input to draft SDDs. Prepare drawings and P&IDs.Participate in prototype work and tests of the Target and Blanket modules. Input to EIS & PSAR.
FY 99	Continue design of Target Module Handling Machine Robotics System, Cavity Vessel, Beam Stops, External Shielding, and Heat Removal Systems. Start Window, Target Expander & Door External Shielding, Cavity Flood Sys, & H.E. Beam Stop designs. Compile instrumentation list. Prepare preliminary design SDDs. Prepare drawings. Initiate prototype work and tests of the Target Module Handling Machine. Prepare procurement package for Cavity Vessel. Complete input to PSAR.
FY 00	Continue detail design of all Target/Blanket systems. Continue integration of ED&D test data into design. Prepare detail drawings. Finalize interfaces. Conduct FMAE analyses and prepare input to FSAR as needed. Liaison with vendors. Continue prototyping activities.
FY 01	Complete detail design of Target/Blanket Systems and Components. Complete all remaining prototyping activities. Finalize data evaluation from ED&D program. Complete SDDs, design reports, and drawing packages. Issue all remaining procurement packages. Complete bid evaluation and vendor selection activities. Complete FMAE analyses and input to FSAR.

SRS Area

FY 98	Participate in the design of the Target Module Handling Machine Robotics System. Help with the development of Target/Blanket removal and replacement sequence. Participate in development of Target Blanket Systems O&M interface requirements and related trade studies.
FY 99	Continue to support design of the Target Module Handling Machine Robotics System & support prototyping activities. Participate in O&M aspects of the Target Blanket Systems design.
FY 00	Continue to support design of the Target Module Handling Machine Robotics System & support prototyping activities. Participate in O&M aspects of the Target Blanket Systems design. Continue O&M integration. Prepare procurement packages and initiate bid evaluation and vendor selection activities as needed. Issue construction ready drawings and documents as needed.
FY 01	Complete O&M integration. Issue remaining procurement packages. Perform bid evaluation and vendor selection activities. Complete issue of construction ready drawings and documents.

LANL Area

FY 98	Conduct Physics & Shielding analyses for prelim design. Continue preliminary design of Target Module, Blanket and Reflector Modules, Cavity Vessel Upper Internals, Internal shielding, and for Heat Removal Systems. Finalize design requirements. Conduct design trade studies. Develop instrumentation requirements. Prepare draft SDDs. Prepare drawings & P&IDs. Integrate ED&D test results into design. Prepare prototype procurement packages. Initiate prototype work and tests of the Target and Blanket modules. Input to EIS & PSAR.
FY 99	Conduct Physics & Shielding analyses for final design. Continue design of Target Module, Blanket and Reflector Modules, Cavity Vessel Upper Internals, Internal shielding, and requirements for Heat Removal Systems. Develop design requirements. Conduct design trade studies as needed. Compile instrumentation list. Prepare SDDs & drawings. Prepare prototype procurement packages as needed. Continue prototype work and tests of the Target and Blanket modules. Integrate ED&D test results into design. Complete input to PSAR.
FY 00	Continue detail design of all Target/Blanket systems. Continue integration of ED&D test data into design. Prepare detail drawings. Finalize interfaces. Conduct FMAE analyses and prepare input to FSAR as needed. Liaison with vendors. Continue prototyping activities
FY 01	Complete detail design of Target/Blanket Systems and Components. Complete all remaining prototyping activities. Finalize data evaluation from ED&D program. Complete SDDs, design reports, and drawing packages. Issue all remaining procurement packages. Complete bid evaluation and vendor selection activities. Complete FMAE analyses and input to FSAR

WBS 1.09 Tritium Separations Facility

Equivalent Full Time Employees

	FY 98	FY 99	FY 00	FY 01
Home Office	0.5	1	3	8
LANL	4.5	18	36	35
SRS	0	0	0	0
Total	5.0	19	39	43

Work Description

Home Office

FY 98	Design Studies for Spallation Product Trap Design
FY 99	Component design and drawing preparation, preparation of specifications for standard TSF equipment
FY 00	Component design and drawings
FY 01	Completion of component designs and preparation of bid packages

