Docket Nos.: 50-390
and 50-391

OCT 23 1986

APPLICANT: Tennessee Valley Authority

FACILITY: Watts Bar Nuclear Plant, Units 1 and 2

SUBJECT: SUMMARY MEETING TO DISCUSS RTD BYPASS SYSTEM REMOVAL AT THE WATTS BAR NUCLEAR PLANT, UNITS 1 and 2

On October 14, 1986, representatives of NRC, TVA, and Westinghouse met to discuss TVA's proposal to remove the RTD bypass system at Watts Bar and replace it with a thermowell mounted RTD in conjunction with the Eagle 21 digital protection system. Enclosure (1) is a list of attendees and Enclosure (2) is a copy of TVA's presentation.

The meeting began with an overview of the planned modification of TVA and a discussion of the proposed licensing schedule. Westinghouse then presented a detailed plan of the mechanical and electronic modifications to the plant, and a discussion of the validation and verification program for the new system. TVA closed the meeting requesting feedback on the proposed licensing schedule presented during the meeting.

During a subsequent telecon with TVA, the staff stated that, if TVA meets their submittal schedule and provides full and complete responses in their submittals, the staff will make every attempt to meet the proposed licensing schedule. The staff reminded TVA that, although TVA issues have a high priority within the agency, Sequoyah reviews take precedence over Watts Bar. The staff stated it was concerned that the review of Sequoyah restart matters (scheduled during the same time frame of the RTD Bypass Modification Review) may impact TVA's submittal and NRC's review schedule of the modification. However, the staff believes that its review will not be the critical path item to implementation of this modification provided TVA meets their proposed schedule.

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T.J. Kenyon, Project Manager
PWR Project Directorate #4
Division of PWR Licensing-A

Enclosure: As stated

cc:
w/o encl

F. Rosa	J. Knight
S. Weiss	J. Wilson
J. Mauck	F. Burrows
P. Gill	H. Balujian
M. Branch	

*SEE PREVIOUS CONCURRENCE

PWR#4/DPWR-A	*EICSB/DPWR-A	PWR#4/DPWR-A
TKenyon/rad	FRosa	BJYoungblood
10/ /86	10/ /86	10/ /86

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Enclosure (1)

RTD Bypass Removal/Eagle 21 Modification

Name	Organization	Title
D. Kulisek	TVA-WBNP	Reg. Lic. Manager
J. Erpenbach	TVA-WBNP	Manager of Projects
B.J. Youngblood	NRC-PAD#4	Director
T. Kenyon	NRC-PAD#4	Watts Bar Project Mgr
F. Rosa	NRC-EICSB	Chief
J. Knight	NRC-PWR-A	Section Leader
J. Mauck	NRC-PWR-A	Elec. Engineer
C. Vitalbo	Westinghouse I&C	Senior Engineer
J. Beard	TVA-WBN	Consultant
F. Burrows	NRC-PWR-A	Elec. Engineer
E. Ennis	TVA-WBND	Plant Manager
H.Balukjian	NRC-PWR-A-RSB	Nuclear Engineer
S. Weiss	NRC/EICSB	EICSB Section Leader
R. Etling	Westinghouse Project Manager	
D. Posey	TVA-WBND	Mechanical Engineer
J. Craig	TVA-WBNP I&C	Instr. Engineer
D. Record	TVA-WBNP	RTDBE Project Manager
D. Adomaitis	Westinghouse NTSD/I&CS	I&CAE Manager
G. Lang	Westinghouse I&C Systems Licensing	Elec. Engineer
J. Sechrist	Westinghouse Nuclear Safety Engineer	
L. Erin	Westinghouse I&C Systems Licensing	Elec. Engineer
B. Rice	Westinghouse RTDBE Tech Lead	Senior Engineer
B. Gergos	TVA-WBNP	License Engineer
L. Tomasic	Westinghouse Nuclear Safety	TVA Lic. Engineer
P. Gill	NRC-EICSB	Elec. Engineer
M. Branch	NRC Resident Inspector	Watts Bar

MEETING SUMMARY DISTRIBUTION

* With enclosure

OCT 23 1986

*Docket File ←
NRC PDR
L PDR
NSIC
PRC System
PWR#4 Reading File
TKenyon
M. Duncan
OGC
J. Partlow
E. Jordan
B. Grimes
ACRS (10)

NRC Participants
B.J. Youngblood
T. Kenyon
F. Rosa
J. Knight
J. Mauck
F. Burrows
H. Balukjian
S. Weiss
M. Branch

bcc: Licensee & Service List

ENCLOSURE (2)

MEETING WITH THE NRC STAFF
OCTOBER 14, 1986
BETHESDA, MD.

RTD BYPASS REMOVAL AND EAGLE 21 ELECTRONICS MODIFICATION TO WATTS BAR UNIT 1

EXECUTIVE SUMMARY

WATTS BAR RTD BYPASS ELIMINATION/EAGLE 21 UPGRADE

INTRODUCTION

Improved electronics technology and accumulated operating plant experience has led to the development of a new design to replace the RTD Bypass system for Reactor Coolant System (RCS) temperatures. The benefits attributable to the RTD Bypass Elimination Modification fall into three primary areas: Reduced Radiation Exposure, Improved Availability, and Reduced Maintenance. As a result of removing the Bypass piping, Radiation Exposure to personnel can be reduced on the average by 80 manrems per outage. Availability can be improved by avoiding forced outages attributed to the present RTD Bypass System. Maintenance Requirements can be reduced by eliminating hardware (e.g. valves and snubbers) which require periodic maintenance and inspection.

For the Watts Bar design, the EAGLE 21 family of qualified microprocessor based equipment is being utilized. The advantages of the EAGLE 21 electronics include: built-in-diagnostics to reduce trouble shooting time, self calibration to eliminate rack drift, and automatic testing to reduce surveillance test time.

The licensing effort which is ongoing for the South Texas Project Qualified Display Processing System (QDPS) includes the RTD Bypass Elimination Modification utilizing EAGLE 21 family electronics. This commonality should expedite the Watts Bar RTD Bypass Elimination licensing process.

BACKGROUND

The first generation of Westinghouse Pressurized Water Reactors were provided with single point temperature measurement instrumentation in both the hot and cold leg reactor coolant piping. Contrary to expected operating conditions, initial plant testing indicated that temperature gradients of 7 to 9 degrees F existed through the cross section of the hot leg. The single point hot leg temperature measurement in use was subject to significant error, thereby requiring a conservative uncertainty be used in the calculation of protection setpoints and in the overall plant safety analyses. This was viewed as an inappropriate use of available plant margin, and efforts were undertaken to improve the design. The solution to the non-uniform hot leg temperatures was the Resistance Temperature Device (RTD) Bypass System which obtained a representative sample of hot leg fluid and measured its' temperature. Cold leg temperature streaming was not found due to the mixing action of the Reactor Coolant Pump. The RTD Bypass System has three hot leg scoops located 120 degrees apart around the circumference of the hot leg to draw a representative sample of Reactor Coolant. This sample is piped to a manifold containing direct immersion RTDs which measure the coolant temperature. The same setup is applied to the cold leg, except that there is a single connection to the cold leg piping without a flow scoop.

The RTD Bypass System is an effective method of accurately measuring RCS temperatures. However, the system piping location within the RCS loop compartment creates a significant source of radiation exposure during plant maintenance. As with all piping systems, there is associated operability testing, periodic maintenance, and, unfortunately, unexpected unavailability.

Westinghouse has developed a new design which is an improvement over the existing RTD Bypass System. The alternative is known as the RTD Bypass Elimination Modification.

DESCRIPTION

MECHANICAL

The mechanical modification removes the valves, piping, snubbers, and supports associated with the RTD Bypass System and replaces them with thermowell mounted fast response RTDs which are installed directly into the Reactor Coolant Pipe. Mechanical modifications begin with the removal of the existing Bypass piping at each connection point to the Reactor Coolant System. The existing hot and cold leg penetrations are machined to accept RTD thermowells. On the hot leg, the scoop tip will be removed to allow the thermowell to protrude directly into the flow stream. The thermowell is installed inside the modified scoop and the RTD is installed within the thermowell. The crossover leg connection is capped and an additional cold leg boss, thermowell and RTD are added as an installed spare.

ELECTRICAL

For the Watts Bar design, the EAGLE 21 family of qualified microprocessor based equipment is utilized to electronically average three hot leg RTD's to obtain a single hot leg average temperature (T HAVE). The system used to calculate T HAVE is referred to as the Temperature Averaging System (TAS). Since the Temperature Averaging System (TAS) becomes part of the Thermal Overpower and Overtemperature Protection System (Delta T / T AVG Protection) replacing the hot leg temperature signal previously measured by the bypass manifold RTD, all Delta T / T AVG Protection racks are being modernized.

The modular design of the EAGLE 21 electronics permits installation of the digital hardware into existing process racks. One rack per Protection Channel Set is configured primarily for Delta T / T AVG Protection. All analog hardware with the exception of the field termination blocks will be removed from these racks and be replaced with EAGLE 21 digital elcctronics.

Verification and Validation (V&V)

Westinghouse introduced the concept of microprocessor based Protection Systems in the early 1970's on the Integrated Protection System (IPS) which was part of the RESAR 414 standard plant. The software verification program conducted on the prototype is documented in WCAP-9153 "414 Integrated Protection System Prototype Verification Program", and WCAP-9739 "Summary of Westinghouse Integrated Protection System Verification and Validation Program".

Building upon the experience gained in performing software Verification and Validation on the IPS prototype and implementing the "lessons learned" from the Nuclear Regulatory Commission (NRC) audit process, a much improved V&V program was defined for the South Texas Qualified Display Processing System (QDPS). The "Design, Verification, and Validation Plan for the South Texas Project Qualified Display Processing System" was transmitted to the NRC in a letter from M. R. Wisenburg (Manager of Nuclear Licensing South Texas Project), to G. W. Knighton (NRC Chief Licensing Branch No. 3), dated September 24, 1985. To date, three NRC audits have been conducted on the South Texas QDPS V&V process with favorable results. A final closeout audit is scheduled for the week of November 17, 1986.

The V&V process to be implemented for Watts Bar RTD Bypass Elimination Modification is the same as the one conducted on the South Texas QDPS, modified only to the extent of refining the process to resolve NRC audit comments. Furthermore, the independent chief verifier assigned to the Watts Bar V&V program is the same individual who is currently completing the South Texas QDPS V&V program. It should also be noted that approximately 25% of the software modules required for the Watts Bar project have already been verified as part of the South Texas V&V program.

TRANSIENT ANALYSIS

Westinghouse will perform evaluations and analyses as necessary to verify that the accuracy and time response of the RTD/thermowell/EAGLE 21 system are acceptable.

The primary impacts of the Watts Bar RTD Bypass Elimination Modification on the safety analyses result from the increase in RTD temperature uncertainty and response time associated with the replacement of the Rosemount RTDs currently used in the bypass loop with Rdf RTDs which will be installed in the thermowells.

The Rdf RTDs have a temperature uncertainty of 1.2 degrees F. This is an increase of 0.5 degrees F over the Rosemount RTD temperature uncertainty of 0.7 degrees F. However, all FSAR Chapter 15 safety analyses conducted for Watts Bar have included an additional 2.5 degrees F temperature uncertainty. As a result, the additional temperature uncertainty of 0.5 degrees F for Rosemount RTDs is bounded and does not impact the overall system accuracy or the safety analyses. In addition, it should be noted that the change from Foxboro analog modules to EAGLE 21 equipment will, at a minimum maintain, and most likely improve the overall system accuracy.

The response time of the present Watts Bar RTD Bypass System is approximately 6.0 seconds. In comparison, the Fast Response Thermowell RTD System response time is 6.5 seconds. A 7.0 second response time will be conservatively assumed in the safety analyses.

LICENSING DOCUMENTATION

The Watts Bar FSAR Chapters to be revised are as follows:

Chapter 5 "Reactor Coolant System" - is revised to include a design description of the RTD Bypass Elimination Modification.

Chapter 7 "Instrumentation and Controls" - is revised to include the EAGLE 21 electronics within the Reactor Trip System.

Chapter 15 "Accident Analysis" - is updated to incorporate the effects of the RTD Bypass Elimination Modification into the Accident Analysis.

Chapter 16 "Technical Specifications" - is revised to include any effects of the RTD Bypass Modification.

MEETING WITH THE NRC STAFF

OCTOBER 14, 1986

BETHESDA, MD.

RTD BYPASS REMOVAL AND EAGLE 21 ELECTRONICS MODIFICATION TO WATTS BAR UNIT 1

PURPOSE OF THE MEETING:

* PROGRAMMATIC, MANAGEMENT OVERVIEW OF MODIFICATION

* DISCUSS LICENSING STRATEGY TO SUPPORT MODIFICATION PRIOR TO FUEL LOAD FOR WATTS BAR UNIT ONE

* TECHNICAL OVERVIEW OF MODIFICATION

AGENDA

* INTRODUCTION — DAVE KULISEK, MGR, WBN REGULATORY LICENSING — 1:00 - 1:15
  - PURPOSE
  - AGENDA

* OVERVIEW OF MODIFICATION — JERRY ERPENBACH, MGR, WBN PROJECT MANAGEMENT — 1:15 - 1:45
  - BACKGROUND
  - OPERATING EXPERIENCE
  - PROPOSED MODIFICATION
  - BENEFITS

* LICENSING — DAVE KULISEK, MGR, WBN REGULATORY LICENSING — 1:45 - 2:15
  - COMPARISON WITH PREVIOUS LICENSING
  - FSAR AND TECHNICAL SPECIFICATION CHANGES
  - SCHEDULE

* BREAK — 2:15 - 2:30

* SYSTEM DESCRIPTION — 2:30 - 3:30
  - MECHANICAL - SENSOR CHANGES — RICK ETLING, W RTDBE PRODUCT MANAGER
  - CHANNEL DIGITAL ELECTRONICS — CARL VITALBO, W EAGLE 21 TECHNICAL LEAD
  - SOFTWARE V & V PROGRAM — GLEN LANG, W RTDBE/EAGLE 21 LICENSING
  - SAFETY ANALYSIS — JIM SECHRIST, W TRANSIENT ANALYSIS

