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

June 20, 1988

Project No. 675

APPLICANT: Combustion Engineering, Inc.

FACILITY: CESSAR-DC, System 80+ Design

SUBJECT: SUMMARY OF MEETING WITH COMBUSTION ENGINEERING TO DISCUSS CONTROL ROOM DESIGN - HUMAN FACTORS PROGRAM - SYSTEM 80+

INTRODUCTION

A meeting of the staff with representatives of Combustion Engineering (CE) was held at the NRC offices in Rockville, Maryland, on May 19, 1988. The purpose of the meeting was to discuss Combustion Engineers Human Factors Program in the design of the Control Room for CESSAR-DC, System 80+. Enclosure 1 provides the list of attendance to the meeting. Enclosure 2 provides the viewgraphs which CE used during their presentation.

DISCUSSION

The meeting was primarily to describe the Human Factors Program as applied to the Control Room design and to obtain NRC feedback early in the design. The Control Room design will follow the concepts the NUPLEX 80 reference design used for the advanced control center for the TVA Yellow Creek 1 and 2. NUPLEX 80+, the instrumentation and controls for System 80+ will be the NUPLEX 80 plus specific changes to improve man-machine interface, reduce construction and maintenance costs and enhance fault tolerance. The viewgraphs provide a clear discussion of the CE philosophy in the design of the control room. Although a full control room layout was presented, it was noted that CE only intended to provide documentation for controls and instrumentation of the reactor coolant system. The staff noted that this was not consistent with what was implied in the draft licensing review basis which indicated that a complete control room design was going to be furnished in the System 80+ design. Also that the philosophy of design of all instrumentation and controls based on the philosophy applied to the RCS may not be relevant.

The staff advised CE that the NUPLEX 80+ design would be evaluated in the context of 10 CFR 50.34 until evaluation criteria for advanced control room design are developed by the NRC. In that context, the staff approval would require "......a control design that reflects state-of-the-art human principles....." and that provides a display of "a full range of important plant parameters and data trends on demand, and capable of indicating when process limits are approached or exceeded." The design should also "provide for automatic indication of the bypassed and operable status of safety systems." The staff noted that the preliminary design discussed at the meeting did not appear to fully satisfy the requirements, e.g., process limits and alarm setpoints are not provided on the system that is intended to satisfy the safety parameter display function.

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It was suggested that the alarm setpoints be shown on the meters. In addition, displays intended to monitor the bypassed and operable status of safety systems are not designed to be fully automatic. Regarding the requirements for "state-of-the-art" human factors design, the staff made two points: (1) CE should survey the operating history of similar CE plants to investigate areas that would benefit from the application of human factors design and the implementation of new technology; and (2) CE should justify and document the basis for final design choices among alternatives, e.g., why retention of conventional technology is preferable to the introduction of new control/display technology, or why the introduction of new technology such as "touch screen" controllers do not represent a greater potential source of operator error than conventional technology.

Overall, the staff was favorably impressed with the proposed CE design methodology and the preliminary design. The staff suggested that CE keep the staff appraised as significant design milestones are met so that further meetings and submittals can be scheduled.

This meeting summary was prepared based on inputs provided by J. Stewart and George Lapinsky.

Guy S. Vissing, Project Manager
Standardization and Non-Power
Reactor Project Directorate
Division of Reactor Projects - III, IV,
V and Special Projects

Enclosures:
As stated

Enclosure 1

Attendance List
For
Meeting With Combustion Engineering
Concerning
Human Factors of Control Room Design
for CESSAR-DC, System 80+

Name	Organization
Guy S. Vissing	NRR/PDSNP
S. E. Ritterbush	Combustion Engineering/Licensing
Linda T. Tomasi	Combustion Engineering/Human Factors
Bob Pearce	Combustion Engineering/Human Factors
Ken Scarola	Combustion Engineering/Advanced Instrumentation Design
Daryl Harmon	Combustion Engineering/Advanced Instrumentation Design
Marty Ebert	NUS/LIS
Jim Stewart	NRR/DEST/ICSB
Dick Eckenrode	NRR/DLPQ/LHFB
George Lapinsky	NRR/DLPQ/LHFB
Joe Joyce	NRR/SISC

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original signed by
Guy S. Vissing, Project Manager
Standardization and Non-Power
Reactor Project Directorate
Division of Reactor Projects - III, IV,
V and Special Projects

Enclosures:
As stated

DISTRIBUTION:
Central File
NRC PDR
PDSNP Reading
LRubenstein
GVissing
EHylton
OGC-Rockville
EJordan
JPartlow
NRC Participants
ACRS (10)
TKing

PDSNP	PDSNP	AD:PDSNP
EHylton	GVissing:cw	LRubenstein
06/ /88	06/17/88	06/20/88

Enclosure 2

CESSAR
DESIGN CERTIFICATION
PROGRAM

SYSTEM 80+™
NUCLEAR POWER MODULE

KICKOFF MEETING FOR
NRC HUMAN FACTORS REVIEW

MAY 19, 1988

COMBUSTION ENGINEERING

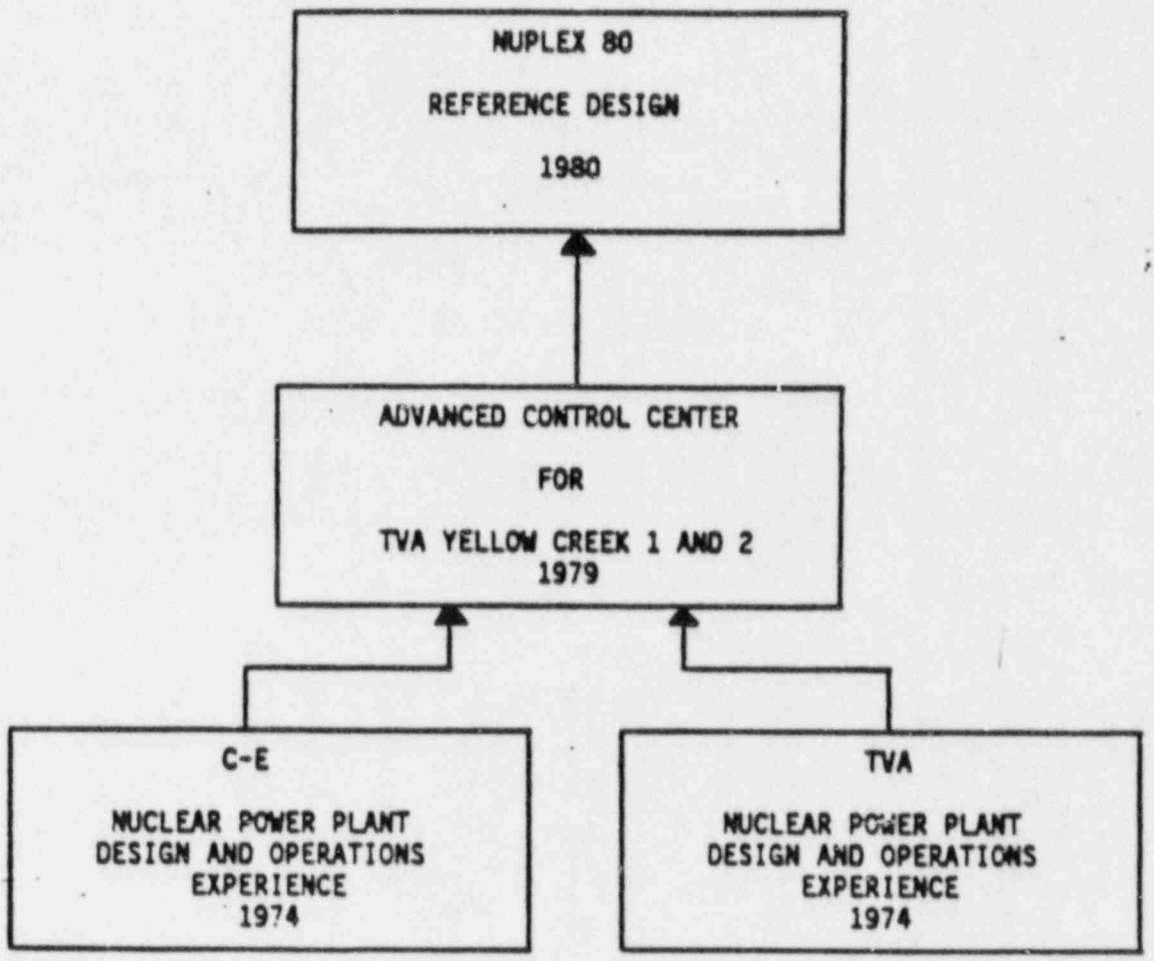
AGENDA

10:00	INTRODUCTION	S. E. RITTERBUSCH
10:10	OVERVIEW OF THE NUPLEX 80+ DESIGN	D. L. HARMON
10:40	NUPLEX 80+ DESIGN PROCESS	D. L. HARMON
11:15	LUNCH	
12:00	HUMAN FACTORS/FUNCTIONAL TASK ANALYSIS	L. T. TOMASI
12:45	CHAPTER 18 FORMAT	D. L. HARMON
1:00	NUPLEX 80+ FEATURES	D. L. HARMON
2:00	CLOSING	S. E. RITTERBUSCH

OVERVIEW OF THE

NUPLEX 80+ DESIGN

SYSTEM 80+


NUPLEX 80
REFERENCE DESIGN
1980
ADVANCED CONTROL CENTER
FOR
TVA YELLOW CREEK 1 AND 2
1979
C-E
NUCLEAR POWER PLANT
DESIGN AND OPERATIONS
EXPERIENCE
1974
TVA
NUCLEAR POWER PLANT
DESIGN AND OPERATIONS
EXPERIENCE
1974

NUPLEX 80
DESIGN OBJECTIVES

- IMPROVED OPERATOR COMPREHENSION
  - HUMAN ENGINEERING PRINCIPLES INCORPORATED FROM START
  - SYSTEM FUNCTION/TASK ANALYSIS
  - SIGNIFICANT UTILITY AND OPERATOR INPUT
- SIMPLIFICATION OF FIELD INSTALLATION
  - MULTIPLEXING TECHNIQUES
  - PREFABRICATED CABLE
- REDUCED MAINTENANCE TIME
  - STANDARDIZED COMPONENTS
  - SOLID-STATE COMPONENTS
- IMPROVED RELIABILITY
  - SYSTEMS APPROACH TO CONTROL COMPLEX

SYSTEM 80+ INSTRUMENTATION AND CONTROLS

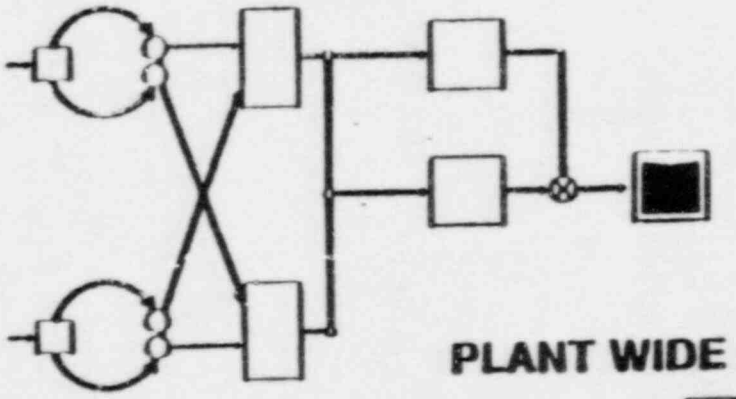
NUPLEX 80+

- NUPLEX 80+ = NUPLEX 80 (TVA - YELLOW CREEK)
  + SPECIFIC CHANGES TO:
  - IMPROVE MAN-MACHINE INTERFACE
    - PLANT OVERVIEW COMPREHENSION
    - ALARM HANDLING
    - FRIENDLY TRANSITION TO ACR
    - OPERATION WITHOUT CRTS
  - REDUCE CONSTRUCTION AND MAINTENANCE COSTS
    - MULTIPLEXING
    - SOFTWARE BASED SYSTEMS
  - ENHANCE FAULT TOLERANCE
    - UNNECESSARY TRIPS
    - EXPOSURE FIRES

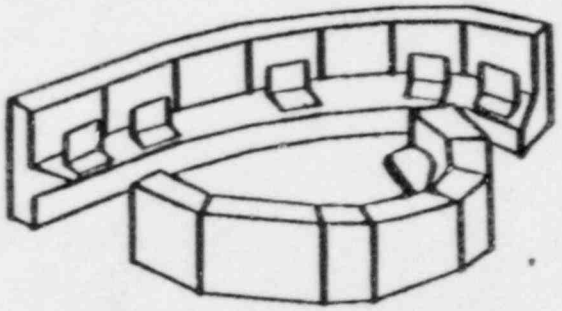
ADVANCED CONTROL COMPLEX

NUPLEX 80+

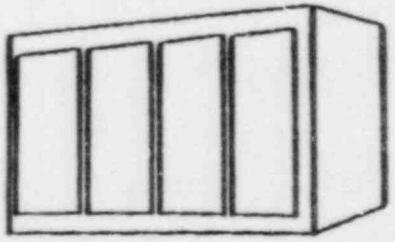
DATA PROCESSING SYSTEM



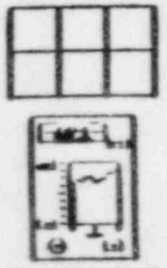
CONTROL CENTER PANELS



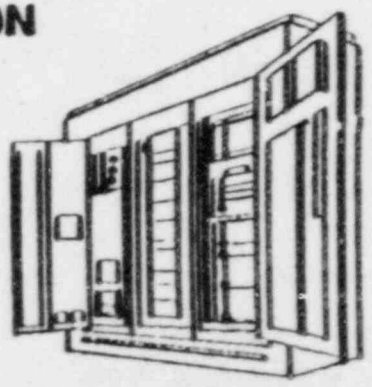
PLANT WIDE INTEGRATION



PLANT PROTECTION SYSTEM



DISCRETE INDICATION AND ALARM SYSTEM



COMPONENT CONTROL SYSTEM

SYSTEM 80+

NUPLEX 80+ OPERATOR STAFFING
DESIGN BASES FOR THE CONTROL ROOM

- TARGET NUPLEX 80+ OPERATING STAFF:

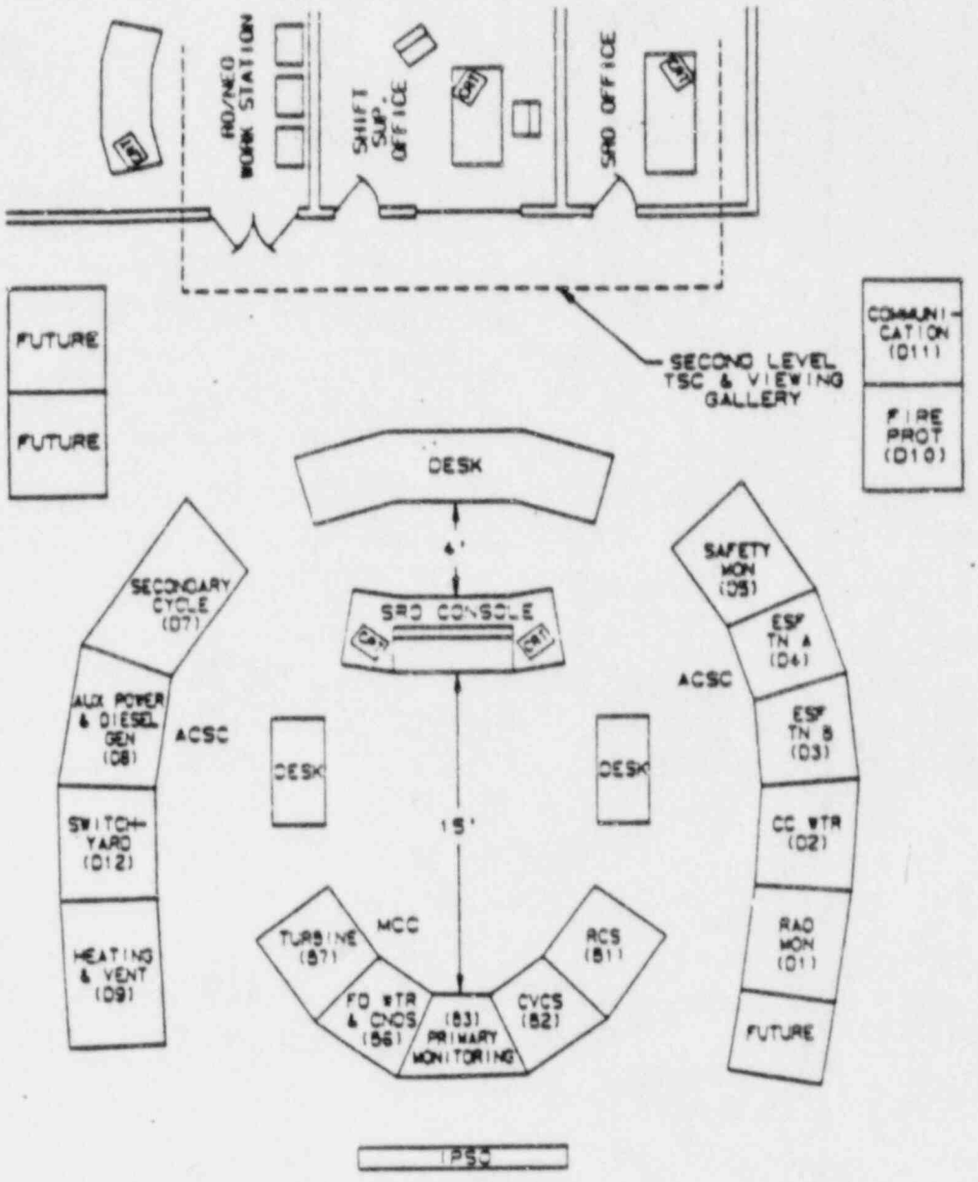
  1 SHIFT SUPERVISOR (SS)
  1 SENIOR REACTOR OPERATOR (SRO)
  2 ASSISTANT REACTOR OPERATORS (ARO)
  1 SHIFT TECHNICAL ADVISOR (STA)
  2 NUCLEAR EQUIPMENT OPERATORS (NEO)

- CONTROL ROOM DESIGNED FOR OPERATIONAL FLEXIBILITY TO MEET THE VARIETY OF STAFFING ASSIGNMENTS EXPECTED AT VARIOUS UTILITIES.

- SELECT WORST CASE STAFFING ASSIGNMENTS TO ESTABLISH DESIGN BASIS CRITERIA FOR CONTROLLING WORKSPACE AND CONTROL ROOM OFFICES.

  A. OPERATION BY SINGLE OPERATOR WITHIN THE CONTROLLING WORKSPACE BETWEEN HOT STANDBY AND FULL POWER.

  B. ACCOMMODATE FULL OPERATING STAFF FOR BOTH NORMAL AND EMERGENCY OPERATION IN CONTROLLING WORKSPACE.



NUPLEX 80+ CONTROL ROOM

[illegible]ATION DISPLAY PHILOSOPHY

- o REDUCE THE NUMBER OF PHYSICAL DISPLAY DEVICES:
  - GROUPED ALARM WINDOWS WITH DYNAMIC MESSAGE DISPLAYS
  - DYNAMIC INDICATORS
  - CRT'S

- o REDUCE THE QUANTITY OF DATA:
  - LIKE SENSOR VALIDATION
  - PARAMETER PRIORITIZATION
  - ALARM ELIMINATION, FILTERING AND PRIORITIZATION

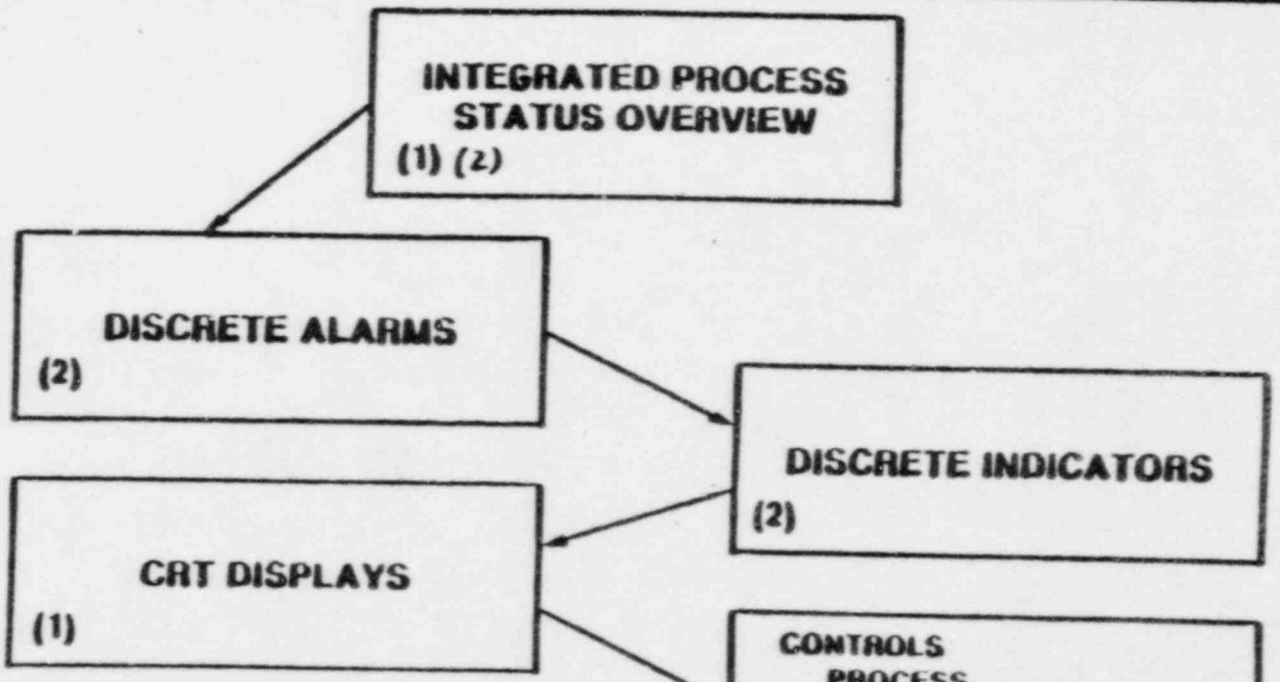
- o PROVIDE REDUNDANCY AND DIVERSITY IN THE DISPLAY SYSTEMS WITH ALL DISPLAYS INTEGRATED SUCH THAT:
  - ALL ELEMENTS OF THE DISPLAY HIERARCHY ARE USED NORMALLY, BUT OPERATION MAY CONTINUE (WITH MINIMAL DEGRADATION TO HUMAN FACTORS) UNDER EQUIPMENT FAILURE CONDITIONS

    AND

  - EQUIPMENT USED DURING ACCIDENT CONDITIONS IS ALSO USED DURING NORMAL OPERATION

INFORMATION DISPLAY HIERARCHY

NUPLEX 80+

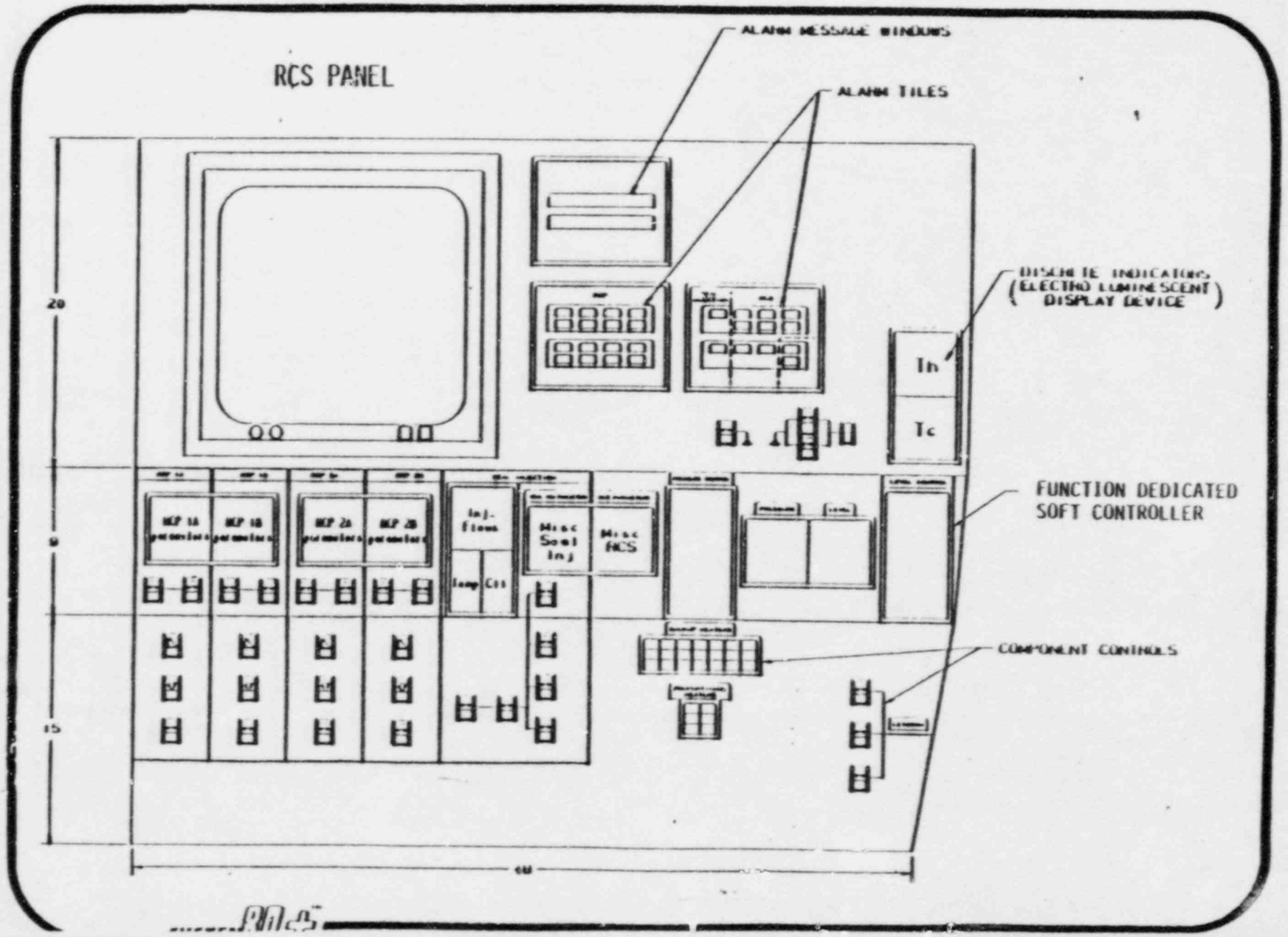


(1) PLANT COMPUTER DRIVEN (DPS)

