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SOFTWARE QUALITY ASSURANCE (SQA) FOR SAVANNAH RIVER REACTORS (U)

by

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ABSTRACT

Over the last 25 years, the Savannah River Site (SRS) has developed a strong Software Quality Assurance (SQA) program. It provides the information and management controls required of a high quality auditable system. The SRS SQA program provides the framework to meet the requirements of increasing regulation.

INTRODUCTION

Westinghouse Savannah River Company (WSRC) has operations responsibility for three production nuclear reactors at the Savannah River Site (SRS) under contract with the United States Department Of Energy (DOE). The site occupies over 300 square miles in South Carolina along the Savannah River, 25 miles southeast of Augusta, Georgia (see Figure 1). The SRS facilities consist of three operable production reactors, two chemical separation plants, a fuel and target fabrication plant, a waste processing plant, a heavy water reprocessing plant, and a support laboratory. The total site employment is about 24,000 with about 13,000 WSRC and 6000 Bechtel (construction) employees.

The reactors were constructed during the early 1950s (see Figure 2). They are heavy water moderated and cooled, and are used primarily for nuclear material production for national defense. Unlike commercial power reactors, the SRS reactors operate at low pressure (5 psig) and low temperature (less than boiling). The heat produced, about 2000 MW thermal, is a waste byproduct. The reactor core has 600 lattice positions for nuclear fuel or target assemblies (see Figure 3). In-core instrumentation consists of four thermocouples and a pressure indication for each assembly position. Additionally, there are about 150 sensors for general reactor data such as bulk moderator temperature and axial power measurements.

Computer use on site has grown exponentially. Process computer applications began in 1964, with the first application for monitoring the reactor process. Today, there are about 650 process computer systems, about 125 non-process mid-size computer systems (many of which are part of the site network), four IBM mainframes, and a CRAY on site (see Figure 4). There are greater than 8000 PCs, about 50/50 IBM and MacIntosh; most are part of the site network. SRS purchases about 100 Mac's each month and is one of the largest MacIntosh sites in the world.

A dedicated site centralized staff of about 150 employees maintains most computer hardware. The CRAY and IBM mainframes are serviced by maintenance contracts. Software with site-wide or network application is generally maintained by site centralized groups. Process or business unit specific software is generally maintained by many independent decentralized groups within the different business units on site.

With the change of site operating contractor to WSRC in April, 1989, came significant culture changes. A major emphasis is compliance with the regulations and standards that apply to the commercial nuclear industry.

This paper will focus on the software quality assurance (SQA) systems developed for the reactor process computers. Historically, these have been the most progressive on site and have been the model for other SQA systems.

SOFTWARE QUALITY ASSURANCE PROGRAM EVOLUTION

In the early 1960s, with the first reactor process monitoring computer system (using a GE-412 computer), there were no requirements for Quality Assurance (QA) documentation (see Figure 5). Documentation was a line management initiative and was developed for technical reference and software maintenance purposes. Configuration control was relatively informal.

Closed loop computer control of control rod position was added in 1970. A Safety Analysis Report (SAR), describing this new feature, was submitted to the Atomic Energy Commission (AEC) for formal review and approval by the Division of Reactor Licensing. Off-line testing facilities were used to demonstrate and validate the new software before implementation. The use of separate off-line testing facilities, with some process simulation capabilities, became a standard part of our software development practices. For all subsequent computer projects, replicate systems were purchased for software development and testing.

In the early 1970s, a project was initiated to replace the General Electric (GE) computers with dual control computers, and the assembly temperature and flow monitoring SCRAM systems with dual safety computers. Both systems use Interdata I-70 computers. The safety computers were implemented in 1976 and the control computers in 1978. With the addition of these systems, the documentation practices were formalized. Requirements for authorized computer abstracts were added to the Nuclear Control Procedures and Technical Standards. The abstracts served as the final approval document. Abstracts provide the basic information for software maintenance and use, including logic flow diagrams. Formal off-line testing and approval statements are required parts of the abstracts and must be completed before software may be placed in production use.

During the early 1980s there were three concurrent activities that resulted in the development of a site SQA procedure, process digital equipment purchase specification, and a configuration control procedure for the field systems.

In 1982, a site Process Digital Equipment Committee (PDEC) was formed with representatives from each of the site operating units and support groups. The purpose of this committee is to promote standardization and ensure that system maintenance requirements are fully addressed. One of the first developments from the PDEC was a standard purchase specification (Reference 1). This specification has been required for all purchases of process digital equipment (see Figure 6). This standard specification was based on the specification developed for a 1983 procurement of a new reactor Remote Monitoring And Control System (REMACS). REMACS is a dedicated network of redundant computers that is used to remotely (from a distance of five to fifteen miles) shutdown an evacuated reactor and maintain a safe shutdown state. Because this purchase was an integrated, customized system, it provided a good test of the specification. Use of the PDEC specification is being incorporated into site standards.

Also during the early 1980s, the site made a commitment to meet the requirements of ANSI/ASME NQA-1. A site QA program which began in the mid-1970s was expanded to include SQA with this NQA-1 commitment. The site QA organization coordinated an effort with PDEC to develop a site process computer SQA procedure (QAP 20-1, Reference 2). It was issued in October, 1985 (see

Figure 7). Early drafts of NQA-2, part 2.7 were also considered in the development of this procedure because future compliance requirements were expected. QAP 20-1 has since been expanded to include all high-impact (nuclear safety related) software on the site. Is currently being revised to require compliance with the recently issued NQA-2, part 2.7, in addition to the NQA-1, section 3 and 11 requirements.

January 1, 1985, a formal configuration control procedure (DPSOL 105-2201, Reference 3) was implemented for the reactor process computer systems to ensure coordination of changes with the operations organization (see Figure 8). This procedure provides tracking of approvals, change descriptions, acceptance test requirements, and verification of software, including a monthly software surveillance. Software source code configuration control is managed on a VAX computer that is dedicated to that task. Features are provided for maintaining master software files for each system, with traceable check in & out, and verification of code differences (changes) records.

IMPLEMENTATION

The Reactor Engineering On-line Computer Systems Group initiates, designs, develops, implements, and maintains computer systems for dedicated applications in the reactor process. Most of the systems are safety-related high impact systems that provide automatic reactor shutdown, control critical reactor systems, or provide important information for the plant operators. The development and maintenance of these systems have included the elements described in the previous section.

The SQA procedure (QAP 20-1, reference 2) requires the development of a SQA plan. For the reactor systems a single plan describes the standard practices used for all systems. Figure 9 shows the primary elements of our program.

For new systems, a Functional Performance Requirements Document is generated to describe the basic requirements of the system, including both hardware and software functions. A more detailed description of the software requirements is provided in a Software Requirements Specification. This specification must also include testing requirements. A clear definition of acceptance criteria is important to both documents. When modifications are required, the Software Requirements Specification is the beginning of the cycle.

The next element is the Conceptual Design Document. To assist in the conceptual design step, we have recently purchased the Computer Aided Software Engineering (CASE) tools, "Teamwork" and Software Analysis Workstation (SAW), from Cadre Technologies Inc. We are currently implementing "Teamwork", the structured analysis and design tool for real-time systems. The Cadre tools were selected because of the planned interface of the SAW with the structured analysis and design tools and their ability to produce documentation that complies with Mil Spec. 2167a. The SAW provides for real-time testing using a CPU probe that directly monitors CPU activity without affecting CPU performance. It also provides features that directly relate source code to the executing code and traceability and timing for all code paths executed. These features will greatly aid the debugging process and provide complete documentation of our off-line testing.

Coding and off-line testing is the next element. At this point the traditional "waterfall" concept for software development no longer applies. Instead, during coding and testing, many cycles repeating the requirements and design phases are normally necessary as our understanding of the undefined details improves. We frequently prototype software and hardware where significant uncertainty in performance or interface requirements exist. Off-line testing with limited process simulation is a normal practice. More extensive off-line performance testing will be performed using the SAW.

Final software documentation consists of the computer abstracts (previously discussed) and operation and maintenance procedures. These documents are maintained for the life of the system and provide the baseline of the system. The basic requirements and design information are incorporated into the abstracts to ensure consistent, comprehensive, system documentation. The abstract and procedure systems have existed since the first process computer applications and have been a model for other organizations, both on and off site.

After final approval of the abstracts and procedures, and completion of any required hardware modification, the new software can be implemented in the field. Configuration control is provided by an administrative procedure, DPSOL 105-2201 (previously described). Both new and modified software are controlled by this procedure. All software must have a documented final functional test, which demonstrates all system requirements and functions. A formal acceptance by the user is required before the software can be used.

During use, all systems are subjected to periodic automatic or scheduled manual testing to ensure system integrity. If a modification is needed, the software development cycle is started again at the Software Requirements Specification step.

