November 16, 1995

LICENSEE: Union Electric Company

FACILITY: Callaway Unit No. 1

SUBJECT: SUMMARY OF NOVEMBER 15, 1995, MEETING WITH UNION ELECTRIC COMPANY TO DISCUSS ITS PLANNED DIGITAL UPGRADE OF THE MAIN STEAM AND FEEDWATER ISOLATION SYSTEM AT CALLAWAY UNIT NO. 1

On November 15, 1995, representatives from the U.S. Nuclear Regulatory Commission (NRC) met with representatives from the Union Electric Company (UE) and its contractor, Spectrum Technologies-USA, Inc. (Spectrum), to discuss UE's planned digital upgrade of the main steam and feedwater isolation system (MSFIS) at Callaway Unit No. 1. Attachment 1 is a list of attendees.

Representatives from UE gave a brief history of the MSFIS at Callaway and then discussed the digital upgrade program. Representatives from Spectrum discussed the verification, validation, and commercial-grade dedication processes for the development of Class 1E software-based computer systems. UE concluded with a discussion of its draft safety evaluation for the upgrade. The presentation material is in Attachment 2.

At the end of the meeting, the NRC staff promised to review the presentation material in detail and give UE additional comments in the near future.

Original signed by:
Kristine M. Thomas, Project Manager
Project Directorate IV-2
Division of Reactor Projects III/IV
Office of Nuclear Reactor Regulation

Docket No. 50-483

Attachments: 1. Meeting Attendees
2. Presentation Material

cc w/atts: See next page

DISTRIBUTION: (w/atts 1 and 2)

Docket File	PUBLIC
PDIV-2 Reading	KThomas
JDyer, RIV	

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WRussell/FMiraglia	RZimmerman
JRoe	EAdensam
WBateman	EPeyton
OGC	EJordan
PLoeser	JStewart
ACRS	JMitchell

DOCUMENT NAME: CALMSFIS.MTS

OFC	PDIV-2/LA	PDIV-2/PM
NAME	EPeyton	KThomas:pk
DATE	11/20/95	11/16/95

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P PDR

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

November 16, 1995

LICENSEE: Union Electric Company

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Kristine M. Thomas

Kristine M. Thomas, Project Manager
Project Directorate IV-2
Division of Reactor Projects III/IV
Office of Nuclear Reactor Regulation

Docket No. 50-483

Attachments: 1. Meeting Attendees
2. Presentation Material

cc w/atts: See next page

cc w/atts:
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Thomas A. Baxter, Esq.
Shaw, Pittman, Potts & Trowbridge
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Washington, D.C. 20037

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Fulton, Missouri 65251

U.S. Nuclear Regulatory Commission
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Regional Administrator, Region IV
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Department of Natural Resources
P.O. Box 176
Jefferson City, Missouri 65102

Mr. Neil S. Carns
President and Chief Executive Officer
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P.O. Box 411
Burlington, Kansas 66839

Mr. Dan I. Bolef, President
Kay Drey, Representative
Board of Directors Coalition
for the Environment
6267 Delmar Boulevard
University City, Missouri 65130

Mr. Lee Fritz
Presiding Commissioner
Callaway County Court House
10 East Fifth Street
Fulton, Missouri 65151

Mr. Donald F. Schnell
Senior Vice President - Nuclear
Union Electric Company
Post Office Box 149
St. Louis, Missouri 63166

Attachment 1

MEETING WITH UNION ELECTRIC COMPANY

TO DISCUSS ITS PLANNED UPGRADE OF THE MSFIS

ATTENDANCE LIST

November 15, 1995

Union Electric

A. Passwater
D. Shafer
D. Cooksey
D. Wingbermueble
E. Goss

Spectrum Technologies

B. Willis
T. Burns

NRC

P. Loeser
J. Stewart
K. Thomas

Attachment 2

PRESENTATION MATERIAL

AGENDA

MSFIS DIGITAL TO DIGITAL UPGRADE AT THE CALLAWAY PLANT MEETING

INTRODUCTION	D. SHAFER
PURPOSE	D. SHAFER

* DIGITAL UPGRADE APPROACH
* MSFIS UPGRADE
* MSFIS 50.59 EVALUATION
* NRC FEEDBACK ON APPROACH

MSFIS HISTORY	D. WINGBERMUEHLE
DIGITAL UPGRADE PROGRAM	D. COOKSEY
SPECIFICATION & VENDOR SELECTION	E. GOSS
SPECTRUM'S V&V AND CGD PROGRAMS	T. BURNS (S.T.) W. Willis (S.T.)
MSFIS 50.59 EVALUATION	E. GOSS
SUMMARY	D. WINGBERMUEHLE

MSFIS HISTORY

1. Consolidated Controls Digital System

2. Single Point Failure Studies

    * ISEG

    * I&C Systems Engineering

3. SA075A&B MSFIS Cabinets

    * 72 solid state circuit cards - 9 per valve

    * Input Buffer Cards - Capacitor Failures

    * Relay Driver Cards

    * Valve Control Modules

4. MSFIS Modification CMP 92-1038

    * 2/3 Coincidence Circuits

5. AP 95-302, Digital Upgrade Action Plan

Presentation of Callaway's Proposed Digital Upgrade Program

Callaway Plant's Nuclear Engineering Department proposes to enhance the plant's current design development program to better meet the unique needs of developing and maintaining designs based on digital components.

Nuclear Engineering has developed Action Plan 95-302 to track the issues and actions that comprise the reviews and updates required to put a program in place. Included in this action plan is the creation of a new engineering procedure to enhance the design development and configuration management of plant digital control and data acquisition systems.

- Regulatory Requirements:

  Reg. Guide 1.152 endorses ANSI/IEEE Std. 7-4.3.2 as a means to comply with the NRC requirements. Standard 7-4.3.2 invokes NQA-2a-1990 Part 2.7 for software quality assurance and invokes the IEEE Standard 603 with additional requirements for hardware quality assurance.

- Plant Implementation:

  APA-ZZ-00111 - Engineering Specifications
  Provides instructions on generation of specifications for overall system, hardware, software, and integration requirements.
  Revision due date 2/20/96.

  APA-ZZ-00140 - Safety, Environmental, and Other Licensing Evaluations
  Provides instructions, guidance, and assigns responsibility for licensing evaluations.
  No revision required.

  APA-ZZ-00400 - Procurement of Parts, Supplies, Materials, and Services
  Provides instructions and assigns responsibilities for procurement of items in accordance with their defined requirements.
  No revision required.

  EDP-ZZ-04005 - Design Development
  Provides instructions on development of design packages. Will incorporate V & V activities for digital systems per EDP-ZZ-04056.
  Revision due date 2/20/96.

  EDP-ZZ-04024 - Configuration Control
  Defines the requirements for maintaining plant configuration control. Will impose EDP-ZZ-04056 requirements for digital systems.
  Revision due date 2/20/96.

  EDP-ZZ-04032 - Design Input Control
  Provides guidance on the design process for preparation, review, approval, and revision of design information to meet ANSI N45.2.11 requirements. Will be revised to list considerations for digital systems / components.
  Revision due date 2/20/96.

  EDP-ZZ-04056 - Development and Configuration Control of Digital Plant Systems.
  Provides instruction and guidance on the design process for plant digital systems to meet ANSI/IEEE 7-4.3.2 requirements. Will define hardware and software development requirements for digital systems / components and establish the Software Configuration Management Program utilizing IEEE Standards 1012 and 828.
  Initial issue due date 2/20/96.

Presentation of Callaway's Proposed Digital Upgrade Program

(Continued)

- Program Overview:

  Flow diagram 1A depicts the tier of requirements / document.

  Flow diagram 2A demonstrates the proposed method of implementing the program at Callaway using purchased software.

  Flow diagram 2B demonstrates the proposed method of implementing the program at Callaway using in-house software development.

  Flow diagram 3A outlines the proposed method of implementing the Configuration Management program at Callaway.

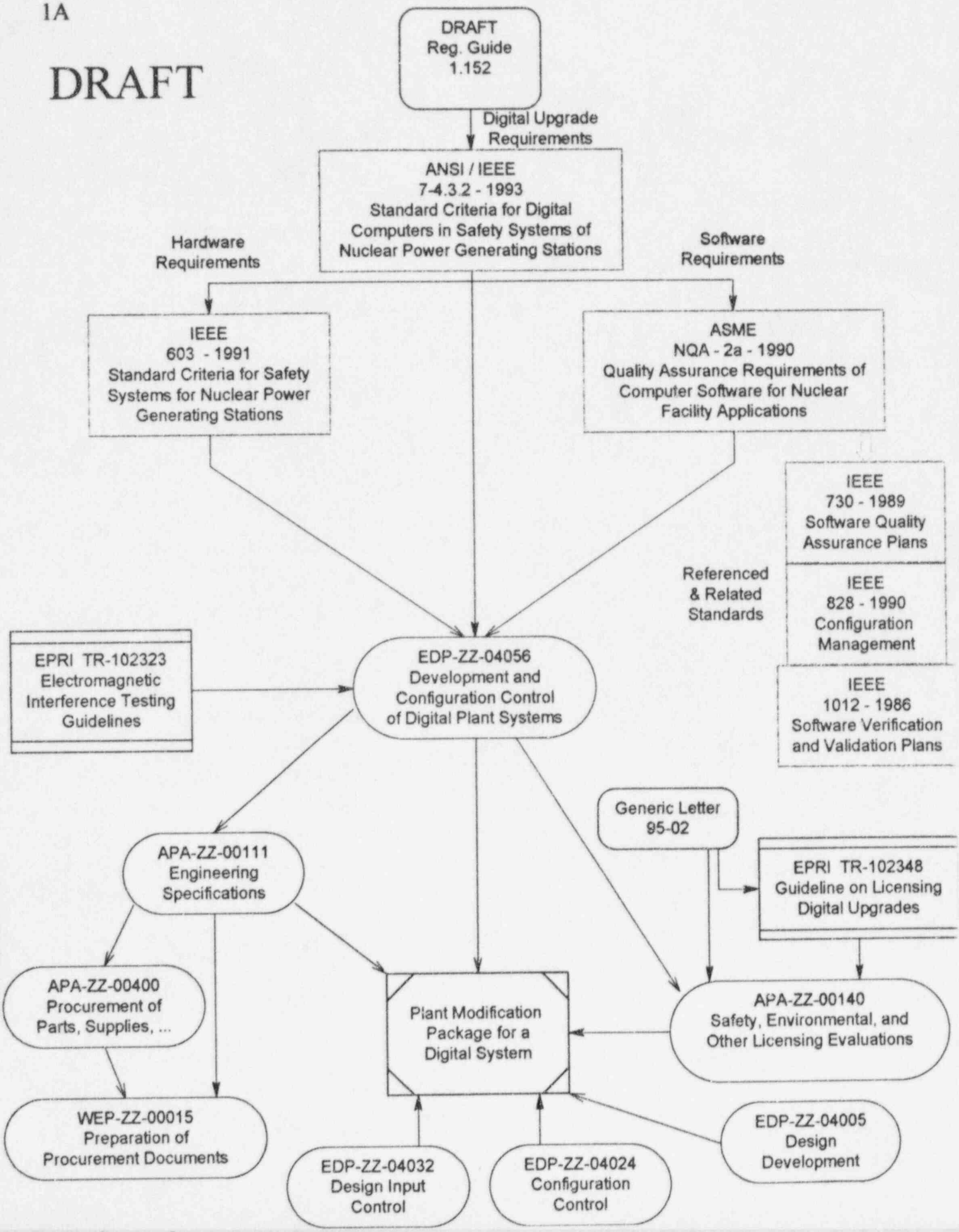
- Questions & Answers:

  Open Floor for discussion of proposed program.