(2) DRIVEN BY MULTIPLE PROCESSORS (DIAS)

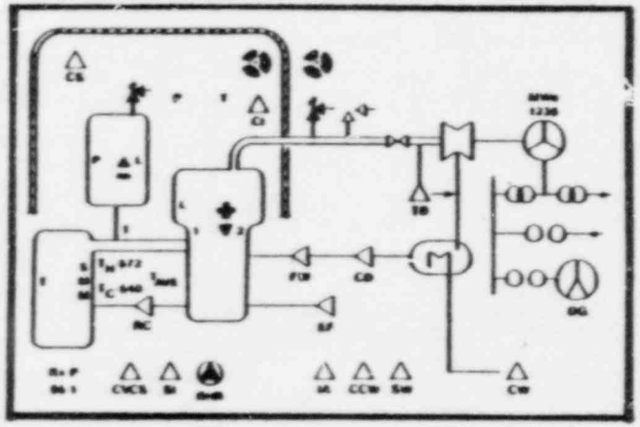
(3) DRIVEN BY INDIVIDUAL PLANT SYSTEMS

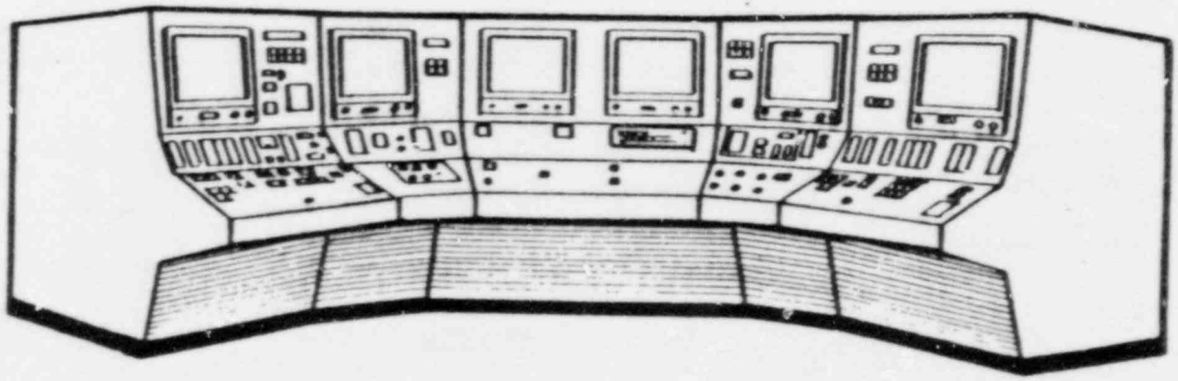
SYSTEM 80+


RCS PANEL
ALARM MESSAGE WINDOWS
ALARM TILES
DISCRETE INDICATORS (ELECTRO LUMINESCENT DISPLAY DEVICE)
Th
Tc
FUNCTION DEDICATED SOFT CONTROLLER
COMPONENT CONTROLS
20
9
15
60

NUPLEX 80+ ALARM SYSTEM FEATURES

- ALARM FEATURES DESIGNED TO SUPPORT OPERATOR DIAGNOSIS
- THREE PRIORITIES OF ALARMS AND A CATEGORY FOR "OPERATOR AIDS"
- PRIORITY 1 AND 2 ALARMS ARE PROCESSED BY BOTH THE DIAS AND DPS
- PRIORITY 3 ALARMS AND "OPERATOR AIDS" ARE ONLY PROVIDED BY THE DPS
- ALARMS INDICATE PROBLEMS - STATUS INFORMATION INDEPENDENT OF ALARM SYSTEM
- ALTERNATE METHODS AVAILABLE FOR ALARM RESPONSE AND DIAGNOSIS

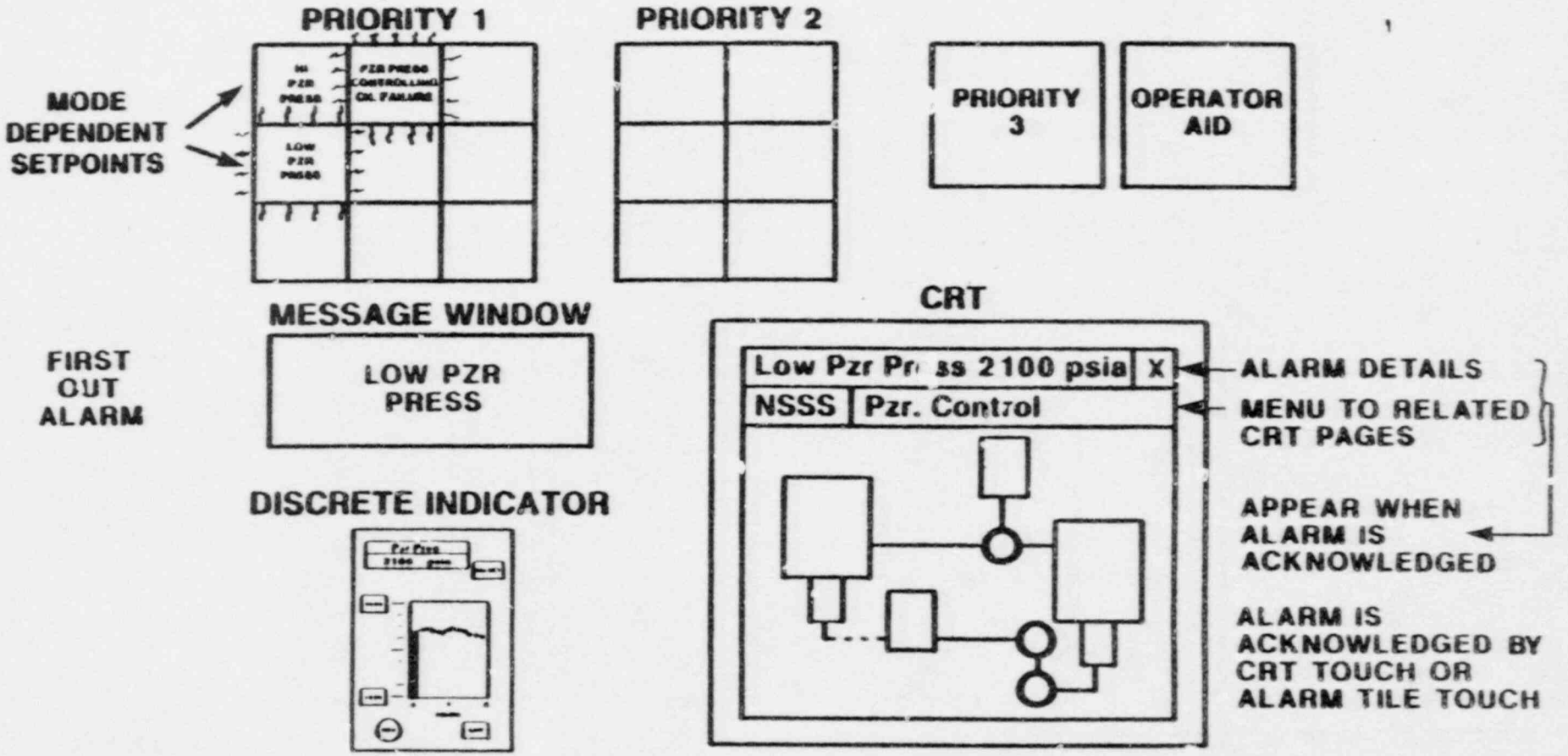




IPSO INFORMATION HELPS AN OPERATOR ESTABLISH PRIORITIES
WHEN A DISTURBANCE AFFECTS A NUMBER OF PLANT FUNCTIONS

RCS PANEL

NUPLEX 80+



NUPLEX 80+ DISCRETE INDICATORS

- PROVIDE CONTINUOUS DISPLAY OF ALL FREQUENTLY MONITORED PLANT DATA.

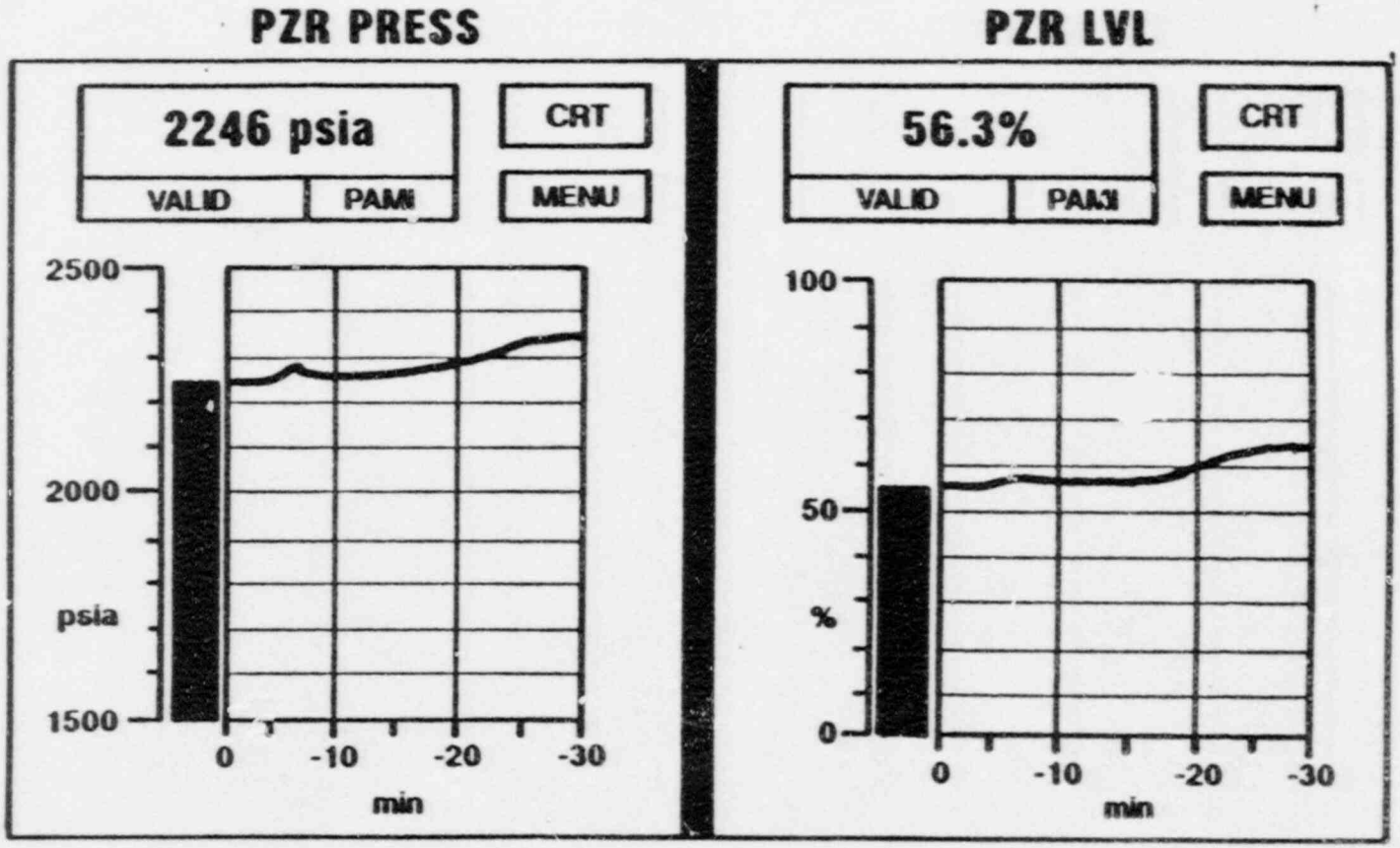
- PROVIDE THE OPERATOR WITH THE MOST ACCURATE VALIDATED INFORMATION.

- PROVIDE REDUCTION OF INDICATIONS THROUGH AUTO RANGING AND SIGNAL VALIDATION TECHNIQUES.

- PROVIDE REDUCTION OF INDICATORS COMPARED TO CONVENTIONAL CONTROL ROOMS THROUGH OPERATOR SELECTABLE DISPLAYS.

- PROVIDE DIRECT ACCESS TO RELATED CRT PAGES.

- PROVIDE ACCESS TO PLANT DATA REQUIRED FOR OPERATION WITHOUT THE PLANT COMPUTER; FUNCTIONALLY INDEPENDENT FROM PLANT COMPUTER.



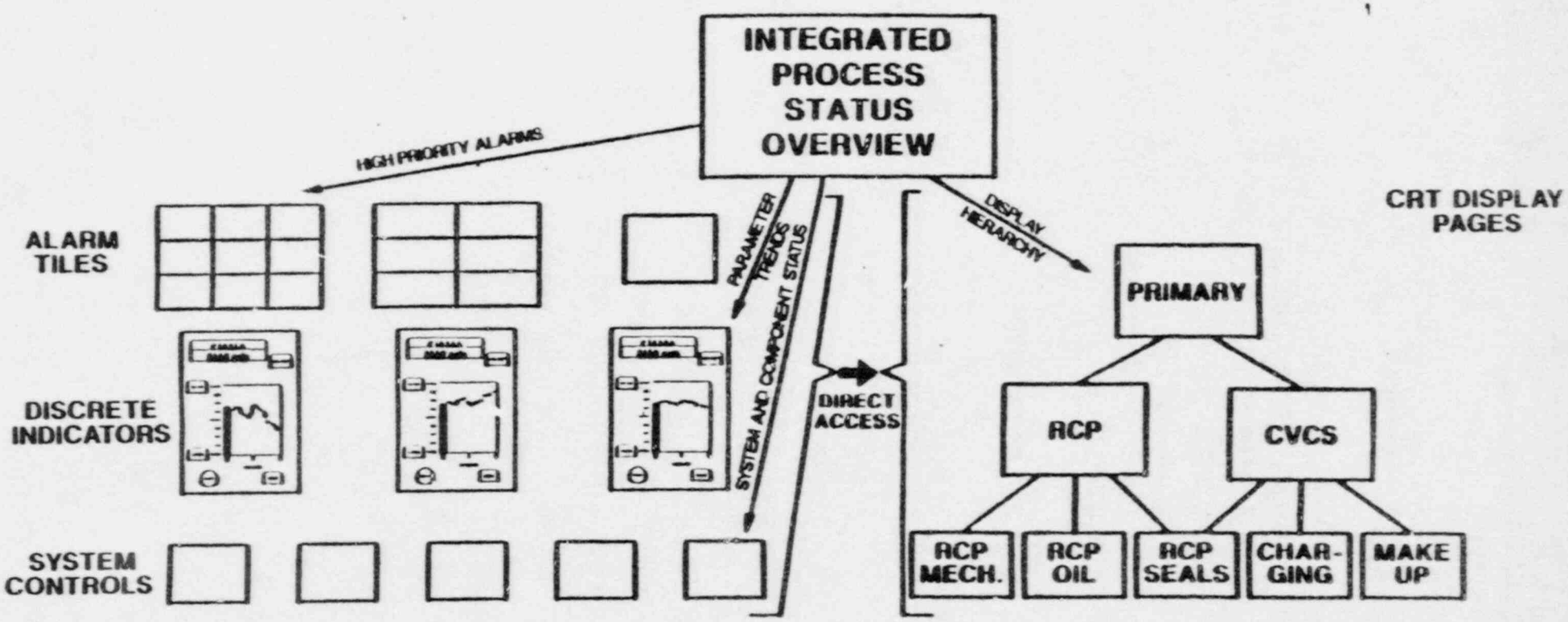
DISCRETE INDICATOR SHOWING NORMALLY INDICATED VALUES FOR PRESSURIZER PRESSURE AND LEVEL

NUPLEX 80+ CRT DISPLAYS

- CRT DISPLAYS PROVIDE ACCESS TO ESSENTIALLY ALL PLANT INFORMATION FROM ANY LOCATION WITHIN CONTROL ROOM OR REMOTE LOCATIONS:
  - DYNAMIC COLOR GRAPHIC PLANT MIMIC DISPLAYS, INCLUDING IPSO
  - ALARMS AND OPERATOR AID INFORMATION
  - PLANT COMPUTER CALCULATED INFORMATION
  - TRENDS AND REPORTS
- IMPLEMENTATION THROUGH NON-SAFETY PLANT COMPUTER.
- DUPLICATES AND VERIFIES ALL DISCRETE ALARM AND DISPLAY SYSTEM PROCESSING AND IDENTIFIES SIGNIFICANT DIFFERENCES.

INTEGRATED INFORMATION PRESENTATION

NUPLEX 80+

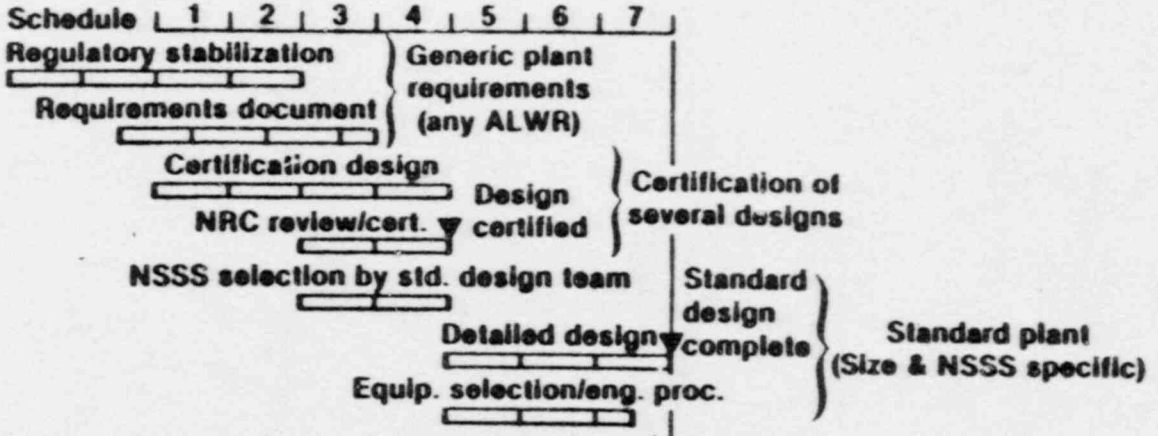


NUPLEX 80+

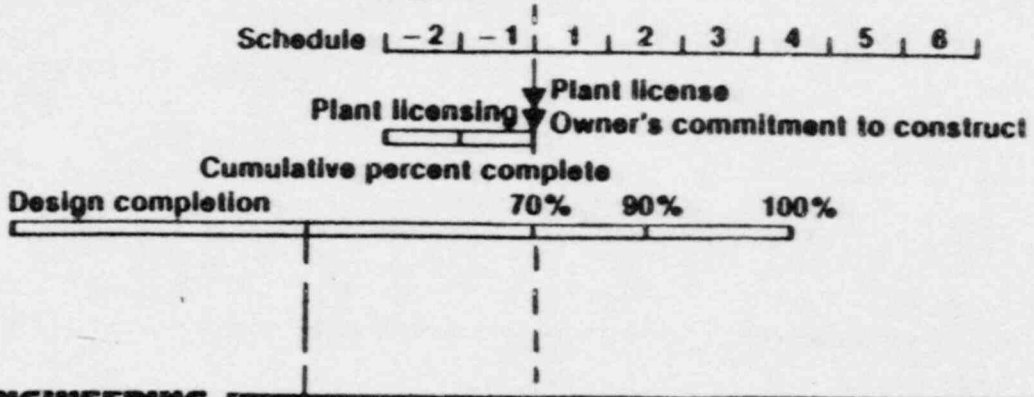
DESIGN PROCESS

ALWR Implementation Logic

- Standard Plant Development



- Specific Plant (First ALWR) Design & Construction



COMBUSTION ENGINEERING

NUPLEX 80+ LICENSING APPROACH

- FOLLOW EPRI ALWR IMPLEMENTATION PHILOSOPHY

- OBTAIN DESIGN CERTIFICATION FOR NUPLEX 80+ CONTROL ROOM THROUGH ACCEPTANCE OF:

  GENERIC CONTROL ROOM CONFIGURATION AND PANEL DESIGN

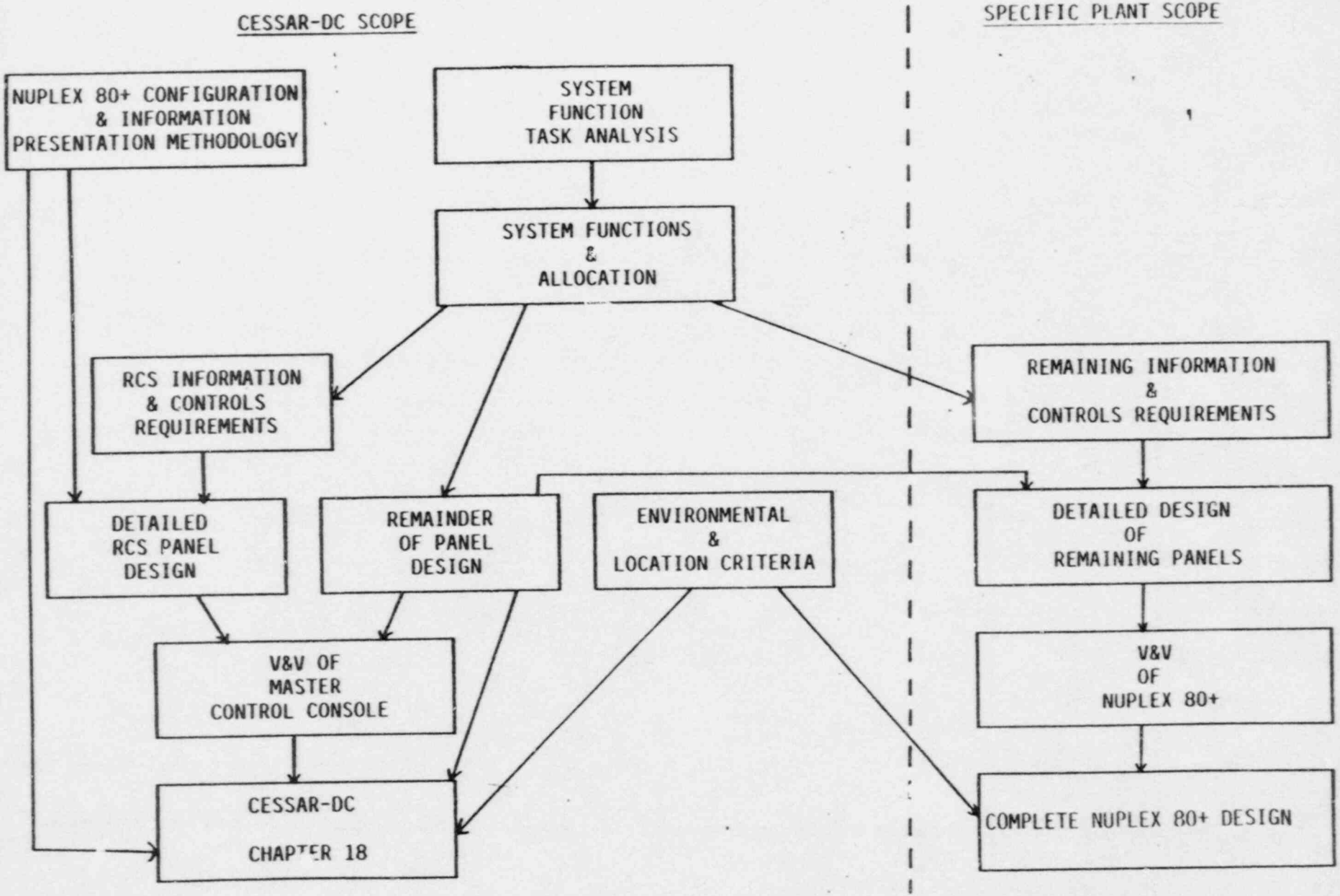
  GENERIC INFORMATION PROCESSING AND PRESENTATION METHODS

  GENERIC CONTROL INTERFACE METHODS

  ANALYSIS PROCESS FOR ESTABLISHING SYSTEM 80+ INFORMATION AND CONTROL REQUIREMENTS

- ACCEPTABILITY OF PROCESS DEMONSTRATED THROUGH DETAILED DESIGN OF RCS PANEL

NUPLEX 80+ CESSAR-DC SCOPE



NUPLEX 80+ DESIGN PROCESS

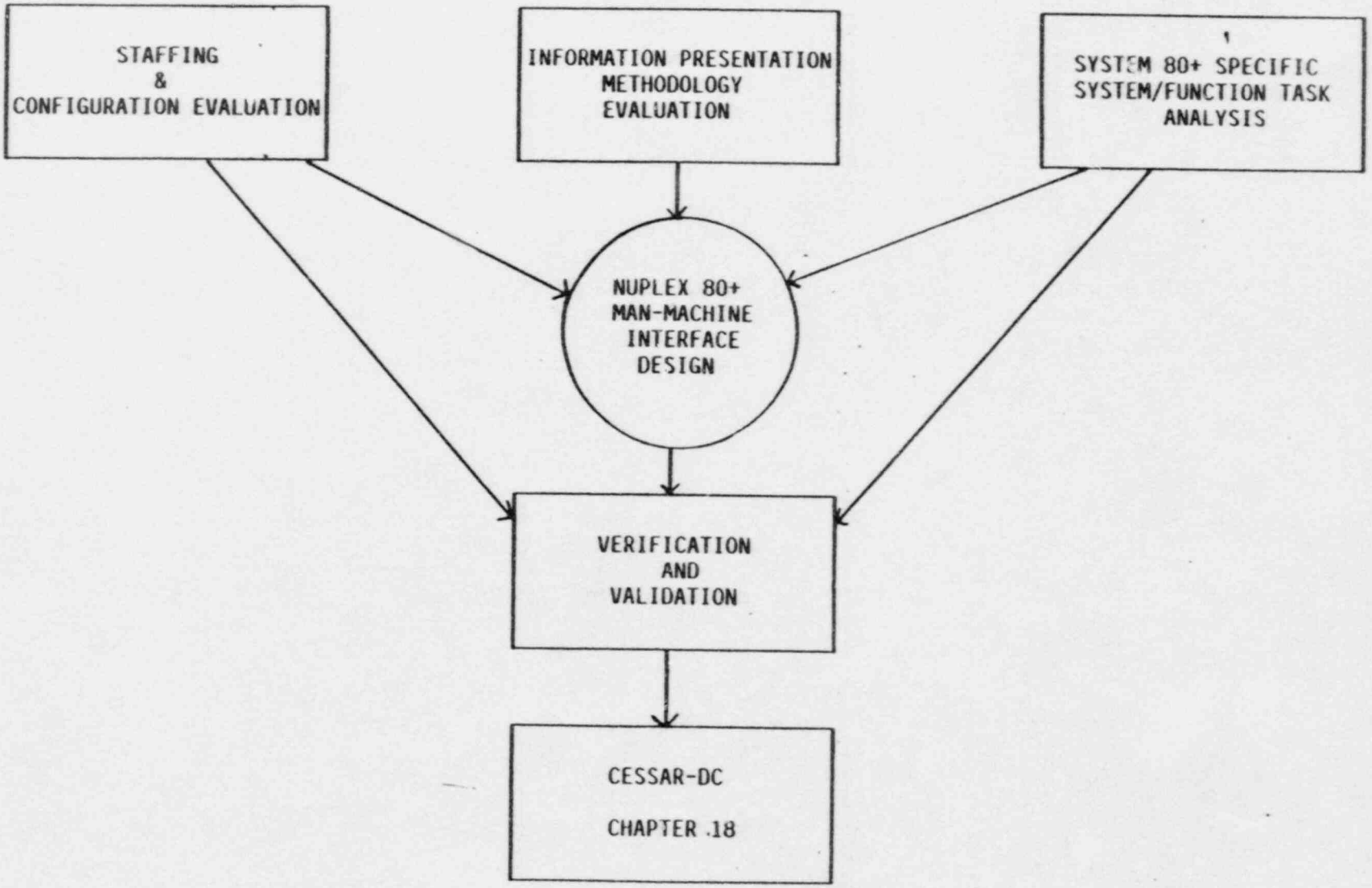
- ESTABLISH A MULTI-DISCIPLINARY DESIGN TEAM
  - HUMAN FACTORS SPECIALIST
    LINDA TOMASI
  - REACTOR OPERATOR
    BOB RESCORL
  - NUCLEAR SYSTEM ENGINEERS
    DARYL HARMON, DAVE JAMISON
  - INSTRUMENT AND CONTROLS ENGINEERS
    RICK MANAZIR, FRANK RIDOLFO,
    GARY ALTENHEIN

- ESTABLISH A MULTI-DISCIPLINARY REVIEW TEAM

  HUMAN FACTORS SPECIALIST
  NUCLEAR ENGINEER
  FLUID SYSTEMS ENGINEER
  STARTUP ENGINEER
  I&C ENGINEERS
  UTILITY REPRESENTATIVE

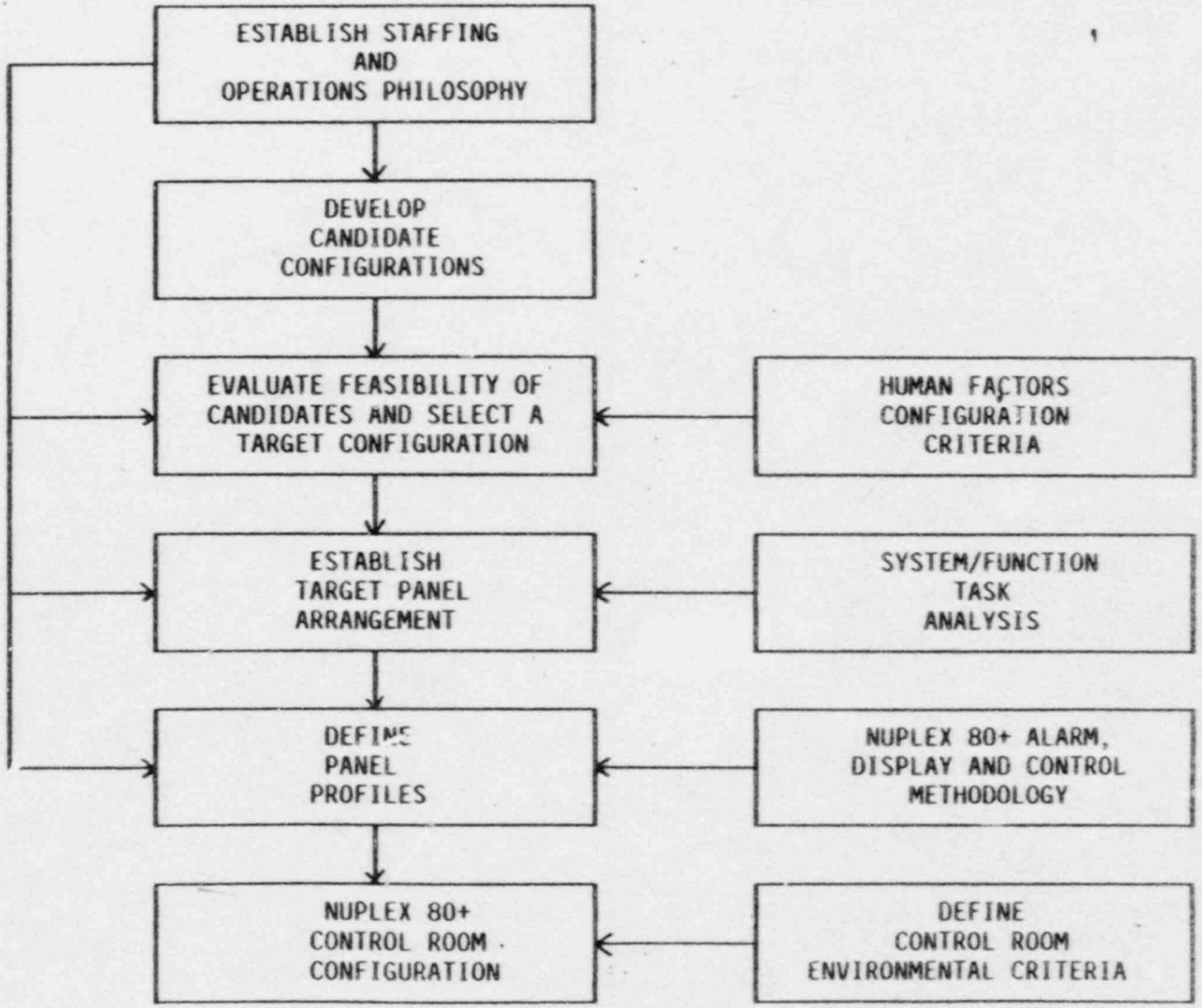
SLIDE078

NUPLEX 80+ DESIGN PROCESS



SLIDE078

STAFFING AND CONFIGURATION EVALUATION



NUPLEX 80+ STAFFING AND OPERATIONS PHILOSOPHY

ESTABLISH A TARGET OPERATING STAFF

DESIGN FLEXIBILITY TO MEET A VARIETY OF STAFFING ASSIGNMENTS

SELECT "WORST CASE" ASSIGNMENTS TO ESTABLISH DESIGN BASES CRITERIA

DESIGN TO MAINTAIN A "CLEAN CONTROLLING WORKSPACE"

DESIGN TO PROVIDE CONTINUOUS PLANT OVERVIEW VISIBLE FROM ALL WORKSTATIONS

CONSIDER ENTIRE CONTROL ROOM IN DESIGN - NOT JUST CONTROLLING WORKSPACE

NUPLEX 80+ CANDIDATE CONFIGURATION FEASIBILITY EVALUATIONS

STAFFING CRITERIA

FUNCTIONAL PERFORMANCE

ANTHROPOMETRIC CRITERIA

MOBILITY CRITERIA

COMMUNICATION CRITERIA

OPERATOR FURNISHINGS
- LAY DOWN SPACE
- STORAGE

VISITOR ACCESS

NUPLEX 80+ CONTROL ROOM ENVIRONMENTAL CRITERIA

ILLUMINATION

ACOUSTICS AND NOISE

COMMUNICATIONS

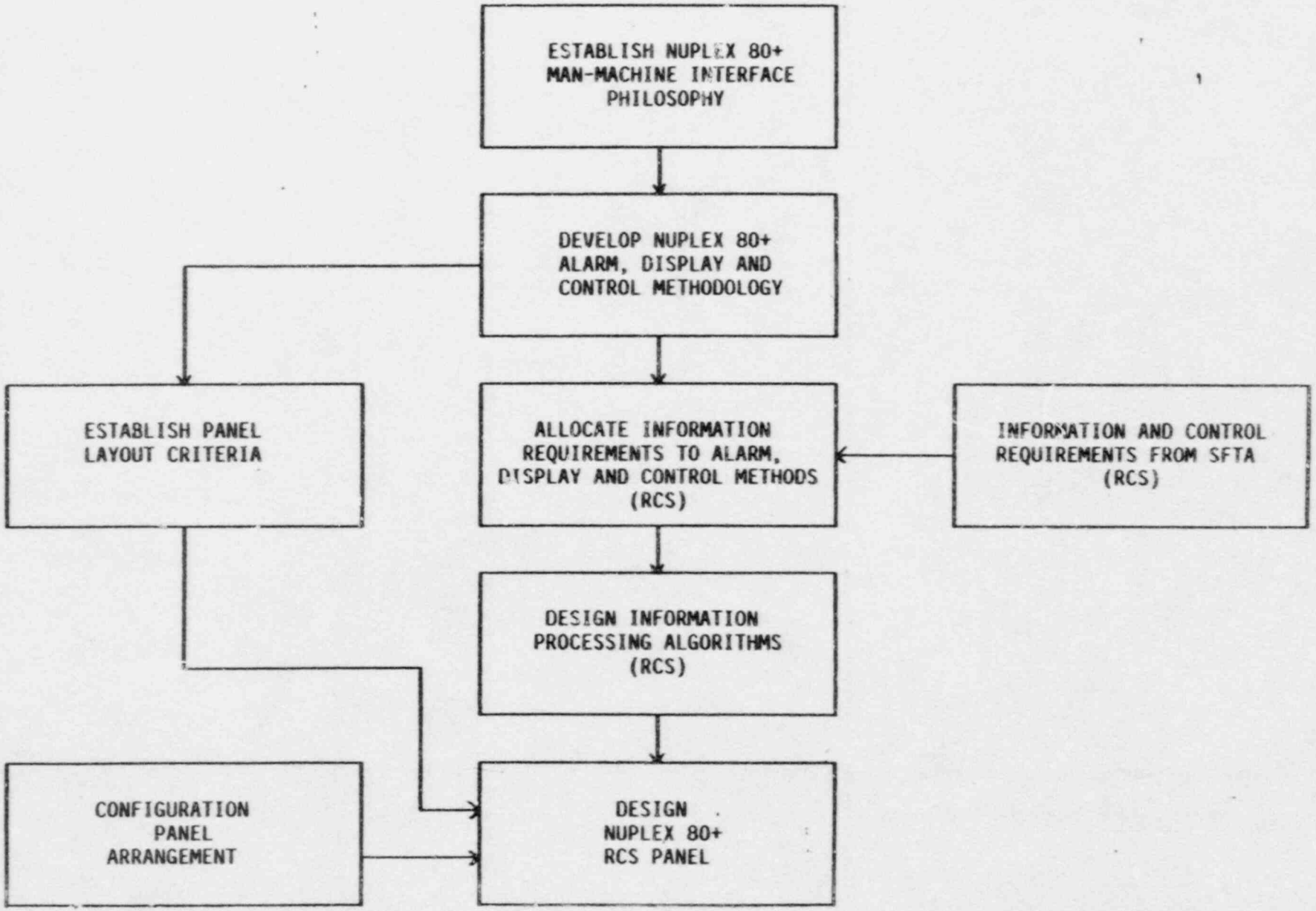
HABITABILITY

CLIMATIC CONDITIONS

MAINTENANCE ACCESS

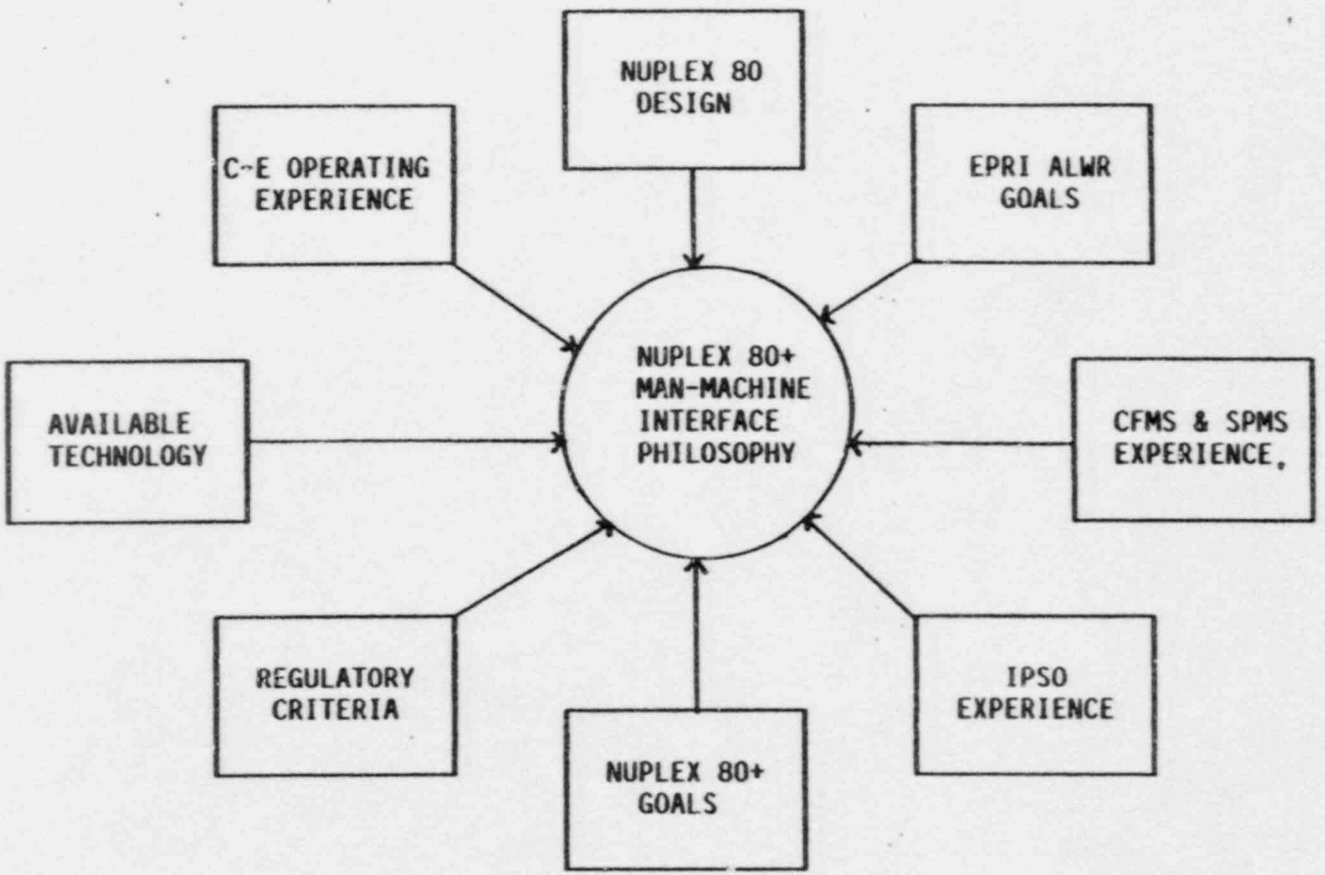
SLIDE078

INFORMATION PRESENTATION METHODOLOGY EVALUATION



SLIDE078

NUPLEX 80+ MAN-MACHINE INTERFACE PHOLOSOPHY



NUPLEX 80+ ALARM METHODOLOGY

DESIGN NUPLEX 80+ ALARMS TO:

- ALERT OPERATORS THAT A DEVIATION EXISTS.
- INFORM HIM OF THE NATURE AND PRIORITY OF THE DEVIATION.
- GUIDE HIS INITIAL RESPONSE TO THE DEVIATION.
- CONFIRM WHETHER THE RESPONSE HAS CORRECTED THE DEVIATION.
- REDUCE SENSORY OVERLOAD DURING LARGE SCALE PLANT UPSETS.

NUPLEX 80+ ALARM METHODOLOGY

ALARMS INDICATE A PROBLEM ONLY.

PLANT MODE AND EQUIPMENT DEPENDENT LOGIC AND SETPOINTS.

AUTOMATICALLY PRIORITIZE ALARMS WITHIN SYSTEMS.

SIMPLIFY OPERATOR PRIORITIZATION BETWEEN SYSTEMS.

REDUCE NUMBER OF ALARM WINDOWS.

REDUCE NUMBER OF ALARMS.

TOTALLY INTEGRATE DISCRETE AND CRT ALARM PRESENTATIONS.

MAINTAIN FUNCTIONAL INDEPENDENCE OF DISCRETE AND CRT ALARMS.

FIRST OUT ALARM INDICATION AT ALL PANELS.

PROVIDE CRITICAL SAFETY FUNCTION AND CRITICAL POWER PRODUCTION FUNCTION ALARMS.

NUPLEX 80+ DISPLAY METHODOLOGY

SUPPORT OPERATOR'S TASK INFORMATION NEEDS AND DECISION MAKING PROCESS BY:

PROVIDING CONTINUOUS DISPLAY OF ALL FREQUENTLY MONITORED PLANT DATA

PROVIDING MOST ACCURATE, VALID INFORMATION

REDUCING NUMBER OF DISCRETE INDICATIONS

PROVIDING "ALL" PLANT INFORMATION THROUGH CRT'S

FULLY INTEGRATING DISCRETE AND CRT DISPLAYS

ASSURING OPERABILITY UNDER FAILURE CONDITIONS THROUGH DISPLAY DIVERSITY

PROVIDING SINGLE LOCATION FOR PLANT OVERVIEW INFORMATION

INTEGRATING ACCIDENT MONITORING AND NORMAL DISPLAYS

PROVIDING CONSISTENT DISPLAY CONVENTIONS IN ALL DISPLAY MEDIA

ENSURING THAT ABNORMAL CONDITIONS ARE ACKNOWLEDGED

NUPLEX 80+ INFORMATION PROCESSING

- CALCULATE MOST APPROPRIATE INFORMATION FOR OPERATOR'S USE

  E.G., VALIDATED T_{AVE}
  ALARM DEPENDENCY

- REDUCE OPERATOR'S NEED FOR PROCESSING LIKE INFORMATION

  E.G., PRESSURIZER PRESSURE INDICATIONS

- CALCULATE HIGH LEVEL INFORMATION REQUIRING COMPLEX ALGORITHMS

  E.G., CRITICAL SAFETY FUNCTIONS
  CORE POWER DISTRIBUTION

NUPLEX 80+ PANEL LAYOUT HUMAN FACTORS CRITERIA

PANEL ORGANIZATION

- FUNCTIONAL GROUPING WITHIN SYSTEMS
- SPATIAL SEPARATION AND DEDICATION
- CONTROL/DISPLAY INTEGRATION

LABELING AND DEMARCATION

ANTHROPOMETRICS

USE OF COLOR

CRT DISPLAY CRITERIA

HUMAN FACTORS/

FUNCTIONAL TASK

ANALYSIS

FUNCTION/TASK ANALYSIS FOR THE NUPLEX 80+ CONTROL ROOM DESIGN

Goal:

1. **To Evaluate the Existing Man-Machine Function Allocation of System 80 Against Nuplex 80+ Philosophy.**
2. **Provide Information and Control Characteristics for Detailed Panel Design.**

METHOD GOALS:

1. ESTABLISH TASK ANALYSIS METHODOLOGY TO BE APPLIED TO TOTAL CONTROL ROOM DESIGN.

2. APPLY METHODOLOGY FOR RCS DESIGN TO DEMONSTRATE AFFECTIVENESS FOR LICENSING CERTIFICATION.

System Function Task Analysis Methodology Based on Approaches Outlined In:

- Rassmussen & Lind (1981)
- EPRI NP-3659 (1984)
- Fine & Wiley (1971)
- NUREG 0700

FUNDAMENTAL ASSUMPTION

OF

SYSTEM FUNCTION TASK ANALYSIS

- OPERATOR'S ROLE IN PLANT IS CONTROL OF THE THERMAL PROCESS BY 4 BASIC STEPS:

  1. MONITOR
  2. EVALUATE/PLAN
  3. PERFORM CONTROL ACTIONS
  4. MONITOR FEEDBACK

FUNCTION/TASK ANALYSIS PROCESS

1. Establish Allocation Criteria
   - — Generic Function Allocation Criteria
   - — Nuplex 80 + Staffing Philosophy
2. Establish Function/Task Analysis Structure:

Gross Function

⇩

Sub Function

⇩

Operations

⇩

Tasks

⇩

Task Information and Control Characteristics

FUNCTION ALLOCATION GUIDELINES (ADOPTED FROM NU-REG 0700)

Humans Excel In:

- Sensitivity to Ambiguous Stimuli
- Perceiving Patterns and Making Generalizations about them
- Detecting Signals in High Noise Levels
- Ability to Exercise Judgment Where Events Cannot Be Completely Defined
- Improvising and Adopting Flexible Procedures
- Ability to React to Unexpected Low-Probability Events

Machines Excel In:

- Monitoring (Personnel and Equipment)
- Performing Routine, Repetitive, or Very Precise Operations
- Responding Very Quickly to Control Signals
- Excerting Great Force, Smoothly and with Precision
- Storing and Recalling Large Amounts of Information in Short Periods of Time
- Performing Complex and Rapid Computations with High Accuracy

FUNCTION ALLOCATION GUIDELINES (ADOPTED FROM NU-REG 0700) (Cont'd)

Humans Excel In:

Applying Originality in Solving Problems: i.e., Alternative Solutions

Ability to Profit from Experience and Alter Course of Action

Ability to Perform Fine Manipulation, Especially Where Misalignment Appears Unexpectedly