* SUMMARY — DAVE KULISEK, MGR, WBN REGULATORY LICENSING — 3:30 -

OVERVIEW OF MODIFICATION

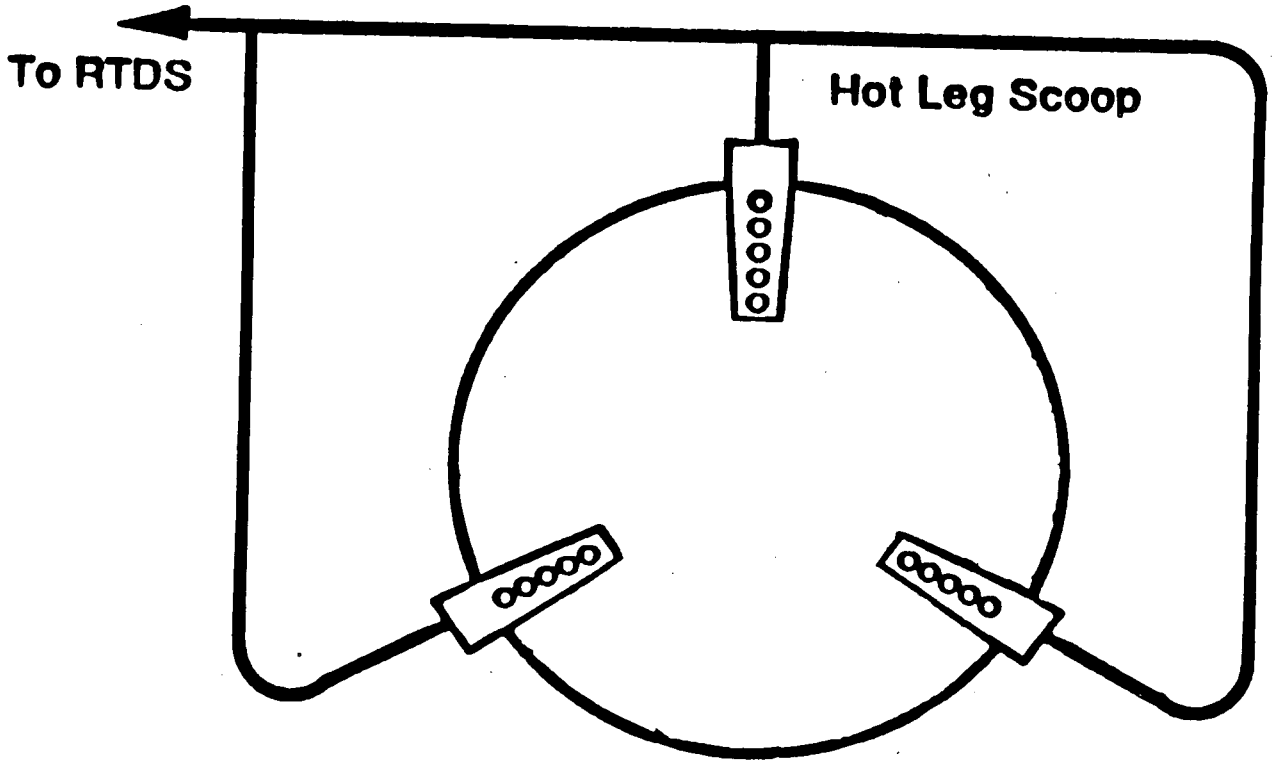
RTD BYPASS ELIMINATION

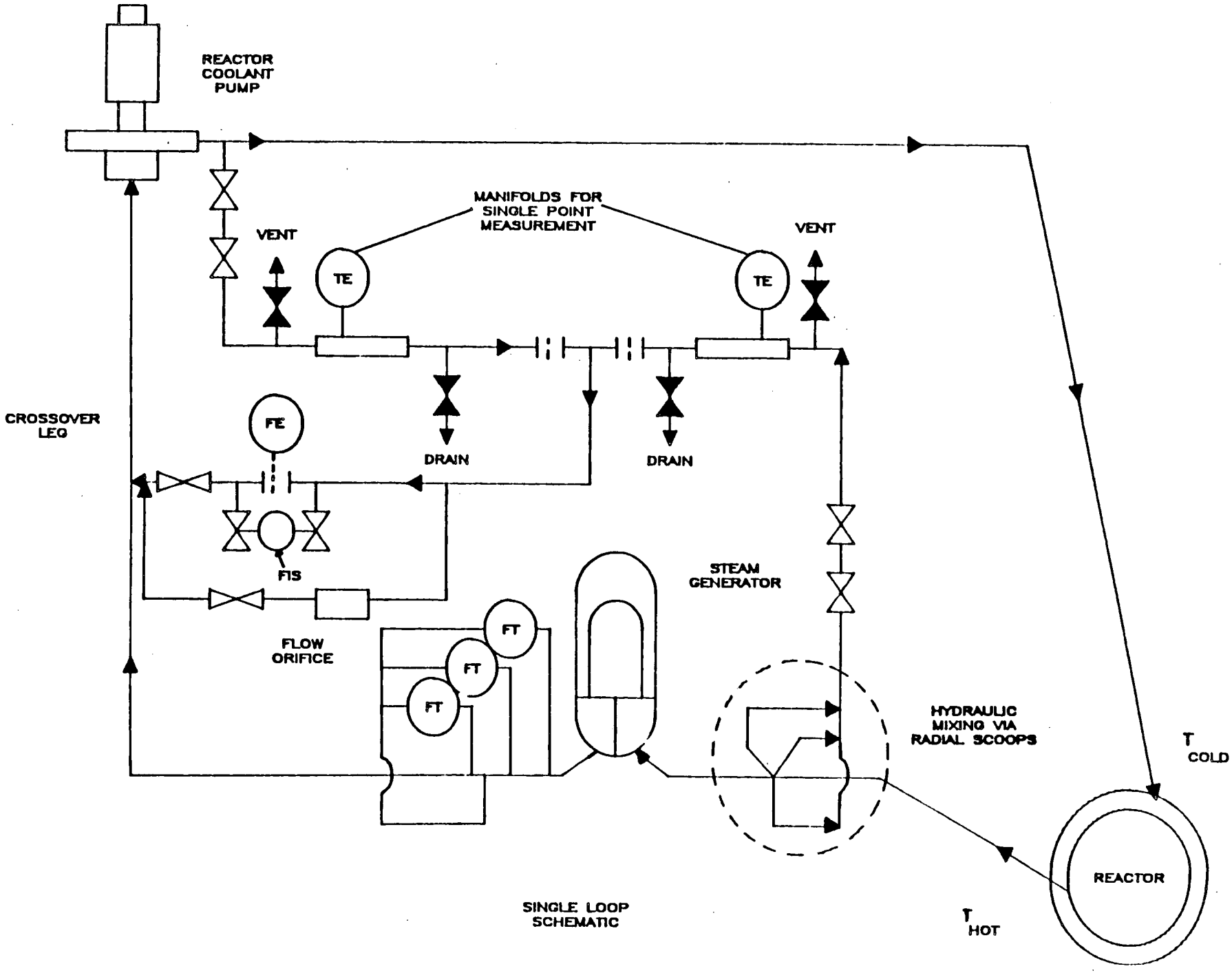
JERRY ERPENBACH

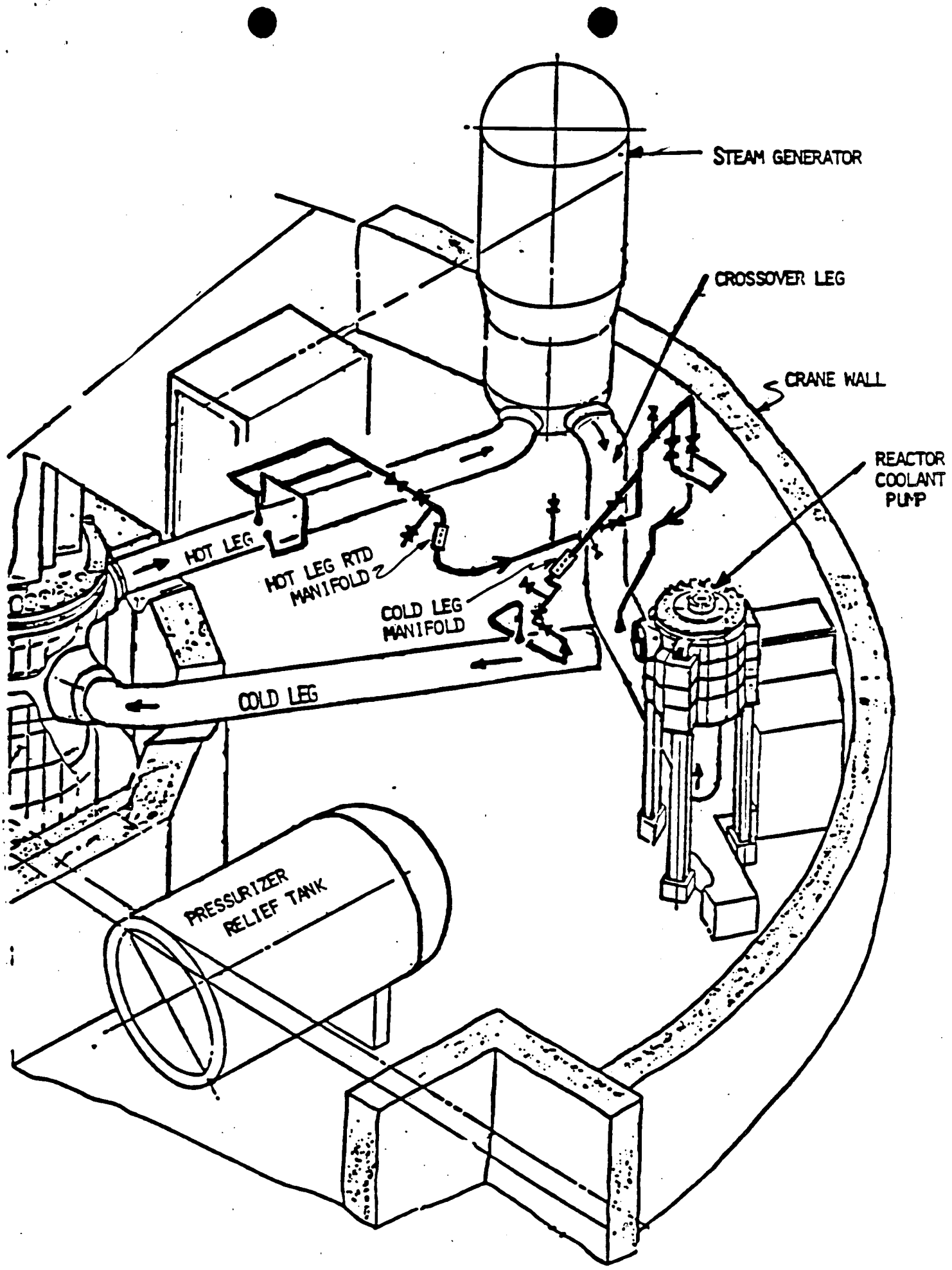
MGR, WBN PROJECT MANAGEMENT

RTD Bypass System

Sample Taps On Hot Leg




REACTOR COOLANT PUMP
MANIFOLDS FOR SINGLE POINT MEASUREMENT
VENT
VENT
TE
TE
CROSSOVER LEG
FE
DRAIN
DRAIN
FIS
STEAM GENERATOR
FT
FT
FT
FLOW ORIFICE
HYDRAULIC MIXING VIA RADIAL SCOOPS
T COLD
REACTOR
T HOT
SINGLE LOOP SCHEMATIC


STEAM GENERATOR
CROSSOVER LEG
CRANE WALL
REACTOR COOLANT PUMP
HOT LEG
HOT LEG RTD MANIFOLD
COLD LEG MANIFOLD
COLD LEG
PRESSURIZER RELIEF TANK

OPERATING EXPERIENCE WITH RTD BYPASS LOOP

- HAS BEEN VERY EFFECTIVE IN MEASUREMENT OF RCS TEMPERATURES

- SIGNIFICANT OPERATIONAL DISADVANTAGES

  - MAINTENANCE REQUIRED DUE TO LEAKAGE FROM VALVES, FLANGES, AND MANIFOLDS

  - LEAKAGES ARE SOURCES OF LIQUID AND AIRBORNE CONTAMINATION

  - FORCED PLANT SHUTDOWNS DUE TO FAILURES OF VALVE STEMS OR VALVE PACKING

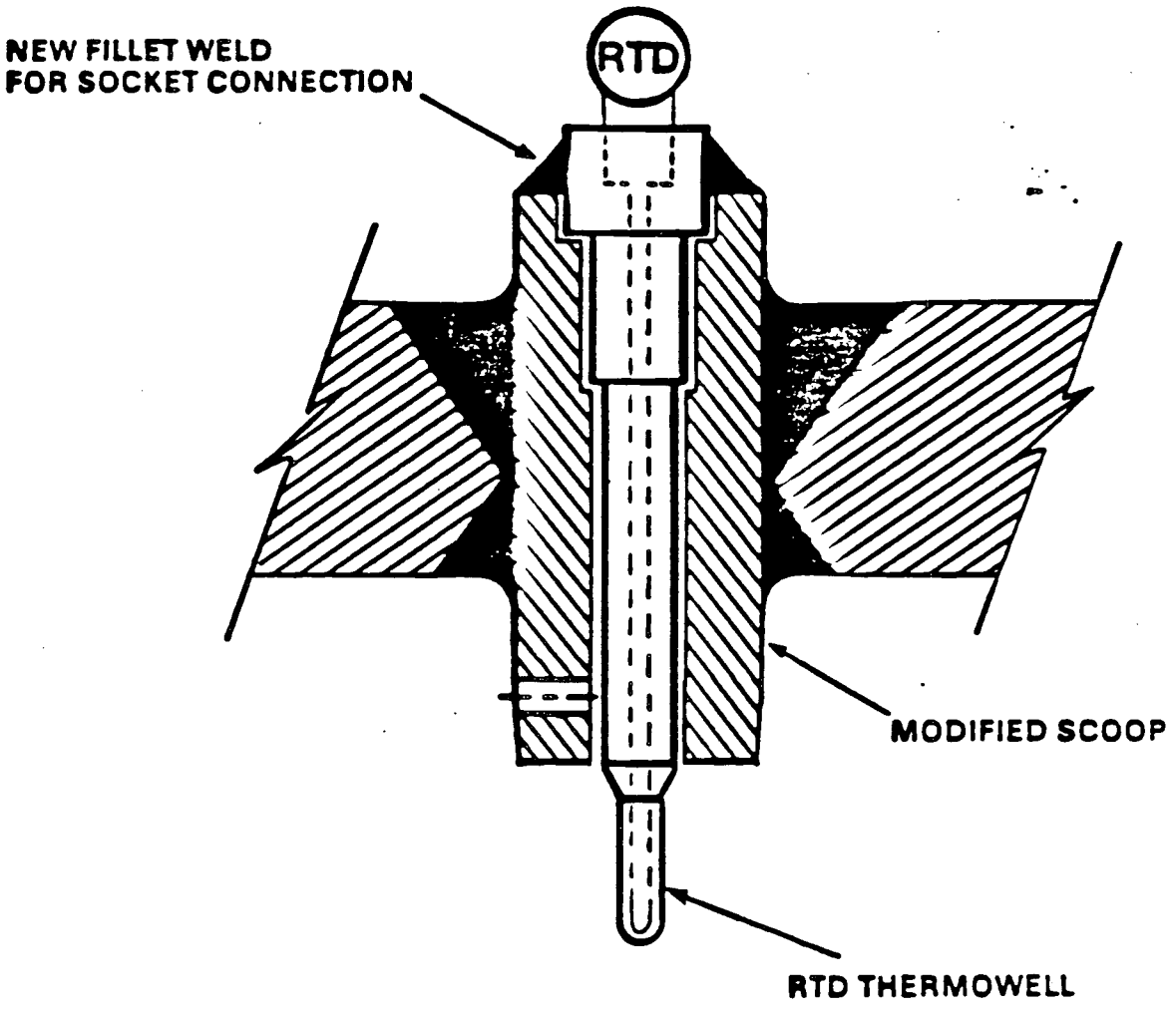
  - HIGH RADIATION EXPOSURES DUE TO CRUD TRAPS OF PIPING LAYOUT REQUIRES LOCAL SHIELDING