REFERENCES

1. PDEC Specification, Attachment 1

2. QAP 20-1, Site Software Quality Assurance procedure, Attachment 2

3. DPSOL 105-2201, software change control, Attachment 3

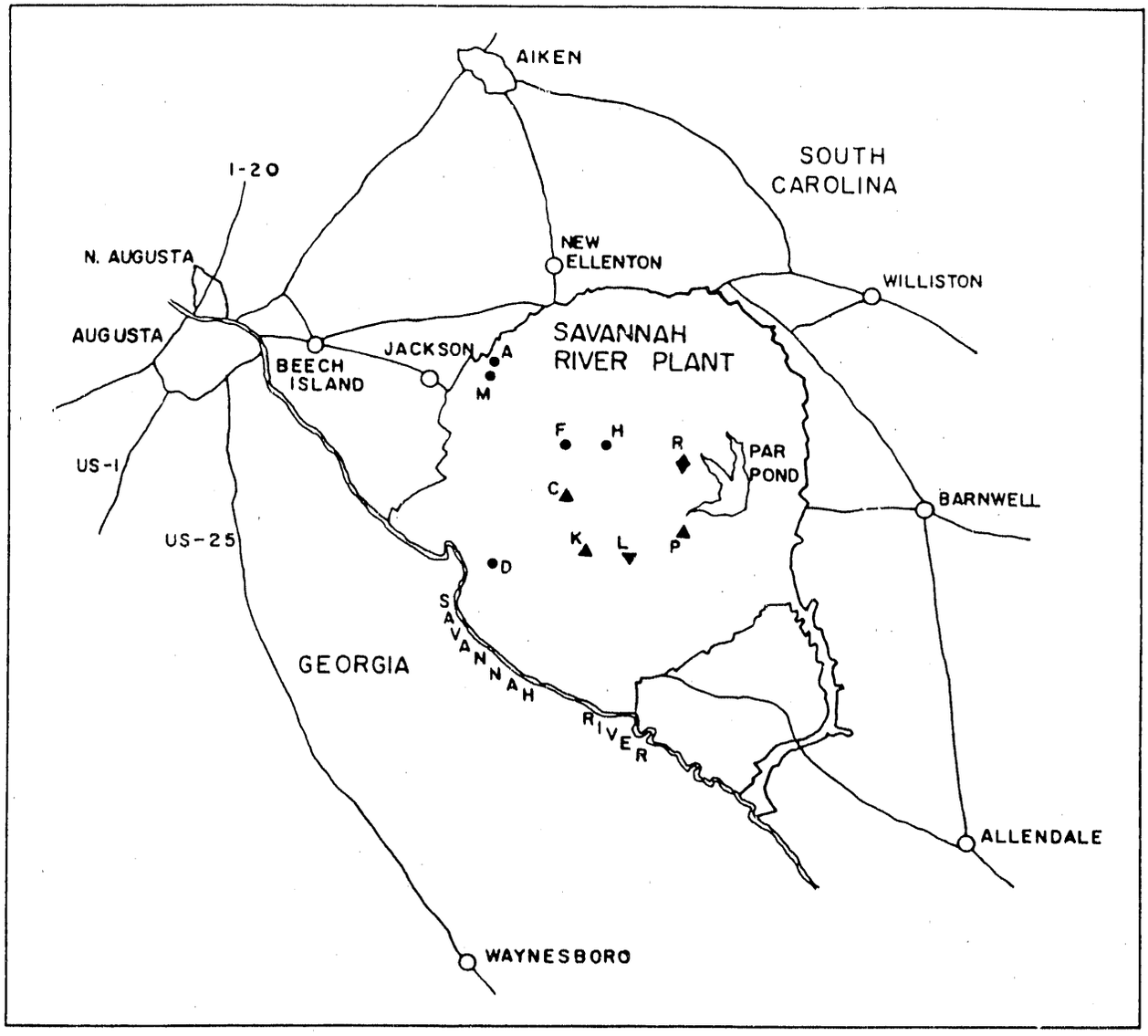

Figure 1. Map of the Savannah River Site and Environs

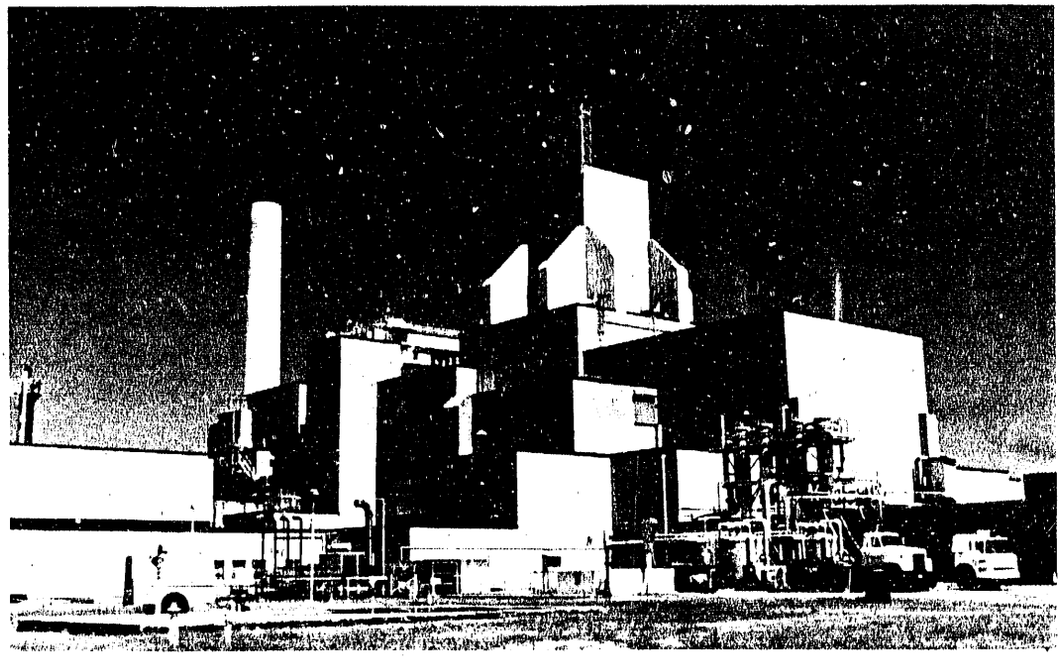

Figure 2. Savannah River Site Reactor Building

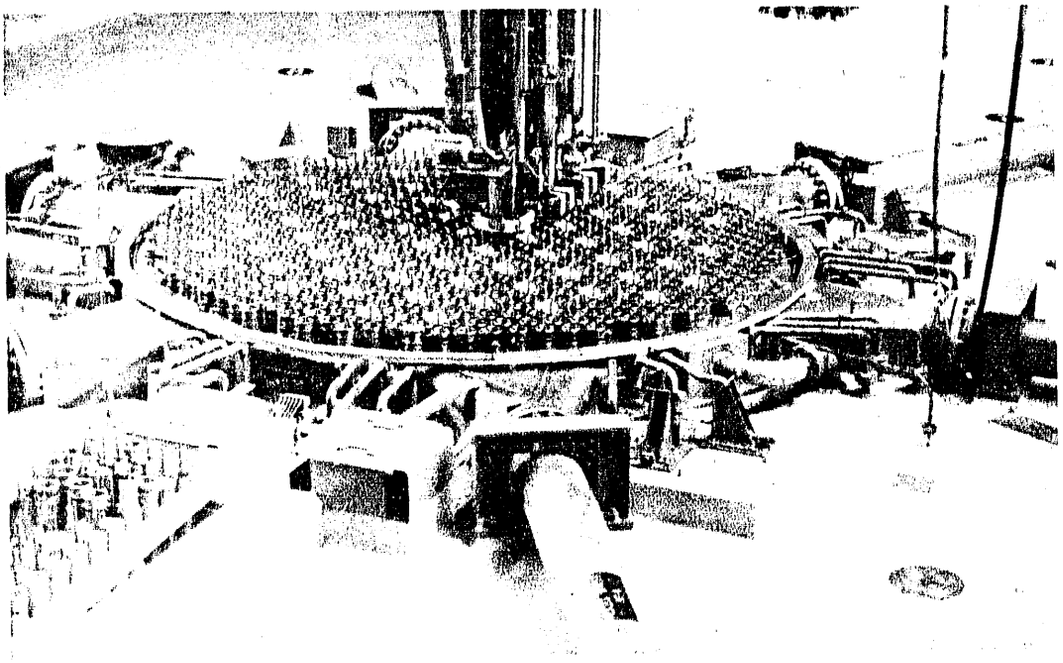

Figure 3. Process Room of Reactor Building Showing Lattice Positions of Reactor Core

Figure 4.

1990 Computer Statistics

650 Process Computer Systems

125 Non-Process Mid-Size Computer Systems
(many are part of the site network)

4 IBM Mainframes and 1 CRAY

~900 Personal Computers (50/50 IBM and Macintosh)
(Most are part of the site network)

Figure 5.

Reactor Computer History

1960s Reactor Monitoring Computer (GE-412)

* Informal Configuration Control

1970s Safety and Control Computers (Interdata I-70)

* Formalized Documentation and Approvals

1980s Charge and Discharge Crane Control (Fabritek)

Remote Monitoring and Control System (August Systems)

* Formalized Configuration Control
* Site Standard Purchase Specification
* Site Software Quality Assurance Procedure

Figure 6.

PDEC Purchase Specification

Promote Standardization

* Maintain Supported Equipment List
* Seven Year Life Cycle Cost

Ensure System Maintenance

* Obtain all Vendor Proprietary Information (including rights to modify or manufacture)
* Minimum Documentation Requirements
* Maintenance Training, Testing Equipment, and Recommended Spare Parts
* Minimum Factory and Site Acceptance Tests

Figure 7.

Site Software Quality Assurance Procedure

1985 High Impact Process Computers

* NQA-1
* Early Drafts of NQA-2, Part 2.7

1988 Non-Process High Impact Software

1990 Combined into Single High Impact SQA Procedure

* Require Compliance with NQA-2, Part 2.7

High Impact = Used directly in the design, construction, operation, modification, repair, or maintenance of "Nuclear Safety Class" and "Critical Protection Class" facilities and components, or that software whose failure would likely cause process hazards criteria to be exceeded.

Figure 8.

Configuration Control Procedure

Ensure Coordination of Changes with Operations

Provides tracking of the following:

* Approvals
* Change Descriptions
* Acceptance Test Requirements
* Verification of Software

Requires Monthly Software Surveillance

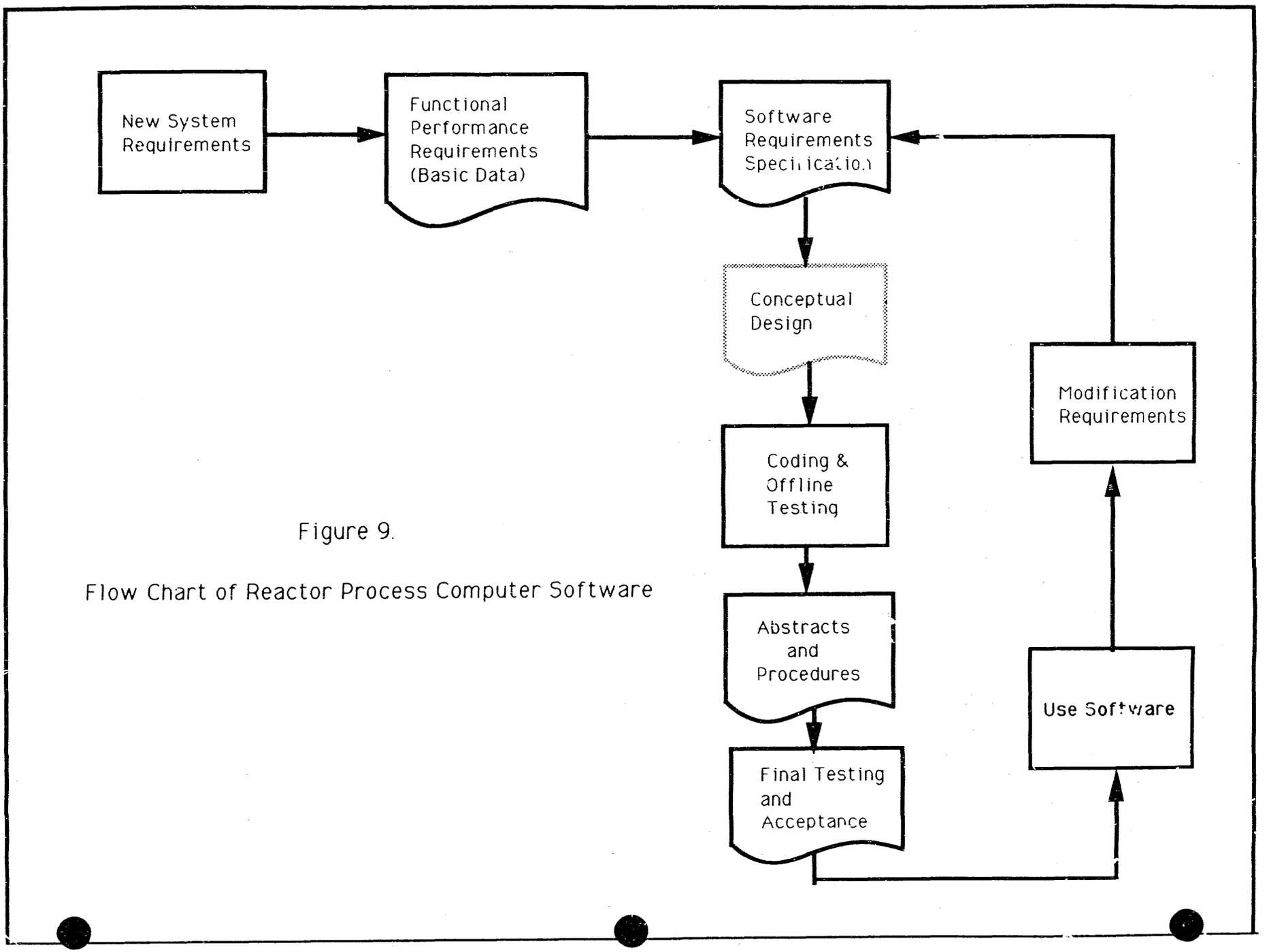

Figure 9.

Flow Chart of Reactor Process Computer Software

ATTACHMENT 1

SAVANNAH RIVER SITE

PROCESS DIGITAL EQUIPMENT COMMITTEE

STANDARD SPECIFICATIONS FOR PROCESS COMPUTER EQUIPMENT PROCUREMENT

EPD-DSQ-90-0005

SAVANNAH RIVER SITE
PROCESS DIGITAL EQUIPMENT COMMITTEE

STANDARD SPECIFICATIONS FOR PROCESS COMPUTER EQUIPMENT PROCUREMENT (U)

Westinghouse Savannah River Company
Savannah River Site
January 1990
REV. 3.0

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This specification applies to the following project and is part of the proposal. The Requirements marked [ ] within this specification are part of the contract and will be enforced. Requirements marked [X] are not part of this contract.

I. IDENTIFICATION

[ ] SAVANNAH RIVER SITE
PROJECT S-_____

II. BID PREPARATION - GENERAL INSTRUCTION

1.0 120 DAY PERIOD

[ ] All proposals under this request must be extended firm for Savannah River Site acceptance for a minimum of 120 days from the date of Vendors proposal.

2.0 VERBAL PRESENTATIONS

[ ] Vendors will have the opportunity to make verbal presentations.

3.0 ITEMIZATION

[ ] Vendors proposal shall be itemized and include purchase, lease, short term lease/ purchase option, maintenance, and field installation rates for both hardware and software. If applicable, Vendor shall include GSA Federal Supply Contract (FSC)price for each item contained in the proposal. If items are not available under Federal Supply Contract, provide a copy of commercial price schedule and applicable discount rates.

3.1 Unit
3.2 Device
3.3 Option
3.4 Function
3.5 Purchase price
3.6 Lease price (7 year)
3.7 Lease/Purchase option price
3.8 Factory maintenance cost
3.9 Installation cost

4.0 DETAILED EXPLANATION

[ ] The Vendor shall provide by page and paragraph a point by point detailed explanation of all items in compliance with or in exception to items of this specification, including any exceptions to the specifications and the full cost for alterations or additions to fit the specification.

5.0 PROPRIETARY INFORMATION

[ ] The Vendor shall provide all proprietary information required to repair all equipment at the component (chip) level. The quotation shall include any nondisclosure agreement which Savannah River Site is requested to execute.

6.0 PROPRIETARY INFORMATION MARKING

[ ] Each page of the bid containing proprietary information shall be so marked. All information, documents, and etc. procured under this contract become the property of the United States Government and may be shared with other government agencies and the general public; unless specifically excluded by written terms of contract, or specifically limited to Westinghouse Savannah River Company, or specifically limited to the Savannah River Site. Clearly identify, in writing, any such limitations.

7.0 TERMS AND CONDITIONS

[ ] Unless better terms and conditions are offered, all terms and conditions, other than price, set forth in the Vendors latest GSA Federal Supply Contract, if any, shall be considered a minimum part of the Vendor's bid. If there are any conflicts between the Vendors FSC and the bid, the better terms and conditions as determined by Savannah River Site shall be controlling. All commitments made in the Vendors proposal shall be contractually binding.

8.0 NO COMMITMENT BY SAVANNAH RIVER SITE

[ ] This request for quotes does not commit Savannah River Site to pay any costs incurred in connection with any proposal, nor to procure or contract for any system option or feature or service.

9.0 STANDARD PRODUCTS

[ ] All items, whether hardware or software, which are supplied by the vendor as a part of the bid, must be currently available and under full support by the Vendor and must be demonstrable in an existing system or as a system at the vendors site. These items must have been available for sufficient time to document reliability.

[ ] A list of at least two current installations similar to the quoted system. List shall include location, company, and name of personal contact for each installation.

10.0 SPARE PARTS AVAILABILITY

[ ] The Vendor shall certify that spare parts for equipment purchased under this specification will be available to Savannah River Site for at least 10 years after completion of the installation.

11.0 SECURITY CLEARANCES

[ ] Vendor personnel working on site or having access to classified information shall be required to obtain appropriate security clearances. This will require, at a minimum, that personnel are United States citizens.

12.0 DIRECT PURCHASE

[ ] Savannah River Site reserves the right to purchase computer equipment, training, documentation, and software directly from third party vendors to reduce system cost. Under such condition, integration of Savannah River Site purchased equipment will be done by Savannah River Site.

13.0 ITEMS TO BE INCLUDED

Each proposal shall include but not be limited to:

[ ] 13.1 All additional items required to complete the system but not otherwise specifically addressed in this document.

a. Software Licenses
b. Support Diagnostics
c. Hardware Jumpers
d. Expansion Backplanes
e. Options
f. Cables
g. Connectors
h. Plugs

[ ] 13.2 Plan and elevation views with dimensions of components, including definition of power requirements, grounding requirements, floor loading, floor area requirements, package dimensions, heat load by area, and noise generation by the system and its peripherals; include space requirements, operating environments, and environment control requirements.