SRS Area

FY 98	No activity
FY 99	No activity
FY 00	No activity
FY 01	No activity

LANL Area

FY 98	Prepare preliminary process flow diagrams (PFDs), conduct facility layout studies and prepare drawings, conduct process trade studies, prepare preliminary piping and instrumentation drawings (P&Ids) of selected systems, prepare input for the PSAR
FY 99	Complete PFDs, select process technology for major systems based on results from the APT ED&D program, begin design of major process units, prepare preliminary P&Ids for all systems, analyze normal, upset, and emergency operating conditions of TSF systems, prepare interface and arrangement drawings, develop final BOP requirements for T/B Building systems and preliminary definitions of BOP interfaces for TSF Building systems.
FY 00	Complete P&Ids, complete design reports for selected major system components, complete definition of BOP interfaces for TSF systems in the TSF Building
FY 01	Complete Design Reports for all components, prepare procurement packages for all TSF systems, prepare operating and maintenance information for all TSF systems, complete System Description Documents for all TSF systems.

Equivalent Full Time Employees

	FY 98	FY 99	FY 00	FY 01
Home Office	2	6	6	4
LANL	2	2	2	2
SRS	6	18	18	14
Total	10	26	26	20

Work Description

Home Office

FY 98	Prepare technical portion of equipment procurement specifications for review. Continue development of plant modeling software for use on project. Perform non-site specific trade studies to select cost effective design methodology.
FY 99	Complete technical portion of equipment procurement specifications. Perform calculations and analytical evaluations to support specification preparations.
FY 00	Detailed electrical design for non-critical buildings. Provide technical support in the selected areas as dictated by the detailed design activities.
FY 01	Provide technical support in the selected areas as dictated by the detailed design activities.

SRS Area

FY 98	Size equipment, finalize general arrangement/layout of critical buildings. Prepare power distribution scheme for the construction power as well as the normal power requirement. Initiate and complete specification(s) to procure and install construction power substation and associated distribution equipment
FY 99	Finalize the plant power distribution scheme including one line diagrams and related detailed design to issue primary substation specifications for bid. Finalize system component technical requirements to allow interdisciplinary interface and detailed design activities.
FY 00	Begin detailed design of all electrical systems (3-D physical pipe/duct, tray routing). Preparation of electrical wiring and interconnection diagrams, finalize design of the various support systems, such as: communication, safeguards & security, etc.
FY 01	Complete detailed design effort. Provide support details for all systems. Issue all the remaining procurement specifications. Perform bid evaluation and vendor selection activities. Issue the construction ready drawings and documents.

LANL Area

FY 98	Liaison with LANL on their E D&D efforts and prepare technical guidance to SRS/Home office staff based LEDA lessons learned on technical maters involving BOP electrical interfaces
FY 99	. Liaison with SRS/Home office staff on technical maters involving BOP electrical interfaces
FY 00	. Liaison with SRS/Home office staff on technical maters involving BOP electrical interfaces
FY 01	. Liaison with SRS/Home office staff on technical maters involving BOP electrical interfaces

WBS 1.11.02 Heat Removal Systems (Mechanical)

Equivalent Full Time Employees

	FY 98	FY 99	FY 00	FY 01
Home Office	2	2		
LANL	5	6	2	
SRS	2	8	10	2
Total	9	16	12	2

Work Description

Home Office

FY 98	Complete technical portion of all heat removal procurement specifications
FY 99	Liaison with SRS
FY 00	
FY 01	

SRS Area

FY 98	Perform cooling tower trade study. Update the 8/8/96 (rev 1) cooling water supply trade study
FY 99	Preliminary design of cryogenic cooling systems Preliminary and final design of target pool cooling systems
FY 00	Preliminary and final design of Beam Stop heat removal systems Preliminary and final design of makeup water systems. Final design of cryogenic cooling systems, Accelerator heat removal
FY 01	Final design accelerator heat removal system

LANL Area

FY 98	Start Preliminary design of heat removal systems for tungston source, blanket, window, cavity flood, and accelerator systems. Start Preliminary design of heat removal cooling towers
FY 99	Continue design of heat removal systems Continue design of heat removal cooling towers
FY 00	Liaison with SRS
FY 01	

