CONTROL ROOM DESIGN REVIEW

PRELIMINARY REPORT

April 1983

Washington Public Power Supply System

WNP-2

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1.0 SUMMARY

The Supply System concurs with the intent of performing a Control Room Design Review and has undertaken an aggressive program to complete a review of the WNP-2 control room in accordance with NUREG-0660 and NUREG-0737, Supplement 1.

The Supply System methodology has been to provide a dual program approach:

1. Participate as an active member in the Boiling Water Reactor Owners' Group (BWROG) Control Room Design Review program.

2. Establish a WNP-2 Task Force for detailed assessment and resolution of control room human factor concerns and to provide configuration control for on-going changes to the WNP-2 control room.

This Control Room Design Review is a Preliminary Report in accordance with NUREG-0737, Supplement 1. The report is based on the BWROG Program Plan submitted to the Regulatory Commission in August 1981 and the BWROG program survey of the WNP-2 control room performed in January 1983. Favorable aspects and deviations in control room design, resulting from the BWROG survey, are noted within this report and occasionally supplemented with results from the WNP-2 Task Force Reviews.

Section 2.0 of this report defines additions and/or exceptions to the BWROG Program Plan, defines the scope of the survey review, provides brief resumes of the BWROG survey team members, and provides additional information required for the review of the report.

Sections 3.0 through 24.0 provide detailed information on the favorable aspects and deviations resulting from the BWROG survey and WNP-2 responses as to recommended actions and schedule for implementation.

Section 24.0 provides for the identification of "open" items for which resolution has been deferred and for those sections of the BWROG survey program that will need to be completed to close out the WNP-2 Control Room Design Review program.

2.0 INTRODUCTION

2.1 BWROG PROGRAM PLAN

2.1.1 Program Scope

The BWROG Control Room Design Review Program Plan was submitted to the U. S. Nuclear Regulatory Commission on August 25, 1981. The BWROG program complies with NUREG-0737, Supplement 1, by meeting the methodology and review intent of the guidelines described in NUREG-0700.

NUREG-0700 includes four phases in the Control Room Design Review:

- Planning
- Review
- Assessment and implementation
- Reporting

The "review" phase is further divided into six processes:

- Review of operating experience
- Analysis of system functions and operator tasks
- Control room inventory
- Control room survey
- Verification of task performance capabilities
- Validation of control room functions.

The BWROG program is designed to address only the first two phases of the control room design review; i.e., the planning and review phases. Assessment, implementation, and reporting are the responsibility of individual utilities.

The BWROG review methodology includes analysis of plant LERs and scram reports, operator interviews, checklist evaluations, task analyses, and walkthroughs of emergency procedures. The LER and scram report analysis and operator interviews together correspond to Process 1 of NUREG-0700. The task analyses and walkthroughs satisfy the intent of Processes 2, 3, 5, and 6. The checklist evaluations correspond to Process 4.

2.1.2 BWROG Program Plan Deviations at WNP-2

WNP-2 has no operating history. Therefore, a review of LERs and scram reports could not be performed. However, during the WNP-2 Task Force reviews, considerable input was obtained from experienced operators and from operational experience and human factor reports from other plants. Also, WNP-2 has established an on-site Nuclear Safety Assurance Group (NSAG), as required by NUREG-0737 and WNP-2 Technical Specifications, to provide formal operational experience reviews relative to WNP-2, which include LER and scram reports. Two of the WNP-2 Human Factors Task Force members are part of the WNP-2 NSAG to ensure continuation of human factors input into WNP-2 plant operations.

2.2 WNP-2 TASK FORCE PROGRAM

2.2.1 WNP-2 Task Force Description

A description of the status and function of the WNP-2 Task Force program was submitted to the U. S. Nuclear Regulatory Commission on January 11, 1982. The WNP-2 Preliminary Control Room Human Engineering Design Report provided a description of the Task Force personnel and review, documentation, and assessment methodology established by the in-house review team.

2.2.2 Assessment, Implementation, and Reporting

Assessment methodology was noted in the report referenced in item 2.2.1, above. The assessment, recommended implementation, and implementation schedule are noted within this preliminary control room design review report under "response" after each BWROG reported deviation. Thus, NUREG-0700, phases 3 and 4, noted under item 2.1.1, above, are satisfied by this report.

2.2.3 Continued Human Factors Involvement

General Physics, Corp., was contracted to provide consulting services in 1981 and 1982 to review Task Force planned hardware changes, review draft standards, and provide generic guidelines and methodology for continued control panel enhancements; i.e., color coding, color banding, new label plate design and layout, demarcation, etc. The review performed by General Physics and their prepared enhancement guidelines provide a basis from which the WNP-2 Task Force can continue to review and respond to control room deviations. Further human factors specialist involvement is not planned during the implementation phase of control room enhancements.

2.3 REVIEW TEAM QUALIFICATIONS

2.3.1 BWROG Survey Team

2.3.1.a Warran Babcock, Boston Edison Co.

WNP-2 BWROG Survey Team Leader.

Bachelor of Science in Electrical Engineering. Experience includes fifteen years in the nuclear industry; four years with Boston Edison Company as a Senior Electronics Engineer; two years with Burns and Roe as a Senior Instrumentation and Control Engineer; two years with Ebasco as a Senior Instrumentation and Control Engineer; three years with Stone and Webster as a Control Engineer; and four years with Babcox and Wilcox as a Plant Electrical Engineer. Experience includes control board design and layout with several of the above companies.

Member of the BWROG Committee on Control Room Design Review Program. Attended ten-day Owners' Group Human Factors Workshop Program and two-week MIT course on Control Room Improvements. Team Leader for BWROG surveys of Limerick 1 and 2, Peach Bottom 2/3, Pilgrim, Nine Mile Point 1 and 2, Brown's Ferry 1/2/3, Duane Arnold, and WNP-2 nuclear power stations.

2.3.1.b Art Vierling, Niagara Mohawk Company

Bachelor of Science in Mechanical Engineering. Experience includes seven years in the nuclear industry with Niagara Mohawk; two years as a Site Quality Control Engineer; and five years as an Instrumentation and Control Engineer. Experience includes three years at Nine Mile Point 1 nuclear power station. Presently Lead PGCC Engineer responsible for the preliminary testing, startup, and human factors review of the Nine Mile Point 2 nuclear power stations control room Power Generation Control Complex (PGCC).

Member of the BWROG Committee on the Control Room Design Review Program; member of the INPO Committee on Control Room Design Review; attended ten-day Owner's Group Human Factors Workshop Program; attended three-day Stone and Webster Control Room Human Factors seminar; coordinated the BWROG survey

of Nine Mile Point 1, and participated as a member of the BWROG survey team for Brown's Ferry 1, 2, and 3, Nine Mile Point 2, and WNP-2 nuclear power stations.

2.3.1.c Al Miller, Yankee Atomic Electric Company

Bachelor of Science in Electrical Engineering. Experience includes fifteen years in the nuclear industry with Yankee Atomic Electric Company and eight years with Foxburrow, Inc., in instrumentation and panel design. Experience includes new plant design and design backfitting at Main Yankee, Vermont Yankee, and Yankee Rowe nuclear power stations and, presently, Senior Instrumentation and Control Engineer in the Human Factors Engineering section at Yankee Atomic Electric Company.

Attended two-week MIT course on control room improvements and several seminars; member of utilities Human Factors Engineering section; and participated as a member of the BWROG survey team at Seabrook and WNP-2 nuclear power stations.

2.3.1.d R. M. Fairfield, General Electric Company

Bachelor of Science in Electrical Engineering; Professional Engineer, Nuclear Engineering. Experience includes seventeen years in the nuclear industry; one year in control and instrumentation; eight years in startup and operations; two years as an operator certification instructor at the Morris, Illinois, simulator; and six years in program management.

Member of BWROG survey team for three plants; author of two Control Room Design Review Summary Reports.

2.3.1.e K. C. Ross, General Electric Company

Experience includes nine years in the nuclear industry; four years as an instructor in the U. S. Navy nuclear power program; two years as an instructor at the Morris, Illinois, simulator; and three years as a Program Manager for General Electric in the BWROG Control Room Improvements program. Holds Senior Reactor Operators license and certified by NRC to teach all phases of BWR operation.

Program Manager for the BWROG Control Room Design Review Program. Provided management support for

eighteen BWR control room reviews; principal author of nine Control Room Design Review Summary Reports; coauthor of an additional seven. Developed, organized, and presented the BWROG Control Room Survey Program Workshop; attended MIT summer program on human factors engineering; and INPO workshop on control room evaluations. Coauthor of BWROG Emergency Procedure Guideline Training appendices.

2.3.1.f R. G. DaValle, Washington Public Power Supply System

Bachelor of Science in General Engineering. Experience includes sixteen years in the nuclear industry; five years as a certified control room supervisor; three years in project design engineering of FFTF; nine years with the Supply System in plant operations holding positions of Senior Operation Engineer, Supervisor Generation Administrative Services, and Nuclear Safety Specialist. Presently, WNP-2 Task Force Coordinator for human factors upgrade of the WNP-2 Control Room.

Member of BWROG Committee on Control Room Design Review Program. Attended ten-day Owner's Group Human Factors Workshop Program and participated in BWROG surveys of the Beach Bottom 2 and 3 and WNP-2. nuclear power station control rooms.

2.3.1.g Dr. Melvin D. Field, Massachusetts Institute of Technology; Human Factors Consultant.

Degree in Electrical Engineering, with profession engineers license. Twenty-eight years experience in Systems Engineering, analysis, and design; communications technology and information science; computer program planning and management; man-machine interfaces; and graphic displays. Member of the BWROG survey team for WNP-2 nulcear power station.

2.3.2 WNP-2 Task Force Members

Task Force members and their qualifications were submitted in the WNP-2 preliminary report noted in item 2.2.1, above.

2.4 BWROG SURVEY AND REPORT

2.4.1 Scope of BWROG Survey

The control panels evaluated by the BWROG survey team are listed in Table 2-1. The Remote Shutdown panels were included in the scope of the review. Figure 2-1 provides a layout arrangement of the WNP-2 Control Room panels.

2.4.2 BWROG Checklist References

BWROG Program checklist items are referenced by parentheses after each Favorable or Deviation statement. Table 2-2 provides a list of general checklist areas. For specific checklist items, see the BWROG Program Plan noted in item 2.1.1.

2.4.3 Final Report References

Where a specific resolution and implementation schedule have not been decided, reference has been made to providing such at the "Final Report." See section 25.0, Open Items, for definition of Final Report. In all cases, deferral of resolution was considered acceptable, as impact to safety and reliability was considered minor.

