UNITED STATES
NUCLEAR REGULATORY COMMISSION
ADVISORY COMMITTEE ON REACTOR SAFEGUARDS
WASHINGTON, D.C. 20555-0001

January 4, 2001

MEMORANDUM TO: ACRS Members

FROM: Amarjit Singh, Senior Staff Engineer

SUBJECT: CERTIFICATION OF THE MINUTES OF THE ACRS SUBCOMMITTEE ON PLANT SYSTEMS OCTOBER 31, 2000, ROCKVILLE, MARYLAND

The minutes of the subject meeting, issued December 12, 2000, have been certified as the official record of the proceedings of that meeting. A copy of the certified minutes is attached.

Attachment: As stated

cc: via E-mail
J. Larkins
R. Savio
S. Duraiswamy
ACRS Staff Engineers
ACRS Fellows

UNITED STATES
NUCLEAR REGULATORY COMMISSION
ADVISORY COMMITTEE ON REACTOR SAFEGUARDS
WASHINGTON, D.C. 20555-0001

MEMORANDUM TO: Amarjit Singh, P.E., Senior Staff Engineer
Technical Support Staff
ACRS/ACNW

FROM: Dr. Robert E. Uhrig, Chairman
Plant Systems

SUBJECT: CERTIFICATION OF THE SUMMARY/MINUTES OF THE ACRS SUBCOMMITTEE ON PLANT SYSTEMS, OCTOBER 31, 2000

I hereby certify that, to the best of my knowledge and belief, the Minutes of the subject meeting issued on December 12, 2000, are an accurate record of the proceedings for that meeting.

Robert E. Uhrig
Dr. Robert E. Uhrig

December 24, 2000
Date

UNITED STATES
NUCLEAR REGULATORY COMMISSION
ADVISORY COMMITTEE ON REACTOR SAFEGUARDS
WASHINGTON, D.C. 20555-0001

December 12, 2000

MEMORANDUM TO: Dr. Robert E. Uhrig, Chairman
Plant Systems Subcommittee

FROM: Amarjit Singh, P.E., Senior Staff Engineer
ACRS/ACNW Technical Support Staff

SUBJECT: WORKING COPY OF THE MINUTES OF THE SUBCOMMITTEE MEETING ON PLANT SYSTEMS OCTOBER 31, 2000, ROCKVILLE, MARYLAND

A working copy of the minutes for the subject meeting is attached for your review. I would appreciate your review and comments as soon as possible. Copies are being sent to the ACRS members who attended the meeting for information and/or review.

Attachment: As stated

cc: D. Powers
G. Leitch
J. Sieber
G. Apostolakis

CERTIFIED

CERTIFIED BY:
Robert E. Uhrig - December 12, 2000

October 31, 2000

THE ADVISORY COMMITTEE ON REACTOR SAFEGUARDS
MINUTES OF THE ACRS SUBCOMMITTEE ON PLANT SYSTEMS FOR
ABB/CE AND SIEMENS DIGITAL I&C APPLICATIONS
OCTOBER 31, 2000

INTRODUCTION

The Advisory Committee on Reactor Safeguards (ACRS) Subcommittee on Plant Systems held a meeting on October 31, 2000, in Room T-2 B3, 11545 Rockville, Maryland, with representatives of the U.S. Nuclear Regulatory Commission (NRC) staff, Westinghouse Electric Corporation (which recently purchased ABB/CE and their Common Q digital platform), and Siemens Power Corporation regarding the safety evaluation reports on the topical reports for Westinghouse and Siemens Digital Instrumentation and Control (I&C) applications. The meeting was held to gather information regarding digital I&C Applications. The entire meeting was open to the public. Mr. Amarjit Singh was the cognizant ACRS staff engineer for this meeting. The meeting was convened on October 31, 2000 and adjourned at 12:15 p.m.

ATTENDEES

ACRS Members

R. Uhrig, Chairman
D. Powers
G. Leitch
J. Sieber

Principal NRC Speakers

E. Marinos, Office of Nuclear Reactor Regulation (NRR)
J. Calvo, NRR

Industry Representatives

L. Erin, Siemens Power Corporation
M. Winkler, Siemens Power Corporation
K. Scarola, Westinghouse Electric Corporation
M. Ryan, Westinghouse Electric Corporation

No written comments or requests for time to make oral statements were received from members of the public. A complete list of meeting attendees is kept in the ACRS Office File and will be made available upon request. A list of those who registered is available in the ACRS office. The presentation slides and handouts used during the meeting are attached to the office copy of these minutes.

Chairman's Opening Remarks

Dr. Robert E. Uhrig, Chairman of the Plant Systems Subcommittee, convened the meeting at 8:30 a.m. He stated that the purpose of the meeting was to discuss the safety evaluation reports for the Westinghouse and Siemens topical reports for digital I&C applications.

Siemens Presentation - Mr. Larry Erin

Mr. Erin presented the overview of the Teleperm access safety system which was designed by Siemens and used for nuclear power plant applications. It is a combined architecture of the Teleperm XS, which is used for safety applications, and Teleperm XP, which is used for non-safety applications. Both of the platforms interface with filled components, and class IE safety applications and non-IE , which are non-safety and control systems. Typical safety applications are used for reactor protection, safeguards actuation, safety controls, and nuclear instrument-ation system. The Teleperm XP operation and monitoring systems is used for plant computer type applications and has the capability to interface with other plant types of buses that are used throughout the plant. When the Teleperm XS system was developed for the safety applications, it was to have a short response time. Typically, the I&C portion of the channel needs to respond in something less than about 200 milliseconds. This is a highly reliable system because of the applications which has the ability to control all of the postulated events. Some of the important criteria for digital-based safety systems have no event driven interruptions and no code optimization.

Mr. Erin stated that the Teleperm XS system has some advantages in terms of operability when performing surveillance tasks and maintenance because of its four channels. One of the protection channel sets can be defeated or shutdown for maintenance and still have the capability of two out of three in the remaining channel sets. If one channel is taken out for maintenance, two out of three of the remaining three are active as opposed to going to one out of three. Hence, a transient on one of the three remaining systems would not trip the reactor. He further stated that there are two completely independent trains feeding from the common set of signals coming from all four channels.

The Teleperm XS system meets the single-failure criterion for U.S. applications, because TXS is applied to four redundant process channels and two trip logic trains for each reactor protection system (RPS) or engineered safety feature (ESF) actuation function. These redundant channels and trains are electrically isolated and physically separated. Qualified isolation devices have been tested to ensure functional operability when subjected to physical damage, short circuits, open circuits, or credible fault voltages on the device output terminals.

The Teleperm XS is environmentally and seismically qualified to ensure the system is capable of performing its designated functions while exposed to normal, abnormal, test, accident and post-accident environmental conditions.

Reliability has been assessed with both probabilistic and deterministic reliability analyses. The probabilistic analysis has been used to quantify the non-availability on demand. The staff has reviewed these calculations. However, the staff does not use probabilistic and deterministic reliability analyses as the sole means of determining acceptability of a safety system. The calculations are related only to the hardware aspects of the Teleperm XS system. However,

confirmatory testing performed by Siemens and Gesellschaft für Anlagen und Reaktorsicherheit (GRS) included the software. The deterministic analysis based on codes and standards delineates postulated failures that the system will be able to withstand.

Mr. Erin stated some of the Teleperm XS applications in Europe are for reactor control limitation systems. In the United States the applications are planned for Callaway and Comanche Peak plants to use both Teleperm XS and Teleperm XP for comprehensive I&C upgrades.

Westinghouse Electric Corporation Presentation -Mr. Ken Scarola

Mr. Scarola presented briefly the organization of the Westinghouse Nuclear Automation group involved in nuclear I&C around the world, background information and overview, and objectives of Common Q Platform's digital I&C applications. The Common Q Platform consists of a class IE qualified I&C platform composed of building blocks applicable to all applications including post accident monitoring, reactor protection, engineered safety features actuation, and diesel sequencer systems. The Westinghouse Electric Corporation submitted its topical report on the digital application to the staff for review. The NRC staff issued the safety evaluation report on August 25, 2000. Mr. Scarola briefly addressed the following objectives of the Common Q Platform:

- Must address the key utility issues for modern plant I&C.
- Must utilize use of industrially proven products.
- To ensure low operational risk and high availability.
- Maximum standardization.
- To minimize operating and maintenance costs but diversify with common mode failure.
- Provides a Pre-established licensing vehicle for new plants and operating plant upgrades, to minimize licensing risk.
- To ensure expectations are achieved for high reliability with reduced manual surveillance.
- Supplier proactive program for long term obsolescence protection to ensure the new equipment is not next years obsolescence problem.

The Common Q platform is a computer system consisting of a set of commercial-grade hardware and previously developed software components dedicated and qualified for use in nuclear power plants. The Common Q platform was developed by Combustion Engineering Nuclear Power (CENP) from the standard AC 160 computer system developed by ABB Automation Products, GMBH (ABB Products) of Europe. The Common Q platform is to be loaded with plant-specific application software to implement various nuclear plant safety system applications. The hardware components of the platform are:

- Advant Controller 160 (AC160) with PM646 or PM645C processor modules.

- S600 input and output (S600 I/O) modules.
- Bus communication interface (CI631) modules.
- Power supply modules.
- Watchdog timer module.
- Communication systems.
- Flat-panel display system (FPDS).

The AC 160 software, residing on flash PROM in the processor module, consists of a real-time operating system, task scheduler, diagnostic functions, communication interfaces and plant specific application programs. The application program is created using the Asea Brown Boveri (ABB) Master Programming Language (AMPL) Control Configuration (ACC) software development environment that includes a function block library for creating specific logic for the application.

The safety-related I&C systems based on the application of Common Q platforms provide protection against unsafe reactor operation during steady-state and transient power operations. They also initiate selected protective functions to mitigate the consequences of design-basis events and accidents, and to safely shut down the plant by either automatic means or manual actions.

CENP's "Software Program Manual for Common Q Systems" (SPM) specifies plans for implementing a structured software life cycle process for application software and provides guidance for configuration management of commercial-grade hardware and previously-developed software. Since the application software has not yet been developed, the staff's evaluation did not include the review of the outputs of the life cycle process, but is limited to the evaluation of the specified process.

For the commercial dedication of the Common Q platform, including the previously developed software and tools, CENP conducted a quality evaluation of the AC160 programmable logic controller (PLC) system planned to be used in implementing the safety functions of the reactor protection system for the Oskarshamn Modernization Project in Sweden. The AC160 system planned for the Oskarshamn Modernization Project is the same as that which will be used for the Common Q system, and the quality evaluation done for the Oskarshamn. The Modernization Project is applicable to the commercial-grade dedication of the Common Q system. The safety-grade application at Oskarshamn is equivalent to Class 1E.

The AC160 PLC system equipment qualification included temperature and humidity tests, seismic tests, and electromagnetic interference/radio frequency interference (EMI/RFI) qualification. All the tests passed successfully, except for the EMI/RFI tests on the AC160 system modules.

Mr. Scarola concluded that the Common Q Platform provides reduced technical support costs and reduced unique spare parts. Modern technology provides improved reliability with extended manual surveillance intervals due to low power consumption electronics, self diagnostics, and automated testing.

NRC Staff Presentation - Mr. Evangelos C. Marinos

Mr. Marinos gave an overview of the reasons for replacing with digital equipment and how the review of the topical reports of Westinghouse and Siemens were conducted by the staff.

Reasons for Replacing With Digital Equipment :

- Analog equipment is becoming obsolescent and replacement is difficult to obtain.
- Plant components are aging and maintenance costs are increasing since vendors are not supporting analog equipment.
- Digital equipment and components are readily available, with potential for performance and reliability improvements.
- Nuclear utility replacement include RPS, ESFAS, Monitoring Systems, and Balance of Plant Control and Electrical Systems.

Following are significant issues covered during the reviews of the topical Reports and are documented in the staff's safety evaluation reports (SERs) for Westinghouse and Siemens:

- adequacy of commercial grade dedication process to ensure safety grade quality of platform
- system requirements, hardware and software specifications, equipment qualification documents, and test data
- formal design process (design life cycle) and implementation in design of hardware and software
- adequacy of configuration management of system and software
- design documentation and outputs
- verification and validation activities of software
- environmental qualification of plant hardware
- interface with existing equipment, including human machine interface changes
- communication between channels, modules, etc
- timing requirements

Siemens Teleperm XS Review

- SER issued on May 5, 2000.
- Siemens Teleperm XS was found acceptable, with the following open items:
  - power supply to be qualified in accordance with EPRI TR-107330
  - environmental qualification test at maximum temperature in accordance with EPRI TR-107330
  - seismic qualifications
  - electromagnetic Compatibility (EMC) tests in accordance with EPRI TR-102323
  - set point analysis
  - accident analyses to confirm that TXS reactor trip system (RTS) is consistent with Chapter 15 of NUREG-0800, "Standard Review Plan"
  - proposed plant-specific Technical Specifications (TS) including periodic test interval and use of bypass mode for test and maintenance
  - isolation devices qualified in accordance with EPRI TR-107330

Westinghouse Common Q Platform Review

- SER issued on August 8, 2000
- Westinghouse Common Q Platform was found acceptable, with the following open items:
  - flat Panel Display System (FPDS) for non-safety functions, not presently used for initiation of automatic safety-related functions
  - FPDS hardware and other non-AC-160 hardware have not undergone commercial grade dedication
  - proposed Standard Technical Specification (STS) changes awaiting approval by Nuclear Energy Institute (NEI) Technical Specification Task Force (TSTF) before staff review
  - suitability of S600 I/O modules for plant-specific input/output requirements

- plant environmental data (i.e., temperature, humidity, seismic, and EMC enveloped by Common Q qualification
- plant-specific hardware and software life cycle process
- common Q timing analysis and validation tests to plant-specific requirements for accuracy and response time for accident analyses
- modifications to plant-specific procedures and TS
- capacity of shared resources to accommodate load requirements

Conclusions

Mr. Marinos stated that the staff expects plant-specific submittals using Siemens Teleperm XS and Westinghouse Common Q in the near future. The staff is seeking to increase the qualified staff for conducting these digital reviews. I&C staff are participating in training programs, conferences, and periodically meet with foreign regulators in order to remain current with technology changes. NRR has submitted the use needs to the Office of Nuclear Regulatory Research for Advanced Issues.

