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AVLIS
Production Plant
Preliminary Quality Assurance
Plan and Assessment

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AVLIS
Production Plant
Preliminary Quality Assurance
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Prepared by the AVLIS Program at Lawrence Livermore National Laboratory and Martin Marietta Energy Systems, Inc., with major contributions from Bectel National, Inc.

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Incorporated

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1. EXECUTIVE SUMMARY

1.1. INTRODUCTION

This preliminary Quality Assurance Plan and Assessment establishes the Quality Assurance requirements for the AVLIS Production Plant Project. The Quality Assurance Plan defines the management approach, organization, interfaces, and controls that will be used in order to provide adequate confidence that the AVLIS Production Plant design, procurement, construction, fabrication, installation, start-up, and operation are accomplished within established goals and objectives.

The AVLIS project is a joint effort by LLNL and Martin Marietta Energy Systems, both having institutional quality assurance programs. To specifically address the AVLIS Production Plant needs, the two organizations have prepared this joint Quality Assurance Plan. This document establishes the joint Quality Assurance Plan requirements. The requirements contained herein are in accordance with those specified in both DOE Document OR 5700.6 "Quality Assurance - ORO Site Implementation Plan" and with DOE Document SAN MD No. 5700.6 "Quality Assurance."

The Quality Assurance Program defined in this document includes a system for assessing those elements of the project whose failure would have a significant impact on safety, environment, schedule, cost, or overall plant objectives. As elements of the project are assessed, classifications are provided to establish and assure that special actions are defined which will eliminate or reduce the probability of occurrence or control the consequences of failure.

1.2. SCOPE

All contractor organizations shall participate in the AVLIS Quality Assurance Program in accordance with the requirements of this document either by direct application or as imposed through contract requirements. The AVLIS Quality Assurance Program applies to activities related to the establishment of design criteria and requirements for the design and development, procurement, fabrication, construction, installation and start-up phases of the project. When equipment and facilities receive final acceptance, the plant operator shall implement an operations quality assurance program consistent with DOE requirements.

Quality Assurance cost and schedule impacts on the AVLIS Production plant have been accounted for by this Quality Assurance Plan and assessment and by existing quality assurance plans at Lawrence Livermore National Laboratory and Martin Marietta Energy Systems, Inc.

1.3. OBJECTIVE

The objective of this program is to assure that management attention and support for quality assurance are systematically applied by all participants. In addition, the program should assure that adequate plans and actions are established, implemented and maintained with emphasis on achieving a high degree of operational success with due consideration to health and safety, environmental protection, performance, and reliability. The emphasis should be on actions necessary to prevent significant quality problems.

Each project participant shall have a program for assuring quality of services, equipment, and facilities. Concern for quality shall be visible and shall receive management attention. To maximize effectiveness, the Quality Assurance program shall be selectively applied to emphasize prevention of major problems. The program shall include provisions which assure that each employee clearly understands his/her role in providing assurance of quality.

The AVLIS quality assurance program is based on the following principles. These principles form the foundation of the quality assurance program.

1. Preplanning is a key element for early detection and prevention of problems: During the preplanning phase, the assessment process is used to evaluate the risk of failure of equipment, facilities, or management systems. When the risk is judged to be unacceptable or unknown a quality assurance action plan is required. This plan describes the action to be taken to prevent or correct the problems. Methods used to detect or prevent quality problems include independent design reviews, vendor surveillance, first-article evaluations, inspections, document and change control, and training.
2. The line organization is responsible for the quality of their work: To achieve quality, the line organization must participate in the quality assurance program. This includes quality assurance planning, development of procedures and the implementation of these plans and procedures.
3. The operator of the facility must be involved in the quality assurance program: Organizations responsible for the operation and maintenance of the facility must participate in and monitor quality assurance during design and construction. Potential operating problems must be identified and corrected before start-up and operation.
4. Independent evaluation will verify the adequacy of the quality assurance program: To enhance the effectiveness of the quality assurance program, quality assurance personnel should provide an independent evaluation of the adequacy of the quality assurance program implementation.

1.4. QUALITY ASSURANCE PROGRAM

A quality assurance program that complies with the requirements of this document shall be established by project participants, at the earliest practical time prior to start of activities. The program shall provide for application of control and verification activities consistent with the importance of an item or service to safety, reliability, and performance, and shall provide for the documentation of quality related activities. The

program shall include a system for identifying, documenting, preventing and resolving problems before they have a significant impact. The Quality Assurance Program applies to activities during development, engineering, procurement, fabrication, construction, operation, and maintenance. Implementing procedures consistant with this quality program plan will be prepared by individual program participants.

1.5. ORGANIZATION

Each contractor organization shall define the organizational structure within which the Quality Assurance Program is to be planned and implemented. The organizational description shall clearly delineate the responsibilities and authority of the various personnel and organizations involved. The person responsible for the formulation and direction of the Quality Assurance Program shall have direct access to management at a level where appropriate action can be initiated when required and shall report regularly on the effectiveness of the program. Persons and organizations performing Quality Assurance functions shall have sufficient authority and organizational freedom to verify conformance to quality requirements, detect early breakdowns in quality systems, identify and report quality problems, and initiate, recommend or provide solutions, as appropriate, through designated channels. The AVLIS Project Organization is defined in Sec. 2. The organizational structure and interface between principal participants is described in detail in the AVLIS Production Plant Project Management Plan (APP010).

1.6. QUALITY ASSURANCE ACTION ELEMENTS

This section lists commonly referenced quality assurance action elements. These elements are frequently used in the management of project activities, and it is necessary for all project participants to have a common understanding of these elements. The selective application of these elements in Quality Assurance Action Plans is determined by the concerns identified in the project risk assessments. The application of these elements is not limited by the Risk Assessment and Quality Assurance Action Plan. Elements

may be applied at the discretion of management when considered necessary for control of project activities. Application of Quality Assurance action elements is further defined in Secs. 3 and 5.

- o Design Control
- o Procurement Control
- o Subcontractor Control
- o Instructions, Procedures, and Drawings
- o Document Control
- o Control of Purchased Materials, Equipment and Services
- o Identification and Control of Materials, Parts, and Components
- o Control of Special Processes
- o Inspection
- o Test Control
- o Control Measuring and Test Equipment
- o Handling, Storage and Shipping
- o Inspection, Test and Operating Status
- o Control of Noncomforming Items
- o Software control
- o Quality Assurance Records
- o Safety Control

1.7. RISK ASSESSMENTS

Risk assessments shall be conducted during the Title I phase of the project with the intent of identifying those elements of the project where significant adverse impact would be experienced if that system, service, facility, or component, etc., did not perform satisfactorily. In determining adverse impact, consideration shall be given to risk which includes the consequences of failure and the probability of failure. The project elements to be formally evaluated shall include any management practice, functional design, equipment selection, organizational infrastructure, environmental factor, safety factor, program goal, cost constraints, program schedules, etc., which would impact the achievement of operational success. Accordingly, items requiring special actions will be identified.

The assessment process is progressive, and iterative. Project assessments shall begin at the management systems level focusing on those project elements necessary to manage the AVLIS project. Subsequent assessments will focus on a further breakdown of the lower levels of the Work Breakdwon Structure and will utilize design details which become available as the design progresses. The entire risk assessment process is iterative in that project element risk may be reevaluated any time sufficient change has occurred to warrant an assessment.

Risk assessments shall be initiated as early as feasible in the design. This permits the early identification of project elements requiring additional management attention.

The organization responsible for performing a risk assessment shall assure all project phases are addressed and that representatives from various appropriate disciplines participate in the assessment. The operator or user of the facility must participate in the assessment process. A preliminary risk assessment has been completed and details are in Sec. 4. This assessment has identified several systems and components require quality assurance actions beyond the existing level of assurance.

1.8. PROGRAM IMPLEMENTATION AND CONTROL

When results of the Assessments identify items requiring special actions, Quality Assurance Action Plans shall be prepared by the responsible design organization to establish actions to eliminate or reduce the probability of occurrence, or to control the consequences of failure. Quality Assurance Action Plans shall be initiated as soon as the necessity for one becomes evident. Preparation and review of Quality Assurance Action Plans should involve all disciplines necessary to cover the broad range of actions required during all phases of the project including design, procurement, fabrication, construction, start up, and operations. Actions to be considered in the preparation of Quality Assurance Action Plans are defined in Sec. 3.

When a Risk Assessment has established that an item requires no special actions, a Quality Assurance Action Plan is not required; however, participants are required to take appropriate steps to identify and prevent

quality problems in their areas of responsibility. Nationally recognized codes and standards shall be invoked in specifications and drawings as applicable. Each participant's standard practices and procedures may also be acceptable. In the event that significant quality problems occur, formal investigations shall be performed to identify deficiencies and immediate corrective action initiated. Quality Assurance Program implementation is defined in Sec. 5.

The Quality Assurance Program is initiated for the AVLIS Production Plant Project upon AVLIS process selection and continues through Title I, II, and III, and start-up phases of the project. The major milestones for the Quality Assurance Program are listed in Table 1-1. The timing of Quality Assurance Key Milestones relative to the Authorization Limited Schedule is shown in Fig. 1-1.

Control of project quality activities shall be accomplished through a system of planned and scheduled audits conducted by teams defined by the detailed Quality Assurance plans, including Quality Assurance personnel. Reports of audits shall be issued identifying deficiencies and recommended corrective actions. Management shall be kept informed of the status and effectiveness of the Quality Assurance program.

Table 1-1. Quality Assurance Program Milestones.

