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10 MWe Solar Thermal
Central Receiver Pilot Plant

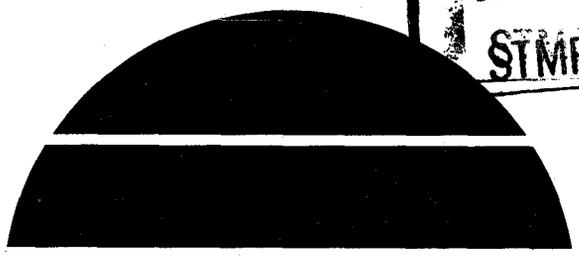
SOLAR FACILITIES DESIGN INTEGRATION

QUALITY ASSURANCE PLAN
(RADL ITEM 1-2)

July 1979

WORK PERFORMED UNDER CONTRACT
DE-AC-03-79SF10499

MCDONNELL DOUGLAS ASTRONAUTICS COMPANY
5301 BOLSA AVENUE
HUNTINGTON BEACH, CA 92647



U.S. Department of Energy

MCDONNELL DOUGLAS CORPORATION

Solar Energy

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Central Receiver Pilot Plant
Solar Facilities Design Integration

QUALITY ASSURANCE PLAN
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PREPARED FOR THE
U.S. DEPARTMENT OF ENERGY
SOLAR ENERGY
UNDER CONTRACT DE-AC-03-79SF10499

PREFACE

This initial Quality Assurance Plan is submitted to the Department of Energy, Solar Ten Megawatt Project Office, in partial fulfillment of contract number DE-AC-03-79SF10499, Reports and Deliverables List (RADL) Item 1-2. An updated and final version of the plan is to be submitted in February 1980.

This plan presents the Quality Assurance Program for the 10 MWe Solar Thermal Central Receiver Pilot Plant. It is designed to assure that material, hardware and software conform to acceptance requirements; that interfaces, subsystems and system have a high probability of performing their intended functions; and that the plant availability goal of 90% can be realized.

The plan stresses effective functional performance through the following tasks.

- Identify system purpose or function in measurable performance terms.
- Select subsystem implementing requirements and the verification position at which evaluation will be made. Include codes, regulations, and standards.
- Design acceptance verifications to truly measure performance emphasizing subsystem-to-system relationships. Include safety, FMEA, availability and maintenance.
- Repeat the above as requirements change.

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CONTENTS

INTRODUCTION

The Quality Assurance Plan for the 10 MWe Solar Thermal Central Receiver Pilot Plant has been prepared by MDAC, the Solar Facilities Design Integrator (SFDI), in response to the contract work statement, WRO EP-028-0.0 dated 18 May 1979, WBS 1.3 and RADL 1-2 in accordance with the DOE recommended outline. Software and subcontractor sections have been added to the outline; ASME code and regulations have been addressed. The plan has been developed as a working document to be implemented by the teaming arrangement of McDonnell Douglas Astronautics Company (MDAC), Rocketdyne Division of Rockwell International, Stearns-Roger, Inc., Energy Foundation of Texas, and Foster Wheeler.

The plan has been arranged in four parts addressing the responsibilities of the SFDI in Part I, Rocketdyne in Part II, Stearns-Roger in Part III, and MDAC as a design-fabricator in Part IV.

Approval by the customer, Solar Ten Megawatt Project Office (STMPO), is required. The program is divided into two phases. Phase I is directed primarily at requirements, planning, design, and long-lead procurement. Phase II is directed primarily at procurement, factory fabrication, test, system checkout, and plant acceptance.

The QA plan is dedicated to assuring that the 10 MWe pilot plant performance satisfies the intended purpose of functional availability. The basic approach is to apply selected controls and assure requirements which will provide a high success probability if passed.

Satisfying the 10 MWe pilot plant program purpose will result in the design, fabrication, integration, operation, and evaluation of a power plant which will convert sunlight into electricity. Engineering feasibility, safety, reliability, maintenance, economic, and environmental data leading to electric plants for the utility industry will be established.

Briefly the principle of operation requires that a boiler be heated by mirror concentrated sunlight. The mirrors are programmed to follow the sun. The boiler produces steam which may be the input to a turbine generator producing electricity or the input to a heat sink storing energy for later use by the turbine generator, or both.

The system is manually/automatically controlled. Automatic control is provided by a master control subsystem. Measurement of each mirror's output energy is also provided. All facilities are interfaced by a plant support subsystem providing interconnections between subsystems, ancillary equipment and structures.

The plant is composed of the following subsystems which collect/concentrate, monitor, store and convert solar energy into thermal energy for the turbine-generator facility.

A. Collector Subsystem - a field of mirrors (heliostats) reflecting energy at a focal zone (provided by DOE).

B. Receiver Subsystem - a tower-mounted absorber at the focal zone receiving thermal energy for transfer into water-steam. (Receiver is a Rocketdyne design; the tower is a Stearns-Roger design.)

C. Turbine Generator - uses water-steam to drive and produce electricity. (Provided by Associates.)

D. Thermal Storage - collects energy for subsequent extraction to operate turbine generator when solar energy is insufficient to meet demand. (Provided by Rocketdyne.)

E. Master Control - coordinates the operation of all subsystems providing optimum matching of solar input to demand. (Provided by MDAC-Huntington Beach.)

F. Beam Characterization - measurement of each mirror's delivered energy. (Provided by MDAC-Huntington Beach.)

G. Plant Support - ancillary equipment and structures for interfacing subsystems needed to provide plant supervisory control, interconnections, distribution, buildings, foundations, security, siting and accessibility. (Provided through Stearns-Roger design packages.)

The turbine-generator facility consists of plant site, turbine generator, heat distribution and rejection, condensate/feedwater and

electrical distribution for transforming thermal energy into mechanical/electrical energy for distribution.

The project is a joint effort by DOE and Associates (SCE, LA Department of Water and Power and California Energy Resources Conservation and Development Commission).

DOE provides Solar Facilities (Collector, Receiver, Thermal Storage, Master Control, Beam Characterization and Plant Support Subsystems). Associates provide turbine-generator facilities (T-G/Heat Distribution and Rejection, Condensate/Feedwater, and Electrical Distribution).

The 10 MWe Pilot Plant Program objectives are identified in the Management Plan RADL 1-1.

PART I

verification methods. Accomplishment is divided into three group of efforts:

- Requirement development
- Quality program implementation
- Quality program evaluation.

1.2.1 Requirement Development

The SFDI QA will participate in the development and release of requirements for plant integration, system and subsystem interfaces, and solar facilities design. This will require system-level requirement review, design review participation, assistance in the development of requirements/the definition of selected controls/inspections, review of test and integration plans, participation in interface coordination meetings with MDAC, Rocketdyne and Stearns-Roger, and review/approval of system, subsystem, and interface specifications.

RADL numbers shown below and in the work plan identify required specifications to be reviewed.

Review/approval will include, but not be limited to, consideration of codes, standards, regulations, safety, availability, and maintainability. Review/approval of changes to requirements associated with the above must be treated with the same controls.

RADL No.	Title
2-1	Initial OPDD Update
2-3	System Specification
2-4	Receiver Subsystem Specification
2-5	Thermal Storage Subsystem Specification
2-6	Beam Characterization Subsystem Specification
2-7	Plant Support Subsystem Specification
2-8	Master Control Subsystem Specification
2-12	Collector Field Layout Specification
2-13	Heliostat Specification
2-14	EPGS Specification
2-20	Identification of Documents, Codes, and Standards
2-21	Fab Simulation Program Description
2-22	Fab Simulation Program Software

RADL No.	Title
2-23	Failure Modes and Effects Analysis
2-24	System Safety Plan
2-28	Design Requirements Document (MCS)
2-30	Interface Document (OPDD) Test Plan
See Work Plan	PSS Construction Packages

1.2.2 Quality Program Implementation

The SFDI QA is responsible for the management and implementation of the QA programs of MDAC, Rocketdyne, and Stearns-Roger. This will require coordination and approval of each susbystem QA plan, implementation of the integrated four-part QA plan, monitoring/auditing of each subsystem plan, and preparation, coordination, and approval of a second release integrated QA plan.

Required in the implementation of QA plans is the preparation of QA procedures; review of drawings, specifications, fabrication, assembly and installation plans, and procurement controls; the preparation of verification plans and implementing techniques. Such effort will emphasize functional performance, safety, and interface control. The SFDI QA will effectively manage the QA team effort in accordance with the management plan program objectives and the controls/procedures of this integrated QA plan. Subsystem plans are shown in Parts II, III, and IV of this document. Specifications are those identified in RADLs shown in the Work Plan RADL 1-3. See Figure 2 for quality assurance controls.

1.2.3 Quality Program Evaluation

The SFDI QA is responsible for the evaluation of the effectiveness of the integrated QA program. This will be accomplished by monitoring the Rocketdyne, Stearns-Roger, and MDAC programs for adherence to approved QA plans, review of manufacturing, procurement and software areas of performance; audit of adherence to hardware, software, and system procedures; corrective action resulting from monitoring, review, and audit feedback.

This effort will emphasize system QA controls that affect functional performance, safety and interface verification.

PART I

SFDI QA RESPONSIBILITIES

Section 1

MANAGEMENT AND PLANNING POLICIES AND PROCEDURES

1.1 SCOPE

The SFDI integrates and monitors implementation of QA plans of Rocketdyne for receiver and thermal storage subsystems, Stearns-Roger for plant support system and construction packages and MDAC for master control and beam characterization subsystems; determines that requirements for system integration and subsystem interfacing are sufficiently detailed to support verification. The QA controls are directed at assuring adequate confidence that the 10 MWe Solar Thermal Central Receiver Pilot Plant will meet the requirements of the OPDD. The techniques for accomplishing assurance are described herein.

1.2 QUALITY ASSURANCE PROGRAM

The SFDI's contractual responsibilities are divided into three major areas of effort. First, the SFDI is responsible for the overall design and engineering integration of the entire plant including both the solar and turbine-generator facilities. Second, the SFDI will provide design, fabrication, delivery and checkout of the receiver, thermal storage, master control, beam characterization, and plant support subsystems. Third, the SFDI will design and provide technical construction packages for the solar facilities portion of the plant. (See Figure 1 for interfaces.)

Engineering requirements for these three areas will be developed basically in Phase I. Implementation of requirements will occur in Phases I and II in accordance with the work plan, RADL 1-3. Verification that requirements have been implemented is the basic task of QA. This integrated QA program is designed to assure the feasibility, accomplishment, effective sequencing, and timeliness of requirement verification. This task is dependent on a clear concise identification of what the requirements are and on effective