[ ] 13.3 A recommended list of spare parts (complete units, circuit boards, components, etc.) to provide inventories to assure 98% spare parts availability, consumables, and special test equipment required to enable Savannah River Site to provide inhouse maintenance shall be itemized and quoted as options. Include unit prices, applicable discounts if purchased as a package at time the system is shipped, and applicable discounts if purchased later. Include the nearest, fastest source of spare parts and expected delivery time after receipt of order. Include, where appropriate, the alternative cost and delivery schedules if defective parts are returned for repair or exchange for reconditioned units.

[ ] 13.4 Cost of additional sets of documentation and training materials.

[ ] 13.5 Software/Firmware Support affirmation

a. State the extent of support for all vendor-provided firmware, both prior to and after system installation.
b. State the configuration assistance available to Savannah River Site to aid in total system implementation including Vendor's preparation of detailed System Design Specifications, preparation of the Acceptance Test Document, and System Configuration.
c. State the procedure and cost, if any, for reassembly or regeneration of vendor provided firmware due either to changes recommended by the Vendor or to modifications desired by Savannah River Site, both before and after system installation.

[ ] 13.6 State the extent of support for all vendor supplied software. both prior to and after system installation. Include cost of updates, policy on communicating known or discovered errors to customers, available newsletters, membership in user groups, or other support items.

[ ] 13.7 Provide photographs or drawings of each type of display, and each state of a display (normal, alarm, acknowledged alarm). Colors shall be indicated.

[ ] 13.8 Failure analysis

a. State the maximum time the power source can be interrupted without disruption of system operations. For time spans of O to 10 seconds, curves are preferred. for longer time spans, tabulations are satisfactory.
b. State the action of the system upon restoration of power after disruption.
c. The vendor must supply, as part of the bid, calculations for Availability for each component of the proposed system. Calculate expected hardware availability by the following equation, where Availability is represented by AV, Mean Time to Repair by MTTR, and Mean Time Between Failures by MTBF.

$$AV = \frac{\text{Uptime}}{\text{Total Time}} \quad \frac{\text{MTBF}}{\text{MTBF + MTTR}}$$

14.0 LICENSES

[ ] List all licenses furnished with the system, identified with hardware or software package to which the license applies; including conditions for use of license and cost of renewing where applicable.

15.0 SELECTION CRITERIA

Bid selection will be based on, but not limited to, consideration of the following items:

[ ] 15.1 Each offerers bid will be evaluated on its technical merit.

[ ] 15.2 Each offerers delivery schedule will be considered.

[ ] 15.3 Each offerers Total 7 Year Life Cycle Cost will be considered. Tota. 7 Year Life Cycle Cost is the sum of the quoted prices plus the additional cost deemed necessary to operate and maintain the system for seven (7) years.

The 7 Year Life Cycle Cost for computer systems consists of four major cost items; the quoted system costs, operating expense, software maintenance, and hardware maintenance. These four items are added together to arrive at the 7 Year Life Cycle Cost for each offerer.

15.3.1 QUOTED SYSTEM COSTS are provided by the offerer in response to this request. Provided the equipment, software, and documentation meet the technical requirements of this Request For Quotation, the items are summed.

Initial software configuration (application programming) may be quoted by the offerer or may be supplied as an alternative by the Savannah River Site. If supplied by the Savannah River Site, the cost of initial programming will be calculated by multiplying the number of man-years required to program similar systems on-site by a programmer salary factor.

The programmer salary factor is the best estimate of wages and overhead for a typical programmer and is currently $54,000 per year. This factor is subject to change without notice, but is applied to all vendor evaluations equally.

15.3.2 OPERATING EXPENSE includes the cost of power, installation, and other operating items as listed below.

15.3.2.1 Cost of power is determined by kilowatt consumption times the Savannah River Site 7 year power factor, currently $2398. This power factor assumes continuous computer operation and is subject to change without notice, but is applied to all offerer evaluations equally.

15.3.2.2 Installation costs are determined from vendor quote and Savannah River Site experience with similar equipment. If the vendor offerings differ significantly, the installation costs may include cost of floor space, electric power supplies, warrantee extensions, on-site assistance, etc.

15.3.2.3 Other operating items that significantly affect cost over seven years may be uncovered during bid evaluation. These could be license renewal, maintenance contracts, cost of updating documentation, etc.

15.3.3 SOFTWARE MAINTENANCE cost is the the sum of software manpower, software training, software development tools, and software documentation.

15.3.3.1 Software manpower is the number of programmers required to maintain the equipment for seven years multiplied by the programmer salary factor described in 15.3.1.

The method of estimating the number of software programmers may vary with the application, but is based on difficulty factors (hours to program) and estimated occurrences for the following software activities expected in seven years; (l) changing a software interlock(if any), (2) changing a display screen, (3) making a process control description (automated sequence) change, (4) adding a new instrument, (5) adding a new process control description (automated sequence), (6) duplicating the process (adding a new line), (7) making a major process revision, (8) performing system management functions such as backups.

The Savannah River Site maintains a list of difficulty factors for systems already on-site which have a process history.

15.3.3.2 Software training costs are the sum of vendor training course tuition (as quoted by the vendor) plus Savannah River Site travel expenses to attend the course times the number of programmers required. The current Savannah River Site travel expense factor is $1000 per week which includes travel, accommodations, and other expenses. This expense factor is subject to change without notice, but is applied to all vendor evaluations equally.

Credit is given for programmers already trained in the vendor's software.

15.3.3.3 Software development tools and documentation required to maintain the system are summed. If this quotation does not include a development system, consideration is given to adding costs for necessary equipment. Costs for software documentation not listed in quoted prices are added.

Credit is given for development tools and documentation already on site.

15.3.4 HARDWARE MAINTENANCE is the sum of spare parts, maintenance manpower, and maintenance training as determined below. Vendor supplied maintenance equivalent to Savannah River Site maintenance may be evaluated as an alternative, if available.

15.3.4.1 Spare parts costs are estimated based on number of expected component failures during seven years multiplied by cost of part. Savannah River Site experience, vendor Meantime To Failure values, and other factors are considered in determining number of expected failures. Cost of component parts and repair kits are quoted by vendor.

Credit is given for spare parts already purchased or on site in excess of minimum requirements.

15.3.4.2 Maintenance manpower cost is the number of maintenance technicians required to maintain the equipment for seven years multiplied by a salary factor. The maintenance technician salary factor is a best estimate of wages and overhead for a typical maintenance technician and currently is $54,000 per year. This factor is subject to change without notice, but is applied to all vendor evaluations equally.

The number of maintenance technicians required to maintain the offered equipment is estimated by the Savannah River Site based on experience with similar equipment.

15.3.4.3 Training costs are the sum of vendor training course tuition (as quoted by the vendor) plus Savannah River Site travel expenses to attend the course times the number of maintenance technicians required. The current Savannah River Site travel expense factor is $1000 per week which includes travel, accommodations, and other expenses. This expense factor is subject to change without notice, but is applied to all vendor evaluations equally.

The number of technicians is the same as estimated in 15.3.4.2.

Credit is given for training already received.

16.0 TERMINAL RESPONSE TIME

[ ] The time from the initiation of a command from any terminal for an interactive function until the time the display of the updated data or response appears on the terminal shall not exceed 2 seconds. If computation time requires greater than 2 second response, a message informing the operator of the current status of his request will be displayed on the terminal and updated at least every 5 seconds.

17.0 HAZARD GUARDING

[ ] Exposed connectors or conductors with voltage greater than 50 Volts shall be guarded to prevent contact by persons operating or servicing the equipment. Exposed fan blades such as on equipment racks, shall have blade guards positioned to prevent contact by persons operating or servicing the equipment.

18.0 SCHEDULE FOR COMPLETION

[ ] A detailed schedule of proposed document, training and equipment approval, fabrication testing, inspection, and delivery in weeks after receipt of order will be presented.

19.0 LOADABLE MAGNETIC MEDIA

[ ] Two copies of all programs, diagnostics, and data files shall be supplied on machine readable magnetic media.

III. DOCUMENTATION REQUIRED WITH PROPOSAL

1.0 APPROPRIATENESS DETERMINATION MANUALS

The Vendor shall supply AS PART OF THE PROPOSAL, manuals which will be used to determine the appropriateness of the system proposed. These will include but not be limited to:

[ ] 1.1 Operating system and functional operation description.
[ ] 1.2 Operating system user guides and associated operating system documentation.
[ ] 1.3 Manuals describing utilities.
[ ] 1.4 Manuals describing hardware options defined in the bid. Samples of logic diagrams, drawings, and prints shall be included.
[ ] 1.5 Manuals for maintenance diagnostics, showing how to implement tests for each system.
[ ] 1.6 Printed source listings of representative sample programs to use in determining appropriateness and completeness as well as maintainability. These will be used in bid evaluation.
[ ] 1.7 All documentation must be at the same revision level as hardware and software to be supplied.
[ ] 1.8 List of all licenses to be furnished with system, identified with hardware and software package to which the license applies; including conditions for use of license and cost of renewing license where applicable.

2.0 QUALITY ASSURANCE DOCUMENTATION

The vendor shall provide the following quality assurance documentation:

[ ] 2.1 An uncontrolled copy of the administrative or procedural controls used by the vendor to control the quality of goods or services provided by the vendor.
[ ] 2.2 A document detailing how the vendor will handle any changes to the original design, and how these will be relayed to Savannah River Site.
[ ] 2.3 A document showing the reporting structure of the vendor's organization.

3.0 NONCONFORMANCE REPORTING

[ ] The vendor shall state his method for reporting items which do not conform to the original specification. At a minimum, the reporting system shall contain:

3.1 Evaluation of nonconformance.
3.2 Supplier notification to Savannah River Site detailing explanation or technical justification, means for disposition, and proposal for resolution of nonconformance.
3.3 Savannah River Site approval of vendor's recommended correction of nonconformance.
3.4 Documented verification that nonconformance has been corrected.

4.0 PROGRAMMABLE LOGIC CONTROLLER (PLC) DOCUMENTATION

These specifications are to ensure that PLC program documentation provided by the vendor is in a form that can be readily maintained by site support personnel. The vendor shall provide all necessary hardware and software to document the application program. Savannah River Site's primary contractor reserves the right to delete from an order any documentation or hardware duplicating material or equipment already in possession from prior acquisitions.

Two major types of programming are currently being used to write PLC programs. There are: (A) Ladder Logic and (B) High Level Languages (C, Basic, etc...). Documentation requirements are different between these two programming methods and will be addressed separately in this document.

5.0 PLC SYSTEM DESCRIPTION

[ ] The PLC System description will consist of three parts:

a. HARDWARE BLOCK DIAGRAM showing the CPU,associated peripherals, local, and remote I/O stations and their respective cabinet numbers.

b. SYSTEM ABSTRACT containing the following:
   1. SYSTEM PURPOSE - A brief description of what the system does.
   2. INSTRUCTIONS FOR USE - any specific instructions necessary for software maintenance (i.e. procedures for system shut-down, start-up, backing-up and up-loading the program, as well as a listing of all of the hardware and software needed to accomplish these tasks).
   3. TESTING STATEMENT - document stating the date that the PLC's program was tested and the name of the test procedure performed.
   4. APPROVAL STATEMENT - document stating who accepted the finished system software and on what date.
   5. REFERENCE LISTING - a listing of all documents used as references by the developer of the system software. This includes all SRS documents as well as vendor/manufacturer information.
   6. LICENSE INFORMATION - The software license's, manuals, and disk and/or tapes for both the operating and the documenting software are to be provided to the system's custodian.

c. SOFTWARE FLOWCHART - a flowchart of the PLC's program with rung number references for ladder logic, line number references for Basic programs, and function references for C language programs.

6.0 PROGRAM DOCUMENTATION
PLC

6.1 LADDER LOGIC BASED SYSTEMS

In an attempt to standardize PLC program documentation on the site, it is recommended that the vendor use the Taylor Industrial Software package whenever they are bidding a PLC supported by this product. If the vendor is bidding a PLC not supported by Taylor, that PLC's program must be documented with a software package that meets the following minimum criteria:

[ ] 6.1.2 Be IBM-PC compatible.

[ ] 6.1.3 Print the following reports:
   6.1.3.1. I/O point address and channel configuration.
   6.1.3.2. Memory address contents - ASCII,Decimal,HEX,Binary.
   6.1.3.3. Fully annotated ladder logic including commenting of each coil and labeling of each contact, coil, and register.
   6.1.3.4. Cross reference tables of all used memory locations.

[ ] 6.1.4 The software package must have the capability to perform two-way program transfers between the magnetic medium on the manufacturer's programming device and the IBM-PC documenting device using serial asynchronous communications.

[ ] 6.1.5 Ability to edit program elements and comments concurrently.

6.2 HIGH LEVEL LANGUAGE BASED SYSTEMS

The following statements specify the minimum requirements for documenting PLC programs written in something other than ladder logic:

[ ] 6.2.1 The hardware and software used for program generation is to be of the type and method recommended by the PLC'S manufacturer.

[ ] 6.2.2 Program listings are to be provided on both magnetic medium and in hard copy form. These listings are to include both comments as well as source code.

[ ] 6.2.3 The program shall be organized and commented sufficiently to allow software maintenance personnel to follow the program flow and to perform changes in the source code without undue effort.

[ ] 6.2.4 Listings of all supplied firmware and software, including source listings, shall be to the level used by the vendor for maintenance (BASIC, C, assembly code, etc.).

[ ] 6.2.5 A programmer's manual showing proper procedures for compiling or assembling, linking, and loading of the executable code must be provided by the vendor.