Key Milestone No.	Date	Milestone
1	Nov. 1984	Complete Preliminary Quality Assurance Plan & Preliminary Risk Assessment
	May. 1985	AVLIS Process Selection
2	Sept. 1985	Submit Quality Assurance Plan to DOE for Approval
	Oct. 1985	Engineering Initiated
	Oct. 1985	Issue DOE Approved Quality Assurance Plan for Implementation
	Oct. 1985	Procurement Initiated
	Nov. 1985	Start Project Engineering and Administration Procedures
	Nov. 1985	Start Procurement Procedures
3	Jan. 1986	Complete Project Engineering and Administration Procedures
4	Jan. 1986	Complete Procurement Procedures
	Jan. 1986	Start Detailed Risk Assessments
5	April 1986	Complete Detailed Risk Assessments
	Oct. 1986	Start Quality Assurance Action Plans for Items Requiring Special Action
	Oct. 1986	Construction Initiated
	Nov. 1986	Start Construction Procedures
6	Jan. 1987	Complete Construction Procedures
7	July 1987	Complete Quality Assurance Action Plans
	Oct. 1988	Special Equipment Installation Initiated
	Dec. 1988	Engineering Complete
	Oct. 1989	Start-up Initiated
8	Jan. 1990	Submit Operations Quality Assurance Plan to DOE
	Aug. 1990	Issue Approved Operations Quality Assurance Plan for Implementation
	Oct. 1990	Production Initiated

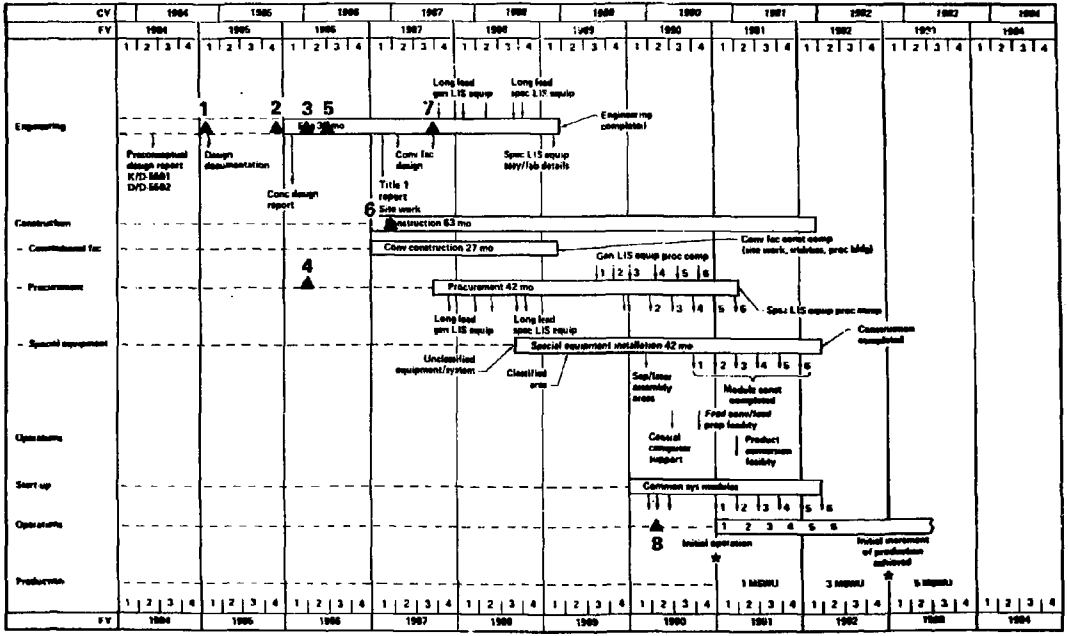


Fig. 1-1. Quality Assurance Program Key Milestones. See Table 5-4 for Milestone Definition and Number

2. ORGANIZATION AND RESPONSIBILITIES

Design and construction of the AVLIS Production Plant will be accomplished under the direction of the U.S. Department of Energy (DOE), by Martin Marietta Energy Systems, Inc., and Lawrence Livermore National Laboratory (LLNL) working as an integrated team. The team will be assisted by one or more architect/engineers for facility design; a construction manager; one or more fixed-price contractors for construction; a cost-plus-award-fee contractor for construction; and subcontractors to the operating contractors. Where feasible, procurement and construction will be awarded on the basis of advertised competitive bids.

The project will be organized within the existing Department of Energy structure. Project and program interfaces upon commencement of the capital project are depicted in the Project Management Plan (APP010) and are shown in Fig. 2-1. Principal participants are DOE Headquarters, the DOE Oak Ridge Operations Office (ORO), the DOE San Francisco Operations Office (SAN), the Technology Program Office (TPO), and the Operating Contractors Lawrence Livermore National Laboratory (LLNL), and Martin Marietta Energy Systems, Inc. (MMES).

The AVLIS Technical Program Office at LLNL receives direction from DOE Headquarters and is responsible for the technical management of the overall program. The Technical Program Office will move to Martin Marietta after completion of Title II design. The Contractor Project Organization led by Martin Marietta has the prime responsibility for executing the AVLIS Production Plant Project. The supporting technical efforts will be led by LLNL until the first plant increment is activated; thereafter, Martin Marietta will lead these activities.

Each contractor organization shall define the organizational structure within which the Quality Assurance Program is to be planned and implemented. The organizational description shall clearly delineate the responsibilities and authority of the various personnel and organizations involved. The person responsible for the formulation and direction of the Quality Assurance Program shall have direct access to management at a level where appropriate action can be initiated when required and shall report regularly on the effectiveness of the program. Persons and organizations performing Quality Assurance functions shall have sufficient authority and organizational freedom to verify conformance to quality requirements, detect early breakdowns in quality

systems, identify and report quality problems, and initiate, recommend or provide solutions, as appropriate, through designated channels. The AVLIS Project Organization is defined in Fig. 2-2. The organizational structure and interface between principal participants is described in detail in the AVLIS Production Plant Project Management Plan (APP010).

The formulation, adminstration and surveillance of the Quality Assurance Plan is the responsibility of Martin Marietta and LLNL Managers. The various project engineers who are assigned responsibility for the conventional and special facilities are responsible for implementing the requirements of this plan consistent with their assigned technical responsibility.

Upon commencement of the project, the AVLIS Production Plant Contractor Project Organization (CPO) shall develop and implement a quality assurance program in accordance with the requirements of this document. This quality assurance program is subject to approval by the Oak Ridge Operations - Field Project Office (ORO/FPO). Contractor and subcontractor Quality Assurance Programs shall be approved by the Contractor Project Organization.

The Quality Assurance Program recognizes that the line organization is responsible for achieving and assuring the desired quality, reliability, and safety of its activities. This plan provides for formal controls that will be integrated within the normal management practices of the project line and engineering organizations to provide a high degree of confidence that the goals of the project will be achieved as planned.

Procedures for performance and control of work will be prepared by the line organization responsible for the work prior to start of work. Procedures shall be approved by appropriate management and reviewed by Quality Assurance personnel for conformance to the Quality Assurance Program requirements.

The project engineering group will be responsible for maintaining the overall status of the project and for proper dissemination of project information such as plans, schedules, budgets, estimates, and project technical and management control documents. This group will prepare the project reports.

The design and systems engineering include Titles I, II, and III as well as analyses, reliability engineering, criteria verification, test plans, operability and maintainability plans, parts lists, and standardization.

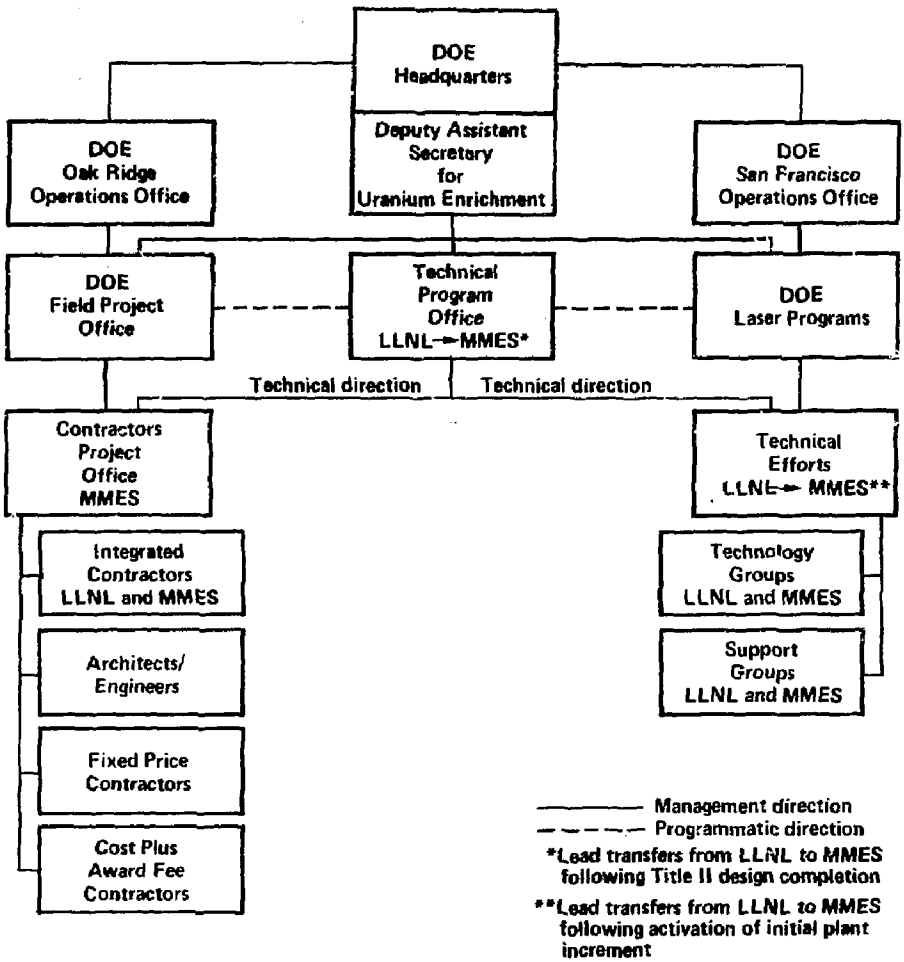


Fig. 2-1. Organization of Project for AVLIS Production Plant.

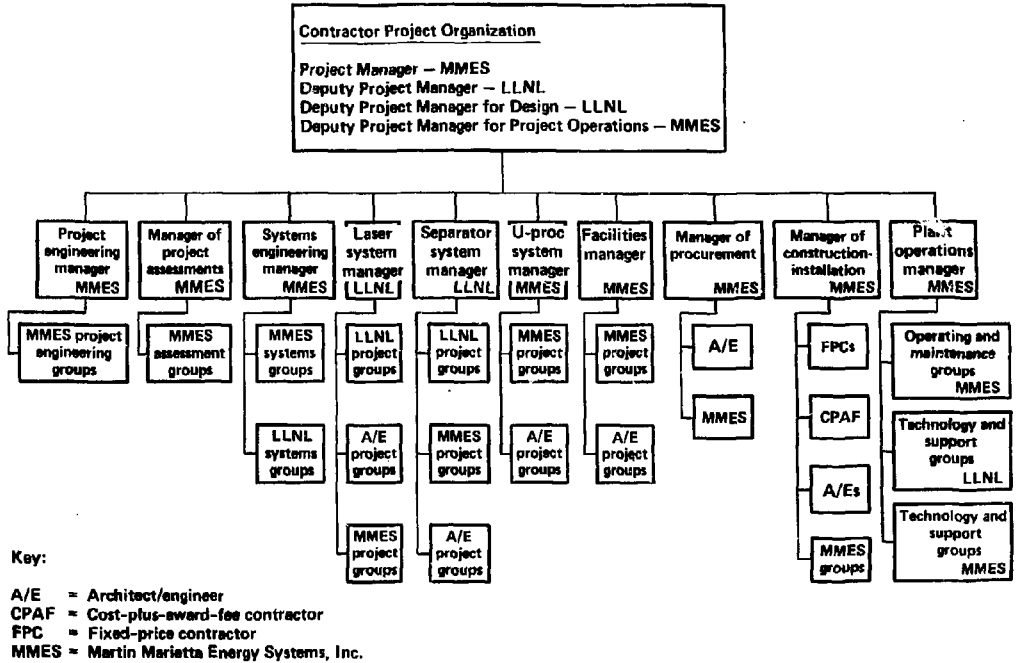


Fig. 2-2. Contractor Project Organization for AVLIS Production Plant Project.