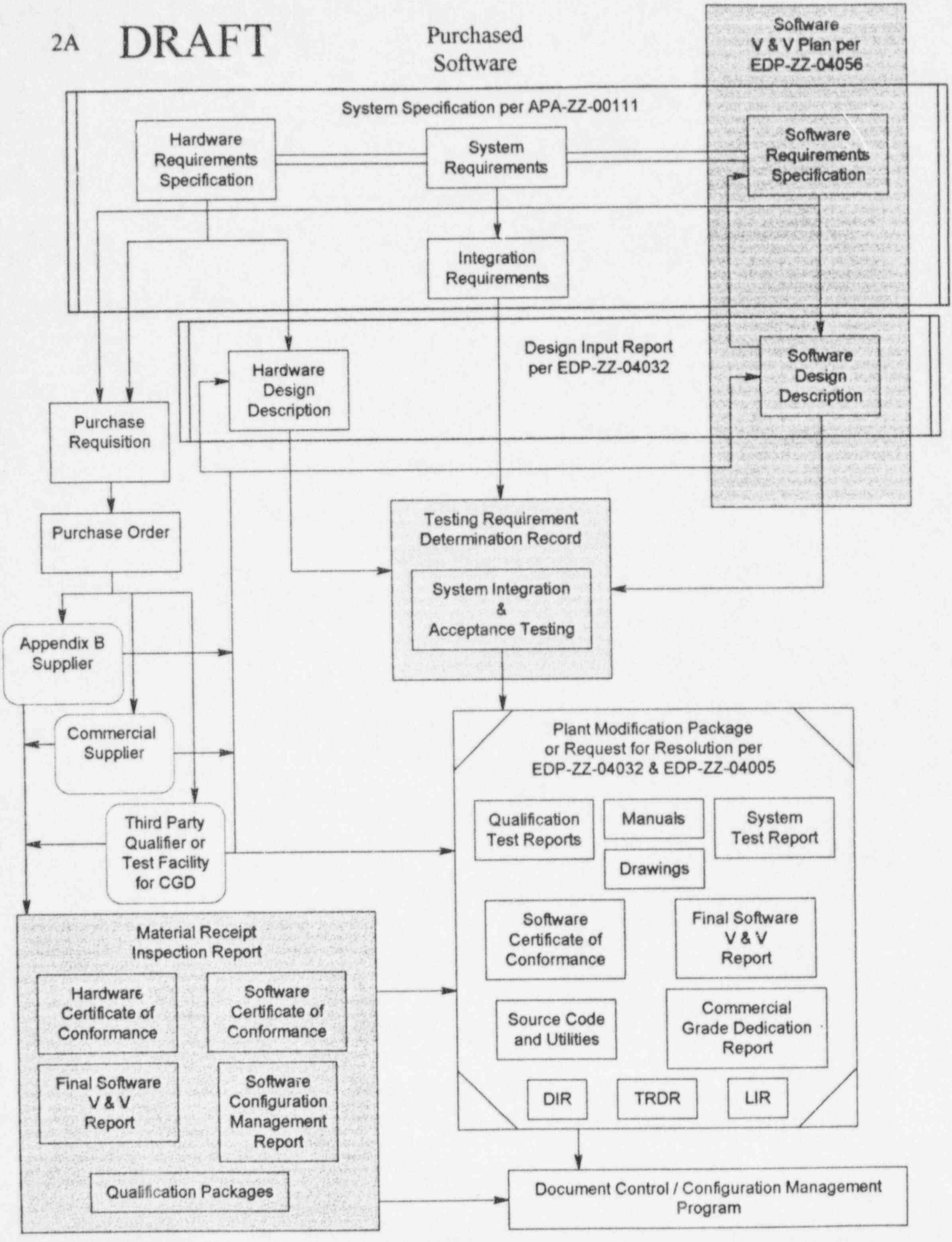
Governing Documents

1A

DRAFT

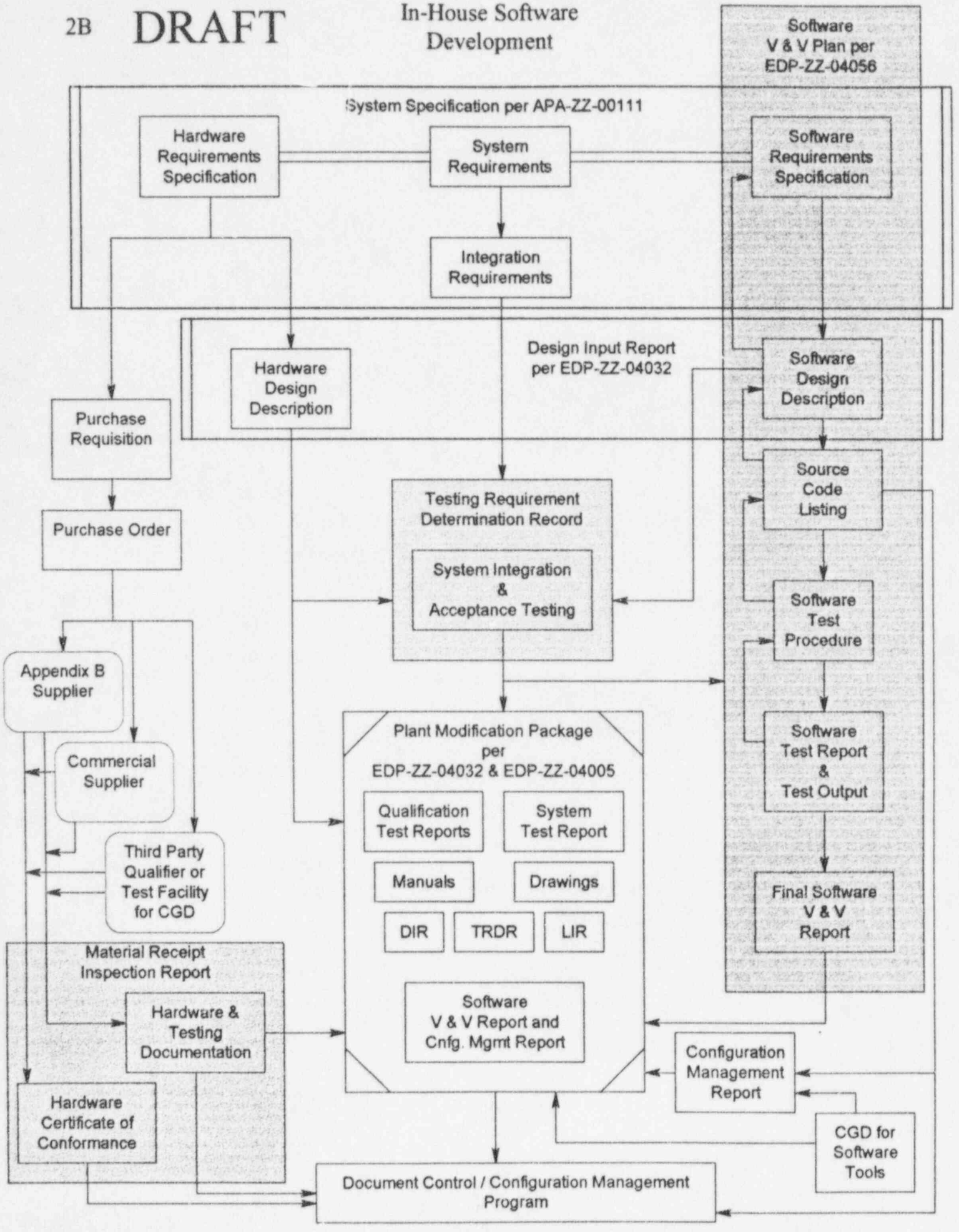


2A DRAFT


Purchased Software
Software V & V Plan per EDP-ZZ-04056
System Specification per APA-ZZ-00111
Hardware Requirements Specification
System Requirements
Software Requirements Specification
Integration Requirements
Design Input Report per EDP-ZZ-04032
Hardware Design Description
Software Design Description
Purchase Requisition
Purchase Order
Testing Requirement Determination Record
System Integration & Acceptance Testing
Appendix B Supplier
Commercial Supplier
Third Party Qualifier or Test Facility for CGD
Plant Modification Package or Request for Resolution per EDP-ZZ-04032 & EDP-ZZ-04005
Qualification Test Reports
Manuals
System Test Report
Drawings
Software Certificate of Conformance
Final Software V & V Report
Source Code and Utilities
Commercial Grade Dedication Report
DIR
TRDR
LIR
Material Receipt Inspection Report
Hardware Certificate of Conformance
Software Certificate of Conformance
Final Software V & V Report
Software Configuration Management Report
Qualification Packages
Document Control / Configuration Management Program