Ability to Reason Inductively

Machines Excel In:

Doing Many Different Things at Once

Collecting Many Different Data Points at Once

Insensitivity to Extraneous Factors

Ability to Repeat Operations Rapidly, Precisely, Continuously, and Consistently Over a Period of Time

Operating in Environments Hostile to Humans

Deductive Processes

PROCESS (Cont'd)

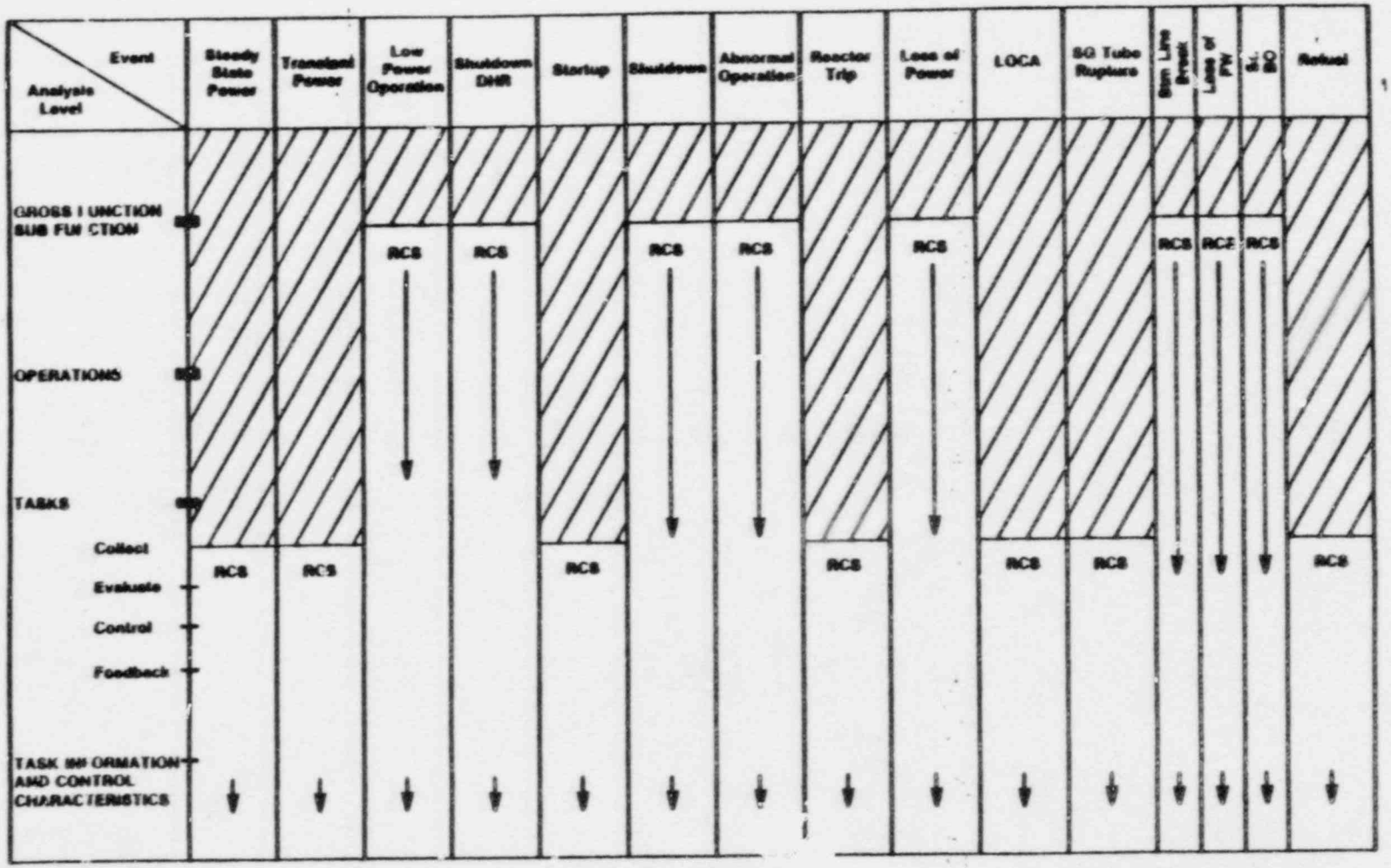
3. Develop Event Sequences to be Analyzed.

- Steady State Power
- Transient Power
- Low Power Operation
- Shutdown DHR
- Startup
- Shutdown
- Abnormal Ops
- Reactor Trip
- Loss of Power
- LOCA
- SG Tube Rupture
- Steam Line Break
- Loss of Feedwater
- Station Blackout
- Refueling

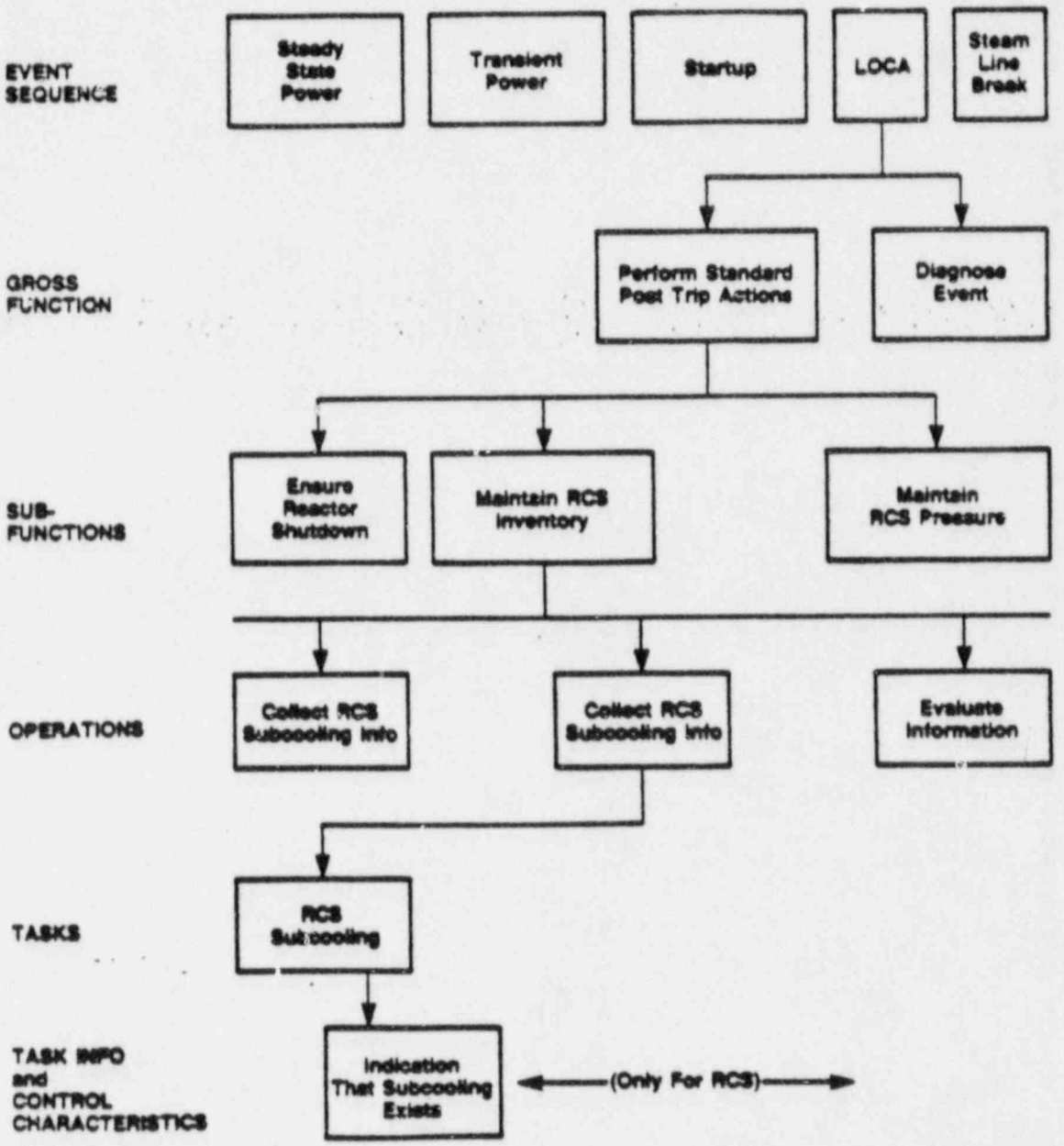
4. Define Representative Nuplex 80+ Workstation to Demonstrate Process for Design Certification.
   — RCS Selected Due to its Significance in All Events.

PROCESS (Cont'd)

5. Analyze All Events to the Subfunction Level to Identify All RCS Related Tasks and Operations.
6. Analyze 7 Out of 15 Events to the Task Level to Evaluate Plant Wide Function Allocation.
   - — Startup
   - — Reactor Trip
   - — LOCA
   - — SG Tube Rupture
   - — Steady State Power
   - — Refueling


Event
Analysis Level
Steady State Power
Transient Power
Low Power Operation
Shutdown DHR
Startup
Shutdown
Abnormal Operation
Reactor Trip
Loss of Power
LOCA
SG Tube Rupture
Stm Line Break
Loss of FW
Lt. of SG
Refuel
GROSS FUNCTION
SUB FUNCTION
OPERATIONS
TASKS
Collect
Evaluate
Control
Feedback
TASK INFORMATION AND CONTROL CHARACTERISTICS
RCS

LOCA TASK ANALYSIS RESULTS



PROCESS (Cont'd)

7. Apply Generic Allocation Criteria to the Tasks Defined (Considering Staffing Target)
8. Evaluate Allocation Based on Historical Operation, Nuplex 80+ Capabilities and Licensing Requirements.
9. Define Allocation and Provide Rationalizations.
10. Analyze All 15 Events to Define Tasks and Information Characteristics for RCS Only.
11. Apply to RCS Panel Design.

RESULTS/PRODUCT

System Function Task Analysis will provide support for CESSAR-DC Chapter 18.

- Function allocation evaluation and recommendations.
- List of required instruments and controls for RCS
- Basis for revised EPGs.
- Task basis for use in developing verification and validation scenarios.

VALIDATION FOR CESSAR-DC

PROCESS:

1. PROTOTYPE REPRESENTATIVE DISPLAYS FOR:
   - IPSO
   - DISCRETE ALARMS
   - DISCRETE INDICATORS
   - CRT DISPLAY PAGE
   - CONTROLLERS
   - COMPONENT CONTROLS

2. VALIDATE GENERAL INFORMATION PRESENTATION AND CONTROL METHODS BASED ON STANDARD HFE CRITERIA.

3. DEVELOP RCS ALARMS AND DISPLAYS AND DATA PROCESSING ALGORITHMS BASED ON SFTA.

4. DEVELOP REMAINING MCC ALARMS AND DISPLAYS BASED ON SFTA.

5. CREATE DETAILED GRAPHIC REPRESENTATIONS OF RCS PANEL AND REMAINING MCC PANELS.

6. LAYOUT PANEL REPRESENTATIONS IN PHYSICAL ARRANGEMENT OF MCC.

7. PHYSICALLY AND VERBALLY WALK THROUGH PANEL DESIGN USING SFTA
   - VALIDATION OF INFORMATION HANDLING TECHNIQUES WILL BE BASED ON REPRESENTATIVE RCS INFORMATION PROCESSING.

RESULTS:

- ENSURE THAT ALL INFORMATION AND CONTROLS SUPPORT ONE MAN OPERATION AT THE MCC.
- ENSURE ALL NECESSARY RCS INFORMATION AND CONTROLS ARE AVAILABLE FOR NECESSARY OPERATOR FUNCTIONS.
- ENSURE RCS INFORMATION IS IN MOST USABLE FORM.

VERIFICATION/VALIDATION OF M-MIS

VALIDATION PROCESS:

1. BUILD FULL SIZE MOCK-UP OF CONTROL PANELS.
2. WALKTHROUGH OPERATOR FUNCTIONS DURING
   - STARTUP
   - SHUTDOWN
   - STEADY STATE POWER
   - REACTOR TRIP
   - EMERGENCY OPERATIONS

RESULTS:

- o ENSURE ALL OPERATOR TASKS CAN BE PERFORMED AT CONTROL PANELS.
- o ENSURE USABILITY
  - INFORMATION ACCESSABILITY
  - ANTHROPOMETRICS
  - SUPPORT FOR OPERATOR DECISION PROCESS
  - SUPPORT FUNCTIONAL NEEDS

CHAPTER 18

FORMAT

CESSAR-DC CHAPTER 18 ORGANIZATION

18.1	DESIGN TEAM ORGANIZATION AND RESPONSIBILITIES
18.2	DESIGN GOALS AND DESIGN BASES
18.3	DESIGN PROCESS AND APPLICATION OF HFE
18.4	NUPLEX 80+ CONTROL COMPLEX DESIGN ANALYSES
18.4.1	INFORMATION AND CONTROLS REQUIREMENTS
18.4.2	CONTROL ROOM CONFIGURATION ASSESSMENT
18.4.3	PANEL LAYOUT EVALUATION
18.4.4	CONTROL AND MONITORING STATIONS OUTSIDE THE MAIN CONTROL ROOM
18.5	VERIFICATION AND VALIDATION

Chapter 18 - Design Certification Deliverables

18.1 Design Team Organization and Responsibilities
18.2 Design Goals and Design Bases
18.3 Design Process and Application of Human Factors Engineering

- 18.3.1 Information and Controls Requirements
- 18.3.2 Control Room Configuration Assessment
- 18.3.3 Panel Layout Evaluation
- 18.3.4 Control and Monitoring Stations Outside the Main Control Room
- 18.3.5 Verification and Validation Process

18.4 Nuplex 80+ Control Complex Design Analyses

18.4.1 Information and Controls Requirements

- Systems Functions and Operational Sequences List
- Man-Machine Functional Allocation
- Task List for RCS-Related Functions, Including Categorization by Functions and Operational Sequences
- Comparison of System 80+ Experienced-based Information and Controls Requirements with Function and Task Lists
- Final List of Nuplex 80+ Information and Controls Requirements for All Systems

18.4.2 Control Room Configuration Assessment

- Operational Requirements
- Human Engineering Criteria for Configuration and Workspace (from NUREG 0700, NP-3659, etc.)
- Results of Configuration Evaluation
- Documentation of Nuplex 80+ Configuration, Including:
  - Panel Arrangement and Configuration Dimensions
  - Results of Workspace Studies
    - Visibility
    - Mobility
    - Access
    - Operator Furnishings
  - Console Profiles
  - Anthropometric and Ergonomic Study Results
  - Allocation of Sit Down/Stand Up Panels
- Control Room Interface (Environmental, Communication, Habitability, etc.) Criteria List

18.4.3 Panel Layout Evaluation

- Man-Machine Interface Design Bases List
- Detailed Descriptions of Information Display and Control Methods, Including Characteristics of Presentation Techniques, Operator Interaction, Relationship to Other Panel Display Methods, and Failure Modes
- Information/Display and Control Allocation Criteria List

- Results of Allocation Criteria Application
- Human Engineering Panel Layout Criteria, Including CRT Display Criteria
- Panel Layouts and CRT Displays for the RCS Panel, Including:

  Panels
  - Panel Drawings
  - Alarm Windows List
  - Alarm Points for Grouped Alarms
  - Discrete Indicators List with All Parameters, Channels, and Logic Provided
  - Operator Module Contents
  - Process Controls List
  - Discrete Controls List and Subgroup Control Allocation

  CRT Displays
  - Content and Layout of System Displays for Selected Systems
  - Content and Layout of Alarm Displays for Selected Systems
  - Integrated Process Status Overview Display
  - Application Program Displays
- Panel Layouts for All Other Nuplex 80+ Panels, Including:
  - Panel Drawings
  - Representative Alarm Windows List and Grouped Alarms
  - Representative Discrete Indicators Parameter List
  - Operator Modules
  - Representative Process Controls List
  - Representative Discrete Controls List and Subgroup Control Allocation

18.4.4 Control and Monitoring Stations Outside the Main Control Room

- Remote Shutdown Panel
  - Information and Controls Requirements
  - Human Engineering Criteria (Panel Layout, Environmental)
  - Panel Layout
- EOF Human Engineering Criteria List
- TSC Human Engineering Criteria List

18.5 Verification and Validation

NUPLEX 80+

FEATURES

SYSTEM 80+

SYSTEM 80+ INSTRUMENTATION AND CONTROLS

NUPLEX 80+

- NUPLEX 80+ = NUPLEX 80 (TVA - YELLOW CREEK)
  +
  SPECIFIC CHANGES TO:

  - IMPROVE MAN-MACHINE INTERFACE

    PLANT OVERVIEW COMPREHENSION
    ALARM HANDLING
    FRIENDLY TRANSITION TO ACR
    OPERATION WITHOUT CRTS

  - REDUCE CONSTRUCTION AND MAINTENANCE COSTS

    MULTIPLEXING
    SOFTWARE BASED SYSTEMS

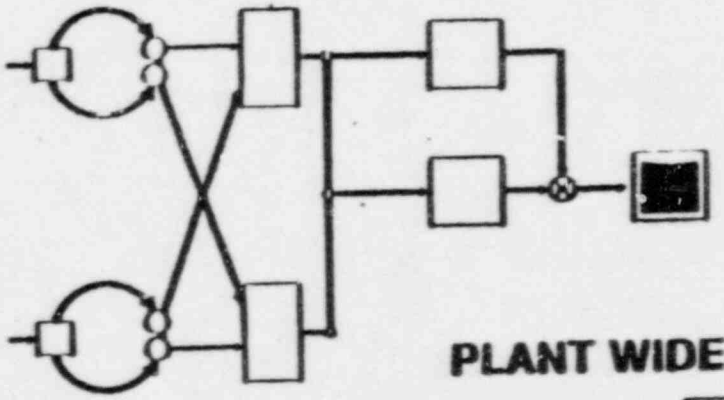
  - ENHANCE FAULT TOLERANCE

    UNNECESSARY TRIPS
    EXPOSURE FIRES

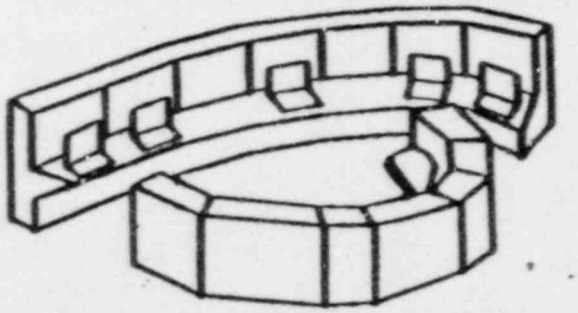
ADVANCED CONTROL COMPLEX

NUPLEX 80+

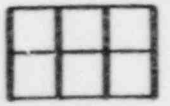
DATA PROCESSING SYSTEM

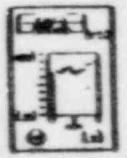


CONTROL CENTER PANELS

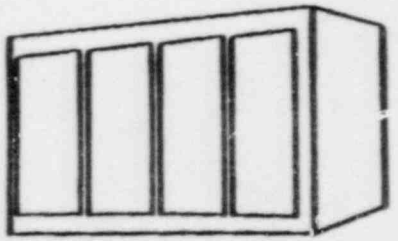


PLANT WIDE INTEGRATION

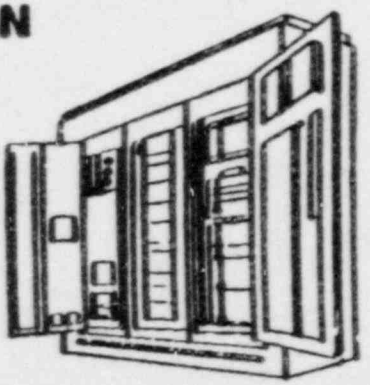




DISCRETE
INDICATION
AND ALARM SYSTEM



PLANT PROTECTION SYSTEM



COMPONENT CONTROL SYSTEM

SYSTEM 80+

NUPLEX 80+ OPERATOR STAFFING
DESIGN BASES FOR THE CONTROL ROOM

- TARGET NUPLEX 80+ OPERATING STAFF:

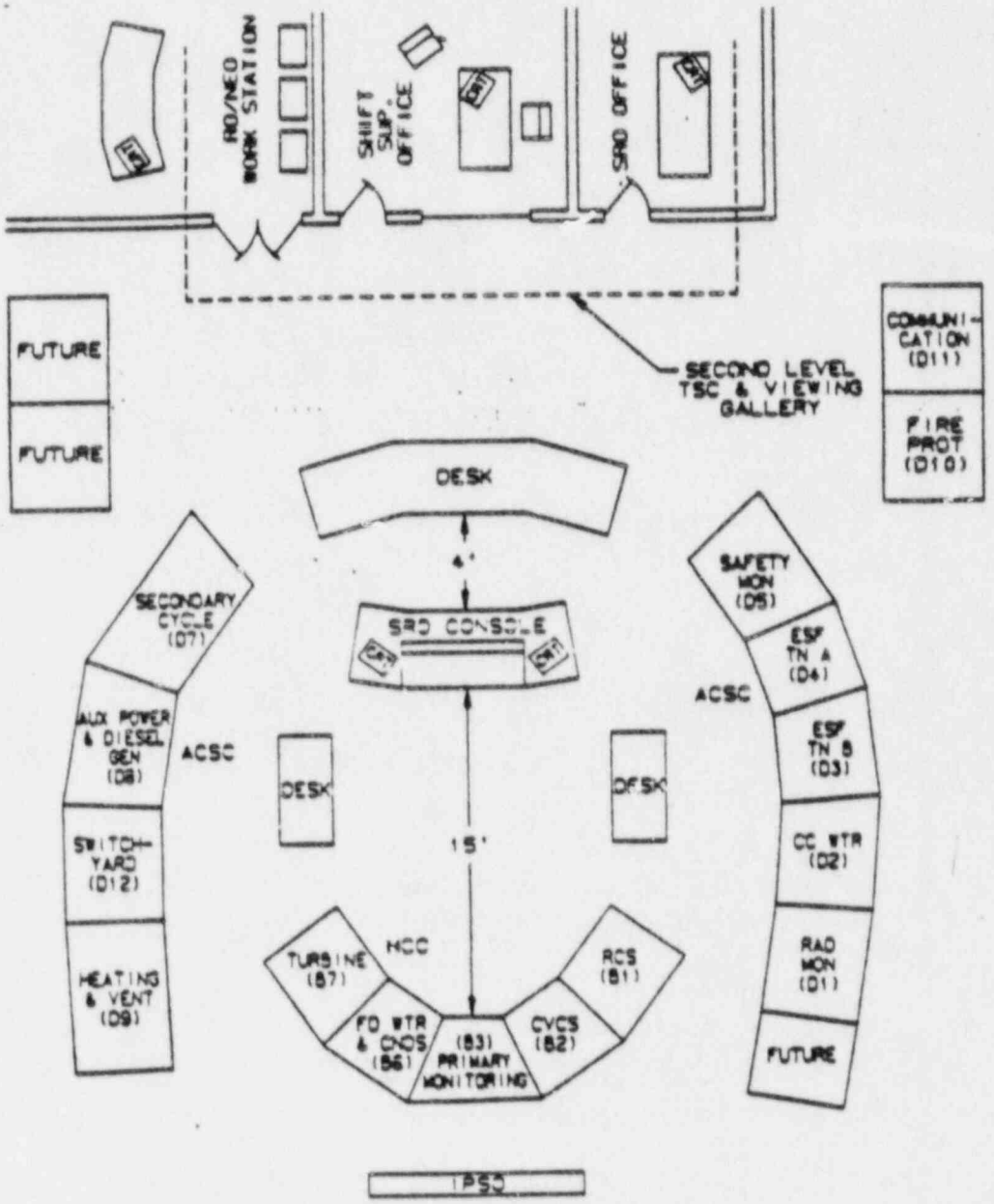
  1 SHIFT SUPERVISOR (SS)
  1 SENIOR REACTOR OPERATOR (SRO)
  2 ASSISTANT REACTOR OPERATORS (ARO)
  1 SHIFT TECHNICAL ADVISOR (STA)
  2 NUCLEAR EQUIPMENT OPERATORS (NEO)

- CONTROL ROOM DESIGNED FOR OPERATIONAL FLEXIBILITY TO MEET THE VARIETY OF STAFFING ASSIGNMENTS EXPECTED AT VARIOUS UTILITIES.

- SELECT WORST CASE STAFFING ASSIGNMENTS TO ESTABLISH DESIGN BASIS CRITERIA FOR CONTROLLING WORKSPACE AND CONTROL ROOM OFFICES.