Procurement and construction include the acquisition, fabrication, installation, and some activation of the facilities and equipment. Procurement activities are described in the Industrial Access Program (PP020).

Training and safety influence the plant design, but pertain primarily to the skills and procedures needed to successfully operate the facility. Quality assurance supports all of the above activities to enhance the success of the deployment.

3. QUALITY ASSURANCE ACTION ELEMENTS

The purpose of this section is to define commonly referenced quality assurance action elements. Although these elements are frequently used in project management activities, it is necessary for all project participants to have a common understanding of the quality assurance action elements. The selection and application of these elements in quality assurance plans are determined by the concerns identified through the quality assurance assessment process.

3.1. DESIGN CONTROL

Design activities, including design changes, interfaces, reviews and checking shall be defined, controlled, and verified in accordance with written procedures and instructions to assure that applicable design bases and quality standards are correctly translated into design documents. Deviations from the original design requirements, including the supporting engineering justification, shall be controlled.

Design control measures such as design reviews, alternate calculations, or performance of suitable tests shall be applied to check the adequacy of design. Adequacy of design shall be verified by persons other than those who designed the item.

3.2. PROCUREMENT CONTROL

3.2.1. Procurement Document Control

Review, approval, and revision of procurement documents shall be performed in accordance with written procedures to assure that items and/or services purchased directly or through sub-suppliers conform to the applicable technical specification and other requirements necessary to assure adequate quality. Documents providing evidence that items or services conform to the requirements of procurement documents shall be retained and must be sufficient to validate that these requirements are met.

As appropriate, procurement documents shall require sub-suppliers to use a quality assurance program consistent with specificed quality requirements.

3.2.2. Subcontractor Control

Quality of construction is verified through surveillance inspection of construction activities performed at random or selected stages of construction.

Subcontractors on-site implementation of their quality control programs shall be monitored by quality control engineers for:

- o Training and certification of personnel.
- o Installation, inspection, examination and test control.
- o Control of nonconforming items.
- o Documentation and records control.
- o Welding and nondestructive examination control.

3.3. INSTRUCTIONS, PROCEDURES, AND DRAWINGS

Approved instructions, procedures, and drawings shall be used to prescribe and accomplish activities affecting quality. These documents must be appropriate to the circumstances and include appropriate acceptance criteria for determining that important activities are satisfactorily accomplished.

3.4. DOCUMENT CONTROL

Documents such as instructions, procedures, calculations, specifications, and drawings (including changes thereto) prescribing activities affecting quality shall be controlled. Documents shall be reviewed for adequacy and approved for release by authorized personnel. Changes to documents shall also be reviewed for adequacy and approved for release by the same organizations that performed the original review and approval.

Means shall be provided for prompt and accurate distribution of both original documents and subsequent revisions to minimize the risk of inadvertent use of superseded or obsolete material.

A controlled project file shall be established and maintained. Control logs which identify the document, its subject, and its status shall be maintained for documents such as bid packages, vendor drawings and correspondence.

3.5. CONTROL OF PURCHASED MATERIALS, EQUIPMENT AND SERVICES

Assurance that materials, equipment, and services purchased directly or through sub-suppliers conform to procurement documents shall be achieved in accordance with procedures that include, as appropriate, provisions for (1) source evaluation and selection, (2) objective evidence of quality, (3) inspection at the sub-supplier source, and (4) examination of products upon delivery. Documentary evidence that materials and equipment conform to procurement requirements shall be available prior to installation or use of such materials and equipment. This documentation shall be retained and must be sufficient to identify the specific requirements such as codes, standards, or specifications met by the purchased materials and equipment. Segregation and control of rejected material shall be clearly identified.

3.6. IDENTIFICATION AND CONTROL OF MATERIALS, PARTS, AND COMPONENTS

Procedural controls shall be established for the identification and control of materials, parts, and components, including partially fabricated assemblies. Materials, parts, and components shall be designated for identification control through either heat number, certification, lot number, or other appropriate means traceable to the items. In cases where identification marking must be removed, substitute identification or traceability shall be provided. These identification and control measures are designed to prevent the use of incorrect of defective materials, parts, and components.

3.7. CONTROL OF SPECIAL PROCESSES

Special processes (including welding, heat treating, and nondestructive examination) used in fabrication of products shall be controlled by using appropriate standards and qualified procedures. Procedures shall be reviewed, approved and maintained on file. Personnel involved in special processes shall be qualified. Specification and referenced code requirements for certification of welders, nondestructive examination and inspection personnel shall be reviewed with subcontractors.

3.8. INSPECTION

Inspection criteria and instructions shall be provided by or for organizations performing activities affecting quality. These inspections verify conformance with documented specifications, instructions, procedures, and drawings for accomplishing the activity. Inspections shall be made by qualified personnel other than those directly performing the activity. Inspection results shall be documented.

Inspection or process monitoring (or both) shall be utilized for control where needed to verify conformance with requirements. When mandatory inspection hold points are specified, work shall not proceed without the consent of the procuring organizations designated personnel. Consent to waive hold points shall be recorded prior to continuation of work beyond the hold point. Source inspection, shop inspection and like operations away from the work site shall be performed by knowledgable engineering personnel.

3.9. TEST CONTROL

Tests required to verify conformance of an item to specified requirements and to demonstrate that items will perform satisfactorily for the service intended shall be controlled by authorized written test procedures. Test procedures must assure that the prerequisites for a given test are met, that adequate test instrumentation is used, and that the test is performed under suitable environmental conditions. Tests shall be monitored by qualified

personnel and test results shall be documented and evaluated to assure that the requirements are satisfied. Documented test results shall be retained. Test records shall, as a minimum, identify: items tested, tester or data recorded and date of test, type of observations, test results or acceptability, and reference to action taken in connection with nonconforming items.

The test program shall include, as appropriate:

- o Prototype qualification tests.
- o Proof tests prior to installation.
- o Construction tests.
- o Preoperational tests.
- o Operational tests during facility operation.

3.10. CONTROL OF MEASURING AND TEST EQUIPMENT

Measuring and test equipment used in activities affecting quality shall be controlled and calibrated to maintain accuracy within necessary limits. The degree of control and frequency of calibration shall be commensurate with the significance of the activity or equipment, and within the accuracy tolerances and calibration frequency established by the equipment and manufacturer.

Measuring and test equipment shall be calibrated against equipment that has a known valid relationship to nationally known standards. If no national standard exists, the basis for calibrations shall be documented.

Documentation of calibration data shall be preserved. Equipment shall be suitably marked to indicate status of calibration.

3.11. HANDLING, STORAGE, AND SHIPPING

Handling, storage, shipping, cleaning, packaging, marking, labeling, and preservation of materials and equipment shall be defined and controlled in accordance with written procedures to prevent damage or deterioration. Special protective environments, such as inert gas atmospheres, specific moisture levels, and temperatures, shall be provided as appropriate.

3.12. INSPECTION, TEST, AND OPERATING STATUS

Appropriate controls shall be applied to indicate the status of inspections and tests performed and to prevent the inadvertent use of items that have not passed the required tests and inspections. The authority for application and removal of indicators of the operating status of structures, systems, and components of the facility, such as tagging valves and switches to prevent inadvertent operation, shall be specified.

Prior to final equipment acceptance all required quality records and other information required by contract, shall be turned over to the procuring organization.

3.13. CONTROL OF NONCONFORMING ITEMS

Measures shall be established to control construction and production of materials, parts, or components which do not conform to requirements in order to prevent their inadvertent use or installation. These measures shall include, as appropriate, procedures for identification, documentation, segregation, disposition, and notification to affected organizations. Nonconforming items shall be reviewed and accepted, rejected, repaired, or reworked and reinspected in accordance with documented procedures.

Material and equipment discovered to be discrepant upon receipt shall be segregated from acceptable material by either tagging, marking, separated storage, or other similar appropriate means to prevent inadvertent use of the discrepant item, and a log maintained.

3.14. SOFTWARE CONTROL

The Quality Assurance Program applies to the development of software or the software product for the design, development, testing, and utilization of AVLIS programs. The program shall address the detection, reporting, analysis, and correction of software deficiencies associated with computer processing.

The responsible contractor(s) shall implement a Software Quality Assurance Program consistent with the requirements of this document which

include practices and procedures to assure compliance with all software requirements and specifications. The Plan shall identify organizational responsibilities and authorities for its execution and the events critical to its implementation.

The Plan shall address as a minimum:

- o Design Reviews.
- o Integration Testing & System Testing.
- o Validations & Verification.
- o Configuration Management.
- o Access Control.

3.15. QUALITY ASSURANCE RECORDS

Sufficient records shall be maintained to document activities affecting quality as required in the technical specifications. The records include drawings, procurement documents, calculations, and operating logs; results of reviews, inspections, tests, audits, monitoring or work performance, and material analyses; and qualification of personnel, procedures and equipment. Records shall be identifiable and retrievable. Retention periods shall be specified. Records shall be protected against damage, deterioration, or loss.

3.16. SAFETY CONTROL

The safety control will minimize the risks of accident by the early detection of significant potential hazards inherent in the design of the AVLIS conventional and special facilities. It will assess the impact of the hazards identified on the health and safety of employees and public, and the environment. It will apply the appropriate design, barricades, warnings, and management controls to eliminate or control the accident risks to an acceptable level.

The controls include identification of hazards, assessment of risks, designing for minimum risk, incorporation of safety devices or systems, and establishment of positive administration controls.

4. PRELIMINARY RISK ASSESSMENT

4.1. INTRODUCTION

This section provides a preliminary risk assessment of the major systems and components of the AVLIS Production Plant, and the impact of failure of these systems on the successful completion and operation of the plant. The criteria and methodology used in performing the preliminary assessment are defined, and the results of the assessment are summarized. Subsequent assessments will focus on further details of the work breakdown structure during the Title I project phase.