  - INACCESSIBILTY TO NEARBY EQUIPMENT DUE TO BYPASS LOOP PIPING, EXTENSIVE SUPPORTS, SNUBBERS, ETC

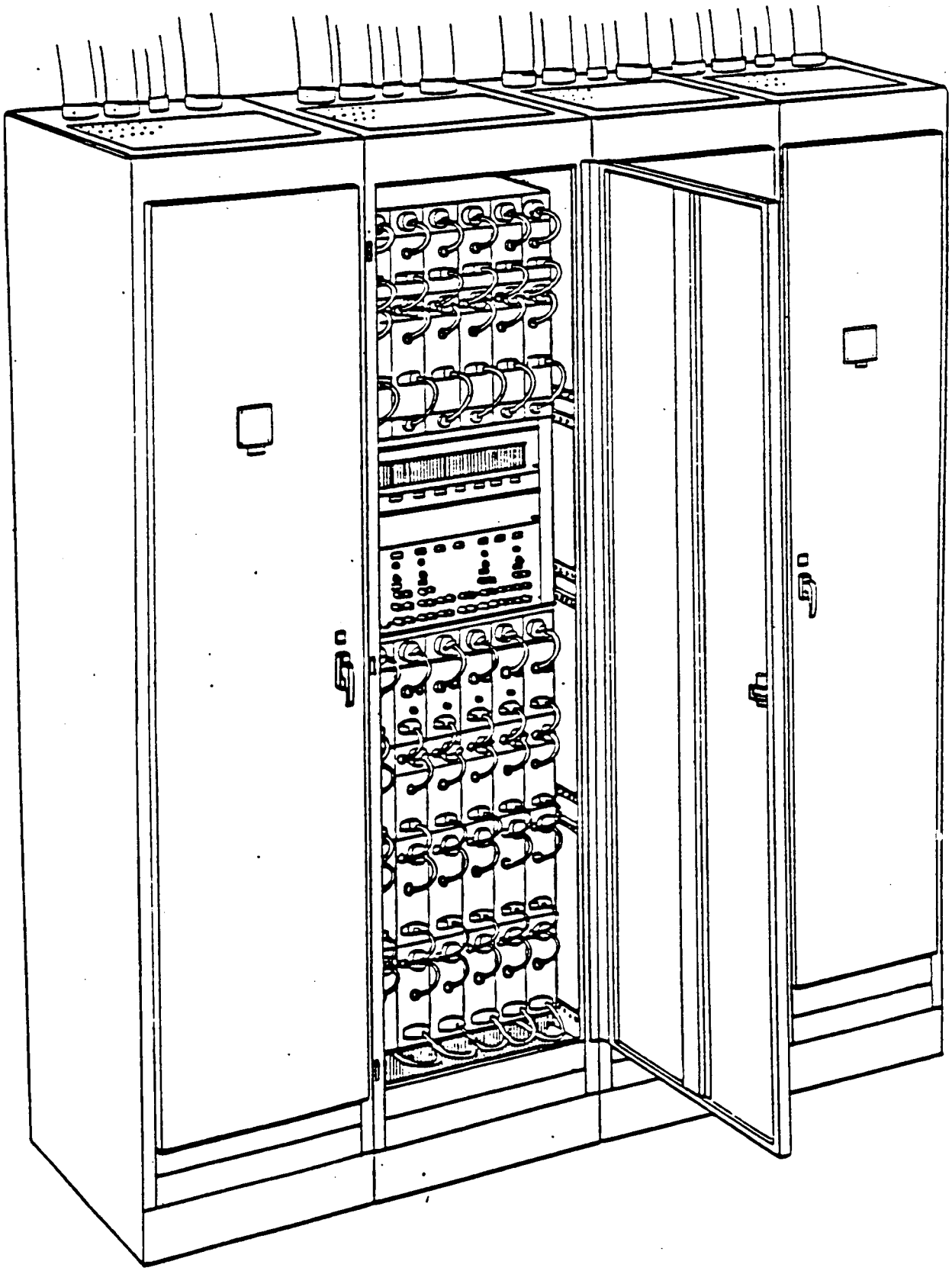
  - CALIBRATION AND MAINTENANCE OF PRESENT ELECTRONICS IS MANPOWER INTENSIVE

RTD BYPASS ELIMINATION MAJOR FEATURES

- THERMOWELL MOUNTED RTDS ARE INSTALLED IN EXISTING REACTOR COOLANT PIPE PENETRATIONS
  - ONE IN EACH HOT LEG SCOOP (TOTAL 3 PER HOT LEG)
  - ONE AT BYPASS PENETRATION TO EACH COLD LEG
- ADDITIONAL SPARE RTD INSTALLED AT NEW PENETRATION IN EACH COLD LEG
- RTD SIGNALS ARE ELECTRONICALLY AVERAGED TO PROVIDE THE THOT SIGNAL FOR USE BY PROTECTION AND CONTROL SYSTEMS
- ALL BYPASS LOOP PIPING AND SUPPORTS ARE REMOVED



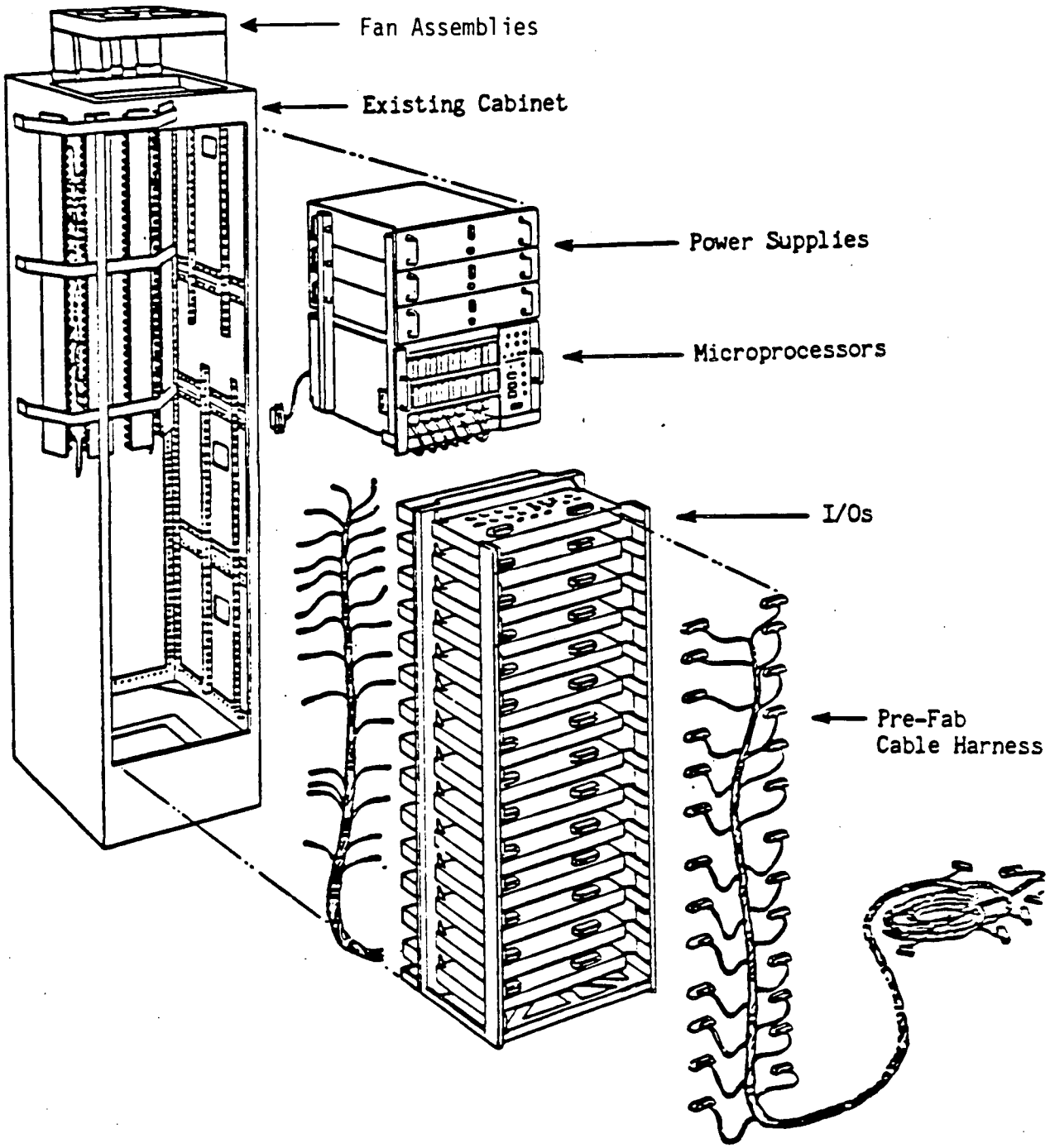
HOT LEG RTD SCOOP MODIFICATION



Existing Cabinet

EAGLE 21 MAJOR FEATURES

- MICROPROCESSOR BASED DIGITAL ELECTRONICS
- IMPROVED RELIABILITY
- IMPROVED TESTABILITY
- CHANGEOUT FROM ANALOG TO DIGITAL IS TRANSPARENT IN FORM, FIT, AND FUNCTION
- ANALOG MODULES FOR OTHER CHANNELS IN AFFECTED CABINETS ARE REPLACED WITH DIGITAL ELECTRONICS



Existing Cabinet Installation of
Eagle 21 Equipment

RTD BYPASS ELIMINATION BENEFITS

- REDUCED RADIATION EXPOSURE
  - AVERAGE OF 80 MANREM PER YEAR ATTRIBUTED TO RTD BYPASS PIPING
- REDUCED OUTAGE TIME
  - VALVE FAILURES AND SYSTEM LEAKAGE FORCES UNPLANNED OUTAGES
- REDUCED MAINTENANCE
  - REDUCED NUMBER OF MECHANICAL COMPONENTS REQUIRING INSPECTION, TESTING, AND MAINTENANCE

EAGLE 21 BENEFITS

- AUTOMATIC SURVEILLANCE TESTING
  - REDUCE TECHNICIAN TEST TIME AND TESTING ERRORS
  - AUTOMATICALLY DETERMINES IF ACCEPTANCE CRITERIA IS MET
- SELF CALIBRATION
  - MINIMIZES RACK DRIFT
  - IMPROVES RACK ACCURACY
- SELF DIAGNOSTICS
  - SIMPLIFIES TROUBLESHOOTING
  - PROVIDES IDENTIFICATION OF FAILURES AT THE PRINTED CIRCUIT BOARD LEVEL

BENEFITS OF MODIFICATION
PRIOR TO FUEL LOAD
VERSUS FIRST OUTAGE

- SUBSTANTIAL MANREM AVOIDANCE DURING PIPING REMOVAL

- FINANCIAL BENEFITS
  - FIRST CYCLE SAVINGS OF $100,000

- POTENTIAL FOR HIGHER FIRST CYCLE AVAILABILTY

LICENSING

RTD BYPASS ELIMINATION MODIFICATION

DAVE KULISEK

MGR, WBN REGULATORY LICENSING

OVERALL PROGRAM ACTIVITIES

- PROCURE AND INSTALL SYSTEM
- TECHNICIAN TRAINING
- OPERATOR TRAINING
- LICENSING
- PROCEDURE UPDATES
- PRE-OPERATIONAL TESTING

COMPARISON TO SOUTH TEXAS PROJECT

- o MECHANICAL MODIFICATION
  - SAME AS SOUTH TEXAS PROJECT
  - SER ISSUED
- o ELECTRICAL MODIFICATION
  - SAME TECHNOLOGY AS SOUTH TEXAS PROJECT (EAGLE 21 FAMILY ELECTRONICS)
  - ADDITIONAL AUTOMATIC TESTING FEATURE
- o VERIFICATION AND VALIDATION (V & V) PROGRAM ON SOFTWARE
  - SAME PROCESS AS SOUTH TEXAS PROJECT
  - ENHANCED BY FEEDBACK FROM NRC VIA SOUTH TEXAS PROJECT AUDIT REPORTS
  - SAME WESTINGHOUSE CHIEF VERIFIER
  - UTILIZES IDENTICAL AUTOMATED VERIFICATION TOOLS
  - 25% SOFTWARE COMMONALITY

FSAR MODIFICATIONS

- CHAPTER 5 - REACTOR COOLANT SYSTEM
  - REACTOR COOLANT SYSTEM PIPING
    - DESIGN DESCRIPTION
    - HOT LEG BYPASS MANIFOLD
    - COLD LEG BYPASS MANIFOLD
    - DIRECT IMMERSION RTDS
    - THERMOWELL MOUNTED RTDS IN RCS
- CHAPTER 7 - INSTRUMENTATION AND CONTROLS
  - REACTOR TRIP SYSTEM
    - SYSTEM DESCRIPTION
    - OVERTEMPERATURE DELTA T TRIP
    - OVERPOWER DELTA T TRIP
    - COOLANT TEMPERATURE SENSOR ARRANGEMENT
- CHAPTER 15 - ACCIDENT ANALYSIS
  - UNCONTROLLED BANK WITHDRAWAL AT POWER
  - UNCONTROLLED BORON DILUTION
  - LOSS OF LOAD/TURBINE TRIP
  - RCS DEPRESSURIZATION
- TECHNICAL SPECIFICATIONS
  - REACTOR TRIP SYSTEM INSTRUMENTATION
  - TIME CONSTANTS FOR OVERPOWER DELTA T AND OVERTEMPERATURE DELTA T
  - RESPONSE TIMES

OVERVIEW OF LICENSING SCHEDULE

- PHASED FSAR/TECHNICAL SPECIFICATION SUBMITTALS
- TECHNICAL PRE-MEETINGS BEFOR NRC AUDITS
- TWO NRC AUDITS ON APPLICATION OF V & V PROGRAM
- RESULTS IN JUNE 1, 1987 SER

LICENSING SCHEDULE

	OCT.	NOV.	DEC.	JAN.	FEB.	MAR.	APRIL	MAY	JUNE
1. TVA/NRC KICKOFF MTG	10/14								
2. SUBMIT FSAR CHAP 5&7 TO NRC FOR REVIEW (12 WKS ALLOCATED FOR NRC REVIEW PROCESS)			12/1						
3. SUBMIT V&V PLAN TO NRC FOR REVIEW (23 WKS ALLOCATED FOR NRC REVIEW PROCESS)			12/29						
4. COMPLETE REVIEW OF FSAR CHAP 5&7 AND PROVIDE COMMENTS TO TVA				1/12					
5. SUBMIT FSAR CHAP 15 TO NRC FOR REVIEW (9 WKS ALLOCATED FOR NRC REVIEW PROCESS)				1/26					
6. TVA/NRC FIRST AUDIT PRE-MEETING				1/26					
7. NRC AUDIT OF DESIGN PROCESS & APPLICATION OF V&V PLAN (FIRST AUDIT)					2/2				
8. RESOLVE NRC COMMENTS TO FSAR CHAP 5&7					2/23				

LICENSING SCHEDULE (CONTINUED)

	OCT.	NOV.	DEC.	JAN.	FEB.	MAR.	APRIL	MAY	JUNE
9. COMPLETE REVIEW OF FSAR CHAP 15 & PROVIDE COMMENTS TO TVA					2/23				
10. ISSUE AUDIT REPORTS ON DESIGN PROCESS & APPLICATION OF V&V PLAN						3/9			
11. RESOLVE NRC COMMENTS TO FSAR CHAP 15						3/30			
12. RESPOND TO FIRST AUDIT OPEN ITEMS						3/30			
13. TVA/NRC FINAL AUDIT PRE-MEETING AND RESOLVE FIRST AUDIT COMMENTS							4/20		
14. NRC AUDIT OF TEST PROCESS & TEST RESULTS (FINAL AUDIT)							4/27		
15. ISSUE SER									6/1

SYSTEM TECHNICAL DESCRIPTION

- MECHANICAL - SENSOR CHANGES

- CHANNEL DIGITAL ELECTRONICS

- SOFTWARE V & V PROGRAM

- SAFETY ANALYSIS

RTD BYPASS ELIMINATION MODIFICATION

MECHANICAL - SENSOR CHANGES

RTD BYPASS ELIMINATION MODIFICATION

RICK ETLING

W RTDBE PRODUCT MANAGER

HOT LEG TEMPERATURE STREAMING BACKGROUND

- TEMPERATURE STREAMING: THE INCOMPLETE MIXING OF COOLANT LEAVING FUEL ASSEMBLIES AT DIFFERENT TEMPERATURES

- TEMPERATURE STREAMING FIRST DETECTED AT SAN ONOFRE AND CONNECTICUT YANKEE IN 1968

- CONFIRMED BY SUBSEQUENT TESTING AT:

  (i) R. E. GINNA

  (ii) DAMPIERRE 3

  (iii) MCGUIRE 1

PROBLEM SOLUTION

- RTD BYPASS SYSTEM DEVELOPED AND INSTALLED ON ALL SUBSEQUENT PLANTS

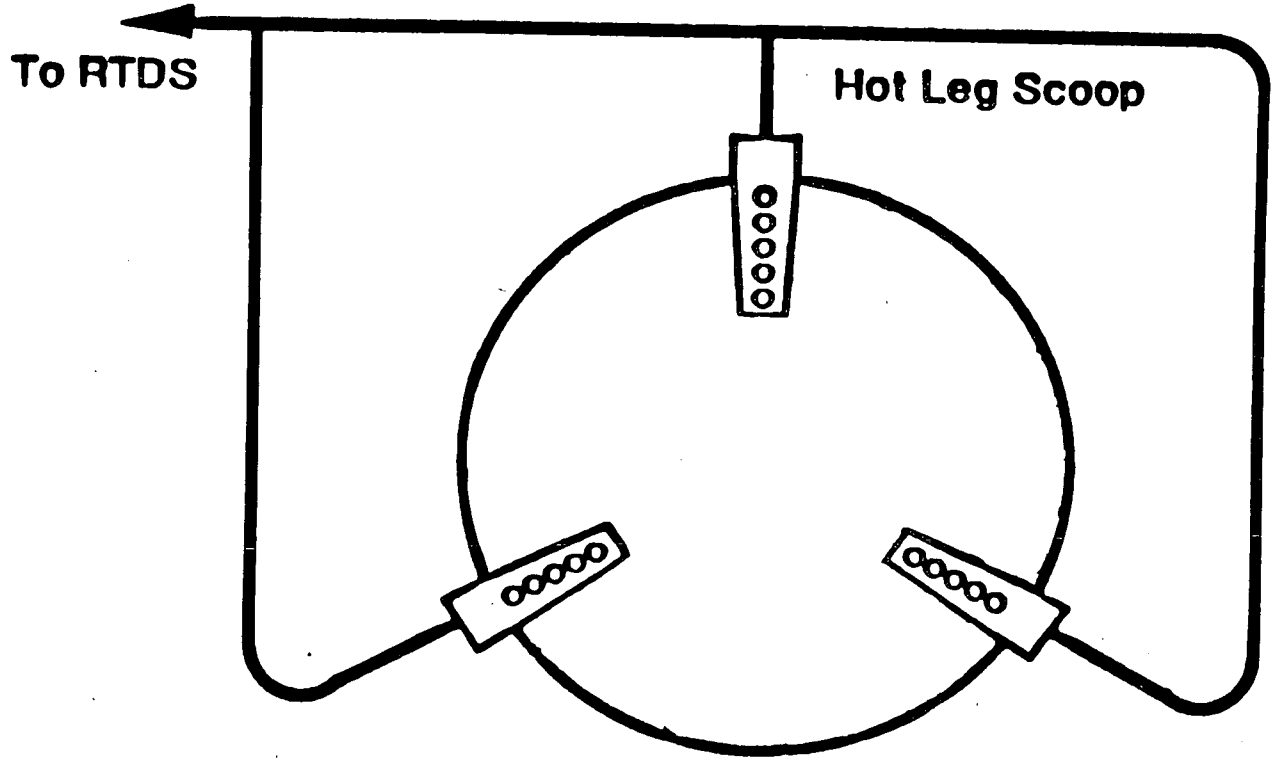
- COOLANT FROM THREE SAMPLE TAPS ON HOT LEG IS MIXED AND MEASURED WITH AN RTD IN A SMALL BYPASS PIPING LOOP AROUND STEAM GENERATORS