EXPECTED COMMITTEE ACTION

The Subcommittee Chairman made the recommendations to the ACRS during the November and December 2000 meetings on this matter.

BACKGROUND MATERIAL PROVIDED TO THE SUBCOMMITTEE

- Memorandum to John T. Larkins, Executive Director, Advisory Committee on Reactor Safeguards, from Jose A. Calvo, Chief, Electrical &Instrumentation and Control Branch, Division of Engineering, NRR, Subject: Safety Evaluation Report of Topical Report CENPD-396-P, Rev.01, "Common Qualified Platform" and Appendices 1,2,3, and 4, Rev., and CE-CES-195, Rev.01, "Software Program Manual for Common Q System" dated August 25, 2000
- Letter to James F. Mallay, Director, Nuclear Regulatory Affairs, Siemens Power Corporation, Subject: Acceptance for Referencing of Licensing Topical Report EMF-2110 (Non-Propitiatory) Revision 1, "Teleperm XS: A Digital Reactor Protection System" dated May 5, 2000

ADVISORY COMMITTEE ON REACTOR SAFEGUARDS

SUBCOMMITTEE MEETING ON PLANT SYSTEMS

OCTOBER 31, 2000
Today's Date

ATTENDEES - PLEASE SIGN BELOW

PLEASE PRINT

NAME	AFFILIATION
Jerry S. Holm	Siemens
MARTIN WINKLER	SIEMENS
Larry Erin	Siemens
MARTY RYAN	Westinghouse
MARK STUFKO	Westinghouse
WARREN ODESS-GILLETT	WESTINGHOUSE
Denny Popp	Westinghouse
J Mauck	JCM Technical
NIHAL KECECI	UQAM
Charles Brinkman	Westinghouse
Ken Scarola	Westinghouse

ADVISORY COMMITTEE ON REACTOR SAFEGUARDS

SUBCOMMITTEE MEETING ON PLANT SYSTEMS

OCTOBER 31, 2000
Today's Date

NRC STAFF SIGN IN FOR ACRS MEETING

PLEASE PRINT

NAME	BADGE #	NRC ORGANIZATION
Hubert C. Li	B-8553	NRR/DE/EEIB
Keith Mortensen	B-7859	NRR/DE/EEIB
Paul Loeser	B-6697	NRR/DE/EEIB
E.C. Marinos	A-6496	"
Pascal REGNIER	F-6118	"
Steven Arndt	B-8340	RES
CLIFF DOUTT	B8622	NRR/DSSA/SPSB
Robert BRIL	B7578	RES/DST/ERAB
Joel Kramer	B8401	RES/DSARE/REAHFB
Roman Shaffer	C-6704	RES/ERAB
Jose A. Calvo	A-6314	NRR/DE/EEIB
D.K Wessman	A-6827	NRR/DE
Matt Gamm	A 6337	NRR/DE/EEIB
John Calvert	B-8392	

ADVISORY COMMITTEE ON REACTOR SAFEGUARDS

SUBCOMMITTEE MEETING ON PLANT SYSTEMS

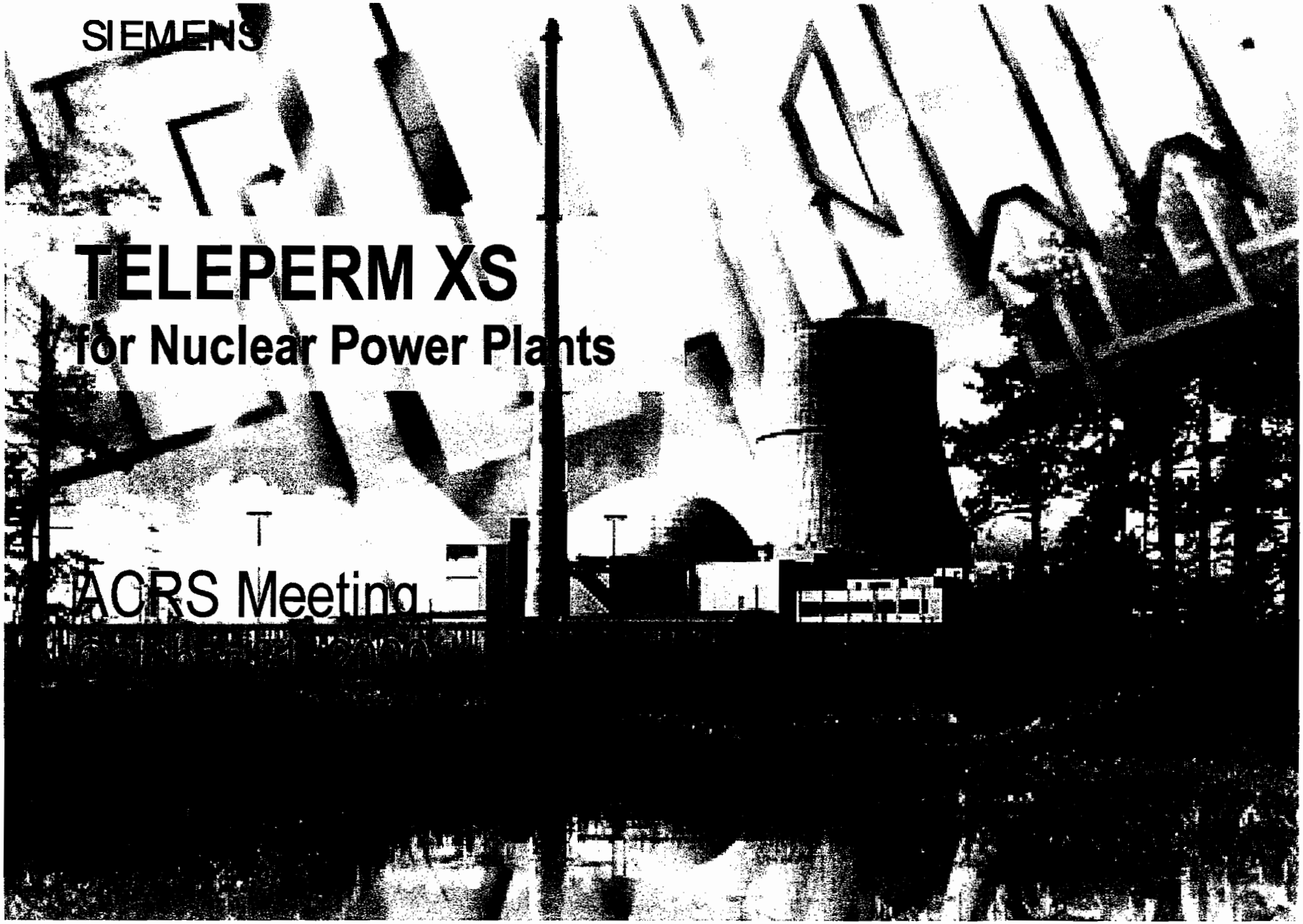
OCTOBER 31, 2000
Today's Date

NRC STAFF SIGN IN FOR ACRS MEETING

PLEASE PRINT

NAME	BADGE #	NRC ORGANIZATION

SIEMENS



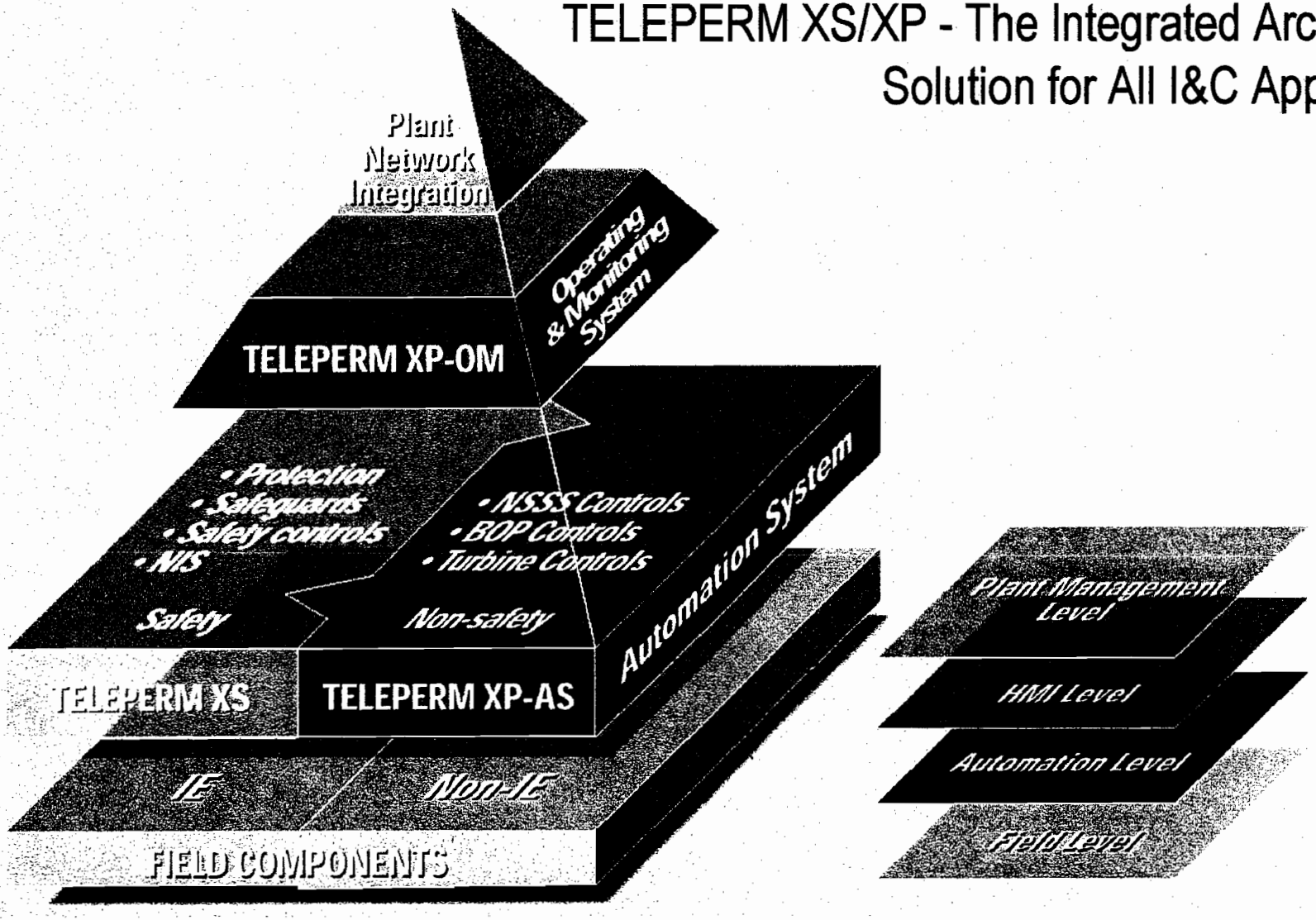
TELEPERM XS

for Nuclear Power Plants

ACRS Meeting

SIEMENS

TELEPERM XS/XP - The Integrated Architecture Solution for All I&C Applications



TELEPERM XS/XP

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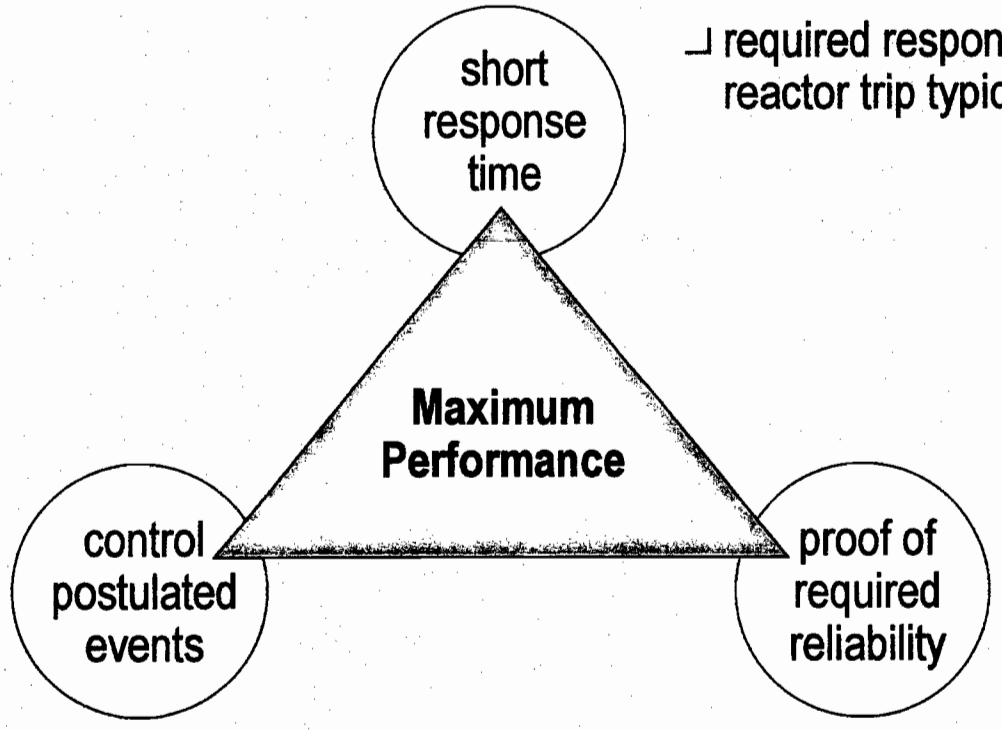
TELEPERM XS