4.2. SCOPE

The purpose of this risk assessment is to provide a preliminary identification of those Work Breakdown Structure elements of the AVLIS Production Plant that are considered most important to the successful operation of the plant.

The assessment was performed by using engineering judgement to determine the consequences and probabilities for various failures. In certain areas limited engineering analyses where conducted to obtain more accurate estimates of the impacts. Detailed descriptions of the systems and components analyzed are contained in the following documents:

EB030	AVLIS Production Plant Laser System Design Report
EB040	AVLIS Production Plant Separator System Design Report
EB050	AVLIS Production Plant Uranium Processing Design Report
EB060	AVLIS Production Plant Conventional Facilities and Process Design Report

If an item is considered critical, special actions as explained in Sec. 5 will be initiated during the design, procurement, construction, or operation phases. These special actions will be identified during the early design phase. Once specific actions are identified the Quality Assurance program will monitor project activities to ensure that these actions are followed.

Conventional facilities and systems which are not unique to the AVLIS technology or are commercially available have been selectively screened from this preliminary assessment in order to focus attention on AVLIS Production Plant special equipment and uranium processing.

As a follow-on to this preliminary risk assessment, a more detailed risk assessment will be conducted early in the design phase. Each organization and discipline including Quality Assurance personnel participating in the Project shall contribute to the assessment process. The knowledge and experience of all disciplines will then be an advantage in the prevention of quality problems. In concert with this activity all design groups shall forward copies of approved Quality Assurance Assessments to each participant having interface responsibilities which need to be addressed as a result of the assessment process.

The Quality Assurance Assessments shall be initiated and completed by the 30% Design Review milestone. Reassessments shall be initiated at project major milestones (60%, 90% and certified for construction design reviews) or when the previous assessments have been invalidated by design changes.

4.3. METHODOLOGY

This preliminary risk assessment was conducted with the intent of identifying the level of project risk for each major project system if that system or component did not perform satisfactorily in service. The basis used to divide the plant into elements was the Work Breakdown Structure, Fig. 4-1.

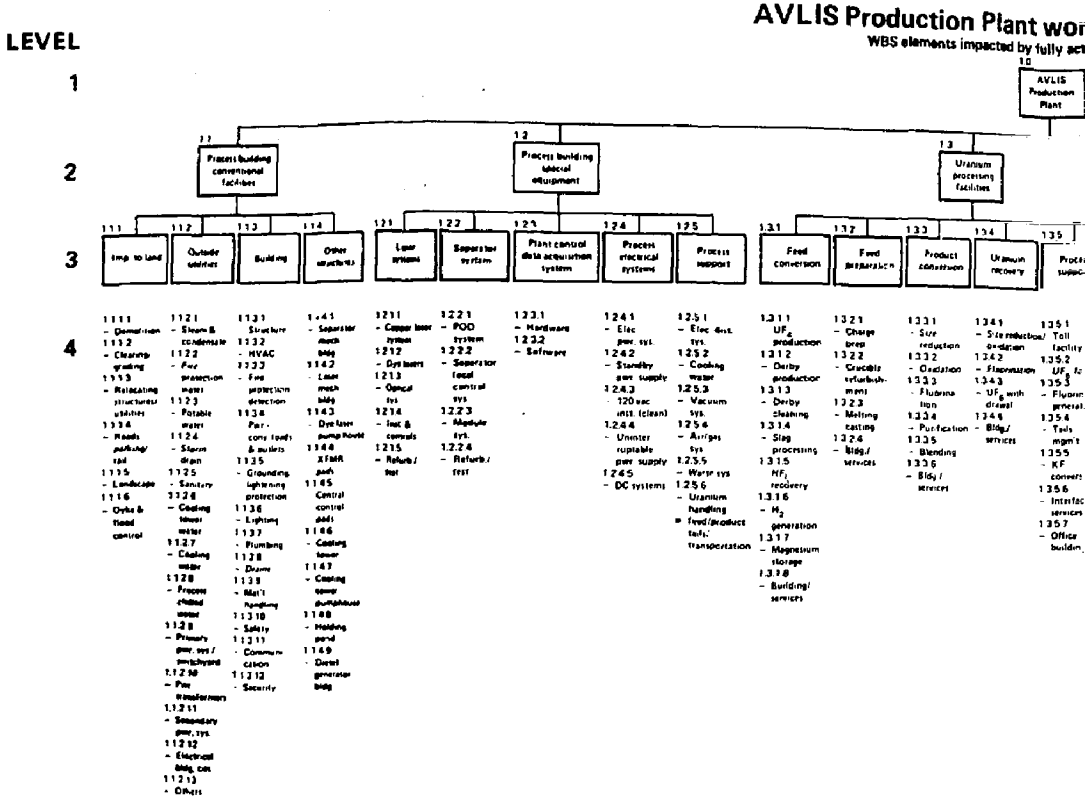
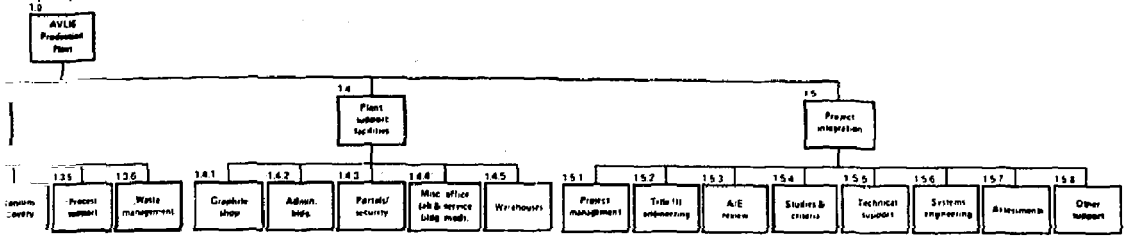


Fig. 4-1. AVLIS Work Breakdown Structure.

;ant work breakdown structure

:ed by fully activated plant supplement



1.3.5.1 Toll facility
1.3.5.2 - UF_6 feed
1.3.5.3 - Pipeline generation
1.3.5.4 - Tails depl'n
1.3.5.5 - UF_6 conversion
1.3.5.6 - Interfacility transport
1.3.5.7 - Office building

1.3.6.1 - Shallow land burial site
1.3.6.2 - Incineration
1.3.6.3 - Concrete fixation
1.3.6.4 - Neutralization
1.3.6.5 - Classified burial
1.3.6.6 - Decontamination (K-1420)
1.3.6.7 - Transportation

The methodology is summarized in Fig. 4-2. In determining risk, both the consequence of failure and the probability of failure are considered.

4.3.1. Consequence Level

Each item was evaluated to determine the consequence of a failure. Potential failures which cause the function of the component to be lost or which cause damage to additional components were identified. No attempt was made to identify all possible causes of failure. Rather, the effort was to identify the more serious failure modes to determine if further consideration was necessary.

Once a failure effect was identified the consequences of the failure were determined. The importance of the failure was assessed by comparison to criteria identifying significant failures. The criteria for consequence of failure used in this assessment are presented in Table 4-1.

The consequence of a failure has been catagorized as either significant, moderate, or insignificant (S, M, I). Failures which result in consequences which exceed any one of the criteria presented in Table 1 would be classified as significant. An insignificant failure has little or no impact on day-to-day operations. A moderate failure is one that falls somewhere between the two failures described above. A moderate failure would require a noticable reallocation of resources over and above what is considered day-to-day operations.

4.3.2. Probability Factor

After determining the consequence of failure, it is necessary to evaluate the probability of failure. Equipment repair or replacement required as a result of normal operation is anticipated. As a result refurbishment facilities are being provided and a preventive maintenance program will be implemented. The objective of this assessment is to consider failure modes which are beyond those anticipated during normal operation and which due to their random occurrence may require additional design provisions. The probability of failure has been catagorized as high, moderate, low, or very

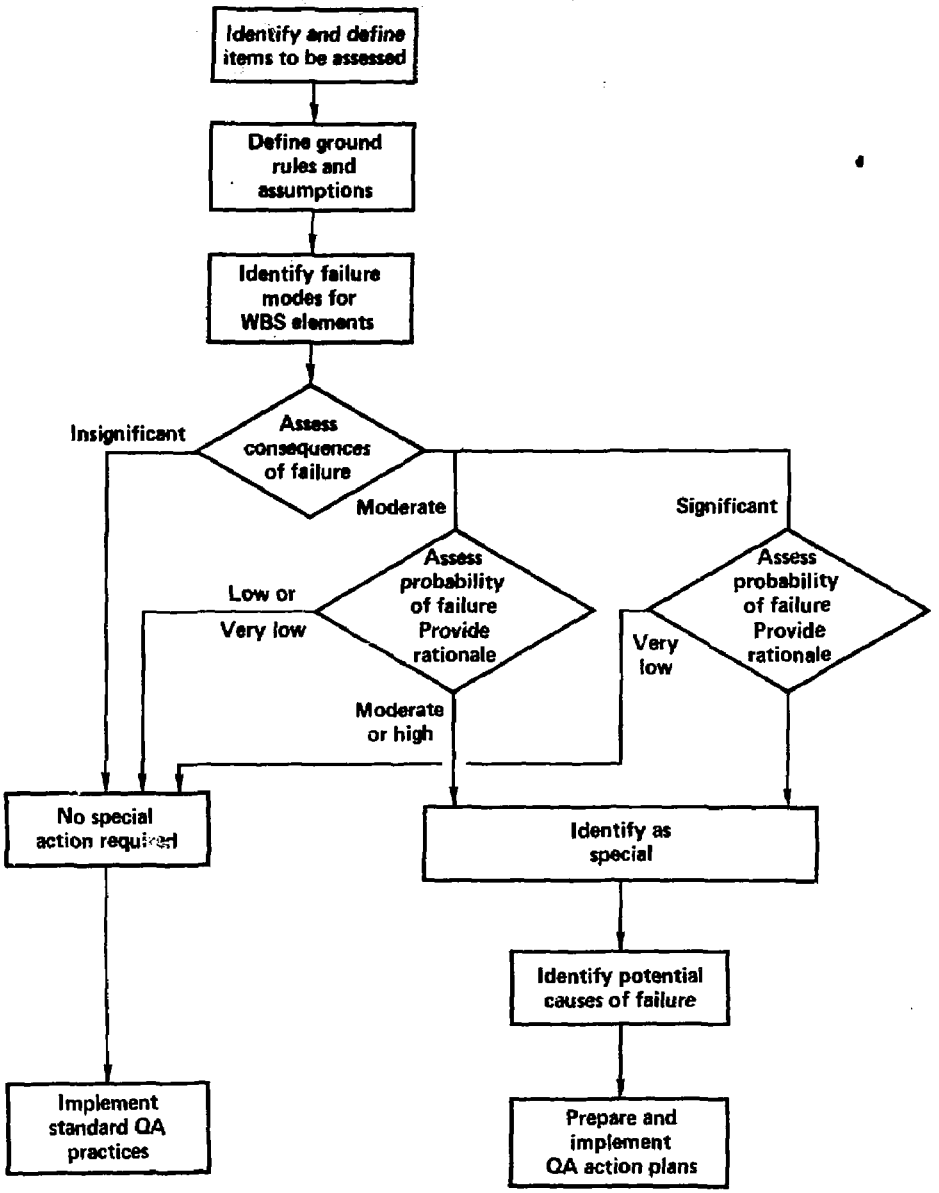


Fig. 4-2. Qualitative Assessment Procedure.