Table 2-1

CONTROL ROOM PANELS REVIEWED

Main Benchboards

P601	P800
P602	P820
P603	P840

Remote Shutdown Panels

P001	P100

Vertical Panels

P614	P824
P672	P825
P811	P826
P812	P827
P813	P831
P814	P832
P821	P851

Fire Control Panels

Figure 2-1

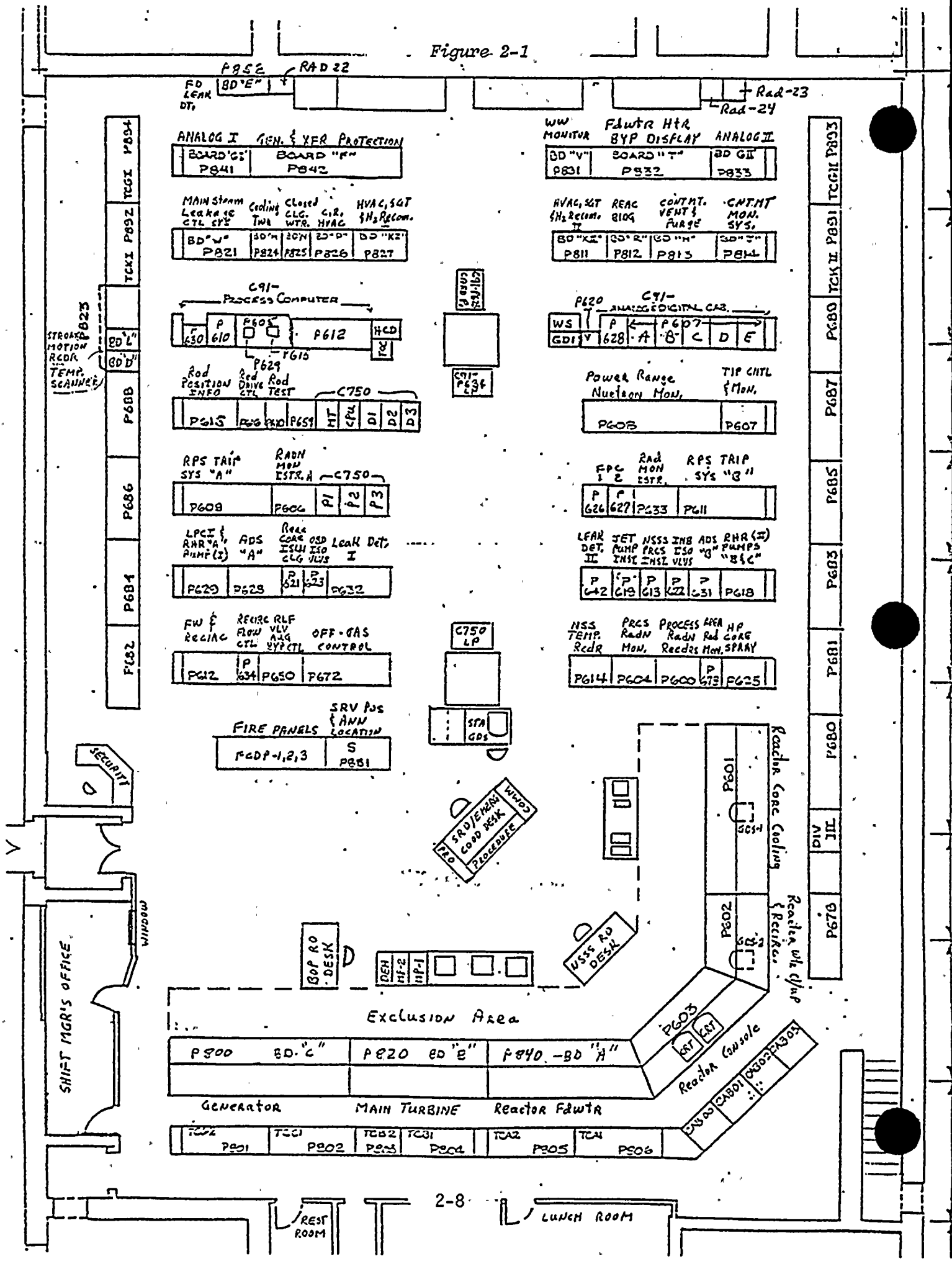

P852
RAD 22
FD LEAK DT,
BD "E"
Rad-23
Rad-24
ANALOG I
GEN. & XFR PROTECTION
BOARD "G" P841
BOARD "F" P842
WW MONITOR
FdwTR HTR BYP DISPLAY
ANALOG II
BD "V" P831
BOARD "T" P832
BD GII P833
MAIN Steam Leakage CTL SYS
Cooling TWR
Closed CLG. WTR.
CIR. HVAC
HVAC, SGT & H2 Recom.
BD "U" P821
BD "M" P824
BD "N" P825
BD "P" P826
BD "K" P827
HVAC, SGT & H2 Recom. II
REAC BLDG
CONTMT. VENT & PURGE
CNTMT MON. SYS.
BD "K" P811
BD "R" P812
BD "H" P813
BD "J" P814
C91- PROCESS COMPUTER
C91- ANALOG & DIGITAL CAB.
C91-P634
P620
WS
GDI
P630
P610
P609
P612
HCD
TCC
P615
P629
P628
A
B
C
D
E
Rod Position INFO
Rod Drive CTL
Rod Test
C750
P613
P616
P610
P659
HT
CPU
D1
D2
D3
Power Range Neutron Mon.
TIP CNTL & MON.
P608
P607
RPS TRIP SYS "A"
RADN MON ESTR. A
C750
P609
P606
P1
P2
P3
FPC 1 & 2
Rad MON ESTR.
RPS TRIP SYS "B"
P626
P627
P633
P611
LPCI & RHR "A" PUMP (2)
ADS "A"
Reac Core ISOLN CLG VLVS
OSD ISO VLVS
Leak Det. I
P629
P628
P621
P623
P632
LEAK DET. II
JET PUMP INST.
NSSS PRCS INSTR.
INB ISO VLVS
ADS "B" PUMPS
RHR (2) PUMPS "B" & "C"
P612
P619
P613
P622
P631
P618
FW & RECIRC
RECIRC FLOW CTL
RLF VLV ALG SYS CTL
OFF-GAS CONTROL
P612
P634
P650
P672
C750 LP
STA GDS
NSSS TEMP. RECDR
PRCS RADN MON.
PROCESS RADN Recdrs
AFR Rad MON.
HP CORE SPRAY
P614
P604
P600
P673
P625
SRV POS & ANN LOCATION
FIRE PANELS
FCDP-1,2,3
S P881
SECURITY
SRO/EMERG COORD DESK
PROCEDURE
WINDOW
SHIFT MGR'S OFFICE
BOP RO DESK
DEH
HP-2
HP-1
NSSS RO DESK
Reactor Core Cooling
Reactor Wtr Clnup & Recirc.
P601
P602
GCS-1
GCS-2
Exclusion Area
P800 BD. "C"
P820 BD "E"
P840 BD "A"
P603
EAST
EAST
Reactor Console
P680
P687
P685
P683
P681
P680
P679
DIV III
TCK I P894
TCK I P892
P684
P686
P688
P684
P682
P823
STROKE MOTION RCDR
TEMP. SCANNER
BD "L"
BD "D"
TCK II P893
TCK II P891
P680
P687
P685
P683
P681
P680
P679
DIV III
Generator
MAIN TURBINE
Reactor FdwTR
TCC2 P801
TCC1 P802
TCB2 P803
TC31 P804
TCA2 P805
TCA1 P806
PA30
CAB01
CAB02
PA30
REST ROOM
LUNCH ROOM

Table 2-2

CHECKLIST SUBJECT AREAS

A. PANEL LAYOUT AND DESIGN

- Anthropometrics and control room layout
- Demarcation lines and mimics
- Control/display grouping
- Color codes
- Labels
- Temporary modifications
- Traffic patterns and panel arrangement

B. INSTRUMENTATION AND HARDWARE

- Controllers
- Indicators
- Recorders
- Indicating lights
- Switches
- Emergency switches
- Key-lock switches

C. ANNUNCIATORS

- Grouping
- Window design
- Visual alarm
- Audible alarm
- Acknowledgement
- Visual alarm
- Procedures
- Maintenance
- Nuisance alarms

D. COMPUTERS

- Console
- Capability
- CRTs
- Typers

E. PROCEDURES

- Availability
- Access and recognition
- Format
- Content
- References
- Revision
- Logkeeping

F. CONTROL ROOM ENVIRONMENT

- Communications
- Auditory displays
- Lighting
- Heating and ventilation
- Fire control
- Emergency situations
- General

G. MAINTENANCE AND SURVEILLANCE

- Operator functions
- Jumpers and lifted leads
- Permanent modifications
- Tags
- Spare parts
- Procedures

H. TRAINING AND MANNING

- Training
- Control room manning
- Shift change

3.0 ANTHROPOMETRICS

3.1 GENERAL DISCUSSION

Recommended dimensions for benchboards and vertical control panels are derived from accepted human factors standards. These are designed to accommodate a theoretical operator population ranging from a 5th percentile female to a 95th percentile male. A comparison of the WNP-2 control panels with these standards is provided in Tables 3-1 and 3-2. Annunciator heights and maximum control heights on the main benchboards are within recommended limits, but deviations from all other standards are evident.

Table 3-1

BENCHBOARD MEASUREMENTS

Panel	Control Height (in) Min(a)	Control Height (in) Max(b)	Display Height (in) Min(c)	Display Height (in) Max(d)	Depth(e) (in)	Annunciator Height(f) (in)	Foot Space(g) (in)
601	26*	49	27*	72*	29.5*	85	5.5*
602	26*	43	27*	63	29.5*	85	5.5*
603	26*	48	27*	66	29.5*	85	5.5*
800	26*	48	35	71*	29.5*	85	5.5*
820	26*	62*	27*	71*	29.5*	85	5.5*
840	26*	52	27*	69*	29.5*	85	5.5*

Notes:
(a) 30 inches recommended minimum.
(b) 60 inches recommended maximum.
(c) 30 inches recommended minimum.
(d) 68 inches recommended maximum.
(e) 28 inches recommended maximum.
(f) 88 inches recommended maximum.
(g) 6 inches recommended minimum.

* Indicates deviation from recommended limit.

Table 3-2

VERTICAL PANEL MEASUREMENTS

Panel	Control Height (in) Min(a)	Control Height (in) Max(b)	Display Height (in) Min(c)	Display Height (in) Max(d)	Annunciator Height (in) Max(e)
001	26*	62*	69	73*	NA
100	26*	52	54	67*	85
614	NA	NA	51	69*	NA
672	29*	73*	42*	75*	87
811	25*	58	30*	72*	87
812	25*	59	45*	71*	87
813	25*	76*	39*	78*	87
814	75	75*	33*	72*	87
821	23*	60	49	71*	87
824	25*	58	67	72*	87
825	38*	60	67	71*	87
826	25*	55	60	66	87
827	25*	58	30*	72*	87
831	27*	27	54	64	NA
832	26*	78*	60	74*	NA
851	49	76*	NA	NA	87

Notes: (a) 42 inches recommended minimum.
(b) 60 inches recommended maximum.
(c) 48 inches recommended minimum.
(d) 66 inches recommended maximum.
(e) 88 inches recommended maximum.

* Indicates deviation from recommended limit.

The height of the apron section of the benchboards is unusually low compared to other BWR control rooms, resulting in minimum control and display heights four inches below that recommended. A secondary effect is in the reduction of knee space at panel 603, creating an uncomfortable operating configuration.

Slight deviations from the suggested standards may be noted in the panel depth and footspace measurements (1.5 inches and 0.5 inch, respectively).

The narrower footspace may be expected to result in minimal inconvenience, but the discrepancy in panel depth suggests more significant ramifications. Addition at a guard rail to protect front edge controls, for instance, would probably be inadvisable. Panel 603 is of greater concern in this respect than the other benchboards, since it may sometimes be operated from a seated position. (The recommended depth for a sit-down console is only 25 inches.)

Nonconformity with anthropometric standards was generally observed to be more prevalent on the vertical panels than on the benchboards. Of the fifteen panels evaluated containing controls, six contain controls mounted too high and thirteen contain controls mounted too low. Of the fifteen panels evaluated containing indicators or recorders, six (not the same six) contain display mounted too low and thirteen contain displays mounted too high. A platform has been added in front of the remote shutdown panel because of the high display placement, but even so, the indicators remain seven inches above the recommended maximum height.

During control rod manipulations, the reactor operator will presumably sit in front of panel 603. From this position, viewing angles to the CRD indications, source range monitors, and the reactor water level indications are rather acute. The operator will, therefore, probably find it necessary to move back from the panel slightly to monitor these instruments.

3.2 FAVORABLE ASPECTS OF ANTHROPOMETRIC DESIGN

3.2.1 Annunciator heights are within recommended limits. (A1.1)

3.2.2 The maximum control heights on the main benchboards are generally within recommended limits. (A1.1, A3.6)

3.2.3 Sharp corners and edges have generally been avoided in panel design. (A1.4)

3.3 DEVIATIONS FROM CHECKLIST CRITERIA PERTAINING TO ANTHROPOMETRIC DESIGN

3.3.1 The main control benchboards deviate from anthropometric standards in the following respects:

3.3.1.a The depth of the apron section is 1.5 inches greater than the recommended maximum of twenty-eight inches. (A1.1)

Response: No controls are located within the last one and one-half inches of the horizontal portion of the benchboard. For those controls on the vertical portion, an anthropometric review was completed.