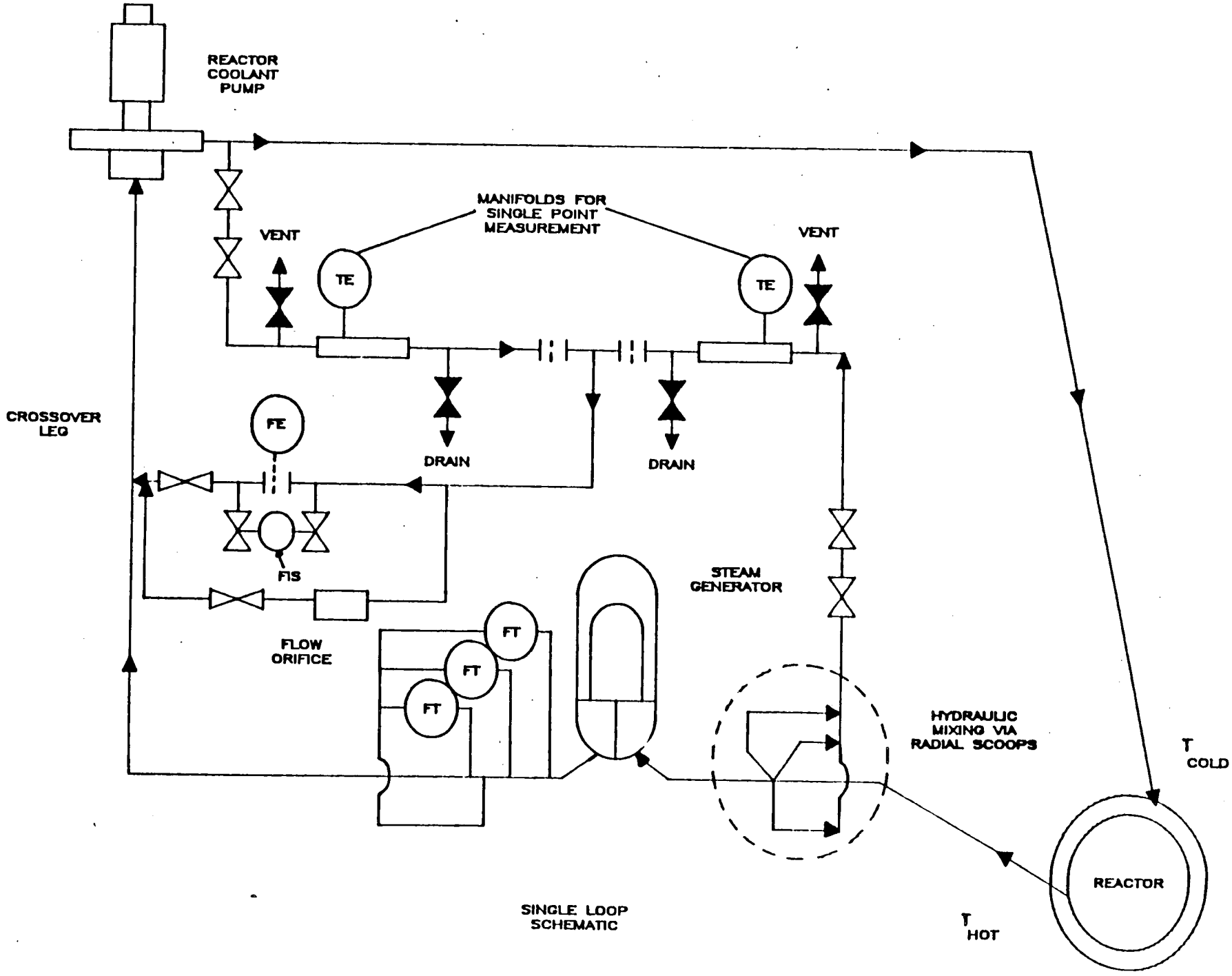
  (i) MIXED SAMPLE PROVIDES AN ACCURATE MEASUREMENT OF HOT LEG TEMPERATURE

  (ii) BYPASS LOOPS PROVIDE A MEANS OF REPLACING RTDS WITHOUT DRAINING THE RCS

RTD Bypass System

Sample Taps On Hot Leg





SINGLE LOOP
SCHEMATIC

RTD BYPASS SYSTEM OPERATION

- SYSTEM HAS BEEN VERY EFFECTIVE IN MEASUREMENT OF COOLANT TEMPERATURES

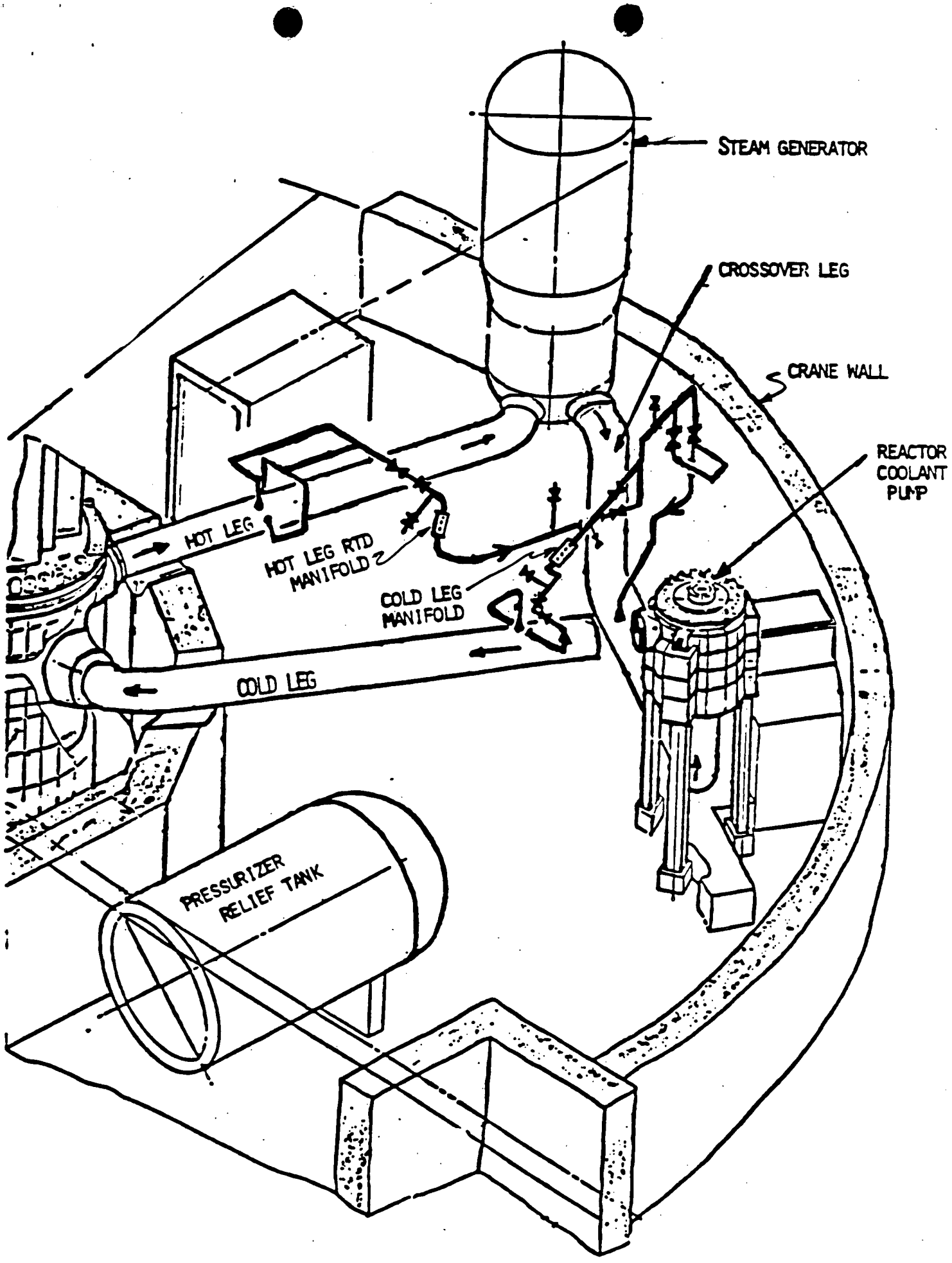
- OPERATING EXPERIENCE

  (i) LEAKAGE OF VALVES, FLANGES AND MANIFOLDS REQUIRES AREA CLEANUP FOR MAINTENANCE

  (ii) FAILURE OF VALVE STEMS OR PACKING, EITHER INTERRUPTING BYPASS FLOW OR CAUSING EXCESSIVE RCS LEAKAGE, REQUIRING A PLANT SHUTDOWN TO CORRECT

  (iii) CRUD TRAPS IN BYPASS LOOP EQUIPMENT, INCREASING RADIATION LEVELS DURING OUTAGE, NEED FOR LOCAL SHIELDING

  (iv) PIPING, SUPPORTS, SNUBBERS, INTERFERE WITH ACCESS TO OTHER COMPONENTS


STEAM GENERATOR
CROSSOVER LEG
CRANE WALL
REACTOR COOLANT PUMP
HOT LEG
HOT LEG RTD MANIFOLD
COLD LEG MANIFOLD
COLD LEG
PRESSURIZER RELIEF TANK

ALTERNATIVE TEMPERATURE MEASUREMENT SYSTEM
EMPLOYING FAST RESPONSE RTDS

- NEW SYSTEM ELIMINATES ALL BYPASS PIPING

- APPLIES FAST RESPONSE THERMOWELL MOUNTED RTD'S RECENTLY QUALIFIED FOR PROTECTION FUNCTIONS

- NEW SYSTEM ADDRESSES TEMPERATURE STREAMING

MAJOR FEATURES

- FAST RESPONSE THERMOWELL MOUNTED RTDS ARE INSTALLED IN EXISTING REACTOR COOLANT PIPE PENETRATIONS

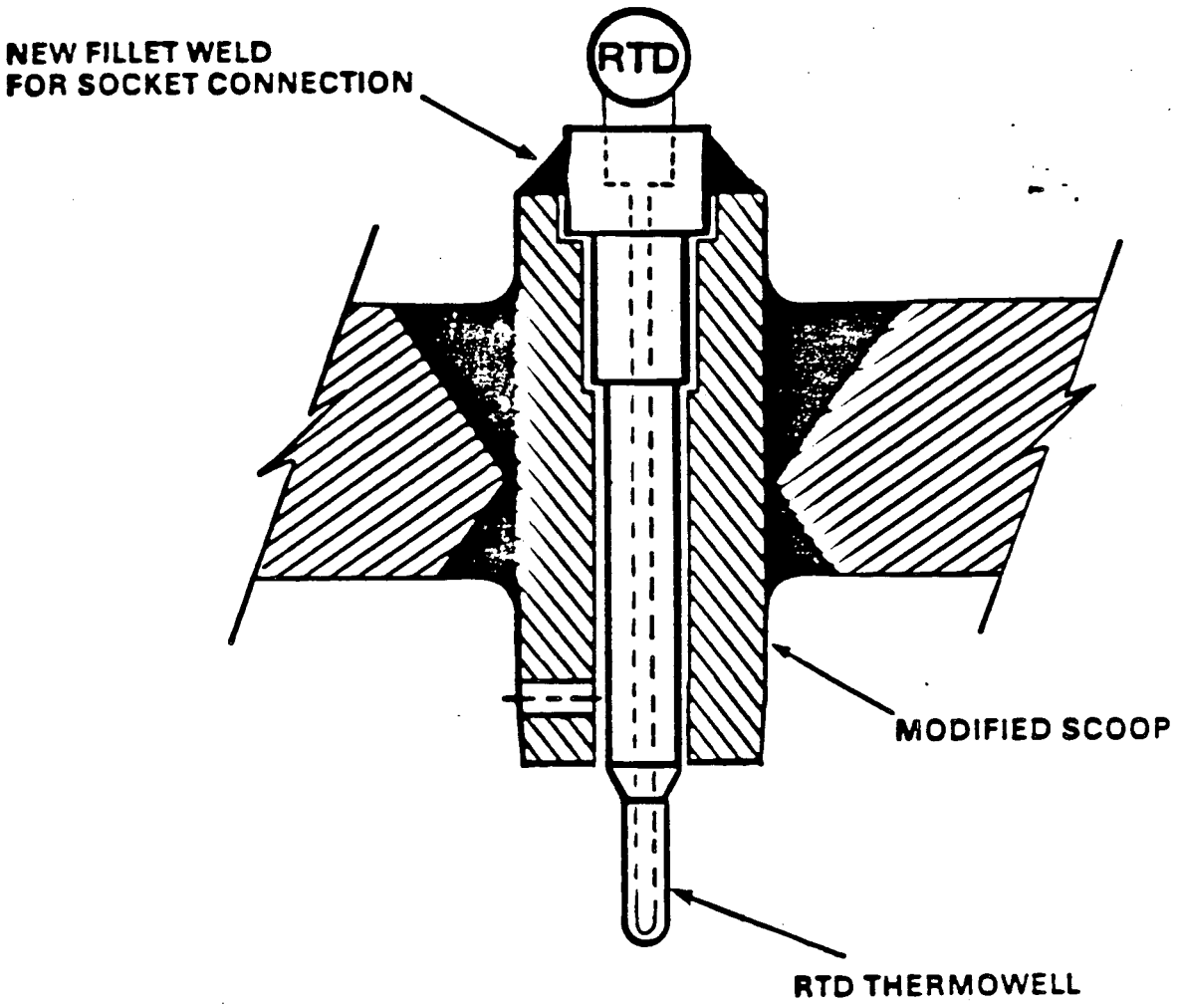
  (i) ONE IN EACH HOT LEG SCOOP (TOTAL 3 PER HOT LEG)

  (ii) ONE AT BYPASS PENETRATION TO EACH COLD LEG

- ADDITIONAL SPARE RTD INSTALLED AT NEW PENETRATION IN EACH COLD LEG

- SIGNALS FROM THE THREE HOT LEG RTDS ARE ELECTRONICALLY AVERAGED TO PROVIDE THE THOT SIGNAL FOR USE BY PROTECTION AND CONTROL SYSTEMS