- System Overview -

SIEMENS

Requirements for Safety I&C Systems



- required response time for reactor trip typically < 200 ms

- dispersed disposition
- redundant trains

- no event driven interrupts
- no code optimization
- simple SW structures

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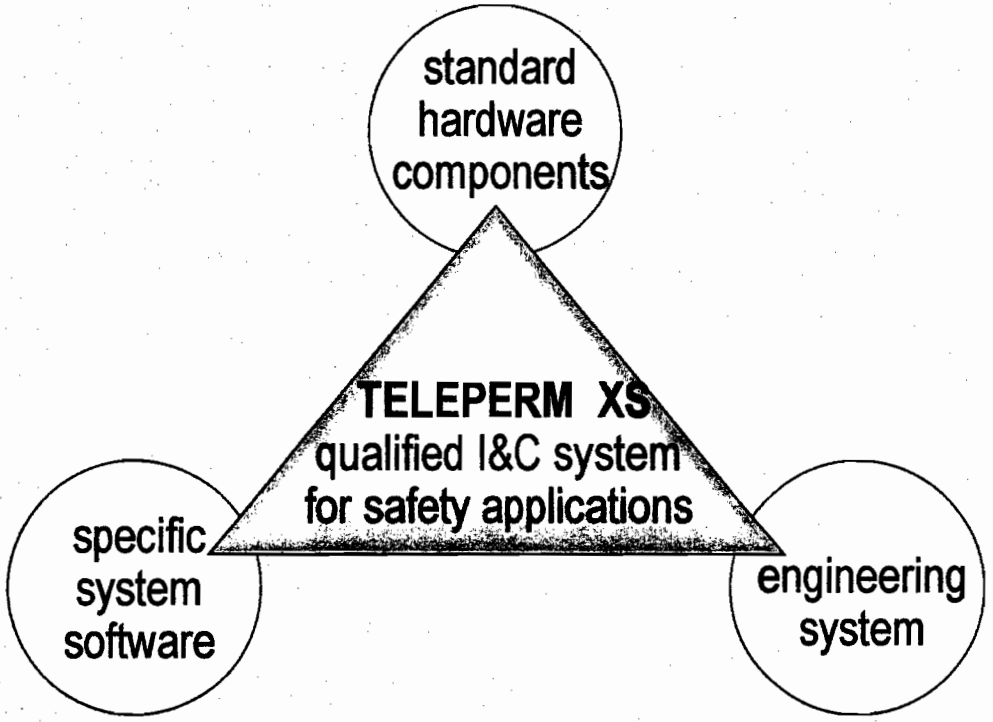
Main TELEPERM XS System Elements



- deterministic operating system
- runtime environment
- software libraries

- one common tool for
  - specification of HW and SW
  - automatic code generation
  - verification
  - documentation
  - diagnostics
  - testing

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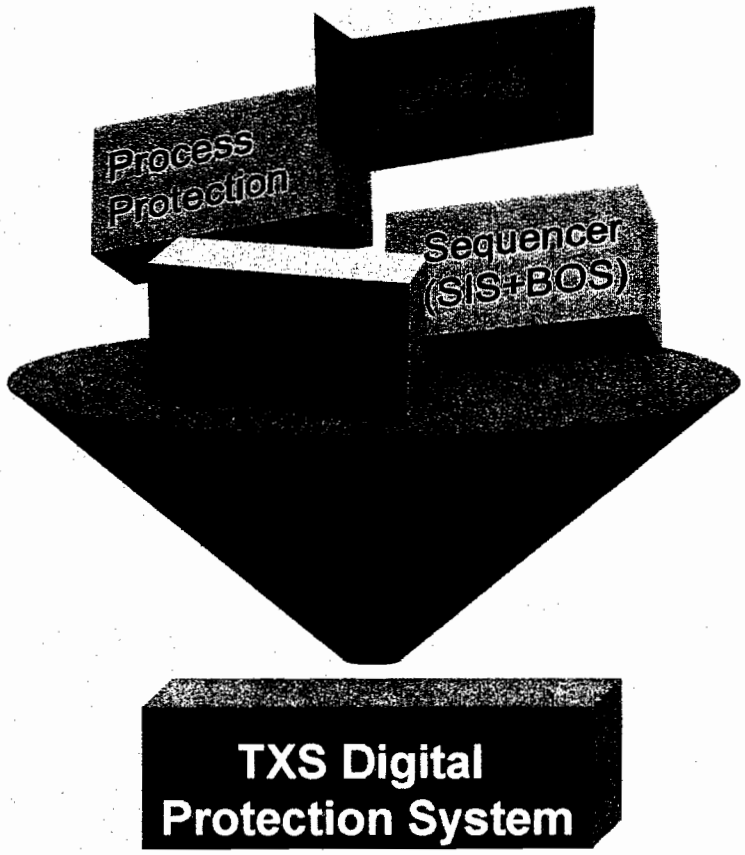
Several Existing Systems are Combined Into a Single Digital Reactor Protection System

- Combine protection functions currently implemented on different equipment platforms into one integrated system
- Eliminate hardware interfaces between protection systems



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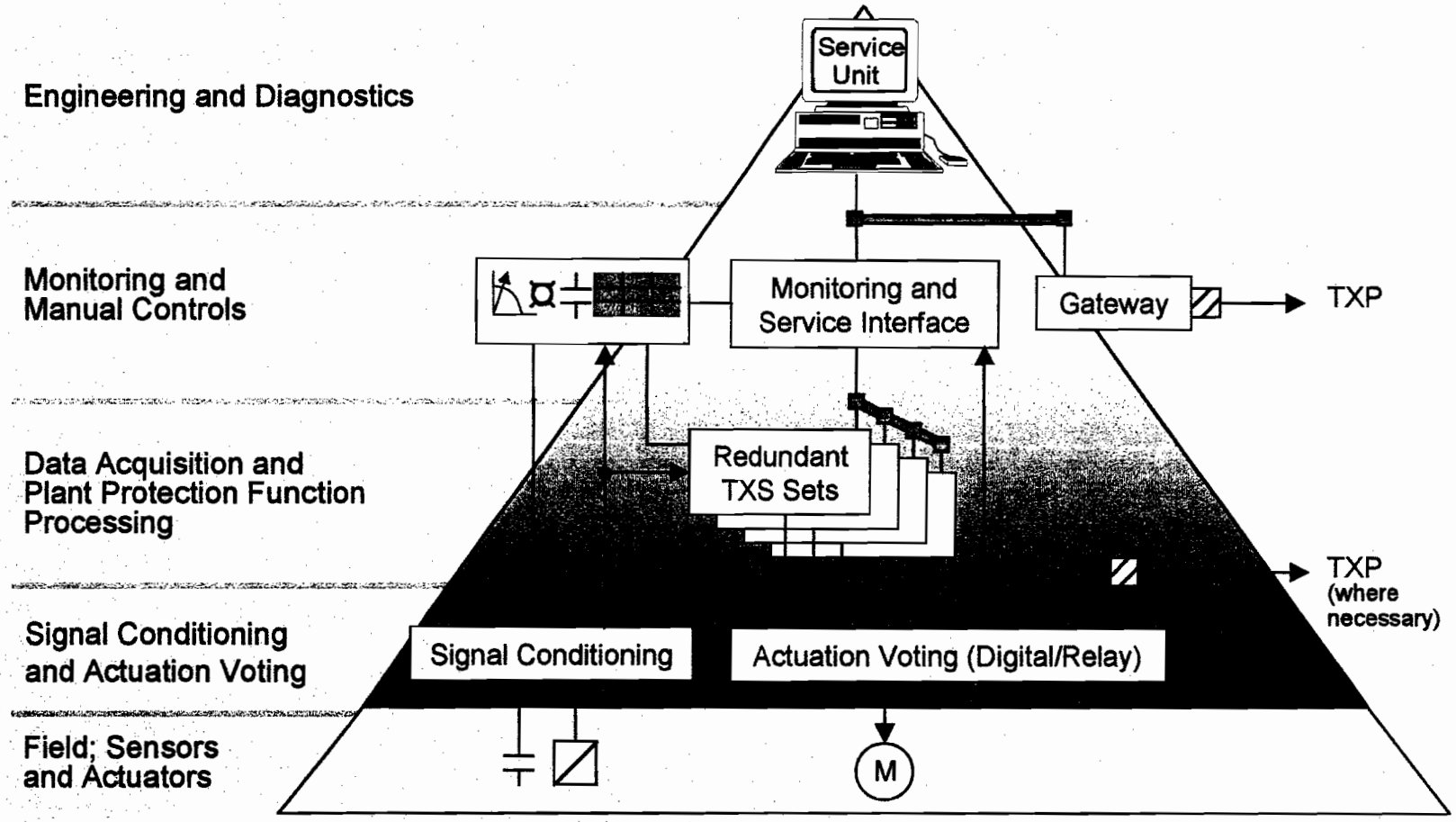
TELEPERM XS for Safety I&C Applications
Hierarchical Structure



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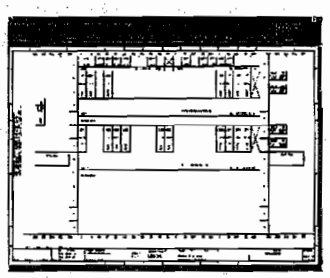
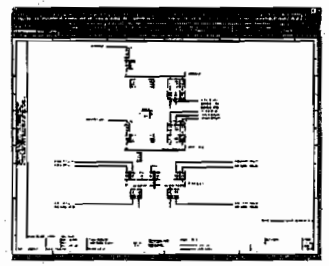
Graphical User Interface
Engineering, Maintenance and Diagnostics