Table 4-1. Criteria for Defining Consequence of Failure.

1. Do not consider failures caused by:
   Labor union strikes
   Sabotage or vandalism
   Acts of war

2. Failure Consequences Classification:
   For the purpose of classifying the consequences of failure, the definition of "significant failure" is, "the effect of primary failure which can result in any one of the following consequences":

   A. Radiation Safety addresses radiation exposures to personnel and members of the general public as a result of the accidental release of radioactive material. For any event, the dose-equivalent received by the maximally exposed off-site individual shall not exceed either:

      1. A weighted whole body 50-year dose commitment of 500 millirem, using the methodology outlined in ICRP Publication 26 for weighting and summing doses to individual organs; or

      2. A dose-equivalent of 5000 millirem to the hands and forearms, feet and ankles, skin, or lens of the eye.

   B. Unanticipated Costs are those costs which result from accidents or other unexpected events, which are considered unacceptable. Costs associated with equipment replacement (both labor and materials), repair of damage, clean-up of radioactive contamination, and loss of production are included.

   C. Process Hazards that may result in death or serious injury to operating personnel as a result of the special or unusual hazards associated with laser isotope separation. Normal industrial hazards are not covered by this criterion.

   D. Criticality addresses those engineered safety features incorporated into the plant primarily to preclude the occurrence of an accidental nuclear excursion. Devices which only mitigate the severity of a criticality (such as shielding or evacuation alarms) do not fall under this criterion.

3. System redundancy should not be considered the sole mitigating factor in the reduction of failure probability. Redundancy, however, is an appropriate design Quality Assurance action when utilized in an attempt to reduce the risk associated with the system.

low (H, M, L, VL). In this qualitative assessment a high probability of failure is one in which an unanticipated failure is likely to occur at a rate greater than approximately once every five years. A moderate probability of failure implies that the failure will occur on an occassional basis. The frequency for moderate probability events ranges from once every 5 years to once during the plant lifetime (about 30 years).

When the failure rate for a component is between once during the plant lifetime and once every 1,000 years it is classified as low. Certain failure modes are considered to be very rare or improbable. The very low probability for certain failures could result from the use of components which have a very high inherent reliability, or a need for several high reliability components to fail before an adverse consequence occurs. Failure rates for components in this range would be below once every 1,000 years.

4.3.3. Risk Evaluation

Equipment failure which result in significant consequences do not necessarily require the application of special Quality Assurance requirements. Similarly, components with high failure rates may not require special actions. The evaluation of which events require a special action must consider the combination of consequence and probability. This combination defines the risk of a given failure. Those items that have a high degree of risk require special actions if the risk is to be reduced. Figure 4-3 provides a matrix for determination of whether the risk is considered sufficient to warrant special actions for the purposes of this preliminary assessment. The assessment process provides a logical approach for determining where special attention should be applied to assure operational success. Where there is relatively little or no risk, special actions are not required. However, as the degree of risk increases it becomes more prudent to apply greater measures to assure success. When the consequence of failure is high and the probability of failure is high, the risk is high. At the other extreme, where the consequence of failure is insignificant and the probability of failure is low, the risk is low. When a particular item has a low risk evaluation, there is seldom any benefit to applying additional valuable resources to further reduce the risk.

Consequence of failure	Probability of failure			
	High $F > .2/yr$	Moderate $.2/yr > F > .03/yr$	Low $.03/yr > F > 10^{-3}/yr$	Very low $F < 10^{-3}/yr$
Significant	X	X	X	
Moderate	X	X		
Insignificant				

X – special action required

Fig. 4-3. Matrix for determination of special action classification.

4.4. RESULTS

The results of the preliminary risk assessment are summarized in Tables 4-2 through 4-13. The assessments are grouped by Work Breakdown Structure elements as indicated below:

WBS No.	System	Table
1.2.1.	Laser Systems	
1.2.1.1.	Copper Laser System	4-2
1.2.1.2.	Dye Lasers	4-3
1.2.1.3.	Optical Systems	4-4
1.2.1.5.	Refurbishment/Test	4-5
1.2.2.	Separator System	
1.2.2.1.	Pod System	4-6
1.2.2.3.	Module System	4-7
1.2.2.4.	Refurbishment/Test	4-8
1.3.	Uranium Processing	
1.3.1.	Feed Conversion	4-9
1.3.2.	Feed Preparation	4-10
1.3.3.	Product Conversion	4-11
1.3.4.	Uranium Recovery	4-12
1.3.5.	Process Support	4-13

The items requiring special action are identified in the column on the worksheet by a "yes" or as appropriate with a "no". A "no" in the column referring to special actions means that at the time of this preliminary assessment there was adequate confidence that the Work Breakdown Structure items, system or subsystem, as presently planned, would perform as intended without additional quality assurance actions beyond those currently utilized or a failure would have insignificant adverse impact on plant performance or

availability. A "yes" in the special action column means that at the time of the assessment there was sufficient risk to warrant formal application of special Quality Assurance actions. The implementation of these special actions is discussed in Sec. 5.

In reviewing the results of this preliminary assessment, it is necessary to understand that, as part of the AVLIS Production Plant Project Management Plan, detailed technical assessments will be conducted during the engineering design phase and completed prior to the issue of the Title I Engineering Report. It is in these detailed assessments that specfic special actions will be identified.

Table 4-2. Preliminary Risk Assessment for WBS 1.2.1.1 Copper Laser System.

WBS No. item name	Potential failure	Failure effect	Consequence of failure (S, M, I)	Probability of failure (H, M, L)	Special action required (yes/no)	Comments
1.2.1.1.1 Copper laser oscillator	Failure of any of the following: Head, optics, encl., vac. sys., electrical	Loss of one copper laser power amplifier chain	I	H[a]	No	There are approximately 100 copper laser oscillators per laser module.[b] Units are independent so that loss of one unit does not affect operation of other units. Loss of a single chain has a minor impact on plant performance.
1.2.1.1.2 Copper laser amplifier	Failure of any of the following: Head, optics, encl., vac. sys., electrical	Max. impact is loss of one copper laser power amplifier chain	I	H[a]	No	There are approximately 200 copper laser amplifiers per laser module. Loss of a single unit causes a 30% reduction in power output for one chain. Maximum impact is loss of one chain. Loss of a single chain has a minor impact on plant performance.
1.2.1.1.3 Herriot cells	Mechanical failure of optics alignment	Loss of one copper laser power amplifier chain	I	L	No	There are approximately 100 Herriot cells per laser module. Units are independent so that loss of one unit does not affect operation of other units. Loss of a single unit has a minor impact on plant performance.

(a) Scheduled maintenance for units is 5000 hours.
(b) Module serves either dye booster amplifier or dye power amplifier.

Table 4-3. Preliminary Risk Assessment for WBS 1.2.1.2 Dye Lasers.

WBS No. item name	Potential failure	Failure effect	Consequence of failure (S, M, I)	Probability of failure (H, M, L)	Special action required (yes/no)	Comments
1.2.1.2.1 Dye wave form generator	Failure of electronics/ temperature controller of one dye master oscillator	No impact	I	M	No	Spare dye master oscillators are provided for each color to provide redundancy. Units can be replaced in about one hour.
	Failure of both dye master oscillators for a single color at the same time	Loss of plant separative capacity until defective units are replaced	M	VL	No	The lower failure rate of these components combined with the short replacement time result in a small risk.
Copper laser oscillator	Failure of any of the following: head, optics, encl., electrical, vac. sys.	Loss of one copper laser oscillator	I	H[a]	No	There are many copper laser oscillators for the dye master oscillators. Fewer are required for operation. Loss of one will have no effect on plant availability.
1.2.1.2.3 Dye amplifiers	Failure of window	Loss of one dye amplifier chain	M	L	No	Interlocks provided to stop loss of alcohol through broken window (sensors detect presssure drop) and once through ventilation provided to remove vapors.
1.2.1.2.3 Dye amplifiers	Leak of dye flow system containment.	Loss of one amplifier chain	M	L	No	Automatic valves close as pressure flow rate drops. Ethanol sensors detect vapors. Once through ventilation provided to remove vapors. Fire suppression system provided.
Dye pumps	Loss of pump due to mechanical or electrical failure	Loss of one pump has no impact	I	L	No	Each loop has a standby pump. Mean-time-between-failures (MTBF) is approximately 63,000 hrs. for each pump.

[a]Scheduled maintenance for units is 5000 hours.

Table 4-4. Preliminary Risk Assessment for WBS 1.2.1.3 Optical System.

WBS No. item name	Potential failure	Failure effect	Consequence of failure (S, M, I)	Probability of failure (H, M, L)	Special action required (yes/no)	Comments
1.2.1.3 Optical System	Mechanical failure	Partial loss of photoion-ization	M	L	No	Components have a low failure potential during normal operation

Table 4-5. Preliminary Risk Assessment for WBS 1.2.1.5 Refurbishment and Test.

WBS No. item name	Potential failure	Failure effect	Consequence of failure (S, M, I)	Probability of failure (H, M, L)	Special action required (yes/no)	Comments
1.2.1.5 Refurbishment and test	Equipment failures	Increased refurbishment times	I	M	No	Failure of equipment in the refurbishment and test areas does not cause loss of plant separative capacity. However such failures could impact refurbishment times.

Table 4-6. Preliminary Risk Assessment for WBS 1.2.2.1 Pod System.