[ ] 6.2.6 If the executable code is to be ROM based, the vendor must furnish a procedure listing the necessary hardware and software to load the code into the ROM itself.

7.0 LICENSES

[ ] A list and signed originals of all licenses furnished with system identified with hardware or software package to which the license applies, including conditions for use of license and cost of renewing where applicable.

8.0 WARRANTY

[ ] The Vendor shall warrant the hardware and software purchased, for 90 days after receipt and acceptance of each component system at the site by Savannah River Site. Such warranty shall cover all parts, labor and travel expenses required for repairs.

IV. CONTRACT REQUIREMENTS

1.0 DOCUMENTATION REQUIRED WITH ORDER

Regardless of information received with the bid, AFTER RECEIPT OF ORDER the vendor shall supply complete documentation for the system purchased to permit site technicians and programmers to maintain, modify, and develop the system defined in this specification. Savannah River Site reserves the right to delete from order manuals duplicating those already in possession from prior acquisitions.

All documentation, prints, print transmittal letters and correspondence must show the following identification:

SAVANNAH RIVER SITE
PROJECT S-XXXX
SAVANNAH RIVER ORDER NUMBER: AX-XXXXXX
ENGINEERING NUMBER: XXXXXX

Project number, Order number, and Engineering number will be supplied to the vendor by the Savannah River Site.

All documentation must be of the same revision or version number or level as the hardware and software provided.

The vendors supplied documentation shall contain but not be limited to:

1.1 HARDWARE MAINTENANCE MANUALS

Hardware Maintenance Manuals shall describe both hardware and firmware. Each part shall be complete, detailed, and directed to technicians who will conduct the hardware maintenance down to the component level.

[ ] 1.1.1 Six (6) complete sets of Manuals shall be provided.
[ ] 1.1.2 Manuals shall cover all purchased components.
[ ] 1.1.3 Manuals shall contain complete and comprehensive description of operating theory, installation guidelines, maintenance and trouble shooting procedures.
[ ] 1.1.4 Manuals shall contain circuit schematics, wiring diagrams, component layout, and parts lists.
[ ] 1.1.5 Manuals shall be of sufficient detail for installation and maintenance by Savannah River Site electronic technicians.
[ ] 1.1.6 Reproducible dimensional and wiring diagrams shall be included.

1.2 AS BUILT HARDWARE MANUALS

[ ] The required documentation shall be developed as the system is built and shall consist of the latest updated version upon delivery. The documentation shall contain:

1.2.1 Overall System

- 1.2.1.1 Theory of operation
- 1.2.1.2 Block Diagram
- 1.2.1.3 Photographs of major components
- 1.2.1.4 Diagram of cable connections between console, cabinets, computers, etc.

1.2.2 Each Cabinet (or Console)

- 1.2.2.1 Layout of major components
- 1.2.2.2 Intercabinet cabling

1.2.3 Each major component (or card file).

- 1.2.3.1 Theory of operation
- 1.2.3.2 Block Diagram
- 1.2.3.3 Layout of circuit cards locations
- 1.2.3.4 Backplane wiring diagram or wiring list
- 1.2.3.5 Illustrated parts list, identifying cards, assemblies, etc.

1.2.4 Each circuit card.

- 1.2.4.1 Theory of operation
- 1.2.4.2 Schematic diagram/logic diagram identifying components, pin numbers, normal voltages, waveforms.
- 1.2.4.3 Component layout, identifying each part with correlation to identification on schematic.
- 1.2.4.4 Parts list cross referenced to generic part numbers, and to second sources.

1.2.5 Cable/connector drawings or wiring lists.
1.2.6 Diagnostic procedures, including diagnostic listing of the same revision level as equipment supplied.
1.2.7 Preventive maintenance procedures and schedules.
1.2.8 Manufacturer - published operation and maintenance instructions for all equipment.
1.2.9 Documentation of all vendor performed modifications to equipment.

1.3 SOFTWARE MAINTENANCE MANUALS

The software maintenance Manuals shall detail the internal operating mechanisms of the computer system. It shall be complete and detailed enough that a programmer can use it to perform maintenance on the software. Savannah River Site reserves the right to delete from order documentation duplicating that already in possession from prior acquisitions.

[ ] 1.3.1 Six (6) complete sets shall be provided.

[ ] 1.3.2 Manuals shall cover all purchased software including executives, device drivers, utilities, and diagnostic programs.

[ ] 1.3.3 Manuals shall be provided for each of the languages used; assembly language, FORTRAN, special high level languages, etc.

[ ] 1.3.4 Listings of all supplied firmware and software, including source listings, shall be to the level used by the vendor for maintenance (FORTRAN, assembly code, machine code, etc.)

[ ] 1.3.5 Structure and Data Flow diagrams and documentation shall be supplied, following the design techniques of Yourdon if applicable, of all software developed by the vendor specifically in response to this procurement. They will provide a general description of the system and how it works, including:

1.3.5.1 Overview of system in narrative form.

1.3.5.2 Narrative description of the data flow through each task.

1.3.5.3 Structure charts depicting the interaction of all the tasks and subroutines, tracing the flow of information through the system, and showing data transfer to and from each task and subroutine on the interconnecting lines.

1.3.5.4 A legend depicting the charting symbols, and explanation of charting techniques.

1.3.5.5 Data dictionary describing each piece of data shown on the structure charts.

1.3.5.6 Complete description of the source of input of all data and description of how it is obtained by the system shall be provided.

1.3.5.7 A complete description of the layout, location, and content of all data files shall be provided.

1.3.5.8 Memory maps shall be provided for main memory.

1.4 DETAILED HARDWARE DESIGN SPECIFICATION

[ ] The vendor shall prepare a Hardware Design Specification which shall be a detailed system description, with drawings of system hardware and firmware. It shall be the basis upon which the vendor shall assemble the system.

1.5 INSTALLATION MANUAL

[ ] This Manual shall include complete installation instructions for all equipment, complete with certified dimension drawings.

1.6 USERS MANUAL

[ ] This manual should be written at a basic level and should present a clear concise and complete description of how to operate the system. The user should be able to operate the system from this manual without reference to any other system manual. This manual should be written such that no familiarity of computer-based system is required to use the equipment effectively.

1.6.1 A description of the objectives of the system.
1.6.2 A narrative describing the theory of operation of the system.
1.6.3 A description of the function of every manual input and instructions on how to achieve the input.
1.6.4 A description of every output and how to achieve the output.
1.6.5 A description of how to utilize the keyboard to call up displays, acknowledge alarms, etc.
1.6.6 A description of every error condition recognized by the system and detailed instructions as to the user's response for correction of the error condition.
1.6.7 A description of the initial startup procedure and detailed instructions on how to effect the startup.
1.6.8 A description of the recovery procedure to be used in the event of system failure, detailed instruction on how to effect recovery, and what the user should expect during the recovery procedure.

1.7 PROCESS OPERATOR'S MANUAL

[ ] This manual explains all of the functions of the system from the process operators perspective, including such information as how the system gathers and processes data, the impact the system has on the site production facilities. The manual will include a system overview, a description of how to operate the terminals, how to use each display, and what each user error message means and how to handle it. The manual shall include the following sections as a minimum.

1.7.1 INTRODUCTION TO THE MANUAL - explains the organization of the manual and all conventions used in the document.
1.7.2 SYSTEM OVERVIEW - introduces the reader to the computer system and how it operates in the site. It should include a very high level description of the software and hardware components of the system and a discussion of the various methods of obtaining data from the system.
1.7.3 TERMINAL DESCRIPTION - should describe the physical layout of the terminal that the operator will be using including definition of every button on the terminal.
1.7.4 GENERAL TERMINAL OPERATION - should describe the general operating procedures that are common to all functions of the terminal, such as printing a report, or entering data in a field.
1.7.5 DISPLAYS - should consist of a paragraph describing every display available on the terminal. These should include an introduction and definition of the display, procedures for accessing from this one, and any alarms associated with this display.
1.7.6 TERMINAL STARTUP - describes the procedures for turning the terminal on and off, including procedures for restarting the terminal after a power outage.
1.7.7 ERROR MESSAGES - lists all error messages that can appear on the operators terminal. This does not include program message that the computer operator will receive. For every message, this chapter should explain the cause of the message and procedures for fixing the problem.
1.7.8 GLOSSARY - alphabetical listing of all terms that may be unfamiliar to the Process Operator.

1.8 SOFTWARE CONFIGURATION MANUAL

[ ] This manual should provide all information required to configure the system software. The manual should cover each task with an example, including any user options.

1.9 TRAINING DOCUMENTATION

[ ] The complete instructional sequence should be presented to the student at the beginning of the training so the student can see at a glance what is to be covered. All training manuals should include sections that introduce the new user to the system, define the purpose of the system, define expected accomplishments, define the materials of instruction, and contain hands-on exercises to develop the skills covered in the course. All of these sections should be designed with the expected audience's skill level in mind. The system introduction should include the general hardware layout of the system and the purpose of each part. It should also state what function each part will serve in this application. The next section should describe what the entire system will be expected to accomplish in the application.

1.10 EMBEDDED MICROPROCESSOR MAINTENANCE MANUAL

[ ] This manual shall detail the internal operating mechanisms of the microprocessor system. It shall be complete and detailed enough that a trained technician can use it to perform troubleshooting and maintenance on the system. Each section need not duplicate the material presented in other manuals.

1.10.1 General description of the system and how it works
1.10.2 Narrative description of the data flow through each segment or subroutine of the software.
1.10.3 Flowcharts depicting the interaction of all the segments and tracing the flow of information through the system.
1.10.4 A legend depicting the charting symbols and explanation of charting techniques.
1.10.5 A complete description of the source of input of all data and a description of how it is obtained by the system.
1.10.6 A complete description of the layout, location, and content of all data files.
1.10.7 Memory maps of main storage
1.10.8 Listing of all vendor produced software.

1.11 SOFTWARE SOURCE

[ ] The vendor shall supply source listings of all vendor supplied software to the level used by the vendor for maintenance (FORTRAN, assembly, machine, etc.). Savannah River Site reserves the right to delete from order any Source duplicating that already in possession from prior acquisitions. This requirement for Software Source Code can only be waived by written consent from the Process Digital Equipment Committee (PDEC) on a case-by-case basis. Requests for waivers should be routed to PDEC through the respective PMT liaison representatives or Project engineer.
[ ] The source shall also be supplied in machine-readable form on either disk or tape, depending on the configuration proposed by the vendor such that Savannah River Site can load the source into the system and make site-specific revisions.

2.0 ACCEPTANCE TESTS

2.1 ACCEPTANCE TEST DOCUMENT

[ ] An Acceptance Test Document shall be prepared by the vendor for approval by Savannah River Site. This document shall define the scope and content of all tests, contain acceptance test schedules, define the criteria to be used for satisfactory performance, and be used as a working reference document during the tests .

2.2 INSPECTION AND ACCEPTANCE

The system shall meet the conditions of one or two tests;

[ ] 2.2.1 A FACTORY ACCEPTANCE TEST at the vendor's factory if elements of hardware or software are unique to this system and were built or written solely in response to specifications of this proposal, and

[ ] 2.2.2 A SITE INSTALLATION ACCEPTANCE TEST. The Vendor shall describe his standard hardware, software, and system test procedure.

2.3 FACTORY ACCEPTANCE TEST

2.3.1 FACTORY ACCEPTANCE TEST NOTIFICATION

[ ] The Vendor shall advise Savannah River Site that the system is ready for the Factory Acceptance Test at least two (2) weeks in advance.

2.3.2 PRELIMINARY FUNCTIONAL TESTS

[ ] The Vendor shall perform a successful preliminary system functional test before advising Savannah River Site that the system is ready for the Factory Acceptance Test which is to be witnessed by Savannah River Site.

2.3.3 SAVANNAH RIVER SITE REPRESENTATION

[ ] Savannah River Site shall assign representatives to witness the test. These representatives shall assist in order to facilitate their training.

2.3.4 DOCUMENTATION DELIVERY

[ ] All system documentation shall be furnished to Savannah River Site prior to start of Factory Acceptance Test. The system documents, appropriately bound, including all hardware documentation, standard software manuals, and user manuals as marked under Section III (Documentation),shall be included. An index of all system documentation together with a key to the index shall be included.

2.3.5 LIST OF LICENSES

[ ] A list and signed originals of all licenses furnished with system shall be furnished to Savannah River Site prior to start of Factory Acceptance Test. The licenses will be identified as to hardware or software to which the license applies, including conditions for use of license and cost of renewing where applicable.

2.3.6 VISUAL INSPECTION

[ ] A complete visual inspection of all system components shall be conducted by Savannah River Site before power is applied. This test shall include removal of printed circuit cards from the card files and verification of card model numbers. Components shall also be checked for obvious faults of workmanship.

2.3.7 PERFORMANCE TEST

[ ] The test will be a specific performance test to demonstrate that all hardware and software function correctly. All interfaces to the system will be included and every input and output shall be simulated by active signals.

2.3.8 COMPLETE STAGING

[ ] The test will include complete staging and operational testing of the entire system.

2.3.9 SYSTEM SOFTWARE GENERATION

[ ] The vendor shall generate the entire software system (operating system, loadable firmware, and application programs) from the source code to verify source is whole and useable. Savannah River Site will witness build and take possession of source copy after successful completion of build. Any subsequent changes to the vendor copy must be communicated to Savannah River Site, who will modify the Savannah River Site copy. Savannah River Site may run a differences listing against the source code after receipt at the Savannah River Site to determine if any unauthorized changes were made during or after acceptance testing.

2.3.10 VENDOR CONNECTION OF COMPONENTS

[ ] The Vendor shall connect all system components and test the operation of all components.

2.3.11 FUNCTIONAL TEST OF INPUTS AND OUTPUTS

[ ] The test shall consist of a functional test of inputs and outputs for proper function and display at the command stations. The test shall be performed using simulated inputs after the preliminary functional test.