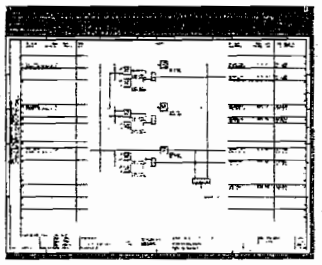
Module location
Cabinet location



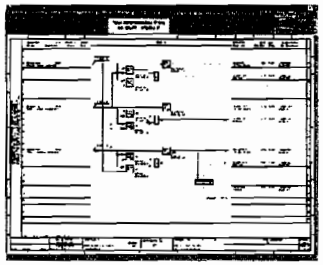
Network diagrams

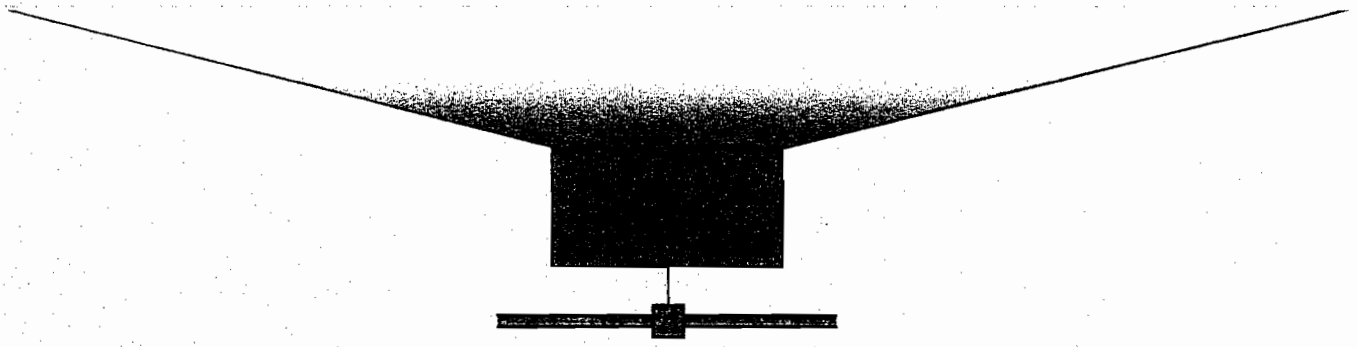


Function diagrams



Diagnosis / Monitoring





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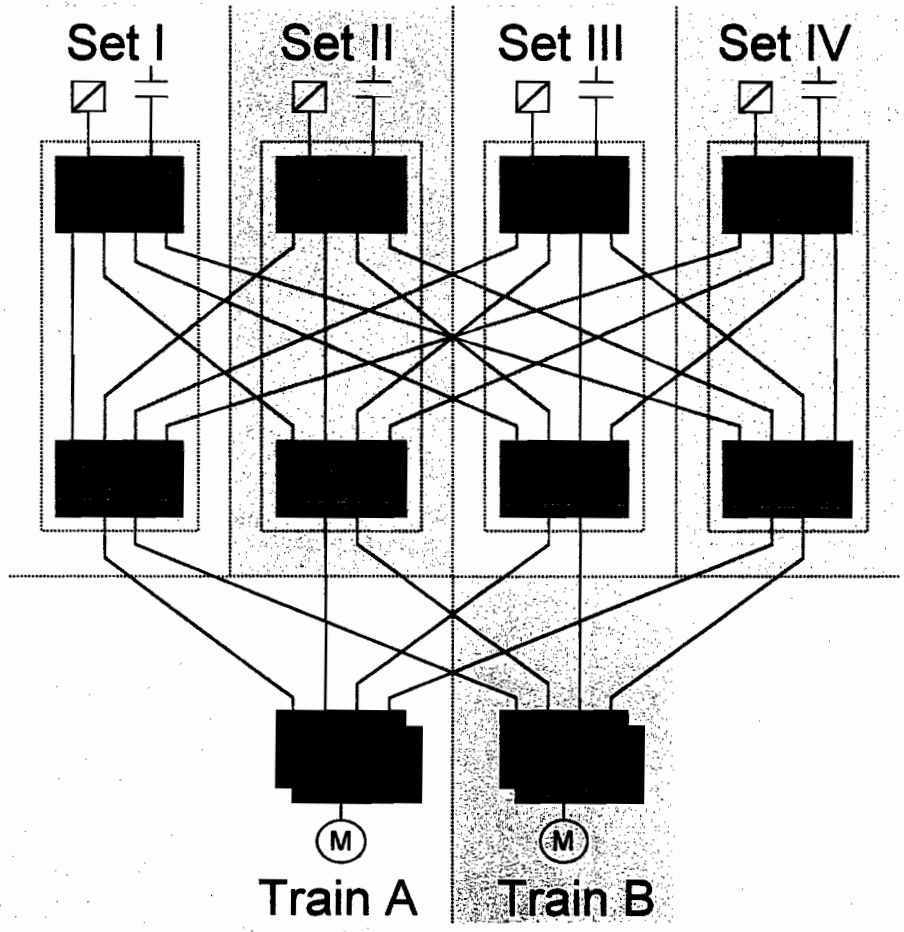
"4 Set / 2 Train" Digital Reactor Protection System (Example)
Introduction

Data Acquisition

Processing
(Plant Protection Functions)

Actuation Voting - Digital/Relay
(Inadvertent Actuation Protection)



TELEPERM XS

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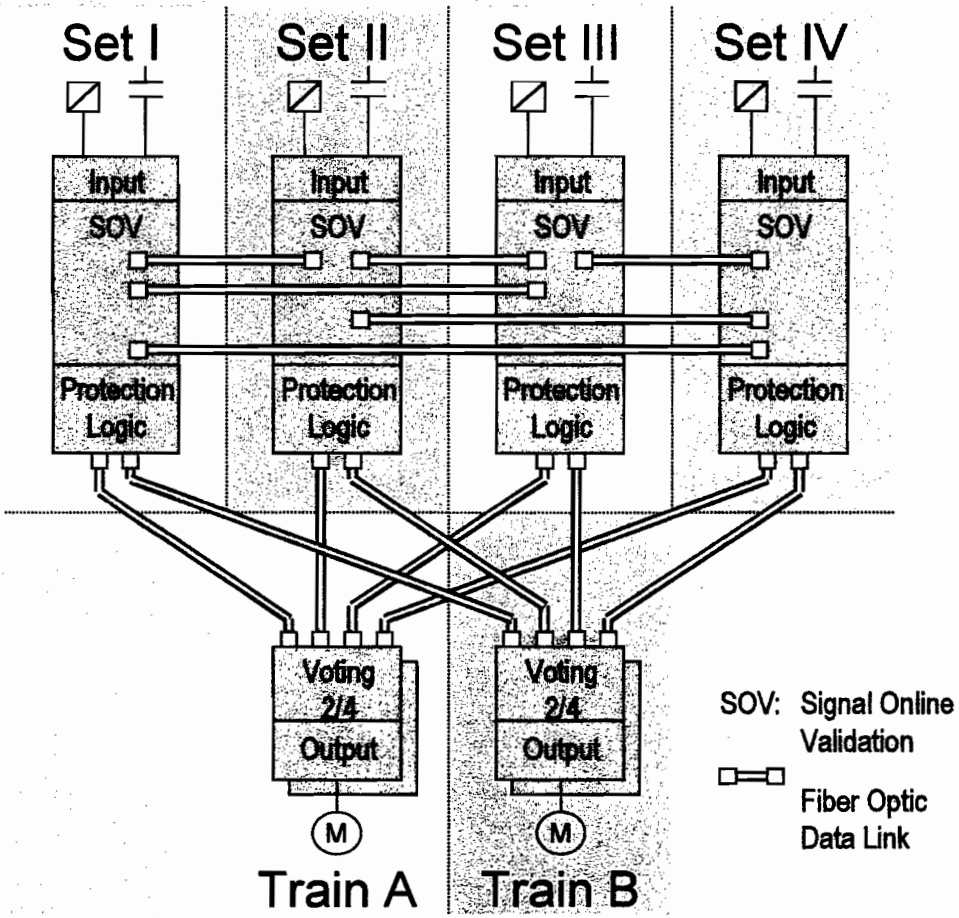
"4 Set / 2 Train" Digital Reactor Protection System (Example) Internal Structure and Data Links - ESF Actuation

Data Acquisition

Processing
(Plant Protection Functions)

Actuation Voting - Digital
(Inadvertent Actuation Protection)



TELEPERM XS

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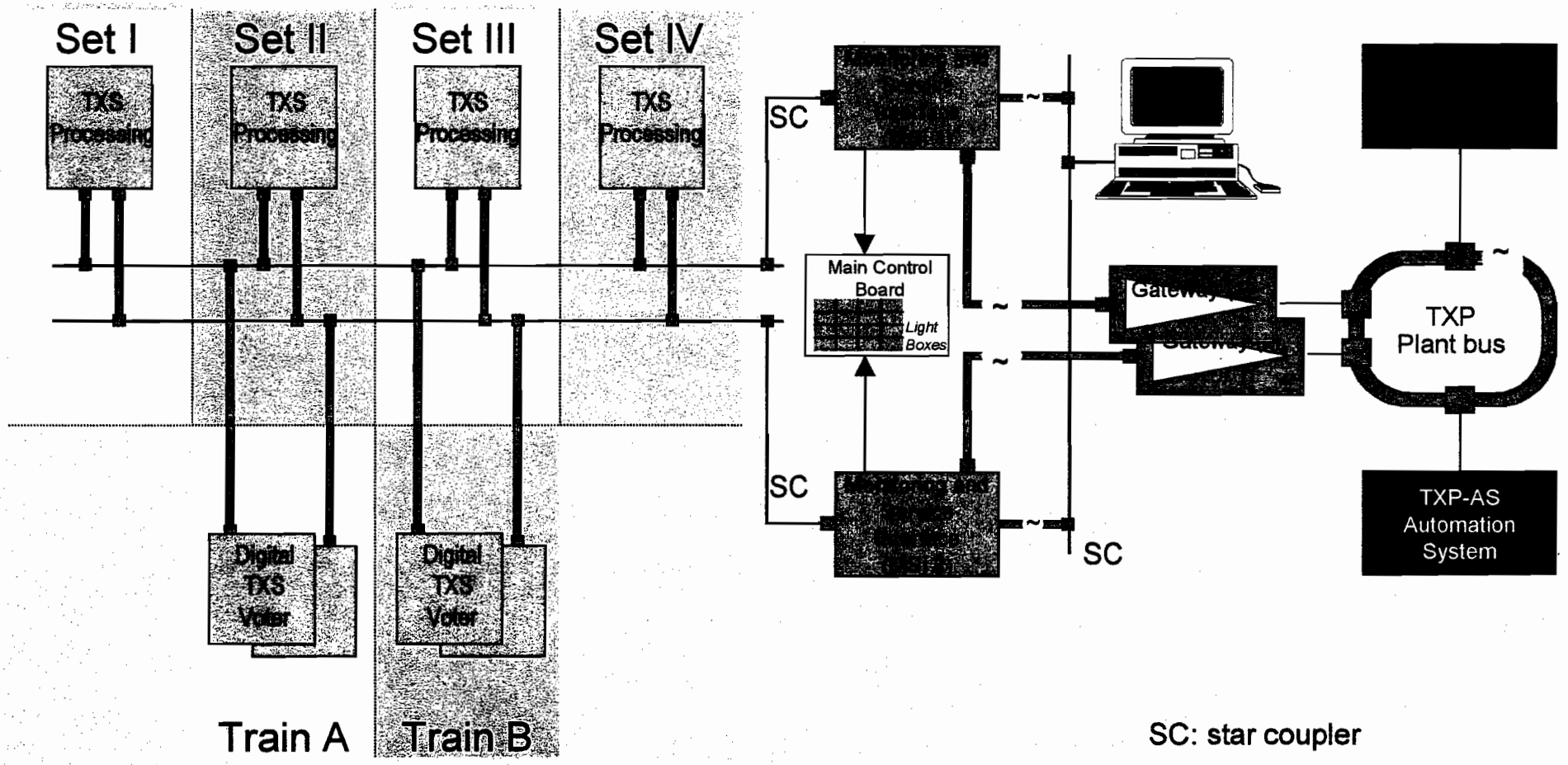
TELEPERM XS - Example of a Protection System Configuration Monitoring and Service Interconnections

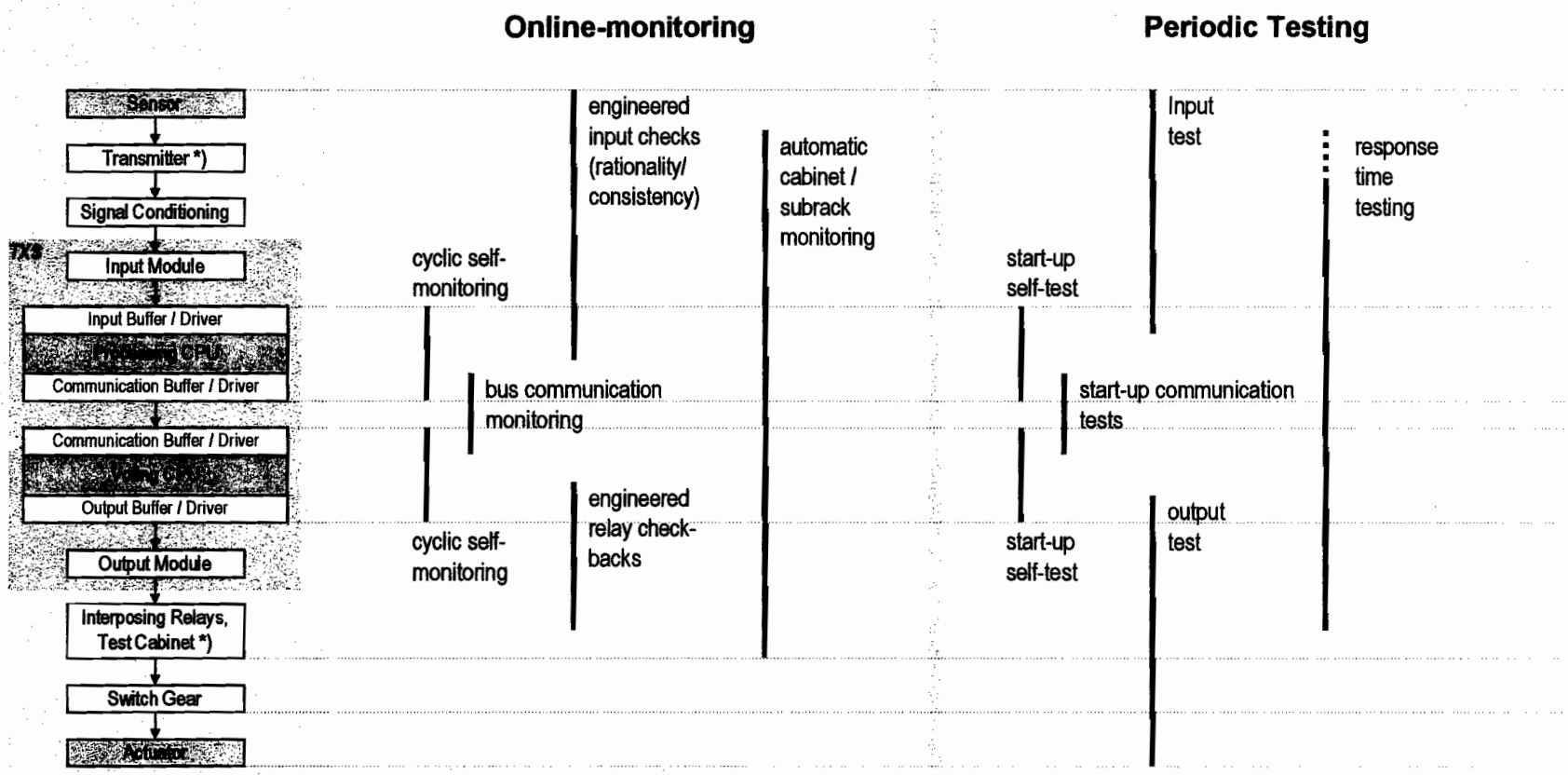


SC: star coupler

TELEPERM XS

SIEMENS

Periodic Surveillance Test Concept
Overlapping Tests of Actuation Path Implemented in TELEPERM XS