  A. OPERATION BY SINGLE OPERATOR WITHIN THE CONTROLLING WORKSPACE BETWEEN HOT STANDBY AND FULL POWER.

  B. ACCOMMODATE FULL OPERATING STAFF FOR BOTH NORMAL AND EMERGENCY OPERATION IN CONTROLLING WORKSPACE.



NUPLEX 80+ CONTROL ROOM

NUPLEX 80+ REMOTE SHUTDOWN PANEL

- RSP PROVIDES INSTRUMENTATION AND CONTROLS NECESSARY TO ACCOMMODATE GETTING TO AND MAINTAINING:

  HOT SHUTDOWN - WITH SAME MMI AS CONTROL ROOM

  COLD SHUTDOWN - WITH CRT INFORMATION AND SOFT CONTROLS

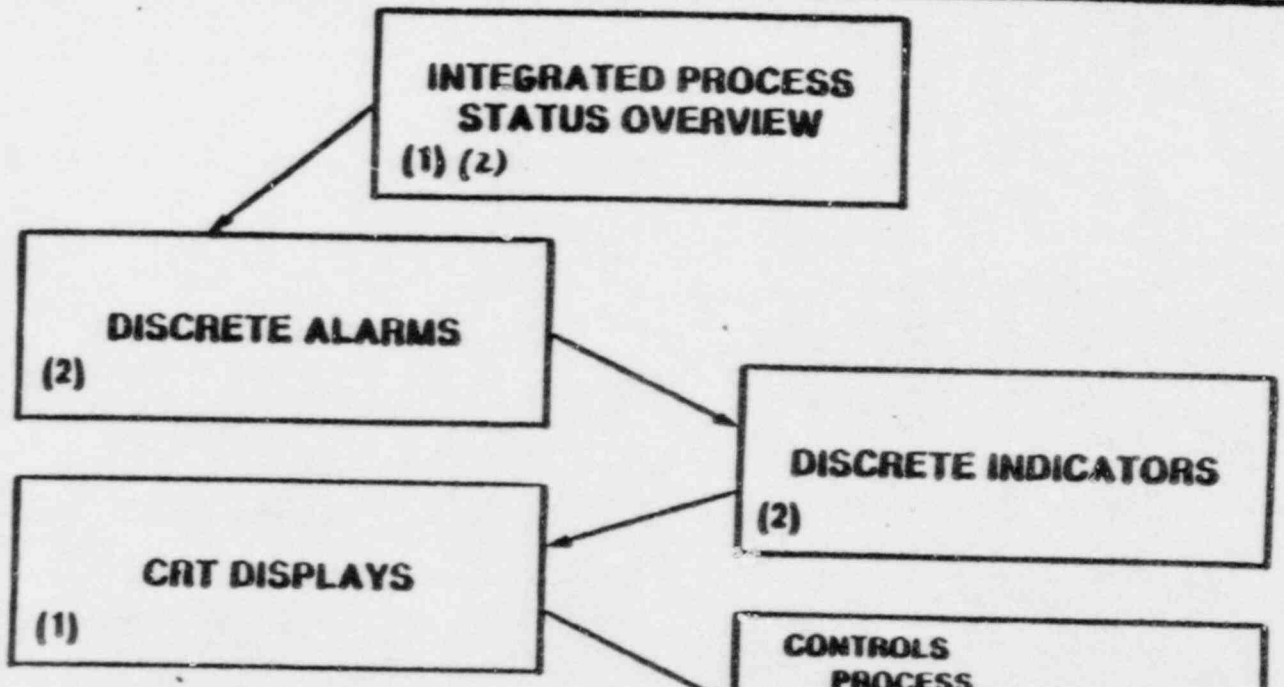
- RSP COMPLETELY ISOLATED FROM CONTROL ROOM.

- RSP PROVIDES TWO CONTROL TRAINS.

- CONTROL TRANSFERRED BY SEPARATE CHANNEL SWITCHES LOCATED IN EQUIPMENT ROOM. ALL TRANSFERS ARE BUMPLESS.

INFORMATION DISPLAY HIERARCHY

NUPLEX 80+

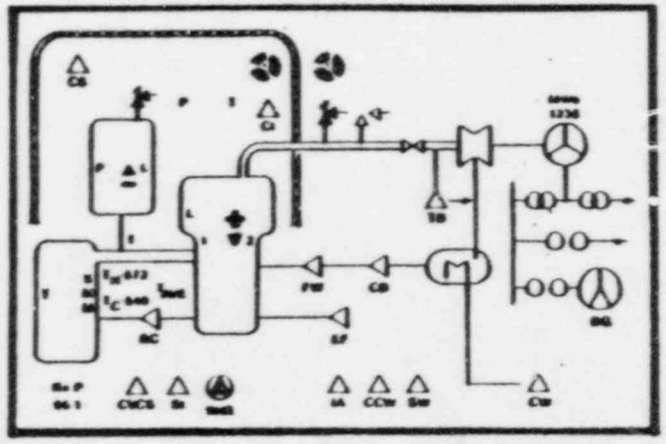


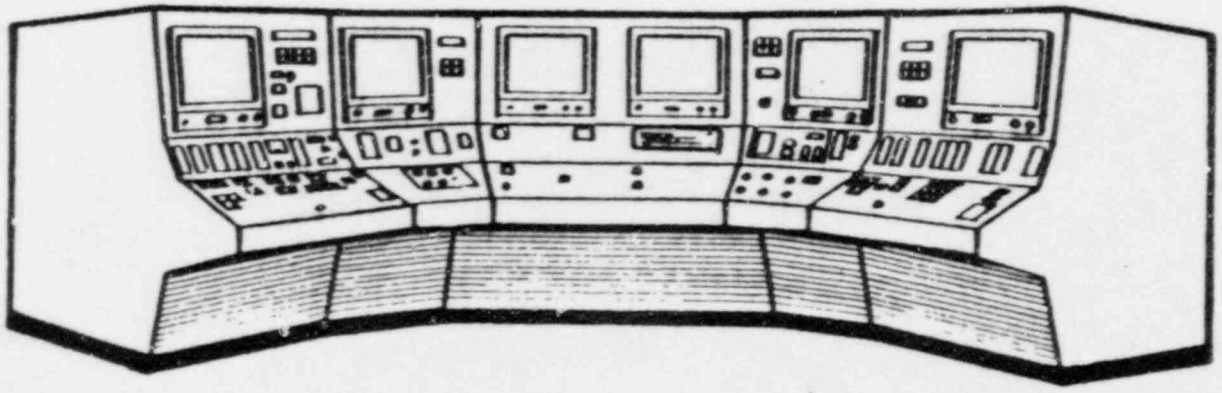
(1) PLANT COMPUTER DRIVEN (DPS)

(2) DRIVEN BY MULTIPLE PROCESSORS (DIAS)

(3) DRIVEN BY INDIVIDUAL PLANT SYSTEMS

SYSTEM 80+





IPSO INFORMATION HELPS AN OPERATOR ESTABLISH PRIORITIES WHEN A DISTURBANCE AFFECTS A NUMBER OF PLANT FUNCTIONS

IPSO

- IPSO PROVIDES A SINGLE LOCATION TO ALLOW QUICK ASSESSMENT OF KEY INFORMATION INDICATIVE OF CRITICAL PLANT POWER PRODUCTION AND SAFETY FUNCTIONS.

- IPSO INFORMATION INCLUDES:

  - TRENDS, DEVIATIONS, NUMERIC VALUES OF MOST REPRESENTATIVE PARAMETERS

  - SYSTEM AVAILABILITY AND PERFORMANCE FOR SYSTEMS SUPPORTING CRITICAL FUNCTIONS

  - EXISTENCE AND RELATIVE LOCATION OF PRIORITY 1 ALARMS

- IPSO BRIDGES THE GAP BETWEEN AN OPERATOR'S TENDENCY TOWARD SYSTEM THINKING AND THE MORE DESIRABLE ASSESSMENT OF CRITICAL FUNCTIONS.

PLANT CRITICAL FUNCTIONS

FUNCTION	CRITICAL TO POWER	CRITICAL TO SAFETY
POWER DISTRIBUTION CONTROL	X	
REACTIVITY CONTROL		X
CORE HEAT REMOVAL	X	X
RCS HEAT REMOVAL	X	X
RCS INVENTORY CONTROL	X	X
RCS PRESSURE CONTROL	X	X
STEAM/FEED CONVERSION	X	
ELECTRIC GENERATION	X	
HEAT REJECTION	X	
CONTAINMENT ENVIRONMENT CONTROL		X
CONTAINMENT ISOLATION		X
RADIOLOGICAL EMISSIONS CONTROL	X	X
VITAL AUXILIARIES	X	X

IPSO DISPLAY

- ONE 6.5' X 4' LARGE PANEL IN CONTROL ROOM

- DISPLAY PAGE FORMAT ALSO AVAILABLE ON ANY CONTROL ROOM/TSC/EOF CRT.

IPSO INFORMATION PROCESSING

THE FOLLOWING INFORMATION IS PROCESSED BY THE DIAS AND USED NORMALLY BY IPSO FOR DISPLAY:

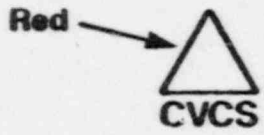
- o PRIORITY 1 ALARMS
- o PARAMETER VALUES AND TRENDS

- THE REMAINING INFORMATION IS PROCESSED BY THE DPS AND USED BY THE IPSO FOR DISPLAY.

- IN THE EVENT OF DIAS FAILURE THE DIAS INFORMATION IS PROVIDED TO IPSO BY DPS.

IPSO FEATURES - SYSTEM STATUS

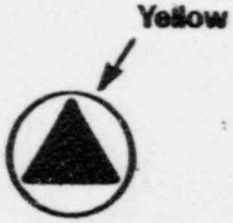
NUPLEX 80+



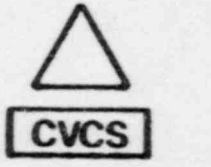
SYSTEM ON

SYSTEM OFF

POOR SYSTEM PERFORMANCE



SYSTEM UNAVAILABLE



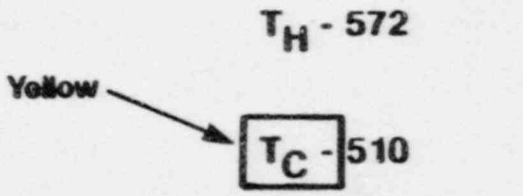
SYSTEM ALARM STATE (PRIORITY 1)

SYSTEMS ON IPSO:

- CONTAINMENT SPRAY - CS
- CONDENSATE - CD
- REACTOR COOLANT - RC
- CHEM VOLUME & CONTROL - CVCS
- SAFETY INJECTION - SI
- RESIDUAL HEAT REMOVAL - RHR
- EMERGENCY FEEDWATER - EF
- MAIN FEEDWATER - FW
- TURBINE BYPASS - TB
- INSTRUMENT AIR - IA
- COMPONENT COOLING - CCW
- SERVICE WATER - SW
- CIRCULATING WATER - CW
- CONTAINMENT ISOLATION - CI

IPSO FEATURES - PARAMETER VALUES

NUPLEX 80+



PARAMETER ALARM STATE

(PRIORITY 1)

PARAMETERS ON IPSO

HOT LEG TEMP - T_H

COLD LEG TEMP - T_C

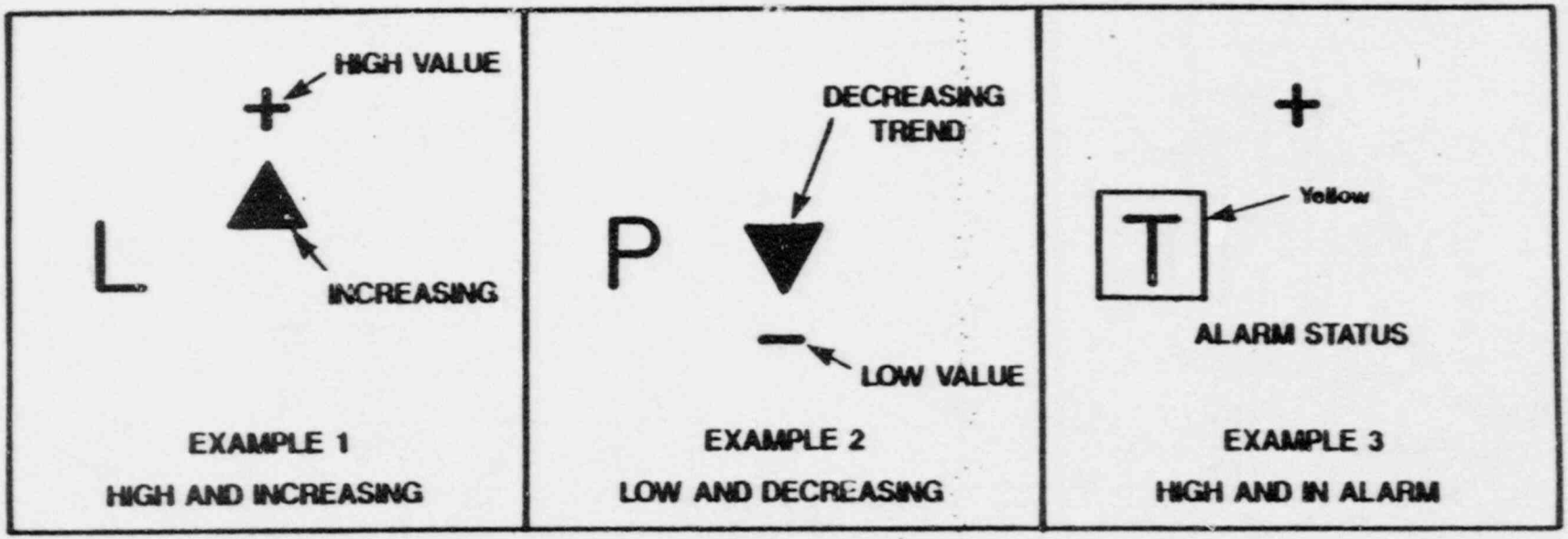
REACTOR POWER - R x P

PLANT POWER OUTPUT - MWe

IPSO PARAMETER REPRESENTATIONS

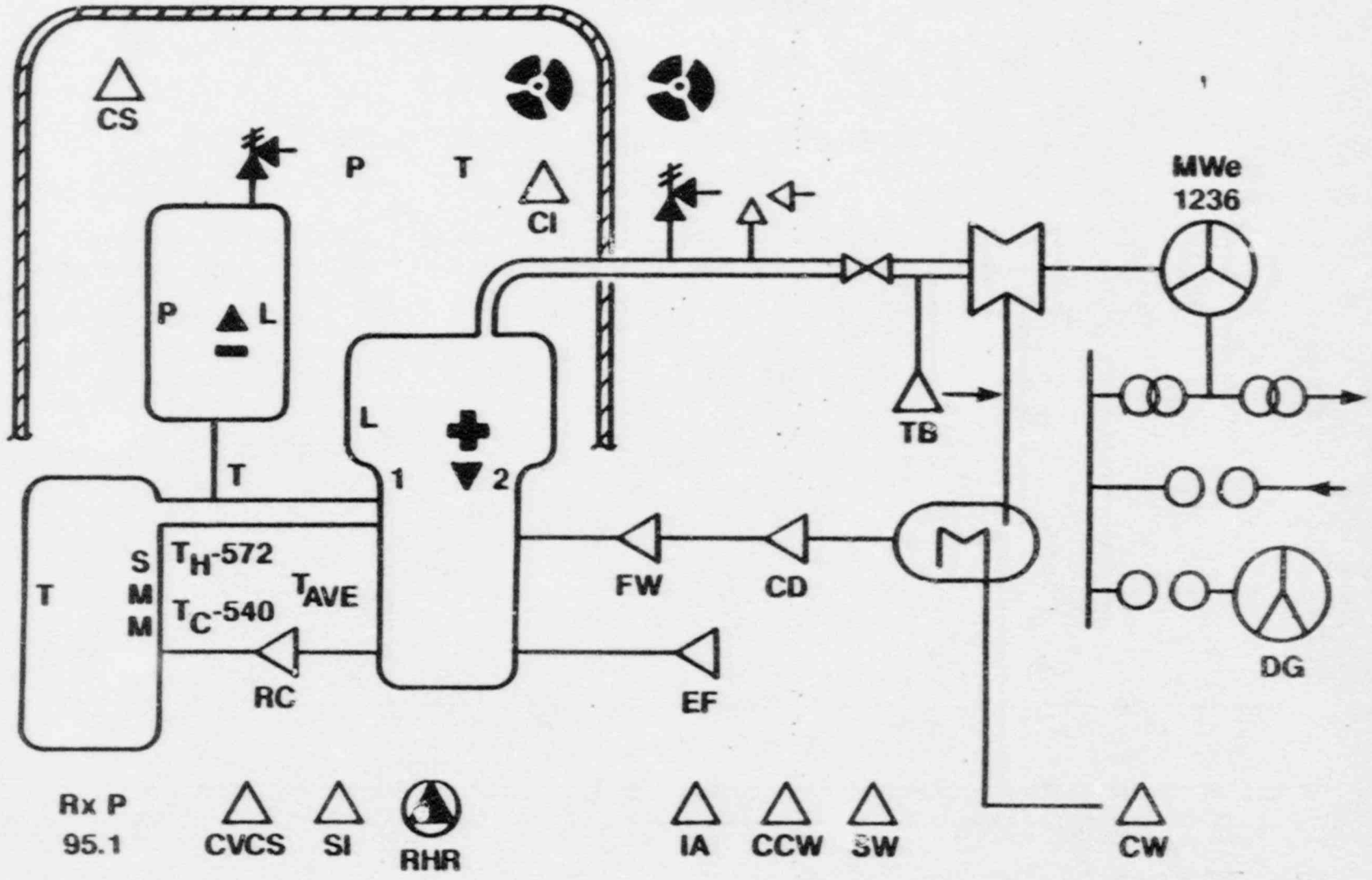
NUPLEX 80+

TRENDS, DEVIATIONS AND ALARMS



IPSO PARAMETERS USING THESE REPRESENTATIONS:

CORE EXIT TEMPERATURE
RCS SATURATION MARGIN
PRESSURIZER LEVEL & PRESSURE
S/G LEVEL NO. 1 & 2
CONTAINMENT Γ & P
RCS T_{AVE}


CS
P
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1236
P
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TB
T
T
S
M
M
T_H-572
T_C-540
T_{AVE}
FW
CD
DG
RC
EF
Rx P
95.1
CVCS
SI
RHR
IA
CCW
SW
CW

NUPLEX 80+ INFORMATION DISPLAY PHILOSOPHY

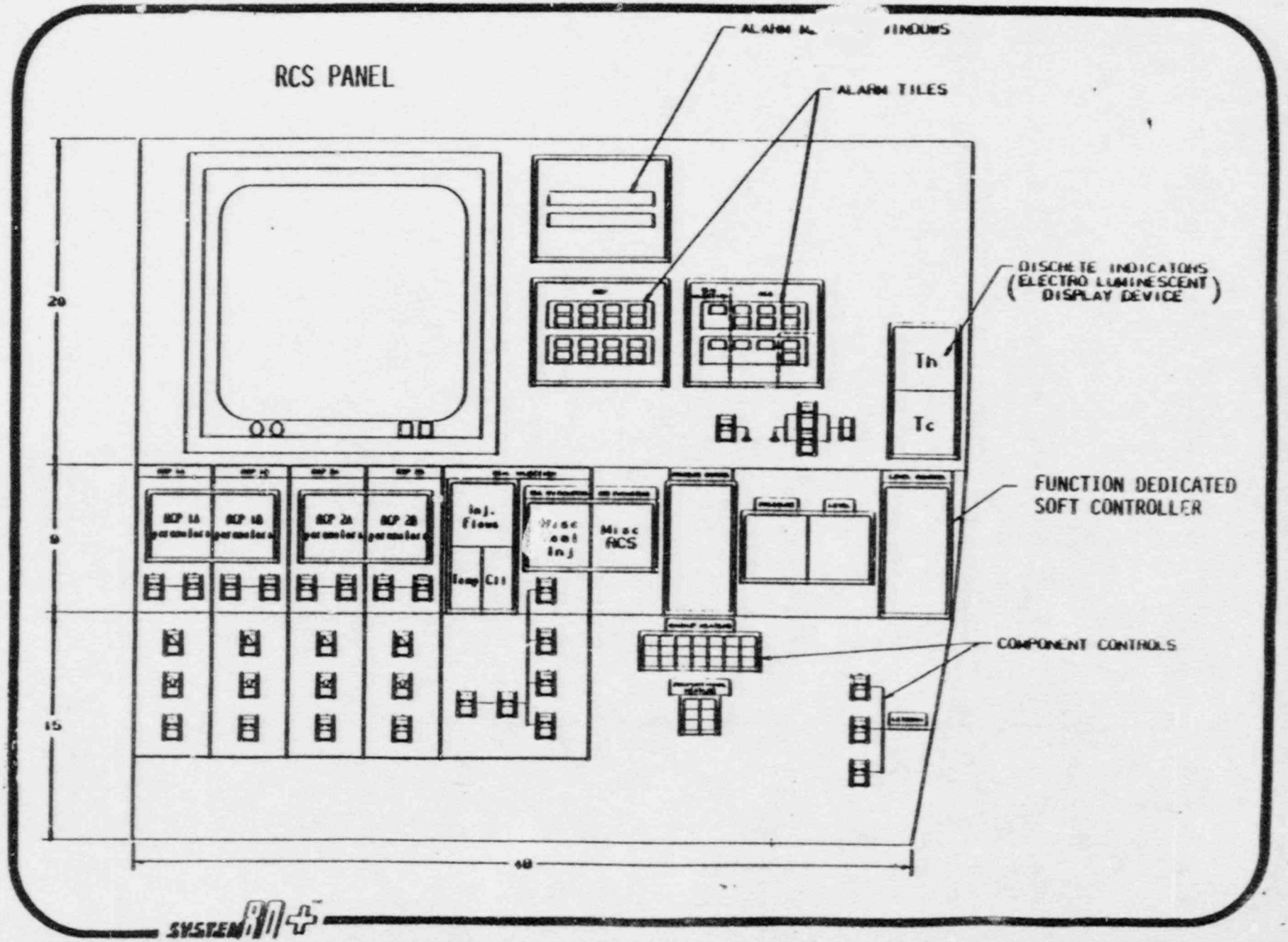
- o REDUCE THE NUMBER OF PHYSICAL DISPLAY DEVICES:
  - GROUPED ALARM WINDOWS WITH DYNAMIC MESSAGE DISPLAYS
  - DYNAMIC INDICATORS
  - CRT'S

- o REDUCE THE QUANTITY OF DATA:
  - LIKE SENSOR VALIDATION
  - PARAMETER PRIORITIZATION
  - ALARM ELIMINATION, FILTERING AND PRIORITIZATION

- o PROVIDE REDUNDANCY AND DIVERSITY IN THE DISPLAY SYSTEMS WITH ALL DISPLAYS INTEGRATED SUCH THAT:
  - ALL ELEMENTS OF THE DISPLAY HIERARCHY ARE USED NORMALLY, BUT OPERATION MAY CONTINUE (WITH MINIMAL DEGRADATION TO HUMAN FACTORS) UNDER EQUIPMENT FAILURE CONDITIONS

AND

  - EQUIPMENT USED DURING ACCIDENT CONDITIONS IS ALSO USED DURING NORMAL OPERATION


RCS PANEL
ALARM TILES
DISCRETE INDICATORS (ELECTRO LUMINESCENT DISPLAY DEVICE)
Th
Tc
FUNCTION DEDICATED SOFT CONTROLLER
COMPONENT CONTROLS
Inj. Flow
Misc RCS
20
9
15
48
SYSTEM 80+

NUPLEX 80+ DISCRETE ALARMS

- PROVIDES STATIC ALARM PRIORITIZATION WITHIN INDIVIDUAL PLANT SYSTEMS WITH MODE DEPENDENT LOGIC AND SETPOINTS.

- ALARMS INDICATE A PROBLEM ONLY - STATUS INFORMATION INDEPENDENT OF ALARM SYSTEM.

- NUMBER OF DISCRETE ALARM WINDOWS SIGNIFICANTLY REDUCED BY ALARM GROUPING WITH DYNAMIC MESSAGE DISPLAYS.

- NUMBER OF ALARMS SIGNIFICANTLY REDUCED THROUGH SIGNAL VALIDATION AND DYNAMIC ALARM PROCESSING.

- DIRECT ACCESS TO CRT PAGES PROVIDED FOR OBTAINING DIAGNOSTIC INFORMATION.

- FIRST-OUT INDICATION PROVIDED FOR REACTOR AND TURBINE TRIPS.

- CRITICAL SAFETY FUNCTION ALARMS PROVIDED FOR POST-TRIP CONDITIONS.

- INDEPENDENT FROM PLANT COMPUTER TO SUPPORT CONTINUED OPERATION.