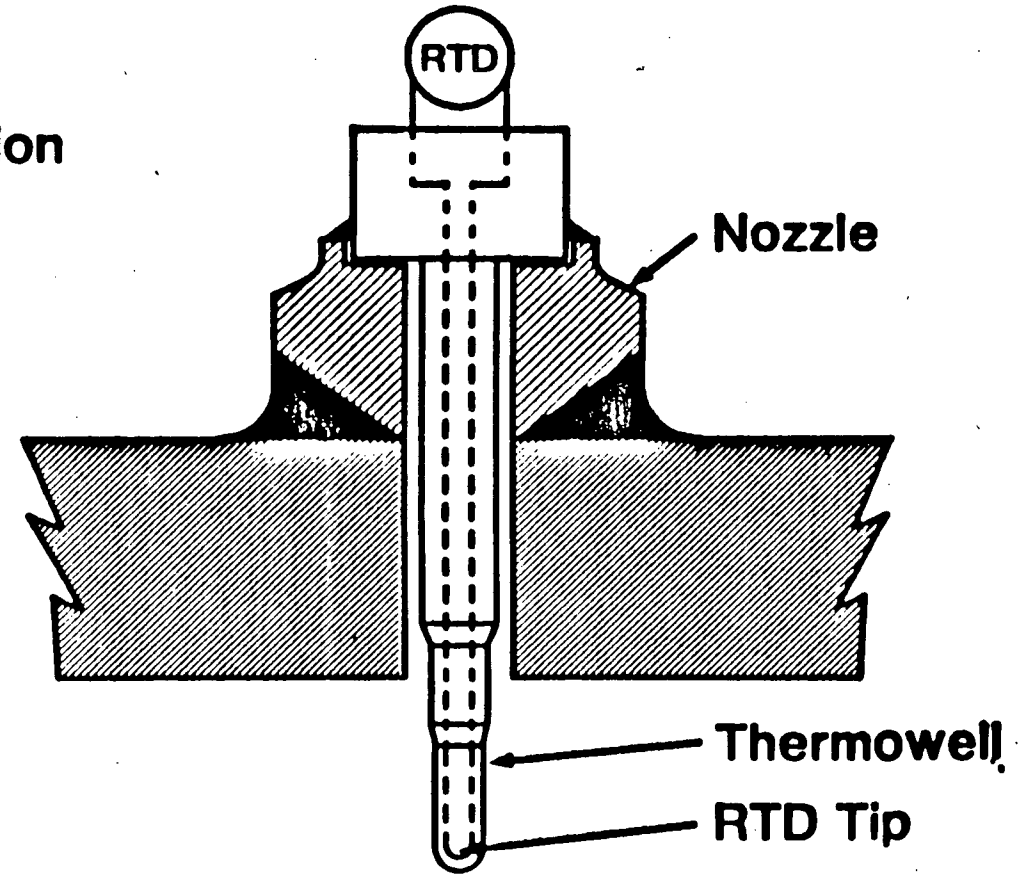
- ALL BYPASS PIPING IS REMOVED



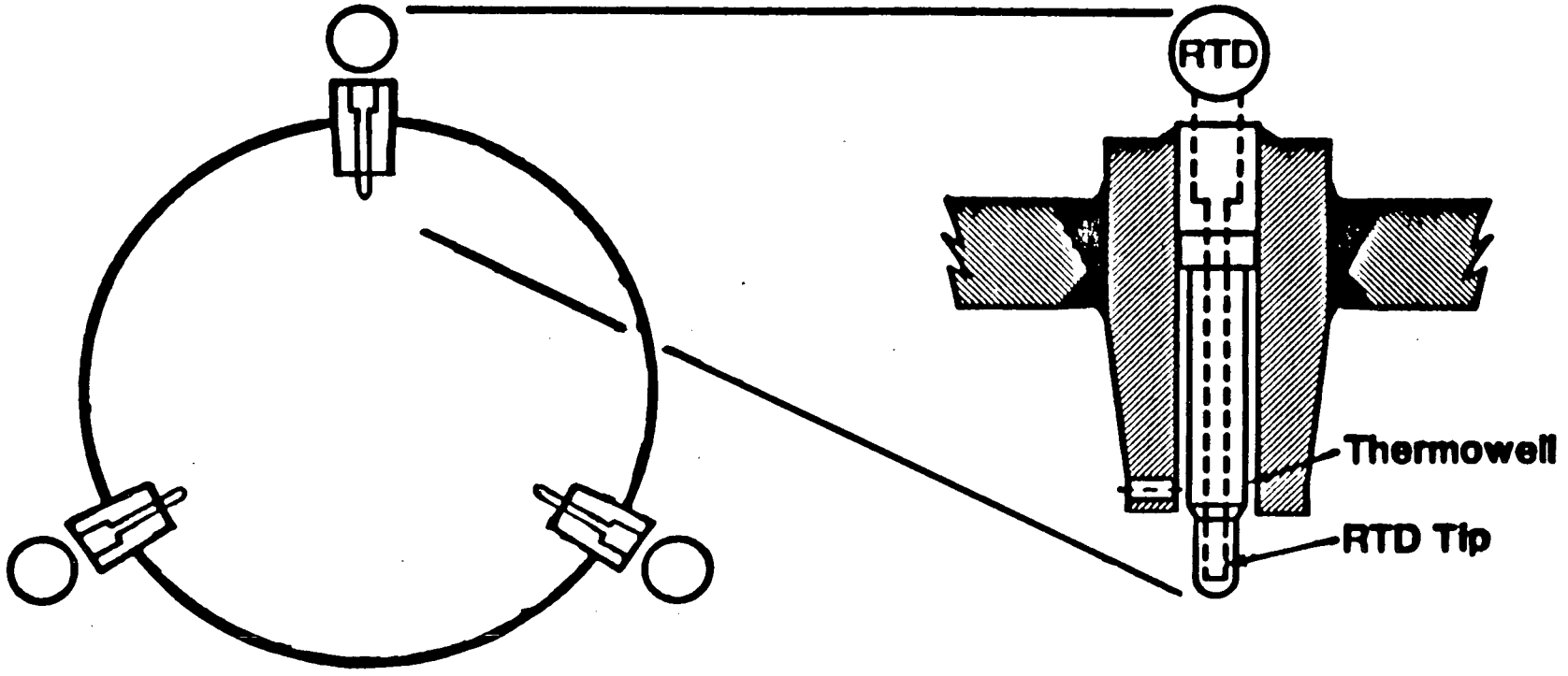
HOT LEG RTD SCOOP MODIFICATION

Cold Leg Pipe Nozzle Modification

- Machining
- Thermowell Installation
- RTD Insertion



RTD Bypass
Thermowell Insertion



WESTINGHOUSE PLANTS

INCORPORATING RTD BYPASS ELIMINATION

- MCGUIRE
- SOUTH TEXAS
- CATAWBA
- WATTS BAR
- BRYON
- BRAIDWOOD
- SHEARON HARRIS (MECHANICAL MODIFICATION ONLY)