*) where necessary

TELEPERM XS

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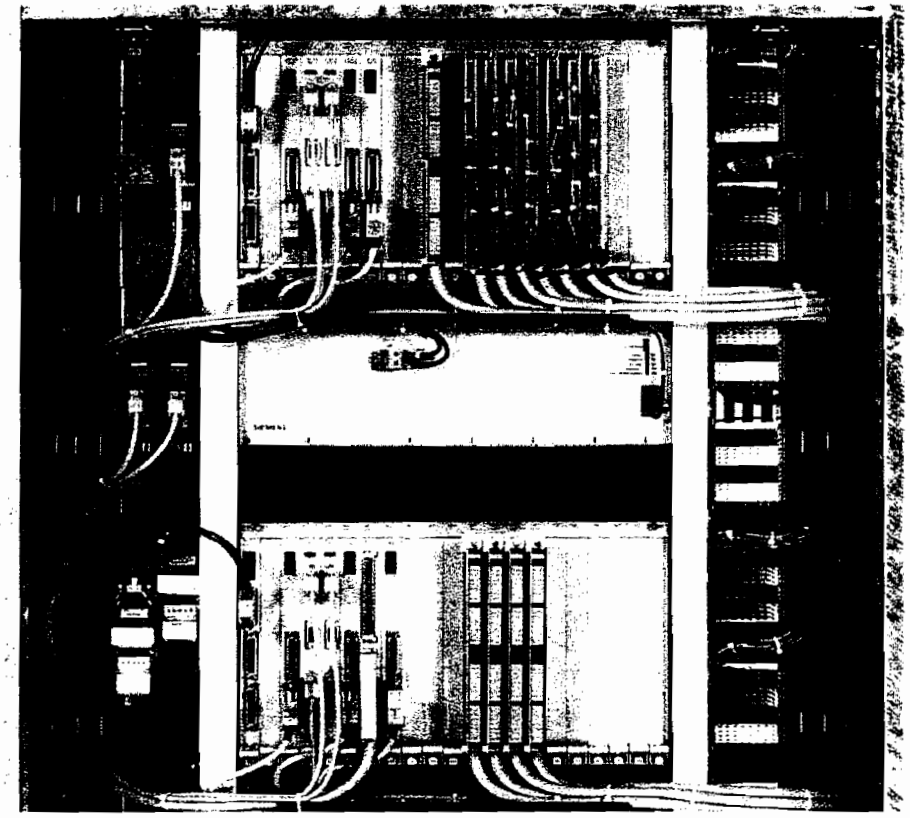
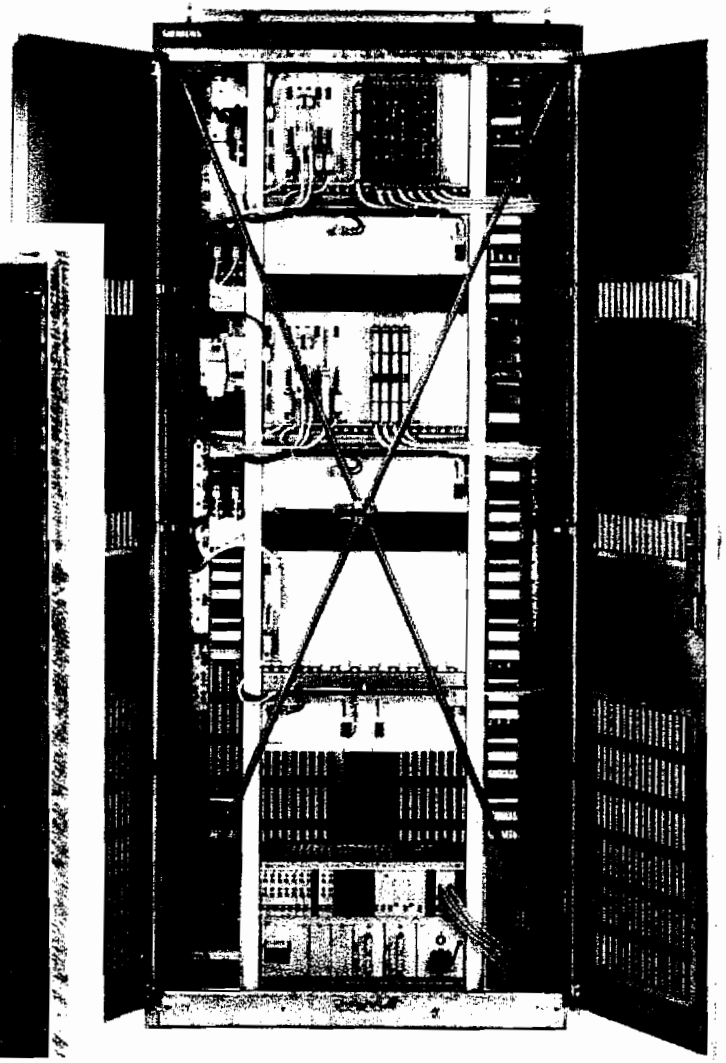
TELEPERM XS
Cabinet





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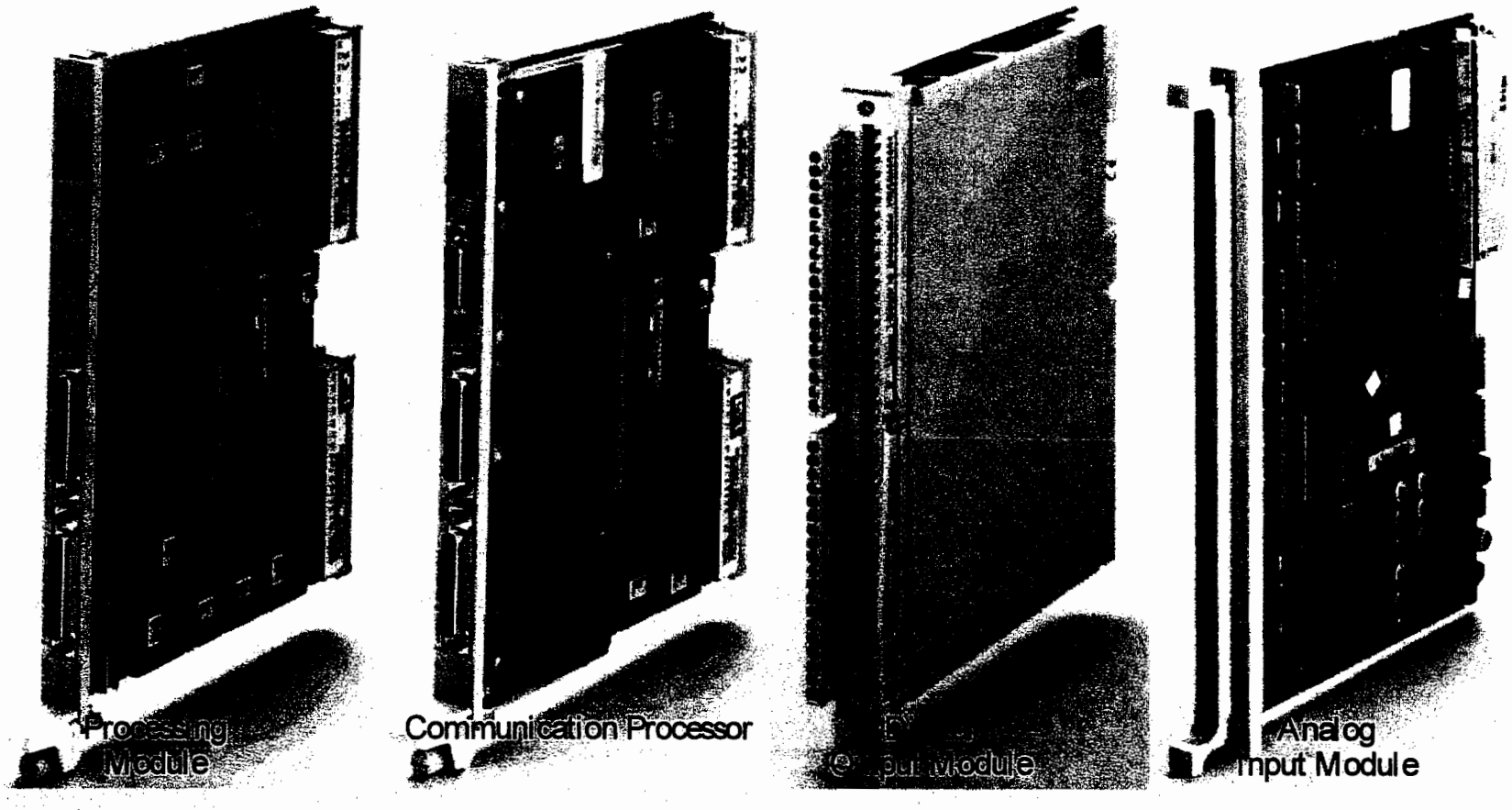
TELEPERM XS Modules - Examples



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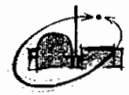

TELEPERM XS

- Key Features -

TELEPERM XS Key Features

- **Overall System Key Features**
  - Part of the Integrated Architecture Solution
  - Process data exchange between channel sets for automatic signal validation
  - Extremely flexible and modularized system for all safety I&C applications
  - Fail-safe behavior
  - Surveillance testing

- **Hardware**
  - I/O modules from Siemens' industrial PLC line
  - CPU modules specifically developed for nuclear application
  - Highly reliable equipment
- **Software / Engineering**
  - SW specifically developed for nuclear application (full third party V&V)
  - Deterministic operating system
  - Qualified SW libraries (function blocks)
  - Qualified automatic code generator
  - One common engineering / maintenance / diagnostics tool set

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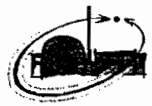

TELEPERM XS/XP

- Siemens Experience in Nuclear I&C Upgrades -

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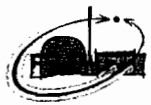

TELEPERM XP/XS Project Reference List (1)

NPP	Type of Reactor	Country	Function	TXP	TXS	In Operation
Callaway	PWR	U.S.A.	Comprehensive I&C	☐	☐	
Comanche Peak Unit 1 + 2	PWR	U.S.A.	Comprehensive I&C	☐	☐	
Brunsbüttel	BWR	Germany	Process Information System	☐		
FRM-II	Research Reactor	Germany	Comprehensive I&C	☐	☐	
Grohnde	PWR	Germany	Process Information System	☐		☐
Neckar 1	PWR	Germany	Reactor Control & Limitation, Rod Control		☐	☐
Neckar 1	PWR	Germany	Water Treatment, Chilled Water System, Primary System Controls	☐		☐
Philippsburg 1	BWR	Germany	Independent Trip & ESFAS		☐	

Status 07/00

SIEMENS

TELEPERM XP/XS Project Reference List (2)

NPP	Type of Reactor	Country	Function	TXP	TXS	In Operation
Philippsburg 1	BWR	Germany	Core Monitoring, Rod Control		☐	
Philippsburg 1	BWR	Germany	Turbine I&C	☐		☐
Unterweser	PWR	Germany	Reactor Control & Limitation, Rod Control		☐	☐
Biblis B	PWR	Germany	Turbine I&C	☐		
Biblis A	PWR	Germany	Replacement limit-value alarm cabinet	☐		
Paks 1, 2	PWR	Hungary	Reactor Protection System, Neutron Flux Measurement		☐	☐
Paks 3, 4	PWR	Hungary	Reactor Protection System, Neutron Flux Measurement		☐	
Bohunice V1, Unit 1	PWR	Slovakia	Reactor Protection & Limitation System, Neutron Flux Measurement, Reactor Control		☐	☐

Status 07/00

SIEMENS

TELEPERM XP/XS Project Reference List (3)