2B DRAFT

In-House Software Development



3A

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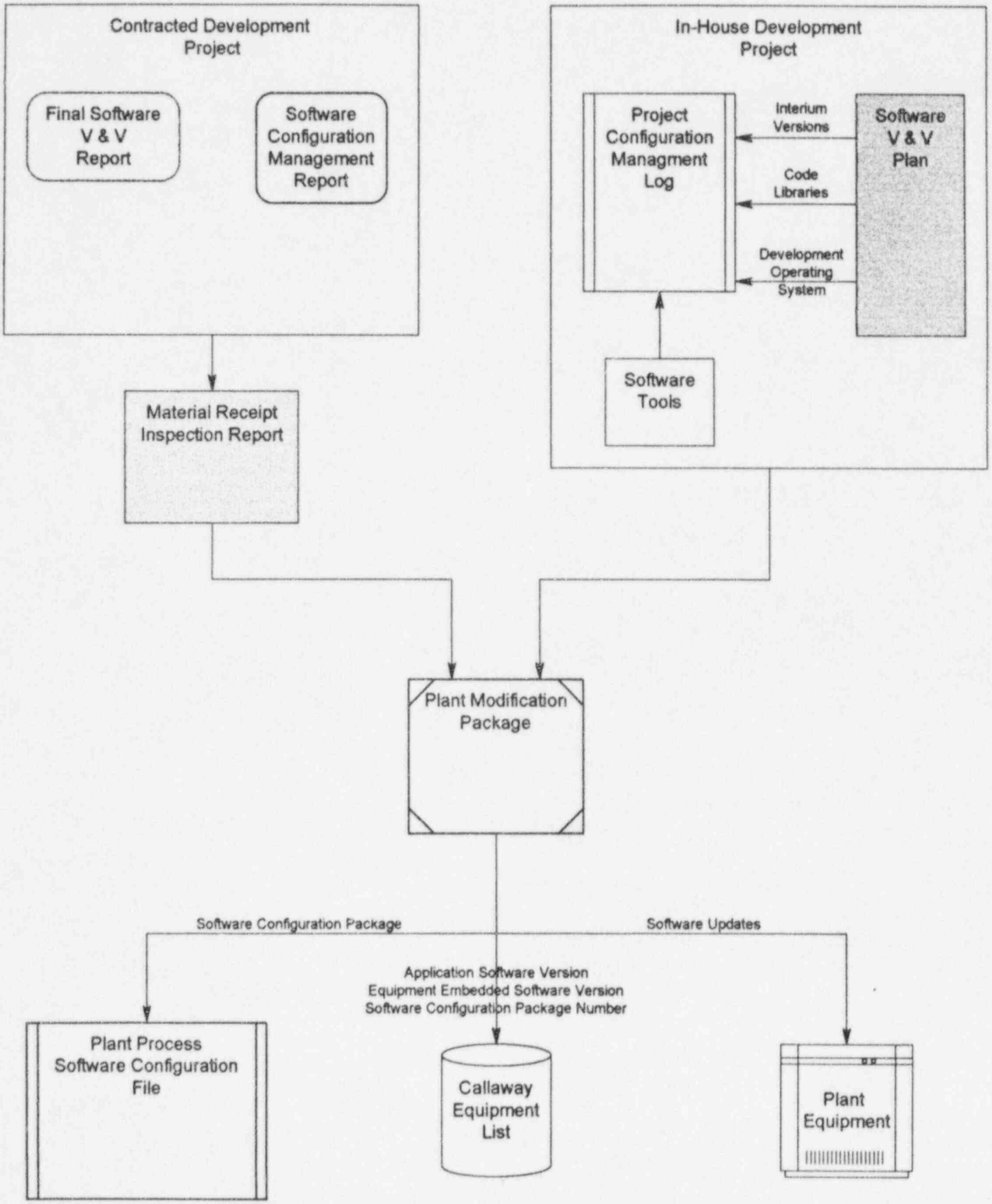
Software Configuration Managment Plan for Plant Process Software