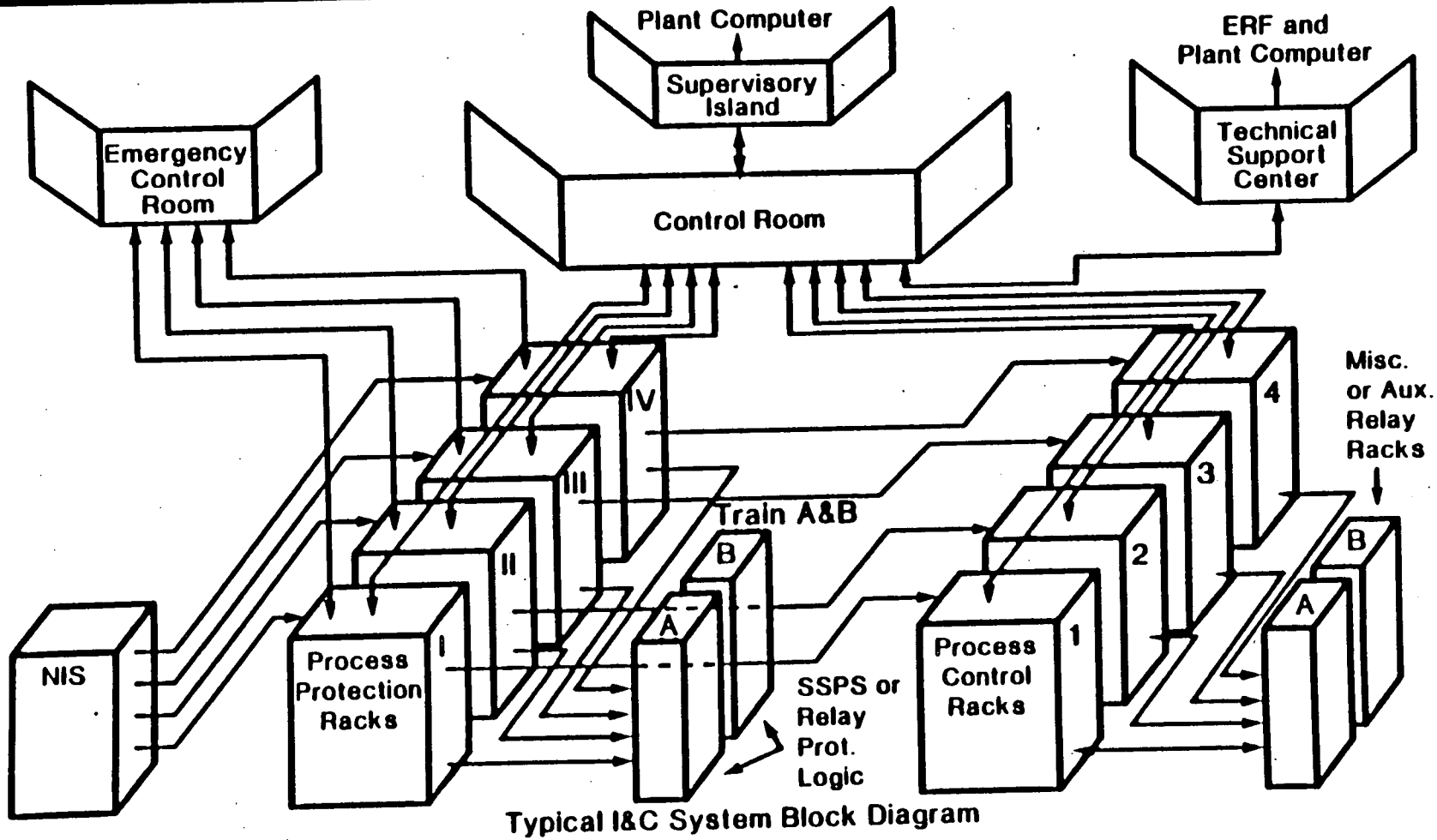
CHANNEL DIGITAL ELECTRONICS

RTD BYPASS ELIMINATION MODIFICATION

CARL VITALBO

W EAGLE 21 TECHNICAL LEAD

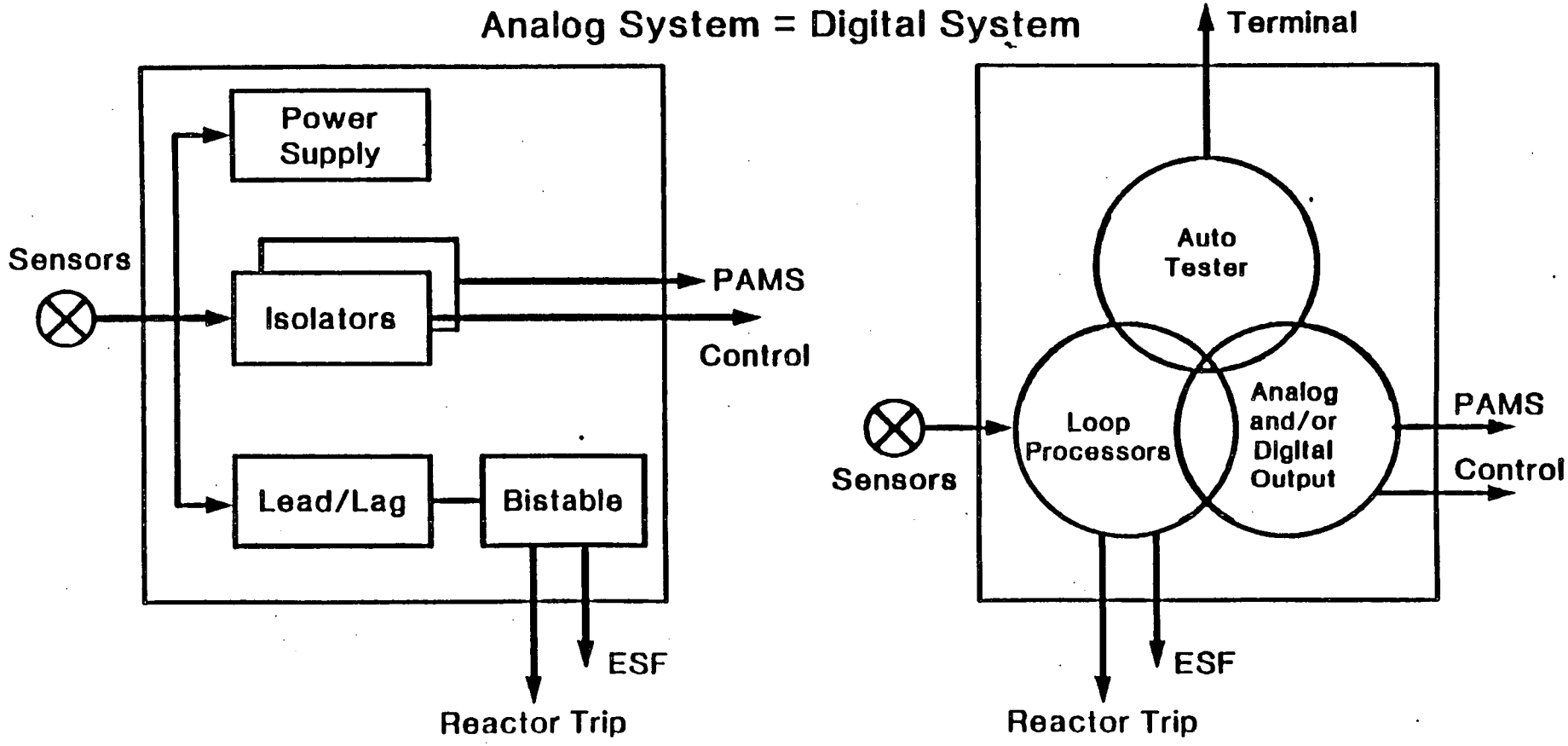
EAGLE-21 IMPLEMENTATION



Typical I&C System Block Diagram

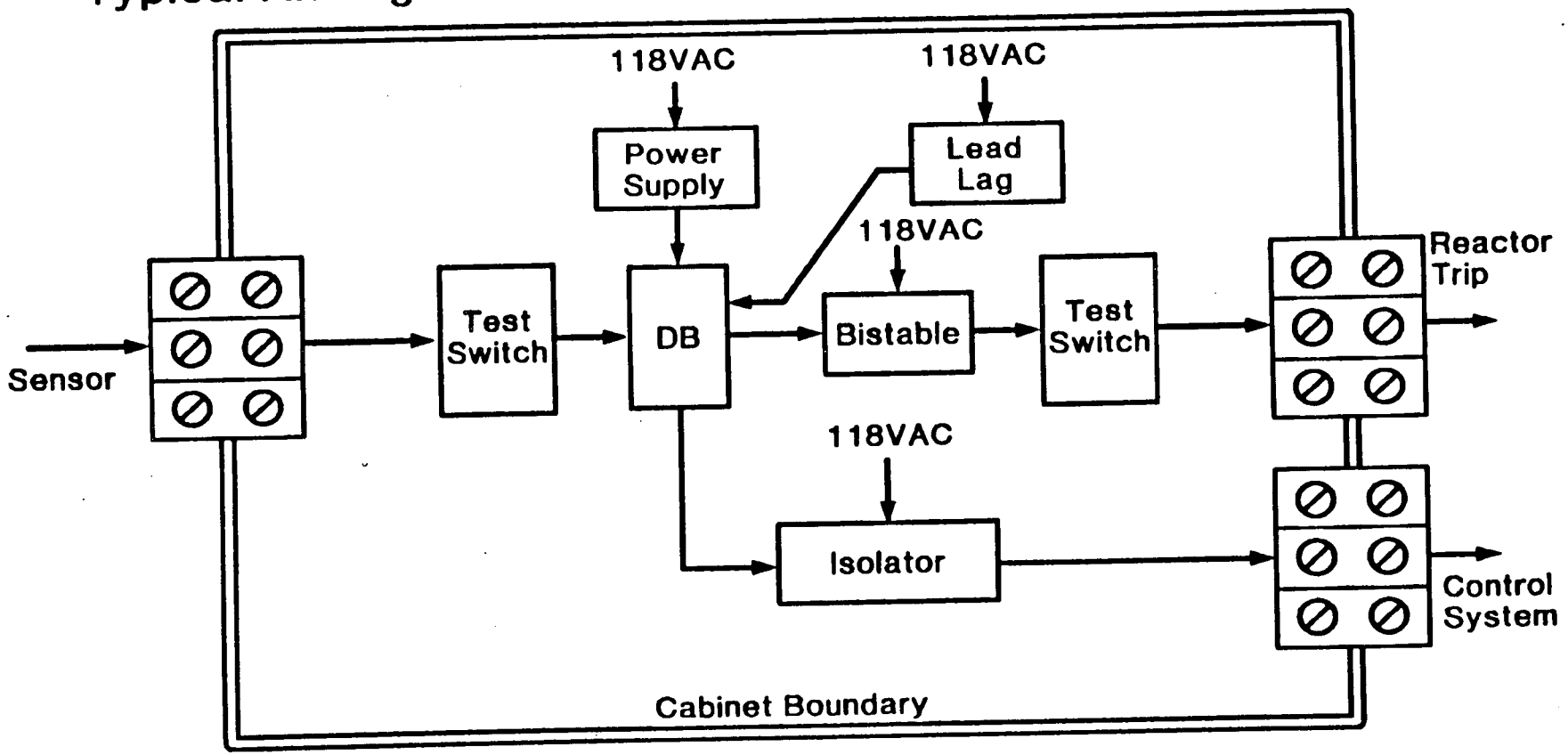
EAGLE-21
DESIGN PHILOSOPHY

- Form, fit and function replacement



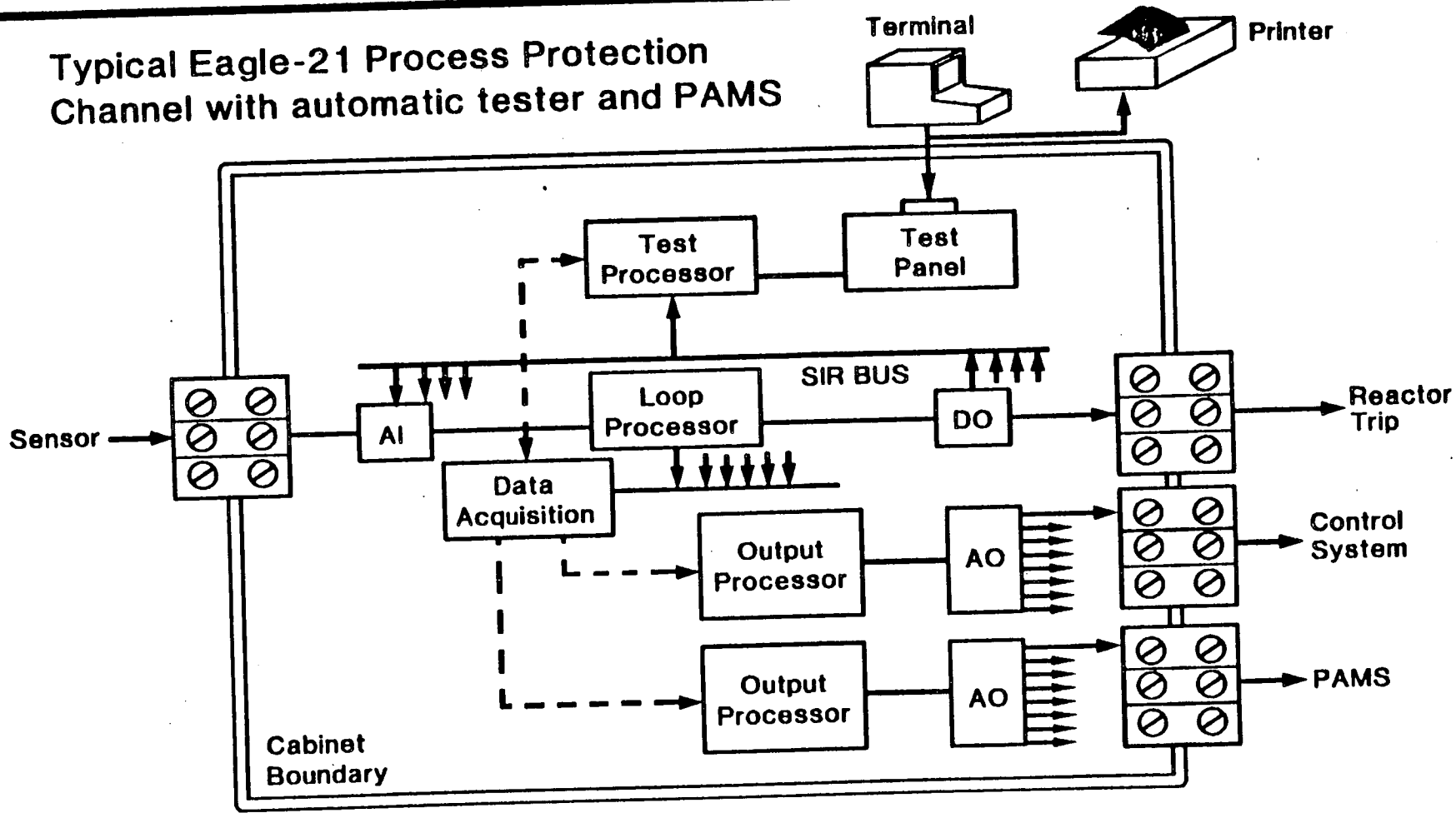
EAGLE-21

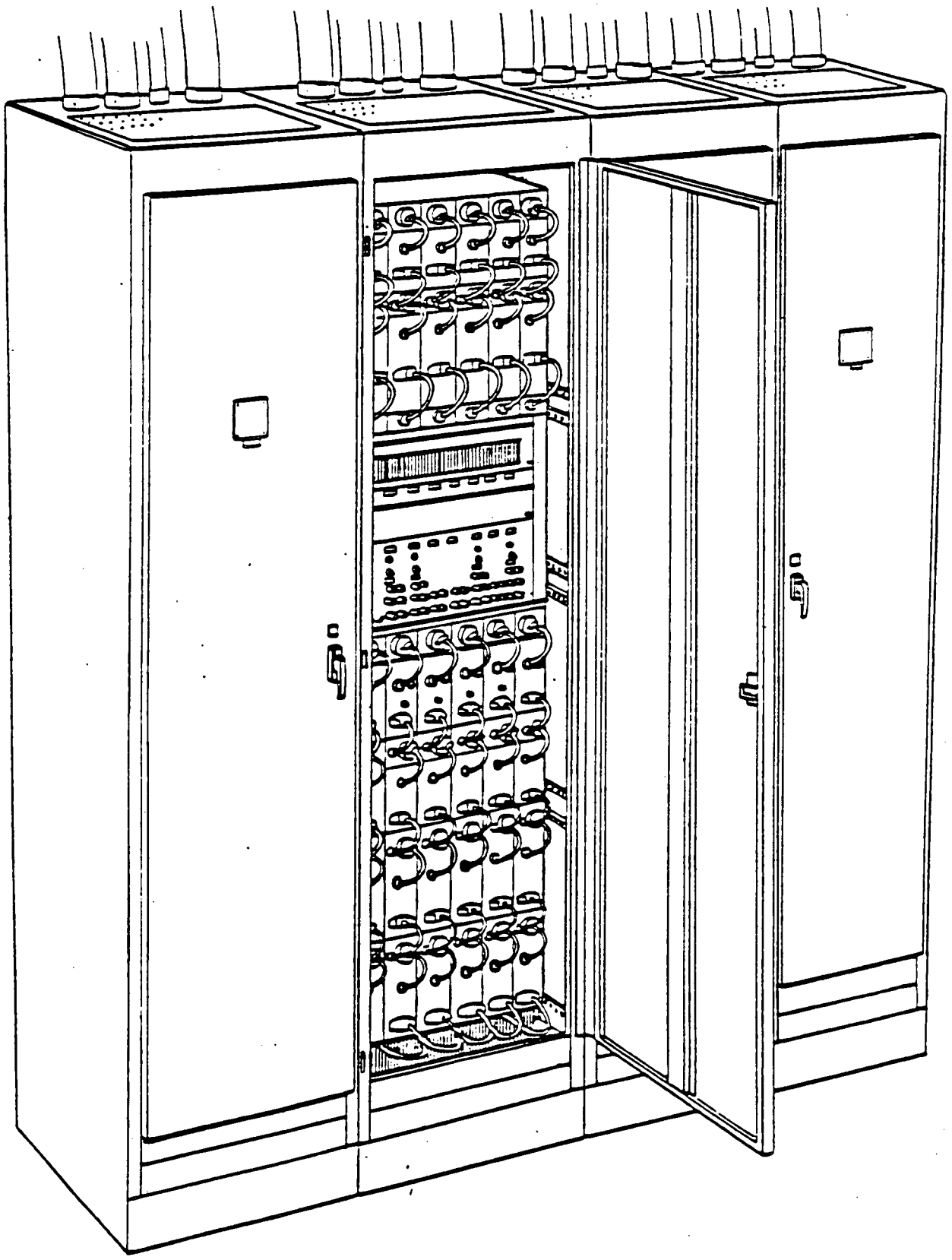
Typical Analog Process Protection Channel