2.3.12 48 HOUR SYSTEM TEST

[ ] A 48 hour system test shall be performed with all components in operation. If error occurs the vendor shall locate and correct the cause. The test may be restarted from the beginning, or at the point of failure, at the discretion of Savannah River Site. A minimum overall operation of 48 hours continuous operation must be achieved.

2.3.13 TEST COMPLETION REQUIRED

[ ] Satisfactory completion of this test shall be a prerequisite for shipment to the site.

2.3.14 AS BUILT DOCUMENTS

[ ] Once the system and display configurations have been accepted, the vendor shall make "as built" hard copies of the configuration data from the configuration displays and also make a record (backup) of the configuration on magnetic media. This (backup) media will be used to reconfigure the system at the site after installation.

2.4 SITE INSTALLATION ACCEPTANCE TEST

[ ] The vendor shall provide personnel to inspect and install all vendor supplied hardware and software, bid as a response to this request for quotations, at the delivery site. A site installation acceptance test will then be performed. This test shall be conducted with a goal of ensuring that the system has been properly delivered, installed, and meets all requirements. This test shall include the following:

- Hardware Diagnostic Test
- Software Functionality Test
- User Load Test
- 100 hour reliability test

2.4.1 HARDWARE DIAGNOSTIC TEST

[ ] The Hardware Diagnostic Test will include:

- 24 Hours on all mass storage devices
- 8 hours on main memory
- A minimum of 10 successful passes on all other equipment

[ ] The system must operate without failure for the duration of time required for the hardware diagnostic tests. If a failure occurs, the vendor shall locate and correct the cause. The test may be restarted from the beginning, or at the point of failure, at the discretion of Savannah River Site.

2.4.2 SOFTWARE FUNCTIONALITY TEST

[ ] The software Functionality Test shall demonstrate that all vendor supplied software has been properly installed and is functioning correctly.

2.4.3 USER LOAD TEST

[ ] The User Load Test is intended to demonstrate the ability of the system to respond to user input under the expected CPU loading without losing data. The vendor is to provide the necessary software and hardware to conduct the test. Generally, a large number of inputs and outputs are activated within 2 to 5 seconds simulating high system loading.

2.4.4 100 HOUR RELIABILITY TEST

[ ] A 100 hour Reliability Test will be performed on site. This test shall be conducted with a goal of ensuring that the system has been properly installed and is ready for use. The system must operate without error for 100 continuous hours. If an error occurs, the vendor shall locate and correct the cause of error. The test may be restarted from the beginning or at the point of failure, at the discretion of Savannah River Site.

2.4.5 WARRANTY PERIOD

[ ] Completion of the Site Installation Acceptance Test shall mark the start of system warranty period.

3.0 TRAINING

3.1 MAINTENANCE TRAINING

[ ] The Vendor shall provide Training courses at Savannah River Site or Vendor's facility for up to ten (10) students, covering theory of operation, gate logic analysis, use of diagnostic routines, and repair procedures for each component offered. Savannah River Site reserves the right to delete from order training duplicating knowledge and capability already existing at Savannah River Site from prior acquisitions.

3.1.1 Information required concerning each course

- 3.1.1.1 Length of course
- 3.1.1.2 Brief course outline
- 3.1.1.3 Attendees qualification
- 3.1.1.4 Prerequisites
- 3.1.1.5 Training site
- 3.1.1.6 Material provided to each student
- 3.1.1.7 Cost

3.1.2 The courses shall include but not be limited to:

- 3.1.2.1 Thorough explanation of instruction sets and machine language software
- 3.1.2.2 Sufficient programming to create test programs or peripheral exercisers
- 3.1.2.3 Detailed instruction in theory of operation
- 3.1.2.4 Logic analysis and practical experience using the equipment specified.
- 3.1.2.5 Instruction in the use of diagnostic test programs
- 3.1.2.6 Instruction must include all options specified in Vendor's system configuration including peripherals, mainframes, and support hardware.
- 3.1.2.7 Engineering and Configuration cou se should cover organization, operation, and configuration of the system, including data base generation, if any.
- 3.1.2.8 Maintenance Training shall enable Westinghouse Savannah River Company to maintain all equipment supplied. These courses shall be presented with sufficient equipment for hands-on training (maximum of 3 students per device).Covering:
  - 3.1.2.8.1 Basic configuration (to run necessary checks on the operating system).
  - 3.1.2.8.2 Repair of all electronic devices down to the component level.
  - 3.1.2.8.3 Operation of diagnostic programs
  - 3.1.2.8.4 Interpretation of diagnostic results (printouts, error codes, etc.)
  - 3.1.2.8.5 Operation of special test equipment
  - 3.1.2.8.6 Interpretation of special test equipment data
  - 3.1.2.8.7 Procedures for restoring the system to normal operation following power failure.

3.2 SOFTWARE TRAINING

[ ] The Vendor shall provide software training courses at Savannah River Site or Vendors facility for up to ten (10) students each.

Courses shall include but not be limited to:

3.2.1 Theory and use of operating system software, including executive and all driver software.
3.2.2 Maintenance and modification of the operating system
3.2.3 Use of all utility programs and operations required for system generation.
3.2.4 Theory and use of all special languages proposed for program development.

3.3 VENDORS ADDITIONAL TRAINING

[ ] The Vendor may provide, for reference purposes, a list of training courses which are available, but have not been required under this specification. The list shall include a detailed description of the courses and the advantages offered by the vendors training. The availability of such courses and their content and cost will be considered during bid evaluation and will be used as part of the selection criteria for this system.

4.0 PREPARATION FOR SHIPMENT

4.1 PRESERVATION AND PACKAGING

[ ] The equipment and all accessories shall be individually crated or mounted on skids as necessary to prevent damage from handling and shipping. The shipping containers shall be of sufficient structural integrity to enable each assembly (container and contents) to be lifted and transported by overhead crane or forklift without receiving damage.

4.2 TRANSPORTATION

[ ] If electronic equipment is part of equipment to be shipped, Vendor should notify shipping carrier that equipment cannot be transported and stored in temperatures below 32 degrees F. Vendor shall be responsible for any damage or loss to equipment caused by temperatures below 32 degrees F, until owners acceptance, even though damage may not be determined until after installation and startup.

4.3 IDENTIFICATION

[ ] Each equipment item shall have a nameplate permanently attached, containing all, but not limited to, the information shown in Section I (Identification)

5.0 MISCELLANEOUS

5.1 COMPLETE SYSTEM

[ ] The purchase contract will include adequate components for initial operation at the site. These components will include:

5.1.1 Complete units
5.1.2 Circuit boards
5.1.3 Subassemblies
5.1.4 Components
5.1.5 Special test equipment
5.1.6 List of normal test equipment required for self maintenance
5.1.7 Expendable supplies(paper, magnetic tape, floppy media, ribbons, etc.) sufficient for a minimum 90 days operation

ATTACHMENT 2

WESTINGHOUSE SAVANNAH RIVER COMPANY

WSRC-1Q

QUALITY ASSURANCE MANUAL

QAP 20-1, Rev 0

SOFTWARE QUALITY ASSURANCE

SOFTWARE QUALITY ASSURANCE

Approved by:

President, WSRC

1.0 PURPOSE

This procedure defines the requirements and responsibilities for the control of WSRC high impact software.

2.0 SCOPE

2.1 This procedure applies to the development, procurement, modification, maintenance, use, and retirement of high impact software.

2.2 This procedure applies to (High Impact) software used directly in the design, construction, operation, modification, repair, or maintenance of facilities and components whose design classification is "Nuclear Safety" or "Critical Protection" as defined in QAP 3-1 of this manual. This procedure also applies to software whose failure would likely cause process hazards criteria as specified in DPSPM-GEN-13 to be exceeded.

3.0 RESPONSIBILITIES

3.1 All Westinghouse Savannah River Company organizations that develop, procure, maintain, use, modify, or retire high impact software (new, existing, and purchased) shall implement this procedure.

3.2 Specific quality assurance-related activities are designated as responsibilities of three functional groups: the Owner, Designer, and the Maintainer. Interacting organizations shall be appropriately identified in the Software Quality Assurance (SQA) Plan. When the designer role is performed by an organization other than WSRC, the SQA Plan shall identify the WSRC Design Authority.

3.3 Software Owners, Designers, and Maintainers shall comply with the requirements of this procedure. Attachment 1 is a flowchart for this procedure. For software with multiple Owners, a primary Owner shall be identified who will represent the interests of all Owners. That primary Owner shall be responsible for all Owner activities required by this procedure.

3.4 The owner organization manager shall ensure that an inventory of all high impact software held within their organization is developed and maintained.

3.5 The owner organization manager shall ensure that SQA Plans are written, reviewed, approved, and implemented.

3.6 Owner Cognizant Quality Functions (CQF) shall:

- Review and approve SQA Plans
- Perform surveillances of the lifecycle processes

4.0 PROCEDURE

4.1 Software Review

The Owner(s) shall review software to determine if the software is high impact and the controls to be applied. If the software is high-impact, it shall be controlled in accordance with this procedure. The definitions of high-impact software along with the criteria for "Nuclear Safety" and "Critical Protection" design classifications shall be used by the owner(s) in determining if software is high impact. Additional assistance maybe obtained from the CQF.

4.2 Software Quality Plans

4.2.1 Owners of software shall write the SQA Plan. Designers and Maintainers may be requested by the Owner to assist in this task.

4.2.2 An SQA Plan shall be written for each high-impact software project. However, the same SQA Plan may be used for a group of software if the level of quality assurance required for that group is similar.

4.2.3 All SQA Plans shall document the quality assurance activities to be performed over the life cycle of the software. SQA Plans shall list the responsible organizations or position titles for completing these activities.

4.2.4 SQA Plans shall identify component documents and define responsible organizations or position titles for at least the following life cycle phases:

- Requirements Phase
- Design and Implementation Phase
- Test and Installation Phase

- Operation and Maintenance Phase
- Retirement Phase

Attachment 2 provides guidelines and requirements for the content of the SQA Plan.

4.2.5 SQA Plans shall be reviewed and approved by the respective CQF and shall be approved by Owner's, Designer's, and Maintainer's management. The CQF review shall verify that appropriate items required by Attachment 2 have been addressed in the SQA Plan. An SQA Plan shall be approved prior to the start of the Requirements Phase.

4.2.6 If conditions require changes in an SQA Plan, a revision to the Plan shall be written, reviewed, approved, and implemented using the same process as the original plan.

4.2.7 The SQA Plan shall be placed into the Owner's document control system.

4.2.8 Software shall be entered in the Owner's inventory of high impact software when it has been identified as having high impact. As a minimum, the inventory shall identify:

- Name or other unique identity of software
- Version or revision
- Owner of the software

4.3 Purchased and Existing Software

4.3.1 For unmodified, off-the-shelf, high impact software that has not been developed in accordance with the requirements of this procedure and for high impact software developed prior to the effective date of this procedure, the SQA Plan shall address all life cycle phase activities except Design and Implementation.

4.3.2 When high-impact software is purchased from a supplier, the organization purchasing the software shall ensure the supplier:

- Operates with policies and procedures which are consistent with the requirements of this procedure
- Furnishes documentation for the software which is acceptable to the purchasing organization

4.4 Requirements Phase

4.4.1 Software developed by the Owner or Maintainer shall be controlled the same as software developed by a design organization (Designer). In all cases, the basis for design shall be documented in a Software Requirements Specification.

The Owner:

- Describes needs, functional requirements, and constraints
- Provides verifiable criteria for accepting or rejecting the software product

The Designer:

- Assesses the adequacy of functional requirements and provides design inputs
- Specifies, as applicable, functional capabilities, mathematical models, algorithms, structure, and interface requirements

The Maintainer:

- Defines any requirements for support systems and support-related documentation
- Provides input to requirements for standards, if applicable

Attachment 3 provides guidelines and requirements for the content of the SR Specification.

4.4.2 The Software Requirements Specification shall be reviewed and approved by the Owner, Designer and Maintainer. The Software Requirements Specification shall be placed into the Owner's document control system.

4.5 Design and Implementation Phase

4.5.1 Software design documentation, based upon the Software Requirements Specification, shall be developed to specify overall structure and the reduction of the overall structure into physical solutions.

4.5.2 The Owner and Maintainer shall review and approve the design package produced by the Designer. The review process shall include an examination of the design package to ensure adherence to the Software Requirements Specification. This review and approval shall be accomplished by individuals other than those who performed the design. The reviewers shall document the results of their reviews and the disposition of review comments shall be documented. The software design package shall be placed in the owner's document control system.

4.5.3 The software design shall be translated into implementing code via the specified programming language. The resulting software shall conform to the applicable coding standards and conventions.

4.5.4 Preliminary, undocumented testing may be performed in the Design and Implementation phase.

4.5.5 A Test Plan shall be prepared by the Designer during the Design and Implementation Phase (or at the beginning of the Test and Installation Phase if no software design or implementation is to occur, as is the case with procured software). This Test Plan shall address the testing to be performed on the software.

4.5.6 Acceptance criteria for test procedures shall be established in Test Plans.

4.5.7 Test Plan requirements and acceptance criteria shall be based on and shall reference requirements in the Software Requirements Specification.

4.5.8 The Test Plan shall be approved by the Owner and the Maintainer.

4.5.9 The Test Plan and all required test procedures shall be placed into the Owner's document control system.

4.5.10 Attachment 4 provides guidelines and requirements for the content of the Test Plan.

4.6 Test and Installation Phase

4.6.1 The Designer shall prepare detailed acceptance test procedures as required by the Test Plan. The Owner and Maintainer shall approve the test procedures.