NPP	Type of Reactor	Country	Function	TXP	TXS	In Operation
Bohunice V1, Unit 2	PWR	Slovakia	Reactor Protection & Limitation System, Neutron Flux Measurement, Reactor Control		☐	☐
St. Maria de Garona	BWR	Spain	Rod Control System, Rod Worth Minimizer		☐	☐
St. Maria de Garona	BWR	Spain	Condensate Filter, Water Treatment	☐		☐
Forsmark 3	BWR	Sweden	Rod Control System	☐	☐	
Forsmark 3	BWR	Sweden	Turbine I&C	☐		
Oskarshamn 1	BWR	Sweden	Neutron Flux Measurement		☐	☐
Oskarshamn 3	BWR	Sweden	Turbine I&C	☐		☐
Beznau 1	PWR	Switzerland	Reactor Protection System, NSSS Controls		☐	☐

Status 07/00

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TELEPERM XP/XS Project Reference List (4)

NPP	Type of Reactor	Country	Function	TXP	TXS	In Operation
Beznau 1	PWR	Switzerland	Emergency Feedwater		☐	☐
Beznau 2	PWR	Switzerland	Reaktor Protection System NSSS Controls		☐	
Beznau 2	PWR	Switzerland	Emergency Feedwater		☐	
Muehleberg	BWR	Switzerland	Compensate Level Monitoring System CLMS		☐	☐
Muehleberg	BWR	Switzerland	Ventilation System	☐		☐
Khmelnitzki 1	PWR	Ukraine	Reactor Protection & Limitation System, Neutron Flux Measurement		☐	
Rovno	PWR	Ukraine	Reactor Protection & Limitation System, Neutron Flux Measurement		☐	
Tianwan	PWR	China	Comprehensive I&C	☐	☐	

Status 07/00

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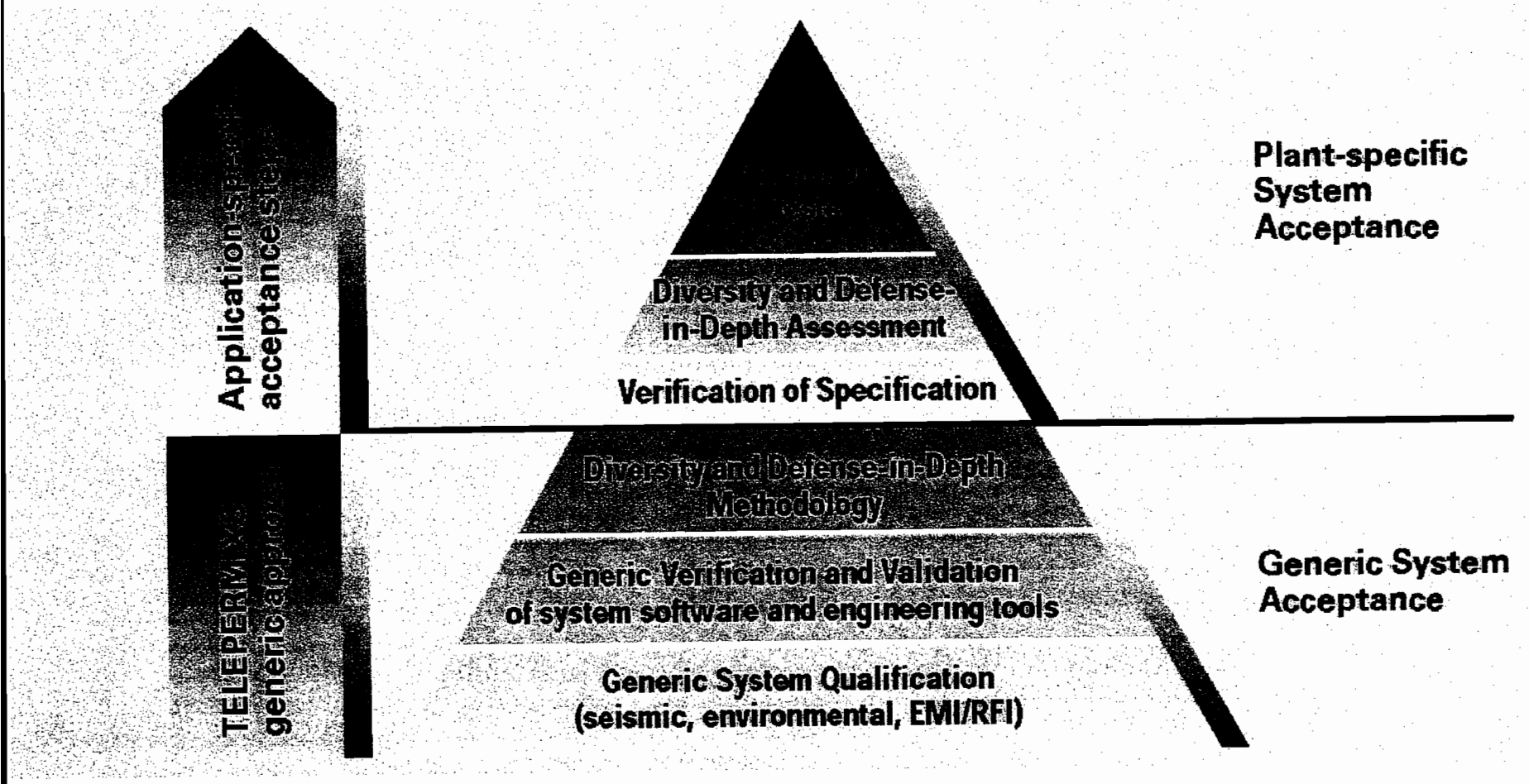
TELEPERM XS

- NRC REVIEW -

SIEMENS

TELEPERM XS Acceptance Approach



TELEPERM XS

Significant Licensing Documents

- **Topical Report EMF-2110(NP)**
  TELEPERM XS: A Digital Reactor Protection System.

- **SPC Report EMF-2341(P)**
  Generic Strategy for Periodic Surveillance Testing of TELEPERM XS Systems in U.S. Nuclear Generating Stations.

- **SPC Report EMF-2342(P)**
  Shielding and Grounding Guidelines for Application of TELEPERM XS.

Significant Licensing Documents

- **SPC Report EMF-2267(P)**
  Siemens Power Corporation Methodology Report for Diversity and Defense-in-Depth.

- **SPC Report EMF-2340(P)**
  Siemens Power Corporation Typical Diversity and Defense-in-Depth Assessment in Accordance with the Methodology of EMF-2267(P).

Significant Licensing Documents

System Architecture Applicable for all Safety System Applications:

- Process Protection System
- Coincidence Logic Voters
- Engineered Safety Features Actuation System
- EDG Load Sequencer
- Safety Related BOP Functions
- Class 1E Controls, etc.

Significant Licensing Documents

- **Equipment Qualification Review**

  Evaluation of TELEPERM XS seismic, environmental, and EMI/RFI qualification test programs with respect to the requirements of EPRI TR-107330 "Generic Requirements Specification for Qualifying a Commercially Available PLC for Safety-Related Applications in Nuclear Power Plants."

- **EPRI TR-114017**

  TELEPERM XS compliance with EPRI TR-107330 "Generic Requirements Specification for Qualifying a Commercially Available PLC for Safety-Related Applications in Nuclear Power Plants."

NRC Review Criteria

NUREG 0800 - Standard Review Plan
Section 7 - Instrumentation and Controls

Branch Technical Position HICB -8
"Guidance for Application of Regulatory Guide 1.22
Periodic Testing of Protection System Actuation Functions."

Branch Technical Position HICB -14
"Guidance on Software Reviews for Digital Computer-Based
Instrumentation and Control Systems."

Branch Technical Position HICB -17
"Guidance on Self-Test and Surveillance Test Provisions."

NRC Review Criteria

- **Branch Technical Position HICB -19**
  "Guidance for Evaluation of Defense-In-Depth and Diversity in Digital Computer-Based Instrumentation and Control Systems."
- **EPRI TR-107330**
  "Generic Requirements Specification for Qualifying a Commercially Available PLC for Safety-Related Applications in Nuclear Power Plants."
- **EPRI TR-102323-R1**
  "Guidelines for Electromagnetic Interference Testing in Power Plants."

Siemens TELEPERM XS Plant-Specific Interface

- Diversity and Defense-in-Depth Assessment in accordance with the methodology of Siemens Report EMF-2267(P).
- Safety analysis confirmation for accuracy and time response.
- Technical specification confirmation for periodic test interval and use of bypass mode in accordance with SPC Report EMF-2341(P).
- Confirmation of plant-specific environment in accordance with EPRI TR-107330 and EPRI TR-102323-R1.
- Plant-specific annunciator and status light arrangement.
- Plant-specific configuration management procedures

TELEPERM XS NRC Review

NRC Conclusion:

"Based on the information provided and the review conducted, the staff concludes that the design of the TXS system is acceptable for safety-related instrumentation and control (I&C) applications and meets the relevant regulatory requirements."

Common Q (Qualified) Platform

Presentation to

Advisory Committee on Reactor Safeguards

Meeting of the Subcommittee on Plant Systems

October 31, 2000

Ken Scarola - Chief Technologist

Westinghouse Nuclear Automation

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Westinghouse Participants

- Denny Popp
  - Manager Licensing
- Mark Stofko
  - Manager Protection Systems
- Marty Ryan
  - Lead Engineer Hardware Qualification
- Warren Odess-Gillett
  - Lead Engineer Software Qualification

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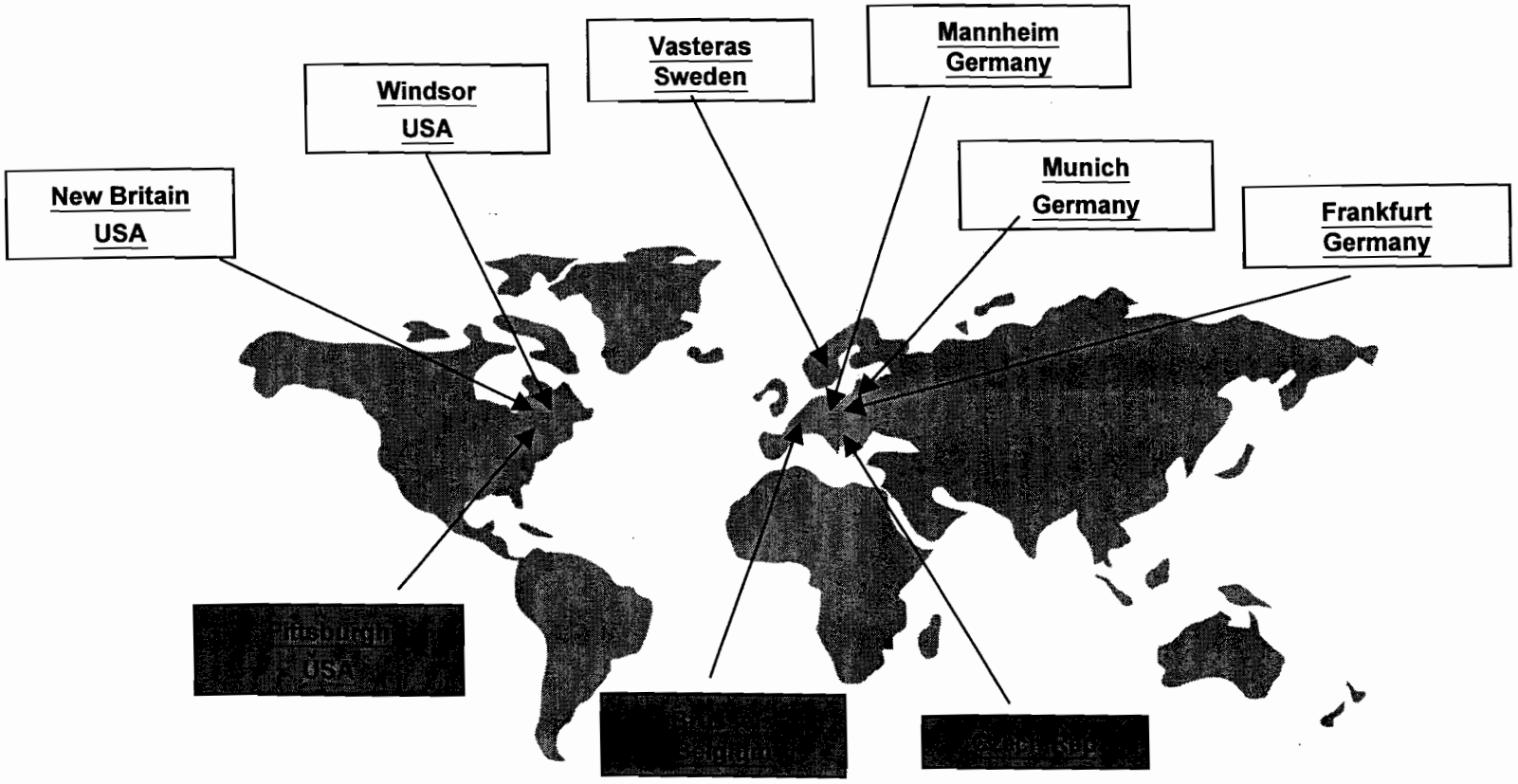
Westinghouse Nuclear Automation