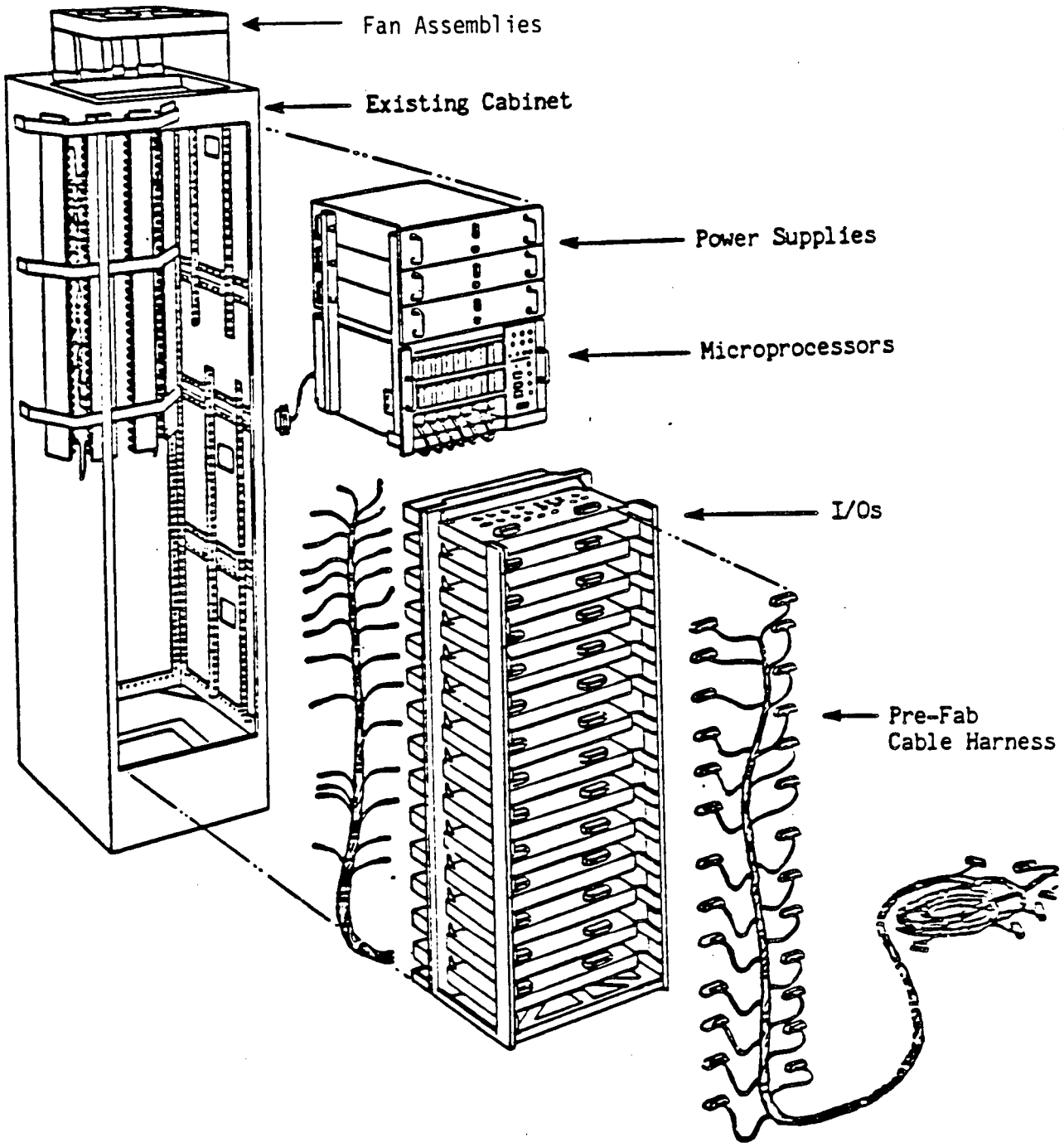
EAGLE-21 IMPLEMENTATION

Typical Eagle-21 Process Protection Channel with automatic tester and PAMS

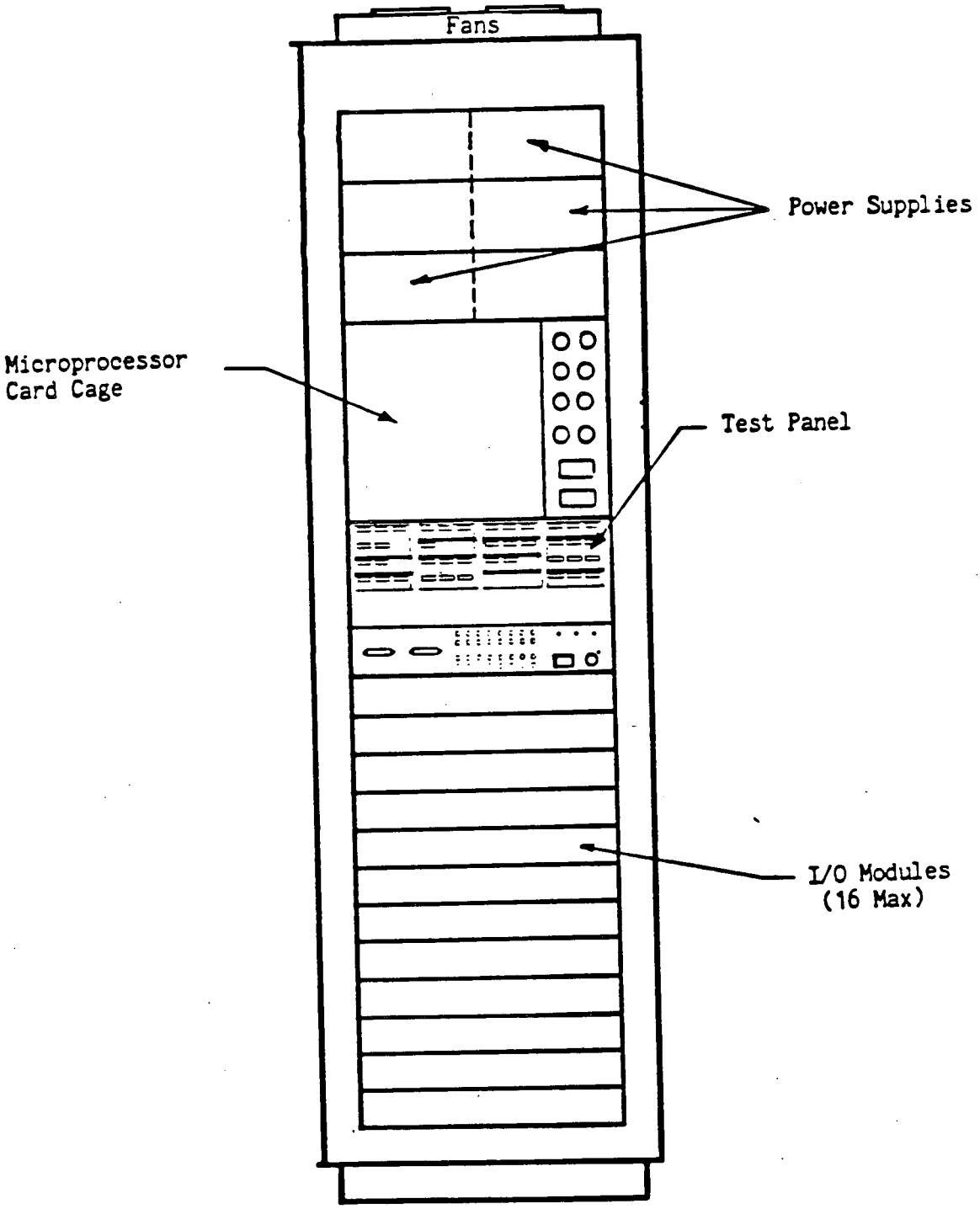




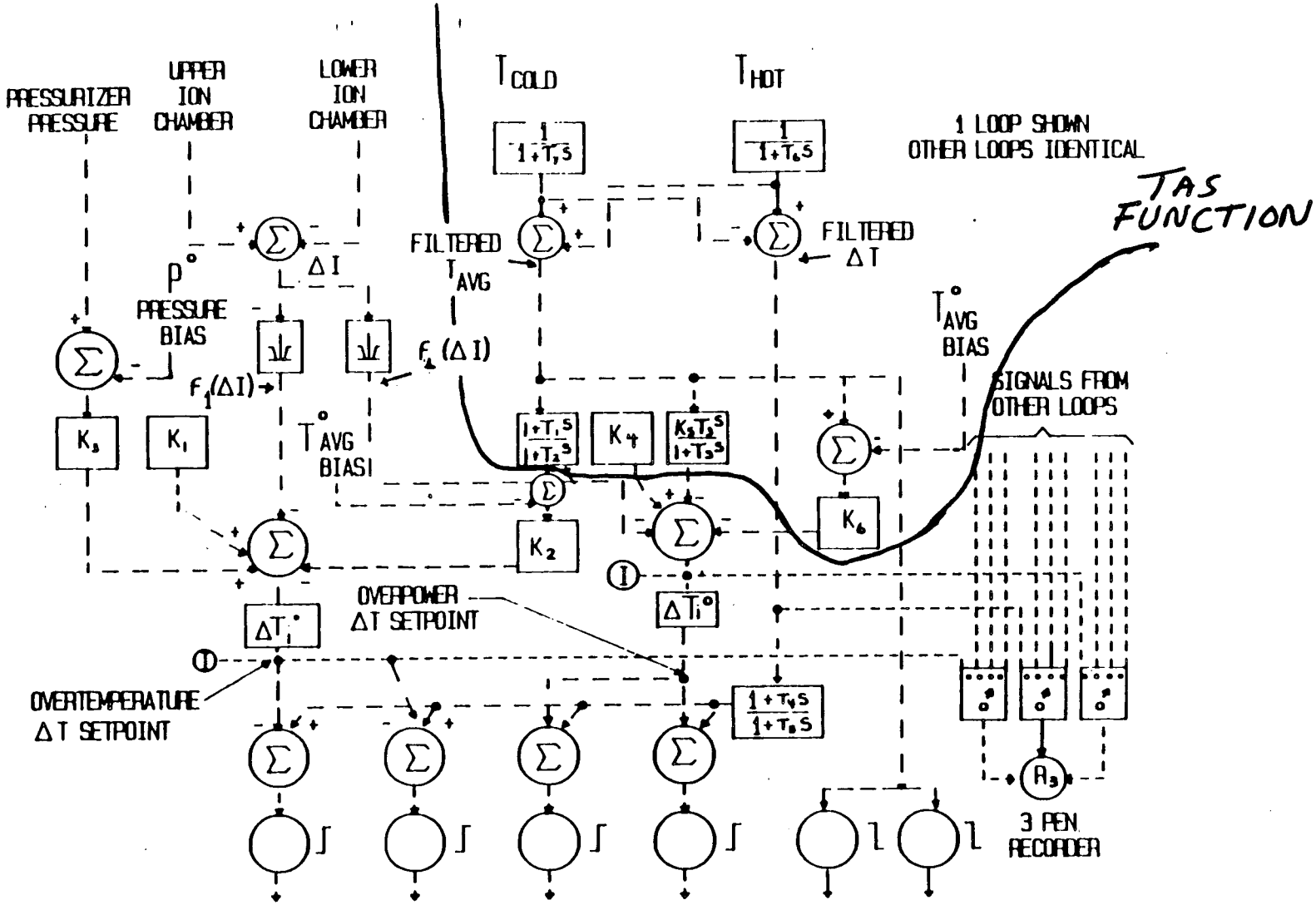
Existing Cabinet



Existing Cabinet Installation of
Eagle 21 Equipment



Front View Typical Rack Arrangement

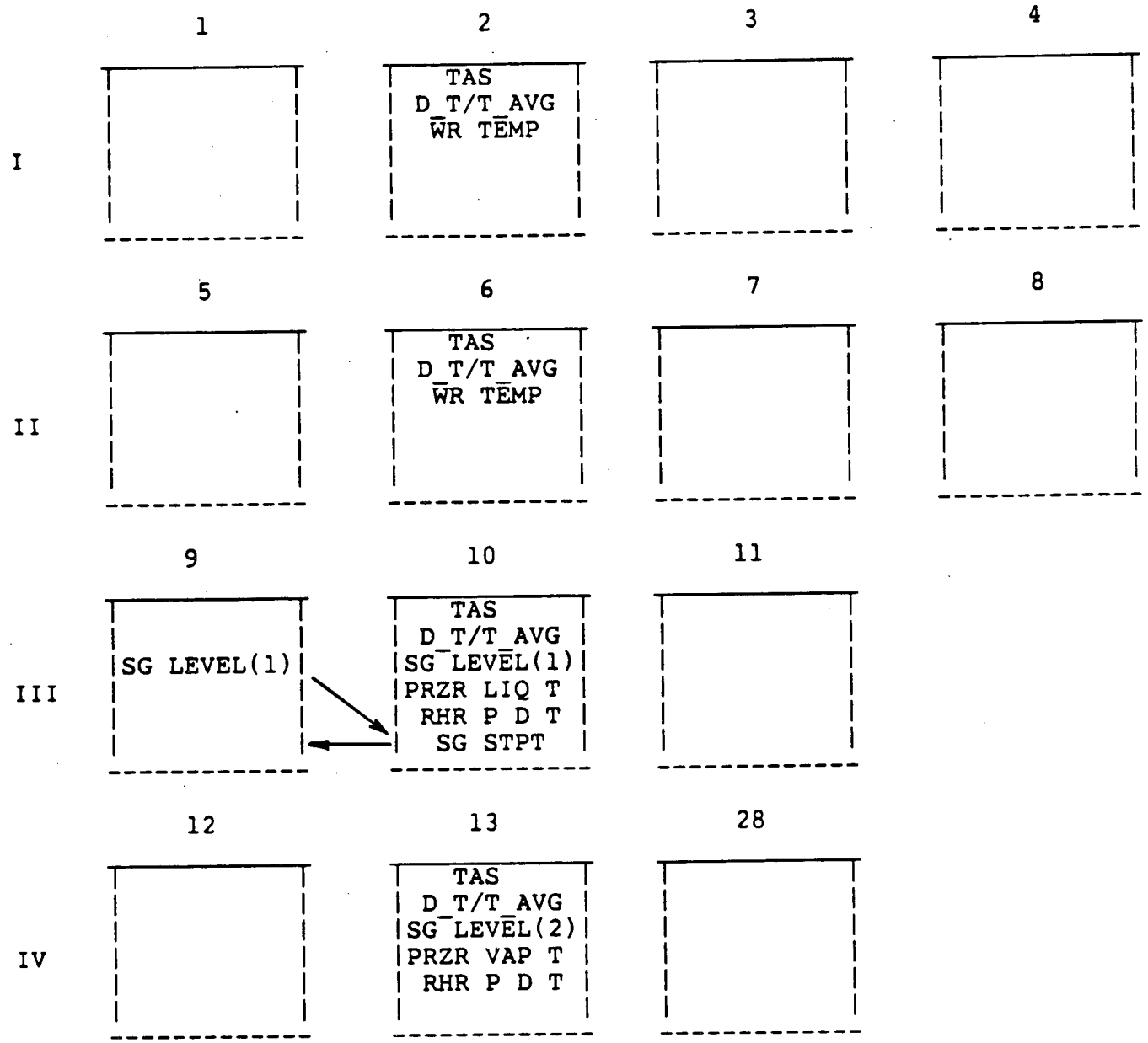


TO SOLID STATE PROTECTION SYSTEM LOGIC (SEE STD. FUNCTIONAL DIAGRAMS, SHEET 5, PRIMARY COOLANT SYSTEM TRIP SIGNALS)

WATTS BAR REV. 4

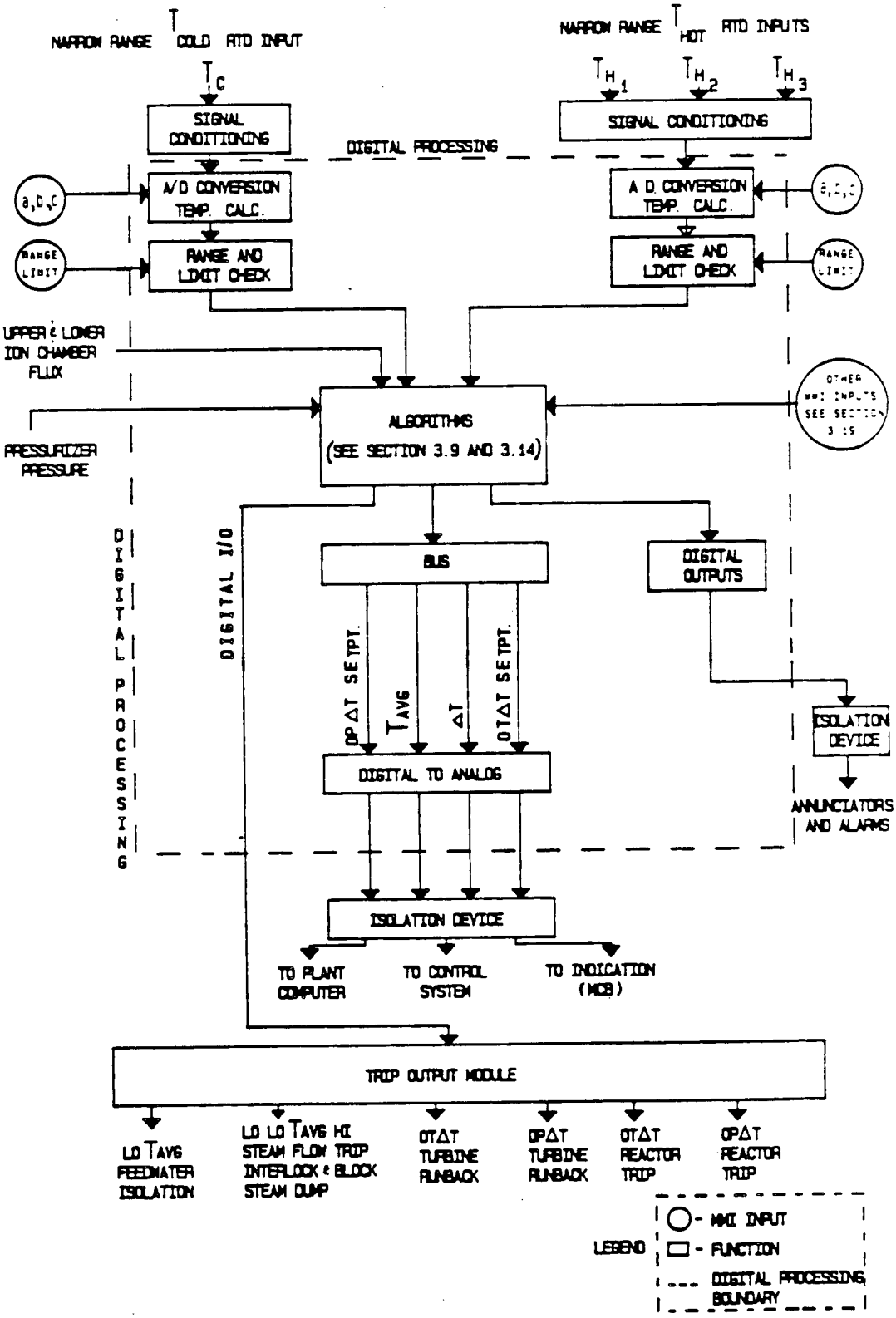
THERMAL OVERTEMPERATURE AND OVERPOWER PROTECTION BLOCK DIAGRAM

FIGURE 1



WATTS BAR

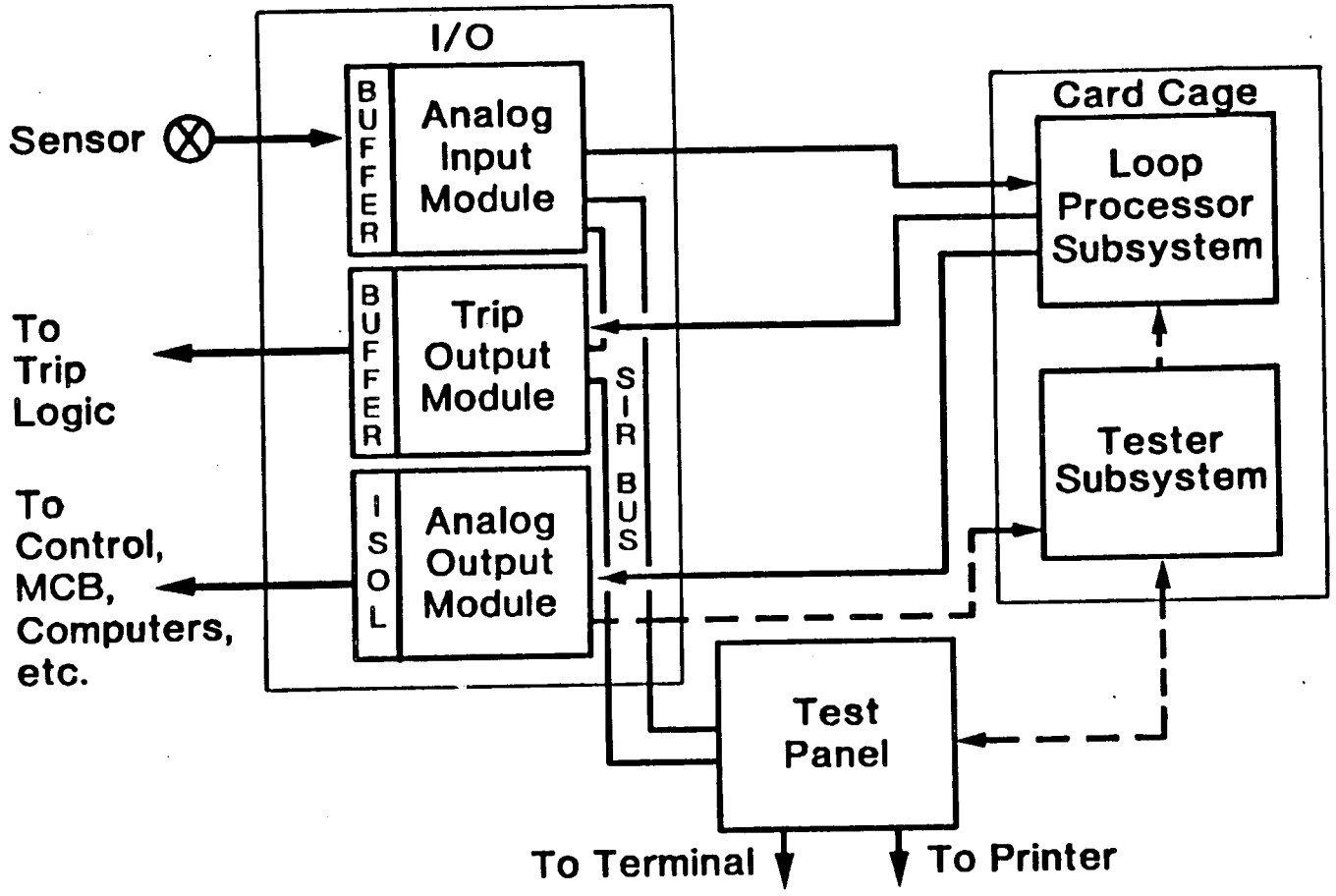
PROCESS PROTECTION SYSTEM



TEMPERATURE AVERAGING SYSTEM
DIGITAL FLOW DIAGRAM

FIGURE 2

EAGLE-21 ARCHITECTURE



DIGITAL

TEMPERATURE AVERAGING SYSTEM

FEATURES

* EXTENSIVE UTILIZATION OF MMI PARAMETER INPUTS IN ENGINEERING UNITS
  + SETPOINTS
  + TUNING CONSTANTS
  + RTD CALIBRATION COEFFICIENTS
* ON-LINE CALCULATION OF TEMPERATURE BIAS AS A FUNCTION OF POWER
* ANTICIPATORY INDICATION OF RTD FAILURE
* AUTOMATICALLY DETECTS AND REJECTS INPUT FROM FAILED RTD
* AUTOMATICALLY APPLIES TEMPERATURE BIAS INTO HOT LEG TEMPERATURE CALCULATION FOLLOWING AN RTD FAILURE
* ON-LINE CALIBRATION AND DIAGNOSTICS