4.6.2 Tests shall be conducted in accordance with the Test Plan and any Test Plan-specified procedures.

4.6.3 The extent of computer program tests shall be based on program complexity and previous experience. Such tests may range from a single test of the completed program to a series of tests performed at various stages of program development to verify correct translation between stages and proper working of individual modules followed by an overall computer program test. Verification testing shall be sufficient to establish that all requirements of the Software Requirements Specification are satisfied and that the computer program produces a valid, verified result for its intended function.

4.6.4 Computer program verification tests shall demonstrate the capability of the program to produce valid results closely matching benchmark solutions for test problems encompassing the full range of usage permitted by the program documentation.

4.6.5 Test problems shall be developed, conducted, and documented to permit confirmation of acceptable performance of the computer program prior to use in the operational system.

4.6.6 For software used to perform design analyses, the model or algorithm shall be demonstrated to be valid. The Test Plan or test procedures shall document the method(s) to be used to demonstrate the validity of the model. The validation process shall document the comparison of the physical problem to the encoded mathematical model, to ensure that the model produces a valid solution. The results of the comparison shall be shown to be valid. The limits of valid solution shall be identified. One or more of the following shall be used for demonstrating the model's acceptability:

- Analysis without computer assistance
- Other computer programs covered by this procedure
- Experiments and tests
- Standard problems with literature-published solutions
- Confirmed published data and correlations

4.6.7 Test results shall be documented, and shall be approved by the Owner, Designer, and Maintainer prior to operational use of the software. The approval shall document that the software produces results suitable for its intended function. This document shall be retained as a QA record.

4.6.8 Preparation of operational user documentation shall be the responsibility of the Designer. The documentation shall include, as applicable:

- User instructions that contain an introduction, a description of the User's interaction with the software, and a description of any required training necessary to use the software
- Input and output ranges and input and output formats
- A description of the applicable hardware system
- A description of system limitations
- Identification of version or revision of software described in the documentation
- A description of error messages and how the User can respond
- Information for obtaining support for Users and Maintainers

User documentation shall be placed into the Owner's document control system. The designer shall assure that input/output alignment is maintained from the Software Requirements specification through development and revision of the test plan and output documents until turned over to the Owner.

4.7 Configuration Control

4.7.1 The Owner's configuration control system shall be documented and shall be in place after the Test and Installation Phase and prior to the Operations and Maintenance Phase for the software. The configuration control system shall provide for the following:

- A method to ensure only approved versions of software are used
- Identification of hardware directly affecting software performance and approval requirements for changes to such hardware
- Assurance that changes to approved software (including documentation) receive approval at the same level as originally approved; changes made to meet originally approved requirements may be delegated in organizational procedures
- Assurance that software changes are accompanied by changes to affected documents
- Assurance of Owner and Maintainer agreement on a method to test the change to ensure that no unanticipated system degradation results from the change. The test results shall be documented.

4.7.2 The Owner shall inform Users of changes to software before the change is implemented.

4.8 Error Control

4.8.1 The Designer shall be responsible to identify and document the methods to control errors/deviations during the test and installation phase.

4.8.2 During the operations phase, errors/deviations of the software from the requirements in the SR specification shall be documented in the user's nonconformance control program.

4.8.3 The Owner shall ensure that all Users are made aware of appropriate error information.

4.9 Operation and Maintenance Phase

4.9.1 Software shall be operated within validated limits and shall be controlled to prevent unauthorized use.

4.9.2 If software changes are required that result in a deviation from the Software Requirements Specification, as determined by the Owner, the Requirements Phase of

the life cycle shall be entered for performance of those changes. If software changes are required that do not result in deviations from Software Requirements Specification requirements, the requirements of the configuration control system shall be followed.

4.9.3 Operational tests shall be conducted by the Owner or the Maintainer to validate the software after changes. If required by the Owner, such tests shall be performed to periodically evaluate the performance of the system if computer malfunction can affect required performance.

4.9.4 Operational test(s) shall be performed as required by the configuration control system following any system maintenance which entails an authorized change in the software, including operating system software.

4.9.5 Owners shall be responsible for coordinating the interaction of multiple Maintainers involved in software changes.

4.9.6 Test problems shall be run whenever the computer program is installed on a different computer, when hardware is modified or added, or when operational system configuration changes are made. Periodic in-use manual or automatic self-check routines shall be prescribed and performed for those applications where computer failure or drift can affect required performance.

4.10 Retirement Phase

Retirement phase procedures shall provide assurance that retired software is not made available for unrestricted use.

5.0 RECORDS

Records shall be controlled in accordance with the requirements of QAP 17-1. The following shall be retained as Quality Assurance records:

- Software Quality Plan
- Software Requirements Specification
- Design package
- Test plan and procedures
- Test results
- Retirement phase procedures

- Documentation of model used (if applicable)
- Evidence of required reviews and approvals of software documents, including design package validation documents.

6.0 REFERENCES

6.1 DPSPM-GEN-13, "SRP Process Safety Management Manual"

6.2 1Q, WSRC QA Manual, QAP 2-1, Quality Assurance Program

6.3 1Q, WSRC QA Manual, QAP 17-1, QA Records Management

7.0 DEFINITIONS

None

8.0 ATTACHMENTS

8.1 Attachment 1, Flowchart for Software Quality Assurance

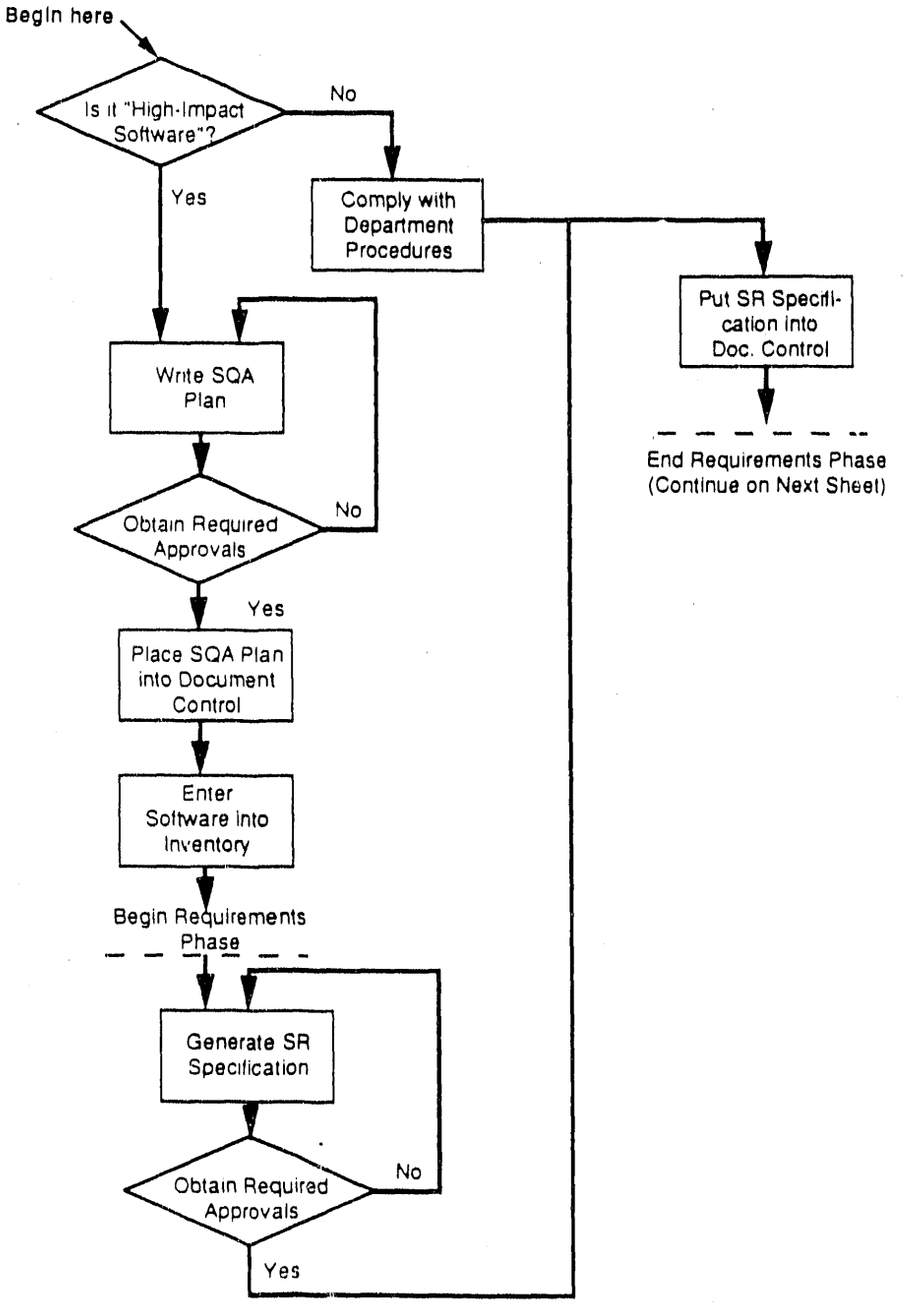
8.2 Attachment 2, Software Quality Assurance (SQA) Plan