The lowest vertical section requires a slight lean by the 95th percentile man to operate controls. For the 5th percentile woman, the whole vertical section requires a slight lean or reach to operate controls. A 5th percentile woman was located and the degree of comfort and accessibility was judged adequate. The individual had no difficulty operating controls and was comfortable in her reaching. A review of the controls on the vertical panel sections indicated none of the controls required frequent operator use. Also, for trip switches, the extra apron distance provides some added protection from inadvertent operation. No action required.

3.3.1.b Foot space is one-half inch narrower than the recommended six inches. (A1.1)

Response: NUREG-0700 guidelines provide for a minimum foot space of four inches. Discussions with operators indicate the present foot space is adequate. No action required.

3.3.1.c The apron height is approximately four inches lower than recommended minimum height of thirty inches. (A1.1, A3.6)

Response: Only one operator (6'5") noted that the benchboards were uncomfortable to operate. The low design partially compensates for the extra apron depth by allowing a more comfortable lean into the panel to reach controls and displays on the vertical section of the panels. Operators recognize the panel design as being low and have adapted accordingly. Except for the awareness of the low design, no operability problems were noted by the operators. No action required.

3.3.1.d The highest indicators on panels 601, 800, 820, and 840 are above the recommended maximum display height of sixty-eight inches. (A1.1, A3.6)

Response: NUREG-0700 guidelines provide for a maximum height of seventy inches. A review was performed of all displays above the sixty-eight-inch guideline. Those displays located above sixty-eight inches were found to have good readability and were not required for fine process control. No action required.

3.3.1.e The DEH CRT controls and the reheater controller on panel 820 are above the recommended maximum control height of sixty inches. (A1.1, A3.6)

Response: The reheater controller was relocated below the sixty-inch guideline and grouped with its related system controls and displays. The DEH controls located above the sixty-inch guideline are CRT display push-button controls and not required for process operation. Access by the 5th percentile female (noted in item 3.3.1.a, above) indicated that present location provides no operability problem. No further action required.

3.3.1.f Knee space provided at panel 603 is four inches less than the recommended minimum of twenty-five inches. (A1.1)

Response: Sitdown operation is only performed during startup and normal shutdown when significant rod movement is performed. The sitdown feature has limited use. Therefore, panel modification is not cost effective. Also, two operators will normally be stationed at panel P603 during rod manipulation to assist and double check each other. No action required.

3.3.2 Most vertical panels have both controls and indicators mounted outside of recommended height ranges (see Table 3-2). (A1.1, A3.6)

Response: Reviews of all vertical panels were performed based on frequency of operation, need for precision control and read-out, and safety implication of the device. The following areas were found to be of concern:

3.3.2.a Remote shutdown panel P001 displays and RCIC turbine controller were located at a height of eighty-one inches. Seismic criteria and internal panel congestion prevented lowering or tilting of the devices. An eight-inch platform was installed to provide an acceptable balance between the control/display upper guideline limit and lower control guideline limit. The lowest switches are now below normal guidelines, but these are nonprocess controls and, therefore, deemed as an acceptable trade-off. One power supply toggle switch had a guard installed to prevent inadvertent operation. No further action required.

3.3.2.b One power supply switch on P100 will be raised to prevent inadvertent operation prior to fuel load. No further action required.

3.3.2.c Recorders of P814, measuring essential drywell and wet-well parameters, were below acceptable guidelines.

The use of these parameters for emergency procedures and normal operation were integrated with RG-1.97 design changes and relocated to benchboard P601. Eight recorders are being deleted from P814 prior to fuel load. No further action required.

3.3.2.d Drywell fan cooler controllers on P813 are above guideline limits. Control response times are slow, and with adjacent drywell temperature monitoring displays on P814, present location is considered acceptable. Also, panel conjection prevents relocation, and present location provides for system grouping and good control/display arrangement. No action required.

3.3.2.e Control room HVAC panel P826 isolation exhaust valve status lights were located below guideline limits. Placement was such that the status lights could not be seen when operating interlocking controls. The status lights were raised and grouped with their respective interlocking controls. No further action required.

3.3.2.f Annunciator response controls make up the majority of the lower guideline concerns. These were reviewed with General Physics Corp. Human Factors personnel. Most panels have little available room to relocate the controls within anthropometric limits and, if done, would not be at a consistent height. Relocation would mix them within control areas, reducing their visibility and possibly adding to operator confusion. As they are, most are consistent in height and location. Color padding is planned for all annunciator response controls to improve visibility. No further action required.

3.3.2.g Design changes to P632 deleted one multipoint recorder. This allows the recorder located above the upper guideline limit to be lowered to the vacated space and within acceptable limits. This will be completed prior to fuel load. No further action required.

3.3.3 Sharp corners are present on the power supplies on panel 001. (A1.4)

Response: The remote shutdown panel is not a normally manned station. The power supply chassis has extruding handles which reduces the potential for inadvertent contact with the chassis faceplate. No action required.

4.0 CONTROL ROOM ARRANGEMENT

4.1 GENERAL DISCUSSION

A control room should be laid out such that the operator's path to the control panels from his normal work station is unobstructed and all important control surfaces are visible. Care must be taken that the various furnishings and peripheral control and monitoring devices are accessible to the operators, yet not placed so as to impede traffic flow or obstruct visual fields.

Because permanent locations have not yet been designated for control room furnishings, the arrangement of the WNP-2 control room could not be evaluated.

4.2 WNP-2 TASK FORCE REVIEW

Control room manning and primary area designations have been identified in the WNP-2 Plant Administrative Operating Procedures and the information factored into the control room reviews. General layout reviews were completed for the location of computer peripherals and operator work station areas. Final layout of bookcases, file and storage supply cabinets, etc., are pending. A review of the control room arrangement will be noted in the Final Report.

5.0 CONTROL/DISPLAY ORGANIZATION

5.1 GENERAL DISCUSSION

The control panels at WNP-2 are generally arranged on a functional basis, each system being assigned to a particular panel or panel area. This functional organization has been made visually apparent through extensive and very effective application of demarcation lines and summary labels. Mimics, where appropriate, have been utilized within system groupings.

5.1.1 Demarcation Lines

With few exceptions, demarcation lines outlining system groupings have been applied to all panels. The layouts are neat, well planned and obviously the product of much creative effort. The use of beveled corners has been particularly effective in accentuating the divisions between component groupings.

Within system groupings, demarcation lines have been less consistently used to differentiate component subgroupings.

5.1.2 Panel Backgrounds

Background shading may also be used to define system operating areas and component relationships. This technique must be used with caution, however, to avoid a confusing, patchwork appearance. Soft, pastel shades are generally considered preferable. Current applications of this technique at WNP-2 are considered effective.

5.1.3 Mimics

Where appropriate, mimic lines have been applied within system operating areas to graphically illustrate major system flowpaths. Since this style of layout was apparently not anticipated in the original designs of most panels, many flowpaths are not as direct as might be desired. The Supply System has minimized the complications related to this situation, by depicting only the most important flowpaths and minimizing secondary interconnections. This has necessarily resulted in the exclusion of some components from the mimic arrangements, such as the test bypass valves and the containment spray valves in the emergency core cooling systems.

Certain mimic layouts, listed in Section 5.3, were found to be somewhat confusing. The mimic of the feedwater heaters on panel 832, for example, is very expansive and somewhat convoluted.

While it is possible that only modest improvements are possible within the constraints imposed by the existing component arrangement, extra attention should be devoted to such complex mimics to ensure that the optimum design is achieved. Enhancement techniques—such as color coding, flow arrows, differential line widths, symbols, and improved labeling (most of which have already been incorporated on panel 832)—may prove useful.

Color coding has been adopted in preference to variations in the width of mimic lines to differentiate primary and secondary flowpaths. This technique is certainly feasible, but care should be exercised to ensure that conflicts do not arise from overlapping uses of color. In the current convention, for example, color is used to prioritize the flowpaths, distinguish emergency from nonemergency systems, and signify process types. This may be an excessive number of variables to realistically impose upon a single coding dimension.

According to a draft standard for mimics made available to the survey team, labels are not normally used to identify start and end points of the graphic layouts. On path 602, for example, neither the Reactor Pressure Vessel (RPV) head vent mimic nor the associated labeling specify that one vent is directed to the "A" main steam line and the other two to the drywell equipment drain sump. In the Emergency Core Cooling System (ECCS) layouts, many mimic lines are terminated at valve controls. While the end point of these lines can be inferred from the associated label, dedicated labels or symbols are generally considered preferable.

5.1.4 Hierarchial Labeling

Demarcation lines are most effective when applied in conjunction with a hierarchial labeling system. System and subsystem labels are visible on most panels, but the hierarchy has been less consistently extended to individual groups of controls and indicators. A detailed discussion of hierarchial labeling may be found in Section 7.0.

5.1.5 Component Arrangements

Controls and indicators are generally grouped together by systems on the panels, indicators above, and controls below. Exceptions were noted on panel 601 where Residual Heat Removal (RHR) and Automatic Depressurization System (ADS) divisions are separated, on panel 602, where the feedwater injection valves are separated from related components on panel 840, and on panel 001, where RHR, Safety Relief Valve (SRV), and Reactor Core Isolation Cooling System (RCIC) controls are intermixed. In addition, the standby service water system controls and indications were found to be divided among panels 601, 820, 825, and 840.

Redundant system subgroupings should be similarly arranged on the control panels. Most such layouts are identical (e.g., RHR A/B and recirculation A/B), but partial mirror imaging was evident on panels 812 and 826. (On panel 826, the mixture of mirror imaged component arrangements with congruent arrangements has complicated the layout of the mimic lines.) Minor differences were also noted in the layouts of corresponding mimics on panels 800, 812, and 826 and the positioning and arrangement of the synchroscope indications on panel 800.

"Population stereotypes," as used here, are cultural conventions dictating the preferred patterns of alphabetic and numeric sequences. In horizontal component arrays, for instance, the sequence should progress in order, from left to right, corresponding to the normal reading pattern. A few exceptions to these criteria were noted and have been listed in Section 5.3.

Also of note are the arrangements of indicating lights on panel 832. In the dual-light valve position displays on all other panels, the red "open" light is on the right, the green "closed" light on the left. On panel 832, however, the relative positions are reversed, green on the right and red on the left (this discrepancy was also occasionally noted on panel 813).

5.2 FAVORABLE ASPECTS OF CONTROL/DISPLAY GROUPING

5.2.1 Extensive use of demarcation lines has been made on virtually all panels. (A2.2)

5.2.2 Mimic flowpaths have been color coded to distinguish primary from secondary flowpaths and process types. (A2.4)

5.2.3 Flowpaths are easily recognized in most mimic layouts. (A2.7)

5.2.4 Panel components are generally grouped by system and arranged on a functional basis. (A3.1, A3.3)

5.2.5 Population stereotypes are usually adhered to. (A3.2)

5.2.6 Many matrices of panel components have been subdivided with demarcation lines. (A3.4)

5.2.7 A formal procedure governing the design and application of mimics is being implemented.

5.3 DEVIATIONS FROM CHECKLIST CRITERIA PERTAINING TO CONTROL/DISPLAY ORGANIZATION

5.3.1 Additional use of demarcation lines to enclose related controls and displays may be desirable on the following panels:

Panel 001: Demarcate RHR and RCIC systems.

Panel 100: Demarcate service water system.

Panel 603: Include the RPV pressure and level recorders in the "RPV Monitor" layout.

Panel 672: Demarcate off-gas layout.

Panel 800: Demarcate DC bus, vital bus, instrument bus, and generator monitor indications.

Panel 811/827: Demarcate the Containment Atmosphere Control (CAC) system.

Panel 820: Demarcate remaining indicators on the vertical section.

Panel 824: Demarcate the tower makeup system controls and indications.

Panel 825: Demarcate the suppression pool and condensate valves at the bottom of the panel.

Response: Mockup of the actual control room panels has provided a method for operator review and feedback and a realistic perspective of the final demarcation layout. It was noted that overuse of demarcation lines and mimicking tended to conjest the panels and cause confusion. Some minor changes will occur prior to finalization of demarcation lines. But, in general, further additions will be dependent on operational experience. Final demarcation lines will be applied prior to fuel load.