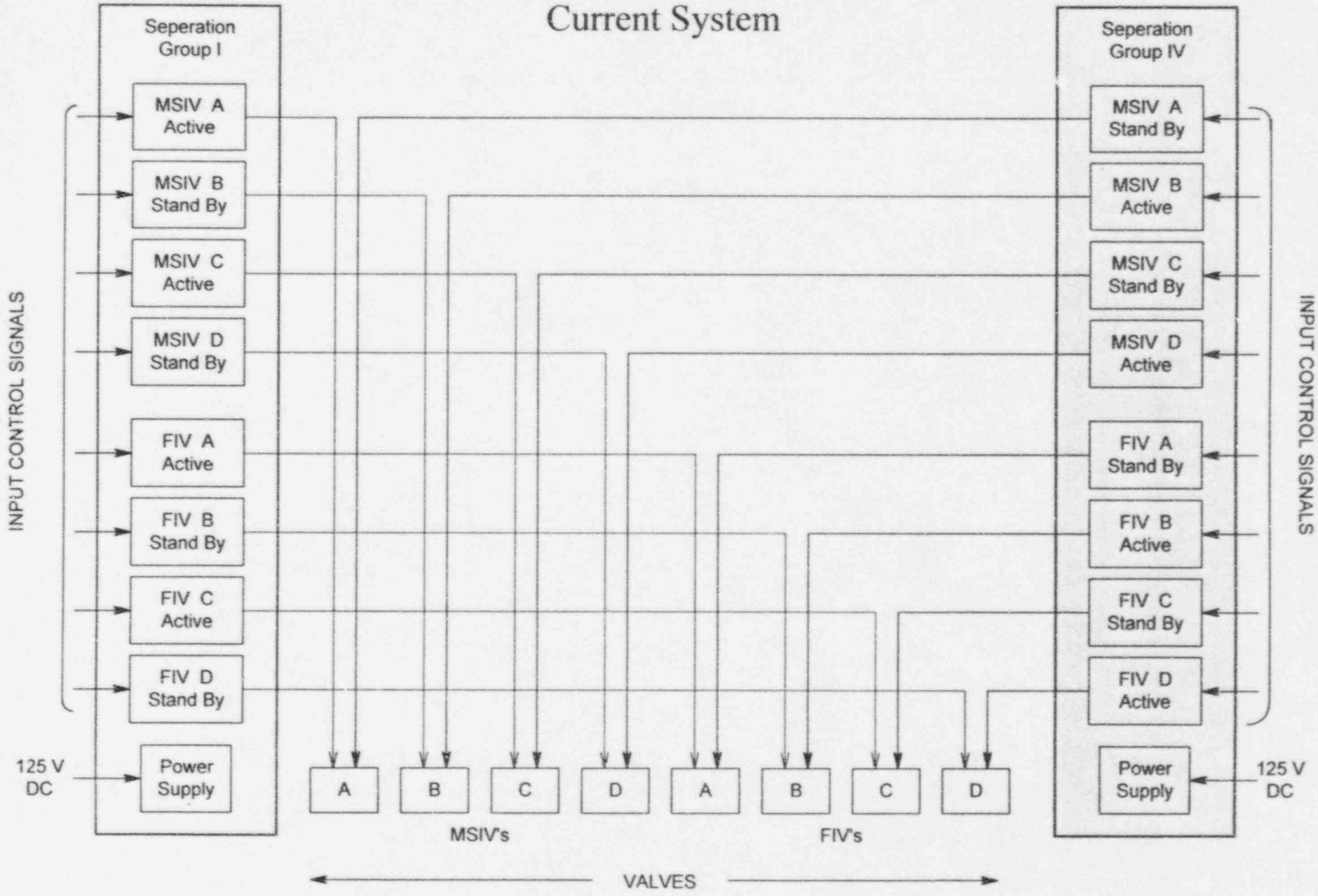
UNION ELECTRIC COMPANY

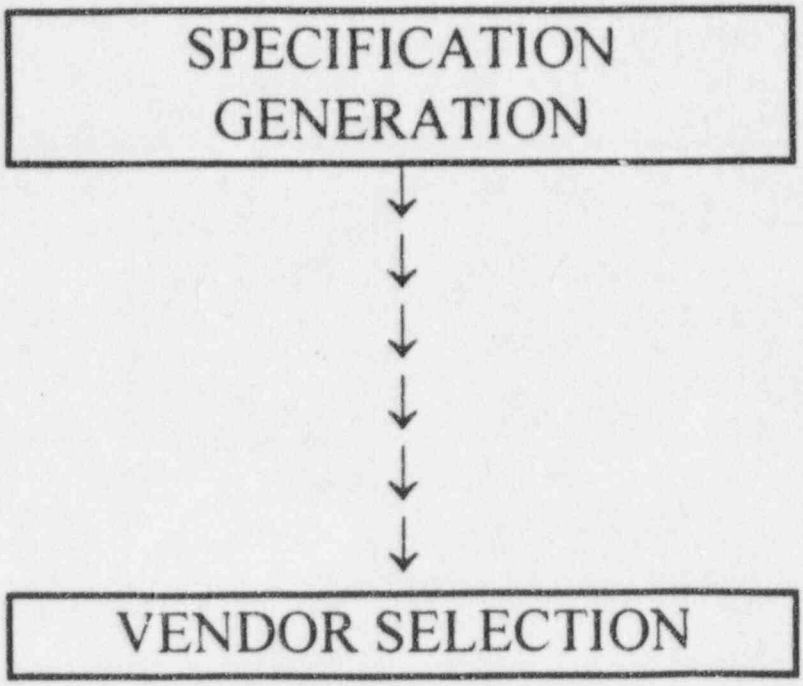
CALLAWAY PLANT

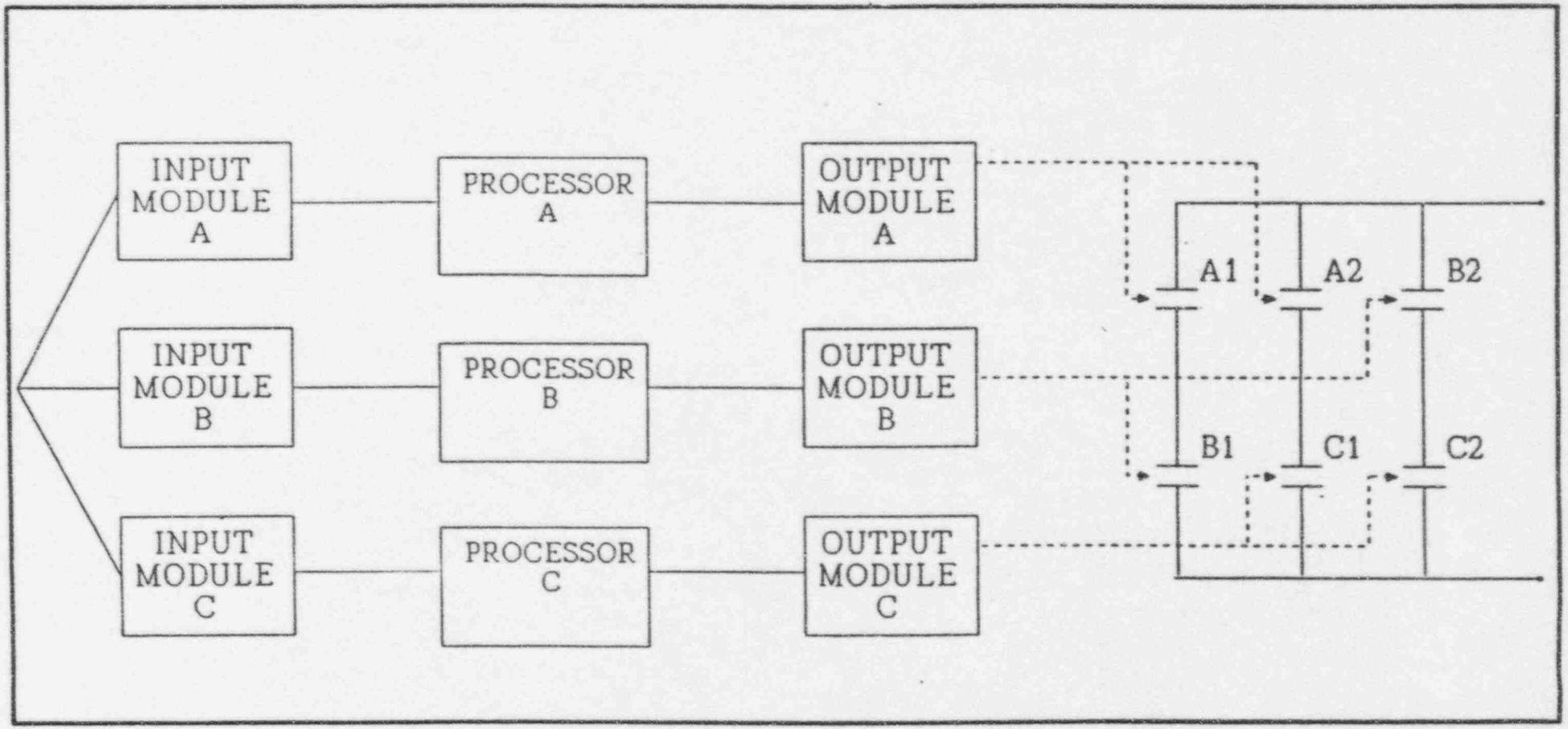
MAIN STEAM & FEEDWATER

SYSTEM REPLACEMENT

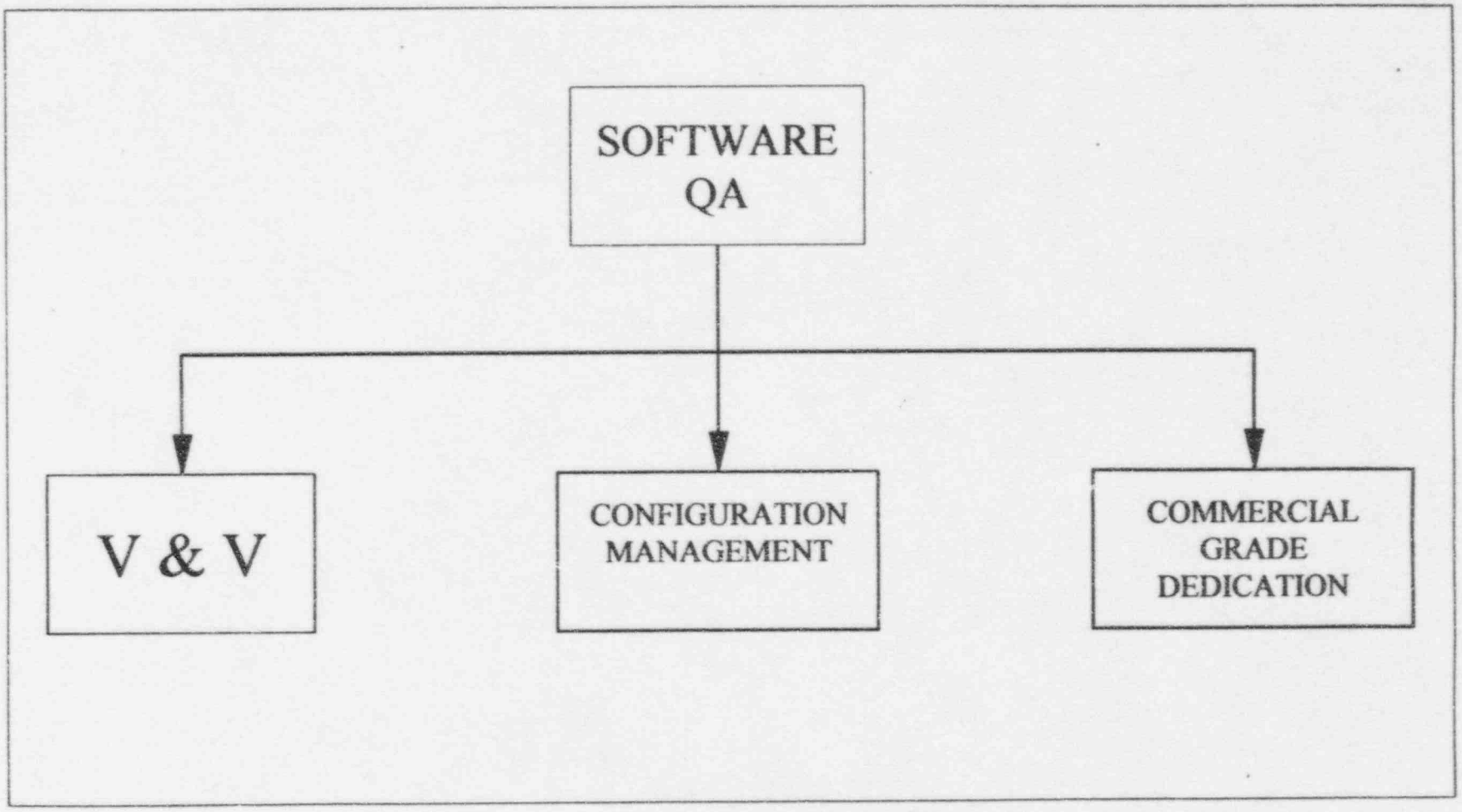
MSIV and FIV Valves
Current System



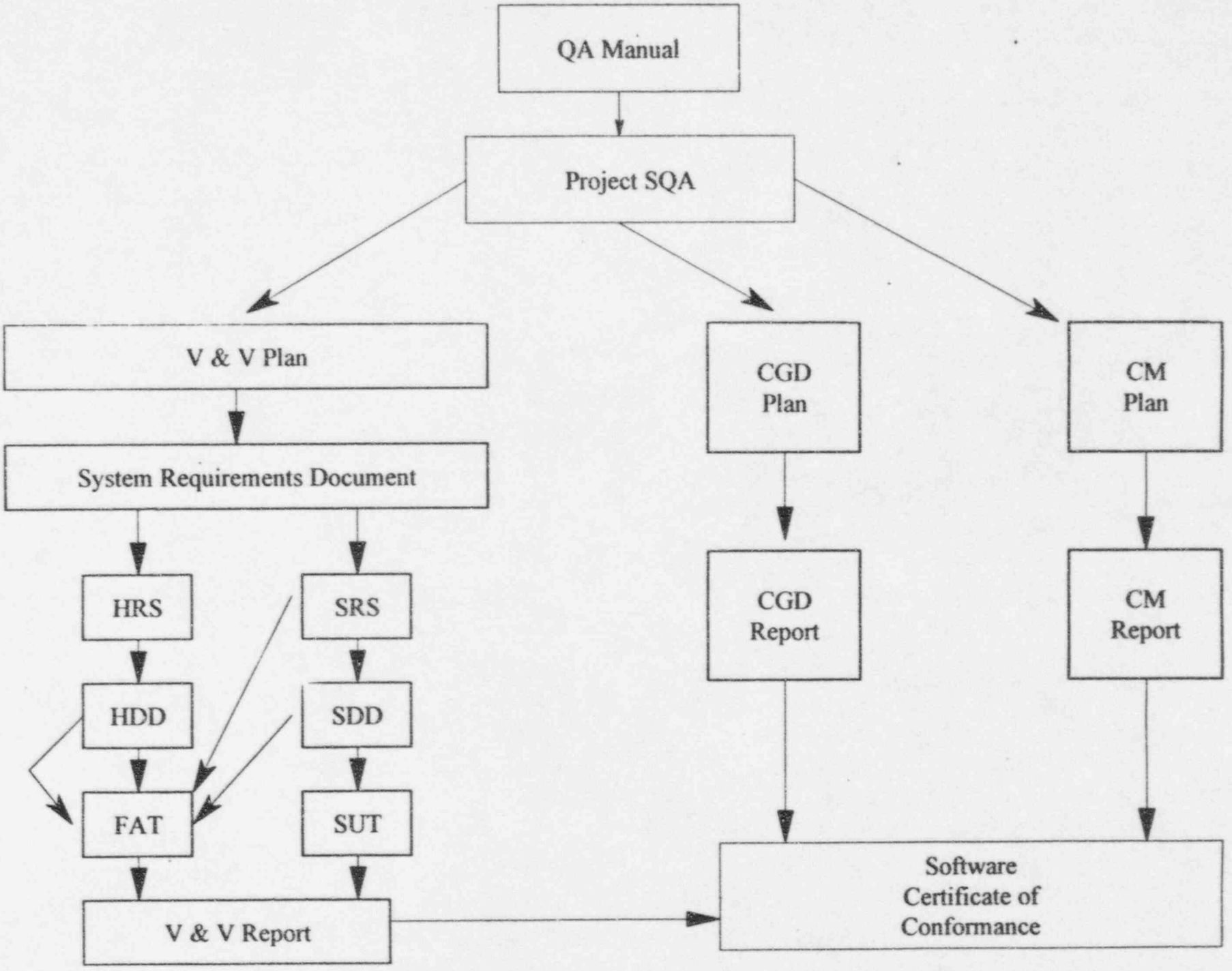

SPECIFICATION
GENERATION
VENDOR SELECTION



Two-out-of-three voting with three independent processors



Software QA Process



Software QA Program for the Specific Project

MSFIS REPLACEMENT PRESENTATION

SPECIFICATION GENERATION

Union Electric re-wrote the original specification for the MSFIS system to accomplish the same logic and functionality. A redundant system such as 2 out of 3 logic was recommended with solid state or programmable controller logic. At the time the specification was generated only IEEE Std 7-4.3.2 (1982) was available. Thus, this standard was referenced for the design, implementation, and testing of all software.