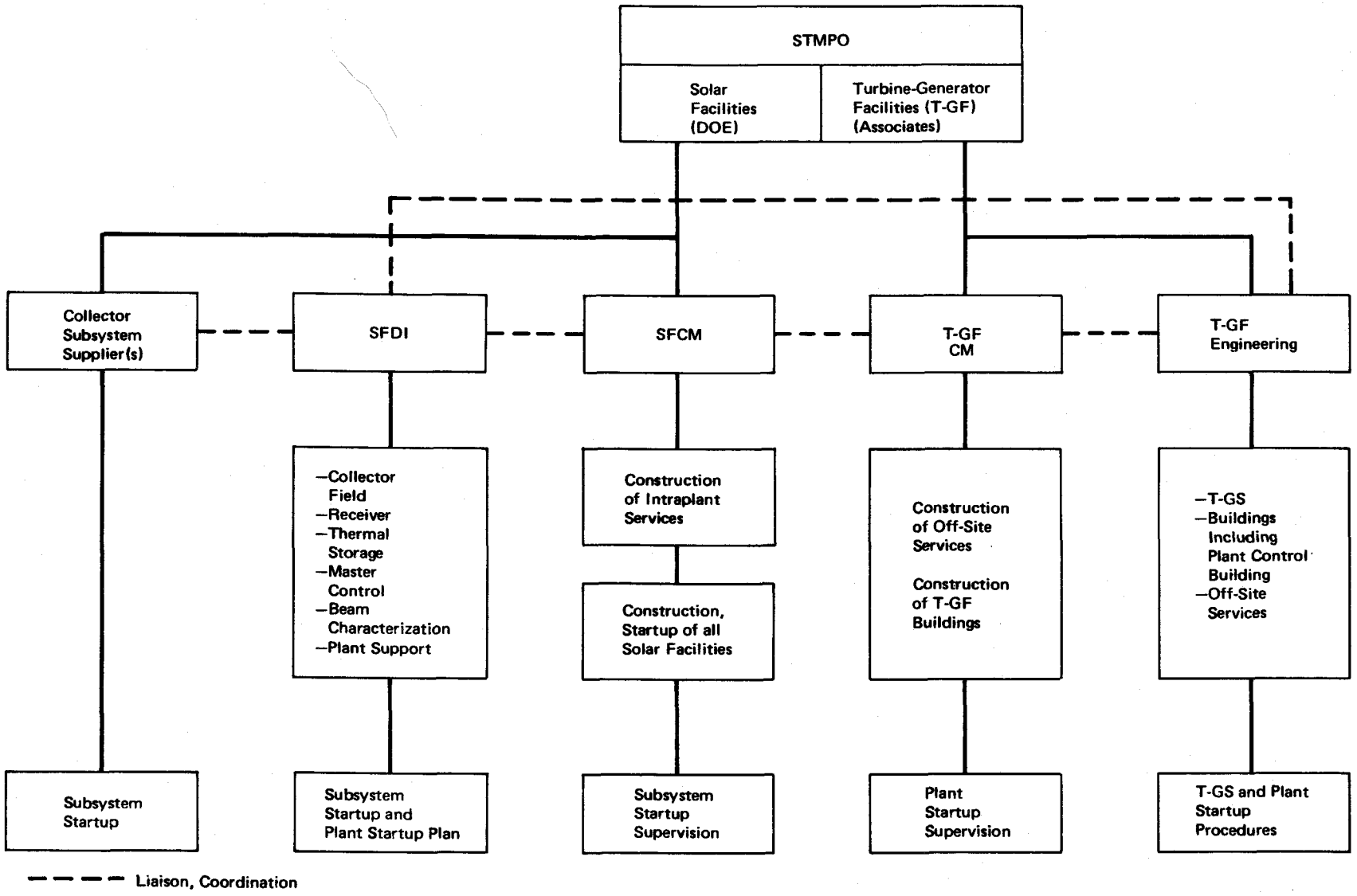

Figure 1. Interface Controls

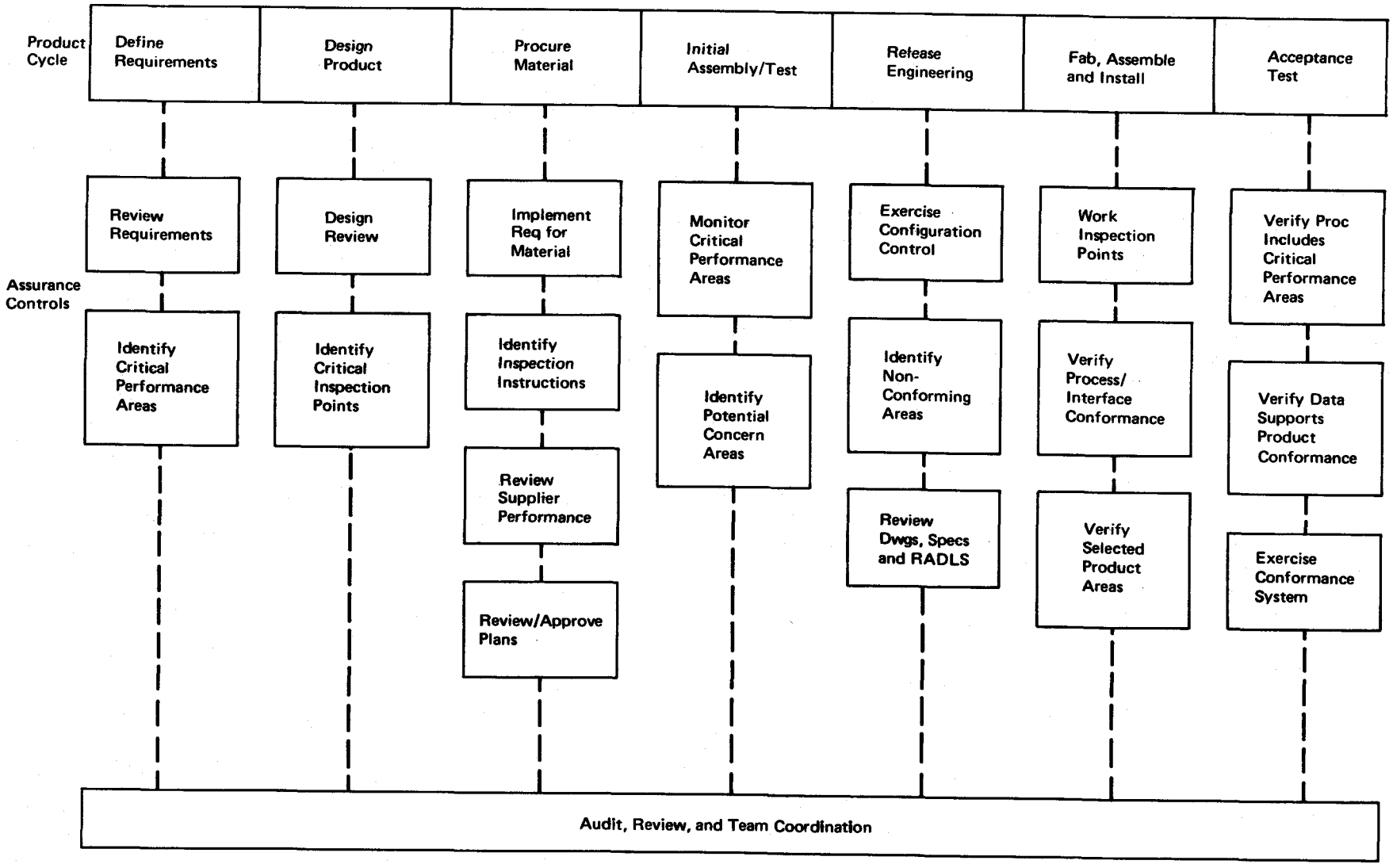

Figure 2. Assurance Controls

In addition, the SFDI QA provides coordination within the SFDI team and with the Associates, collector supplier, and SFCM on QA issues.

1.2.4 Integrated QA Program Objectives

- To assure that successfully passing the plant acceptance test will provide a high probability that the system meets requirements.
- To assure that adequate objective evidence exists to support the safe and effective use of the plant and each subsystem.
- To identify, isolate, and correct nonconforming conditions, services, or products.
- To assure a high probability of meeting the 90 percent plant availability.

1.2.5 Key Features of QA Program

- Responsibility for verifying requirements lies with the SFDI and team members.
- Verification is the responsibility of organizations independent of those whose work is evaluated.
- The system for assuring accomplishment of the system specification applies tried and proven procedures and controls tailored to the unique requirements of the 10MWe Solar Plant.
- Controls, procedures, and results are open to STMPO for review.
- Functional performance, interface control, and safety are primary issues.

1.3 SFDI ORGANIZATION*

Quality assurance management for the 10MWe Solar Facilities Design Integration is centralized under the Manager - Quality Assurance, SFDI. He is responsible for program QA activities at all levels and reports directly to the Program Manager - SFDI as indicated in Figure 3.

Responsibilities of the Manager - QA, SFDI are to define and implement the integrated QA program, provide technical direction, assure implementation of systems, subsystem and interface verifications, provide QA coordination

*See Parts II, III and IV for team member organizations.

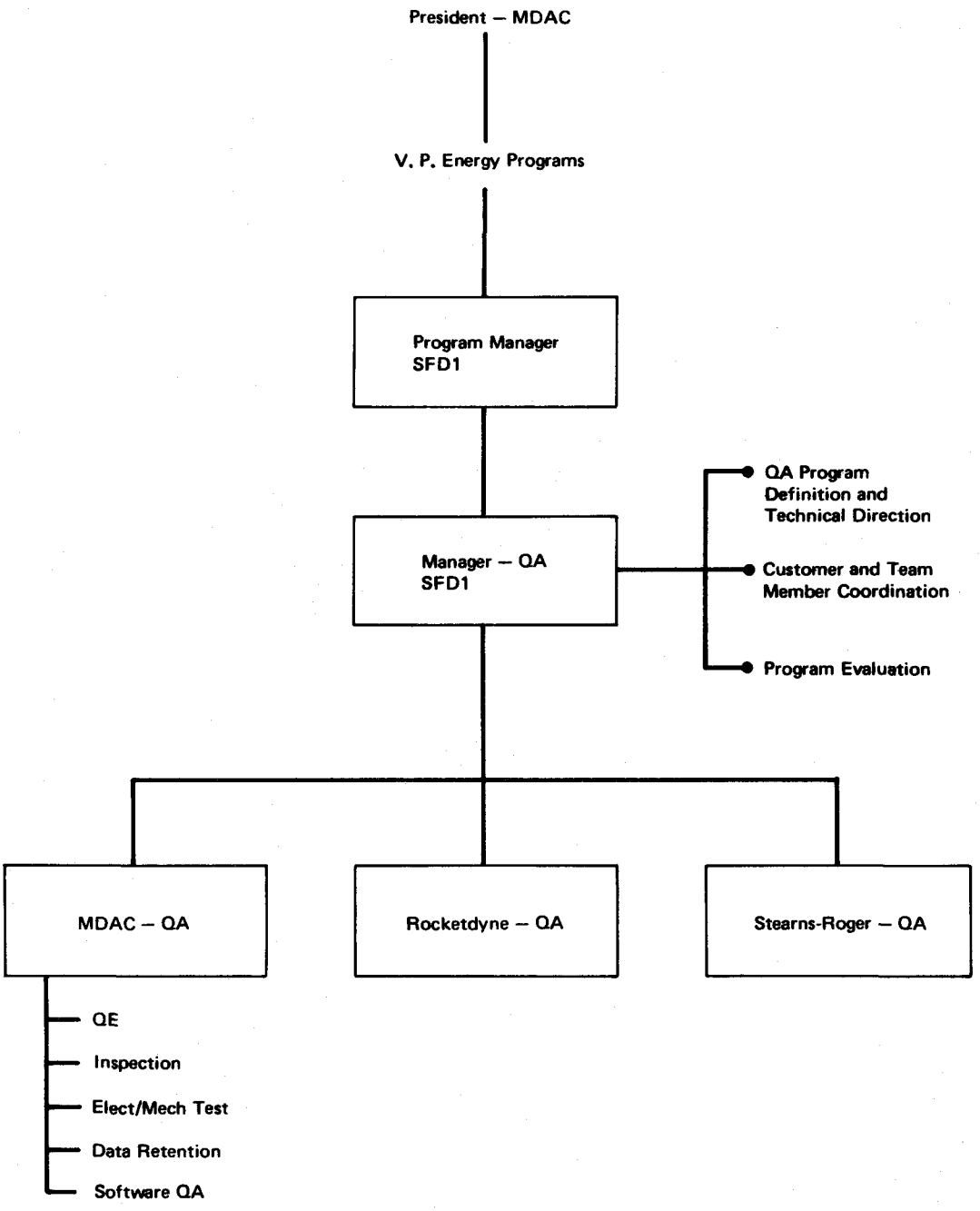

Figure 3. Quality Assurance Organization

within the SFDI team and with the Associates, collector supplier, and the SFCM. Audit, review, feedback, and effect correction of QA system effectiveness.

Specific tasks are:

- Prepare and implement the integrated plan.
- Coordinate, review, and approve Stearns-Roger and Rocketdyne QA plans for plant support and receiver and thermal storage subsystems.
- Monitor, coordinate, and evaluate Stearns-Roger and Rocketdyne implementation of subsystem plans.
- Prepare, coordinate, and implement MDAC QA plan for MCS and BCS.
- Coordinate integrated QA plan with Safety, FMEA, Maintenance, and Management Plans.
- Coordinate, monitor, and implement necessary changes to the integrated QA program.

1.4 DOCUMENTATION

The following documents will be used by the SFDI QA to implement and track requirement verification.

- The Work Release Order will be issued to document work statements.
- System and subsystem requirements will be documented in specifications as RADLs shown in the Work Plan, RADL 1-3.
- The requirement-verification matrix will be used to document methods of verifying requirements and will be a part of each specification.
- Documented release of specifications, drawings and changes will be in accordance with the Management Plan, RADL 1-1.
- RADLs will be used to document test plans, procedures, and reports in accordance with Management Plan, RADL 1-1.
- Audit and review findings will be documented via memoranda to the Program Manager - SFDI and the Manager of the subsystem affected.

1.5 AUDITS AND REVIEWS

The Manager - QA, SFDI is responsible for the status and adequacy of the integrated QA program. Audits and reviews will be the principal means by which Rocketdyne for receiver and thermal storage subsystems, Stearns-Roger for construction packages, and MDAC for BCS and MCS subsystems

implementation of QA plans will be evaluated. These will be conducted on a bimonthly schedule.