5.3.2 Within system groupings, demarcation lines have only infrequently been used to divide related subsystems. Possible applications at this technique include: (A2.3)

Panel 601: Division of inboard and outboard isolation valve controls. Separation of ADS valve controls from other SRV controls.

Panel 672: Separation of recombiner trains. Separation of H_2 analyzer trains. Separation of adsorber trains. Division of glycol and refrigeration controls. Separation of dryer trains.

Panel 800: Subdivision of bus groupings.

Panel 811/827: Division of heater unit controls.

Panel 813: Separation of vacuum breaker control divisions.

Panel 814: Separation of Divisions I and II.

Panel 820: Separation of steam evaporator controls. Separation of reheater controls. Separation of air ejector controls.

Panel 824: Subdivision of tower makeup pump controls.

Panel 826: Separation of Divisions I and II.

Panel 840: Separation of feedwater subsystems. Subdivision of feedwater heater pressure indicators. Separation of the condensate booster pump and associated valve controls. Subdivisions of the condensate valve controls.

Response: See response item 5.3.1, above.

5.3.3 The light green demarcation and mimic lines used on panels 602 and 840 and the brown demarcation lines used on panel 813 are not distinctive against the panel background. (A2.5)

Response: The light green lines on P602 and brown lines on P813 were mockups of potential color padding areas. Color padding will not be applied in these areas; instead, demarcation will be applied. The green mimic on P840 is temporary tape and does not reflect the final color tone. However, it should be noted that only certain color tones are available on the market for material which meets material specifications. The most contrasting tones available will be selected and applied prior to fuel load. No further action required.

5.3.4 One mimic label is beginning to loosen on panel 832. (A2.6)

Response: The mimic on P832 will be repaired prior to fuel load.

5.3.5 The following mimic layouts were found to be somewhat confusing: (A2.7)

Electrical portion of the recirculation system, panel 602.

Electrical distribution system, panel 800.

Feedwater system, panel 840.

Panel 001.

Panel 813.

Panel 826.

Panel 832.

Response: New labeling will provide improved visibility. Also, operators have been using these panels (except for P001) and have expressed only positive comments to date. These panels will be reviewed again prior to final application of mimicking. No further action required.

5.3.6 The layouts of corresponding mimic and demarcation lines are not identical in the following repetitive groups of components. (A2.8)

Radwaste building HVAC divisions, panel 812.

Control room HVAC divisions, panel 826.

Diesel generator No. 1 and No. 2 layouts, panel 800.

Response: Mimic layout is based on the physical constraint of component arrangement. Improved labels, mimicking, and demarcation to be implemented prior to fuel load are being used to provide a cost effective method of control enhancement. No further action required.

5.3.7 By procedure, labels identifying the start and end points at mimic lines are not always used. On panel 602, for example, neither the RPV head vent mimic nor the associated labeling specify that one vent is directed to the "A" main steam line and the other two to the drywell equipment drain sumps. (A2.10)

Response: Overuse of mimic labels at the beginning and end of mimic lines may congest and confuse a panel layout. The WNP-2 standard limits the use of such labels but does not prevent their application where additions clarify or information is of benefit to the operator. Where the legend plate of the associated control adequately describes the mimic end point, additional labels are not normally used. No action required.

5.3.8 Certain valves have not been integrated into the simplified system flowpaths diagrammed by the ECCS mimics. Examples include the test bypass valves, the RHR service water crosstie, manual injection, heat exchanger vent, containment spray valves, and the RCIC turbine trip/throttle and governor valves. (A2.11)

Response: Restrictions of panel space and control arrangements make mimicking of all secondary interconnections impractical without causing panel congestion and confusion. New labels and demarcation will provide acceptable enhancement of miscellaneous controls. No further action required.

5.3.9 The transfer switches are not clearly associated with their related controls by the graphics applied to panel 001. (A2.11)

Response: Transfer switch handles have been color coded to

provide contrast from process controls. By design, each transfer switch is located below its respective group of control switches. The color contrast provides improved visibility as to grouping arrangement. No further action required.

5.3.10 The feedwater injection valve controls are located on panel 602, separated from controls on panel 840. (A3.1)

Response: Feedwater injection valve controls will be relocated to the feedwater system control area on panel P840 prior to fuel load. These are being integrated into the feedwater mimicking scheme. No further action required.

5.3.11 Controls are not well grouped by system on panel 001. RHR and SRV controls are intermixed with the RCIC controls, and one RCIC control has been placed in the RHR-B operating area. Functional subgroups do not appear to be well arranged. (A3.1)

Response: Electrical separation criteria and panel congestion prevents further rearrangement of controls. New labels, mimicking, and demarcation will be applied prior to fuel load to improve operator response and visibility. No further action required.

5.3.12 Some mirror imaging of component subgroup layouts were evident on panels 812 and 826. (A3.1)

Response: Mirror imaging is considered minor and acceptable as is on these panels. The application of new labels, demarcation, and mimicking to be installed prior to fuel load has minimized the mirror effect. No further action required.

5.3.13 A computer trend recorder is enclosed by the Control Rod Drive (CRD) demarcation lines on panel 603. (A3.1)

Response: Deletion of the recorder has been deferred until after fuel load to determine if an operational need exists. Enclosing the CRD system in one demarcation grouping was judged acceptable rather than cause a patch-quilt effect and redundant hierarchy labeling. The use of the trend recorder for other functions than monitoring CRD parameters did not concern the operators. The present arrangement is preferred. No further action required.

5.3.14 Synchroscope indications on panel 800 are not consistently positioned or arranged. (A3.1)

Response: The four sets of synchroscope indicators will have improved labels prior to fuel load as to their functional description. Minor differences in orientation (right or left side of their respective sync lights) does not present an operational sequence or visibility problem. Demarcation has been applied for improved grouping on two sets of indicators. No further action required.

5.3.15 Main steam line temperature indications are not grouped together on panel 820. (A3.1)

Response: New group legend plates will be installed prior to fuel load to improve visibility. Rearrangement of displays is not required as displays are nonessential for system operation. No further action required.

5.3.16 The following deviations from population stereotypes pertaining to alpha-numeric sequences were observed: (A3.2)

5.3.16.a SRV controls on panel 602 are arranged in columns rather than rows. Valves "U" and "V" are out of sequence on the vertical section of the panel.

Response: Rearrangement of SRV controls has been deferred until past fuel load. Resolution will be based on operational and simulator experience and noted in the Final Report.

5.3.16.b The RHR subsystems are arranged in a C-B-A left-to-right sequence on panel 601.

Response: Electrical separation criteria do not make rearrangement of system controls and displays cost effective. Existing systems will be demarcated and mimicked and hierarchy labels installed to improve visibility prior to fuel load. No further action required.

5.3.16.c Position indications for RHR valves F073A and F074A are arranged in a right-to-left numerical order on panel 601. Position indications for valves F073B and F074B are similarly arranged.

Response: Controls and displays were arranged to enforce to the operators the operational sequence and flowpath of left to right. Valve 74A is opened prior to 73A. No action required.

5.3.16.d The manual scram switches on panel 603 are arranged in a C-D-A-B left-to-right sequence.

Response: The scram switches were rearranged by RPS system grouping. New escutcheons and labels will be installed prior to fuel load that will note their sequence as A1, B1 (left side pushbuttons) and A2, B2 (right side pushbuttons). With this arrangment, association with annunciator alarms and other RPS Group 1 and 2 trips are consistently located on the left and right side of the panel. No further action required.

5.3.16.e The feedwater heater pressure indicators on panel 840 are arranged in a right-to-left numerical sequence.

Response: Feedwater heater arrangement is presently from high pressure heaters to low pressure heaters (left to right). This arrangement is preferred by operations. No action required.

5.3.16.f The turbine drain valves on panel 820 are not arranged in numerical sequence.

Response: These are thirteen miscellaneous line drain monitoring lights actuated from one control switch. All are either open or closed at one time. Orientation would not increase individual visibility, and operational sequence is not of concern. These will be demarcated for group visibility prior to fuel load. No further action required.

5.3.16.g SRV controls on panel 001 are arranged in an E-D-A left-to-right sequence.

Response: New labels will identify the above as 1B, 2C, and 2A, respectively. Panel design requires extensive changes to transfer switch modules in order to rearrange the control switches. With the planned new labels and demarcation lines, the arrangement is considered acceptable as is. No further action required.

5.3.16.h Controls for Division II vacuum breakers are placed above those for Division I on panel 813.

Response: Vacuum breaker controls are used only for surveillance testing of the valves, and their control air will normally be valved out. Testing of the valves is by procedure and has no effect on any plant system or process. Therefore, it is not cost effective to rearrange the controls as the controls are well grouped as is within Division 1 and 2. Demarcation lines and new labels will be applied prior to fuel load to improve visibility and grouping. No further action required.

5.3.16.i The tower makeup pump controls and indicators on panel 824 are arranged in a B-C-A-C sequence (it is believed that one of the "C" subsystems is mislabeled).

Response: Tower Makeup Pump "C" can be operated from two different sources of power: "C-BUS 7" and "C-BUS 8." Operators have expressed preference to the existing lay-out as the arrangement places supervisory system A controls and supervisory system B controls on the left and right sides of the panel, respectively. Resolution will be based on operational experience and noted in the Final Report.

5.3.16.j Feedwater heaters on panel 832 are arranged in a bottom-to-top numerical sequence.

Response: Panel P832 is a nonsafety panel. In general, heater vents and drains are aligned during plant startup, and subsequent panel use is minimal during operation or transients. The arrangement, with the new labels and mimicking improvements to be installed prior to fuel load, is considered acceptable as is. No further action required.

5.3.16.k The spray pond "A" temperature indication is placed to the right of the "B" indication on panel 820.

Response: Spray pond temperatures and levels will be resequenced. Schedule for correction will be noted in the Final Report.

5.3.16.l The "incoming" voltage indicator associated with the High Pressure Core Spray (HPCS) synchroscope on panel 601 is placed to the right of the bus voltage indicator; whereas, it should be placed to the left to be consistent with the arrangements on panel 800.

Response: Resolution will be noted in the Final Report.

5.3.17 The relative positions of the "open" and "closed" valve position indicating lights on panel 832 (and some on panel 813) are the reverse of those on all other panels. (A3.2)

Response: Indicating position lights on P813 will be corrected prior to fuel load.

P832 is a nonsafety panel (feedwater heater vent and drains). Correction of the indicating lamps has been deferred until the first refueling outage.

5.3.18 The arrangements of the Intermediate Range Monitor (IRM) and Approach-to-Power Range Monitor (APRM) channels on the IRM/APRM recorders on panel 603 are not consistent. (A3.2)

Response: P603 will be rearranged prior to fuel load to locate all RPS-A controls/displays on the left side of P603 and all RPS-B controls/displays on the right side. This arrangement is consistent with the placement of annunciator alarms.

5.3.19 The positions of the HPCS pressure and flow indications are reversed relative to the sequence implied by the associated label. (A3.3)

Response: A new label will be installed prior to fuel load.

5.3.20 Functional groupings are not well defined for the containment ventilation system on panel 813. (A3.3)

Response: Extensive design changes have been planned for P813. Integration of panel arrangement, mimicking, demarcation, and labeling has been factored into the design changes. Upgrade of the panel will be completed prior to fuel load.

5.3.21 Undifferentiated or only partially differentiated strings or matrices of components were noted in the following locations: (A3.4)

Panel 601	HPCS indicators. SRV controls. Isolation valve controls.
Panel 603:	Standby Liquid Control (SLC) system indicating lights.
Panel 800:	Indicators on vertical section.
Panel 811/827:	Indicators and controllers.
Panel 813:	Containment vacuum breaker controls.
Panel 814:	Drywell temperature indicators.
Panel 820:	Turbine auxiliaries indicators. Steam Jet Air Ejector (SJAE) indicators. Turbine drain valve controls. Reheater controls. Evaporator controls.
Panel 832:	Control switches.
Panel 840:	Reactor Feedwater Pump Turbine (RFPT) indicators.