The existing system redundancy with system Engineering Safety Feature Actuation System inputs from the Reactor Protection System and system actuation relay outputs to the solenoids on the valves would remain the same.

VENDOR SELECTION

Of all the vendors who submitted proposals, Spectrum Technologies, Inc. (SP) in Schnectady, New York, was selected to supply the new MSFIS replacement. SP has been an approved Quality Supplier for Union Electric. SP was selected because of its Allen-Bradley Programmable Logic Controller (PLC) and triple redundant design. The proposed system is based upon a reliable PLC with a high mean time between failures (MTBF), the ability to perform maintenance/modification easily, and on-line monitoring capability. The PLC design will be per IEEE Std 7-4.3.2 (1993). PLC's from Allen-Bradley have been previously qualified, dedicated, and approved for Class-IE applications (a safeguard load sequencer/diesel generator starter system at Turkey Point,

FP&L, and a safeguard load sequencer/diesel generator starter system at Prairie Island, NSP).

SP utilizes three principles of software engineering to assure the software is thoroughly tested as follows:

- Structured Programming - using simple control structures with a minimum number of "GO-TO" statements. This facilitates Verification and Validation (V&V) and future changes.
- Modularity - breaking down the program into small entities, each performing a specific, well defined function. This feature reduces complexity and supports independent testing.
- Information Hiding - the program can use any module by calling it, obeying its rules of module interface, and not having to know the implementation. This reduces the possibility of "un-intended" functions.

SP has been audited twice by NUPIC in August, 1992, and May, 1994, successfully. Their successful track record is evidence of the high standards they maintain as well as the high quality product and services they produce.

SP's Software QA Process

- Software QA shall be performed according to SP's QA manual which complies with 10CFR50 Appendix B and ANSI N45.2.
- Defects are reportable according to 10CFR Part 21.

- A software QA Plan (SQAP) was written for the MSFIS modification. It described the process each package undergoes before and during use in the safety-related application. The SQAP is based upon IEEE Std 730 - Software QA Plans.

Commercial Grade Dedication (CGD)

- Applies to pre-existing off-the-shelf software and hardware items that were developed by a vendor without a 10CFR50 Appendix B program.
- The qualification process for the computer shall entail identification of functional and performance requirements necessary to provide adequate confidence that the safety function can be achieved.
- Acceptance is based upon engineering judgment that the available evidence provides adequate confidence for the equipment to perform its intended function.

CGD Criteria:

1) Not subject to design requirements, unique to nuclear facilities.
2) Used in applications other than nuclear facilities.
3) Is to be ordered from the manufacturer/supplier on the basis of specifications set forth in the manufacturer's published product description.

Configuration Management

- Applies to hardware drawings/documents and software configuration control.
- Software will be configured per SP's Software Configuration Management Plan, including source code and drawings/documentation.

Verification and Validation

- Applies only to the application software developed by SP.
- V&V is a QA process, in parallel with the design process that is put in place to assure that the developed system complies with the customer's technical specification requirements.
- The software development life cycle phases will follow the "waterfall model". Based upon this life cycle model SP has produced their V&V process.

SPECTRUM TECHNOLOGIES®
USA, Inc.

DEVELOPMENT OF CLASS 1E

SOFTWARE BASED COMPUTER SYSTEMS

AT

SPECTRUM TECHNOLOGIES-USA, INC.

VERIFICATION AND VALIDATION

THOMAS W. BURNS,

PROJECT MANAGER

SPECTRUM TECHNOLOGIES®
USA, Inc.

FUNDAMENTAL PRINCIPAL

ALL ELEMENTS OF THE DESIGN, MANUFACTURE, AND TEST OF EACH SYSTEM FURNISHED BY SPECTRUM TECHNOLOGIES-USA, INC. SHALL BE CONTROLLED BY A VERIFICATION AND VALIDATION PLAN THAT COMPLIES FULLY WITH IEEE-7.4.3.2 (1993), AND IEEE-1012 (1986).

OTHER PRINCIPAL REQUIREMENTS SOURCE DOCUMENTS:

US CODE OF FEDERAL REGULATIONS--TITLE 10, PART 50, AND PART 21

SPECTRUM QUALITY ASSURANCE MANUAL

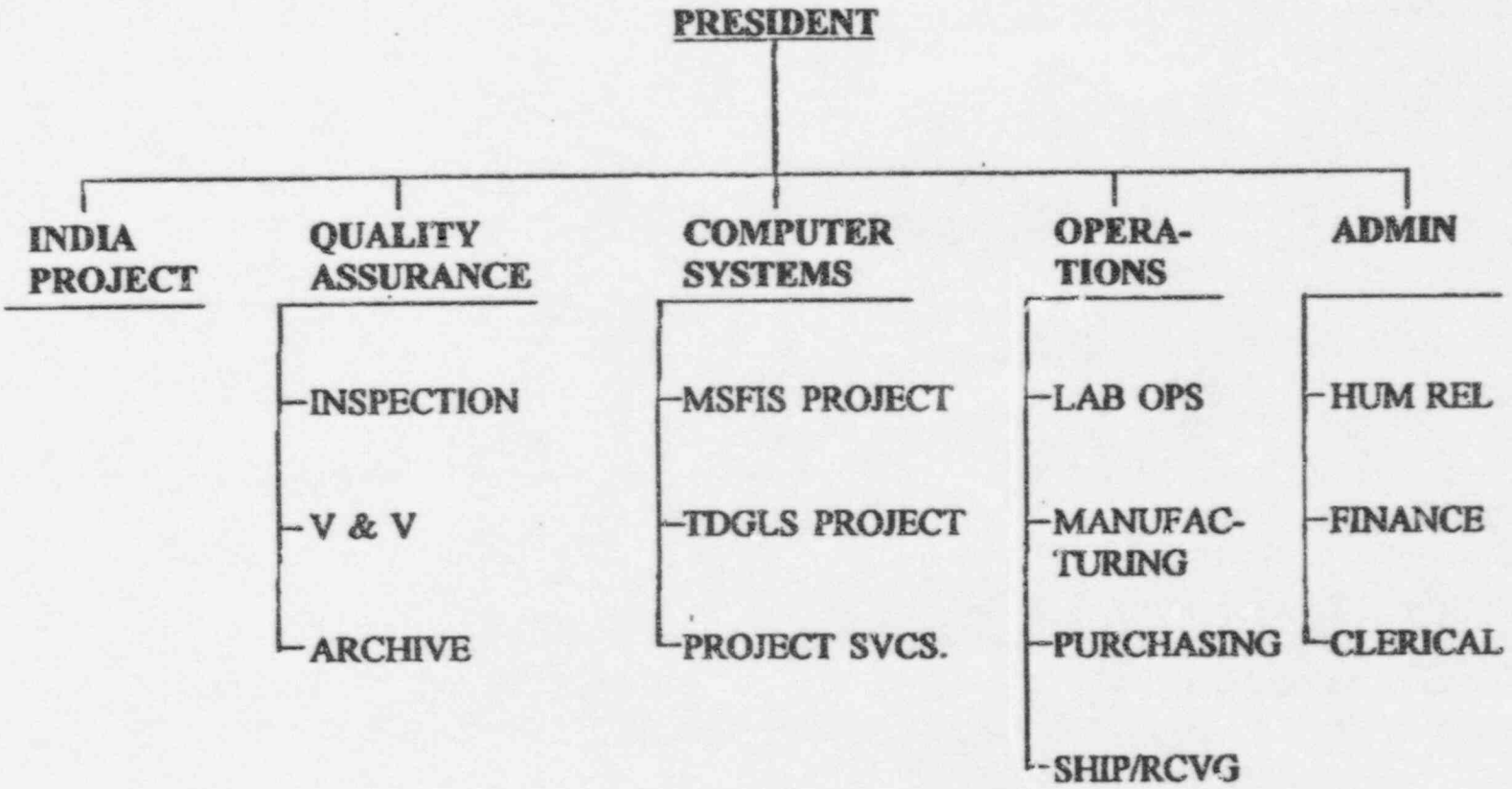
REGULATORY GUIDE 1.152 (NOV 1985)--CRITERIA FOR PROGRAMMABLE DIGITAL COMPUTER SYSTEM SOFTWARE IN SAFETY-RELATED SYSTEMS OF NUCLEAR POWER PLANTS

IEEE-603(1991)--STANDARD CRITERIA FOR SAFETY SYSTEMS FOR NUCLEAR POWER GENERATING STATIONS

ASME NQA-2a-1989--QUALITY ASSURANCE REQUIREMENTS FOR NUCLEAR FACILITY APPLICATIONS--INCL. 1990 ADDENDA

SPECTRUM TECHNOLOGIES®
USA, Inc.

ORGANIZATION



Spectrum Sets Standards Above The Standards

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USA, Inc.

V&V OF CONCEPTUAL DESIGN PHASE (PHASE 1)

KEY ELEMENTS:

PARTICIPATION IN SPECIFICATION DEVELOPMENT

CONCEPTUAL DESIGN REVIEW OF SYSTEM SPECIFICATION

SPECTRUM'S DESIGN GROUP AND V&V GROUP CONDUCT A FORMAL DESIGN REVIEW OF THE CUSTOMER'S SPECIFICATION WITH THE PARTICIPATION OF THE CUSTOMER'S DESIGN ENGINEER(S). V&V ENGINEER CHAIRS DESIGN REVIEW.

PROJECT DOCUMENTS PREPARED BY SPECTRUM TECHNOLOGIES-USA, INC. DURING PHASE 1:

VERIFICATION & VALIDATION PLAN

SOFTWARE QUALITY ASSURANCE PLAN

CONFIGURATION MANAGEMENT PLAN

CUSTOMER ORDER PROCESSING PLAN

SPECIFICATION VERIFICATION PLAN

CONCEPTUAL DESIGN REVIEW AGENDA

CONCEPTUAL DESIGN REVIEW REPORT

SPECTRUM TECHNOLOGIES®
USA, Inc.