1.6 CORRECTIVE ACTION

Findings reflecting noncompliance with QA plans will be corrected by direct contact with the QA agency at fault. This will be followed by memorandum reports of the status of resolution until the noncompliance is corrected. Copies of reports will be sent to the SFDI Program Manager and the Subsystem Manager of the subsystem affected. Corrective action affecting more than one agency will be resolved through coordinating meetings with the affected agencies.

1.7 ENGINEERING HOLDS

Directions associated with engineering holds will be implemented in accordance with the Management Plan, RADL 1-1. Verifications affected by the engineering hold will be coordinated/monitored by the SFDI QA Manager.

1.8 UNUSUAL OCCURRENCE REPORTING

Unusual occurrence reporting originating at the SFDI for subsystem level or affecting system interface/integration will be coordinated by the SFDI QA with the affected Subsystem Managers. Coordination will be both verbally and via memorandum to the affected Subsystem Manager and the Program Manager - SFDI. Unusual occurrence reporting originating at Rocketdyne or Stearns-Roger will be reported to the SFDI via the existing system of the reporting agency. In addition, the Hot Line Report, RADL 1-14, will be used when required.

Section 2

DESIGN AND DEVELOPMENT POLICIES AND PROCEDURES

2.1 SCOPE

The methods necessary to assure measurable requirements and compliance to system specifications, codes and regulations are described in the following paragraphs.

2.2 DESIGN PLANNING

The tools of design planning, layout drawings, flow diagrams, design reviews, and hybrid simulator test results will provide information necessary to initiate conformance evaluations of subsystem and interface requirements with system specifications. Planned evaluation of this information will be directed at effecting measurable requirements. The SFDI QA will coordinate/evaluate Rocketdyne, Stearns-Roger, and MDAC planning efforts to be in harmony with this direction.

2.3 DESIGN DEFINITION AND CONTROL

Engineering documentation of requirements in system, subsystem, and interface specifications shown in RADLs identified in the Work Plan, RADL 1-3, constitute design definition when approved and released. Changes to these documents will be controlled after first release in accordance with the Management Plan, RADL 1-1. The SFDI QA will coordinate/evaluate the effect of these document controls on the implementation of QA subsystem plans. Team members will be monitored to provide assurance that adequate definition and control are retained.

2.4 DOCUMENTATION REVIEW AND CONTROL

Specifications developed under the RADL numbers shown in the Work Plan will be reviewed by the SFDI QA for compliance with and traceability to the OPDD and system specifications. These documents include interface specifications/subsystem specifications, regulations, codes, standards and plans. Review will also support identification of acceptance and qualification verifications which will effect a high probability of plant success if

conforming. Each specification will contain a verification matrix identifying the verification method for each requirement. The SFDI QA will assist in the specification matrix preparation. Control of these documents will be monitored in accordance with the Management Plan, RADL 1-1. Documents are identified in the Work Plan, RADL 1-3. The SFDI QA will coordinate, monitor, review, audit/evaluate the incorporation/implementation of these requirement documents into the Rocketdyne receiver and thermal storage subsystems, the Stearns-Roger plant support design packages, and the MDAC BCS and MCS subsystems, in accordance with the QA Plans, Parts II, III, and IV of this integrated QA Plan, RADL 1-2.

2.5 DESIGN REVIEWS

Design reviews will be effected in accordance with the Management Plan, RADL 1-1. The SFDI QA will participate by providing historical data relative to the design in review; coordinate with Rocketdyne, Stearns-Roger, and MDAC information required for the implementation of the applicable subsystem QA Plan, Parts II, III, or IV of this plan; ascertain that the design presentation supports the measurability of requirements; assure that implementation of codes, regulations, plans and specifications identified in the Work Plan, RADL 1-3, have been incorporated; assure that the design review conforms to the Management Plan, RADL 1-1.

2.6 DESIGN VERIFICATION TESTING - NOT APPLICABLE TO PHASE I

Design verification testing is a Phase II effort; therefore, the design and development policies and procedures will appear in the second issue of this plan. The specifications produced in Phase I under RADLs shown in the Work Plan, RADL 1-3, will contain a matrix identifying the requirements planned to be verified by test. The SFDI QA will assist in the preparation of this matrix; review the measurability of requirements identified for verification by test; review, monitor, and coordinate test policies, plans, and procedures developed in Phase I. Policies and procedures will be directed at verification of matrix requirements, documentation of test setup, location of test, identification of test data and collection format; sequence, rules, and regulations for performing the test. The SFDI QA will monitor team member activity to assure policies and procedures are conforming with the integrated QA program. Some in-process testing may be performed in Phase I which provides necessary acceptance data. QA monitoring of this activity for

conformance to subsystem QA plans, codes, standards, regulations, and safety is required.

2.7 ITEM QUALIFICATION - NOT APPLICABLE TO PHASE I

Controls, policies, and procedures will be identified in the second issue of this plan. The approach will be similar to verification testing.

2.8 QUALITY RECORDS

The SFDI QA records for Phase I will be limited to design review open items; audit and review open items for Rocketdyne, Stearns-Roger and MDAC; logs of specification reviews and plans; and action items resulting from coordination meetings. Phase II records will be identified in the second issue of this plan.

2.9 QUALITY AUDITS

Audits of Rocketdyne, Stearns-Roger, and MDAC will be conducted on a scheduled basis. Audits will be directed at determining conformance to approved QA plans, system implementation, nonconformance control, corrective action accomplishments, procurement controls, safety controls, and adherence to codes, regulations, and specifications. In addition, test planning, test results and test controls will be reviewed where applicable.

Audit findings will be communicated via memoranda to the SFDI Program Manager and the subsystem manager affected. Where audit results affect the integration effort, data will be coordinated with the appropriate team members.

2.10 CONFIGURATION CONTROL

Configuration control will be implemented in accordance with the Management Plan, RADL 1-1. Rocketdyne, Stearns-Roger, and MDAC will be monitored for adherence to these controls. Violation of controls will be reported via memoranda to the SFDI Program Manager and the Subsystem Manager affected. Action items will continue until satisfied.

Section 3
PROCUREMENT POLICIES AND PROCEDURES

Procurement effort in Phase I is limited to specific items. Controls for this procurement activity are defined in the subsystem QA Plans, Parts II, III, and IV of this plan. The SFDI QA will monitor adherence to the subsystem plans and coordinate QA issues affecting team members: Rocketdyne, Stearns-Roger, and MDAC. Emphasis will be placed on functional acceptance, nonconformance control, codes, regulations, and standards.

Section 4

MANUFACTURING, FABRICATION, AND ASSEMBLY POLICIES AND PROCEDURES

The policies and procedures for this activity are defined in the subsystem QA Plans, Part II, III, and IV of this plan. The SFDI will monitor the limited Phase I activity in accordance with these plans. Emphasis will be placed on functional interface and safety requirements, nonconformance control, and acceptance test. QA issues affecting the integrated QA program will be coordinated with the team members.

PART II

PART II
ROCKETDYNE QA RESPONSIBILITIES
Section 1
MANAGEMENT AND PLANNING POLICIES AND PROCEDURES

1.1 SCOPE

This section describes the Rocketdyne responsibilities and the functions necessary to accomplish the QA program objectives of the receiver and thermal storage subsystems (RSS and TSS).

1.2 QUALITY ASSURANCE PROGRAM

This publication sets forth the basic elements of a Quality Assurance Plan for the RSS and TSS and associated components designed, manufactured, and tested by Rocketdyne or by contractors under Rocketdyne surveillance.

Rocketdyne policies for quality follow the broad outline established by Rockwell International. However, the constitution of the Rocketdyne Quality Assurance Program is determined specifically by the MDAC Quality Assurance Plan Part I and directs emphasis to the goal of 90 percent availability.

Implementation of this QA Plan, applicable to the receiver subsystem is accomplished through the Rocketdyne Quality Assurance Manual using selected ASME code sections. The system defined in the manual is in compliance with the requirements of the ASME Code Section 1, Power Boilers, and is the basis for the ASME S stamp certification. Implementation of this plan applicable to the thermal storage subsystem is accomplished through the Rocketdyne Quality Assurance Manual. Through these manuals the requirements of this plan are detailed and effectively translated into operating practice.

1.3 ORGANIZATION

Quality assurance at Rocketdyne is administered by Assurance Management which has the general responsibility for developing, monitoring, and

evaluating quality assurance policies and operations. Specific functions of Assurance Management include the study, analysis, and interpretation of operating data to provide significant reports on quality and reliability assurance activities; investigation and recommendation of new methods, techniques, and equipment for quality assurance operations; coordination and assistance in the development of uniform quality requirements; and review of quality policies, concepts, and trends with customers. Specific quality program functions performed wholly or in part by other organizations are subject to review by the Assurance Management organization. Where procedures or action by these organizations adversely affect the quality of the product, action will be taken by the Assurance Management organization to correct the condition.

Assurance Management directs and monitors all quality assurance functions in the line and staff organizations ensuring that all contractual quality requirements are met.

1.3.1 Program Representative

A program representative, assigned to the Solar Power Program Office, has the responsibility and authority to represent Rocketdyne Assurance Management on program activities and, under cognizance of the Rocketdyne Program Manager, to convey program requirements to the line organizations. His scope of responsibility is defined by the following job functions:

A. Represent Assurance Management on solar power program activites.

B. Maintain a continual understanding of program requirements and coordinate with the line organization to ensure compliance.

C. Maintain a familiarity with contractual requirements as they affect quality assurance operations.

D. Provide QA liaison to construction site.

E. Monitor and assist in the preparation of specific program quality assurance instructions and obtain customer concurrence when required.

F. Review program plans of action prepared by other functional divisions, and assist in clarifying quality assurance requirements.

G. Coordinate the solution of quality problems with other functional divisions, as required.

H. Keep MDAC informed, and review and coordinate with MDAC to resolve quality problems on the program.

I. Assist the quality organization with significant corrective action programs. Anticipate potential problems and recommend necessary actions.

J. Participate in the formulation and implementation of training programs.

K. Keep the Rocketdyne Program Manager and the QA Manager SFDI informed of significant factors affecting the program.

1.3.2 Operations Structure

Assurance Management is composed of five organizational entities, each directed by a manager. These organizations are Quality Project Management, Metrology, Procurement Quality Assurance, Product Inspection, and SSME Quality Engineering.

1.3.2.1 Quality Project Management

Quality Project Management has the basic responsibility for formulating the quality program, planning its implementation, and monitoring its effectiveness.

In developing and formulating the quality program, this unit participates in engineering design reviews documented per RADL 1-5, assists engineering in developing new process requirements and in defining the control of special manufacturing and inspection processes and reviews and approves engineering specifications.

In planning the implementation of the quality program, Quality Project Management develops Quality Assurance Manual procedures, conducts detailed drawing and specification reviews of documents such as the Receiver Subsystem and Thermal Storage Subsystem Specifications (RADL 2-4 and 2-5), reviews manufacturing planning and purchased material requirements, and formulates the associated inspection plans, including statistical applications, when required.

In monitoring the effectiveness of the quality program, Quality Project Management evaluates manufacturing and supplier performance; administers equipment and personnel certifications; conducts hardware, inspection

process, and procedure audits; provides information feedback; and assists in formulating, implementing, and following up corrective actions.

In addition to the three basic quality program responsibilities, Quality Project Management also prepares quality assurance proposals, conducts contract review, and administers the program cost control system for Assurance Management.

1.3.2.2 Metrology

Metrology has the responsibility for Rocketdyne measurement standards with traceability to the National Bureau of Standards, or to a controlled measurement process utilizing a fundamental constant of nature, and the development of calibration procedures for measuring equipment. The responsibility for calibration of inspection measuring and test equipment is shared by Metrology and the Engineering Department.

Metrology maintains surveillance over all calibration practices, and exclusive of field laboratory equipment, is responsible for the physical calibration of all equipment used for product acceptance. Metrology also monitors production measuring equipment. Recalibration and periodic inspections are made to verify the continued accuracy of the equipment.

1.3.2.3 Procurement Quality Assurance

Procurement Quality Assurance maintains control over the activities of Rocketdyne suppliers and is responsible for the adequacy and quality of all production purchased articles, materials, and services associated with the division. Receiving and source inspection are performed in accordance with inspection plans prepared by Procurement Quality Assurance to assure conformance to procurement document requirement requirements. Warehouse surveillance is performed to control product storage and rotation of age-dated materials.