NUPLEX 80+ ALARM PRIORITIZATION

PRIORITY 1 — IMMEDIATE ACTION

- INDICATED BY:

  MOMENTARY AUDIBLE
  ALARM TILES
  DISPLAY PAGE FEATURES
  IPSO

- ALARM CONDITIONS GROUPED WITHIN TILES RELATED TO SPECIFIC EQUIPMENT OR PROCESSES

- CONDITIONS ALARMED:

  MAY CAUSE TRIP IN < 10 MINUTES
  MAY CAUSE MAJOR EQUIPMENT DAMAGE
  PERSONNEL/RADIATION HAZARD
  CRITICAL SAFETY FUNCTIONS
  IMMEDIATE TECHNICAL SPECIFICATION ACTION
  FIRST OUT REACTOR/TURBINE TRIP

NUPLEX 80+ ALARM PRIORITIZATION

PRIORITY 2 — PROMPT ACTION

- INDICATED BY:

  MOMENTARY AUDIBLE
  ALARM TILES } DISTINGUISHED
  DISPLAY PAGE FEATURES } FROM PRIORITY 1

- ALARM CONDITIONS GROUPED WITHIN TILES RELATED TO SPECIFIC EQUIPMENT OR PROCESSES

- CONDITIONS ALARMED:

  MAY CAUSE TRIP IN > 10 MINUTES
  TECHNICAL SPECIFICATION ACTION NOT IN PRIORITY 1
  EQUIPMENT DAMAGE POSSIBLE
  REG. GUIDE 1.47 BYPASSED AND INOPERABLE STATUS

NUPLEX 80+ ALARM PRIORITIZATION

PRIORITY 3 — CAUTION

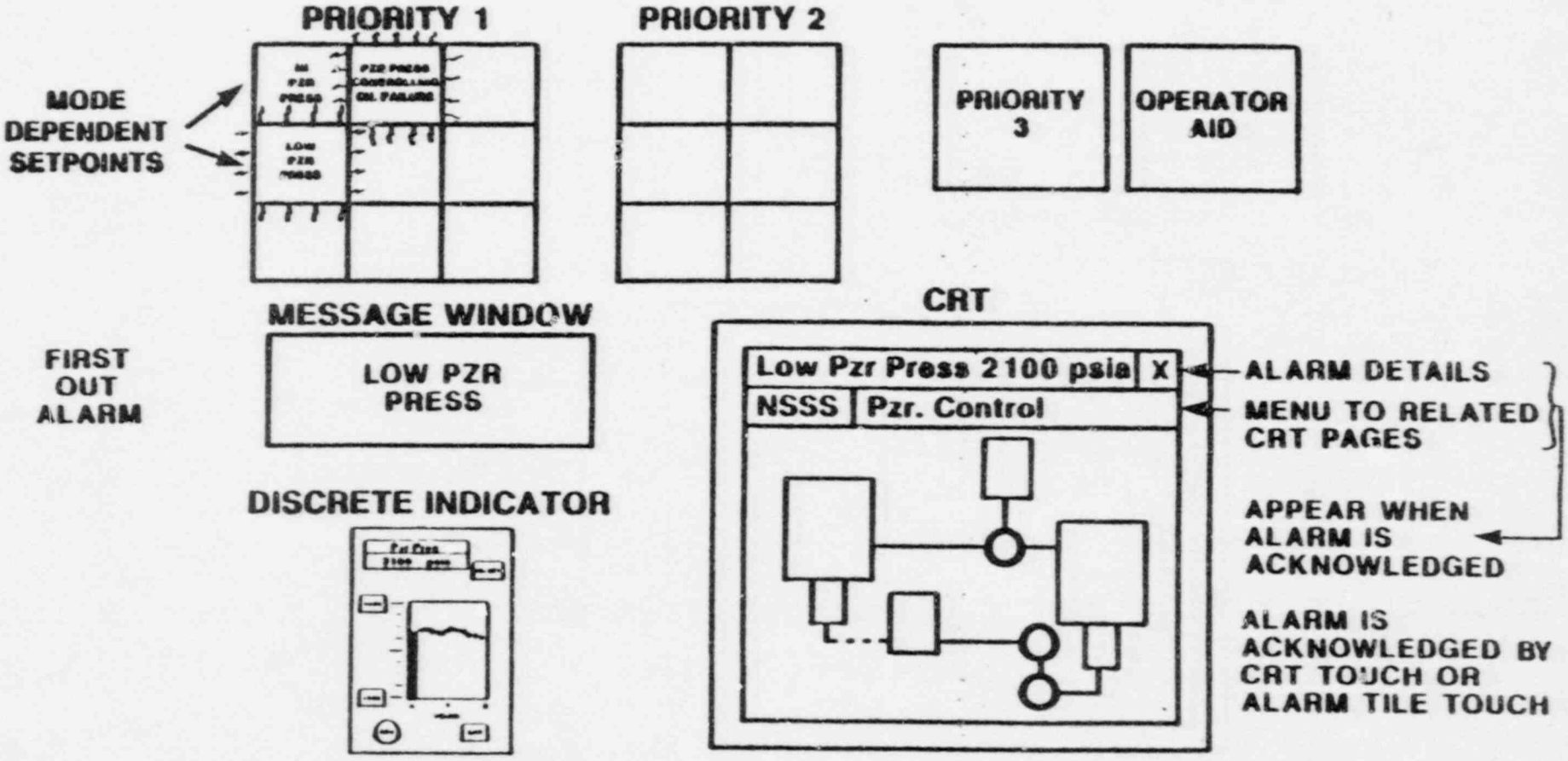
- INDICATED BY CRT DISPLAYS WITH ALARM TILE CUE (NO AUDIBLE)
- CONDITIONS ALARMED:

  SENSOR DEVIATIONS
  EQUIPMENT STATUS DEVIATIONS
  EQUIPMENT FAILURES NOT CRITICAL TO OPERATION

OPERATOR AID — INFORMATION

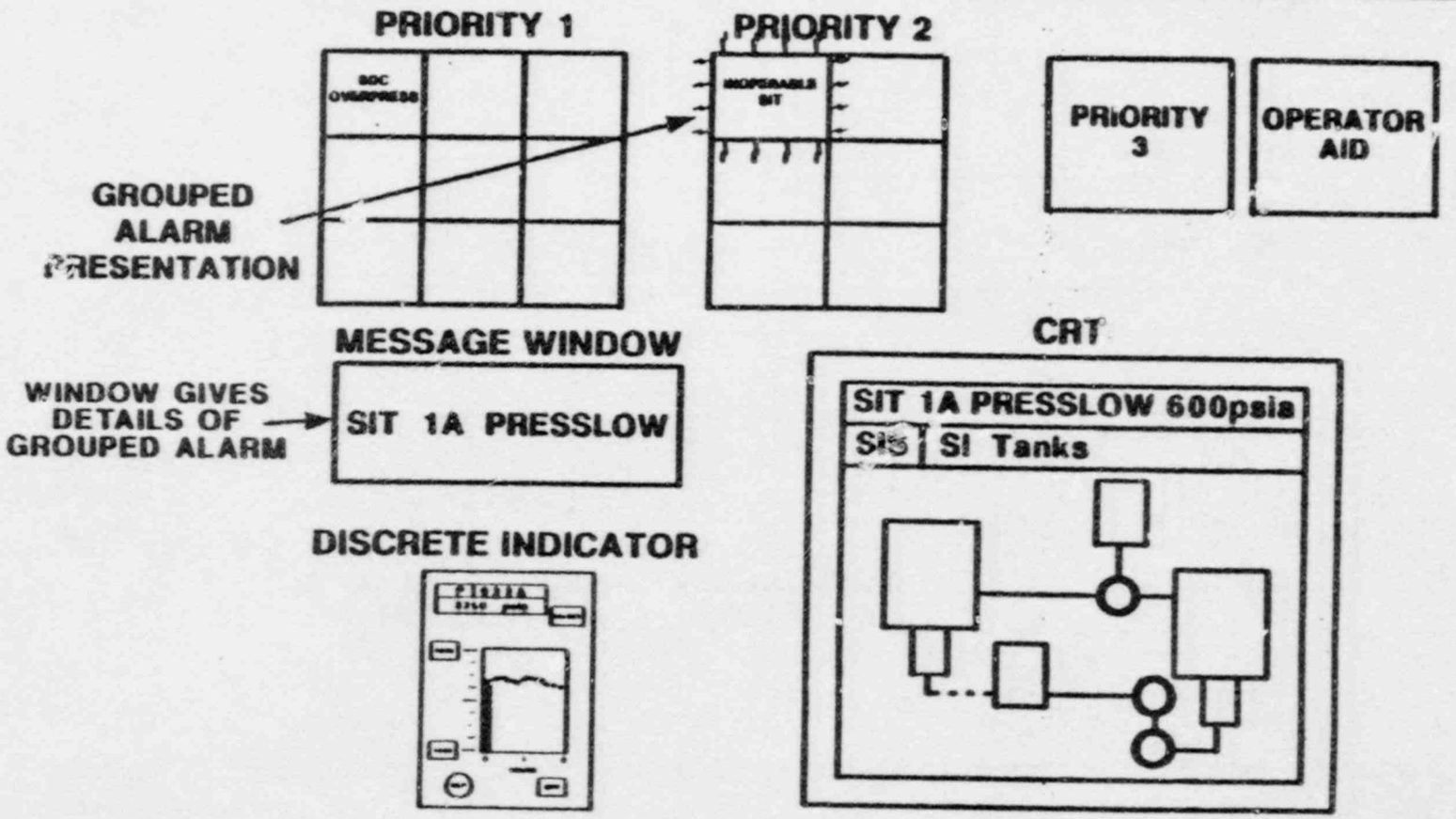
- INDICATED BY CRT DISPLAY WITH ALARM TILE CUE (NO AUDIBLE)
- CONDITIONS IDENTIFIED:

  EQUIPMENT STATUS CHANGE PERMISSIVE
  CHANNEL BYPASS CONDITIONS


PRIORITY 1
PRIORITY 2
PRIORITY 3
OPERATOR AID
MODE DEPENDENT SETPOINTS
MESSAGE WINDOW
LOW PZR PRESS
FIRST OUT ALARM
DISCRETE INDICATOR
CRT
Low Pzr Press 2100 psia
X
NSSS
Pzr. Control
ALARM DETAILS
MENU TO RELATED CRT PAGES
APPEAR WHEN ALARM IS ACKNOWLEDGED
ALARM IS ACKNOWLEDGED BY CRT TOUCH OR ALARM TILE TOUCH

SI/SDC PANEL

NUPLEX 80+

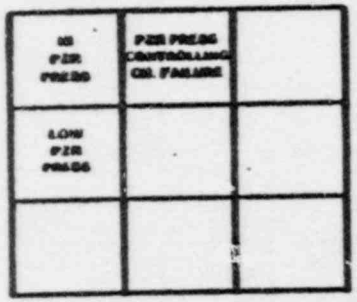


SYSTEM 80+™

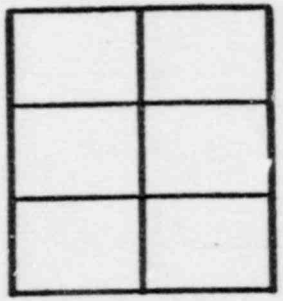
RCS PANEL

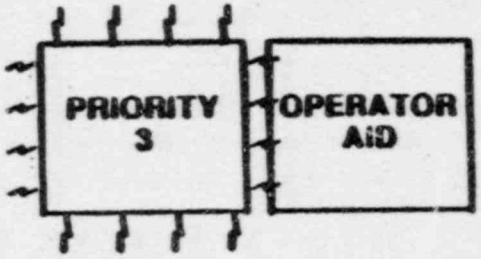
NUPLEX 80+

PRIORITY 1

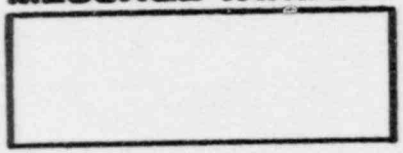


PRIORITY 2

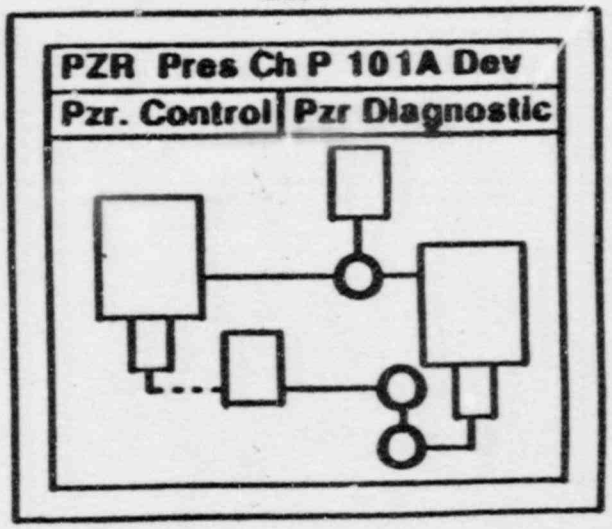




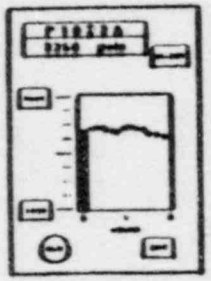
MESSAGE WINDOW



CRT



DISCRETE INDICATOR

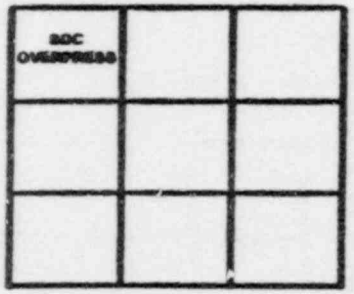


SYSTEM 80+

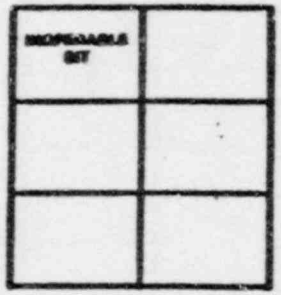
SI / SDC PANEL

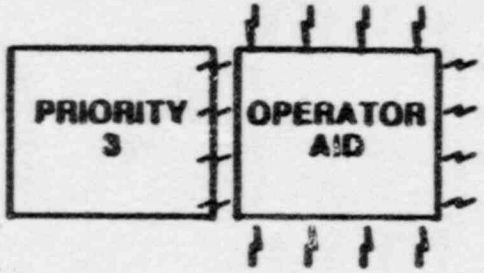
NUPLEX 80+

PRIORITY 1

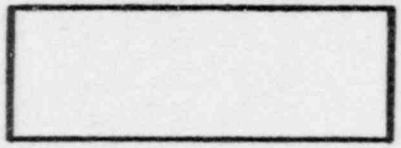


PRIORITY 2

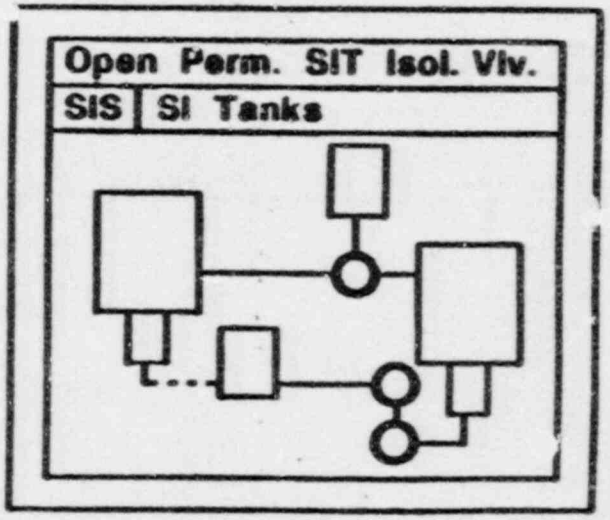




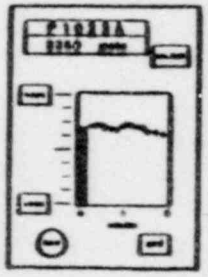
MESSAGE WINDOW



CRT



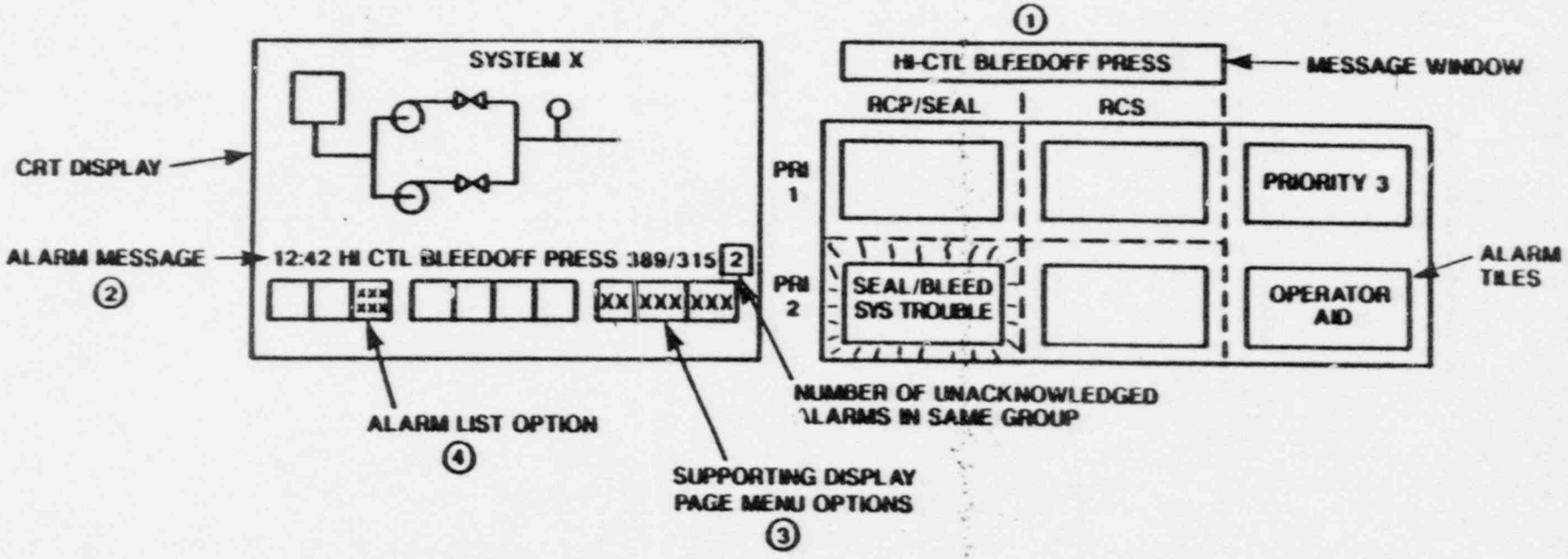
DISCRETE INDICATOR



SYSTEM 80+

ALARM RESPONSE USING TILES

NUPLEX 80+



OPERATOR RESPONSE

- DEPRESS ALARM TILES

ALARM SYSTEM SUPPORT

① ALARM DESCRIPTOR ON MESSAGE WINDOW (PRI 1 & 2)

② COMPLETE ALARM MESSAGE ON CRT

③ MENU OPTIONS INDICATE USEFUL SUPPORTING DISPLAY PAGES

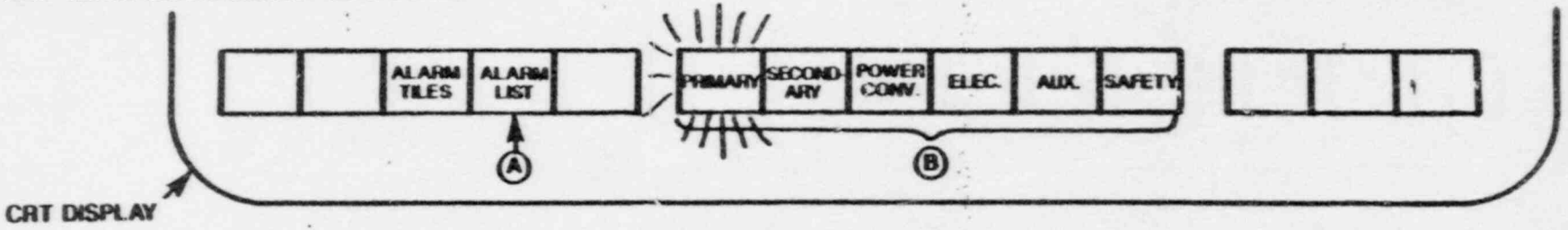
④ DIRECT ACCESS TO LISTING OF ALL ALARMS IN GROUP

SYSTEM 80+™

ALARM RESPONSE ON CRT

NUPLEX 80+

BY CATAGORIZED LISTING

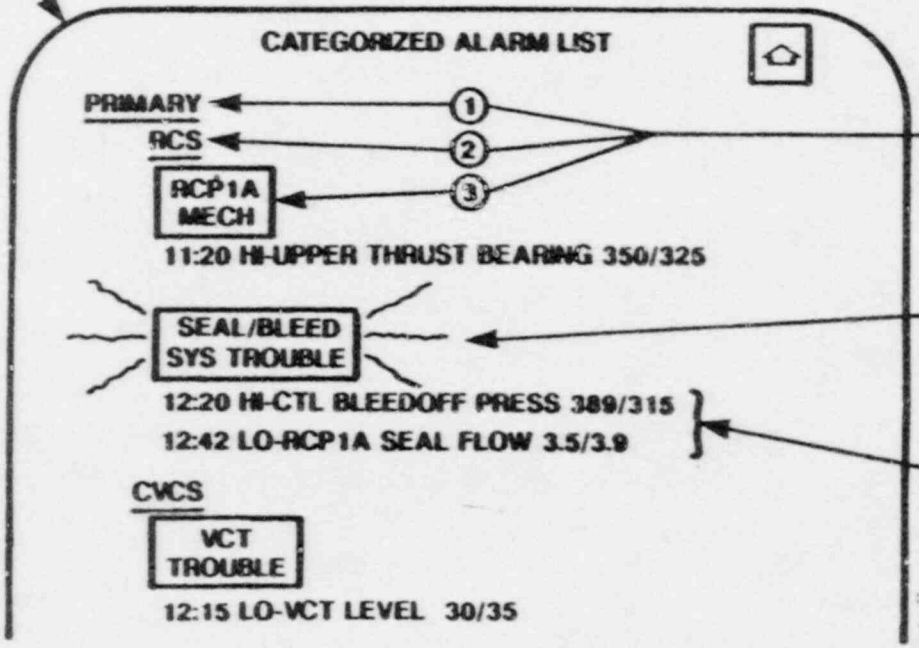


OPERATOR SELECTS - ALARM LIST MENU OPTION (A)

FOLLOWED BY PRIMARY (A 1st LEVEL DISPLAY PAGE IN ALARM) (B)

CRT DISPLAY

RESULT:



CATEGORIES - (1) - FIRST LEVEL DISPLAY PAGE

(2) - WORK STATION

(3) - ALARM TILES

ALARM TILE IS A TOUCH/ACKNOWLEDGED TARGET - ACKNOWLEDGES ALL ALARMS IN TILE'S BUFFER

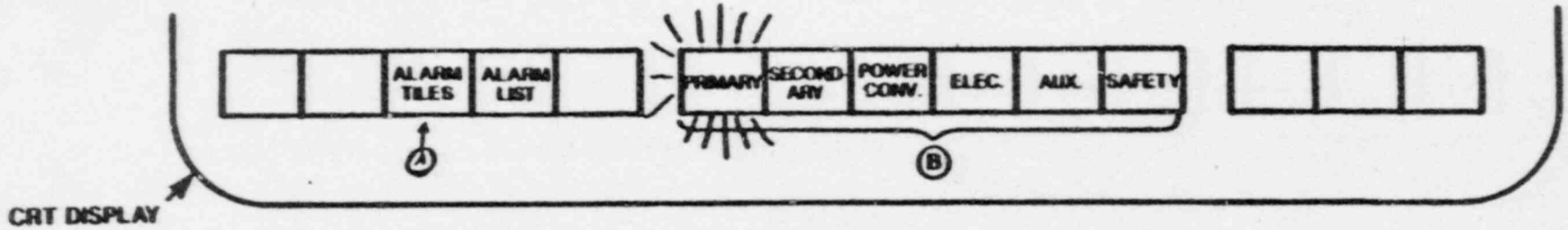
ALARM MESSAGES

SYSTEM 80+™

ALARM RESPONSE ON CRT

NUPLEX 80+

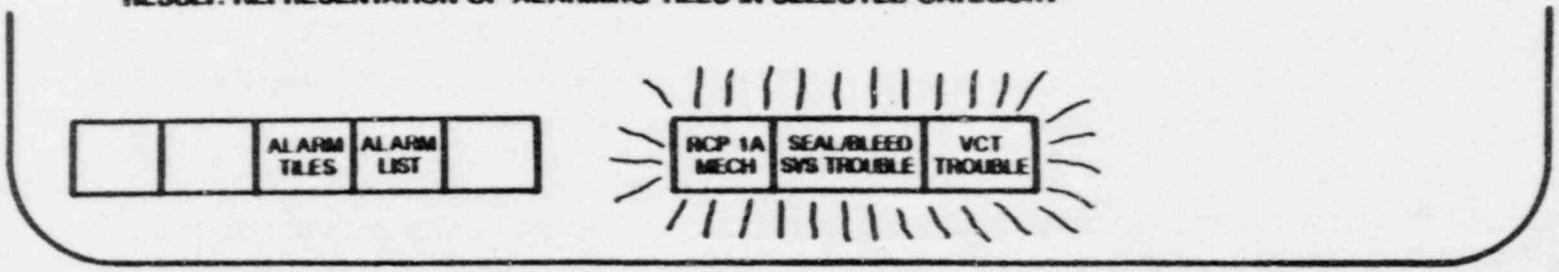
ALARM TILE REPRESENTATIONS



OPERATOR SELECTS - ALARM TILES MENU OPTION (A)