WBS No. item name	Potential failure	Failure effect	Consequence of failure (S, M, I)	Probability of failure (H, M, L)	Special action required (yes/no)	Comments
1.2.2.1.1.1 E-beam system	Single gun failure	Temporary loss of heat to melt	I	H[a]	No	Redundant E-guns are provided
	Gun power system or controls failure	Loss of heat to melt, premature separator shutdown	I	M	No	A failure of this type would result in a reduced run time for a module, below the average 400 hours
1.2.2.1.1.2 Crucible melt beam dump system	Crucible failure	Loss of melt containment	S	L	Yes	Extended module downtime due to cleanup and inspection.
	Cooling water supply headers failure	Cooling water introduced into operating module, loss of vacuum, loss of production	I	M	No	Extended module downtime due to cleanup and inspection.
1.2.2.1.1.3 Feed/reflux dist. systems	Feed system failure	Premature module shutdown	I	M	No	Replace defective feeder.
	Reflux system failure	Inability to return material to melt, material build-up on troughs, material splashing into crucible	I	M	No	This may cause premature module shutdown.
1.2.2.1.2.1 Frame assy.	Frame failure	Loss of umbilical seal, loss of alignment, jamming of pod withdrawal system	M	L	No	Loss of the umbilical seals during operation would cause premature module shutdown.

Table 4-6. (Continued)

WBS No. item name	Potential failure	Failure effect	Consequence of failure (S, M, I)	Probability of failure (H, M, L)	Special action required (yes/no)	Comments
1.2.2.1.2.2 Umbilical seal bellows	Seal failure	Introduction of atmosphere into module	I	L	No	Covered above (1.2.2.1.2.1)
1.2.2.1.2.3 Utility dist. manifolds	Failure in electrical connector for E-beam gun	Loss of power to E-beam gun	I	L	No	Switch to spare gun.
	Failure in electrical connector for heater	Loss of power to heater	I	L	No	Loss of one heater can generally be tolerated with no effect on performance.
	Failure of cooling water dist. lines	Introduction of water into module	M	L	No	Low pressure system. Introduction of cooling water into operating module has been previously discussed (1.2.2.1.2.1)
1.2.2.1.3.1 Enclosure assy.	Failure of enclosure component	Release of U vapor to module interior	I	L	No	Module turnaround time would be increased due to unscheduled cleanup.
	Component falls into melt	Melt splashes onto E-guns, and/or module interior	M	VL	No	Module runtime would be decreased. Module turnaround time could increase due to extended cleanup time.
1.2.2.1.3.2 Ion extractor	Failure of graphite component or coating	Decreased module capacity or premature module shutdown.	I	VL	No	Component or coating failure before avg. run time is reached is highly improbable. Coating degradation after avg. runtime is reached is anticipated and is accounted for by pod refurbishment.

Table 4-6. (Continued)

WDS No. item name	Potential failure	Failure effect	Consequence of failure (S, M, I)	Probability of failure (H, M, L)	Special action required (yes/no)	Comments
	Component falls into melt	(see 1.2.2.1.3.1)	M	VL	No	(see 1.2.2.1.3.1)
1.2.2.1.3.3 withdrawal system	Casting accumulator structural failure	Loss of vacuum	S	L	Yes	Module turnaround time would be increased due to unscheduled cleanup.
	O-ring failure	Loss of vacuum	I	L	No	Any vacuum loss is anticipated to be a slow bleed rather than an immediate introduction of significant amount of air. This would lead to module shutdown, but not to significant uranium oxidation.
	Heater failure	Uranium freeze in withdrawal overflow, module shutdown.	I	M	No	Loss of one heater can generally be tolerated with no effect on performance.
1.2.2.1.3.4 Alignment system	System fails completely or functions at a less than optimal level	Decreased module capacity or premature module shutdown	I	M	No	The alignment system generally isn't required after the system temperatures have equilibrated
1.2.2.1.3.5 Thermal system	System fails or operates incorrectly	Loss of liquid flow, loss of pod production potential loss of module production	I	M	No	Shutdown module and carryout normal pod replacement.
	Cooling shroud loss of water containment	Introduction of cooling water into module, loss of vacuum, loss of production	I	L	No	Extended module downtime due to long cleanup.

a)1000 hour design life.

Table 4-7. Preliminary Risk Assessment for WBS 1.2.2.3 Module System.

WBS No. item name	Potential failure	Failure effect	Consequence of failure (S, M, I)	Probability of failure (H, M, L)	Special action required (yes/no)	Comments
1.2.2.3.1.1 Process vessel	Rapid loss of vacuum	Rapid oxidation of U metal	I	L	No	Shutdown module and repair.
	Thermal liner panels leak or don't flow coolant	Cooling water introduced into vessel. Vessel is not cooled	I	L	No	System shuts down to safe configuration.
1.2.2.3.1.2 Partition panels	Panels leak or don't flow coolant	Cooling water introduced into vessel. Vessel is not cooled	I	L	No	System shuts down to safe configuration.
1.2.2.3.1.3 Rail system	Difficulty or inability to remove pod with normal means	Alternate method must be used to remove pod	M	L	No	An alternate method can be used to remove the pods and get the module back on line.
1.2.2.3.1.4 Magnetic field coils	Coils cease operation or or operate incorrectly	Premature vessel shut-down	I	L	No	Continuous monitoring of magnetic field coils is provided to ensure proper E-beam containment.
1.2.2.3.3.1 Mechanical vacuum pumps	Pump fails or operates poorly	Increased module turn-around time or module shutdown until pump is repaired.	I	L	No	Redundant pumping capacity is provided.
1.2.2.3.3.3 Diffusion vacuum pumps	Pump fails or operates poorly	Increased module pump down-time	I	L	No	Loss of one diffusion vacuum pump will not cause a loss in production.

Table 4-7. (Continued)

WBS No. item name	Potential failure	Failure effect	Consequence of failure (S, M, I)	Probability of failure (H, M, L)	Special action required (yes/no)	Comments
1.2.2.3.4.1 Fan/Filter Units	Failure of units	Alternate means of manned entry to module would be required. Manned entry could be made with proper respiratory protection	I	L	No	Manned entry is not planned as part of normal operations. Redundancy is provided.
1.2.2.3.4.2 Duct Work	Breach of duct work	Small amounts of contamination spread at the breach	I	L	No	Breach would be detected, contamination cleaned up. Operations of module would not be affected. Redundancy is provided.

Table 4-8. Preliminary Risk Assessment for WBS 1.2.2.4 Refurbishment/Test.

WBS No. item name	Potential failure	Failure effect	Consequence of failure (S, M, I)	Probability of failure (H, M, L)	Special action required (yes/no)	Comments
1.2.2.4.1.1 Handling Transport	Failure of crane, tug, forklift	Equipment unusable	I	M	No	Redundancy is provided.
	Failure of rails	Rail unusable	I	M	No	Manual alignment can be used.
1.2.7.4.2.1 Pod Transporter	Transporter fails	Transporter unusable	I	M	No	Redundancy is provided.
1.2.2.4.2.2 Disassy. and Stripping	Equipment fails	Equipment unusable	I	M	No	In all cases, redundancy is provided. A third shift and weekends are also avaiable.
1.2.2.4.2.3 Coating Equipment	Equipment fails	Equipment unusable	I	M	No	In all cases, redundancy is provided. A third shift and weekends are also available
	Equipment applies faulty coatings undetected	Decreased module run cycle	I	M	No	QC program should provide for proper calibration and verification of inspection equipment operations. Extended operational experience is planned with MHDM, MARS and FSDF.
1.2.2.4.2.7 Assy. and Inspection	Fixture/ tooling failure	Equipment unusable	I	M	No	Redundancy is provided.

Table 4-8. (Continued)

WBS No. item name	Potential failure	Failure effect	Consequence of failure (S, M, I)	Probability of failure (H, M, L)	Special action required (yes/no)	Comments
1.2.2.4.2.5 Electrical Comp. Refurbishment	Equipment fails	Equipment unusable	I	M	No	Redundancy is provided.
	Equipment provides faulty readings	Pod is incorrectly certified, decreased run time	I	M	No	QC program should provide for proper calibration and verification of electrical component refurb. equipment operation.
1.2..2.4.2.6 Mech. Comp. Refurb.	Equipment fails	Equipment unusable	I	M	No	Redundancy is provided
1.2.2.4.2.7 Air Handling System	Fan/filter/ duct work fails	Loss of contamination control in refurb. area, localized contamination	I	L	No	This system will be protected to prevent a loss of entire system which could effectively shutdown the refurb. area. Short term shutdowns of the system should not significantly affect refurbishment operations. Redundancy is provided.
1.2.2.4.3.1 *Tooling*	*Tooling failure*	*Tooling unusable*	I	M	No	*Redundancy is provided.*
1.2.2.4.3.2 Test Equipment	Equipment fails	Equipment unusable	I	M	No	Redundancy is provided.
	Equipment gives faulty readings	Decreased module run time	I	M	No	Equipment will be periodically calibrated.

Table 4-9. Preliminary Risk Assessment for WBS 1.3.1 Feed Conversion.

WBS No. item name	Potential failure	Failure effect	Consequence of failure (S, M, I)	Probability of failure (H, M, L)	Special action required (yes/no)	Comments
1.3.1.1 UF_4 Production	Leak of H_2 and subsequent explosion.	Hazard to personnel.	S	L	Yes	Risk assessments to be performed where leaks might occur.
	Airborne release of UF_6 and HF in reduction towers and/or support equipment	Partial loss of UF_4 production (40% loss per process train disabled)	I	M	No	There are independent UF_4 reduction lines. Downtime is expected to be only a few days for a line out of service.
1.3.1.4 Slag Processing	Failure of process equipment supporting size reduction operations, dust control system leakage	Partial loss of process availability to support uranium recovery and reaction vessel lining operations.	M	L	No	Downtime is expected to be only a few days. One day slag surge storage is provided.
1.3.1.5 HF Recovery	Failure of HF containment system	Airborne release, exposure of personnel to hazardous material	S	L	Yes	Liquid HF storage tanks are located out-of-doors to facilitate air dilution if leakage occurs.
1.3.1.7 Mg Storage	Spontaneous combustion of Mg	Loss of Mg feed to support derby production, fire damage to to facility	M	L	No	Mg storage is compartmented and fire resistant to limit loss of Mg feed.

Table 4-10. Preliminary Risk Assessment for WBS 1.3.2 Feed Preparation

WBS No. item name	Potential failure	Failure effect	Consequ of failure (S, M, I)	robability of failure (H, M, L)	Special action required (yes/no)	Comments
1.3.2.3 Melting and Casting	Failure of melting/casting machine, conveyor crucible, and/or components; possible molten uranium metal fire hazard	Partial loss of production of uranium alloy feed material, equipment damage	L	M	No	There are independent process lines. Downtime is expected to be only a few days. Operating schedule can be expanded to compensate for loss of capacity.
	Accidental discharge of molten uranium feed material	Personnel injury, equipment damage	M	L	No	

Table 4-11. Preliminary Risk Assessment for WBS 1.3.3 Product Conversion.