Additional duties include facility survey evaluations of potential suppliers to determine supplier ability to deliver products or perform processes consistent with Rocketdyne and customer quality standards; procurement document review to ensure that the supplier is furnished all quality requirements and other information to ensure the capability to deliver a product which meets

quality requirements; and conduct the supplier corrective action program to ensure that effective remedial and preventive actions are implemented as required.

1.3.2.4 Product Inspection

Product Inspection is responsible for ensuring the quality of all deliverable items fabricated or overhauled within the Rocketdyne Division. In performing this function, Product Inspection has the final responsibility to ensure Rocketdyne compliance with all quality requirements of drawings, specifications, and other contractual documentation. Hardware inspection is conducted at each stage of development in accordance with established manufacturing and quality plans; the inspections include physical and dimensional tolerance checks on individual components and electromechanical and functional testings of in-process assemblies and systems. In addition, results of inspections are recorded in work order documents to provide a quality history and data buildup of selected components as well as completed systems. End-item shipping inspection is also performed by Product Inspection.

1.3.2.5 SSME Quality Engineering

SSME Quality Engineering reviews manufacturing planning and inserts the required inspection points. The review is conducted according to drawing and program requirements. The planning is reviewed for appropriate callouts on (1) materials, (2) material traceability, (3) process specifications and procedures, (4) process controls, (5) NDT inspections, (6) cleaning, and (7) sealing and packaging.

SSME Quality Engineering also coordinates the planning review with the Authorized Inspector. The Authorized Inspector designates the hold points for his inspections during this fabrication process.

1.4 AUTHORIZED INSPECTOR

The Authorized Inspector is the designated representative of the Division of Industrial Safety, Department of Industrial Relations, State of California. His participation is required for fabrication of the Receiver Subsystem which is in accordance with the ASME Code.

The Authorized Inspector performs the following functions:

A. Review design drawings and calculations

B. Perform receiving inspection of code materials

C. Review manufacturing planning and insert hold points for his inspections.

D. Review rework planning and insert hold points for his inspections.

1.5 AUDITS AND REVIEWS

The Program Representative is responsible for monitoring Quality Assurance performance during all phases of the program.

1.6 RECORDS

Data for inspections and tests performed are documented as required to provide a chronological history of the procurement, fabrication, assembly, and test of supplies. Included are repair, rework, modification data, and nonconforming material reports.

Procurement records consist of the completed Source Inspection data, Quality Assurance copies of the Receiving Reports, Supplier Performance Records, and complete Purchase Order packages including certified test results for chemical and mechanical properties of material. Fabrication, assembly, and test history consist of the completed MOs and MOR books.

Rocketdyne retains these inspection records for a minimum of 3 years after contract completion.

1.7 CORRECTIVE ACTION

Rocketdyne has established a corrective action program that is specifically addressed to isolating the causes of nonconformance and preventing recurrence not only within Rocketdyne but at suppliers as well. Through application of quality assurance analytical techniques, the source of nonconformance is isolated to areas such as design problem, a material or processing deficiency, or a faulty production operation or test procedure. Once the source is identified, corrective action requests are directed to the responsible department or supplier.

When recurring nonconformances are found in a supplier's products or materials, Quality Assurance directs a request for corrective action to the Purchasing Department for transmittal to the supplier. The supplier is requested to notify Rocketdyne Quality Assurance of the actions taken to prevent further deficiencies. Quality Assurance evaluates the supplier's response for adequacy and for further action, if required. The goal of this activity is to ensure that the supplier is promptly notified of the nonconformance, that corrective action is quickly implemented, and that the problem is documented in the formal communication channel with the supplier. Failure of the supplier to product quality hardware, or to implement prompt and effective corrective action, will result in the withholding of hardware acceptance.

Corrective action within Rocketdyne is accomplished through a similar process. The responsible department is notified of the nonconforming condition; Quality Assurance evaluates the response, requests additional action, if required, and performs follow-up to ensure implementation and effectiveness of action taken.

1.8 UNUSUAL OCCURRENCE REPORTING

Routine communication via telecon, memo, and work statement between the SFDI and Rocketdyne will resolve most issues. When required, the Hot Line Report, RADL 1-14, will be used.

Section 2

DESIGN AND DEVELOPMENT POLICIES AND PROCEDURES

2.1 SCOPE

This section describes how Rocketdyne controls design documentation for the Receiver and Thermal Storage Subsystems.

2.2 DESIGN DEFINITION AND CONTROL

Design requirements and the acceptance criteria for procured and fabricated hardware are defined and documented in drawings and specifications identified as RADL 2-4 and 2-5 in the Work Plan, RADL 1-3. Rocketdyne fabrication, assembly, and inspection operations are sequentially planned and controlled in accordance with those drawings, specifications, documents, and manufacturing work orders.

Approved changes are released through the Rocketdyne release system. Engineering Orders (EOs) are issued to authorize the release or cancellation of engineering requirements and to distribute drawings, specifications, and other technical information. The release of the change document authorizes revision of all directly related documents to reflect the change. When a previously released document is cancelled, direction to remove all documents which are made obsolete by the cancellation is provided in the change document. Implementation of approved changes is monitored by the Rocketdyne Program Configuration Control Board (PCCB) and planned by Manufacturing Engineering and Quality Project Management. Change points are established to be compatible with hardware schedules and good engineering and manufacturing practices. Change incorporation into production units and/or into previously delivered units by retrofit are verified by Assurance Management. Assurance Management also records and reports the change incorporation date at each level of assembly as required by contract.

Change management is the function of the SFDI Configuration Control Board (PCCB) which reports to the MDAC CCB and is composed of representatives of all contributing organizations including Assurance Management. All

proposed changes to the production configuration baseline established by contract are evaluated by the board. The changes deemed to benefit to the program are classified, proposed, and when required by contract, submitted to MDAC for approval prior to implementation.

2.3 DESIGN REVIEWS

Quality Assurance personnel serve as regular members of the team participating in the design review and contribute information on adequate product identification, definition of characteristics, and conformance limits affecting quality. They also review the required inspection and test methods to ensure that adequate measuring or test equipment is available in order to verify the quality of the product, codes, regulations and standards.

Equipment and process specifications are reviewed and approved by Quality Assurance before release. Manufacturing and Quality Assurance review all drawings, in addition to the design reviews described above, during the development of manufacturing and inspection instructions. Changes deemed necessary by Quality Assurance are coordinated and processed by Engineering.

2.4 RECORDS

Records pertaining to design reviews and design release are retained by Engineering.

Section 3

PROCUREMENT POLICIES AND PROCEDURES

3.1 SCOPE

Rocketdyne has developed a system for determining potential quality assurance capability of procurement sources and of monitoring and controlling the quality of supplier products. This system provides for quality assurance surveys; purchase order reviews; supplier product inspection; and supplier assistance programs, where required, to ensure adequate performance in delivering products to required quality standards. The program will be tailored to the commercial requirements of the TSS and RSS by selecting appropriate controls for each procured item.

3.2 PROCUREMENT PLANNING

Rocketdyne source and receiving inspections are performed in accordance with established inspection plans prepared, issued, and maintained by Procurement Quality Assurance.

The source inspection plans provide direction to the Rocketdyne inspector for the performance of both in-process and final inspections. The requirement for supplier recording of quantitative dimensional and functional test results is also planned and invoked as a requirement of the purchase order for selected articles.

The purchase order, supplemented by the established receiving inspection plans, provides direction to the receiving inspector for supplier data review, the performance of hardware inspections, and the generation of records data. All inspection plans are maintained to the latest, applicable revisions of drawings and specifications. During the planning process, the need for specialized inspection and test equipment is also evaluated.

3.3 PROCUREMENT DOCUMENT REVIEW

Procurement documents for supplier products are reviewed by Procurement Quality Assurance prior to release. This review consists of verifying the

completeness of documents with respect to item identification; provision for Government and Rocketdyne source inspection, where required; conformance with certified special processing sources, qualified products, and qualified source lists; and other special requirements which may affect quality.

In addition to the purchase order, the supplier is provided with drawings, specifications, necessary Quality Control Inspection Plans, and applicable Procurement Quality Assurance Codes. The requirement for Government source inspection is included as a specific purchase order in accordance with the procurement agency policy.

Rocketdyne requires that suppliers maintain a quality system which satisfies the applicable requirements of Rockwell International Corporate Specification ST0802GT0001, ST0802GT0002, or ST0802GT0003. These Quality Control Specifications are invoked by purchasing codes made a part of Rocketdyne purchase orders for productive material.

Changes which are deemed necessary by Procurement Quality Assurance are coordinated with Purchasing prior to procurement document release.

3.4 EVALUATION AND SELECTION OF PROCUREMENT SOURCES

The following controls will be tailored to the commercial requirements of the RSS and TSS. Where required, suppliers are initially investigated by representatives of the Rocketdyne Purchasing Department. When the Purchasing Department is satisfied with items such as supplier financial stability and agreement with standard terms and conditions, a survey of supplier facilities is conducted. Representatives of Assurance Management and other functional divisions participate in these surveys as required.

The management and manufacturing capability to fulfill schedule commitments and the adequacy of packaging, packing, and marking procedures are evaluated during these surveys. When survey results indicate that the supplier has implemented and agreed to maintain an acceptable quality assurance program, the supplier is considered capable of supplying products consistent with Rocketdyne quality standards. The supplier is certified to the appropriate Rocketwell International Quality Control Specification, i. e., ST0802GT0001, "Supplier Quality Program", ST0802GT0002, "Supplier's

Inspection System", or ST0802GT0003, "Quality Requirements for Distributors and Warehousers," prior to purchase unless satisfactory quality history is on file.

3.5 MEASURING AND TEST EQUIPMENT CALIBRATION AND CONTROL

Procurement Quality Assurance is responsible to ensure that suppliers maintain an adequate calibration system and certification program. Where required, the supplier's capability in these areas is initially evaluated during the pre-award survey. When source inspection is a requirement of the purchase order, the Rocketdyne inspector also monitors these activities as required.

3.6 SOURCE SURVEILLANCE AND INSPECTION

Where required, provisions are made for Customer, Government, and Rocketdyne source inspections to be performed at the supplier's plant. Source inspection performed by and for the convenience of the Customer or Government does not relieve Rocketdyne or the supplier of the responsibility for the quality of the delivered products.

Rocketdyne source inspections are performed when: (1) necessary test equipment is not available at Rocketdyne; (2) it is expedient to check an item in the process of fabrication, assembly, or processing; (3) destructive testing or excessive disassembly would be required during receiving inspection; (4) the item is to be delivered directly to the customer or a facility other Rocketdyne; or (5) it is more economical.

Where required, source inspection verifies that the product conforms to applicable drawings, specifications, and other requirements stipulated in the purchase order. This inspection includes verification of selected characteristics and analysis of processing, materials, and supplier records. The object is to confirm that approved materials and processing sources have been used, and that functional and proof tests have been carried out in accordance with the requirements of applicable documents.

In-process source inspections required prior to welding, plating, or similar operations are established as necessary. Pertinent information for the completion of unfinished operations or inspections is entered on applicable

inspection records which are delivered, along with the supplier product, for Rocketdyne receiving inspection.

Rocketdyne inspectors, on receiving a supplier product which has been subjected to source inspection, determine that necessary source inspection and processing stamps affixed to the record and to the parts are identified, and that any further inspections or tests are performed.

3.7 RECEIVING INSPECTION

On receiving a supplier-fabricated product, Rocketdyne conducts an inspection in accordance with the established inspection plan for the RSS or TSS. Characteristics of the product are verified in addition to or in conjunction with requirements of the purchase order, drawings, and specifications to determine acceptance or nonconformance.

3.8 CONTROL OF NONCONFORMING ITEMS

Nonconforming items are identified and stored in the Rejections Area pending disposition by Engineering/Quality Assurance. Engineering/Quality Assurance disposition is made on the Receiving Report. Dispositions of nonconforming code items must require replacement or rework to drawing, since no code variances are allowed in the final report.

3.9 CONTROL OF RECEIVED ITEMS

During the process of receiving inspection, supplier-furnished products and materials are physically separated to maintain integrity of the lots. After inspection, the materials are transferred to a warehouse where identity and proper storage conditions are maintained.

3.10 QUALITY AUDITS

Periodic audits of supplier performance are conducted to confirm continued compliance with Rocketdyne and MDAC requirements. Supplier's performance records are compiled for each supplier to provide a continuous record of supplier performance.

3.11 ALLOY VERIFICATION

Where required, supplier raw material testing and supplier submittal of test reports are imposed on the purchase document by inspection codes.