Response:

Panel 601:	Application of new labels, color padding, and demarcation as presently defined, and rearrangement of the SRVs as noted in item 5.3.16.a, above, will minimize the undifferentiated effect. No further action required.
Panel 603:	The placement of the new labels will be against their respective indicating lights, leaving a visual gap below them to provide adequate differentiation. No further action required.
Panel 800:	The new labels and demarcation lines minimize this effect. The only areas of concern are at the diesel generator displays, which are pending

several design changes. Resolution in this area will be noted in the Final Report.

Panel 811/827: A design review noted that four of the controllers on each panel had been made nonfunctional but not removed from the panels. These will be removed prior to fuel load. New group labeling for the indicators will be installed prior to fuel load to provide visual differentiation. No further action required.

Panel 813: See item 5.3.16.h, above, for response.

Panel 814: New group labeling will be installed prior to fuel load. The displays were rearranged by drywell elevation and area (top-to-bottom, left-to-right) to allow application of group labels. No further action required.

Panel 820: New group labeling and demarcation lines will be installed prior to fuel load. No further action required.

Panel 832: New labels, demarcation, and improved mimicking will be installed prior to fuel load. No further action required.

Panel 840: The string of eight RFPT displays will be separated (three turbine displays and five oil system displays) during the first refueling outage. No further action required.

5.3.22 The HPCS service water pump control is located on panel 601, but the discharge valve control switch and the discharge pressure indicator are located on panel 840. (A3.7)

Response: The discharge valve and pressure indicator will be relocated to P601 prior to fuel load.

5.3.23 The controls for the "A" and "B" standby service water pumps are located on panels 820 and 840, along with the related current and pressure indicators, but flow must be measured at panel 601 and the system supply valves are controlled from panel 825. (A3.7)

Response: Total system flow indicators are being located with each system on P820 and P840 per RG-1.97. The flow displays on P601 are for RHR heat exchanger secondary side cooling. These displays and controls are integrated with their respective RHR system layouts for ease of operational control of the RHR systems.

P825 controls were located for poximity to panel P812 reactor building room cooler controls and to reduce unnecessary controls on the main benchboards. No further action required.

5.4 WNP-2 TASK FORCE REVIEWS

5.4.1 Panel Configuration Reviews

The Supply System panel configuration reviews covered specifically the human factor areas of Control/Display Integration, Panel Layout, and Controls. Other areas of human factor concerns, such as anthropometrics, mimicking, demarcation, hierarchy labeling, color coding, etc., were integrated in with the panel layout design reviews. This was to ensure that all design aspects were covered in the review and that recommended configuration changes would later allow for the addition of panel enhancements.

Reviews were performed on a panel and system basis. Each system was reviewed for operability, layout, and integration with supporting systems and systems it supports. Corrective recommendations and reports were prepared for each panel. In addition, proposed regulatory, engineering, and operational changes were integrated into the reviews. These specifically included RG-1.47, RG-1.97, Safety Perimeter Display System (SPDS), and Emergency Procedure requirements.

Prior to finalizing panel configuration design on the primary area benchboards, panel arrangement drawings were prepared to reflect the proposed layout design, incorporating additions of potential mimicking, demarcation, and label grouping changes. Final configuration, including mimicking and demarcation, was mocked on the ECCS Panel P601 in the WNP-2 Control Room to provide perspective of the recommended corrective actions and potential enhancement capabilities.

Panel configuration reviews have been completed on all control room and remote shutdown room panels. A typical documentation package is contained in the WNP-2 Preliminary Report submitted to the Nuclear Regulatory Commission (NRC) in January 1982. A summary of the changes implemented as a result of these reports are noted in Table 5-1.

Table 5-1

SUMMARY OF WNP-2 TASK FORCE REVIEWS

ESTIMATE OF CHANGES

	Main Benchboards	Vertical Panels	Remote Shutdown Panels
Relocation/Rearrangement:			
Controls	132	66	9
Displays	56	29	0
Indicating lights	17	5	0
Recorders/controllers	4	1	0
Deletion:			
Controls	6	0	1
Displays	51	0	0
Indicating lights	15	2	0
Recorders/controllers	3	12	0
Switch Changes (Due to rotation, style, etc., inconsistencies)	4	38	1

6.0 COLOR CODING

6.1 GENERAL DISCUSSION

Specifications have been drafted by the Supply System governing the application of color codes to indicating lights and mimic lines. The Supply System is to be commended for this effort, as institution of such formalized procedures promotes the standardization of color conventions, thus minimizing the likelihood of ambiguity. The following comments should be considered as the draft procedures are finalized:

- Color codes for switches and demarcation lines are not specified.
- Amber and white lights may be used in a multiplicity of situations. It may, therefore, be desirable to clarify the significance of these indications with individual labels.
- The indicating light standard does not specifically address bypass lights, such as found on panel 603. The diesel cranking lights on panel 800 are also difficult to categorize.
- Some overlap appears to exist between the applications of white, blue, and green indicating lights. If possible, these categories might be more precisely defined.

A comparison of panel indicating light colors against the draft standard revealed numerous discrepancies. Manual override lights and ECCS logic lights, especially, were frequently not colored as specified. A similar review at mimic line colors revealed no discrepancies.

Vendor-supplied modular panel inserts, such as the rod worth minimizer on panel 603 and the reheater controller on panel 820, sometimes utilize indicating light colors at variance with the normal convention. If possible, these inconsistencies should be eliminated.

6.2 FAVORABLE ASPECTS OF COLOR CODING

6.2.1 A comprehensive procedure has been drafted defining standardized color codes for mimics, labels, and indicating lights. (A3.1)

6.2.2 The colors selected for mimic lines closely conform to the draft standard. (A3.2)

6.3 DEVIATIONS FROM CHECKLIST CRITERIA PERTAINING TO COLOR CODING

6.3.1 No standards are in effect governing the color coding of controls and demarcation lines. (A3.1)

Response: A separate demarcation guideline has been completed. A switch color coding guideline will be prepared and reviewed against the control room prior to the Final Report.

6.3.2 The colors of the following indicating lights are not in compliance with the draft color code standard: (A4.2)

Panel 601:
- HPCS high water level seal-in.
- HPCS high drywell pressure/reactor low level.
- HPCS pump manual override.
- E22-F004 manual override.
- E22-F015 manual override.
- RCIC initiation logic.
- RCIC isolation logic (2).
- E51-F064 isolation logic.
- Low Pressure Core Spray (LPCS) initiation logic.
- E21-F005 manual override.
- E21-C001 manual override.
- RHR B/C high drywell pressure.
- E12-C002 A/B/C manual override.
- E12-F024 A/B manual override.
- E12-F042 A/B/C manual override.
- E12-F027 A/B manual override.

Panel 602:
- Recirculation system interlocks (10)

Panel 603:
- Continuous rod withdrawal.

Panel 672:
- Hydrogen analyzer A/B auto/manual.
- Hydrogen analyzer A/B mode.
- Hydrogen analyzer A/B high hydrogen.
- Primary refrigeration machine select.

Panel 800:
- Disconnect closed (4).
- Synchroscope bus select (2).
- Bus S2-1 ground detector.
- Diesel voltage regulator (4).
- Main generator field ground test (2).

Panel 813:
- CSP-V-6 position indication.

Panel 820:
- Turbine trip circuit supervisory.
- Auto stop trip latch.
- Power supply lights.
- Turbine generator monitoring.
- Oil reservoir low level.

Panel 840:
- RFPT governor controls (2).

Response: Design changes to indicating lamp lenses will be completed prior to fuel load to correct color discrepancies.

6.3.3 Unique indicating light color codes are utilized on several vendor-supplied modular panel inserts (Digital Electro Hydraulic (DEH), rod worth minimizer, reheater controller, and vibration monitors). These color conventions are sometimes at variance with those defined by the standard. (A3.2)

Response: Color code review and upgrading of vendor status light modules were deferred until past fuel load. Resolution will be noted in the Final Report.

6.3.4 The demarcation lines applied on panel 602 to delineate the recirculation system operating area are a different color than those used in all other panels. (A3.2)

Response: The temporary lines on P602 was to simulate a color padded area. It has been subsequently determined that use of color padding in the intended application had limited merit. Demarcation will be applied in accordance with the WNP-2 guidelines. No further action required.

6.3.5 Most manual trip and initiation pushbuttons are red, but the RCIC turbine trip on panel 601 is silver, and the RCIC manual isolation button is black. (A3.2)

Response: Red pushbutton switches for the two RCIC controls on P601 could not be installed. Red switches are not available on the market which meet the switch design and Class IE requirements. Painting of the buttons would initiate a nonconformance with material parts documentation. Red collars and escutcheons were provided as an alternative solution to a red center button. The existing silver and black center does not present any confusion to the operator. No further action required.

6.3.6 Most "reset" buttons are silver, but the RCIC initiation logic reset button on panel 601 is black. (A3.2)

Response: Resolution will be noted in the Final Report after a switch color standard has been prepared.

6.3.7 Most "test" pushbuttons are black, but the standby DEH pump test button on panel 820 is silver. (A3.2)

Response: Resolution will be noted in the Final Report after a switch color standard has been prepared.

6.3.8 Because white and amber lights may be used in a multiplicity of applications, it may be desirable to clarify the significance of these indications with individual labels. (A4.3)

Response: Square, engraved, colored lenses will be installed prior to fuel load.

7.0 LABELING

7.1 GENERAL DISCUSSION

With few exceptions, all panel components at WNP-2 are identified with engraved functional labels. (Labels are not yet installed on panel 832. Panel should, therefore, be reviewed at a later date.) Some, however, could be more succint or precise, and several inconsistencies were noted in label content, font, and placement.

At the time of the Boiling Water Reactor Owners Group (BWROG) review, WNP-2 was in the process of completely revising the labeling system based upon an extensive internal review. The concerns discussed herein are necessarily based upon a review of the labels as they currently exist.

7.1.1 Component Identification

Indicating lights are generally unlabeled, identified only through physical proximity to related controls. This convention is satisfactory for pump, valve, and breaker controls, since indicating light colors are standardized in these applications, but additional labeling may be desirable for other indications. It is not clear, for example, that the unlabeled white lights associated with ECCS pump and valve controls are "manual override" lights or that the white lights associated with breaker controls on panel 800 are "power available" lights.

Labels associated with ECCS logic lights and reset switches may also require clarification. In a typical automatic system, a white light is provided, designed to illuminate when a system initiation signal is present, and extinguish when the logic is reset. Notwithstanding the fact that the use of single indicating lights is not recommended, the component label does not clearly define the significance of the illuminated state.

RPV water level instrument labels usually do not specify the applicable instrument range. As documented in Table 7-1, the "narrow range" recorder on panel 603 is labeled as such, but no other ranges are so designated. It is, therefore, not apparent that one "reactor water level" indicator on panel 603 is a wide range instrument while another on panel 601 (with the same scale) is a fuel zone instrument. (Note that the "wide range" level recorder on panel 603 is actually an "upset range" instrument.)

Table 7-1

LEVEL INDICATOR LABELS

Instrument Range	Display Type	Location	Label
Fuel zone	Recorder	P601	REACTOR LEVEL
	Indicator	P601	REACTOR LEVEL
Wide range	Recorders (2)	P601	POST-ACCIDENT MONITORING
	Indicators	P603	REACTOR WATER LEVEL
	Indicator	P001	NUCL BLR LEVEL
Narrow range	Recorder	P603	NARROW RANGE REACTOR LEVEL
	Indicators (3)	P603	REACTOR WATER LEVEL
Upset	Recorder	P603	WIDE RANGE REACTOR LEVEL
Shutdown	Indicator	P602	RPV LEVEL

Controls and displays in several component groupings are labeled with identical functional descriptions, distinguished only through numerical designations. Three "HEAD VENT" valve controls are provided on panel 602, for example, distinguished only through the numerical designations "B22-F001," "B22-F002," and "B22-F005." One of these valves vents to a main steam line, the other two to the drywell equipment drain sump. While numerical designations may be advantageously included in component labels to supplement functional descriptions and allow easy cross reference to procedures and drawings, it is not recommended that exclusive reliance be placed in numerical designations for component identification.