WBS 1.11.03 Balance of Plant- Integrated Control System

Equivalent Full Time Employees

	FY 98	FY 99	FY 00	FY 01
Home Office				
LANL	19	22	22	22
SRS	2	3	6	6
Total	21	25	28	28

Work Description

Home Office

FY 98	
FY 99	
FY 00	
FY 01	

SRS Area

FY 98	Document BOP interface requirements. Work on requirements for O&M issues and compliance with SRS codes and standards.
FY 99	Document BOP interface requirements. Document requirements for O&M issues and compliance with SRS codes and standards. Contribute to grounding and shielding guidelines. Contribute to naming conventions. Develop preliminary staging and testing plans for hardware.
FY 00	Maintain O&M and SRS compliance requirements. Prepare preliminary control room equipment layout and specifications. Prepare preliminary plant equipment layout documentation. Review software and hardware specifications.
FY 01	Finalize O&M and SRS codes and standards compliance documents. Final design for Main Control Room eqipment layout and specifications. Final plant equipment layout specifications. Final grounding and shielding guidelines. Participate in vendor bid evaluation

LANL Area

FY 98	Write preliminary software and hardware requirements documents. Develop preliminary control database format description. Contribute to the I&C sections of SDDs for other specific plant systems. Develop working software QA plan document.
FY 99	Maintain and update SDDs, requirements documents. Begin channel list, database information consolidation. Evaluate output from ED&D. Develop preliminary network requirements document. Prepare ICS to subsystem interface requirements for hardware and software.
FY 00	Update SDDs, requirements documents and channel list, database information. Evaluate output from ED&D and coordinate flowdown into final design. Refine preliminary requirements documentation into formal specifications. Prepare ICS to subsystem interface requirements for hardware and software.
FY 01	Prepare control system block diagrams and specifications for procurement of hardware and software. Provide preliminary test procedures for hardware and software. Issue bid packages to vendors and evaluate.

WBS 1.11.04 Balance of Plant - Instrumentation and Controls

Equivalent Full Time Employees

	FY 98	FY 99	FY 00	FY 01
Home Office	0	0	0	0
LANL	1	2	3	2
SRS	2	5	8	5
Total	3	7	11	7

Work Description

Home Office

FY 98	(No Work)
FY 99	(No Work)
FY 00	(No Work)
FY 01	(No Work)

SRS Area

FY 98	(No Work)
FY 99	(No Work)
FY 00	Liaison w/LANL Area coordinating purchasing and technical matters
FY 01	Liaison w/LANL Area coordinating purchasing and technical matters

LANL Area

FY 98	Finalize Design Criteria, Trade Studies, SDD text sections #1 & #2, start Control Scheme Block Diagrams. Coordinate with Nuclear Requirements
FY 99	Complete Control Scheme Block Diagrams, start P&ID development, Logic Diagrams, Instrument & I/O List, Safety Analysis, Location of Panels on GA. Coordinate with nuclear & electrical requirements.
FY 00	Complete detailed design effort including Specifications & Data Sheets, Panel Drawings, Location Plans, Instrument & I/O List, P&ID's, Loop and Wiring Diagrams.
FY 01	Finalize SDD's, Issue procurement specifications, perform bid evaluation and vendor selection activities.

WBS 1.11.05 Misc. Support Systems (Mechanical)

Equivalent Full Time Employees

	FY 98	FY 99	FY 00	FY 01
Home Office	1	2	2	
LANL	2	0.25	0.25	
SRS	0.5	14	6	3
Total	3.5	16.25	8.25	3

Work Description

Home Office

FY 98	Complete technical portion of all misc. plant systems procurement specifications
FY 99	Preliminary design of neutralization waste treatment system and chemical treatment systems for cooling towers and closed cooling loops
FY 00	Final design of neutralization waste treatment system and chemical treatment systems for closed cooling loops
FY 01	

SRS Area

FY 98	Start preliminary design of misc. support systems
FY 99	Complete preliminary design and start final design of misc. support systems
FY 00	Complete final design of misc. support systems
FY 01	Procurement support. Liaison with home office