WBS No. item name	Potential failure	Failure effect	Consequence of failure (S, M, I)	Probability of failure (H, M, L)	Special action required (yes/no)	Comments
1.3.3. Product Conversion		Criticality accident-possible personnel injury	S	L	Yes	Criticality accident from enriched product handling is a generic concern throughout the product conversion facility. Extensive design reviews required.
1.3.3.1 Size Reduction	Accident to and or failure of the size reduction equipment.	Partial loss of process capacity to support product production, to support pro-uranium metal oxidation	I	M	No	Jaw crushers and roller mills have 100% spares.
1.3.3.2 Oxidation	Failure of vibrating tray kiln and oxidation equipment	Partial loss of process capacity to support product production	I	M	No	Independent oxidation kilns are provided.
1.3.3.3 Fluorination	Failure of fluorination reactor	Airborn releases to working area partial loss of process capacity to support product production personnel injury from exposure to hazardous material	M	M	Yes	Potential exposure of personnel to F_2, UF_6 and HF.

Table 4-11. (Continued)

WBS No. item name	Potential failure	Failure effect	Consequence of failure (S, M, I)	Probability of failure (H, M, L)	Special action required (yes/no)	Comments
1.3.3.4 UF_6 Purification	Containment failure of UF_6 cold traps and/or distillation column purification equipment	Airborne releases to working area, partial loss of process capacity to support product production, personnel injury from exposure to hazardous material	M	L	No	Large number of cold traps mitigates the consequences in production caused by a single trap failure
	Containment or hardware failure of KOH Scrubber equipment	F_2, HF discharge to environment	M	L	No	Monitored, elevated release mitigates release to environment.
1.3.3.5 Blending	Containment failure of blending equipment.	Airborne releases to working area, partial loss of process capacity to support product production, personnel injury from exposure to hazardous material	M	L	No	Monitoring and quick isolation limit the released quantities.

Table 4-1. Preliminary Risk Assessment for WBS 1.3.4 Uranium Recovery.

WBS No. item name	Potential failure	Failure effect	Consequence of failure (S, M, I)	Probability of failure (H, M, L)	Special action required (yes/no)	Comments
1.3.4.1 Grinding/Oxidation	Failure of process equipment dust control equipment to contain material	Loss of uranium recovery.	I	M	No	Loss of facility does not directly affect production.
	Uranium metal (casting slag) oxidation in grinding equipment	Equipment damage, partial loss of recovered uranium to UF_6 feed facility.	M	L	No	Clean-up required, loss in production is minor
1.3.4.2 Fluorination	Failure of process equipment to contain F_2 and UF_6	Airborne releases to working area, personnel injury due to exposure to hazardous materials.	M	M	Yes	Potential exposure of personnel to UF_6
1.3.4.3 Cold Trapping	UF_6 discharge to working area	Personnel injury due to exposure to hazardous material.	M	L	No	Monitoring and alarm mitigate health hazard.
	Containment or hardware failure of KOH Scrubber equipment	F_2, HF discharge to working area and/or environment, personnel injury.	M	L	No	Monitored, elevated release mitigates risk to the environment.

Table 4-13. Preliminary Risk Assessment for WBS 1.3.5. Process Support.

WBS No. item name	Potential failure	Failure effect	Consequence of failure (S, M, I)	Probability of failure (H, M, L)	Special action required (yes/no)	Comments
1.3.5.3 Flourine Generation	Containment or hardware failure of KOH Scrubber equipment	F_2, HF discharge to working area and/or environment, personnel injury.	S	L	Yes	Monitored, elevated release mitigates risk to the environment.

5. PROGRAM IMPLEMENTATION AND CONTROL

Both LLNL and Martin Marietta have in effect existing quality assurance programs and procedures that address engineering, procurement, construction, administration, and start-up operations for existing systems and facilities. These quality assurance programs further define and provide for the application of quality assurance action elements to the extent considered appropriate to the activities being performed, and they provide for the appropriate level of documentation to support the performance of these activities. The Quality Assurance Plan defined in this document will serve to continue to existing LLNL and Martin Marietta quality assurance programs when the project is initiated.

5.1. LEVEL OF QUALITY ASSURANCE

The level of quality assurance applied is based on the importance to health, safety, environmental protection, performance, reliability and project objectives. The level and extent of quality assurance is determined by the degree of concern identified in the risk assessment process. This quality assurance action approach is shown graphically in Fig. 5-1.

The Preliminary Risk Assessment in Sec. 4 of this document has identified systems of the AVLIS Production Plant that require special actions. Special actions are defined as those actions over and above the standard engineering, procurement, construction, operations practices, and industry codes and standards that must be implemented to assure performance and project objectives. These special actions will be defined in detail in a Quality Assurance Action Plan. Action plans define the specific quality assurance steps to be taken during design, procurement, construction and start-up of the project. A more detailed risk assessment as well as the Quality Assurance Action Plan will be prepared early in Title I activities, based on this Plan and Preliminary Risk Assessment. This preliminary risk assessment shall be the basis for subsequent risk assessments and provides a basis for proceeding with conceptual design.

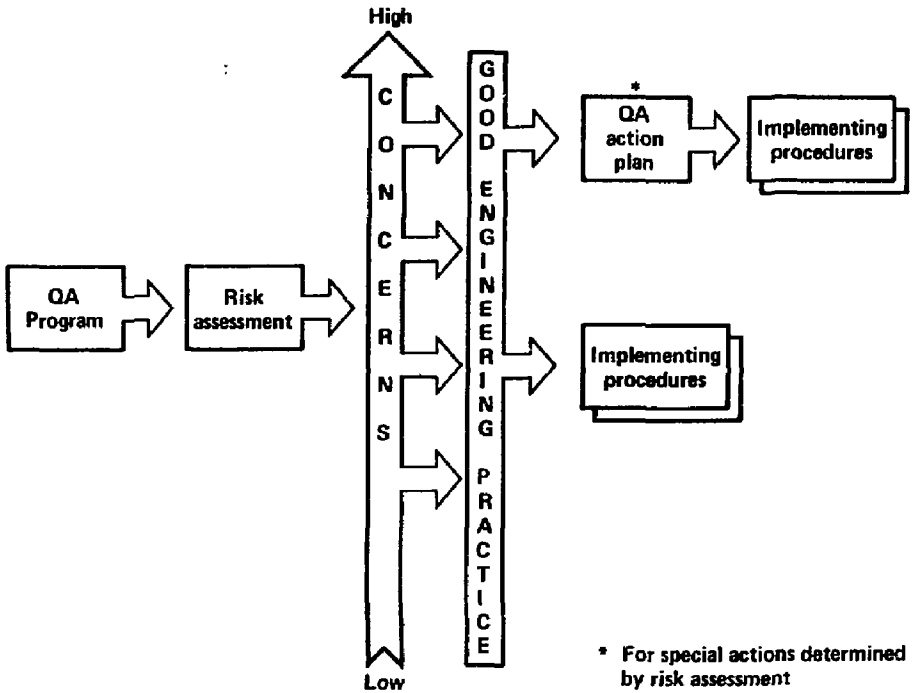


Fig. 5-1. Requirements of Quality Assurance Program.

The special actions identified will be documented and applied to design, procurement, and construction, utilizing the quality assurance action elements defined in Sec. 3. The selection of the appropriate Quality Assurance action elements is based on the risk assessment and quality assurance Action Plan. Engineering and management judgement assure the appropriate application of special actions for each item, system, service or facility.

Where no special actions are required, normal Quality Assurance practices will apply as will applicable industry codes and standards. Activities considered for control by standard Quality Assurance practices include design and interface control, procurement control, construction control, document and records control, and Quality Assurance Program controls through appraisal and audits. In the next sections, the application of these practices are discussed in more detail.

5.2. APPLICATION OF Quality Assurance ACTION ELEMENTS TO DESIGN

Control of design activities during Title I & II is defined in procedures that implement the Quality Assurance Program. These procedures are listed in Table 5-1. Procedures for checking, review and approvals of drawings, calculations and specifications, design interface control and revision control are considered standard quality assurance practice in LLNL and MMES procedures. Special actions for design, when identified by risk assessment, will include the following: (1) design reviews and peer reviews not normally required, (2) inclusion of more stringent inspection and test requirements in drawings and specifications, (3) increased documentation requirements in specifications for vendors, and (4) supporting documentation for design activities.

Table 5-1. Procedures Applicable to Design (Title I & II).

Design Control
Design criteria control
Design interface control
Design calculation control
Computer calculation control
Drawing control
Specification control
Design reviews
Design document control, review, and approval
Administration
Communication control
Records retention, control and turnover
Microfilming
Project Engineering
Schedule control
Budget and cost control
Performance measurement system
Trends

5.3. APPLICATION OF Quality Assurance ACTION ELEMENTS TO PROCUREMENT

Control of procurement activities is defined in procurement procedures that implement the Quality Assurance program. These precedures are listed in Table 5-2. Procedures for control of vendors through surveillance and shop inspection are considered standard quality assurance practice in LLNL and Martin Marietta procedures. Special actions for procurement, when identified by risk assessment, will include (1) vendor qualification for special items or services, (2) increased vendor surveillance and shop inspection, (3) vendor submittal of a quality assurance program that responds to AVLIS Production Plant Quality Assurance Program, and (4) audits of vendor to assure compliance with Quality Assurance Program and specification requirements.

Table 5-2. PROCEDURES APPLICABLE TO PROCUREMENT

Procurement document control
Vendor qualification and surveys
Bid evaluation
Vendor evaluation
Vendor shop surveillance and inspection
Vendor quality audits

5.4. APPLICATION OF Quality Assurance ACTION ELEMENTS TO CONSTRUCTION

Control of construction activities is defined in construction quality control procedures that implement the Quality Assurance Program. These procedures are listed in Table 5-3. Control of construction quality is considered standard Quality Assurance practice in LLNL and Martin Marietta procedures. Standard practices include routine inspection and verification of tests, material control, and routine weld control. Special actions for construction when identified by risk assessment will include (1) welder qualifications, (2) nondestructive testing and examination, (3) handling and storage of special materials, (4) increased inspection, more stringent inspection and test requirements, and (5) increased documentation for inspection and test activities.

Table 5-3. Procedures Applicable to Construction.

Vendor document review and approval
Weld control
Nondestructive examination
Qualification of personnel
Document control
Material control
Measuring and test equipment calibration and control
Inspection
Test control
Records

5.5. QUALITY ASSURANCE PROGRAM SCHEDULE AND MILESTONES

The Quality Assurance Program is initiated for the AVLIS Production Plant Project upon AVLIS process selections and continues through Title I, II, and III, and start-up phases of the project. The major milestones for the Quality Assurance Program are listed in Table 5-4. The timing of Quality Assurance Key Milestones relative to the Authorization Limited Schedule is shown in Fig. 5-2.