V & V OF REQUIREMENTS PHASE (PHASE 2)

KEY ELEMENTS:

RESTATEMENT AND REFORMULATION OF CUSTOMER REQUIREMENTS--PREPARATION OF THE SYSTEM REQUIREMENTS DOCUMENT (SRD)

PARTITION OF REQUIREMENTS INTO SOFTWARE AND HARDWARE REQUIREMENTS--PREPARATION OF THE SOFTWARE REQUIREMENTS SPECIFICATION (SRS) AND THE HARDWARE REQUIREMENTS SPECIFICATION (HRS).

DESIGN GROUP PREPARES EACH DOCUMENT--V&V GROUP REVIEWS AND APPROVES EACH AND BEGINS TRACEABILITY MATRIX.

PROJECT DOCUMENTS PREPARED BY SPECTRUM TECHNOLOGIES-USA, INC. DURING PHASE 2:

SYSTEM REQUIREMENTS DOCUMENT (SRD)

SOFTWARE REQUIREMENTS SPECIFICATION (SRS)

HARDWARE REQUIREMENTS SPECIFICATION (HRS)

SPECIFICATION VERIFICATION REPORT (SVR)

TECHNICAL REQUIREMENTS TRACEABILITY MATRIX/1

SPECTRUM TECHNOLOGIES®
USA, Inc.

V & V OF DESIGN PHASE (PHASE 3)

KEY ELEMENTS:

DEVELOPMENT OF THE SOFTWARE DESIGN--THE SOFTWARE DESIGN DOCUMENT (SDD)

DEVELOPMENT OF THE HARDWARE DESIGN--THE HARDWARE DESIGN DOCUMENT (HDD), AND SYSTEM DRAWINGS.

DEVELOPMENT OF TEST AND DEDICATION DOCUMENTS

INTERIM DESIGN REVIEW

TECHNICAL REQUIREMENTS TRACEABILITY MATRIX/2

DESIGN GROUP PREPARES DESIGN DOCUMENTS AND COMMERCIAL GRADE DEDICATION PROCEDURES--V&V GROUP REVIEWS AND APPROVES EACH, PREPARES TEST PROCEDURES, AND CONTINUES TRACEABILITY MATRIX. V&V ENGINEER CHAIRS DESIGN REVIEW.

PROJECT DOCUMENTS PREPARED BY SPECTRUM TECHNOLOGIES-USA, INC. DURING PHASE 3:

SOFTWARE DESIGN DOCUMENT (SDD)
HARDWARE DESIGN DOCUMENT (HDD)
SYSTEM DRAWINGS (SD)
INTERIM DESIGN REVIEW AGENDA
INTERIM DESIGN REVIEW REPORT
ACCEPTANCE TEST PROCEDURE (HARDWARE/SOFTWARE CGD)
SOFTWARE WALKTHROUGH VERIFICATION PROCEDURE (WVP)
SOFTWARE UNIT TEST PROCEDURE (SUT)
TECHNICAL REQUIREMENTS TRACE MATRIX/3

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USA, Inc.

V & V OF IMPLEMENTATION PHASE (PHASE 4)

KEY ELEMENTS:

PREPARATION, WALKTHROUGH AND UNIT TEST OF APPLICATION SOFTWARE

COMMERCIAL GRADE DEDICATION OF COMPONENTS AND PURCHASED SOFTWARE

ASSEMBLY OF HARDWARE

INTEGRATION OF SOFTWARE WITH HARDWARE

DEVELOPMENT OF SOFTWARE ACCEPTANCE/SOFTWARE-HARDWARE ACCEPTANCE TEST PROCEDURE

DEVELOPMENT OF SEISMIC AND EMI/RFI TEST PROCEDURES

DESIGN GROUP PREPARES SOFTWARE, ASSEMBLES AND INTEGRATES SOFTWARE/HARDWARE, AND DEVELOPS SEISMIC AND EMI/RFI TEST PROCEDURES. V&V GROUP PERFORMS WALKTHROUGH VERIFICATION AND UNIT TESTS OF SOFTWARE, PREPARES SOFTWARE ACCEPTANCE/SOFTWARE-HARDWARE ACCEPTANCE TEST PROCEDURE, AND APPROVES SEISMIC AND EMI/RFI TEST PROCEDURES

PROJECT DOCUMENTS PREPARED BY SPECTRUM TECHNOLOGIES-USA, INC. DURING PHASE 4:

WALKTHROUGH VERIFICATION TEST REPORT
SOFTWARE UNIT TEST REPORT
SEISMIC TEST PROCEDURE
EMI/RFI TEST PROCEDURE
SOFTWARE ACCEPTANCE SOFTWARE-HARDWARE ACCEPTANCE TEST PROCEDURE
ACCEPTANCE (CGD) TEST REPORT

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V & V OF TEST PHASE (PHASE 5)

KEY ELEMENTS:

PERFORMANCE OF SEISMIC QUALIFICATION

TEST, EMI/RFI QUALIFICATION TEST, SOFTWARE-HARDWARE ACCEPTANCE TEST, AND SYSTEM FINAL ACCEPTANCE TEST.

FINAL DESIGN REVIEW

DESIGN GROUP AND V & V GROUP PERFORM TESTS TOGETHER, ACTING AS PERFORMER AND OBSERVER/VERIFIER RESPECTIVELY. V&V ENGINEER CHAIRS DESIGN REVIEW BY DESIGN GROUP AND CUSTOMER'S ENGINEERS.

PROJECT DOCUMENTS PREPARED BY SPECTRUM TECHNOLOGIES-USA, INC. DURING PHASE 5:

SEISMIC TEST REPORT
EMI/RFI TEST REPORT
SOFTWARE-HARDWARE ACCEPTANCE TEST REPORT
SYSTEM FINAL ACCEPTANCE TEST REPORT
TRACEABILITY MATRIX
VERIFICATION AND VALIDATION REPORT
QUALIFICATION TEST REPORT
CONFIGURATION MANAGEMENT REPORT
CERTIFICATE OF CONFORMANCE
INSTRUCTION MANUAL
SOFTWARE MANUAL

SPECTRUM TECHNOLOGIES®
USA, Inc.

V & V OF INSTALLATION AND TEST PHASE (PHASE 6)

KEY ELEMENTS:

SPECTRUM CONDUCTS A TRAINING PROGRAM FOR CUSTOMER OPERATION, MAINTENANCE AND ENGINEERING PERSONNEL.

SPECTRUM PROVIDES FIELD ENGINEERING COVERAGE OF INSTALLATION

SPECTRUM PROVIDES OVERSIGHT/WITNESSING OF PLANT ACCEPTANCE TESTING

CUSTOMER PREPARES INSTALLATION DOCUMENTS AND TEST PROCEDURES AND REPORTS. SPECTRUM DESIGN AND V& V GROUPS REVIEW AND PROVIDE COMMENTS ON THESE.

SPECTRUM TECHNOLOGIES®
USA, Inc.

V & V OF OPERATION AND MAINTENANCE PHASE (PHASE 7)

KEY ELEMENTS:

SYSTEM IS OPERATED AND MAINTAINED IN ACCORDANCE WITH SPECTRUM PREPARED INSTRUCTION MANUAL AND CUSTOMER'S PROCEDURES.

SURVEILLANCE OF PROBLEM REPORTS, SUPPLIER BULLETINS, CUSTOMER NOTIFICATIONS, NRC BULLETINS, ETC.

SPECTRUM PROCESSES AND COMMUNICATES ANY INFORMATION REGARDING PROBLEMS ENCOUNTERED IN THEIR APPLICATIONS OR OTHERS AS IDENTIFIED (PART 21)

SPECTRUM PROVIDES ADVICE AND COUNSEL UPON REQUEST BY CUSTOMER.

SPECTRUM TECHNOLOGIES®
USA, Inc.

SUMMARY

SPECTRUM CONDUCTS THE FURNISHING OF CLASS 1E SYSTEMS IN STRICT ACCORDANCE WITH IEEE-7.4.3.2 (1993) AND IEEE-1012(1986) AND OTHER GOVERNING STANDARDS AND SPECIFICATIONS. PROCESS HAS SUCCESSFULLY DELIVERED SEVERAL SYSTEMS THAT HAVE BEEN STARTED UP AND LICENSED WITH NO KNOWN PROBLEMS TO DATE.

SPECTRUM TECHNOLOGIES®
USA, Inc.

DEVELOPMENT OF CLASS 1E

SOFTWARE BASED COMPUTER SYSTEMS

AT

SPECTRUM TECHNOLOGIES-USA, INC.

COMMERCIAL GRADE DEDICATION

WILLIAM R. WILLIS

VICE PRESIDENT-QUALITY ASSURANCE

SPECTRUM TECHNOLOGIES®
USA, Inc.

COMMERCIAL GRADE DEDICATION

FIVE STEPS:

1. ITEM SELECTION
2. VENDOR/VENDOR DATA BASE EVALUATION
3. INSPECTION
4. TESTING
5. OPERATIONAL SURVEILLANCE

STANDARDS AND CODES:

EPRI GUIDELINE NP5652 FOR UTILIZATION OF COMMERCIAL GRADE ITEMS IN NUCLEAR SAFETY RELATED APPLICATIONS

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SELECTION (STEP 1.)

1. ESTABLISH REQUIREMENTS FOR COMMERCIAL ITEM
2. IDENTIFY CRITICAL CHARACTERISTICS FOR ITEM
3. IDENTIFY ITEM(S) SUITABLE FOR TASK
4. ITEM(S) TRACK RECORD FOR PERFORMANCE, RELIABILITY
5. SUPPLIER REPUTATION/TRACTABILITY
6. JUDGED LONGEVITY OF SUPPORT BASE
7. AVAILABILITY OF DESIGN TOOLS (FOR SOFTWARE ITEM)

133 WALL STREET, SCHENECTADY, N.Y. 12305 • TEL: 518-382-0056 • FAX: 518-382-0283

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VENDOR DATA BASE EVALUATION (STEP 2)

1. REVIEW VENDOR'S QA PROGRAM VS. REQTS OF 10CFR50

2. REVIEW VENDOR'S DESIGN DATA/RECORDS WITHIN PROPRIETARY CONCERNS

3. DEVELOP PROCEDURES FOR ADDITIONAL INSPECTION AND TESTING REQUIRED FOR 1E APPLICATION

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COMPONENT INSPECTION (STEP 3.)