8.3 Attachment 3, Software Requirements Specification

8.4 Attachment 4, Test Plan

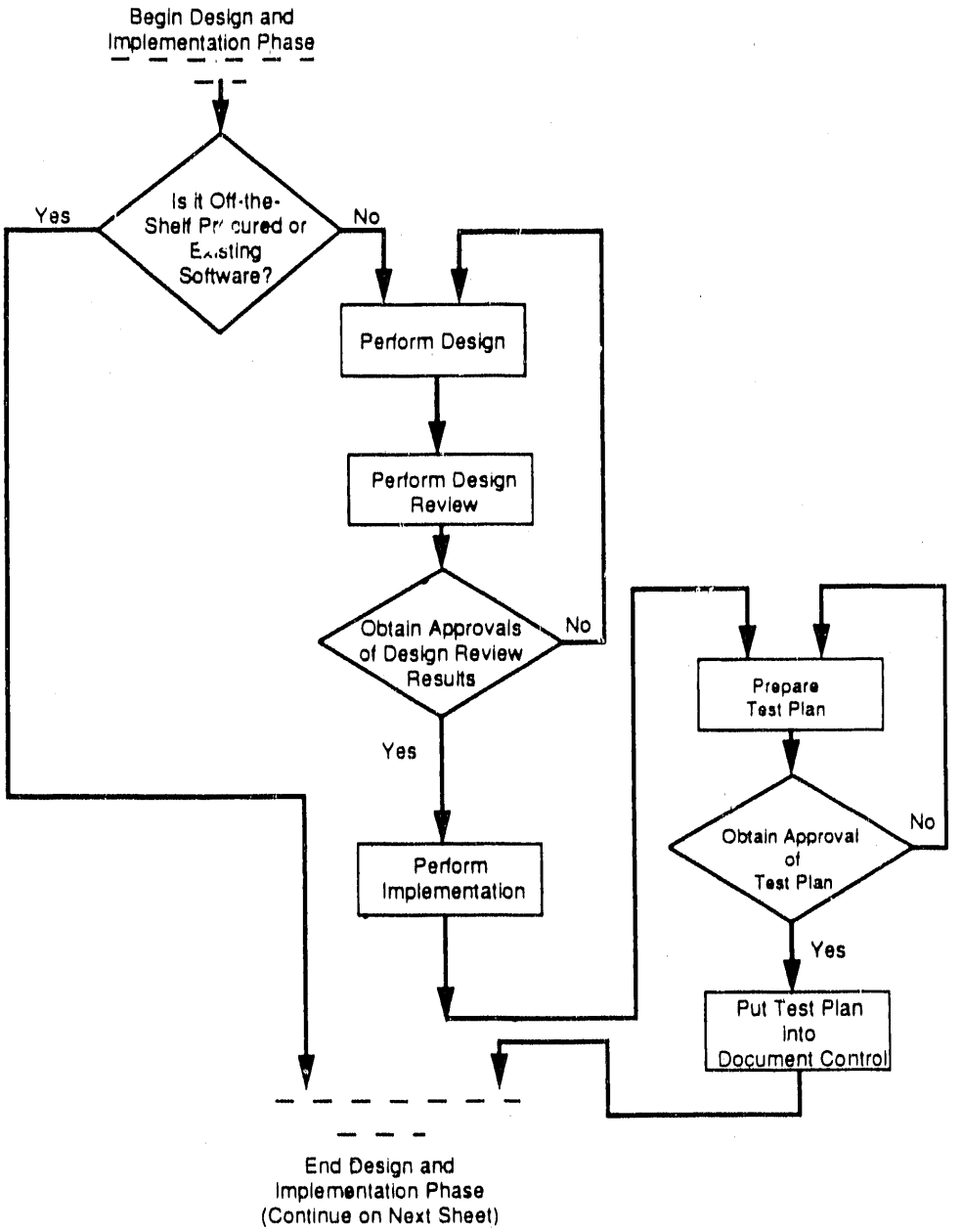
ATTACHMENT 1

FLOWCHART FOR SOFTWARE QUALITY ASSURANCE



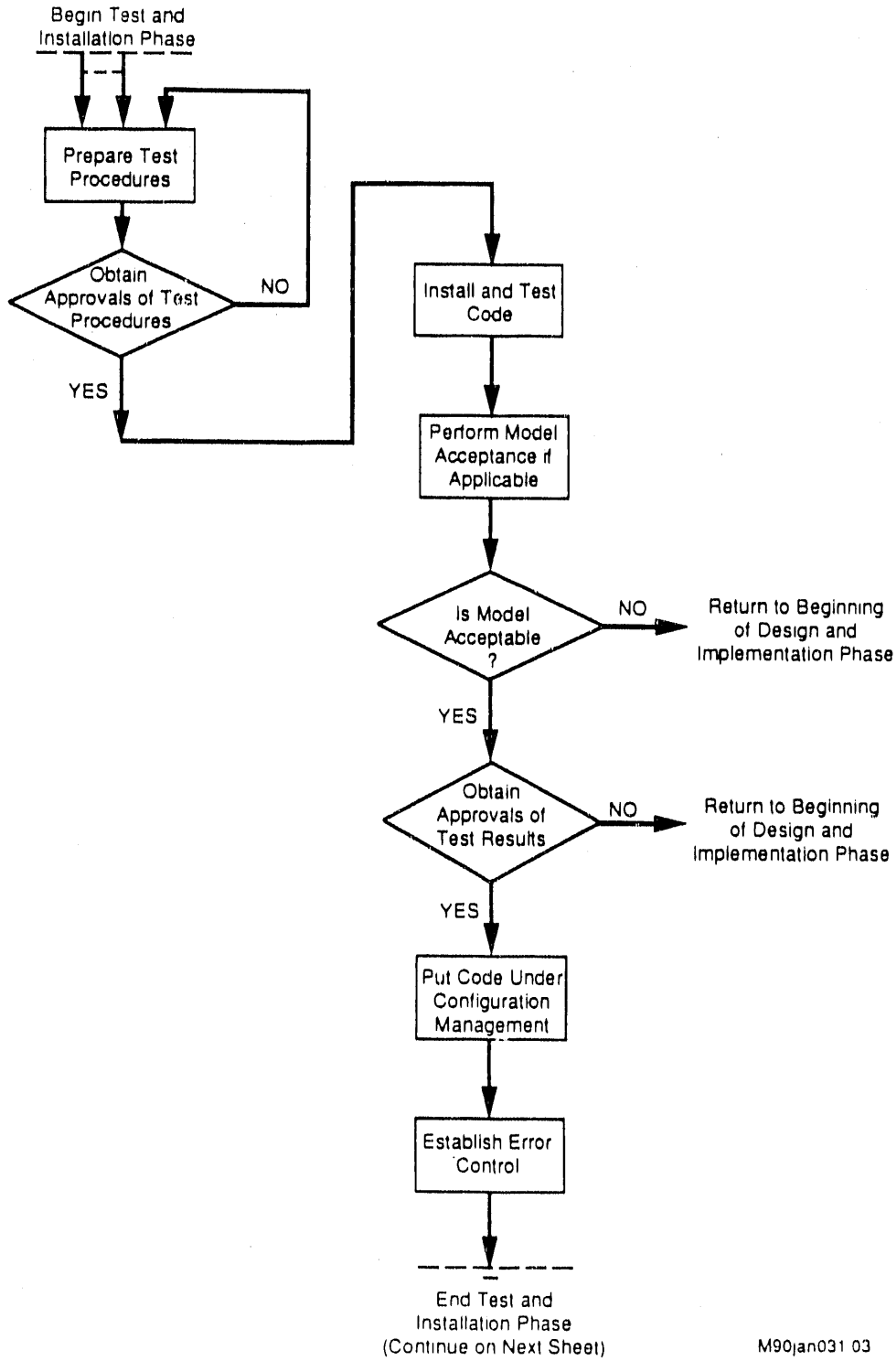
M90jan031 06

ATTACHMENT 1 (Cont.)



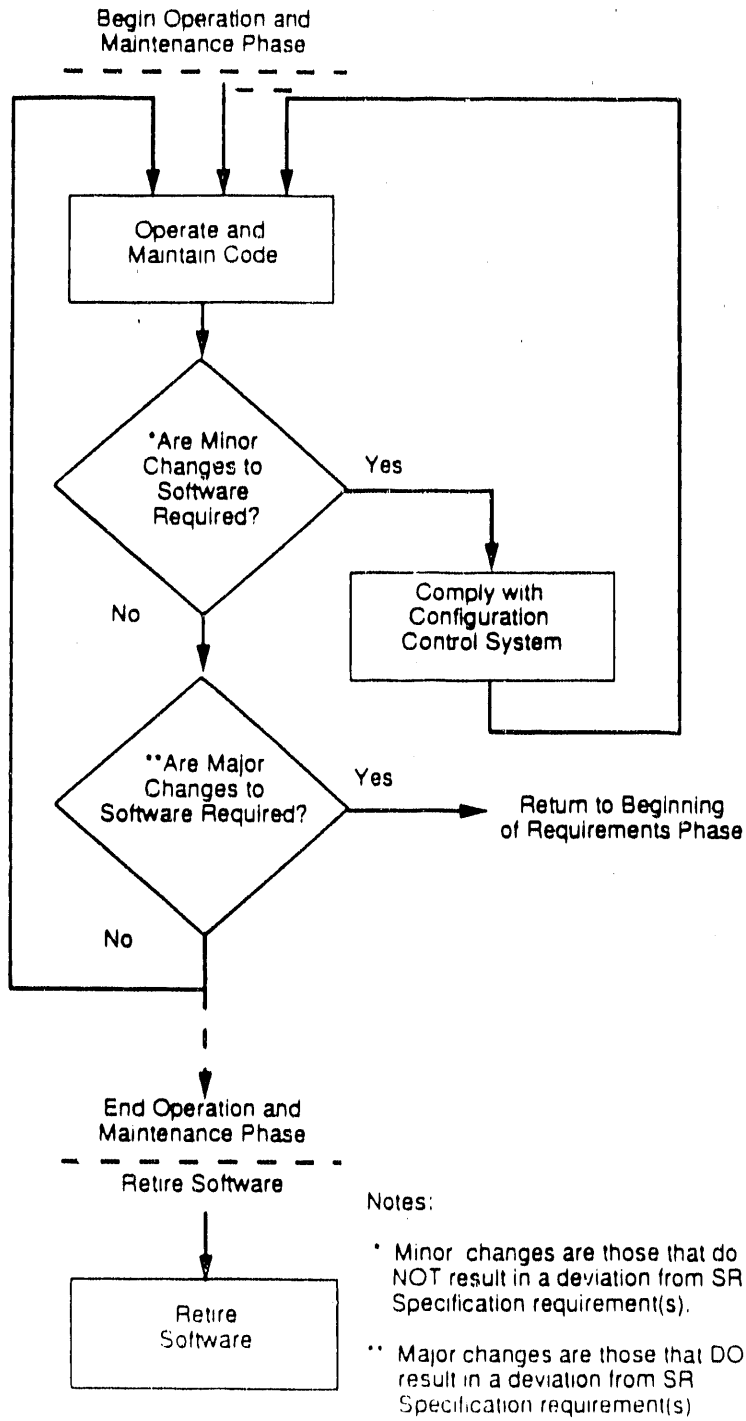
M90jan031 07

ATTACHMENT 1 (Cont.)



M90jan031 03

ATTACHMENT 1 (Cont.)



ATTACHMENT 2

SOFTWARE QUALITY ASSURANCE (SQA) PLAN

REQUIRED CONTENT:

Identification of the Following, as Applicable:

- Software and its source, high impact application
- Responsible organizations or position titles
  - Owner (Define Primary Owner if more than one Owner is involved)
  - Intended Users other than Owner
  - Designer
  - Maintainer
  - User support organizations
  - Approving Cognizant Quality Function
  - Organizational interfaces (If sof ware is developed or purchased from more than one source, some type of communication for information exchange must be set up. Describe those communications.)
  - All required reviewers/reviewing organizations
- Software Requirements Specification
- Test Plan
- Retirement phase procedures
- Owner's document control system
- Owner's configuration control system
- User manuals
- Exception if software is off-the-shelf or existing
- User training to be provided

GUIDANCE:

- Schedule for completion of tasks
- Additional records
- Training to be provided
  - Maintainer
  - Other
- Additional verification and validation Activities
  - Preliminary tests
  - Factory acceptance tests
  - Integration tests
  - Testing standards, codes

ATTACHMENT 3

SOFTWARE REQUIREMENTS SPECIFICATION

The Software Requirements Specification shall clearly describe each software requirement. Each applicable requirement shall be defined such that its achievement can be verified and validated objectively by a prescribed method (e.g., inspection, demonstration, analysis, or testing.) The Software Requirements Specification shall specify in detail the requirements stipulated by the Designer and/or Owner.

REQUIRED CONTENT:

Identification of the Following:

Software Requirements
Specification Approvers: Owner, Designer, Maintainer

Software Requirements Specifications shall address the following, as applicable:

Function
- the functions the software is to perform, including its interactions with data

Performance
- the time-related issues of software operation such as speed, recovery time, response time, etc.

Design Constraints Imposed on Design and Implementation Phase Activities
- elements that restrict design options

Attributes
- non-time-related issues of software operation such as portability, acceptance criteria, maintainability, security, etc.

External Interfaces
- interactions with people, hardware, and other software

An item is a requirement only if its achievement can be verified and validated, and it is traceable throughout the remaining stages of the software life cycle.

ATTACHMENT 4

TEST PLAN

REQUIRED CONTENTS:

Identification of the following:

Software
Approvers: Owner, Maintainer
Hardware configuration
SQA Plan
Software Requirements Specification
Tester(s) and data recorder(s)
Evaluator(s) of test results
Testing standards, codes, or methods specified in the SQA Plan
Approvers for each test

Test Plan and/or Derived Procedures Shall Address the Following:

Required tests and their sequence. These may be described directly in the Test Plan, or in test procedures referenced in the Test Plan. The following information shall be included in the Test Plan or test procedure, as applicable:

- Software identification
- Test procedure name, unique identification number and revision
- Test Plan from which procedure is derived
- Criteria for test cases, if not included in procedures
- Traceability to specific Software Requirements Specification and SQA Plan requirements
- Prerequisites for test(s), for example, calibrated instrumentation, required computer hardware, qualified personnel, environmental conditions, pretest notifications, and special monitoring or data acquisition equipment
- Requirements for testing logic branches
- Objective(s) of test
- Encoded model and method for model validation
- Test method or type of observation
- Range of inputs and outputs over which testing must occur (as a minimum, those ranges permitted by user documentation)
- If the software is used for operational control, testing shall demonstrate required performance over the full range of operation of the controlled function or process
- Acceptance criteria

ATTACHMENT 4

TEST PLAN (Cont.)

Test Results Shall Document the Following:

- Software identification
- Hardware identification
- Date, name of tester(s) or data recorder(s)
- Evaluator(s) of test results
- Test results and acceptability, including results of any model validation
- Nonconformance reports generated because of test failure (if any)

GUIDANCE

Documents other than the SQA Plan and Software Requirements Specification from which test requirements and acceptance criteria are derived may be identified.

Required Tests may include: code verification, hardware and software integration, preliminary qualification, plant acceptance, factory acceptance, site acceptance, and module integration tests.

ATTACHMENT 3

WESTINGHOUSE SAVANNAH RIVER COMPANY

DPSOP 330-46

REACTOR DEPARTMENT

DPSOL 105-2201-PLK

PROCESS COMPUTER PROGRAM CHANGE CONTROL

PROCESS COMPUTER PROGRAM CHANGE CONTROL

PURPOSE:

To provide a method for controlling changes to process computer programs and for periodically verifying the correct revision level of programs.

SCOPE:

This procedure covers program change control for:

- Control Computers
- Safety Computer
- REMACS Computers
- Discharge Machine Multiplex Computer
- C & D Machine Input Order Computer
- External Fission Counters
- Vibration Analysis Monitor

FREQUENCY:

o Division A:

- Whenever program changes are required for any reason (for example to implement abstract revision, to correct abnormal condition, etc).

o Division B:

-Monthly Check:

--All computer systems. (Every month if the computer is operated during that month)

-When directed by other DPSOLs or management.

--Specified computer system only.

-After any computer maintenance is performed. This includes any time software is reloaded or a disk is replaced.

REFERENCES:

DPSOL 105-

-2156B-21,	Safety Computer Program - Verify
-2202,	Computer Program Change - Checkout
-2221B-49,	Control Computer Program Dump Package
-2221B-55,	Control Computer Program - DMA History File
-5329,	Fabritek Computer Tape Control
-5352	Discharge Machine Multiplex Computer - Startup or Shutdown
DPSTS 105-3.09	Surveillance Requirements

GENERAL LIMITATIONS AND PRECAUTIONS:

WARNING! FAILURE TO COMPLETE THIS PROCEDURE CORRECTLY IN ITS ENTIRETY AND WITHIN THE FREQUENCY SPECIFIED MAY RESULT IN OPERATION OUTSIDE THE REQUIREMENTS OF THE TECHNICAL STANDARDS, OR ULTIMATELY THE TECHNICAL SPECIFICATIONS.

PREREQUISITES:

Any program change requires proper authorization before implementing the change.

INFORMATION:

Division A of this DPSOL documents approval and verification for accuracy of a program change. Three types of program change are permitted using this procedure:

Type 1. Implementation of a new or revised program authorized by an approved abstract.

Type 2. Program changes to correct errors or provide additional instruction to permit computer programs to perform functions already approved in abstracts.

Type 3. Program changes which modify a program outside the specifications of an approved abstract. An abstract must be processed expeditiously to document the change.

All types of program changes require Reactor Plant Manager (or delegate) and Reactor Engineering Technical Support Manager (or delegate) approval. In addition, type 3 changes require Reactor Operations Manager (or delegate) and Reactor Engineering Manager (or delegate) approval. Type 2 changes that have not been previously tested require Reactor Operations Manager (or delegate) and Reactor Engineering Manager (or delegate) approval.

Routine observation of computer input, output, or action, or inability to complete procedures usually reveals abnormal conditions which require a program change. Any program change must be followed by a checkout to verify correctness of computer operations.

INFORMATION: Contd

Division B of this DPSOL is used for verifying the correct revision level of the installed programs. The revision level is verified monthly, and following any maintenance on a computer.

This DPSOL provides a permanent record of Reactor Operation Department computer program changes. Separate computer systems are used for flux control, surveillance, assembly flow monitoring, and C&D of assemblies. Maintain records per the following guidelines:

- Establish a separate record binder for each computer system. Retain the C & D Machine Computer System Binder in the Crane Control Room and all other binders in the Central Control Room (CCR).