LANL Area

FY 98	Start preliminary design of misc. support systems
FY 99	Liaison with SRS
FY 00	Liaison with SRS
FY 01	

WBS 1.11.06 Radwaste Systems

Equivalent Full Time Employees

	FY 98	FY 99	FY 00	FY 01
Home Office	1	1	1	1
LANL	2	2	2	1
SRS	3	5	3	3
Total	6	8	6	5

Work Description

Home Office

FY 98	Prepare technical portion of equipment procurement specifications for review and approval. Perform shielding calculations to size I nternal walls. Continue development of plant modeling software for use on project.
FY 99	Complete technical portion of equipment procurement specifications. Perform calculations and analytical evaluations to support specification preparations.
FY 00	Stress analyses of radwaste piping systems. Provide technical support in the selected areas as dictated by the detailed design activities.
FY 01	Provide technical support in the selected areas as dictated by the detailed design activities.

SRS Area

FY 98	After preliminary design, prepare P&IDs for all Radwaste Systems (Liquid, Gaseous, and Solid). Size equipment, finalize general arrangement/layout of the radwaste equipment in the Target/Blanket Building. Prepare technical information required for the PSAR , EIS, and the Waste Management Plan.
FY 99	Complete P&IDs for all Radwaste Systems (Liquid, Gaseous and Solid). Finalize system component technical requirements to allow interdisciplinary interface and detailed design activities.
FY 00	Begin detailed design of all Radwaste Systems (3-D physical pipe/duct, tray routing). Preparation of electrical wiring and interconnection diagrams, for all Radwaste Systems.
FY 01	Complete detailed design effort. Provide support details for all systems. Issue all the remaining procurement specifications. Perform bid evaluation and vendor selection activities. Issue the construction ready drawings and documents.

LANL Area

FY 98	Preparation of source terms for each radwaste stream. Preparation of process flow portion for each radwaste (Liquid, Gaseous, and Solid)system P&IDs. Prepare design development studies to evaluate process alternatives. Liaison with LANL on their E D&D efforts and prepare technical guidance to SRS/Home office staff based on technical maters involving BOP interfaces
FY 99	. Liaison with SRS/Home office staff on technical maters involving BOP interfaces
FY 00	. Liaison with SRS/Home office staff on technical maters involving BOP interfaces
FY 01	. Liaison with SRS/Home office staff on technical maters involving BOP interfaces

Equivalent Full Time Employees

	FY 98	FY 99	FY 00	FY 01
Home Office		2	4	
LANL		0.25		
SRS				1
Total		2.25	4	1

Work Description

Home Office

FY 98	
FY 99	Prepare water treatment system procurement specifications. Start preliminary design of deionized water system and process water supply system
FY 00	Complete design of deionized water system and process water supply system
FY 01	

SRS Area

FY 98	
FY 99	
FY 00	
FY 01	Procurement Support and Home Office liaison

LANL Area

FY 98	
FY 99	Liaison with Home Office
FY 00	
FY 01	

WBS 1.11.08 HVAC Systems (Mechanical)

Equivalent Full Time Employees

	FY 98	FY 99	FY 00	FY 01
Home Office	1	0.25		
LANL	4	4	1	
SRS	3	6	10	2
Total	8	10.25	11	2

Work Description

Home Office

FY 98	Complete technical portion of all HVAC plant systems procurement specifications
FY 99	Liaison with SRS
FY 00	
FY 01	

SRS Area

FY 98	Preliminary design of wave guide and Klystron Gallery HVAC
FY 99	Preliminary design of BOP HVAC Systems Preliminary design of Beam Stop Building, TSF and final design of Wave Guide HVAC Final design of Klystron Gallery HVAC
FY 00	Complete final design of Beam Stop Building and BOP HVAC systems Preliminary and final design of Radwaste Building HVAC Final design of Operations Building HVAC Preliminary and final design Klystron Remanufacturing HVAC
FY 01	Liaison with construction

LANL Area

FY 98	Preliminary design of Accelerator Tunnel HVAC, and T/B HVAC
FY 99	Final design of Accelerator Tunnel HVAC and T/B HVAC
FY 00	Liaison with SRS
FY 01	