FOLLOWED BY PRIMARY (A 1st LEVEL DISPLAY PAGE IN ALARM) (B)

RESULT: REPRESENTATION OF ALARMING TILES IN SELECTED CATEGORY



ALARM RESPONSE ON CRT

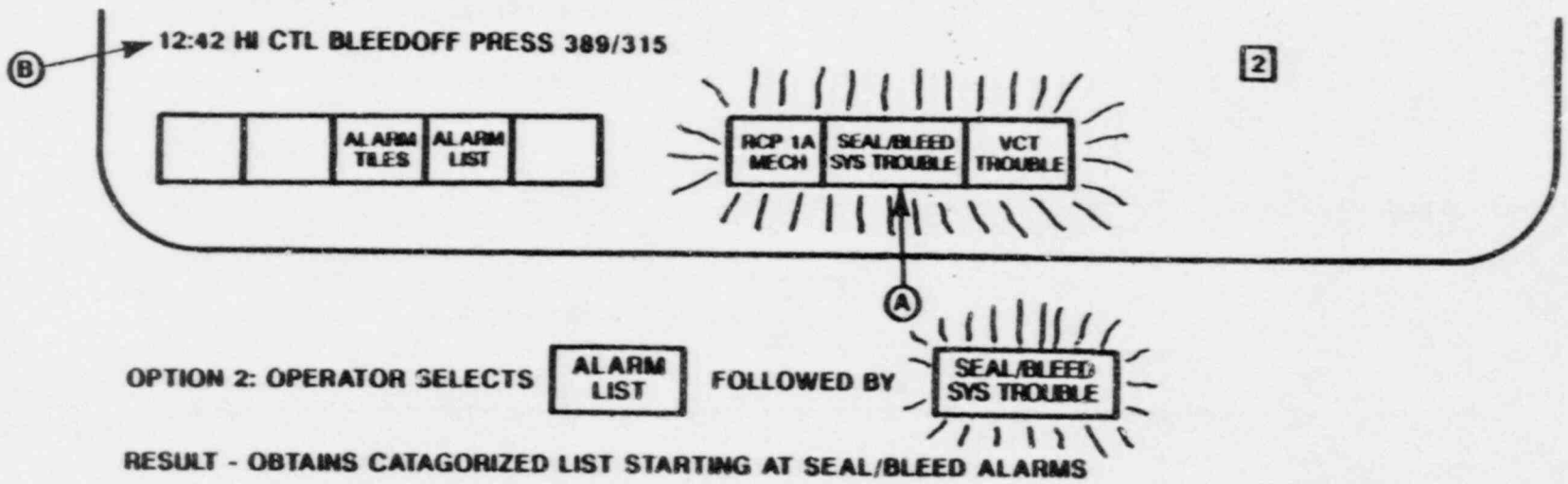
NUPLEX 80+

(USING ALARM TILE REPRESENTATION - CONTINUED)

OPERATOR CAN ACKNOWLEDGE USING 1 OF 2 OPTIONS

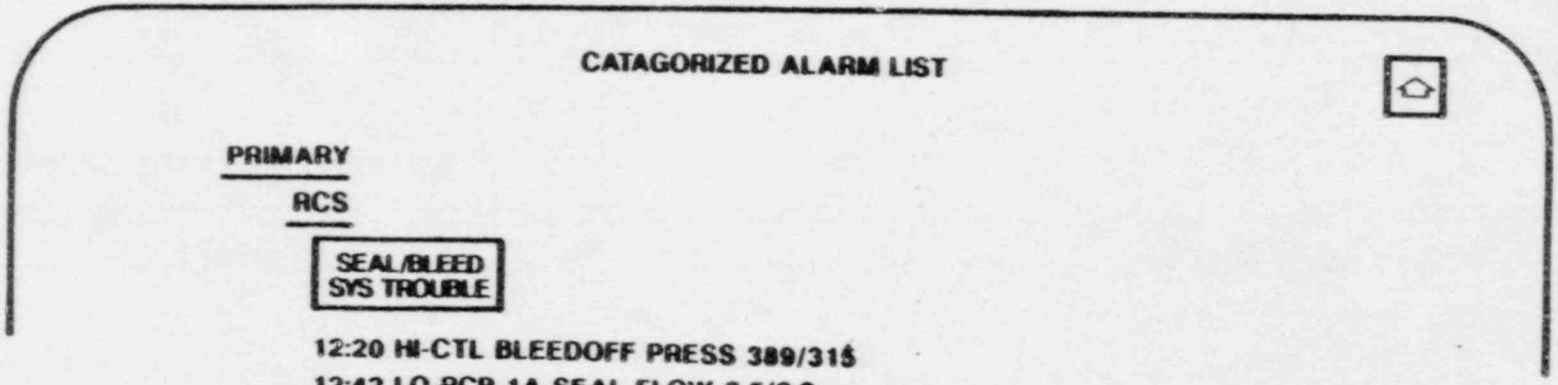
OPTION 1: SELECT/TOUCH ALARM TILE REPRESENTATION (A)

RESULT - OBTAIN CRT ALARM MESSAGE (B)



OPTION 2: OPERATOR SELECTS [ALARM LIST] FOLLOWED BY [SEAL/BLEED SYS TROUBLE]

RESULT - OBTAINS CATAGORIZED LIST STARTING AT SEAL/BLEED ALARMS



REACTOR COOLANT SYSTEM

ALARMS

SYSTEM 80		NUPLEX 80+	
ALARM TILES	ALARMS	ALARM TILES	ALARMS
6	46	PRIORITY 1 - 8	11
		PRIORITY 2 - 1	6
		PRIORITY 3 - 1	41
		OPERATOR AID - 1	6
		(NEW SENSOR DEVIATION ALARMS)	

REACTOR COOLANT SYSTEM
ALARMS

NUPLEX 80+/SYSTEM 80 COMPARISON

1. ALARMS REDUCE OPERATOR PROCESSING TIME BY MORE ACCURATELY IDENTIFYING CAUSE

   - SYSTEM 80 HAS A "HIGH, LOW PRESSURIZER PRESSURE" ALARM

     POSSIBLE CAUSES
     - CHANNEL X SENSOR FAILURE
     - CHANNEL Y SENSOR FAILURE
     - NUISANCE HIGH PRESSURIZER PRESS AFTER TRIP
     - NUISANCE LOW PRESSURIZER PRESS AFTER TRIP
     - HIGH PRESSURE ON PROCESS
     - LOW PRESSURE ON PROCESS

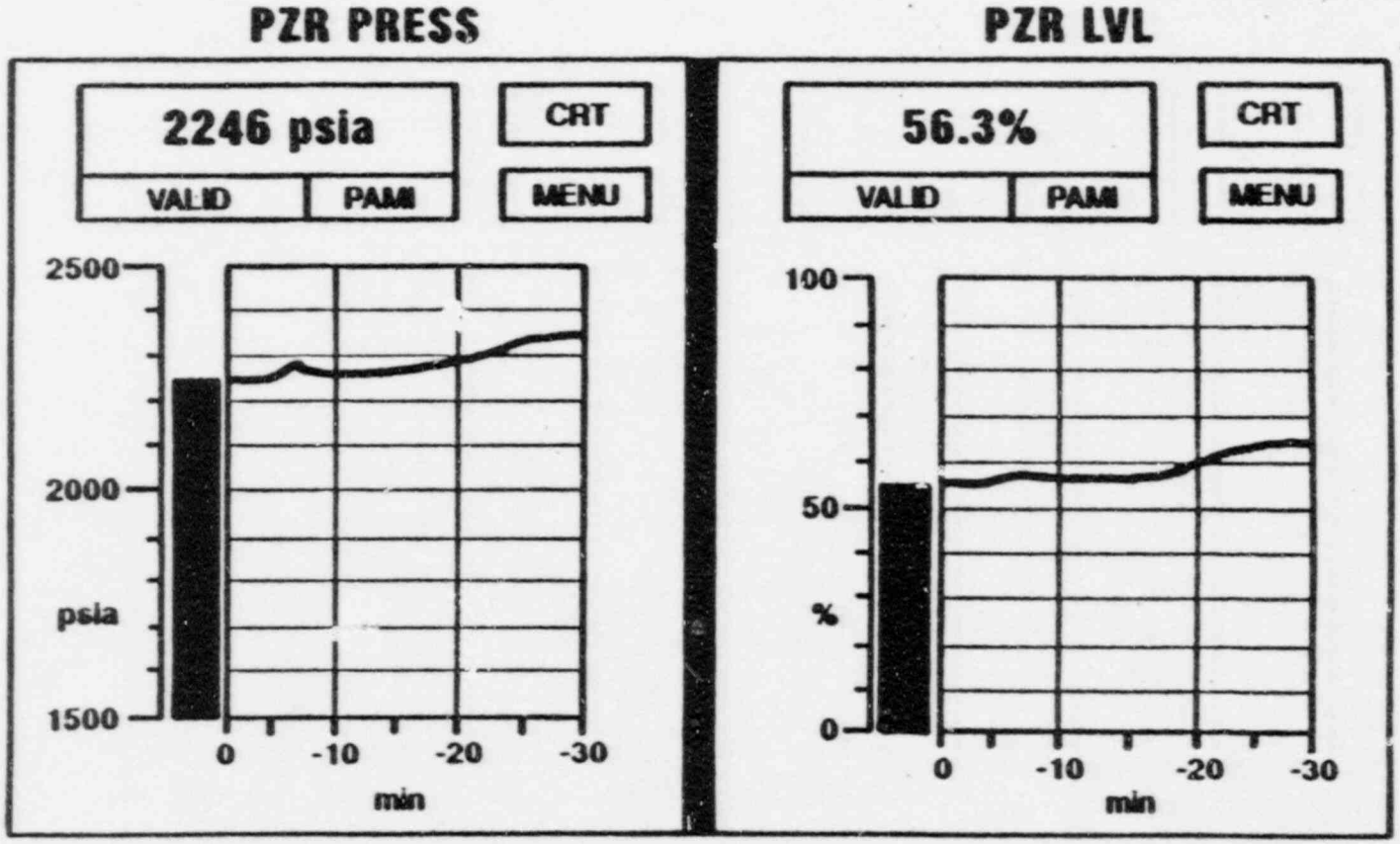
   - REPLACE ON NUPLEX 80+ WITH FOUR ALARMS

     - MODE DEPENDENT ABNORMAL HIGH VALIDATED PRESS (P1)
     - MODE DEPENDENT ABNORMAL LOW VALIDATED PRESS (P1)
     - PRESS CONTROLLING CHANNEL FAILURE (P1)
     - SENSOR DEVIATION (P3)

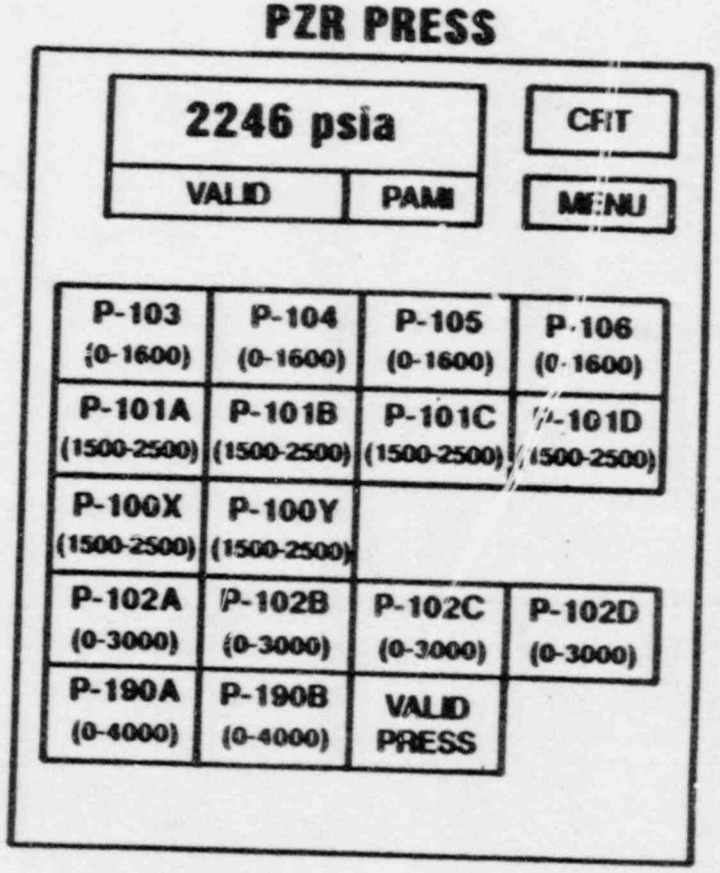
2. EASIER CLARIFICATION OF PROBLEMS

   - ONLY 11 CONDITIONS CAN CAUSE PRIORITY 1 ALARMS ON NUPLEX 80+

   - ALL 46 RCS ALARM CONDITIONS HAVE EQUAL IMPORTANCE ON SYSTEM 80



DISCRETE INDICATOR SHOWING NORMALLY INDICATED VALUES FOR PRESSURIZER PRESSURE AND LEVEL

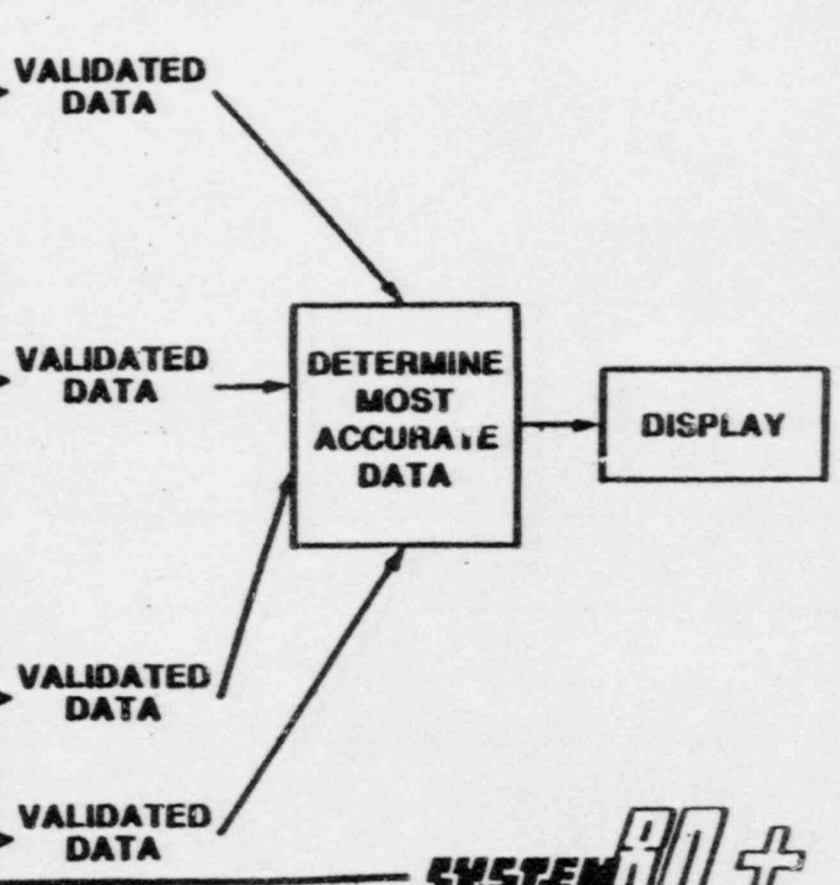


DISCRETE PZR PRESS INDICATOR AFTER DEPRESSING "MENU" BUTTON

DISCRETE INDICATOR VALIDATION APPLICATION

NUPLEX 80+

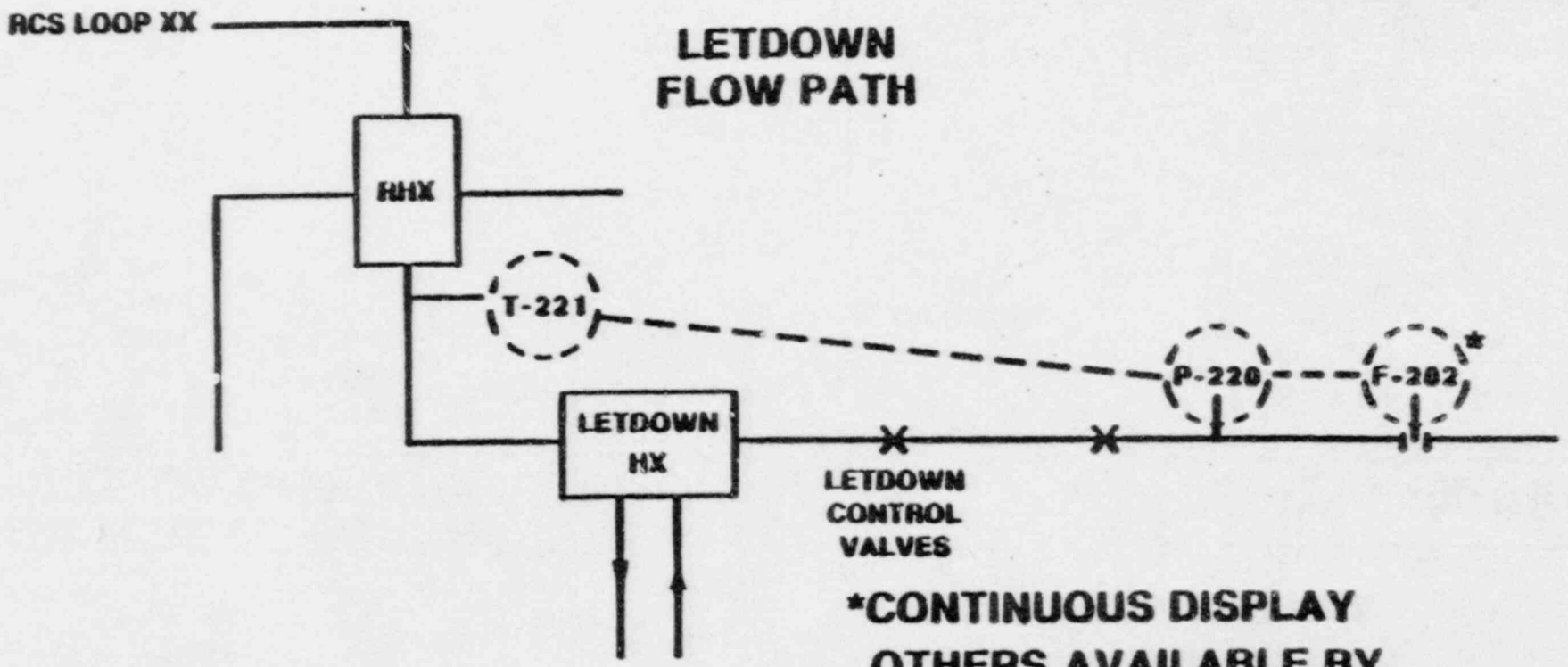
PRESSURIZER SENSORS	PRESSURE RANGE	CONVENTIONAL CONTROL ROOM INDICATION
P-103	0-750 psia	RECORDER
P-104	"	"
P-105	"	"
P-106	"	"
P-101A	1500-2500 psia	INDICATOR
B	"	"
C	"	"
D	"	"
P-199A	1500-2500	INDICATOR
B	"	"
C	"	"
D	"	"
P-100X	1500-2500	INDICATOR
Y	"	"
P-102A	0-3000	IND./REC
B	"	"
C	"	"
D	"	"
P-190A	0-4000	RECORDER
B	"	"



SYSTEM 80+

DISCRETE INDICATOR FLOW PATH APPLICATION

NUPLEX 80+



SYSTEM 80+

REACTOR COOLANT SYSTEM

INDICATORS

SYSTEM 80	NUPLEX 80+
43	6 (INCLUDES PAMI INDICATOR ON ACSC)

SYSTEM 80

- ALL PARAMETERS NEEDED FOR OPERATION CONTINUOUSLY DISPLAYED
- INFREQUENTLY VIEWED PARAMETERS TAKE UP BOARD SPACE (I.E., PRESSURIZER SURGE LINE TEMPERATURE)
- MANY METERS MEASURING THE SAME PARAMETER (I.E., THREE INDICATORS FOR PRESSURIZER LEVEL)

NUPLEX 80+

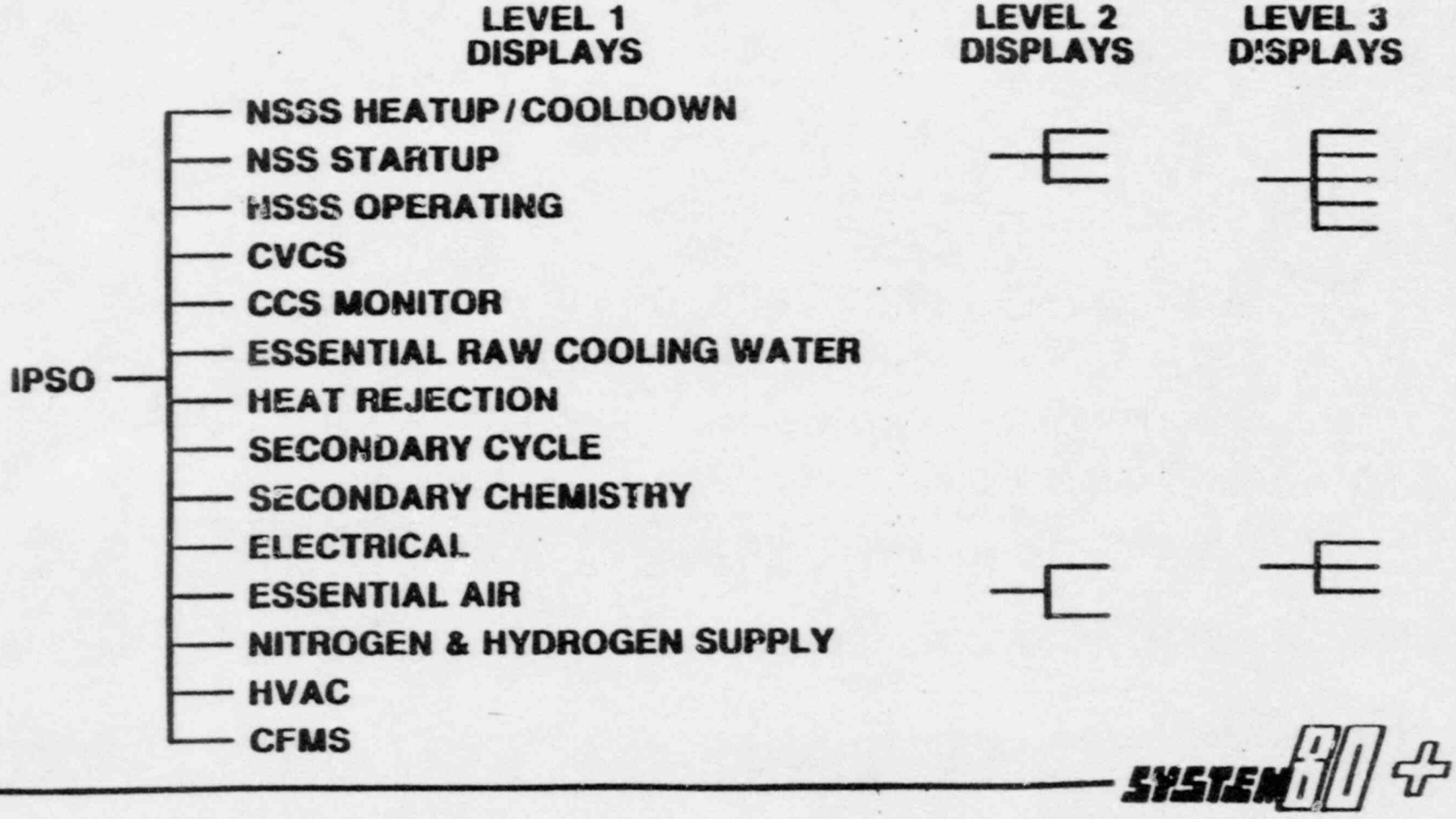
- ONLY FREQUENTLY VIEWED PARAMETER CONTINUOUSLY DISPLAYED (I.E., PRESSURIZER PRESSURE, T_{COLD}, ETC.)
- INFREQUENTLY VIEWED PARAMETERS AVAILABLE USING THE DISCRETE INDICATOR PAGING SYSTEM OR THE CRT
- ONE SINGLE VALIDATED INDICATOR TAKES THE PLACE OF MANY METERS MEASURING THE SAME PARAMETER (I.E., ONE VALIDATED PRESSURIZER LEVEL METER REPLACES THREE INDIVIDUAL PRESSURIZER LEVEL METERS ON THE RCS PANEL)

NUPLEX 80+ CRT DISPLAYS

- CRT DISPLAYS PROVIDE ACCESS TO ESSENTIALLY ALL PLANT INFORMATION FROM ANY LOCATION WITHIN CONTROL ROOM OR REMOTE LOCATIONS:
  - DYNAMIC COLOR GRAPHIC PLANT MIMIC DISPLAYS, INCLUDING IPSO
  - ALARMS AND OPERATOR AID INFORMATION
  - PLANT COMPUTER CALCULATED INFORMATION
  - TRENDS AND REPORTS
- IMPLEMENTATION THROUGH NON-SAFETY PLANT COMPUTER.
- DUPLICATES AND VERIFIES ALL DISCRETE ALARM AND DISPLAY SYSTEM PROCESSING AND IDENTIFIES SIGNIFICANT DIFFERENCES.