5.6. QUALITY AUDITS

Quality audits are conducted to evaluate the effectiveness of a quality assurance activity and to verify compliance with the quality assurance activities. Quality audits serve as a mechanism for early detection of a breakdown in the implementation of the various systems established to assure quality. The audits shall be preplanned and scheduled in a manner to promote their effectiveness. Audits shall be conducted by appropriately trained and qualified personnel who have no direct responsibilities for the areas being audited. Results of audits shall be documented and reviewed by management.

5.7. QUALITY FAILURE REPORTS

When quality problems are encountered, each must be investigated to identify those corrective actions that will prevent a reoccurrence. Corrective actions consist of those actions required to fix the technical problems and of those actions required to prevent a reoccurrence. A quality failure reporting system shall be established such that all project participants can benefit from the identified corrective actions.

5.8. QUALITY MANAGEMENT REPORTS

There shall be established, a system for routinely informing management of the status of quality. Persons responsible for quality assurance programs shall regularly report to management on the effectiveness of the Quality

Assurance program and on the status of any significant quality problems. This report will cover the status of quality assurance program implementation, procedures, audits, accomplishments, assessment status, action plan status, and status of corrective actions with schedules for completion.

Table 5-4. Quality Assurance Program Milestones.

Key Milestone No.	Date	Milestone
1	Nov. 1984	Complete Preliminary Quality Assurance Plan & Preliminary Risk Assessment
	May. 1985	AVLIS Process Selection
2	Sept. 1985	Submit Quality Assurance Plan to DOE for Approval
	Oct. 1985	Engineering Initiated
	Oct. 1985	Issue DOE Approved Quality Assurance Plan for Implementation
	Oct. 1985	Procurement Initiated
	Nov. 1985	Start Project Engineering and Administration Procedures
	Nov. 1985	Start Procurement Procedures
3	Jan. 1986	Complete Project Engineering and Administration Procedures
4	Jan. 1986	Complete Procurement Procedures
	Jan. 1986	Start Detailed Risk Assessments
5	April 1986	Complete Detailed Risk Assessments
	Oct. 1986	Start Quality Assurance Action Plans for Items Requiring Special Action
	Oct. 1986	Construction Initiated
	Nov. 1986	Start Construction Procedures
6	Jan. 1987	Complete Construction Procedures
7	July 1987	Complete Quality Assurance Action Plans
	Oct. 1988	Special Equipment Installation Initiated
	Dec. 1988	Engineering Complete
	Oct. 1989	Start-up Initiated
8	Jan. 1990	Submit Operations Quality Assurance Plan to DOE
	Aug. 1990	Issue Approved Operations Quality Assurance Plan for Implementation
	Oct. 1990	Production Initiated

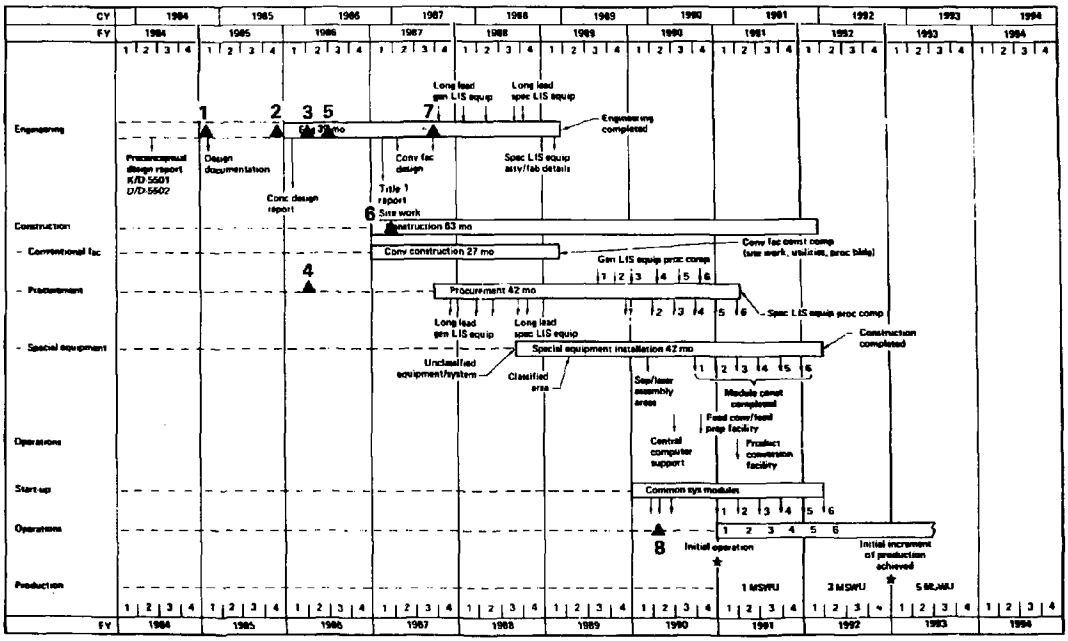


Fig. 5-2. Quality Assurance Program Key Milestones. See Table 5-4 for Milestone Definition and Number

APPENDIX A
TERMS AND DEFINITIONS

Acceptance Criteria: Specified limits placed on characteristics of an item, process, or service defined in codes, standards, or other requirement documents.

Audit: A planned and documented activity performed to determine by investigation, examination, or evaluation of objective evidence the adequacy of and compliance with established procedures, instructions, drawings, and other applicable documents, and the effectiveness of implementation.

Certificate of Compliance: A document signed by an authorized individual certifying the degree to which items or services meet specified requirements.

Certification: The act of determining, verifying, and attesting in writing to the qualifications of personnel, processes, procedures, or items in accordance with specified requirements.

Characteristic: Any property or attribute of an item, process, or service that is distinct, describable, and measurable.

Condition Adverse to Quality: An all-inclusive term used in reference to any of the following: failures, malfunctions, deficiencies, defective items, and nonconformances. A significant condition adverse to quality is one which, if uncorrected, could have a serious effect on safety or operability.

Contractor: Any organization under contract for furnishing items or services. It includes the terms vendor, supplier, subcontractor, fabricator, and subtier levels of these where appropriate.

Corrective Action: Measures taken to rectify conditions adverse to quality and, where necessary, to preclude repetition.

Design Input: Those criteria, parameters, bases, or other design requirements upon which detailed final design is based.

Design Output: Documents, such as drawings, specifications, and other documents, defining technical requirements of structures, systems, and components.

Design Process: Technical and management processes that commence with identification of design input and that lead to and include the issuance of design output documents.

Deviation: A departure from specified requirements.

Document: Any written or pictorial information describing, defining, specifying, reporting, or certifying activities, requirements, procedures, or results.

Final Design: Approved design output documents and approved changes thereto.

Inspection: Examination or measurement to verify whether an item or activity conforms to specified requirements.

Interface: The specifically defined physical and/or functional juncture between two or more itmes of equipment or between an item of equipment and facility.

Item: An all inclusive term used in place of any of the following: appurtenance, assembly, component, equipment, material, module, part, structure, subassembly, subsystem, system, or unit.

Measuring and Test Equipment (M&TE): Devices or systems used to calibrate, measure, gage, test, or inspect in order to control or to acquire data to verify conformance to specified requirements.

Nonconformance: A deficiency in characteristic, documentation, or procedure that renders the quality of an item or activity unacceptable or indeterminate.

Objective Evidence: Any documented statement of fact, other information, or record, either quantitative or qualitative, pertaining to the quality of an item or activity, based on observations, measurements, or test which can be verified.

Operator: The contractor responsible for operation of the plant.

Procedure: A document that specifies or describes how an activity is to be performed.

Procurement Document: Purchase requisitions, purchase orders, drawings, contracts, specifications, or instructions used to define requirements for purchase.

Purchaser: The organization responsible for establishment of procurement requirements and for issuance, administrations or both, of procurement documents.

Qualification (Personnel): The characteristics or abilities gained through education, training, or experience, as measured against established requirements, such as standards or tests, that qualify an individual to perform a required function.

Quality: Fitness for intended use.

Quality Assurance (QA): All those planned and systematic actions necessary to provide adequate confidence that an item or a facility will perform satisfactorily in service.

The goal of quality assurance is to assure that research, development, demonstration, and production activities are performed in a controlled manner; that components, systems, and processes are designed, developed, constructed, tested, operated, and maintained according to sound engineering standards, quality practices, and technical specifications; and that resulting technology data are valid and retrievable. Quality assurance includes quality control, which comprises all those actions necessary to control and verify the features and characteristics of a material, process, product, or service to specified requirements.

Quality Assurance Action Plan (QAAP): A QAAP is a document which describes all the actions required to provide adequate assurance that items or services will perform as specified.

Quality Control (QC): The prevention of defects through control of processing variables involving equipment, procedures, and personnel.

Quality Assurance Record: A completed document that furnishes evidence of the quality of items and/or activities affecting quality.

Receiving: Taking delivery of an item at a designated location.

Repair: The process of restoring a nonconforming characteristic to a condition such that the capability of an item to function reliably and safely is unimpaired, even though that item still does not conform to the original requirement.

Risk Assessment: A Risk Assessment is a formal qualitative review to determine the consequences and probability of failure of an item to perform as intended, and to identify items or activities requiring special actions. Risk Assessments shall be performed for all AVLIS systems, equipment, and structures defined in the Project Work Breakdown Structure.

Routine Item: No special actions are required, however, appropriate steps are required to identify and prevent quality problems. Nationally recognized codes and standards shall be invoked in specifications and drawings as applicable.

Service: The performance of activities such as design, fabrication, inspection, nondestructive examination, repair, or installation.

Special Item: An item having a failure mode which can result in significant or unknown consequences in terms of production loss, equipment damage, schedule impact or personnel safety and health, with a high or unknown probability of occurrence. Special actions are required to eliminate or reduce the probability of occurrence or to control the consequences of failure.

Surveillance: The act of monitoring or observing to verify whether an item or activity conforms to specified requirements.

Testing: An element of verification for the determination of the capability of an item to meet specified requirements by subjecting the item or activities by means of recorded identification.

Traceability: The ability to trace the history, application, or location of an item and like items or activities by means of recorded identification.

Verification: The act of reviewing, inspecting, testing, checking, auditing, or otherwise determining and documenting whether items, processes, services, or documents conform to specified requirements.

Waiver: Documented authorization to depart from specified requirements.

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