Rocketdyne also performs testing of samples from each receival of raw materials to verify conformance with chemical, physical, and mechanical properties. A test report is filed and retained with the applicable receiving document.

Section 4

MANUFACTURING, FABRICATION, AND ASSEMBLY POLICIES AND PROCEDURES

4.1 SCOPE

This section describes the Quality Assurance activites associated with the manufacturing, fabrication, and assembly of the Receiver System and applicable portions of the Thermal Storage System. The Receiver System is fabricated in accordance with ASME Code, Section 1. Applicable inspections are coordinated with the Authorized Inspector.

A Quality Assurance Functional/Organization is presented in Table 1.

4.2 INSPECTION AND TEST PLANNING

Production work documents are based upon engineering design requirements, fabrication processes and assembly techniques, material considerations, equipment and facility capabilities, and related tooling requirements. Manufacturing and Quality Engineers review the released engineering drawings and specifications to plan a controlled sequence of operations for the fabrication of parts, and the manufacture, assembly, test, and inspection of components and systems. The planning document is submitted to the Authorized Inspector for his approval and insertion of hold points for his inspections. The planning document:

A. Identifies the part to be manufactured.

B. Specifies the materials to be used.

C. Stipulates the configuration requirements.

D. Describes the operations to be performed.

E. Specifies the methods and tooling to be used in performing the operations and controlling the processes.

F. Designates a controlled routing for operations accomplishment.

G. Records data of consumable materials such as weld rod.

These instructions are delineated on the controlled Manufacturing Order (MO) or Manufacturing Operation Record (MOR) book. The MO is a planning ticket used primarily for instructions pertaining to detail parts. The MO is

Table 1

ROCKETDYNE QUALITY ASSURANCE FUNCTIONAL/ORGANIZATION FLOW CHART

	Contract Performance Phase						
	Contract ⟶	Design ⟶	Release for Manufacturing ⟶	Procurement ⟶	Fabrication Assembly ⟶	Test ⟶	Package and Ship
Typical Quality Assurance Functional Action ↓	Review RFP for Quality Assurance requirement Prepare cost input Prepare program plan and proposal writeup Commit Quality Assurance effort	Review drawings for Quality Assurance Requirements re: • Contract • Inspectability • Facility capability	Prepare Procurement inspection plans Review and approve Manufacture Orders Tooling drawings review and tool inspection Metrology calibration Personnel, procedures and equipment qualification and certification	Survey suppliers Approve purchase orders for: • Approved source • Inspections • Documentation Perform inspections Supplier analyses and recurrence control Raw material traceability Stores control Nonconformance control Supplier surveillance	Assure traceability Perform inspections Verify assembly Monitor safe handling Contamination control Process control Interface checkoff Storage control	Installation OK Instrumentation accuracy precision calibration Test sequence verify Documentation verify Test results Contamination control	Proper identification per drawing Port closures Damage inspection Installation into/onto container Documentation finalization and buyoff Proper labeling Monitor safe handling
Quality Assurance Organization ⟶	Quality Project Management, Quality Engineering	Quality Project Management, Quality Engineering, PQA, NDT	Quality Engineering PQA, Metrology Quality Project Management	PQA, Receiving Inspection, Source Inspection, Quality Project Management, NDE	Product Inspection NDT, Quality Project Management	Test QA Quality Project Management	Product Inspection, Quality Project Management

supplemented by instruction sheets for more complex detail parts that provide further definition of the fabrication process, and indicate the desired intermediate machining dimensions for in-process hardware control. The MOR book is used for instructions pertaining to the manufacture, assembly, functional testing, and inspection of complex machine parts, components, and systems. These documents provide the means to outline and record the sequence of operations, compile and correlate the various forms and records, control installation, and record specific measurement and test results where required. These work documents (1) define serialization requirements, (2) provide for or invoke controlled and approved processing and test procedures, and (3) incorporate required customer inspection(s).

4.3 MATERIAL IDENTIFICATION AND CONTROL

Raw materials inspection consists of (1) review of supplier-furnished certified test reports which contain actual results of chemical and mechanical tests for the heat/lot/batch of material received, or any other tests required by the Purchase Order or procurement document; (2) reverification of materials as deemed necessary by Quality Assurance and Materials and Processes Engineering; (3) assignment of a given control designator for traceability of material to be carried forward on all subsequent documentation, and traceable back to the original receival.

After Receiving Inspection acceptance, articles and materials are held in productive storage pending issuance for shop use. Identification of articles and material is maintained to provide traceability to source, and age-dated materials are rotated for "oldest item first" issuance.

Materials are taken from storage for shop use by manufacturing work orders that identify the material to be issued. Positive verification is made by Product Inspection so that the material issued corresponds to that specified on the authorizing work order, and any age or use data and material control traceability are properly recorded. During the manufacturing process, the identity of materials that have been serialized is maintained by Manufacturing and Product Inspection on the work order with the completed part. Throughout the cycle of receipt, storage, fabrication, and delivery, nonconforming material is immediately identified and withheld pending disposition.

4.4 CONTROL OF PROCESSES

Rocketdyne has developed methods of defect prevention for controlling special processes in which the quality of the product cannot be determined solely by inspection of the end item. These control methods are delineated in detailed processing procedures designed to achieve the engineering results required of the process as specified in the engineering specification. These procedures provide the mechanic and inspector with step-by-step instructions to accomplish their respective tasks.

The equipment and machines used for performing special processes are certified by Quality Engineering in accordance with engineering specification requirements. The equipment is inspected, calibrated, and tested during operation as part of the certification process. Recertifications are conducted in response to specification changes, or equipment modifications, or as a function of time.

Special processes include, but are not limited to, metal treatment, welding, brazing, soldering, bonding, heat treatment, plating, and chemical surface treatment.

Cleanliness of close-tolerance parts and critical fabrication processes are controlled by the engineering specifications for the particular part or operations. The necessary procedures are conducted in limited-access areas in which environmental conditions are controlled, solutions are filtered, temperature and atmospheres are regulated, and special clothing is worn by operating and inspection personnel. Provisions for design and control of environmentally controlled areas are adequately defined in Engineering, Industrial Engineering, and Assurance Management procedures.

Particular emphasis is placed on training and certifying personnel performing special processes or inspections. The applicants for certification are required to complete a course of instruction for each type and class of certification requested. Upon completion of written and functional examinations, successful applicants are issued certificates showing the type of certification earned and the time period for which it is valid. Personnel are recertified through periodic testing or on the basis of a continuous record of satisfactory performance.

When certification of supplier personnel is required for selected special processes, an analysis of the supplier's certification procedures is included in the Rocketdyne evaluation of his capability. All qualified suppliers performing special processes are included in the Certified Special Processors' list and are monitored periodically by Quality Assurance.

4.5 INSPECTION AND TESTS

Before testing, Quality Assurance will verify that the designated test specifications or instructions are current and available, and that the equipment specified for the test bears a valid calibration and/or certification. The build records for the hardware to be tested will be reviewed to ensure that any discrepancy that would affect test performance is cleared before test. The installation of the hardware and activation of the equipment will be monitored to ensure that all elements of the test procedure remain in control.

During testing, Quality Assurance will ensure that the testing is accomplished in accordance with the applicable instructions; that the recording of test data and results is accurate and complete; that any rework, repair, or modification occurring during testing is documented and that any nonconformance is resolved.

After the completion of all test requirements, Quality Assurance will monitor the removal of the hardware and perform a visual inspection to detect any damage to the hardware that may have been incurred during testing. Any additional discrepancies will be documented and dispositioned, and preventive and remedial action will be taken.

4.5.1 Measuring and Test Equipment

Rocketdyne maintains a calibration system that ensures adequate accuracy in the use of measurement and test equipment. The Metrology unit of Quality Assurance is responsible for ensuring that adequate procedures are prepared and effectively used for all elements of the calibration system at Rocketdyne, including those calibrations performed by organizational units other than Metrology.

All new test and measuring equipment is inspected, calibrated, identified, and entered in the appropriate recall system by Metrology at Canoga Park facilities before use. Documented results of the inspection and/or test are maintained.

A complete appraisal of the capability of the test or processing equipment to perform is conducted either by a thorough technical evaluation, or by satisfactory completion of formal acceptance test procedures. If applicable, an actual or simulated first article test is performed that verifies that the equipment is functionally compatible with the unit being tested or processed and that the test instructions are adequate. Documented results of the evaluation are maintained.

Labels are provided for standards and test and measuring equipment items when calibrated. These labels indicate the date calibrated, by whom calibrated, and the next calibration due date. Other labels (i.e., limited use, not calibrated, mercury warning, etc.) are used to convey information applicable to a specific item.

Calibration and inspection intervals, based on stability, purpose, and degree of use, are assigned during the initial calibration or inspection of each item. A system is employed that allows for the adjustment of the calibration or inspection interval for each item, in accordance with its quality history.

Recall systems are employed at Rocketdyne to provide notification of calibration due, as well as inventory and historical information for inspection, test, and measuring equipment. In addition, certificates, and/or calibration data are maintained for standards.

Calibration records are maintained that identify the equipment to be calibrated, the calibration interval, dates, and coded variable data indicating the as-found condition and due dates of next calibration. Calibration procedures are developed by type of instrument.

4.6 NONCONFORMANCE

Material which is determined to depart from the requirements of specifications, drawings, code, or other applicable documents is immediately

identified, and the extent of the nonconformance is defined. Causes of nonconformance are identified and remedial and preventive actions are initiated.

The nonconformance is entered on the manufacturing work document. The part is withheld pending review and disposition of the nonconformance by authorized Engineering and Quality Assurance personnel.

ASME code-controlled hardware must meet code requirements without variation or deviation.

4.7 MATERIAL HANDLING

Rocketdyne provides for protection of articles and materials during all phases of fabrication, processing, and storage to prevent handling damage. Evidence is maintained of the defined proof-testing of handling equipment.

Articles and materials are protected against deterioration and damage during storage. Age-limited articles or materials are identified on the part, package, or accompany documentation as required by drawings or specifications to provide proper control.

All preservation, packaging and packing, handling, storage, and marking and labeling requirements are specified by the instructions covering these items, the product model instructions, and special requirements listed on the applicable engineering drawing. Special instructions define the requirements and outline the procedures for cleaning and drying, maintenance of cleanliness, applying masking and protective closures, using preservation compounds, wrapping, cushioning, and packaging methods.

PART III

PART III

PART III
STEARNS-ROGER (S-R) QA RESPONSIBILITIES
Section 1
MANAGEMENT AND PLANNING POLICIES AND PROCEDURES

1.1 SCOPE

Part III describes the S-R actions necessary to control: the plant support subsystem design; the A&E support services of design, preparation of construction packages and procurement of selected elements of the Solar Facilities Subsystems.

The QA Plan is prepared in two issues. This first issue concentrates on (1) Management and Planning Policies and Procedures, (2) Design and Development Policies and Procedures. Issue two will concentrate on (1) Procurement Policies and Procedures, and (2) Manufacturing, Fabrication, and Assembly Policies and Procedures.

The approach uses S-R established quality systems as the basis for the QA plan; the S-R Management and Work Plans, RADL 1-1 and 1-3, in accordance with Work Statement WS-2035, WBS 1.3; the S-R Project Procedures Manual, C-21700, which documents significant controls.

1.2 QUALITY ASSURANCE PROGRAM

The S-R QA program establishes controls for Documentation, Design, and Procurement. Included are engineering standards which document procedures directed at maintaining the required system controls.

The QA program implements controls necessary in the execution of S-R responsibilities associated with the 10 MWe Solar Pilot Plant, and covers all facets of the project. The effectiveness of QA controls identified in this plan will be evaluated by the S-R project organization identified in the S-R Management Plan. Findings will be reported to MDAC. Formal documented

controls which affect design and checking, in-house review and approval, S-R project approval, MDAC approval, and distribution of design documents will receive major emphasis.

Controls effected through organized, uniform, documented methods accomplished in a proper manner with complete records are S-R's basic approach to assuring that plant requirements will be met.

These controls include, but are not limited to:

1. Engineering documents reviewed and checked within the S-R project organization.

2. Staff engineers review documents for specialized areas of information.

3. The Drawing and Data Controller (DDC) controls document logging, distribution, transmittal and revisions.

4. Interface Control is effected by the Team Interface Control Document (TICD) which communicates engineering information among the SFDI team members.

5. S-R Engineering Standards for Calculations and Drawing procedures are enforced.

6. Technical change control is effected by the S-R Engineering Change Notice (ECN) recording all changes in engineering scope.