Approximately 1000 People Dedicated to Nuclear I&C



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Common Q Program Objective

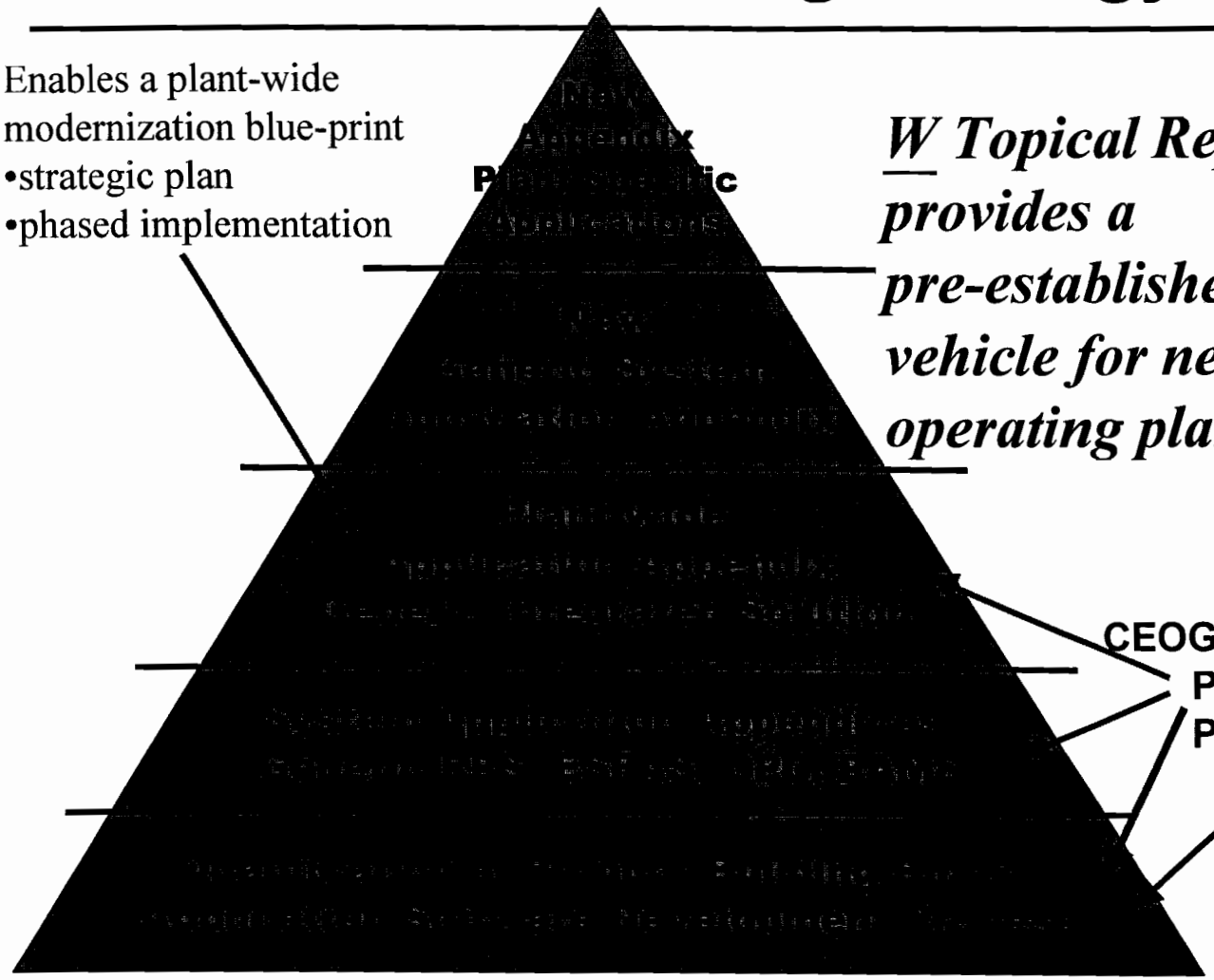
- A Class 1E qualified I&C platform
- Composed of building blocks applicable to all safety applications
    - Post Accident Monitoring Systems
    - Reactor Protection Systems
    - Engineered Safety Features Actuation Systems
    - Other Class 1E Systems
        - Diesel sequencers
        - Complete Class 1E Component Control
- To accommodate various modernization strategies
    - System replacement
    - Plant-wide modernization

Common Q Program Objective

- Address Key Utility Issues for Modern Plant I&C Systems
  - Utilization of industrially proven products
    - to ensure low operational risk, high availability
  - Maximum standardization
    - to minimize O&M costs
    - but diversity to cope with Common Mode Failure (BTP - 19)
  - Pre-licensed
    - to minimize licensing risk
    - to ensure expectations are achieved for high reliability with reduced manual surveillance
  - Supplier proactive program for long term obsolescence protection
    - ensure new equipment is not next years obsolescence problem

Common Q Licensing Strategy

Enables a plant-wide modernization blue-print
- strategic plan
- phased implementation



W Topical Report approach provides a pre-established licensing vehicle for new plants and operating plant upgrades

CEOG/EPRI Program
Phase 2 - AC160
Phase 3 - Flat Panel Display

CPC - Core Protection Calculator
PAMS - Post Accident Monitoring System

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Common Q Licensing

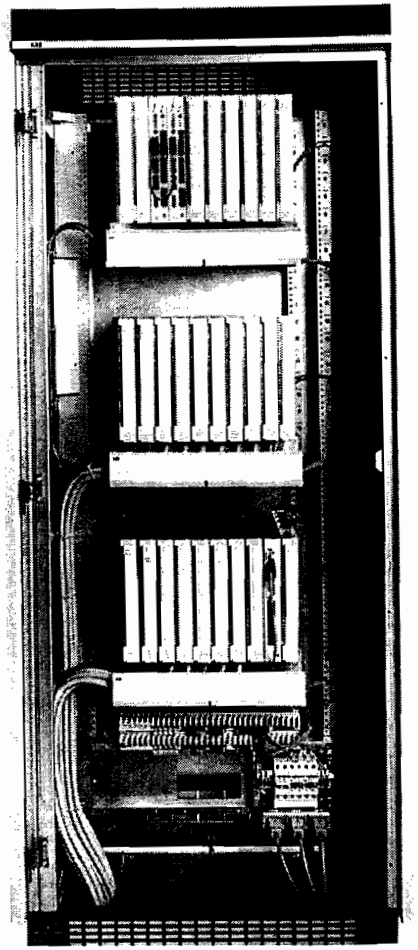
• Generic Topical and Software Program Manual	3/5/99
• Post Accident Monitoring System Appendix	5/10/99
• Core Protection Calculator System Appendix	6/2/99
• Matrix of Compliance to EPRI TR-107330	6/23/99
• Integrated Solution Appendix	7/2/99
• RPS/ESFAS Appendix	7/9/99
• SER Expectations	9/2/99
• Equipment Qualification Report	9/30/99
• QNX Commercial Grade Dedication Report	11/11/99
• AC160 Design & Life Cycle Evaluation Report	11/19/99
• AC160 Generic Operating History Evaluation	11/19/99
• Revised submittals	6/5/00
• NRC SER Issued	8/28/00

Topical Report

- **Main Body**
  - Description of basic building blocks
  - Address all key Standard Review Plan issues for advanced digital systems
    - Hardware and software qualification
    - Configuration management
    - Application development
    - Diversity and Defense-in-Depth
- **Appendices**
  - Appendix 1 - Post Accident Monitoring System
  - Appendix 2 - Core Protection Calculator System
  - Appendix 3 - RPS/ESFAS
  - Appendix 4 - Integrated Solution

Common Q Building Blocks

- ABB Advant Controller - AC160
  - Key product for ABB Fossil Business Unit
    - Since 1997
    - Evolved from AC110 (1993)
  - Used in Turbine and Boiler Control and Protection Systems
    - Certified 7/99 by TuV in Germany for boiler protection systems
  - Up to 27 I/O modules with up to 1500 I/O points
  - Supports up to six parallel processors
  - Deterministic operating system
    - Including back-plane and network communications
  - Extensive self-diagnostics



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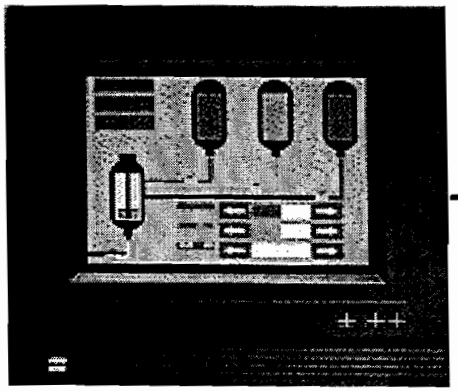
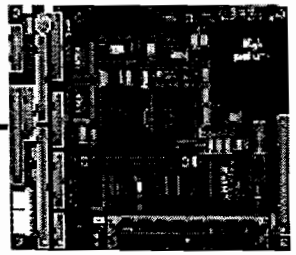
Common Q Building Blocks

- ABB Advant Fieldbus - AF100
  - Multi-drop configuration with up to 79 nodes
    - Node fault does not affect bus communication
  - Deterministic bus
    - Bus mastership rotates with token
    - 1.5 Mbit/s
  - Configurable transmission cycles
    - 1,2,4,8,...4096 ms
  - Optical fiber media
  - Self-diagnostics
  - Automatic reconfiguration after failures are repaired

Common Q Building Blocks

- Flat Panel Video Display System
  - Maintenance & Test Panel in system cabinet
  - Operators Module in Main Control Room





AF 100

Ethernet/TCPIP

- Color Thin Film Transistor Technology
- Touch Screen
- Embedded X86 Processor
- QNX Operating System
- Photon Graphical User Interface

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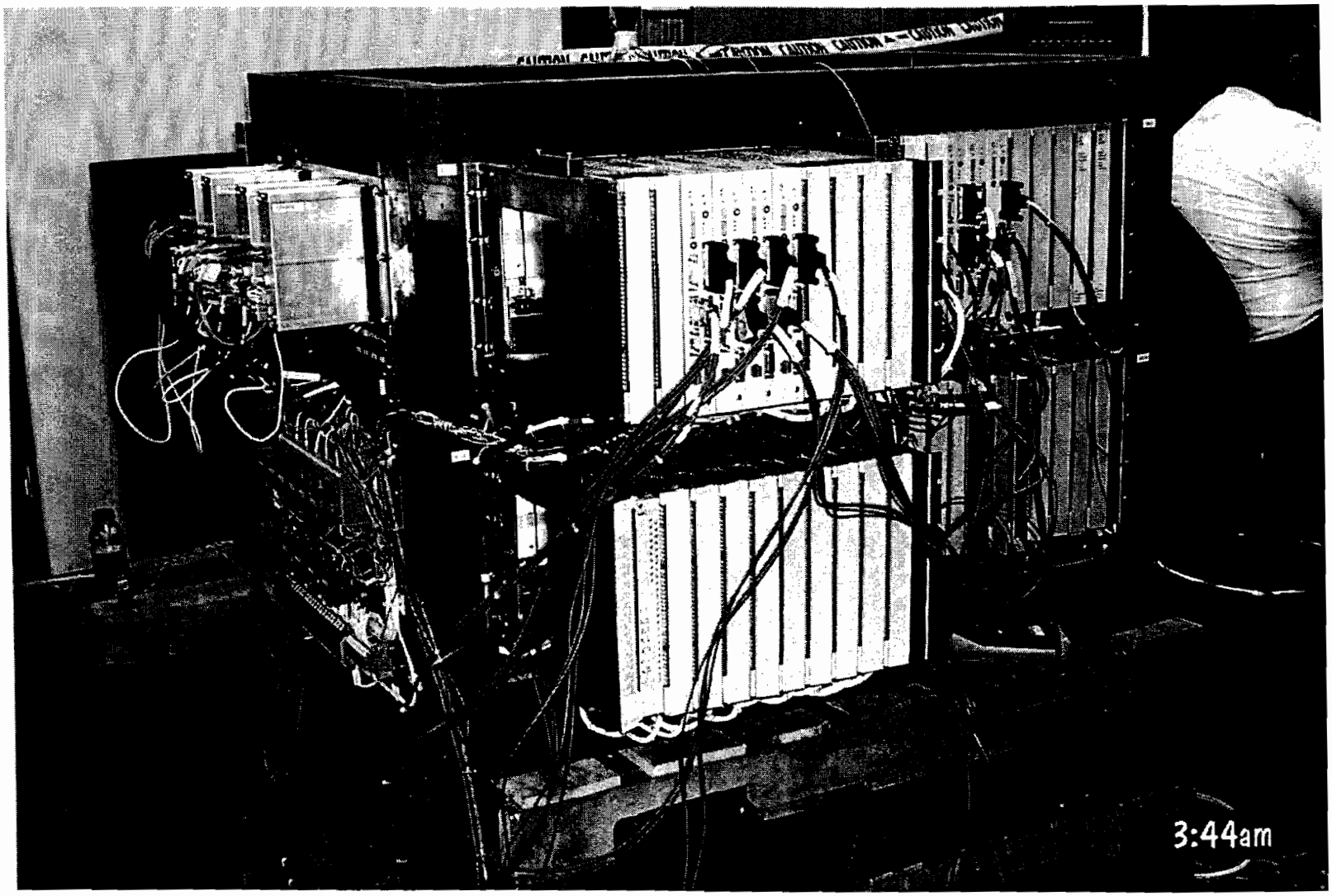
Equipment Qualification