SOFTWARE V & V PROGRAM

RTD BYPASS ELIMINATION MODIFICATION

GLEN LANG

W RTDBE/EAGLE 21 LICENSING

V & V PROGRAM

APPLICABLE STANDARDS

- ANSI/IEEE-ANS-7-4.3.2 - 1982

  "APPLICATION CRITERIA FOR PROGRAMMABLE DIGITAL COMPUTER SYSTEMS IN SAFETY SYSTEMS OF NUCLEAR POWER GENERATING STATIONS"

- REGULATORY GUIDE 1.152

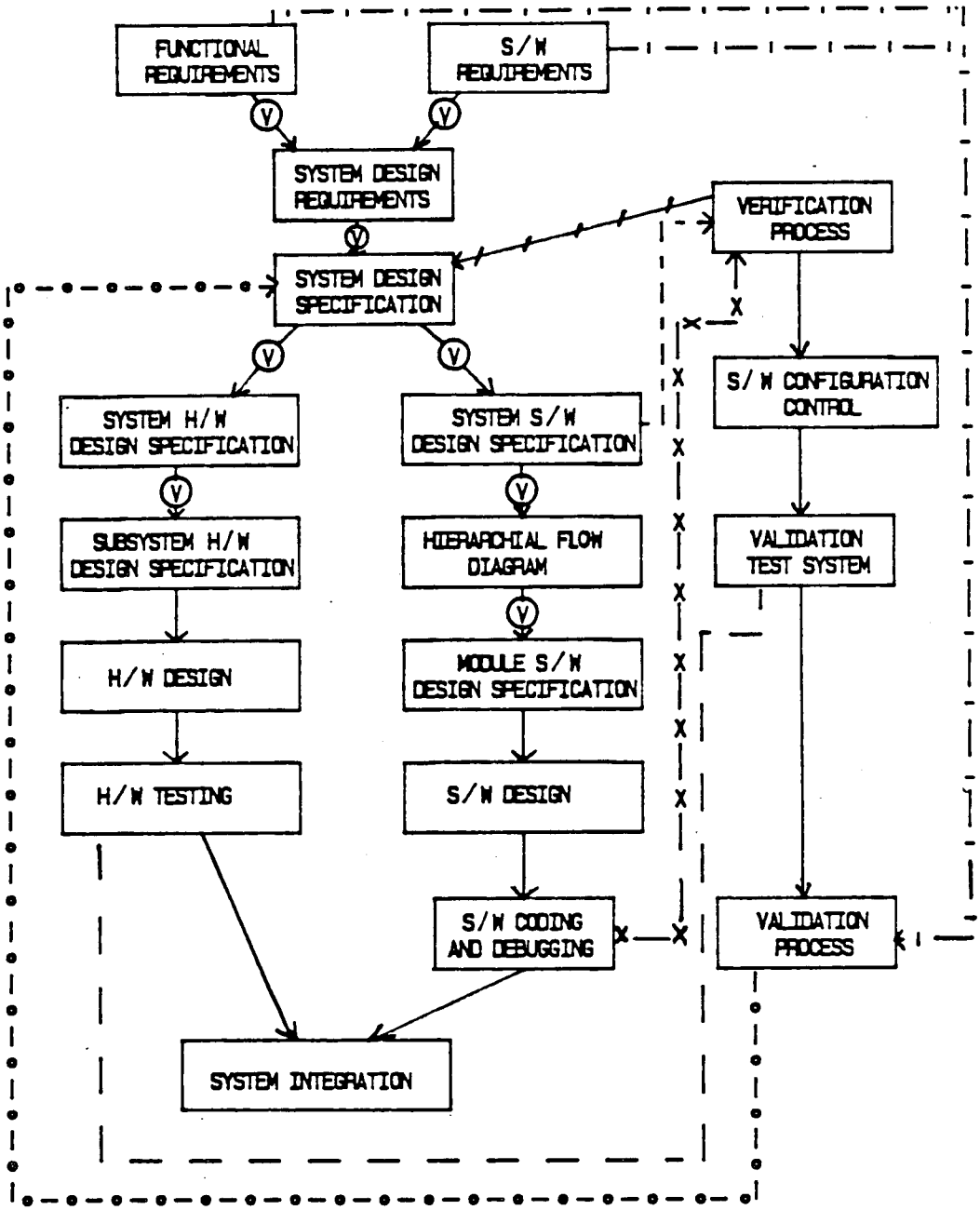
  "CRITERIA FOR PROGRAMMABLE DIGITAL COMPUTER SYSTEM SOFTWARE IN SAFETY-RELATED SYSTEMS OF NUCLEAR POWER PLANTS"

- IEEE-603 - 1980

  "IEEE STANDARD CRITERIA FOR SAFETY SYSTEMS FOR NUCLEAR POWER GENERATING STATIONS"

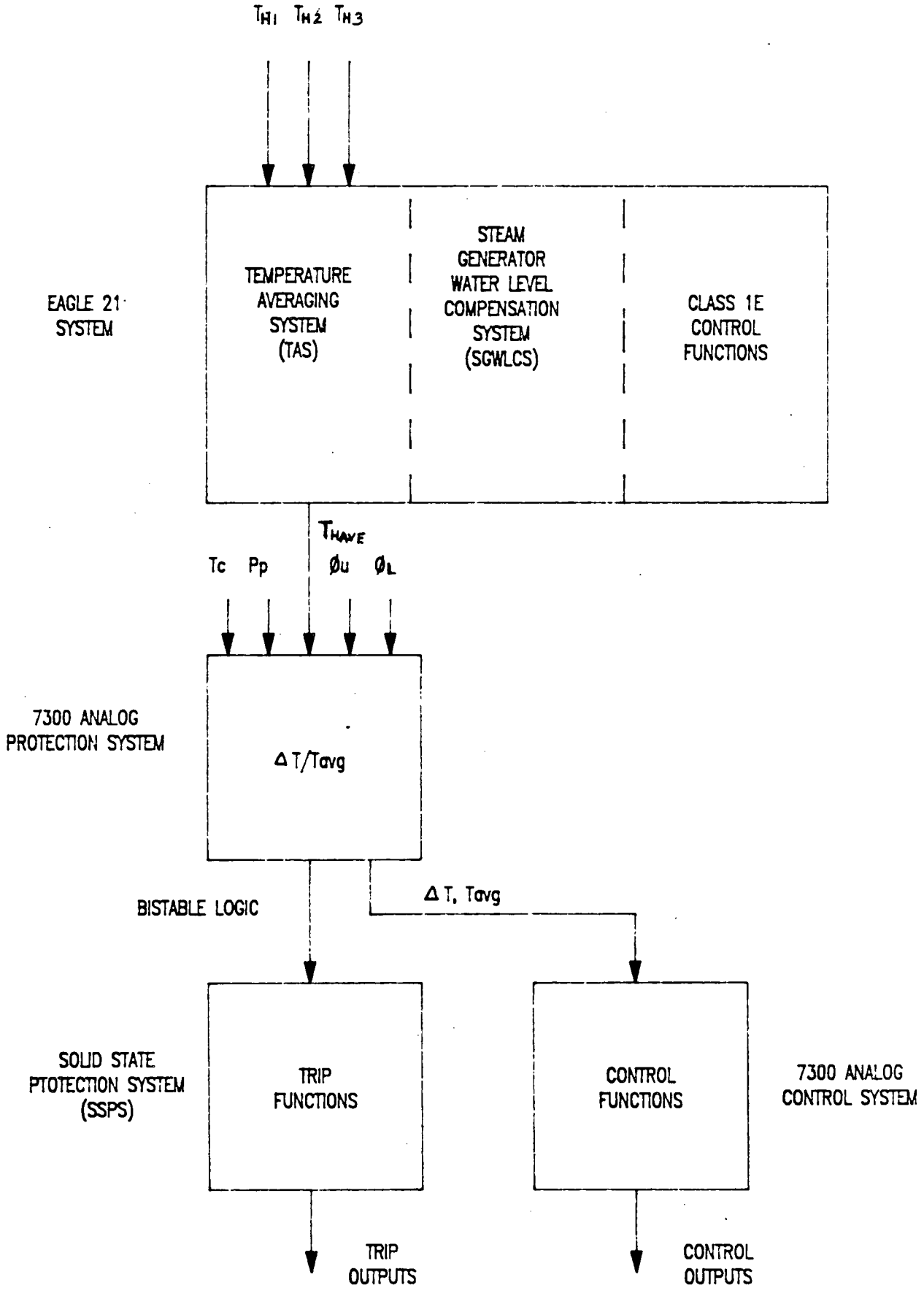
- REGULATORY GUIDE 1.153

  "CRITERIA FOR POWER, INSTRUMENTATION, AND CONTROL PORTIONS OF SAFETY SYSTEMS"

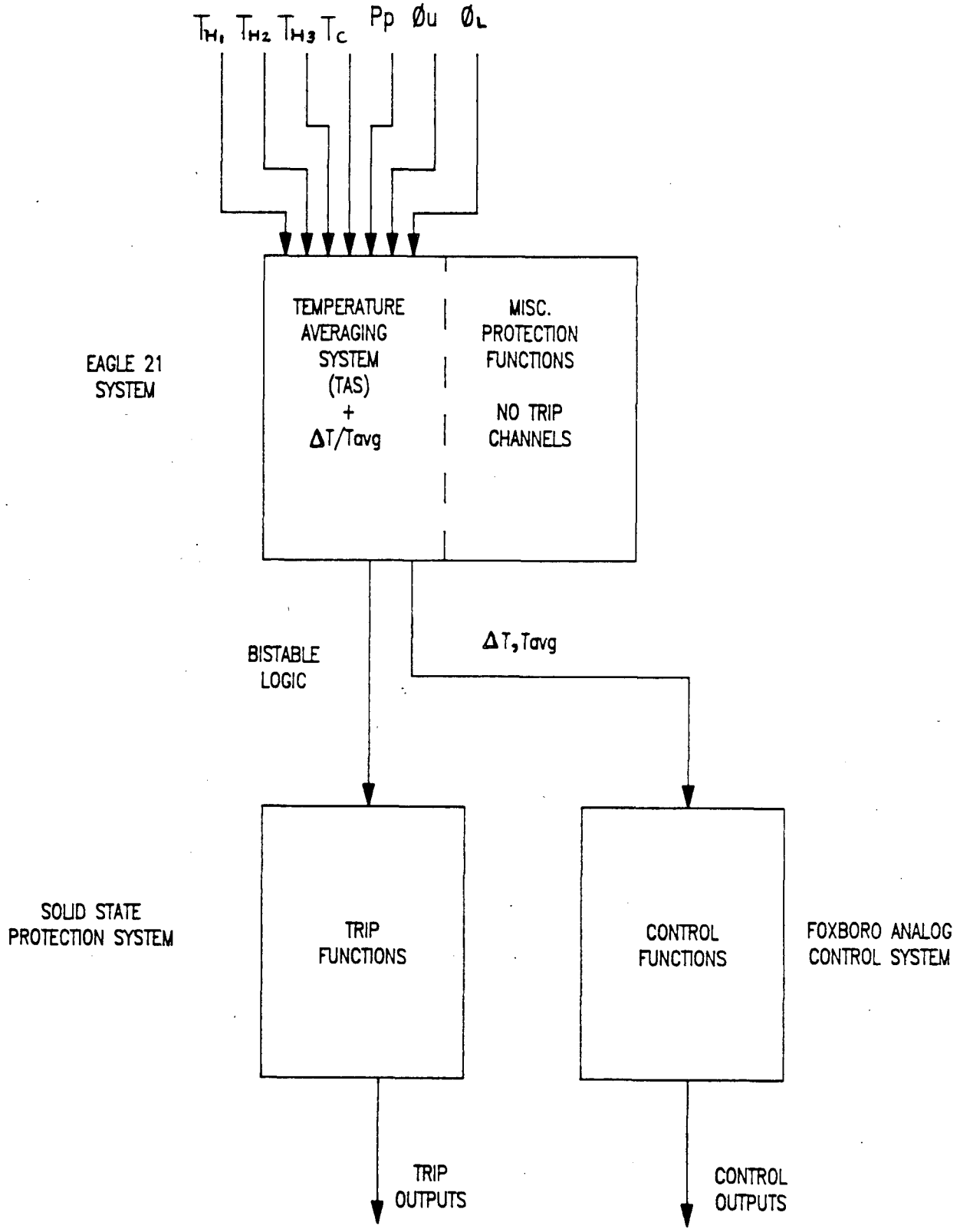


DESIGN VERIFICATION AND VALIDATION PROCESS

SOUTH TEXAS EAGLE 21



WATTS BAR EAGLE 21



PROPOSED INITIAL AUDIT

- PRE-AUDIT TECHNICAL MEETING SCHEDULED FOR WEEK OF JANUARY 26, 1987

- AUDIT SCHEDULED FOR WEEK OF FEBRUARY 2, 1987

- SCOPE

  - REVIEW APPLICATION OF VERIFICATION AND VALIDATION PLAN FOR WATTS BAR PROGRAM

  - AUDIT DESIGN PROCESS

PROPOSED FINAL AUDIT

- PRE-AUDIT TECHNICAL MEETING SCHEDULED FOR WEEK OF APRIL 20, 1987

- AUDIT FOR WEEK OF APRIL 27,1987

- SCOPE

  - RESOLVE INITIAL AUDIT OPEN ITEMS

  - CONDUCT "THREAD" CONCEPT OF VERIFICATION PROCESS

  - CONDUCT "THREAD" CONCEPT OF VALIDATION PROCESS

VERIFICATION AND VALIDATION PROGRAM

- UTILIZES SAME V&V PROCESS AS WAS IMPLEMENTED ON SOUTH TEXAS PROJECT QDPS

  - PROCESS SUPPLEMENTED WITH FEEDBACK FROM SOUTH TEXAS NRC AUDITS

  - WATTS BAR CHIEF VERIFIER SAME INDIVIDUAL AS USED ON SOUTH TEXAS PROJECT

  - SEVERAL VERIFIERS UTILIZED ON SOUTH TEXAS PROJECT WILL PERFORM VERIFICATION TESTS ON WATTS BAR

  - AUTOMATED TEST TOOLS

  - 25 PERCENT SOFTWARE COMMONALITY WITH SOUTH TEXAS

SAFETY ANALYSIS

RTD BYPASS ELIMINATION MODIFICATION

JIM SECHRIST

W TRANSIENT ANALYSIS

SAFETY ANALYSIS CONSIDERATIONS:

- RTD Accuracy
- Channel Response Time
- FSAR Chapter 15 Accident Analysis

RTD ACCURACY:

- RTD Temp Uncertainty (0.7°F --> 1.2°F)
- Current Analyses Assume Additional 2.5°F Temperature Uncertainty
- Digital System Accuracy ≥ Analog System Accuracy
- No Impact on Accident Analyses

CHANNEL RESPONSE TIME:

- Current Accident Analyses Assume 6 Seconds
- New Analyses Assume 7 Seconds
- Increased Response Time Delays Overtemperature Delta-T (OTDT)/Overpower Delta-T (OPDT) Trips
- Accident Analyses Affected

FSAR CHAPTER 15 ACCIDENT ANALYSIS

TRANSIENTS AFFECTED:

- Uncontrolled Bank Withdrawal At Power -- OTDT Trip
- Uncontrolled Boron Dilution -- OTDT Trip
- Loss of Load/Turbine Trip -- OTDT Trip
- RCS Depressurization -- OTDT Trip