7. Guidelines for technical review of S-R subcontractor and vendor procedures are implemented in accordance with S-R "Vendor Document Review Procedure."

8. Configuration Management and Control is implemented in accordance with S-R Management Plan.

9. Drawing Control and Release is implemented in accordance with S-R Project Procedures Manual.

10. The S-R Project Manager audits and reviews controls for proper implementation.

These controls are effective on issuance of this plan. Revisions must be approved by the S-R Project Manager.

1.3 ORGANIZATION

The overall implementation and continued use of the S-R QA plan is the responsibility of the S-R Project Manager. Project Supervisors are responsible for implementation and operation of controls as follows*:

A. Document Control - Drawing and Data Controller (DDC)

B. Specification Control - Project Controller (PCI)

C. Design Calculation Control

1. Mechanical - Project Mechanical Engineer
2. Piping - Project Piping Engineer
3. Electrical - Project Electrical Engineer
4. Civil and Structural - Project Civil Engineer
5. Instrumentation - Project Instrument Engineer

D. Drawing Control - Drawing and Data Controller (DDC)

E. Procurement Control - Project Controller (PCI)

Each supervisor shall familiarize himself and his staff with their areas of responsibility and with the program procedures so that all project areas, working together, will assure meeting the requirements identified in documents of WS 2035.

1.4 DOCUMENTATION

Management and Planning Policies and Procedures are documented in the S-R Management Plan, RADL 1-1, and in the S-R Project Procedures Manual, C-21700. These documents describe how S-R plans to manage the program, with particular emphasis on controls to be utilized. These controls assure that Plant program schedules and Plant requirements are met at the lowest cost.

S-R Management Plan, Section VII, Technical Controls, includes:

A. Document Control System

B. Interface Control System

C. Technical Review and Approval Process

D. Technical Change Control, Cost Change Control and Contract Change Control Relationships

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*The Management Plan, RADL 1-1, and the S-R Project Procedure Manual, C-21700, present the project organization.

E. Technical Control of Subcontractors and Vendors
F. Manufacturing Control
G. QA Control
H. Management Participation in Technical Control Process
I. Configuration Management and Control
J. Drawing Control and Release

For Design and Development Document Review and Control, see Section 2.4.

1.5 AUDITS AND REVIEWS

The audit of controls for adherence to approved procedures is the responsibility of the S-R Project Manager implemented through frequent iterations by the Project Organization. Findings will be reported to MDAC and followed until resolved. Documentation will be via memo/letter.

In addition, Management Policies and Procedures are continuously reviewed via the Project Organization signature system.

1.6 CORRECTIVE ACTION

The S-R system of Project organization control by review of technical documents to the S-R engineering standards produces immediate corrective action as signatures are held in abeyance until corrections are accomplished. Such reviews are directed at maintaining compliance with the S-R Management Plan, RADL 1-1; S-R Work Plan, RADL 1-3; S-R Project Procedures Manual, C-21700; S-R QA Program Document, RADL 1-2.

1.7 ENGINEERING HOLDS

The use of Engineering Holds is circumvented via the S-R Standards No. EJ-33.02, .03, .04 Design Deviation, Nonconformance Deviation, and Field Request for Deviation, respectively. All three are design change methods which respond to necessary design requirement changes. Changes to designs which cause revisions to drawings continuing to meet design requirements are not considered a design deviation.

The procedures for accomplishing design change review controls are documented in S-R Engineering Standards EJ33.01 through EJ33.07.

1.8 UNUSUAL OCCURRENCE REPORTING

The frequent communication between S-R and the SFDI via telecon, meetings and memoranda provides a timely responsive system acting between SFDI Subsystem Manager, S-R Project Manager, and SFDI QA Manager. In addition, the Hot Line Report, RADL 1-14, will be used when required.

The S-R Project Procedure Manual, C-21700, provides specific directions for communications. Included are procedures for:

A. Written correspondence
B. Telephone calls
C. Trip reports
D. Conference meeting agenda and memoranda
E. Interoffice memoranda

Section 2

DESIGN AND DEVELOPMENT POLICIES AND PROCEDURES

2.1 SCOPE

This section of the S-R plan describes QA controls for development and release of Plant Support Subsystem Design and Engineering Services for the 10 MWe Solar Thermal Control Receiver Pilot Plant.

For complete documentation of policies and procedures for design and development, see the Management Plan, RADL 1-1, and the S-R Project Procedures Manual, C-21700.

2.2 DESIGN PLANNING

Basic to the S-R approach is the management of requirement documentation which presents the criteria for the verification process. These requirements will be presented in the following documents:

A. Refined updated or modified performance specifications for the CS, RS, TSS, MCS, PSS and T-GF

B. Plant Piping and Instrumentation Diagrams (P&ID)

C. Design specifications for the main steam/feedwater loop and thermal storage oil loop

D. Plot plan, building layout drawings

E. Existing utilities location drawing

F. Master equipment list (to be updated periodically)

Included are regulations, codes and standards which are applicable to the design and construction process and which must be employed specifically for those portions of the plant design for which S-R has prime design responsibility. This material addresses, but is not limited to:

1. Safety requirements
2. Structural loading criteria
3. Process flow quality
4. Seismic design requirements
5. Environmental requirements, and data
6. Quality/reliability requirements

Where the material does not exist in a convenient reference format, S-R will develop an appropriate document for use in design. The material will be identified in OPDD appendices.

The OPDD and the System Specification identified in the Work Plan, RADL 1-3, provide the starting point for requirements and are supported by the Design Review Package, RADL 1-5. The S-R Project organization will exercise QA controls to monitor conformance of the system in accordance with the Management Plan, the Work Plan applicable RADLs, the Project Procedures Manual and the Work Statement WS-2035.

2.3 DESIGN DEFINITION AND CONTROL

Specifications identified in the WS 2035 and the Work Plan, RADL 1-3, under the following, provide design definition.

- A. Plant system design
- B. Engineering service support
- C. Interface documentation
- D. Master control subsystem
- E. Plant support subsystems and engineering services
- F. Collector field
- G. Receiver subsystem
- H. Thermal storage subsystem
- I. Construction packages
- J. Procurement

Control of design definition is exercised by the Project Organization in accordance with the Management Plan, RADL 1-1, the S-R Project Procedures Manual, the S-R Engineering Standards for calculations EJ22 and RADL 7-8. Engineering Design changes are controlled in accordance with S-R Engineering Standards EJ33 and EJ30.

2.4 DOCUMENT REVIEW AND CONTROL

Document control will be applicable to "final" documents stamped "Approved for Project Use" or "Approved for Construction." Such documents must carry the validation signature of the Project Engineer.

The Drawing and Data Controller (DDC) will maintain in the Control Engineering File (CE file) all originals of current S-R documents and reproducibles of vendor documents given a "final" status.

The DDC will be responsible for distribution of prints and issuance of originals and reproducibles for revision.

Technical documentation will be prepared from Project design criteria by the responsible Project Design Engineer and Staff Engineering Group under the direction of the Project Controller. Specifications will be reviewed by the Staff Engineer providing design criteria, the responsible project discipline engineer, other project discipline engineers, the Solar consultant and the Project Engineer. The Project Discipline Engineer shall verify that the document has been properly accomplished. Changes and status will be controlled by the Project Organization, per the Project Procedure Manual, C-21700.

The following drawing checklist will be used for design checking:

1. Where the inputs correctly selected and incorporated into design?
2. Are assumptions necessary to perform the design activity adequately described and reasonable?

   Where necessary, are the assumptions identified for subsequent reverification when the detailed design activities are completed?
3. Are the appropriate quality and quality assurance requirements specified?
4. Are the applicable codes, standards and regulatory requirements including issue and addena properly identified and are their requirements for design met?
5. Have applicable construction and operating experience been considered?
6. Have the design interface requirements been satisfied?
7. Was an appropriate design method used?
8. Is the output reasonable compared to input?
9. Are the specified parts, equipment, and processes suitable for the required application?
10. Are the specified materials compatible with each other and the design environmental conditions to which the material will be exposed?
11. Have adequate maintenance features and requirements been specified?
12. Are accessibility and other design provisions adequate for performance of needed maintenance and repair?
13. Has adequate accessibility been provided to perform in-service inspection expected to be required during the plant life?

14. Are the acceptance criteria incorporated in the design documents sufficient to allow verification that design requirements have been satisfactorily accomplished?

15. Have adequate pre-operational and subsequent periodic test requirements been appropriately specified?

16. Are adequate handling, storage, cleaning and shipping requirements specified?

17. Are adequate identification requirements specified?

18. Are requirements for record preparation review, approval, retention, etc., adequately specified?

NOTE: If the answer to any question is "no", provide additional information and resolution.

2.5 DESIGN REVIEWS

Reviews will be controlled by the S-R Project Organization in accordance with the S-R Management Plan, RADL 1-1, the S-R Work Plan, RADL 1-3, and the S-R Work Statement, WS-2035 and documented in S-R RADL 1-5. Action items will be followed by the S-R Project organization until resolved.

2.6 DESIGN VERIFICATION TESTING

Design verification testing is a Phase II effort.

2.7 ITEM QUALIFICATION

Item qualification is a Phase II effort.

2.8 QUALITY RECORDS

Records identifying the history of changes are maintained by the DDC; drawings are retained in the Central Engineering (C. E.) file; calculations are controlled in accordance with S-R Engineering STD-EJ22.

2.9 QUALITY AUDITS

Audits are performed by the Project organization under the control of the Project Manager.

Continuous follow-up is maintained until findings are resolved.

Findings are reported to MDAC the SFDI.

Section 3
PROCUREMENT POLICIES AND PROCEDURES

This subject will be detailed in the second issue of this plan. The data will include the control for subcontract services and items purchased from vendors as stipulated in the formal subcontract or procurement specification. The S-R purchasing department will have primary control of the contracts under direction of the Project Engineer.

The cognizant Project Discipline Engineer will review vendor drawings and data.

S-R will initiate the procurement activity associated with the Receiver Subsystem riser feedwater pumps, the Master Control Subsystem Plant Control Cabinet. The Procurement Documents are RADL 7-38 and RADL 6-1.

Section 4

MANUFACTURING, FABRICATION, AND ASSEMBLY POLICIES AND PROCEDURES

Not applicable in this issue.

PART IV

PART IV
MDAC RESPONSIBILITIES, MASTER CONTROL SUBSYSTEM (MCS), BEAM CHARACTERIZATION SUBSYSTEM (BCS), DESIGN AND FABRICATION

Section 1
MANAGEMENT AND PLANNING POLICIES AND PROCEDURES

1.1 SCOPE

Part IV describes the MDAC action necessary to effect verification to acceptance requirements of hardware and software associated with the MCS and BCS and assure a high probability of compliance with subsystem and interface specifications.

1.2 QUALITY ASSURANCE PROGRAM

The program is designed to assure the BCS performs the functions of measuring each heliostat's delivered energy; the MCS coordinates the operation of all subsystems, providing optimum matching of solar input to demand.

In order to accomplish this, both hardware and software will be necessary. The requirements for both will be documented as indicated in work tasks under WBS 3 and 6. The following RADL numbers will identify the BCS and MCS requirements documents to be developed.

RADL No.	Title
6-1	Hardware and Software Specification
6-2	Procurement Document, Hardware
6-3	Procurement Document, Software
6-4	Acceptance Test Procedures
2-26	Technical Objectives Report (MCS)
2-28	Design Requirements Document (MCS)
2-8	Master Control Subsystem Requirements Specification
2-6	Beam Characterization Subsystem Specification
3-2	Hardware and Software Specifications and Drawings
3-4	Procurement Specification

The QA program purpose is to identify, implement, verify and evaluate requirements.

In identifying requirements, support will be provided during preparation of requirement documents, design reviews will be attended, methods of verification will be evaluated, controls will be provided, and specifications will be reviewed/approved.

In implementation and verification planning, drawings will be reviewed, procurement QA controls will be identified, receiving inspections selected, supplier acceptance reviewed, assembly plans reviewed, inspection points selected, conformance system selected, and control procedures identified.

In the evaluation areas, QA program effectiveness will be evaluated, audits will evaluate hardware, software, inspections, and QA system controls, suppliers and assembly operations will be evaluated, feedback controls will be monitored, and corrective action will be implemented.

Hardware requirements dictate procurement of commercial off-the-shelf items. Procurement directions for receiving/source inspection will reflect the requirements of RADL 6-2.

Some software will be procured as off-the-shelf items. Procurement directions for receiving/source inspection will reflect the requirements of RADL 6-3.