WBS 1.17.00/.01/.02/.04 Systems Engineering

Equivalent Full Time Employees

	FY 98	FY 99	FY 00	FY 01
Home Office	5	5	6	5
LANL	9	9	11	9
SRS	0	0	1	3
Total	14	14	18	17

Work Description: All Syst's Eng'g except for Config Mgmt and Cost Est'g

Home Office

FY 98	Perform RAMI and design point and design envelope calculation packages defined by Los Alamos Office. Develop preliminary design requirements evolving from above analyses. Support trade studies centered in Los Alamos.
FY 99	Perform RAMI and design point and design envelope calculation packages. Refine design requirements evolving from above analyses. Support trade studies centered in Los Alamos.
FY 00	Perform RAMI and design point and design envelope calculation packages defined by Los Alamos Office. Finalize design requirements in areas noted. Support trade studies centered in Los Alamos.
FY 01	Support plant RAMI analyses packages defined by Los Alamos Office. Support design incorporation of RAMI. Support trade studies centered in Los Alamos.

SRS Area

FY 98	
FY 99	
FY 00	Coordinate Systems Engineering effort related to BOP final design activities, construction and O&M Support integration of operations based requirements in design process
FY 01	Coordinate Systems Engineering effort related to BOP final design activities, construction and O&M Support integration of operations based requirements in design process

LANL Area

FY 98	Overall lead and coordination of systems engineering effort. Maintain systems engineering interface with TPO. Lead plant RAMI program including requirements definition, design systems support, and assessment of expected performance. Perform other plant assessments as required to define preliminary requirements. Support systems trade studies.
FY 99	Overall lead and coordination of systems engineering effort. Maintain systems engineering interface with TPO. Plant RAMI program including requirements definition, design systems support, and assessment of expected performance. Perform other plant assessments as required to update or define requirements. Support ongoing systems trade studies.
FY 00	Overall lead and coordination of systems engineering effort. Maintain systems engineering interface with TPO. Lead plant RAMI program including requirements definition, design systems support, and assessment of expected performance. Perform other plant assessments as required to finalize requirements. Support systems trade studies.
FY 01	Overall lead and coordination of systems engineering effort. Maintain systems engineering interface with TPO. Lead plant RAMI program including design systems support, and final assessment of expected performance. Ensure plant requirements compliance and documentation of design basis.

WBS 1.17.03 Systems Engineering: Configuration Management

Equivalent Full Time Employees

	FY 98	FY 99	FY 00	FY 01
Home Office	1	1	1	1
LANL	3	3	2	2
SRS	3	3	5	5
Total	7	7	8	8

Work Description: Configuration Management at the four PPO Sites

Home Offices (NJ & LaJolla)

FY 98	Execute activities associated with maintaining the Engineering Data Base (EDB) for Engineering & Design work accomplished at the NJ and LaJolla home offices and integrate the data into the centralized repository at the Trinity Office.
FY 99	Execute activities associated with maintaining the Engineering Data Base (EDB) for Engineering & Design work accomplished at the NJ and LaJolla home offices and integrate the data into the centralized repository (at the Trinity Office until 2Q FY 99, then will switch to the SRS Office).
FY 00	Execute activities associated with maintaining the Engineering Data Base (EDB) for Engineering & Design work accomplished at the NJ and LaJolla home offices and integrate the data into the centralized repository at the SRS Office.
FY 01	Execute activities associated with maintaining the Engineering Data Base (EDB) for Engineering & Design work accomplished at the NJ and LaJolla home offices and integrate the data into the centralized repository at the SRS Office.