Indicator labels should identify the specific parameter being displayed, as "HPCS PUMP PRESSURE" on panel 601. On some labels, however, the parameter must be inferred from the units of measurement on the indicator face. In "SERV WTR," for example, the parameter "flow" is not stated.

7.1.2 Label Content

Some labels could be more explicitly worded to better define the functions of the designated components. A few examples, drawn from Section 7.3, serve to illustrate this concern:

- Three "CONTAINMENT SPRAY" valves are included in each RHR layout. The labels might be reworded to designate the valves more precisely as the drywell spray inboard and outboard isolation valves and the suppression pool spray valves.

- A common manual initiation button is provided for the LPCS and RHR-A systems, labeled "INITIATION LOGIC" and located in the LPCS operating area. The label should specify that the button initiates both systems.

- The Main Steam Isolation Valve (MSIV) controls and MSIV test switches on panel 601 are both labeled "MAIN STEAM LINE VALVE." This single designation does not distinguish the two control groups.

- Most transfer switches on panels 001 and 100 are not labeled as such but are identified with the same designation used for the associated component.

WNP-2 has implemented a procedure standardizing the abbreviations used on panel labels. Though existing labels are not consistent with this list, the revised labels will reportedly use only approved abbreviations.

Variations were also noted in label nomenclature and syntax. Names for the containment structures and the safety relief valves are particularly in need of standardization. Consideration might be given to expanding the procedure governing abbreviations to address this concern.

Two different valve numbering systems are currently in use in the WNP-2 control room, one relying upon vendor designations (applied to the Nuclear Steam Supply System (NSSS) benchboards and panel 001) and the other relying upon architect-engineer designations (applied to all benchboards and panels except panel 672). A single convention should be selected and applied consistently throughout the control room.

Two panel numbering systems are also evident, one using alphabetic designations (e.g., "panel B") and the other using numerical designations (e.g., "panel 820"). Some panel labels specify only the number, some both the number and the letter. Again, a single convention should be adopted and redundant labels removed.

Some component labels in the WNP-2 control room appeared to be rather wordy. While lengthy descriptions may, on occasion, be necessary to accurately distinguish certain components, consideration of the following general suggestions may result in more succint labels.

7.1.2.a Standard acronyms should be used where appropriate. "HPCS" should always be used, for example, in favor of "high pressure core spray." Other acronyms allowed by the WNP-2 approved list of abbreviations include:

CST (Condensate Storage Tank), SRM, CRD, RPV, MSIV, and MSL (Main Steam Line).

7.1.2.b Consideration might be given to adding additional acronyms to the approved list including: SDV (Scram Discharge Volume), RFPT (Reactor Feed Pump Turbine), and RBCCW (Reactor Building Closed Cooling Water).

7.1.2.c Obvious or unnecessary information should not be included in component designations. Examples include:

- "HPCS AMBIENT ROOM TEMP" (panel 812) may be shortened to "HPCS ROOM TEMP."
- "Valve" need not be included on every control if shape coding is used.
- "Recorder," "Controller," and "Indicator" need not be specified on labels; the type of device is obvious to the observer. "CONDENSATE FLOW RECORDER AND CONTROLLER" (panel 840) may thus be shortened to "CONDENSATE FLOW."
- "Position" is implicitly included in valve position indicating light labels and, therefore, need not be included. "RFW TURB B DR VLV BS-V-44B POSITION" on panel 840 may thus be shortened to "RFW TURB B DR VLV BS-V-44B." Similarly, "motor" may be deleted from "CONDENSATE PUMP 1B MOTOR" (panel 840).
- System names need not be repeated on each individual component label if a hierarchial labeling system is instituted.
- Abbreviations may be used in labels on indicator faces specifying the units of measurement. "Degrees F," for example, may be abbreviated as "^{o}F" and "feet" as "ft."

Electrical designations are particularly complex. The following examples prove helpful:

- "6.9 KV BUS 5 VOLTAGE" may be shortened to "BUS 5 VOLTS."
- "4.16 KV BUS 7 TIE BKR 7-1" may be shortened to "BUS 7/BUS 1 TIE."

- "DIESEL GEN NO 1 GOVERNOR CONTROL" may be shortened to simply "GOVERNOR." ("Control" is defined implicitly; "Diesel Gen No. 1" is obvious from the system label, demarcation lines, and proximity to related controls.)

Labels associated with the Reactor Water Clean-up (RWCU) pump controls direct the operator to "hold [the switches] in [the] start position for 3 seconds." This type of information label can be a valuable operator aid and should be considered for more widespread application. The need for such labels, however, often cannot be defined until the plant is operational.

7.1.3 Placement and Design

In the WNP-2 control room, normally labels are placed below indicators, recorders, controllers, and indicating lights but above switches. In clusters of controls and indicating lights, this arrangement serves to define the control/display relationships, but in other applications the practice may be somewhat confusing. Notwithstanding, a few inconsistencies were observed even within these conventions. For instance, the labels associated with the ECCS testable check valve actuator and disc position indications are placed between the two pairs of lights.

A second concern related to the current placement of panel labels is that labels below recorders and controllers tend to be obscured by the projecting instrument cases when the devices are mounted below eye level. This tendency was also noted for the labels below the horizontal indicators on panel 800.

Narrow, equal spacing between labels and panel components should be avoided in large groups of controls and displays. Differential spacing is recommended to avoid this ambiguity.

A white-on-black color scheme has been selected for the revised engraved label plates. While this combination affords good contrast, the white engravings often exhibit a tendency to fill with dirt over a period of time, detracting from label visibility. Optimum contrast may be retained by cleaning the labels periodically or by applying a clear filler to the engravings to exclude dirt.

Differences in font were noted on engraved labels, legends, and numerals on indicator faces and switch escutcheons. Differences were especially apparent in labels which had been recently added to the panels and in the parameter labels of pressure indicators. Consistency is recommended to preserve a uniform appearance and avoid visual distractions.

7.1.4 Hierarchial Labeling

Functional groupings of control and display elements can be accentuated through use of a "hierarchial" labeling system, preferably employed in conjunction with demarcation lines. In this type of labeling, large, summary labels identify system operating areas, intermediate-sized labels identify functional component subgroups, and smaller labels provide individual component identifications. This arrangement acts in concert with demarcation lines, narrowing and focusing the operator's attention to the appropriate panel region without the component-by-component visual search necessary when only individual labels are used. Hierarchial labeling also allows shorter, more concise labels to be used, since the information supplied on summary labels need not be repeated on each individual component label.

Temporary hierarchial labeling was visible on several panels, but the effectiveness of the technique could be improved through certain modifications. The following suggestions may prove helpful:

- Redundant system labels are evident on many panels. As proposed modifications are implemented, old labels should be removed to avoid visual clutter.
- While system labels are used on most panels, the hierarchial labeling scheme has only infrequently been extended to the component level.
- Existing hierarchial labels situate component identifiers below generic component designations. The reverse convention is recommended.
- Consideration should be given to more extensive use of subsystem labels, as seen on panel 820.
- System names need not be repeated on individual component labels when summary labels are used.

7.1.5 Projected Modifications to Panel Labels

At the time of the BWROG review, WNP-2 was in the process of completely revising its labeling system based upon an extensive internal review. If implemented as indicated in the documents made available to the survey team ("WNP-2 Control Room Labels and Visual Display Review"), these modifications should address many of the concerns addressed herein relative to the existing labels. A concerted effort has obviously been made to standardize label abbreviations, nomenclature, and syntax. Individual indicating lights are to be identified with lens engravings, and some use of hierarchial labeling is planned.

7.2 FAVORABLE ASPECTS OF LABELING

7.2.1 Most panel components are provided with permanent functional labels. (A5.1, A5.12)

7.2.2 System summary labels have been extensively used throughout the control room. (A5.3)

7.2.3 Most panels are identified with both number and function labels. (A5.4)

7.2.4 A standardized list of abbreviations and acronyms has been developed. (A5.5)

7.2.5 Labels are oriented to read from left to right. (A5.14)

7.3 DEVIATIONS FROM CHECKLIST CRITERIA PERTAINING TO LABELING

7.3.1 Many components on panel 832 are currently unlabeled. (A5.1)

Response: New labels will be installed prior to fuel load.

7.3.2 No labels are provided for the Local Power Range Monitor (LPRM) indicators in the four rod display on panel 603. (A5.1)

Response: Indicator scale legends and grouping location provide sufficient function information that additional labeling is not required. No action required.

7.3.3 The functions of the following white and amber indicating lights are not clearly defined by existing labels: (A5.1)

ECCS logic lights, panel 601.

ECCS manual override lights, panel 601.

Recirculation system interlock lights, panel 602

Feedwater system trip lights, panel 603.

Breaker indications, panel 800.

Circulating water pump lights, panel 840.

Response: Square engraved colored lenses will be installed prior to fuel load. No further action required.

7.3.4 The annunciator buttons on panel 100 are unlabeled. (A5.1)

Response: A new label will be installed prior to fuel load.

7.3.5 Only temporary labels are provided for the following components: (A5.1, A5.12)

RHR valves F073A/B and F074A/B, panel 601.

Two HPCS breakers, panel 601.

RCIC initiation reset switch, panel 601.

Radwaste cycle timer, panel 602.

Diesel cranking and maintenance lights, panel 800.

Electrical indicator subgroup designations, panel 800.

Remote air inlet isolation valve controls, panel 826.

Response: New labels will be installed prior to fuel load.

7.3.6 Labels for the DEH pump controls on panel P820 rely only upon numerical designations. (A5.1)

Response: New labels will be installed prior to fuel load.

7.3.7 Redundant labels are provided for the RCIC isolation button on panel 601, the recirculation flow controllers on panels 602 and 609, and the moisture separator reheater controller on panel 820. (A5.1)

Response: New labels will be installed prior to fuel load.

7.3.8 The following indicator labels do not specify the parameter monitored to: (A5.1)

"SERV WTR," panel 601 (A and B channels; flow).

"HEAD COOLING," panel 601 (flow).

"REGEN HT EX INLET," panel 601 (pressure).

"RECIRC PUMP A(B) MOTOR," panel 602 (current).

"RECIRC PUMP A(B) MOTOR," panel 602 (RPM).

"JET PUMP LOOP A(B)," panel 602 (flow).

"REAC BLDG EQUIP DRAIN SUMP," panel 602 (temperature).

"PLANT SVC WTR," panel 840 (current).

Response: New labels with parameter designation will be installed prior to fuel load.

7.3.9 Redundant system identification labels are present on panels 601, 602, 820, and 840.

Response: Old labels will be removed upon application of new permanent labels prior to fuel load.

7.3.10 No system identification labels are evident on panel 832. (A5.3)

Response: New labels will be installed prior to fuel load.

7.3.11 Redundant panel number labels are provided on panels 001, 601, 602, 800, 813, 814, 820, 821, and 840. (A5.4)

Response: Old labels will be removed upon application of new permanent labels prior to fuel load.

7.3.12 Two different panel numbering systems are in use, one relying upon alphabetic designations and the other upon numeric designations. Some panel labels specify only the number, others specify both number and letter. A single convention should be adopted for the entire control room. (A5.4)

Response: The alphabetic designations are used by the operators to identify Balance of Plant (BOP) operating panels from NSSS panels. The alphabetic system is easier to memorize and provides for quicker response to back vertical panels. Numeric designations are required due to plant design nomenclature. Panel labels will provide both designations in a consistent manner where applicable. No further action required.

7.3.13 Numerous abbreviation forms are inconsistent with those specified in the WNP-2 standard. (A5.5)

Response: A plant abbreviation standard has been issued. The new legend plates to be installed prior to fuel load will provide consistency.

7.3.14 The WNP-2 standard list of abbreviations for control room labels does not include the following terms: (A5.5)

Reactor Building, abbreviated as "REAC BLDG" and "RB" on panel 602, "REACTOR BLDG" and "REAC BLDG" on panel 812.

Radwaste Building, abbreviated as "RDWST BLDG" on panel 812 and "RBW BLG" on panel 825.