Hardware drawings will be released under a development drawing system using the Engineering Development Laboratories for assembly/fabrication in accordance with the Management Plan, RADL 1-1.

Instructions to the laboratory technicians will be by assembly drawings and associated documents. QA will verify hardware compliance to these documents. One of each assembly drawing or associated document (i.e., test procedure, etc.) will be identified as a Master Inspection Control Drawing (MICD). Redline changes to the MICD will be provided by Engineering and

verified by QA as being incorporated. Upon completion, both hardware designer and QA will sign off the MICD indicating acceptance.

The original MICD will be filed by QA as objective evidence.

1.3 ORGANIZATION

The Manager – Quality Assurance, SFDI is also responsible for the MCS and BCS hardware and software WA program. He will assure implementation of this QA plan, audit conformance to controls, and coordinate policy. The organization figure in Part I is applicable. Assistance from Quality Engineering (Software QA and Electrical and Mechanical Test) and line organizations will be required.

1.4 DOCUMENTATION

Management directives defining operations described in this QA Plan are available for review.

The RADL numbers described in Section 1.2 will provide requirements. In addition, drawings, test requirement documents, and test procedures will provide QA standards for evaluation.

Work Release Orders will authorize work; Engineering Orders will identify quantity and configuration of hardware and software; Purchase Orders and Subcontracts will provide procurement details and quality evidence necessary for acceptance; all will be in accordance with the Management Plan, RADL 1-1.

1.5 AUDITS AND REVIEWS

Manager – Quality Assurance, SFDI, will perform audits and reviews to determine compliance with QA controls, procedures and standards. Emphasis will be placed on functional, interface and safety requirements. Deviations from this Part IV QA Plan or Part I will be directly communicated to the Subsystem Manager, followed by a memo documenting the findings. The Program Manager – SFDI will receive a copy of the audit results memorandum.

1.6 CORRECTIVE ACTION

MDAC maintains a nonconformance manual which describes the system to be used. This system will be in concert with the development release system described in the Management Plan, RADL 1-1.

Hardware anomalies will be corrected in accordance with system regulations. Software nonconformance is controlled as described in Section 5 of this plan.

Apart from the control to correct nonconformance and prevent its recurrence, there is a Quality Action Request (QAR). QA will use the QAR to report to management detrimental conditions such as processes, equipment safety, or a malpractice that could adversely affect the product. It can be used to halt operations or to report and hold hardware that is conforming but unsatisfactory. A reply by responsible agents is mandatory.

1.7 ENGINEERING HOLDS

The Development Release System (DRS) provides controls for changes and stops through the master control drawing. However, a formal stop order is available for use by Engineering to stop a single part or a number of different parts related to a common design change. A stop order against a part or nonpart requirement (e.g., acceptance test requirement, wiring diagram, software) stops testing, manufacturing or procurement or next assembly usage for the effectivity indicated. The ensuing drawing change releases the stop order. Nonconforming items will be held for disposition and failure analysis, where required. The system will be monitored for compliance with the Management Plan, RADL 1-1.

1.8 UNUSUAL OCCURRENCE REPORTING

The Manager – QA, SFDI will report unusual occurrences to the BCS and MCS Subsystem Manager and the Program Manager – SFDI. Occurrences affecting Rocketdyne or Stearns-Roger will be reported in accordance with Part I of this Plan.

In addition, MDAC participates in the Government-Industry Data Exchange Program (GIDEP) and in "Alert" systems of NASA and Department of Defense agencies. Procedures prompt immediate analysis to determine if our

programs are affected when GIDEP or Alert reports are received. The activities are reciprocal, and problems detected by MDAC are reported into the systems, when appropriate.

A formal procedure provides positive action to maintain a closed-loop system of reporting and follow-up in the event of a major accident or significant incident concerning hardware or technically related items. This includes notification of appropriate levels of management, including the Program Manager, who immediately informs the customer of occurrences that may impact the project or contract performance. The procedure provides for protection of personnel and initiation of appropriate investigative and corrective actions. In addition, the Hot Line Report, RADL 1-14, will be used when required.

Section 2

DESIGN AND DEVELOPMENT POLICIES AND PROCEDURES

2.1 SCOPE

This section of the QA Plan describes MDAC controls for development and release of the subsystem design, design reviews, and controls of configuration.

For complete documentation of policies and procedures for design and development see the Management Plan, RADL 1-1. See Section 5 of this plan for unique software controls.

2.2 DESIGN PLANNING

The Management Plan provides the MDAC approach to design release. Basic to this approach is the management of requirements which are the foundation of the QA verification process. This plan provides a Development Release System (DRS) setting forth guidelines for drawing release. Included in the process are specifications, layouts, assembly, and installation drawings and the approval process. The OPDD and the System Specification, identified in the Work Plan RADL 1-3, provide the starting point for the BCS and MCS requirements and are supported by the Design Review Packages, RADL 1-5. QA will monitor conformance of the system in accordance with the Management Plan and the Work Plan applicable RADLs.

2.3 DESIGN DEFINITION AND CONTROL

Specifications will be prepared as identified in the Work Plan for both the BCS and the MCS. These specifications will provide the requirements for design which QA will verify in accordance with a verification matrix included in each specification. Drawings and procurement documents will implement the specifications constituting design definition. Control of drawing release will be in accordance with the Management Plan and the DRS. Change control after release will also be in accordance with the Management Plan, RADL 1-1.

QA effort will be directed at monitoring specification, drawing, and procurement releases for conformance to system requirements, controls and regulations.

2.4 DOCUMENT REVIEW AND CONTROL

Upon completion of the design drawings, the documents are signed by the preparer and submitted for approval by program design supervision. The cognizant supervisor designates other technology approvals on an individual drawing basis and provides for their signoff. For development release, each drawing is submitted for review and signoff by the Manager – Quality Assurance, SFDI.

The Composite Parts List (CPL) for the program is separately checked and approved by program design supervision and the Manager – Quality Assurance, SFDI.

Document reviews will be used to evaluate hardware and software drawings for cost effective accept/reject criteria.

2.5 DESIGN REVIEWS

The MDAC tasks in preparing for, conducting, and acting upon design reviews will be in accordance with the Management Plan and the Work Plan.

Design reviews will be attended by QA to present verification feasibility, verification equipment requirements and related historical data. Design Review packages will be in accordance with RADL 1-5.

2.6 DESIGN VERIFICATION TESTING

Performance of Design Verification Testing is a Phase II effort. Controls will be documented in the second issue of this plan. Such controls will include review of test procedures, test setup, test data, and implementation methods for accept/reject criteria. The verification matrix to be included in RADL 6-1 and 3-2 (hardware and software specifications) is a Phase I joint effort having engineering and QA controls.

Safety, maintainability, FMEA, and management plans will be reviewed in Phase I for requirements to be considered in test plans developed in WBS

6.1.1 and 3.4 and RADL 6-4 and 3-3. The MDAC Electrical and Mechanical Test QA Manual (M1.218-AJC) will be used as a guide in evaluation of documents for hardware test. RADL 2-20 will be reviewed for areas affecting test.

2.7 ITEM QUALIFICATION

Performance of Item Qualification is a Phase II effort. Controls will be identified in the second issue of this plan. RADL 6-1 will document test requirements and will be reviewed in Phase I for measurable accept/reject criteria. Preparation of the verification Phase I matrix is a joint engineering and QA effort. Evaluation of requirements will include effects of safety, maintainability, FMEA and management plans, and RADL 2-20, Identification of Documents, Codes and Standards.

2.8 QUALITY RECORDS

The following quality records relate to products procured and manufactured. Such records, when approved, become objective evidence and will be retained by a Quality Data Management Center.

Three principal types of records or data are basic to the operation of the quality program. They comprise the "objective quality evidence" which formally document project acceptability.

A. Product records include test reports/results and certification provided by suppliers, reports and data sheets reflecting tests performed by MDAC, inspection acceptance as indicated in stamped master prints of drawings, purchase orders (PO), the Material Review Records (MRR), Software Discrepancy Reports (SDR) and Failure Analysis Reports (FAR). Completed product records are filed in the data center for future reference.

B. Equipment records include factory process control records, equipment calibration records, and tooling control records. Process control records are maintained in logs at the work position or in the cognizant engineering agency. Equipment calibration records are maintained by the Metrology Laboratory. Tooling control records are maintained by Production Engineering. All records are subject to surveillance by QA.

C. Personnel records include employe training and certification data, identity of responsible employes for specified operations, and identity of responsible inspectors.

Evaluation of specific SFDI objective evidence requirements will be performed and the data center filing and retrieval system implemented accordingly. The system will address the guidelines of the Development Release System documented in the Management Plan, RADL 1-1 and DRS manual M 8.041-AC.

2.9 QUALITY AUDITS

The controls associated with design and development policies and procedures will be evaluated periodically by the Manager – Quality Assurance, SFDI for adherence and effectiveness. The findings will be published, directed to the Manager of the BCS/MCS, and followed until resolved. Corrective action will be implemented on a timely basis, using the Quality Assurance Audits Manual (M 1.310-SCJ) as a guide.

Section 3

PROCUREMENT POLICIES AND PROCEDURES

3.1 SCOPE

This section describes policies and procedures tailored to control performance requirements, supplier capability, planned inspections, configuration and nonconforming material handling for supplier-furnished materials or services.

3.2 PROCUREMENT PLANNING

The procurement process will exercise as required controls which evaluate supplier capability, procurement order clauses for control/data, source inspection/receiving inspection, and inspection instructions at receiving.

The MCS and BCS requirement documents identified in Section 1.2 dictate commercial components for most items. The controls will be tailored in accordance with item requirements and the DRS to provide cost effective conforming items.

3.3 PROCUREMENT REQUIREMENTS

RADL 3-4, 6-2, and 6-3 provide procurement requirement documentation for hardware and software. These documents will be reviewed for effective acceptance criteria and required controls. WBS 3.2 and 6.2 provide supporting information.

The following controls will be considered when defining procurement requirements; however, commercial hardware will limit such use to specific requirements.

A. Source Evaluation
   1. Supplier Nonconformance Control
   2. Supplier Inspection and Quality System
   3. Supplier Process Control
   4. Government Source Inspection

5. Supplier First Article Inspections and Preproduction Control
6. Supplier Tooling Inspection
7. Supplier Quality Data and Traceability
8. Supplier Certification of Raw Materials
9. Supplier Data for Functional Tests

B. Purchase order procurement clauses for process controls and test data requirements.

C. Procurement document review for requirement inclusion.

D. Source inspection or surveillance.

E. Plan for item receipt.

F. Inspection of received item.

3.4 PROCUREMENT DOCUMENT REVIEW

Procurement documents are reviewed prior to release for compliance with Section 3.3 and in accordance with the Management Plan.

3.5 EVALUATION AND SELECTION OF PROCUREMENT SOURCES

Supplier history of performance, surveys, and product control provide sources of information for evaluation when supplier selection is required. Section 3.3 and the DRS provide information to be included when selections are required.

The MCS computer supplier selection has been made by STMPO.

3.6 CONTROL OF CONFIGURATION

For commercial items, configuration will be dictated by existing supplier documentation and MDAC procurement clauses.

Where required, control of procured material will be affected via the verification of supplier objective evidence/inspection to specific part drawing configuration requirements.

Where required, configuration control of procured material will be maintained through a series of procurement clauses defined in the terms and conditions sections of purchase orders and subcontracts.

3.7 SOURCE SURVEILLANCE AND INSPECTION

Engineering and QA will witness performance of products at the supplier location. Supplier will perform factory QA per his existing system.

3.8 RECEIVING INSPECTION

For most items, receiving will be limited to damage and identification verification.

Where receiving inspection is required, acceptability of each operation will be documented on the Material Acceptance Plan. Satisfactory completion of receiving inspection will permit transfer to the SIL.

The requirement for receiving inspection will ensure that:

A. Procured articles and materials records accompanying them show evidence of inspections and tests performed by suppliers in accordance with purchase requirements.

B. Articles and material or accompanying records show evidence of MDAC inspection if required.

3.9 CONTROL OF PROCURED NONCONFORMING MATERIAL

Control of nonconforming purchases is managed in accordance with the MDAC nonconformance manual and the DRS. The system provides documentation, impound, disposition, segregation and corrective action for rejected material as required.

3.10 SUPPLIER QUALITY AUDITS

Product audits will be designed to identify uncontrolled areas which have or will result in products which do not fulfill their intended purpose.

In general, procurement from commercial suppliers will not be subject to quality audits. Findings will be reported via memo to the Manager of the BCS and MCS.