SRS Area

FY 98	Execute activities associated with maintaining the Engineering Data Base (EDB) for Engineering & Design work accomplished at the SRS Office and forward to the centralized repository at the Trinity Office. In conjunction with lead from Trinity Office, extend the Configuration Management System to support the start of construction (Oct '98).
FY 99	Assume overall lead for Configuration Management activities in the 2Q FY 99. Serve as the centralized repository of the EDB to support construction activities. Extend the Configuration Management System to accomodate capture of vendor data . Execute activities associated with maintaining the Engineering Data Base (EDB) for Engineering & Design work accomplished at all of the PPO Offices and for the construction and procurement work.
FY 00	Provide overall lead for Configuration Management activities. Execute activities associated with maintaining the Engineering Data Base (EDB) for Engineering & Design work accomplished at all of the PPO Offices and for the construction and procurement work. Manage the change control process consistent with the change control authorities and responsibilities outlined in the PEP and Project Controls Policy Manual.
FY 01	Provide overall lead for Configuration Management activities. Execute activities associated with maintaining the Engineering Data Base (EDB) for Engineering & Design work accomplished at all of the PPO Offices and for the construction and procurement work. Manage the change control process consistent with the change control authorities and responsibilities outlined in the PEP and Project Controls Policy Manual.

LANL Area

FY 98	Provide overall lead for Configuration Management activities. Execute activities associated with maintaining the Engineering Data Base (EDB) for Engineering & Design work accomplished at the Trinity Office. Extend the Configuration Management System to encompass work to be done at the other three PPO Offices (SRS, NJ, and LaJolla), and to support start of construction in Oct 98 (e.g., implement Field Change System). Manage the change control process consistent with the change control authorities and responsibilities outlined in the PEP and Project Controls Policy Manual.
FY 99	Provide overall lead for Configuration Management activities until 2Q FY 99. Execute activities associated with maintaining the Engineering Data Base (EDB) for Engineering & Design work accomplished at the Trinity Office. Manage the change control process consistent with the change control authorities and responsibilities outlined in the PEP and Project Controls Policy Manual.
FY 00	Execute activities associated with maintaining the Engineering Data Base (EDB) for Engineering & Design work accomplished at the Trinity Office, and integrate the data into the centralized EDB at SRS. By 1Q of FY 00, responsibility for Change Control Process will have switched to SRS.

FY 01	Execute activities associated with maintaining the Engineering Data Base (EDB) for Engineering & Design work accomplished at the Trinity Office, and integrate the data into the centralized EDB at SRS.

WBS 1.17.05 Systems Engineering: Cost Estimating

Equivalent Full Time Employees

	FY 98	FY 99	FY 00	FY 01
Home Office	1	1	1	1
LANL	3	2	2	2
SRS	1	2	2	2
Total	5	5	5	5

Work Description: Cost Estimating

Home Offices (NJ & LaJolla)

FY 98	Provide direction/ guidance and review of APT cost estimating efforts. Assist in providing additional home office support during periods of peak estimating efforts.
FY 99	Provide direction/ guidance and review of APT cost estimating efforts. Assist in providing additional home office support during periods of peak estimating efforts.
FY 00	Provide direction/ guidance and review of APT cost estimating efforts. Assist in providing additional home office support during periods of peak estimating efforts.
FY 01	Provide direction/ guidance and review of APT cost estimating efforts. Assist in providing additional home office support during periods of peak estimating efforts.

SRS Area

FY 98	Realign the Project Baseline Estimate into construction subcontractor packages, and prepare other required document packages for support of a phased construction. Support Construction Management for estimating costs to comply with EIS and other ES&H Requirements and integrate into the over-all cost estimates.
FY 99	Continue development of subcontractor packages and associated construction baseline cost estimates. Continue preparation of other required documents for a phased completion of Final Design and phased Construction. Continue supporting Construction Management in estimating cost impacts of addressing EIS and other ES&H requirements and include in over-all cost estimates. Address requirements of Labor Agreements and integrate into over-all cost estimates.
FY 00	Continue development of subcontractor packages and associated construction baseline cost estimates. Continue preparation of other required documents for a phased completion of Final Design and phased Construction. Continue supporting Construction Management in estimating cost impacts of addressing EIS and other ES&H requirements and include in over-all cost estimates. Address requirements of Labor Agreements and integrate into over-all cost estimates.
FY 01	Continue development of subcontractor packages and associated construction baseline cost estimates. Continue preparation of other required documents for a phased completion of Final Design and phased Construction. Continue supporting Construction Management in estimating cost impacts of addressing EIS and other ES&H requirements and include in over-all cost estimates. Address requirements of Labor Agreements and integrate into over-all cost estimates.