- Divide each binder into a Program Change Description Section and a Program Verification Log Section.

- File completed Data Sheets 1 and 2 from this DPSOL and all data sheets from DPSOL 105-2202-PLK, Computer Program Change - Checkout, in the Program Change Description Section of the appropriate binder in order of increasing date and time (chronologically).

- File completed Data Sheets 3 from this DPSOL in the Program Verification Log Section of the appropriate binder chronologically.

- Maintain only the current year Data Sheet 3 in the Program Verification Log Section of each binder. At year end transfer current entries on Data Sheet 3 to a new Data Sheet 3 for the new year. Move old Data Sheets 3 to the Program Change Description Section of binder and retain as permanent record.

OUTLINE

DIVISION A - PROGRAM CHANGE AND VERIFICATION
DIVISION B - PROGRAM VERIFICATION
Data Sheet 1 - COMPUTER PROGRAM CHANGE REQUEST
Data Sheet 2 - MEMORY CHANGE SHEET
Data Sheet 3 - COMPUTER APPROVED PROGRAM DOCUMENTATION LIST

PROCEDURE:

A. PROGRAM CHANGE AND VERIFICATION

1) Record the following on Data Sheet 1:

Line 1: Enter today's date.

Line 2: Enter identifying letter for this reactor area.

Line 3: Enter name of person requesting change.

Line 4: Enter computer system name (for example, safety, control, REMACS, etc).

Line 5: Enter specific program name.

Line 6: Enter current abstract: Number, Rev. No., Addendum No., and Approval Date.

Line 7: Enter authorized Programmer name. Verify name is listed on the authorized programmer list in the appropriate computer systems binder.

Line 8: Check appropriate YES or NO.

If NO, approval of Reactor Operations Manager or delegate and Reactor Engineering Manager or delegate is required at line 15. Forward a completed copy of Data Sheet 1 to authorized programmer. The programmer will attach the copy of Data Sheet 1 to the abstract approval routing record.

Line 9: Enter a brief description of change requested. Obtain from Programmer.

Line 10: Check appropriate Yes or No. If yes, enter location and date program was tested (for example, PDC, 105-L 11/29/87).

Line 11: State duration program change is intended to remain in effect.

Line 12: List DPSOLs affected by program change.

Line 13: List online tests which must be completed or special data which must be used to verify satisfactory program performance. Specify bypass requirement for performance of program check.

Line 14: List program checksum if available, version number or other unique identification (if applicable). (Obtain from programmer). Mark N/A if not applicable.

A...

2) Obtain the following approval for the requested program change on Data Sheet 1 line 15.

a) All program changes:

Approval: ROD: Plant Manager or Delegate

RED: Technical Support Manager or Delegate

b) Program changes which modify a program outside the specifications of an approved abstract (Type 3).

Approval: ROD: Reactor Operations Manager or Delegate

RED: Reactor Engineering Manager or Delegate

c) Program changes which are untested prior to installation in an area:

Approval: ROD: Reactor Operations Manager or Delegate

RED: Reactor Engineering Manager or Delegate

3) Have Reactor Engineering Programmer perform the following:

a) If possible, functionally test program changes in the PDC or another Reactor Area and prepare a new program listing. If new listing is not prepared, mark changes in existing master listing and enter program change instructions on Data Sheet 2.

b) If Data Sheet 2 is used enter signature and date at bottom of page.

c) If Data Sheet 2 is used, request either of the following to review Data Sheet 2 changes and enter their signature on bottom of Data Sheet 2.

- 2nd Reactor Engineering Programmer (if available).

- Reactor Department shift manager.

d) If program change is for Control Computer perform the applicable section of DPSOL 105-2202, Data Sheet 1 to be used as a baseline comparison after program change.

e) If program change is for Safety Computer obtain REPORT program [20 (RETURN)] for use as baseline comparison after program change.

f) Enter required changes in computer.

4) Complete applicable division of DPSOL 105-2202 and required online test and data review specified on Data Sheet 1, Line 13.

A...

5) If tests and/or review indicate satisfactory performance, complete the following:

a) Control Computer.

(1) Request a printout of control computer system program checksums.

(a) DPSOL 105-2221B-49. (49 5 2 VOL1:) This print out all program checksums on line printer.

(b) DPSOL 105-2221B-55, (55 2). This prints out the DMA LOGIC checksum on line printer.

(2) Review printout and verify:

- Revised program checksum is value listed on Data Sheet 1, Line 14.
- All other program checksums agree with last approved checksum listed in Computer Program Verification Log section of binder for that computer system.

(3) Proceed to Step A.6).

b) Safety Computer

(1) Obtain the checksum printout from Data Sheet 2 of DPSOL 105-2202.

(2) Review checksums and verify data is correct.

(3) Proceed to Step A.6).

c) REMACS System

(1) SELECT SLAVE: Local Slave 1

(2) **Press: CONSOLE COMM.**

(3) **Enter: SV**

(4) **Press: ENTER**

A.5)c)...

(5) VERIFY PRINTER

S1 VERSION NUMBERS X.XX (DATE) Y.YY (DATE)

S REMACS MASTER VERSION IS Z.ZZ (DATE)

Then after about one minute:

S1 PROMCRC = XXXX

where: S = Area

X.XX = Slave program number

Y.YY = RTTS program number

Z.ZZ = Master program number

XXXX = Computer calculated alpha numeric

(6) SELECT SLAVE: Local slave 2

(7) Press: CONSOLE COMM.

(8) Enter: SV

(9) Press: ENTER

(10) VERIFY PRINTER:

S2 VERSION NUMBERS X.XX (DATE) Y.YY (DATE)

S REMACS MASTER VERSION IS Z.ZZ (DATE)

Then after about one minute:

S2 PROM CRC=XXX

where: S = Area

X.XX = Slave program number

Y.YY = RTTS program number

Z.ZZ = Master program number

XXXX = Computer calculated alphanumeric

(11) Review printouts and verify:

- RTTS, MASTER, and SLAVE version numbers and dates are identical to information contained in the abstract revision listed in Data Sheet 1, Line 6.

(12) If data are correct proceed to Step A.6).

A.5)...

d) Discharge Machine Multiplex Computer

- Startup computer using DPSOL 105-5352.

- Verify computer program version listed in the welcome message agrees with data entered in Data Sheet 1 Line 6.

- If data are correct, proceed to Step A.6).

e) C & D Machine Input Order Computer

(1) Verify DPSOL 105-5329, "Fabritek computer tape control" has been completed.

(2) Proceed to Step A.6).

f) EFC Computer

- Proceed to Step A.6).

g) Vibration Monitor (VAM).

- Proceed to Step A.6).

6) Complete the following:

a) Enter name, date and time on line 16 of Data Sheet 1.

b) Obtain Data Sheet 3 for the current year from the applicable computer system binder.

c) Complete Data Sheet 3 as follows:

Column 1: Enter todays date.

Column 2: Enter present time of day.

Column 3: Enter computer system name.

Column 4-6: List data entered in Data Sheet 1, Line 6.

Column 7: Enter checksums if applicable. Mark N/A if not applicable.

Column 8: SHIFT MANAGER: Enter signature.

Column 9: SHIFT MANAGER: Print Name

d) - Control Computer: Attach program checksum printouts from Step A.5)a) to Data Sheet 3.

- REMACS Computer: Attach program I.D. printouts from Step A.5)c) to Data Sheet 3.

e) Place Data Sheet 3 in appropriate computer program verification log section.

A...

7) If test and/or data review indicate an abnormal computer status, notify day management and Reactor Engineering Programmer. Day management and the Reactor Engineering Programmer will determine what corrective action needs to be taken.

8) File Data Sheet 1 (stapled to Data Sheet 2 if used) documenting the program change in the program change description section of the appropriate computer system binder.

Completed By _____/_____
Signature Print Name

Date _____ Time _____a.m./p.m.

B. PROGRAM VERIFICATION

1) Complete the following for the desired computer system to verify the current program revision level is correct.

a) CONTROL COMPUTER:

(1) Request a printout of control computer DMA history File using DPSOL 105-2221B-55. Type: (55 2) (RETURN). The checksum for the DMA LOGIC can be found toward the beginning of the printout.

(2) Request a printout of control computer program checksums using DPSOL 105-2221B-49 (49 5 2 VOL1:) (RETURN).

NOTE: The TTY lock button on the CRT must be in the LOCK position.

(3) Proceed to step B.2).

b) SAFETY COMPUTER

(1) Request a printout of safety computer program checksums using DPSOL 105-2156B-21.

(a) Type: 21 2 (Return)

(b) Printer will Print: 21 2

Verify option 02 run date = XX/XX/XX

Test values stored XX/XX, XX

File F8C new sum = YYYY old sum = YYYY

File 08C new sum = YYYY old sum = YYYY

where XX/XX/XX = date YYYY = checksum values

(c) Verify the file F8C new sum value is the same as the old sum value.

(d) Verify the file 08C new sum value is the same as the old sum value.

(2) Verify the checksum values are the same as the values kept in the safety computer program binder.

(3) Proceed to step B.2).

B.1)...

c) REMACS COMPUTER

(1) Request a printout of REMACS computer program version numbers as follows:

(a) Press: Area key to select local Slave 1

(b) Press: CONSOLE COMM.

(c) Type: SV

(d) Press: ENTER

(e) VERIFY PRINTER

S1 VERSION NUMBERS X.XX (DATE) Y.YY (DATE)

S REMACS MASTER VERSION IS Z.ZZ (DATE)

Then after about one minute:

S1 PROM CRC = XXXX

where: S = Area

X.XX = Slave program number

Y.YY = RTTS program number

Z.ZZ = Master program number

XXXX = Computer calculated alphanumeric

(f) SELECT SLAVE: Local slave 2

(g) Press: CONSOLE COMM.

(h) Enter: SV

(i) Press: ENTER

B.1)c)(1)...

(j) VERIFY PRINTER

S2. VERSION NUMBERS X.XX (DATE) Y.YY (DATE)

S REMACS MASTER VERSION IS Z.ZZ (DATE)

Then after about one minute:

S2 PROM CRC = XXXX

where: S = Area

X.YX = Slave program number

Y.YY = RTTS program number

Z.ZZ = Master program number

XXXX = Computer calculated alphanumeric

(2) Proceed to Step B.2).

d) Discharge Machine Multiplex Computer.

(1) Verify computer program version listed in WELCOME message agrees with data listed in C&D machine console computer verification log.

(2) Proceed to Step B.2).

e) C&D Machine Input Order Computer

(1) Note computer program information is available on standard screen display.

(2) Proceed to Step B.2).

f) External Fission Counter

(1) Obtain approved EFC computer abstract number.

(2) Proceed to Step B.2).

g) Vibration Monitor (VAM)

(1) Obtain approved VAM computer abstract number.

(2) Proceed to step B.2).

B...

2) Verify printout checksum and/or version number and/or abstract number agrees with information listed in Program Verification Log section of the appropriate computer system binder.

3) If the printup checksums do not match the information in the program verification log section of the appropriate Computer System Binder, contact the Reactor Engineering Programmer for that computer system.

Completed By _____/_____
Signature Print Name

Date _____ Time _____a.m./p.m.

DATA SHEET 1

COMPUTER PROGRAM CHANGE REQUEST

1. Date_____

2. Area 100-_____

3. Requested By:_____

4. Computer System _____

5. Computer Program Name:_____

6. Abstract: Number_____Rev. No._____ Add. No._____

Approval Date_____

7. Programmer:_____

8. Change within specification of current abstract Yes____ No*____

Change has been previously tested Yes____ No*_____

*If no, approval of Reactor Engineering Manager and Reactor Operations Manager or their delegates is required on line 15. Forward copy of completed data sheet to RE programmer. The programmer will attach copy of Data Sheet 1 to abstract approval routing sheet.

9. Change Requested:_____

10. Change Tested: Yes _____ or No _____ Location _____ Date_____

11. Duration of Program Change: a) Permanent_____ b) Other _____

12. DPSOLs affected by program change: _____

13. Online tests (or Special Data) required after change made: _____

DATA SHEET 1 Contd

14. Program checksum(s) (if applicable)_____

15. Approved By: RED_____Date_____
Technical Support Manager (or delegate)

*RED _____Date_____
Reactor Engineering Manager (or delegate)

ROD _____Date_____
Plant Manager

*ROD _____Date_____
Operations Manager

16. Conclusion:

Test completed satisfactorily_____/_____
(RE Programmer) Signature Print Name

Date_____ Time_____a.m./p.m.

Reviewed By _____/_____
Signature Print Name

Date_____ Time_____a.m./p.m.

PROGRAM _____ CHECKSUM _____ DATA SHEET 2 MEMORY CHANGE SHEET DATE _____

OVERLAY SECTOR _____ PAGE _____ OF

ADDRESS ARS	ADDRESS REL	OLD VALUE HEX	OLD VALUE OCTAL	NEW VALUE HEX	NEW VALUE OCTAL	LABEL	OP	OPERAND	REMARKS

*Not required for program changes checked out in PDC or other reactor area.

Completed By (RE Programmer) Signature _____ / Print Name _____

*Reviewed By (2nd RE Programmer) or (Shift Manager) Signature _____ / Print Name _____

Date _____ Time _____ a.m./p.m.

Date _____ Time _____ a.m./p.m.

DATA SHEET 3
COMPUTER APPROVED PROGRAM DOCUMENTATION LIST

1	2	3	4	5	6	7	8	9
DATE	TIME	COMPUTER SYSTEM	ABSTRACT NUMBER	REVISION NUMBER	APPROVAL DATE	CHECKSUM LISTING ATTACHED ( )	SHIFT MANAGER SIGNATURE	SHIFT MANAGER PRINT NAME

END

DATE FILMED

01 / 15 / 91