Section 4

MANUFACTURING, FABRICATION, AND ASSEMBLY POLICIES AND PROCEDURES

This task is a Phase II effort and will be presented in the second issue of this plan. Included will be hardware and software controls necessary to verify requirements as an integrated subsystem in SIL.

Section 5

SOFTWARE QUALITY ASSURANCE (PHASE I)

5.1 SCOPE

The methods MDAC will use in Phase I to promote and assure conformity to requirements in the development of SFDI operational and simulation software are described in this part of MDAC's Quality Program Plan. The software QA program described in this section responds to the quality program requirements of MDAC Control Procedure CP 10.055-AC, Software Quality Assurance Policy as tailored to the 10 MWe Solar Thermal Central Receiver Pilot Plant requirements.

5.2 QUALITY PROGRAM MANAGEMENT

Software development and test will be authorized using Work Release Orders. Engineering Orders are used to release technical requirements to establish software product baselines and encode firmware devices. Detailed software development and test schedules will be maintained by Engineering and used by QA and program management to evaluate progress. An SFDI program procedure implementing the software quality program will be issued for detail control. Adherence to procedures will be controlled through in-process reviews and audits, and deficiency reports to appropriate management for corrective action.

The MDAC software quality program will be applied to the development and test of SFDI operational software. This includes:

A. Master Control System Software, consisting of:
   1. Operational Control System
   2. Peripheral Control System
   3. Data Acquisition System
   4. Proportional Integral Derivative Controller (firmware)
   5. Process Interface Unit (firmware)

B. Beam Characterization System

C. On-Site Simulation

Support software essential for the production and acceptance of the operational software includes:

A. Compilers, assemblers, like editors
B. Format conversion utilities
C. Laboratory Hybrid Simulation (OLSF)
D. Test Data Processors

This software will be subject to configuration verification and control. Tests of support software will be controlled as required when the accuracy of this software is essential to the evaluation of the acceptability of operational software.

Assuring the quality of SFDI operational software will involve a progression of reviews, audits, and certifications throughout the development and test process, as shown in Figure 4. The evaluation of software accomplished in these reviews will be based on the criteria given in Table 2. Engineering, QA, and Configuration Management (CM) will participate as required by management procedures.

5.3 ESTABLISHMENT OF DOCUMENTATION AND CODE STANDARDS

Design documentation and code standards will be established in order to maximize the transferability, maintainability and reliability of the SFDI operational software. These standards will be documented in software working design manuals. They will prescribe uniform formats for design flow charts, standardized nomenclature, code commentary, modularity, and reliable code structures. Requests for deviations from these standards will be reviewed and authorized by the SFDI Software Manager.

5.4 DESIGN AND DOCUMENTATION REVIEWS AND AUDITS

At the preliminary design reviews, initial drafts of the computer program design specifications and related test documents for the operational software will be reviewed. Starting with the final design review, the program design specifications will be controlled. Test procedures will be controlled prior to the start of acceptance tests (however, acceptance test is a Phase II effort). Engineering, QA, and CM will review and approve these documents and all subsequent changes through their participation on the Software Configuration Control Board (SCCB).

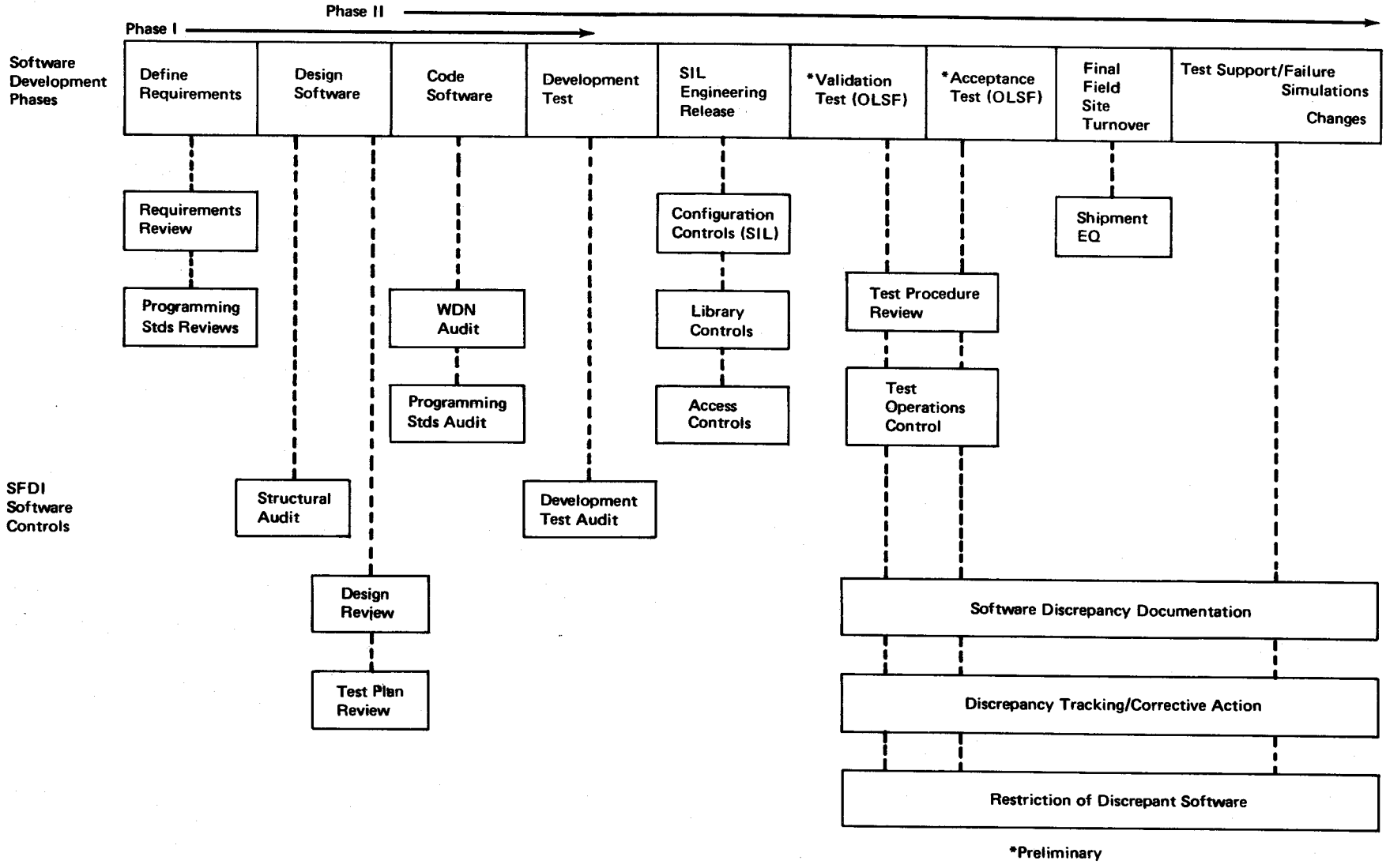

Figure 4. Software Development Approach – SFDI

Table 2. Review and Certification Criteria (Page 1 of 2)

A. DESIGN AND DOCUMENTATION REVIEWS

1. Program documentation is clear and precise. The format and content of software documentation will conform to that described in the SFDI Programmers Reference Manual, including:

   a. Documentation data
   b. Program name
   c. Name of responsible programmer
   d. Listing data
   e. Brief description of program
   f. Functional description
   g. Type of program
   h. Calling sequence
   i. Subroutines or functions used
   j. Input
   k. Output
   l. Flowchart(s)
   m. Program listings

2. Documentation change requests are evaluated, authorized and implemented as authorized.

3. Compatibility and traceability of design to the performance requirements is established with the development specification.

4. Interfaces are compatible between programs and throughout the system.

5. Interactions with the data base are consistent.

6. Acceptance test plans and procedures are traceable to performance requirements and adequately define the test configuration and operational controls.

   a. Code Walkthroughs and Audits

      (1) Code complies with design requirements and standards.
      (2) Code detects and disposes of possible software-induced errors.

   b. Development Test Reviews and Audits

      (1) Test cases exercise each module over a range of data values and through all logic paths.
      (2) Code changes are documented, controlled and retested.
      (3) Test results are consistent with simulations and the design intent.

   c. Code Configuration and Library Control Reviews.

      (1) Code and changes to code are completely defined, identified, authorized, and incorporated, and impact on documentation baselines is identified.

Table 2. Review and Certification Criteria (Page 2 of 2)

(2) Test, archive, and shipment files are generated from and duplicate released baselines.
(3) Controls are operative to prevent unauthorized changes to test, archive, and shipment files.
(4) Microprogramming of PROMs and EPROMs duplicate released software baselines.
(5) Duplicate copies of released software/firmware are maintained throughout the life-cycle of the project. These duplicate files are stored in a physically separate location.

d. Test and Evaluation Certification

(1) Hardware and software configuration and test operations are as required by the baselined test procedure.
(2) Software loading is verified against the controlled load media.
(3) Software performance complies with the acceptance criteria in the baselined test procedures.
(4) All nonconformances are documented and dispositioned completely, including retest and regression tests.
(5) As-run test documents are protected from unauthorized changes.
(6) Test reports accurately reflect the test activity and results.

e. Nonconformance and Corrective Action Reviews

(1) Problem statements are accurate and complete.
(2) Software configuration is identified.
(3) Problem classification and priority are identified.
(4) All affected documentation baselines are identified, updated and baselined.
(5) Disposition is defined, authorized, scheduled and completed.
(6) Retest and regression tests are authorized, scheduled, and successfully completed.

f. Configuration and Quality Record Reviews and Audits

(1) Records are maintained for the configuration and status of baselined documentation, code releases, nonconformances, and acceptance tests.
(2) Configuration baselines are accurately identified, accounted for, and controlled per management procedures.
(3) Records are maintained current and are protected from unauthorized changes.

Developers will maintain the evolving software design, code and testing in Working Design Manuals. Auditing the manual contents will assure they comply with requirements and are maintained current.

5.5 CODE WALKTHROUGHS AND AUDITS

During coding, programmers will participate in code walkthroughs with the chief programmer to evaluate code compliance with design requirements and standards. QA will verify that code walkthroughs are accomplished for all routines. Code audits will verify code compliance to standards. Audit findings will be documented and given to the chief programmer for corrective action.

5.6 DEVELOPMENT TEST REVIEWS AND AUDITS

As the operational software progresses through coding into development testing, software developers will compare all code performance with expected results established by analysis and simulation. All logic paths will be exercised at the module level over a range of data values to provide confidence in the code and design. QA will verify testing as part of auditing design notebooks to assess test conformance to plans and the criteria of Table 2.

5.7 CODE CONFIGURATION AND LIBRARY CONTROL

Prior to the start of formally controlled acceptance testing, operational and support software code will be released by Engineering Order. Generation and verification of controlled media, including firmware microprogramming will be implemented in Phase II and will be documented in the second issue of this plan.

5.8 TEST AND EVALUATION CERTIFICATION

Acceptance testing is a Phase II effort. Both a stand-alone acceptance test and a factory acceptance test is being planned. Stand-alone testing will evaluate hardware and I/O software only. Factory testing will evaluate operational and support software. Controls for Phase II will be documented in the second issue of this plan.

5.9 DISCREPANCY REPORTING AND CORRECTIVE ACTION

Discrepancy reporting and corrective action will be implemented in Phase II. The second issue of this plan will document controls.

5.10 CONFIGURATION AND QUALITY RECORD CONTROL

Records will be verified to provide a traceable path of software and system compliance with requirements. Configuration, documentation and code baseline controls will be exercised in Phase II; test and product records will be maintained to permit test repeatability.

REFERENCE DOCUMENTS

1. Overall Plant Design Description (OPDD)
2. SFDI Management Plan RADL 1-1
3. SFDI Work Plan RADL 1-3
4. Rocketdyne Work Statement - 2038
5. Rocketdyne Management Plan
6. Rocketdyne Work Plan
7. Rocketdyne QA Program Document RADL 1-2
8. Rocketdyne QA Manual
9. Stearns-Roger Work Statement - 2035
10. Stearns-Roger Management Plan
11. Stearns-Roger Work Plan
12. Stearns-Roger QA Program Document RADL 1-2
13. Stearns-Roger Project Procedure Manual C-21700
14. MDAC Inspection Manual M1.204-ACJ
15. MDAC Nonconformance Manual M10.048A
16. MDAC Development Release System Manual MB.041AC
17. MDAC Software QA Manual M1.210 ACJ
18. MDAC QA Audits Manual M1.310-ACJ