Scram Discharge Volume, variously abbreviated as "SDV," "SCRAM DISCH VOL," and "DISCHARGE VOL" on panel 603.

Startup, abbreviated as "SU" on panel 800.

Tower makeup, abbreviated as "TMU" on panel 824.

Response: TMU (Tower Makeup System) and SDV have been added to the abbreviation standard. Others will be added as the need arises. No further action required.

7.3.15 The nonstandard abbreviation "PRI" is misspelled as "RPI" on the label associated with the RCC-V-21 control on panel 825. (A5.5)

Response: A new label will be installed prior to fuel load.

7.3.16 The abbreviation for "header" is misspelled on the desuperheater condensate header pressure indicator label on panel 840. (A5.5)

Response: A new label will be installed prior to fuel load.

7.3.17 Use of the terms "drywell," "containment," "suppression pool," "suppression chamber," and "wetwell" does not appear to be completely standardized. Inconsistencies were noted among panels 001, 100, 601, 811, 813, 814, 825, and 827. (A5.5)

Response: Consistency has been established in the new labeling scheme. New labels will be installed prior to fuel load.

7.3.18 The terms "safety valve," "relief valve," "safety relief valve," and "manual blowdown valve" are used interchangeably (panels 614, 814, 601, and 001, respectively). (A5.5)

Response: See item 7.3.17, above, for response.

7.3.19 The terms "nuclear boiler," "reactor," and "RPV" are used interchangeably (panels 001, 603, and 601, respectively). (A5.5)

Response: See item 7.3.17, above, for response.

7.3.20 Both Roman and Arabic numerals are used for divisional designations, sometimes on the same panel (compare panels 601, 811, 812, 814, 826, 827, and 831). (A5.5)

Response: See item 7.3.17, above, for response.

7.3.21 Some indications on panel 812 are labeled "room ambient temperature" while others are labeled as "ambient room temperature;" consistent syntax should be maintained. (A5.5)

Response: See item 7.3.17, above, for response.

7.3.22 The nomenclature and abbreviations used on the remote shutdown panels are not consistent with those used on the main benchboards. (A5.5)

Response: See item 7.3.17, above, for response.

7.3.23 The wording of the label associated with the annunciator response buttons on panel 603 is not consistent with the corresponding label on all other panels. (A5.5)

Response: See item 7.3.17, above, for response.

7.3.24 The following labels are of nonstandard syntax ("VOLTAGE MCC," for example, would normally read "MCC VOLTAGE;" "MAN CONDENSATE TANK A DISCH VALVE" would normally read "CONDENSATE TANK A MAN DISCH VALVE"): (A5.5)

Panel 601	VOLTAGE BUS
	VOLTAGE INCOMING
	VOLTAGE HPCS POWER SUPPLY
	VOLTAGE 125VDC BUS
	VOLTAGE MCC
	POSITION VALVE
	MAN CONDENSATE TANK A DISCH VALVE
Panel 840	A SJAE CONDENSER INLET VALVE

Response: See item 7.3.17, above, for response.

7.3.25 Two alternate spellings are in use for the same word: "disk" on panel 601 and "disc" on panel 602. (A5.5)

Response: See item 7.3.17, above, for response.

7.3.26 On panel 820, Steam Jet Air Ejectors are designated both alphabetically (e.g., "SJAE A") and alphanumerically (e.g., "SJAE 1A"). (A5.5)

Response: See item 7.3.17, above, for response.

7.3.27 Two valve numbering systems are in use, one relying upon vendor designations (e.g., E22-F004 on panel 601) and the other upon architect-engineer designations (e.g., RCC-V-71B on panel 813). Vendor designations are used on all benchboards, on panels 672 and 001. Architect-engineer designations are used on the remaining vertical panels.

Response: See item 7.3.17, above, for response.

7.3.28 Labels associated with some components are of nonstandard font. (A5.6)

Response: A single vendor has been selected to perform all engraving in accordance with a WNP-2 engraving specification. New plates will be installed per item 7.3.12, above.

7.3.29 Labels specifying parameter units on the faces of some indicators are of nonstandard font. (A5.6)

Response: A review of indicator scales was completed for readibility. In general, font size variations did not prove distracting and existing font size appeared adequate for visibility. No action required.

7.3.30 Numerals on some indicators are of nonstandard font. (A5.6)

Response: See item 7.3.29, above, for response.

7.3.31 The fonts used for switch escutcheon legends are not consistent. (A5.6)

Response: A review of escutcheon fonts was completed for readability. Backing ring-type escutcheons were found to be uniform. Control head style escutcheons varied on font size. Most of the control head escutcheons were easily readable. Changes will be made based on operational need and review after fuel load. Resolution will be noted in the Final Report.

7.3.32 Use of temporary hierarchial labeling was evident. Coordinated implementation of such a system could minimize redundant labels, shorten component designation, and accentuate functional groupings of controls and displays. (A5.7)

Response: The new labeling scheme incorporates the use of hierarchy labels and strives to reduce redundancy of wording and labels. New labels will be installed per item 7.3.12, above.

7.3.33 The labels for critical buses 7 and 8 on panel 800 are partially covered by the bus mimic. (A5.9)

Response: The new mimicking and labeling system will correct the concern prior to fuel load.

7.3.34 The labels below recorders and controllers mounted relatively low on panels 001, 100, 607, 608, 800, 811, 812, 813, 814, and 827 tend to be obscured by the projecting instrument cases. (A5.9)

Response: New labels will be installed prior to fuel load and will be located on recorder doors and controllers, where applicable.

7.3.35 RPV water level indicators labels do not specify the applicable range. (A5.10)

Response: New labels will be installed prior to fuel load.

7.3.36 Labels associated with some components do not clearly and unambiguously define the component functions. (A5.10)

Response: See item 7.3.17, above, for response.

7.3.37 Controls and displays in some component groupings are labeled with identical functional descriptions. Functional differences are distinguished only by numerical designations. (A5.10)

Response: The new labeling scheme minimizes this concern.

7.3.38 The following errors were noted on component labels: (A5.10)

RHR pump B and C ammeters on panel 601 are both labeled "RHR PUMP C002C."

The LPCS pump ammeter on panel 601 is labeled "LRS PUMP."

The CRD temperature indicator on panel 603 is labeled "REACTOR WATER LEVEL."

A single-channel pressure indicator on panel 603 is labeled "REACTOR PRESS A B."

The RBCC "A" heat exchanger discharge temperature indicator on panel 820 is labeled "RBCC WATER DISCH HDR TEMP."

The HPCS and RCIC injection valves are inappropriately referred to as "PUMP DISCHARGE VALVES" on panel 601.

Response: New labels will be installed prior to fuel load.

7.3.39 Labels associated with the following components could be more succintly worded:

Panel 602:	RWCU pumps
Panel 603:	CRD flow indicator
Panel 800:	Breaker controls and related indications
Panel 812:	Differential pressure recorder
Panel 840:	RFW pump minimum flow controllers

RFW turbine differential pressure indicators

Condensate flow recorder and controller

CW inlet plenum level indicator and controller

RHR heat exchanger cooling water pressure controller

RFW turbine drain valve indicating lights

Steam desuperheater pressure regulator and bypass valves

In addition, several general modifications to current labeling practices, as discussed in section 7.1.2, may result in more succint component designations. (A5.10)

Response: New labels will be installed prior to fuel load.

7.3.40 Labels are generally placed below indicators, recorders, controllers, and indicating lights but above switches. Even within this convention, several inconsistencies were noted as follows: (A5.11)

7.3.40.a The temporary labels associated with the diesel cranking lights on panel 800 are placed above the related indications.

7.3.40.b The labels associated with the tower makeup pump discharge valve position indications on panel 824 are placed above the related lights.

7.3.40.c Labels on panel 832 are placed on the side of the related switches.

7.3.40.d Labels are below the heater coil control switches on panels 811 and 827.

7.3.40.e Labels for the RHR, HPCS, and LPCS inlet check valve actuator and disc position indications are placed between the two pairs of lights.

Response: Items 7.3.40.a and d will be corrected with the new labeling scheme. Items 7.3.40.b, c, and e are physically constrained due to panel layout design or circuit design. The new labels to be installed prior to fuel load and use of square engraved lenses will improve visibility. No further action required.

7.3.41 Temporary labels, where used, are usually placed above switches.

Those associated with the exhaust head spray valve controls on panel 820, however, are placed below the switches, and several on panel 812 are placed to the side of the switches. (A5.11)

Response: The use of temporary labels will be reduced to a minimum after the new labels are installed and application controlled by plant administrative procedure.

7.3.42 The correspondence between labels and the following displays is not readily apparent due to the equal, relatively narrow spacing maintained between labels and components: (A5.11)

HPCS indications, panel 601

CST discharge valve lights, panel 601 (HPCS)

RHR manual injection valve lights, panel 601

SLC valve lights, panel 603

Turbine drain valve lights, panel 820

SJAE valve lights, panel 820

Hydrogen analyzer alarm lights, panel 672

SGT heater lights, panels 811 and 827

Response: The new labels and use of square lenses will minimize this concern. Placement location of the labels and use of group labels will also help improve the correspondence concern. No further action required.

7.3.43 Labels for the annunciator boxes on panel 813 are placed inside the containment vent and purge system demarcation line, implying the labels pertain to controls rather than to the annunciators. (A5.11)

Response: The new labeling scheme will correct this concern prior to fuel load.

8.0 PANEL MODIFICATIONS

8.1 GENERAL DISCUSSION

Over the life of a plant, it may be anticipated that modifications to its control panels will be necessary. These changes must be implemented in a consistent manner if orderly panel appearances are to be maintained.

Though WNP-2 has already promulgated a procedure controlling the panel modification process and is to be commended for this step, it was impractical for the survey team to evaluate the consistency of the changes themselves, due to the construction status of the plant. This aspect of panel design should, therefore, be reconsidered at a later date. Nothwithstanding, several concerns merit comment at this time.

System design changes occasionally necessitate the removal of certain panel components. It is recommended that the holes so formed be covered to preclude the entry of dirt into the control panel internals. Ideally, the covers should be flush with the panel surface and painted to blend with the panel background. Less desirable are the silver plugs, as these introduce a visual distraction. Old label plates should not be left in place for the same reason.

Temporary labels are evident on many control panels. While label tape does provide a simple and inexpensive means of supplementing existing component designations, temporary labels should be used as an expedient only, to be eventually replaced with permanent labels. Overabundant application of label tape tends to result in a distracting layout and can lead to inconsistencies in nomenclature, abbreviations, color, and placement. The impermanence of the approach also can manifest itself in peeling labels.

The calibration stickers applied to indicators and controllers are not, strictly speaking, "panel modifications" but are treated as such here, since they are distinct from the permanent labeling system.

Response: Due to the present status of construction, holes presently exist. Methodology of patching panel holes is being finalized. Holes will be covered prior to fuel load.

Old labels and most temporary labels will be removed when the new labels are installed.

A plant administrative procedure has been prepared for the control, use of, and routine review of temporary labels and tags within the control room. Implementation will commence after the new legend plates are installed but no later than prior to fuel load.

BWROG checklist section A6, Temporary Modifications, will be reviewed against checklist criteria after fuel load and reported in the Final Report.

9.0 CONTROLLERS

9.1 GENERAL DISCUSSION

The majority of controllers at WNP-2 are clearly marked and easily accessible. Those on panels 001 and 813, however, are mounted above optimum heights and are consequently somewhat difficult to operate.

The RHR controllers on panel 601 and the feedwater controllers on panel 840 are mounted immediately adjacent to one another. When adjusting the setpoint on one controller, the operator, therefore, tends to use the adjacent controller as a handrest. In doing so, it is possible to inadvertently change the setpoint of the controller used as a handrest.

Operator comments and simulations indicate that all controllers afford the necessary precision at control.