- Qualification tests
  - Electromagnetic Interference (EPRI TR - 102323)
  - Environmental (IEEE - 323)
  - Seismic (IEEE - 344)
    - •Qualification tests included criteria which embody requirements for target markets
      - •US, Korea, China, Europe
- Testing completed on AC160
- Additional EQ testing to be completed 1st Qtr 2001
  - Flat Panel Display
  - Power Supplies
  - PM646A
    - • latest AC160 processor

Environmental / Seismic Test Specimen



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Software Qualification (IEEE 7- 4.3.2-1993)

- **Product Software**
  - **ABB - Advant Controller Base Software**
  - **QNX Software Systems Limited - QNX/Photon for Flat Panel Display**
  - Design Life Cycle Evaluation
    - Evaluated OEM software development and life cycle management process for 'equivalence' to nuclear standards
    - Accommodated deficiencies through supplemental review, testing, process change, documentation, application restrictions
  - Generic Operating History Evaluation
    - Reviewed experience in other industries
    - Ensured all applicable problems have been resolved (or will be)
- **Application Software Development Process**
  - Coding standards, testing, documentation including V&V
  - Basis for future NRC submittals

Configuration Management

- Westinghouse agreements and processes with key suppliers ensure:
    - Configuration control of hardware and software
    - pro-active obsolescence management
  - contracts currently in place with ABB, others to follow
- As a result Westinghouse can ensure:
  - N^{th} product is equivalent to qualification specimen
  - 20+ years total obsolescence management

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Diversity and Defense-in-Depth

- Analysis addresses
  - Common mode failures and effects
  - For all postulated initiating events
- Systems using diverse non-safety I&C platform are credited for coping:
  - Control Systems, ATWS system, Supplemental RPS/ESFAS functions
- Perform Bounding Coping Analysis One Time
  - Based on complete plant modernization plan
    - Common Q Integrated Solution
  - Document diverse I&C equipment credited
  - Confirm applicability for each phase of the upgrade

Topical Report

- **Main Body**
  - description of basic building blocks
  - address all key SRP issues
    - hardware and software qualification
    - configuration management
    - application development
    - common mode failure
- **Appendices**
  - Appendix 1 - PAMS
  - Appendix 2 - CPC
  - Appendix 3 - RPS/ESFAS
  - Appendix 4 - Integrated Solution

Topical Report Appendices

- Generic System Configuration for each application
  - Processor architecture
    - Intra-division and inter-division communication
    - Expected variations
  - Plant interfaces
  - Automatic test, manual test and bypass features
- Failure Modes and Effects
- Technical input for
  - 50.59 evaluations
  - Tech Spec changes (for extended manual test intervals)
- Systems in
  - Stand alone configurations
  - Integrated together as in a plant-wide modernization

A full spectrum of Class 1E systems can be implemented with the Westinghouse Common Q platform

- Reactor Protection System
- Engineered Safety Features Actuation System
- Core Protection Calculators
- Post Accident Monitoring Systems
- RG 1.97 Displays & Recorders
- Diesel Load Sequencer
- Class 1E Component Controls

Current Common Q Applications

- Oskarsham 1 Modernization - Sweden
  - RPS, ESFAS, Diesel Load Sequencer, Class 1E Component Control (including discrete HSI)
  - operation 2001
- Ulchin 5&6 - South Korea
  - RPS, ESFAS
  - operation 2003
- Ringhals 2 - Sweden
  - RPS, ESFAS, Diesel Load Sequencer, Class 1E Component Control (including discrete and Video HSI)
  - operation 2004
- KEDO 1&2 - North Korea
  - RPS, ESFAS
- Modernization planning with several US utilities

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Advant Technology Currently in Nuclear Facilities

- Forsmark 1 and 2 - Sweden
  - All Reactor and Turbine Control systems and HSI
  - Strategic partnership for complete I&C modernization
- TVO I and II - Finland
  - Neutron flux measurement
  - Turbine control and protection
  - Plant Computer with new HSI
- Beaver Valley 1 - US, and Ringhals 2 - Sweden
  - CERPI - Replacement for early Westinghouse Analog Rod Position Indication system
    - uses AC160 predecessor - AC110

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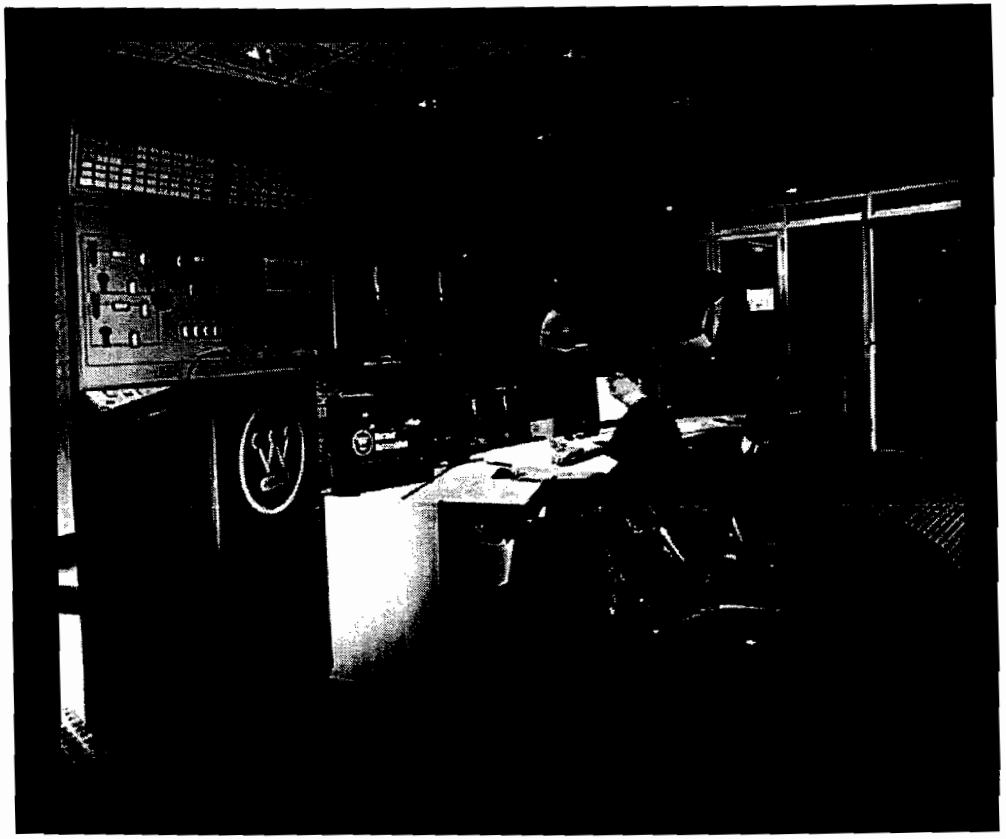
Common Qualified Platform - Summary

- **One common solution provides**
  - Reduced technical support costs
  - Reduced unique spare parts
- **Modern technology provides**
  - Improved reliability with extended manual surveillance intervals, due to
    - Low power consumption electronics
    - Self-diagnostics
    - Automated testing

Westinghouse Nuclear Automation Customer Center

- Located at Nuclear Automation Headquarters in Pittsburgh, PA
- Opened in July, 2000
- Multi-purpose Design
- Product Display Area
- Nuclear Power Plant "Control Room" Look
- Demonstrates Westinghouse's commitment to nuclear I&C



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NRR Review of Topical Reports of Commercial, Off-the-Shelf Digital Instrumentation Systems in Nuclear Power Plants

October 31, 2000

Evangelos C. Marinos, Chief
Instrumentation and Controls Section
Electrical & Instrumentation & Controls Branch
Division of Engineering, NRR

Reasons for Replacing with Digital Equipment

- Analog equipment are becoming obsolescent and replacement is difficult to obtain
- Plant components are aging and maintenance costs are increasing since vendors are not supporting analog equipment
- Digital equipment and components are readily available, with potential for performance and reliability improvements
- Nuclear utility replacement include RPS, ESFAS, Monitoring Systems, and BOP Control and electrical Systems

Topical Report Review Status

Vendor	Subject	Platform	Submittal Date	Status
Siemens	Teleperm XS	1486DX	10/5/98	Review Completed on 3/2000
Westinghouse	ASICS	Custom	11/9/98	Expected completion 11/2000
ABB-CE	Common Q	AC160	4/26/99	Review completed on 8/2000
Westinghouse	E-3	Intel Pentium	8/2/99	Withdrawn - No restart expected
Triconex	Triconex PLC	NS32	10/5/00	Meeting with Triconex scheduled for 11/17/00

Review Guidance

- **Principal Guidance contained in SRP Chapter 7 and IEEE Standards 603 (RG 1.153) and 7-4.3.2 (RG 1.152), include:**

  - Software Reviews - (HICB-14)
  - Defense-in-Depth and Diversity (HICB-19)
  - Real-Time Performance (HICB-21)
  - On-Line and Periodic Testing (HICB-17)
  - Level of Detail for Design Certification applications (HICB-16)
  - Programmable Logic Controllers (HICB-18)
  - Verification, Validation, Reviews & Audits - RG 1.168 (IEEE 1012 & 1028)
  - Software Configuration Management - RG 1.169 (IEEE 828 & 1042)
  - Software Test Documentation - RG 1.170 (IEEE 830)
  - Software Unit Testing - RG 1.171 (IEEE 1008)
  - Software Requirements Specification - RG 1.172 (IEEE 830)
  - Software Life Cycle Processes - RG 1.173 (IEEE 1074)

- **Since most systems first used overseas, NRC is cooperating with foreign regulators**

Challenges in Review of Digital Systems

- Rapidly changing software engineering technology
- Discontinuous performance (sequential operation of tasks)
- Software reliability
- Undetected Design errors
- Incomplete testing
- Potential for common mode/cause failure due to software errors
- Complexity of previously designed operating systems, and software tools.
- Equipment sensitivity to environment - temperature, humidity, EMI/RFI, power quality, surges, grounding, static electricity

Topical Report Reviews

- Adequacy of commercial-grade dedication process to assure safety-grade quality of platform
- System requirements, hardware and software specifications, and equipment qualification documents and test data
- Formal design process (design life cycle) and implementation in design of hardware and software
- Adequacy of configuration management of system and software
- Design documentation and outputs
- Verification and validation activities of software (independence of V&V staff)
- Environmental qualification of platform hardware
- Interface with existing equipment including human-machine interface changes
- Communication between channels, modules, etc
- Timing requirements

Plant-specific Reviews

- Plant Specific System requirements
- Design details
- Hardware differences and existing plant equipment interfaces
- Application specific software and integration with qualified platform
- Control room design details
- Technical specification modifications
- Defense-in-depth and diversity determination
- Implementation of design

Siemens Teleperm XS Review

- SER issued on 5/5/2000
- Siemens Teleperm XS found acceptable, with the following open items:
  - Power supply to be qualified in accordance with EPRI TR-107330.
  - Environmental qualification test at maximum temperature in accordance with EPRI TR-107330.
  - Seismic qualifications.
  - EMC qualification tests in accordance with EPRI TR-102323.

Siemens Teleperm XS Review
(Continued)

- **Items to be addressed in Plant-specific review in addition to standard items:**
  - **Setpoint analysis.**
  - **Accident analyses to confirm that the TXS RTS consistent with Chapter 15**
  - **Proposed plant-specific Technical Specifications including periodic test interval and use of bypass mode for test and maintenance.**
  - **Power supply complies with EPRI TR-107330 requirements.**
  - **Isolation devices qualified in accordance with EPRI TR-107330.**

Westinghouse / CE Common Q Review

- SER issued on 8/2000
- Westinghouse / CE Common Q found acceptable, with the following open items:
  - FPDS limited for non-safety functions, not presently used for initiation of automatic safety-related functions
  - The FPDS hardware and other non-AC160 hardware have not undergone commercial-grade dedication
  - Proposed STS changes awaiting approval by NEI Technical Specification Task Force (TSTF) before staff review.

Westinghouse / CE Common Q Review
(Continued)

- **Items to be addressed in Plant-specific review in addition to standard items:**
  - **Suitability of the S600 I/O modules for plant-specific input/output requirements.**
  - **Plant environmental data (i.e., temperature, humidity, seismic, and electromagnetic compatibility) enveloped by Common Q qualification.**
  - **Plant specific hardware and software life cycle process.**
  - **Common Q timing analysis and validation tests to plant-specific requirements for accuracy and response time for accident analyses.**
  - **Modifications to plant specific procedures and TS.**
  - **Capacity of shared resources to accommodate load requirements.**

Conclusion

- Staff expects plant-specific submittals using Siemens Teleperm XS and Westinghouse / CE Common Q in the near future.
- Review of Triconex PLC and Westinghouse ASICS is ongoing.
- Seeking to increase our qualified staff for conducting digital reviews.
- I&C staff are participating in training programs, conferences and periodically meet with foreign regulators on order to remain current with technology changes.
- NRR has submitted user needs to research for advanced issues. This was the subject of a previous ACRS briefing.