1. VISUAL EXAMINATION

   NEW CONDITION/SEALED CONTAINER(DROP SHIPMENT)/NO VISIBLE DAMAGE OR SIGNS OF PREVIOUS USE OR REFURBISHMENT

   COMPARISON AGAINST DRAWINGS, DOCUMENTS, AND/OR OTHER IDENTICAL ITEMS

   VERIFY DIRECT TRACEABILITY TO MANUFACTURER

2. PHYSICAL EXAMINATION

   DIMENSIONS

   WEIGHT

   PHYSICAL OPERATING CHARACTERISTICS

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TESTING (STEP 4.)

1. PERFORMANCE VS. MANUFACTURER'S SPECIFIED AT BOUNDARIES

2. RADIATION/THERMAL AGING AS APPROPRIATE

3. SEISMIC, EMI/RFI TEST AS APPROPRIATE

4. RANGE TESTING/RANDOM TESTING

5. CASE TOOLS AND DATA SYSTEMS FOR DEMONSTRATION CASES SPECIFICALLY SELECTED TO BRACKET APPLICATION

6. TEST TARGET SOFTWARE, EMBEDDED SOFTWARE, FIRMWARE FOR PERFORMANCE, UNINTENDED FUNCTIONS IN ROUTINES CRITICAL TO APPLICATION

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OPERATIONAL SURVEILLANCE (STEP 5.)

1. CUSTOMER LIAISON

2. SUPPLIER REPORTS OF PROBLEMS IN OTHER (NUCLEAR AND NON-NUCLEAR) APPLICATIONS

3. LITERATURE REVIEW (INCL. ANY NRC BULLETINS)

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SUMMARY

SPECTRUM CONSERVATIVELY APPLIES ITS ESTABLISHED COMMERCIAL GRADE DEDICATION PROGRAM TO COMPUTER EQUIPMENT, PURCHASED SOFTWARE, AND DESIGN TOOLS, TO ACHIEVE FULLY COMPLIANT CLASS 1E SYSTEMS DESIGN

LICENSING IMPACT REVIEW

(1) This review is applicable to_____

IN ANSWERINC THE FOLLOWING QUESTIONS, REFER TO ATTACHMENT 4 OF APA-ZZ-00140.

(2) 10CFR 50.59 APPLICABILITY

(2.1) ☐ No Formal Safety Evaluation Required.
(Refer to Attachment 4 of APA-ZZ-00140, justify your findings in Section 7, and proceed to Section 3)

(2.2) ☐ Outside Safety Evaluation
(Attach CA-#1340 and proceed to Section 3)

(2.3) SAFETY EVALUATION SCREENING

(2.3.1)	Yes ____	No ____	A proposed change to the facility as described in the FSAR?
(2.3.2)	Yes ____	No ____	A change to procedures as described in the FSAR?
(2.3.3)	Yes ____	No ____	A test or experiment not described in the FSAR?
(2.3.4)	Yes ____	No ____	A change to the Technical Specifications?

If any question in this section is answered "Yes", complete a Formal Safety Evaluation per APA-ZZ-00140. If the answers are all "No", use Section 7.0 to provide a written evaluation why an Unreviewed Safety Question does not exist.

NOTE *Changes to the FSAR or Technical Specifications require additional processing in accordance with APA-ZZ-00108.*

(3) EQUIPMENT QUALIFICATION IMPACT REVIEW

Does this modification/change involve:

(3.1) Yes ____ No ____ An activity which involves any safety-related structure, system, equipment, or component?

If no, then mark questions 3.2 through 3.8 "N/A" and proceed to question 3.9.

(3.2) Yes ____ No ____ N/A ____ Installation of a new or modification to an existing system, subsystem, equipment or component involving the issuance of a new design specification and/or the assignment of new equipment tag numbers?

If yes, then mark question 3.3 "N/A" and proceed to question 3.4.

(3.3) Yes ____ No ____ N/A ____ An activity which will modify or change any system, equipment or component which must function in a harsh post accident environment? (LOCA, MSLB or HELB Category A or B in FSAR Table 3.11(B)-3).

If no, then mark questions 3.4 through 3.6 "N/A" and proceed to question 3.7.

FORMAL SAFETY EVALUATION COVER SHEET

1. Evaluation applicable to: CMP 92-1038

2. ☐ OUTSIDE AGENCY SAFETY EVALUATION ATTACHED
   ☒ UNION ELECTRIC SAFETY EVALUATION

   2.1 May the proposed activity increase the consequences of an accident evaluated previously in the FSAR?
   Yes _____ No X

   2.2 May the proposed activity increase the probability of occurrence of an accident evaluated previously in the FSAR?
   Yes _____ No X

   2.3 May the proposed activity increase the probability of occurrence of a malfunction of equipment important to safety evaluated previously in the FSAR?
   Yes _____ No X

   2.4 May the proposed activity increase the consequences of a malfunction of equipment important to safety evaluated previously in the FSAR?
   Yes _____ No X

   2.5 May the proposed activity create the possibility of an accident of a different type than any evaluated previously in the FSAR?
   Yes _____ No X

   2.6 May the proposed activity create the possibility of a malfunction of equipment important to safety of a different type than any evaluated previously in the FSAR?
   Yes _____ No X

   2.7 Does the proposed activity reduce the margin of safety as determined in the basis for any Technical Specification?
   Yes _____ No X

3.0 SAFETY EVALUATION CONCLUSION

Based upon the results of this Formal Safety Evaluation, the change:

X Does not involve an Unreviewed Safety Question.
_____ Involves an Unreviewed Safety Question.

4.0 APPROVALS

4.1 Responsible Engineer Ed Doss Date 11/2/95

4.2 Qualified Reviewer _____ Date _____

4.3 Approved By: _____ Date _____
Department Head
As defined in APA-ZZ-00140

AGENDA

MSFIS CRITICAL DESIGN REVIEW

Agenda:

1) Introduction of Design Review Team to Spectrum's organization

2) Spectrum to provide an introduction and overview of the following:
   a) Software tools and strategies for software development and configuration management.
   b) Spectrum's software QA program
   c) Commercial Grade Dedication Program

3) Design Review Outline and Work Plan by Design Review Team. Overview of topics to be covered in the review.

4) Slot 0: Document revision thread by Spectrum - brief overview of the document change process and controls to include the following:

   a) Anomoly Report
   b) Traceability Matrix
   c) Verification and Validation Report

5) Slot 1&2: Coding standards and methods
   Verify a code thread back to the logic diagram.

6) Slot 3: Commercial Grade Dedication

7) Slot 4: Failure Analysis Session

8) Slot 5&6: Testing/Test Plans/Response Time

9) Slot 7: EMI/RFI, Seismic, Environmental

10) Slot 8: Forward thread on the traceability matrix and configuration management

11) Wrap Up

DRAFT

FORMAL SAFETY EVALUATION for CMP 92-1038

1.0 Applicability

This modification is for the replacement of the Main Steam and Feedwater Isolation System (MSFIS) electronic controls.

2.0 Introduction

2.1 System Purpose

The MSFIS provides actuation relay outputs to energize or deenergize control solenoids to operate or test the plant's Main Steam Isolation Valves (MSIV) and Feedwater Isolation Valves (FIV).

2.2 Current System

The MSFIS is divided into twe actuation trains which are totally independent. Each of the two independent actuation trains monitor system inputs, and by means of logic matrices, energize or deenergize the required solenoids for the appropriate valve operations. Except for the electromechanical relays used as the final output devices, the control and logic circuitry is of a single logic solid state design.

The MSFIS accepts input signals (in the form of control conditions) from Main Control Board (MCB) switches (such as Slow Open, Slow Close and Manual Fast Close), MSFIS Test Panel rotary test switches, from Engineering Safety Feature Actuation System (ESFAS) output relays and from valve limit switches.

2.3 Replacement System

The new MSFIS replacement will be an Allen Bradley (A-B) Programmable Logic Controller (PLC) provided by Spectrum Technologies-USA, Inc. (SP) that will perform the same logic as the current system design. The new system will be comprised of a triple redundant logic in the two different trains or separation groups. The Solid State Protection System (SSPS) or Reactor Protection System (RPS) will still input the ESFAS signals, and the Main Control Board switches will still be inputted to the MSFIS cabinets. The same actuation output relays will still be utilized, too. The man-machine interface for operators and maintenance technicians will be very similar to the existing configuration, except, the PLC status indication and coincidence logic test functions will be provided in addition. The PLC status will be provided by MCB annunciation.The coincidence logic test functions will accomplished on the MSFIS test panel. Thus, this modification is a digital to digital conversion.

SP is a 10CFR50 App B supplier and has performed commercial grade dedication (CGD) on the hardware and software. The software and hardware CGD ensure that the off-the-shelf A-B components can provide adequate confidence that the safety function can be achieved by testing to verify critical characteristics.

The software CGD will require assessment of the software functional performance as compared to specifications, the manufacturer's QA program, and the manufacturer's product performance record. Additionally, testing to check specific requirements per the manufacturer's QA program and perform a formal documented decision process to define software acceptability will be required. Finally, the dedicated software will be placed under configuration management.

SP has provided a high quality product for nuclear safety related applications at different plants. Likewise, UE's MSFIS application will be of a high quality design for a couple reasons:

---- The software has undergone the Verification and Validation process of IEEE Standard 1012 (1986). SP has experience with an established software lifecycle process which conforms to IEEE 7-4.3.2 (1993). The V&V process has assured that both the hardware and software have been reviewed for no timing or interface problems.

---- The MSFIS's limited complexity allows for more complete testing which adds to the system's reliability. In fact, the modular design of the PLC software allows 100% testing of all possible input combinations.

---- Allen-Bradley is a proven and experienced vendor in the PLC area of control equipment. In fact, the processors and input/output modules utilized for this application have been in field use in sufficient numbers to estimate the MTBF from operations data. The resulting MTBFs calculated by A-B is 0.3-2.5 10EE6 hrs.

---- The new system has been reviewed for diversity and hardware has been added as required. The FIVs have a diverse backup if a common mode software failure exists by the Main Feedwater Control Valves receiving the same Feedwater Isolation signal to isolate the feedwater lines. However, the MSIVs do not have a diverse backup for common mode software failures (See attached Defense in Depth Analysis). As a result, this design will include a switch to manually fast close the MSIVs at the MSFIS cabinets to isolate the Steam Generators and prevent an uncontrolled blowdown of more than one Steam Generator per the safety analysis. The system is triple redundant and each PLC has an external watchdog timer.