NUPLEX 80+ CRT DISPLAY HIERARCHY

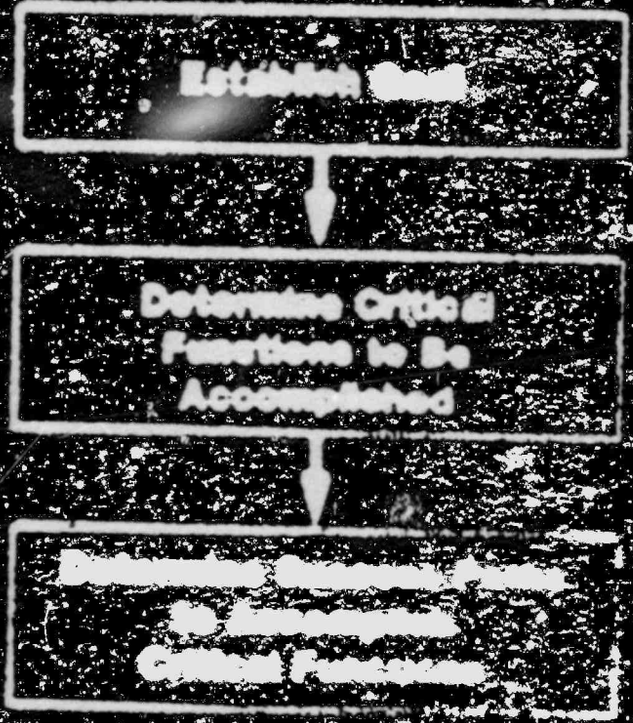
NUPLEX 80+



SYSTEM 80+

DESIGN PHILOSOPHY

Basic Human Cognitive Process to Reach an Established Goal, Utilizing the Concept of Critical Functions



CRITICAL FUNCTIONS

CORE REACTIVITY
- CEA DROP MALFCTN
  HI POST TRIP PWR
- THERMAL REACT ADD
- LO BORON CONC

RCS INVENTORY
- LO PZR LEV
- QUENCH TANK LEV
- QUENCH TANK PRES
- QUENCH TANK TEMP
- RELIEF VLV DISCH

3

RCS PRESSURE
- COLD STRESS TEMP
  HI PZR PRES/RATE
- LO SUBCOOLED MAR

CORE HEAT REMOVAL
- HI CORE DT
- LO RCTR VES LEV
- HI CORE EXIT TEMP
- CORE SAT MARGIN
- LO RCP LOAD

RCS HEAT REMOVAL
- SDCS NOT COOLING
- LO SIS PUMP FLOW
  ECCS NOT COOLING
- SG NOT COOLING
- LO SI/FW COOLING

CNMT ISOLATION
- CNMT ISOLATION
- CNMT PURGE ISO
  SAFETY INJ ISO
- MAIN STEAM ISO

CNMT TEMP / PRESS
- FAN COOLERS
- LO SPRAY FLOW
- CNMT PRESS CHANGE
  HI CNMT PRES
- LO CNMT PRES
- HI CNMT TEMP

RADIATION EMISSIONS
- HI COND AIR EJEC
- HI CNMT
- HI CNMT DOME
  HI VENT/STACK

INFORMATION REQUIREMENTS

- Success Path Readiness
- Automated System Status
- Support System Parameters Monitored (i.e. Voltage, Pressure, Etc.)
- Gen Indicating (Within Limits or Not) of Success Path Technique If Success Path Will Be Required When Called Upon

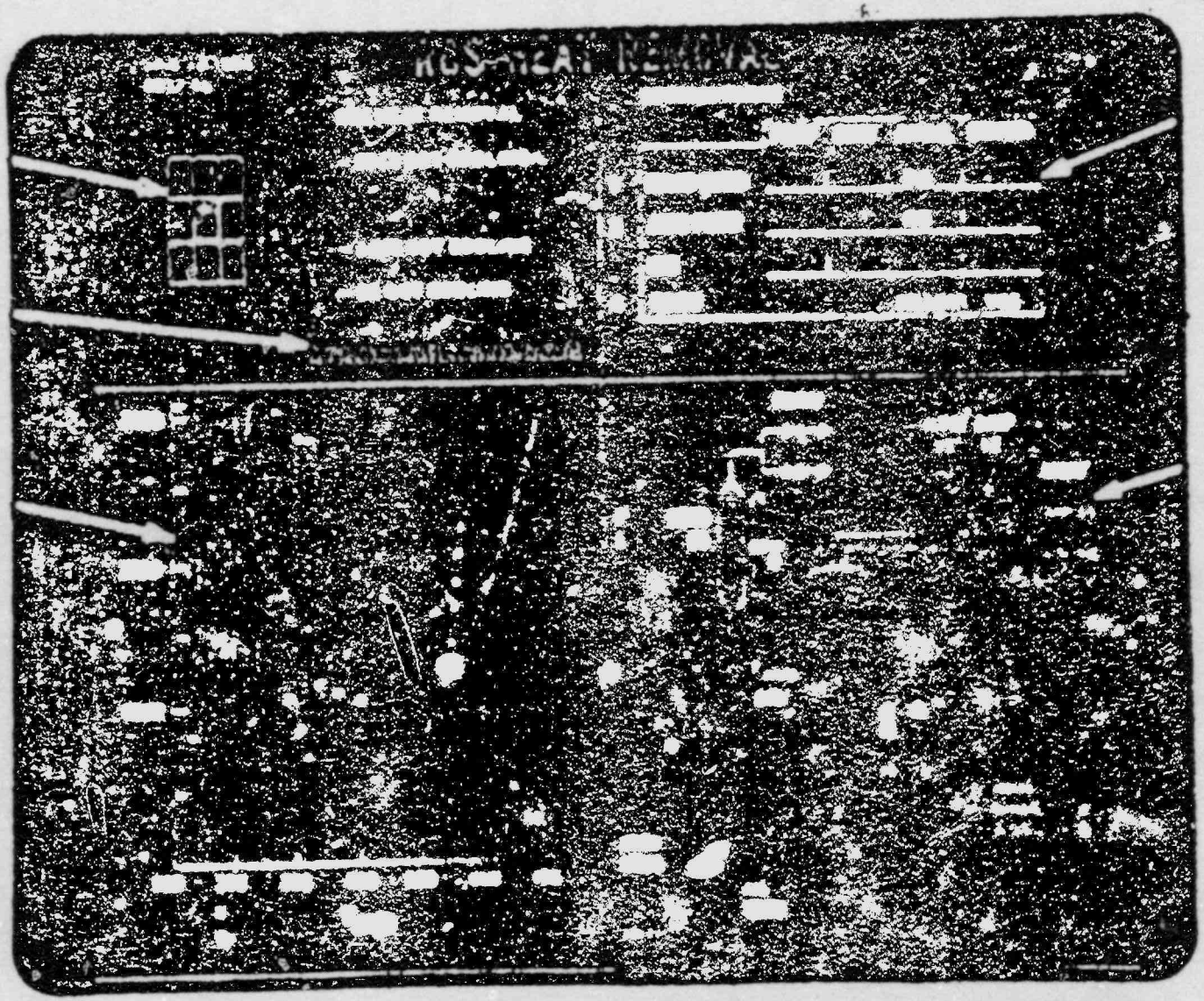
INFORMATION REQUIREMENTS

Success Path Performance

Criteria: Must Meet Minimum Functional Requirements

COMPONENT and SYSTEM Performance

Performance Assessment Independent of Critical Function Status



NUPLEX 80+ SAFETY-RELATED DISPLAY INFORMATION

NUPLEX 80+ HAS THREE METHODS OF REG.GUIDE 1.97 PARAMETER DISPLAY:

- DIAS CHANNEL Y - SAFETY MONITORING PANEL
  SEISMIC DISPLAY DEDICATED TO CATEGORY 1 PARAMETERS

- DIAS CHANNEL X - CATEGORIES 1 AND 2 PARAMETERS
  INTEGRATED INTO NORMAL WORKSTATION DISPLAYS.

  DISPLAYS ARE SEISMIC, SELECTABLE TO PAMI CHANNELS AND INDEPENDENT FROM DIAS-Y.

  FIVE SEGMENTS DIVIDED BY PLANT AREA.

- PMDS - CRT'S DISPLAY ALL REG. GUIDE 1.97 VARIABLES.

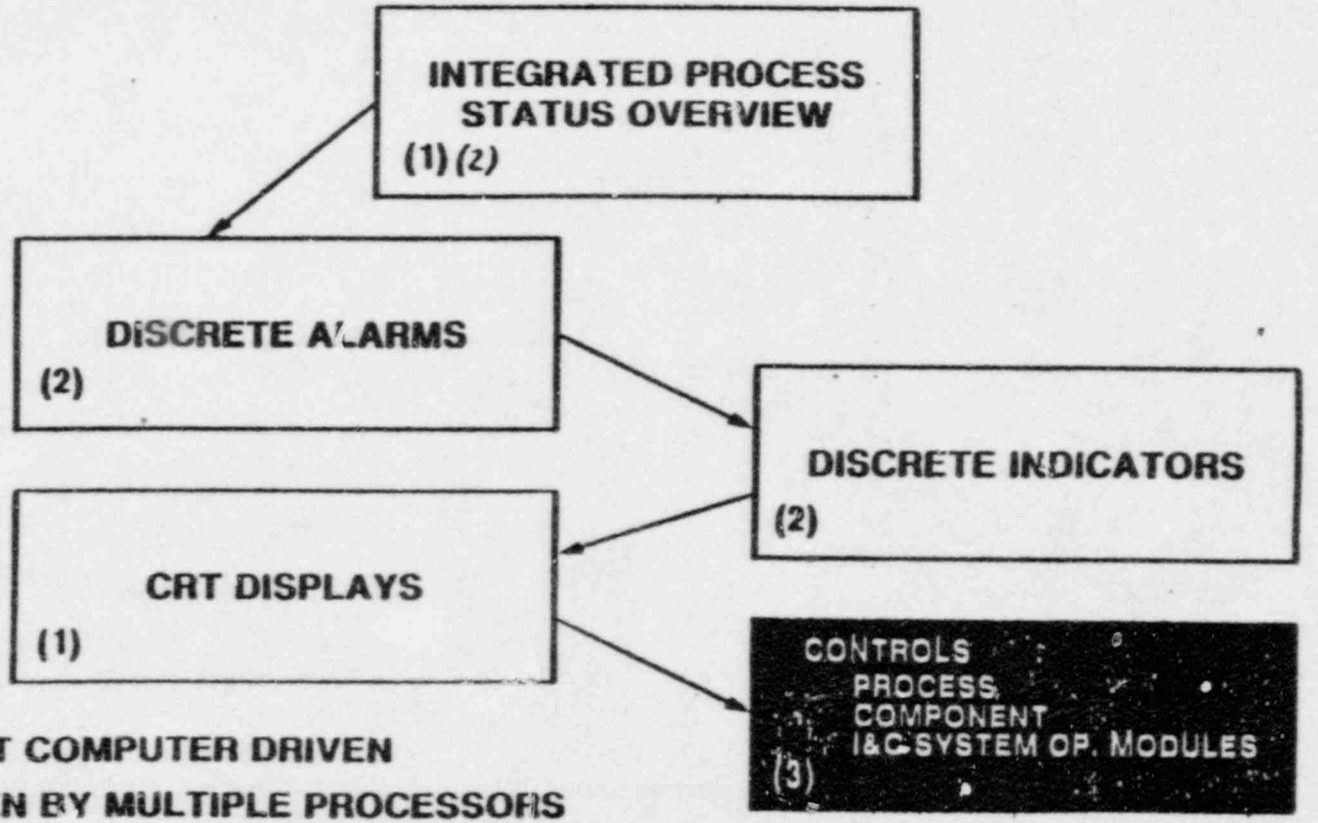
  INDEPENDENT FROM DIAS X AND Y.

  PROVIDES TRENDING.

ALL DISPLAYS SHOW VALIDATED DATA FROM CROSS-CHANNEL INPUT CHECKS. PMDS ALARMS DISCREPANCIES.

INFORMATION DISPLAY HIERARCHY

NUPLEX 80+



(1) PLANT COMPUTER DRIVEN

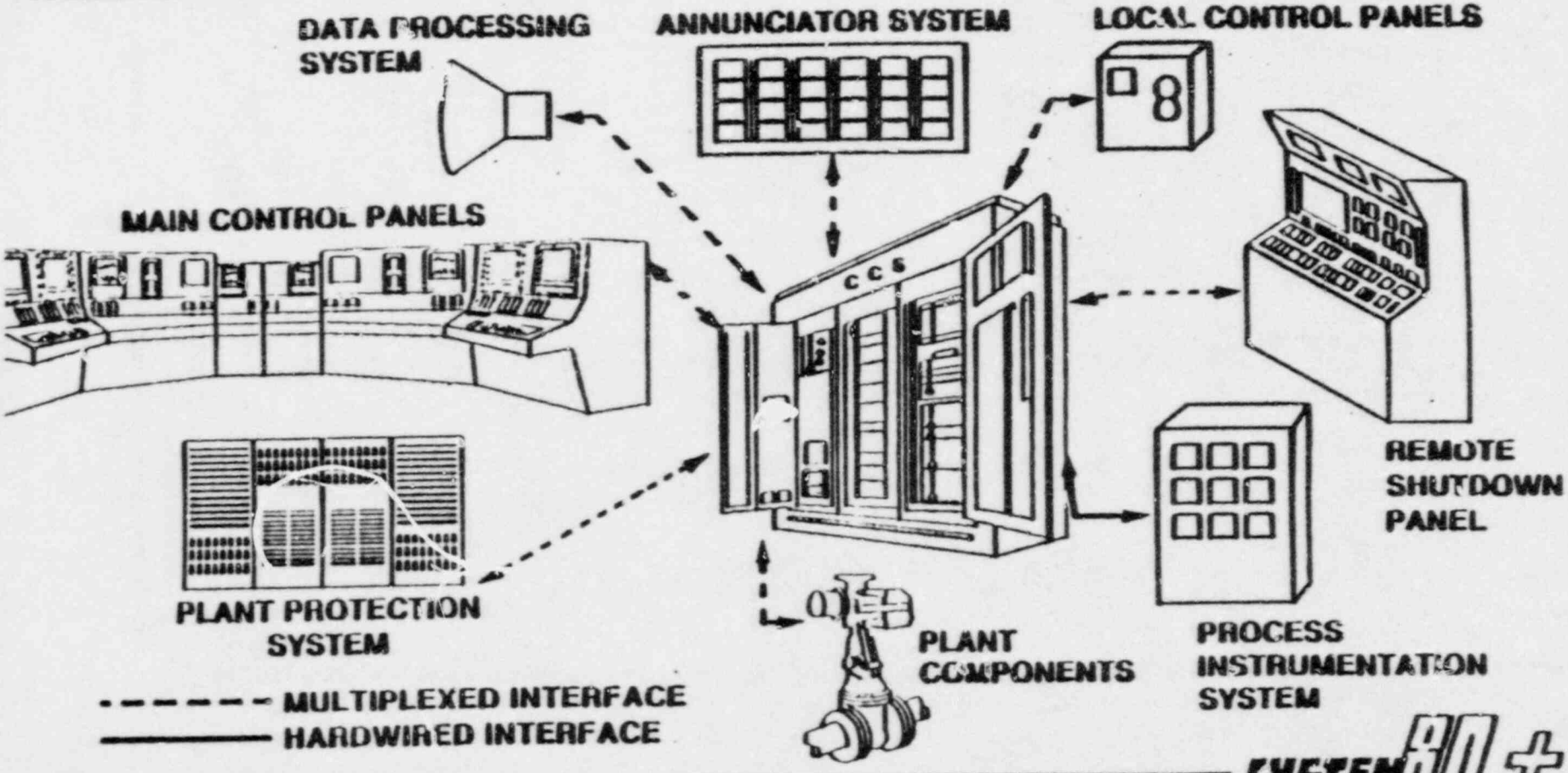
(2) DRIVEN BY MULTIPLE PROCESSORS

(3) DRIVEN BY INDIVIDUAL PLANT SYSTEMS

SYSTEM 80+

CENTRALIZED CONTROL WITH MAXIMUM MULTIPLEXING

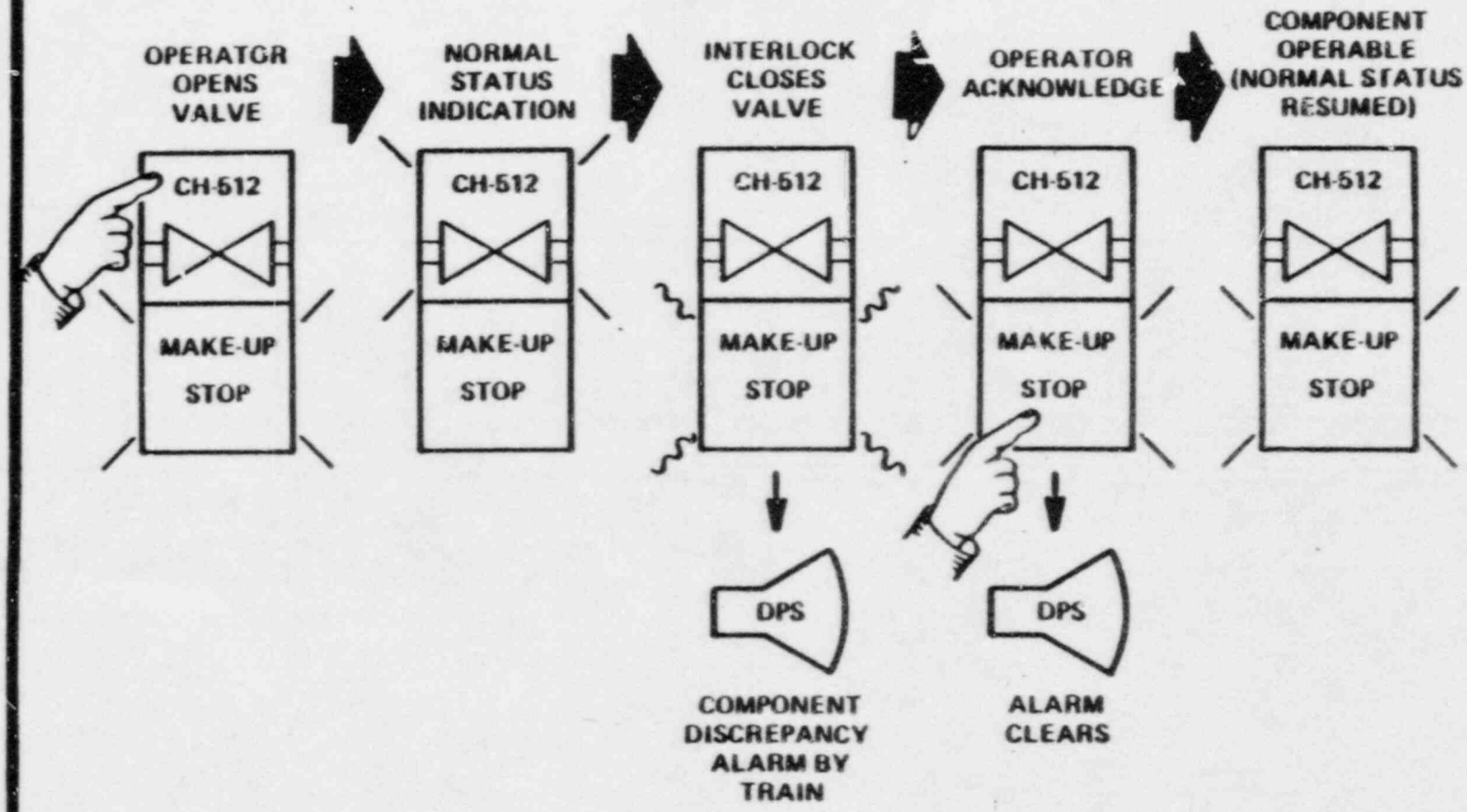
NUPLEX 80+



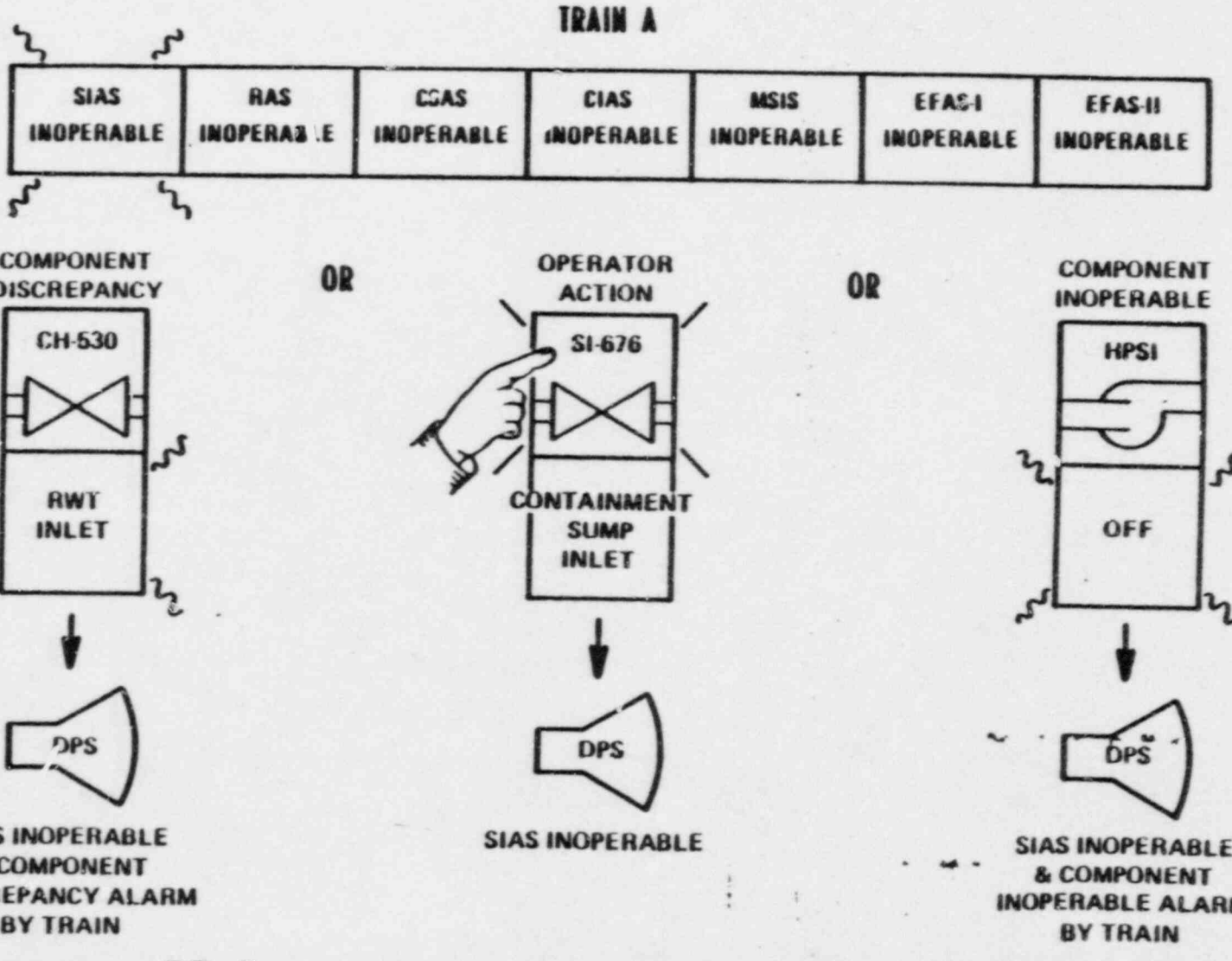
SYSTEM 80+

FLASHING DISCREPANCY INDICATION

COMPONENT DISCREPANCY IN MANUAL MODE



ESF SYSTEM STATUS MONITORING AND DISCREPANCY INDICATION



CLOSING

- SUMMARY OF ACTION ITEMS
- NEXT MEETING