LANL Area

FY 98	Complete installation and training for *Success Estimating System*, and complete transfer of the CDR estimate to this system. Update cost estimates in support of the CD-3 (Start Construction) decision process. Estimate Trade Study alternatives and incorporate into the CDR estimate. Perform a bottoms up estimate for the Linac.
FY 99	Based on completion of all Preliminary Engineering, complete an updated cost estimate and associated documents, and perform a reconciliation between this estimate and the Project Baseline Estimate. Assist in the integration of schedule and cost estimates and the development of associated funding profiles/ requirements.
FY 00	Assist in the integration of schedule and cost estimates and the development of associated funding profiles/ requirements. Continue to update cost estimates based on priced proposals to supply major procured components.
FY 01	Assist in the integration of schedule and cost estimates and the development of associated funding profiles/ requirements. Continue to update cost estimates based on final proposed prices to supply major procured components.

WBS 1.18 Project Management

Equivalent Full Time Employees

	FY 98	FY 99	FY 00	FY 01
Home Office	4	12	10	4
LANL	8	24	16	10
SRS	12	44	30	18
Total	24	80	56	32

Work Description

Home Office

FY 98	Same as SRS area
FY 99	Same as SRS area
FY 00	Same as SRS area
FY 01	Same as SRS area

SRS Area

FY 98	Provide Project Management Services including: project management and coordination, cost and schedule control, quality assurance/quality control, project operations, procurement management, contract management, financial management, personnel management, project administration, and clerical.
FY 99	Provide Project Management Services including: project management and coordination, cost and schedule control, quality assurance/quality control, project operations, procurement management, contract management, financial management, personnel management, project administration, and clerical.
FY 00	Provide Project Management Services including: project management and coordination, cost and schedule control, quality assurance/quality control, project operations, procurement management, contract management, financial management, personnel management, project administration, and clerical.
FY 01	Provide Project Management Services including: project management and coordination, cost and schedule control, quality assurance/quality control, project operations, procurement management, contract management, financial management, personnel management, project administration, and clerical.

LANL Area

FY 98	Same as SRS area
FY 99	Same as SRS area
FY 00	Same as SRS area
FY 01	Same as SRS area

WBS 1.19.02 Plant Safety

Equivalent Full Time Employees

	FY 98	FY 99	FY 00	FY 01
Home Office	2	2	3	3
LANL	2	2	0	0
SRS	3	3	5	5
Total	7	7	8	8

Work Description

Home Office

FY 98	Prepare input to PSAR section drafts. Perform verification and validation of safety analysis softtware. Provide safety input to design trade studies. Perform calculations and analytical evaluations to support safety analyses. Establish codes and standards to be used for safety class and safety significant structures, systems and components.
FY 99	Perform calculations and analytical evaluations to support safety analyses. Provide input for responses to DOE SAR questions. Assist in safety reviews of preliminary design drawings, specifications and other documents.
FY 00	Perform calculations and analytical evaluations to support safety analyses.
FY 01	Perform calculations and analytical evaluations to support final safety analyses . Assist in safety reviews of final design documents.

SRS Area

FY 98	Develop APT specific standards/requirements information document (S/RIDS) for the Project. Prepare input for technical safety requirements (TSR) section for the PSAR.
FY 99	Assist construction management with safety input and safety reviews of construction procedures. Perform safety reviews of drawings , specifications and other design documents.
FY 00	Perform safety reviews of drawings , specifications and other detail design documents. Implement construction safety plans, policies and procedures. Coordinate preparation of final safety analysis report (FSAR) sections.
FY 01	Provide safety input to operational readiness review. Provide safety input to final design change control. Coordinate responsaes to DOE FSAR questions.

LANL Area

FY 98	Coordinate preparation of Preliminary Safety Analysis Report (PSAR) sections. Prepare PSAR executive summary. Review Safety Test Plans. Review safety test results. Participate in safety working group meetings. Update safety implementation plan.
FY 99	Coordinate with SRS/Home office staff on safety matters involving Accelerator, Target /Blanket and BOP design and interfaces. Participate in safety working group meetings.
FY 00	NA
FY 01	NA