----The probability of common mode failures will be reduced through design features that simplify maintenance. Self-test features will verify the health of the processor, input and output, and software. Failed components will be annunciated.

2.4 Reason for Change

In order to minimize plant trips and increase the reliability of the electronic circuitry for the MSFIS, the electronic controls are being replaced with the PLC and associated input/output cards. A single failure outside of the common mode software failure in any of the logic channels will not cause nor prevent a failure of the system to perform its safety function.

The diversity provided by manual actuation avoids the risk of common mode failure due to undetected PLC software errors. As a result of the high quality established throughout the equipment design process and diversity provided, the common mode failure possibility is reduced to a very low probability.

2.5 Failure Modes and Effects Affects Analysis (FMEA)- see attached.

2.6 References

Spectrum Technologies -
Proposal - #9300247
System Requirements Design - #SRD9400700/001

UE Design Specification - J-1065

3.0 Effects on the Accidents Evaluated as the Design Basis

3.1 May the proposed activity increase the consequences of an accident previously evaluated in the FSAR ?

a. The following design basis accidents rely upon FIVs and/or MSIVs to close and mitigate their consequences:

i. Feedwater system malfunction that result in an increase of feedwater flow -- FIVs
ii. Inadvertent opening of a steam generator relief or safety valve --FIVs,MSIVs
iii. Steam system piping failure --FIVs,MSIVs
iv. Loss of non-emergency AC power --FIVs
v. Loss of normal feedwater --FIVs
vi. Feedwater system pipe break --FIVs,MSIVs
vii. Steamline break in Area 5 --MSIVs
viii. SGTR --MSIVs
xi. SB LOCA --FIVs

No design basis accidents will be affected by this design change since the same logic as currently exists will be performed by the new system replacement, thus, the radiological consequences will not change.

b. The new system response time will be enveloped by the current 5 second stroke time. The valves normally operate in approximately 3 seconds with 2 seconds available for MSFIS. The MSFIS response time will be within 500 msec.

c. The new system could produce a software common mode failure for a single failure. However, this failure has a very low probability of occurring based upon the inherent quality of the design and diversity provided (see Section 2.3 above).

d. A common mode failure situation could possibly exist, even though the failure mode is highly unlikely, if both separation groups had their PLCs (3 per train - six total) malfunction at the same time. However, a diverse means of isolating the feedwater lines currently exists with the ability of the Main Feed Control Valves to close on a Feedwater Isolation signal. The MSIVs do not have a diverse means of isolating their respective steam lines if a common mode software failure occurs. As a result, this modification will provide a means to manually close the valves at the MSFIS cabinets and mitigate any effects. The operators will be alerted of the failure conditions via MCB annunciators of any PLC logic channel failures and via MCB indicators of plant conditions. Thus, the accident consequences are not increased for this failure mode.

e. The operator's ability to adequately respond to an accident are not hindered by the human-machine interface design added as a result of this modification. Training will be provided to the technicians, engineers and operators on the new features of the system prior to installation. There are not more consequential effects due to the human-machine interface design.

3.2 May the proposed activity increase the probability of occurrence of an accident evaluated previously in the FSAR?

a. The new system will perform functionally to the same degree as the current system since it will perform the same logic, receive the same inputs, and produce the same outputs. At the same time, the new system will operate with increased reliability because the system has more reliable components and a triple redundant logic scheme. See Section 2.5 above - FMEA. Since the system does rely on software, assurance has been made that the software is of a high quality. Thus, the probability of malfunction will not be increased.

b. Operator interface with the new system will be similar to the current system without any increased burden. During normal operation, the new system will perform similar to the existing system permitting operator inputs at the MCB and receiving the appropriate valve actions. During abnormal conditions, such as a common mode software failure coincident with an MSIV closure accident event, the operator will have to close the MSIVs at the MSFIS cabinets. Therefore, this will not increase any probability of the accidents analyzed.

c. The new system will be compatible with the installed environment (ie. temperature, humidity, seismic and electromagnetic). The equipment will be qualified seismically in accordance with the SNUPPS seismic spectra profile. The equipment will be qualified for electromagnetic interference concerns in accordance with EPRI document TR-102323 - EMI Guideline (International Standard 801 Parts 2-6) and and will meet the EPRI EMI limiting practices.

3.3 May the proposed activity increase the probability of occurrence of a malfunction of equipment important to safety evaluated previously in the FSAR?

a. As stated above in 3.2, the new system will be qualified environmentally and seismically to not cause any increase in the probability of occurrence of malfunction of safety equipment. Proper grounding will be available.

b. The operators will be alerted to system malfunctions through annunciation. The current system has a status output for each MSIV and FIV valve on the ESF Status Panel which will be maintained. In addition, an isolated Plant Annunciator interface will provide a MSFIS Channel Failure plant annunciator window for both trains.

c. Software common cause failures have been evaluated in Section 3.1.d.

d. The electrical load of the new A-B equipment and existing 48 vdc actuation relays will be less than existing equipment .

e. The new system will not require any additional cooling over the existing equipment.

3.4 May the proposed activity increase the consequences of a malfunction of equipment important to safety evaluated previously in the FSAR?

a. For the reasons stated in 3.1 through 3.3 the proposed activity will not increase the consequences of a malfunction of equipment important to safety.

b. The new system has the same failure mode upon loss of power as the current system and behaves similarly upon power restoration. A loss of power will not result in a MSFIS actuation.

c. Any resets or repowering of the equipment will reset the processor which initiates a new scan cycle, whereby, the inputs are all read, the logic is performed, and outputs written to.

d. The human-machine interface will not introduce new failure modes different from the existing system.

e. The Safety Analysis Report bounds the consequences of b,c, & d above.

4.0 Potential for Creation of a New Type of Unanalyzed Event

4.1 & 4.2 May the proposed activity create the possibility of an accident or malfunction of equipment important to safety of a different type than any previously evaluated in the FSAR ?

a. The new system performs the same logic as the existing system for the same accidents, but with added reliability because of the triple redundant logic. If a PLC fails in a given train, that logic will revert to a 2 out of 2 logic from 2 out of 3 logic. The failure modes and effects assessment indicates no new types of failure modes are generated that will cause different types of accidents than previously presented in the FSAR.

b. The common mode failure situation as explained in Section 3.1.d is different than the equipment malfunctions evaluated in the FSAR, however, a diverse means of operation will exist for this malfunction. The Defense in Depth Analysis attached supports this position. Sufficient indication, diverse from the MSFIS and procedural guidance from Operation's procedure, exist for the operator to take manual actions to mitigate the transients involved in Callaway's accident analysis. The probability is low for an accident or transient coupled with a common mode software failure that does not fail into the preferred state.This position was found acceptable by the NRC as documented in Commonwealth Edison Zion Plant's Eagle 21 SER.

c. The new equipment will not create any new EMI environmental problems nor be impacted by the existing environment to cause a different type of malfunction than previously evaluated.

5.0 Impact on the Margin of Safety

a. The new system will not reduce the margin of safety as defined in the basis for any Tech Spec.

b. The new system response time for any given valve will not exceed the required time.

c. The MSFIS does not contain any analog channels, and therefore, no channel trip accuracies are impacted.

6.0 Safety Evaluation Conclusion

As a result of this evaluation, no unreviewed safety question exists.

7.0 10CFR50.59 Report Summary

Modification, CMP 92-1038A, replaces the existing Main Steam & Feedwater Isolation System electronics with a new digital upgrade. Based upon the review above no unreviewed safety question exists.

DEFENSE in DEPTH ANALYSIS for CMP 92-1038

As stated in the Formal Safety Evaluation, a common mode software failure situation could exist if both trains of Programmable Logic Controllers (PLCs) have a simultaneous software malfunction and/or fault. This would prevent the operator from manually closing the FIVs or MSIVs from the Main Control Board when required. Diversity is one method of addressing this concern. If adequate diversity exists or can be added to the nuclear power generating station design, then computer/PLC diversity is not necessary.

Per the FSAR Sect. 10.4.7, "In the event of a secondary cycle pipe rupture inside the containment, the main feedwater control valve (MCFV) (and associated bypass valve) provide a diverse backup to the FIV to limit the quantity for high energy fluid that enters the containment through the broken loop. For emergency closure, either of two separate solenoids, when deenergized, will result in valve closure. Electrical solenoids are energized from separate Class 1E sources."

A diverse means to operate the MSIVs is not available currently like for the FIVs. Thus, each MSFIS train cabinet will have an MSIV closure switch for each valve to allow operator manual action in the event of a common mode software failure coincident with an accident requiring an MSIV closure. Control room indicators for steamline pressure, containment pressure, SI, SG level, etc. will be available to permit manual mitigation of the accidents listed on the Formal Safety Evaluation in the unlikely event of a common mode failure. Based upon the high quality established throughout the equipment design process and diversity provided , the possibility of a common mode failure will be reduced to a very low probability. Thus, in the event of a common mode software failure, sufficient indication diverse from the MSFIS and procedural guidance from Operations procedures exist for the operator to take manual actions to mitigate the transients involved in Callaway's accident analysis. In MSIV cases, where backup protective functions or manual operator actions are credited, Callaway has not performed detailed analytical modeling to determine if the response time of these functions/actions is consistent with that of the primary function being replaced. In fact, in most cases the modeled response times would not be met. However, these manual actions are considered backups , and the probability is low for an accident or transient coupled with a common mode failure.

Design Documents

Formal Safety Evaluation - 10CFR50.59 (see attached)

Defense in Depth Assessment (see attached)

Third-Party Design Review

Due to the MSFIS modification being UE's first major digital upgrade, UE management has elected to utilize a third-party to review the design in accordance with the required standards and guidelines. Data Refining Technologies was selected to perform this critical design review in a joint task team with UE.

A site visit to Spectrum Technologies USA, was made on November 7, 8, and 9. The design review agenda entailed reviewing the SP's design documents and verifying the digital design will perform its intended safety function. No significant concerns were found in this review.

Site Acceptance Test

After the MSFIS equipment design, implementation, and testing phases are completed at Spectrum Technologies USA, shipment to the UE - Callaway site will be made. Callaway site personnel will perform the installation and operation phases of the V&V process per IEEE Std 1012 (1986). After installation the equipment will have a site acceptance test/system retest performed to verify operation of the MSFIS is per design.