9.2 FAVORABLE ASPECTS OF CONTROLLER DESIGN

9.2.1 All controllers reportedly afford the necessary precision at control. (B1.2)

9.2.2 All controller operating modes (manual/auto) are easily discerned. (B1.3)

9.2.3 Mechanical stops are provided at the beginning and end of thumbwheel travel on all controllers. (B1.4)

9.3 DEVIATIONS FROM CHECKLIST CRITERIA PERTAINING TO CONTROLLERS

9.3.1 Controllers on panels 001 and 813 are mounted above optimum heights. (B1.1)

Response: See item 3.3.2 for response.

9.3.2 Controllers on the vertical sections of panels 601 and 840 are situated immediately adjacent to one another. When adjusting one controller, the operator must, therefore, use the adjacent controller as a handrest. (B1.5)

Response: Discussions with the operators have indicated no problems or concerns to date, and use of controllers for handrests has not been observed by the operators. The arrangement is considered adequate as is. No action required.

10.0 INDICATORS

10.1 GENERAL DISCUSSION

Human factor standards suggest that, for optimum readiability, numbers on indicators scale progress in decimal multiples of two, five, or ten, with no more than nine intermediate marks between numbered subdivisions. Exceptions to these criteria were found on many panels and have been listed in section 10.3.

The pointers of most indicators are triangular, white against a black background, or black against a white background. This design provides good contrast and appears to satisfy the recommended functional design requirements for pointers. Smaller pointers, such as used in the reheater controller module indicators and the DEH instruments, were considered much less distinctive and were sometimes difficult to see. Pointers in circular meters, such as used for electrical indications, were noted to partially obscure scale numerals in certain positions. A similar concern was evident in some recorders where pointers were observed to partially obscure numerals and scale graduations.

Glare and parallax were evident on some instruments, particularly those mounted relatively low or relatively high on the panels. The horizontal indicators on panel 800 are also of concern in this regard, as the operator must stand directly in front of the instruments to avoid parallax.

Temporary markings signifying normal and abnormal parameter values have been added to several instruments on panel 840. This type of coding can be a valuable operator aid, providing qualitative indications of system status. More widespread application of this technique is encouraged.

Two different zero references are used for reactor water level instruments. While this may be desirable in certain respects, direct comparison of multiple level indications is complicated by this design.

Most indicators and recorders are calibrated in appropriate units, but alternate choices might be considered in a few instances. Several level indicators on panel 840, for example, are scaled in feet of elevation above sea level; whereas, a level referenced to the bottom of the volume being measured is generally easier to interpret.

Scaling conventions pertaining to the use of multipliers were found to vary from panel to panel. For example, multipliers of 10, 100, and 1000 are used on three different pressure indicators spanning approximately the same range. Similar inconsistencies were noted on flow and RPM instruments. While differences in indicating ranges may, on

occasion, necessitate the use of a variety of multipliers, standardized scales are generally easier to interpret. In most cases, multipliers need not be used at all.

Indicators should be designed such that a failure of the device would be apparent to the operator; i.e., an indicator should not fail in its normal range. Since instrument failure points had already been documented separately by the Supply System, BWROG did not re-evaluate this aspect of indicator design in its review.

Several recorders, such as the turbine-generator temperature recorder on panel 820, are provided with dual scales for a single parameter or series of parameters. In these instances, color coding or other identification techniques might be used to clarify the correlation of inputs to scales.

10.2 FAVORABLE ASPECTS OF INDICATOR DESIGN

10.2.1 Pointers move from bottom-to-top, left-to-right, or clockwise for all indicators and recorders. (B2.5)

10.2.2 Scale numerals are oriented in an upright position in all instruments. (B2.15)

10.2.3 Control room instruments will reportedly be calibrated and surveillance tested on a regular basis.

10.3 DEVIATIONS FROM CHECKLIST CRITERIA PERTAINING TO INDICATORS

10.3.1 Indicator scales have generally not been marked or color coded to indicate normal and abnormal ranges. (B2.1)

Response: Color banding and trip setpoint additions will be applied past fuel load when application guidelines and operational experience have been obtained. Resolutions will be noted in the Final Report.

10.3.2 Some glare was evident on the following indicators: (B2.2)

Upper indicators on panels 001 and 100

Recirculation Controller Meters, panel 602

Top row of indicators on panel 800

Lowest row of indicators on panels 820 and 840

Vibration monitors, panel 840

Upper indicators and controllers on panel 813

Response: Diffusers will be installed on the lamp fixtures relative to panels P001 and P100 during the first refueling outage. Glare on the other panels is considered minimal. No further action required.

10.3.3 Parallax was noted on the following indicators; (B2.2)

RCIC controller, panel 001

Horizontal indicators on panel 800

Lowest row of indicators on panels 820 and 840

Response: An eight-inch platform was installed in front of P001 to provide the operator improved access and visibility to the displays and controller. Residual parallax on this panel is considered minimal. Color banding and setpoint additions, as noted in item 10.3.1 response, above, will minimize the parallax on panels P800, P820, and P840. No further action required.

10.3.4 Indicators and recorders should be scaled in units which directly relate to system operation. The following inconsistencies were noted: (B2.3)

10.3.4.a The containment instrument air differential pressure indicator on panel 840 is scaled in psig rather than psid.

10.3.4.b The circulating water plenum level indicators on panel 840 are scaled in feet elevation (referenced to sea level). A level referenced to the bottom of the plenum would be preferred (as on the spray pond pit level indicators).

10.3.4.c LPRM indicators in the four rod display on panel 603 are scaled in "% heat flux." Usually, these indicators are actually scaled in watts/cm^2.

10.3.4.d The SLC tank "level" indicator on panel 603 is scaled in "gallons" (volume).

10.3.4.e Some feedwater heater shell pressure indicators on panel 840 are scaled in psig, while others are scaled to psia.

10.3.4.f The condenser vacuum indicators on panel 820 are scaled in "in. Hg absolute;" whereas, alarm points and action levels relative to condenser vacuum are normally specified in "in. Hg vacuum."

10.3.4.g The recombiner differential pressure indications on panel 672 are scaled in "inches." The labels should more correctly specify "inches H_2O."

10.3.4.h The tower makeup flow recorder on panel 824 is scaled in percent. Indication of the actual flow, in gallons per minute, may be more useful.

Response: Item 10.3.4.a is a pressure display. The legend plate wording "ΔP" is incorrect and will be corrected prior to fuel load. Items 10.3.4.b, f, g, and h will be corrected prior to fuel load. Item (5) is correct as is. Low and high pressure feedwater heaters have different pressure range requirements. The "PSIA" indicators are grouped apart from the "PSIG" indicators such that display conflict should be minimal. Resolution to items 10.3.4.c and d will be noted in the Final Report.

10.3.5 Units of measurement are not specified on the following instruments: (B2.3)

RCIC controller, panel 001

Post-accident monitors, panel 601

Fuel zone level recorder, panel 601

Total core flow/differential pressure recorder, panel 603

Absorber vault temperature recorder, panel 672

Absorber outlet flow recorder, panel 672

H_2 Analyzer Electronics recorder, panel 672

Dessicant dryer outlet temperature recorders, panel 672

Recorders on panel 814

Chlorine recorders, panel 826

Controller scales, all panels

Response: All recorders and indicators will have units of measurement on them prior to fuel load. Resolution as to the RCIC controller will be noted in the Final Report.

10.3.6 Numbers on the scales of the three recorders on panel 800 are difficult to read. (B2.4)

Response: These recorders have internal lamps to improve readability. The lamps are presently not energized but will be turned on prior to fuel load. These are not used for process control, and quick readout response is not required. No action required.

10.3.7 The LPCS flow indicator on panel 601 and the makeup water header pressure indicator on panel 824 have only handwritten scales. (B2.4)

Response: These are temporary scales. New scales will be installed prior to fuel load.

10.3.8 Pointers in the following indicators were not considered visually distinctive: (B2.4)

Recirculation flow controllers, panels 602 and 603

DEH indicators panel 820

Moisture separator/reheater controller indicators, panel 820

Vibration monitor indication, panel 840

Response: These instruments are used during closeup operation. Visibility from a distance is not required. No action required.

10.3.9 Labels on recorder scales specifying units of measurement and labels on controller scales specifying scale multipliers are often small and difficult to read. (B2.4)

Response: See item 7.3.29 for response.

10.3.10 Scale numbers can be partially obscured by the pointers of the circular indications found on panels 601, 603, 800, and 820. (B2.5)

Response: A review was completed of circular indicators. These are nonprocess indicators and do not require exactness of reading for process control. Color banding, to be applied past fuel load, will enhance operator recognition of normal operating bands where required. No further action required.

10.3.11 Recorder scale numerals or graduation marks can be obscured by the recorder pointer in the following instruments: (B2.5)

Post-accident monitors, panel 601

Recirculation flow recorder, panel 602

Computer trend recorders, panels 602 and 603

Core pressure drop and flow recorder, panel 603

Nuclear instrumentation recorders, panel 603

Hydrogen analyzer recorder, panel 672

Prefilter inlet temperature recorder, panel 672

Absorber outlet flow recorder, panel 672

Dessicant dryer temperature recorders, panel 672

Generator voltage, frequency, and megawatt recorders, panel 800

Differential pressure recorders, panel 812

Containment pressure, suppression chamber temperature, and suppression chamber level/pressure recorders, panel 814

Generator temperature recorder, panel 820

Tower makeup flow recorder, panel 824

Chlorine recorders, panel 826

Blowdown flow recorder, panel 840

Response: A review was completed of the listed recorders. Those recorders considered essential (i.e., Post-Accident Monitors) have backup indicators for monitoring and process control. Quick response readability and/or exactness are not required for the other recorders. Readability is considered adequate on the above listed recorders. No action required.

10.3.12 The automatic setpoint scale in Bailey controllers moves up in response to a downward movement of the controller thumbwheel and vice versa. (B2.7)

Response: Resolution will be noted in the Final Report.

10.3.13 The fuel zone RPV water level instrument uses a zero reference different from the other RPV level instruments. (B2.8)

Response: All RPV water level instrumentation will have a common zero reference prior to fuel load.

10.3.14 The relatively large space between scale and pointer in the turbine-generator temperature and vibration/eccentricity recorders on panel 820 produces a parallax effect in these instruments. (B2.9)

Response: Parallax is considered minimal. The recorders are nonprocess monitoring recorders. Discussion with the operators indicates no readability concerns versus the accuracy requirements of the data. No action required.

10.3.15 The main steam line A, B, C, and D temperature indications are not aligned on panel 820. (B2.10)

Response: New group labels, rather than individual labels, will be applied prior to fuel load. The new wording and group labels will improve visibility of the temperature indicators. No further action required.

10.3.16 The scale ranges of the following instruments may be too narrow: (B2.11)

Main generator voltage recorder, panel 800

Gland exhaust condenser pressure indicator, panel 820

Condenser vacuum indicators, panel 820

Nitrogen pressure indicators, panels 820 and 840

Containment instrument air pressure indicator, panel 840

Response: A review of the adequacy of all control room and recorder scales was completed. These five were previously identified as not having the required range and will be corrected prior to fuel load.

10.3.17 Many instruments are scaled with more than the recommended nine intermediate graduations between numbered divisions. (B2.12)

Response: A review was completed of all indicator and recorder scales in the control room. Seventeen scales were found inadequate and require changeout, and four will be deleted prior to fuel load. Extrapolation capability and readability were found adequate on all other scales. No further action required.

10.3.18 Nonstandard numerical progressions were noted on many instruments. (B2.13)

Response: A review was completed of all indicators and recorder scales in the control room. See item 10.3.17 for response. Most of the remaining scales use major progression steps of three, with two submajor and twelve minor lines, or are nonlinear due to hardware design. Readability and extrapolation were found as adequate on these scales. No further action required.

10.3.19 Color coding might be used to differentiate scales on dual-range recorders, such as the turbine-generator temperature recorders on panel 820. (B2.18)

Response: Color banding and setpoint identification coding will be initiated after fuel load when sufficient operational experience has been obtained. Resolution will be noted in the Final Report.

11.0 RECORDERS

11.1 GENERAL DISCUSSION

The concerns noted in section 10.0 relative to indicator scales may be considered equally applicable to recorder scales. Scale progressions and subdivisions, pointer design, choice of units, etc., were evaluated according to the same criteria. Exceptions are, therefore, noted in section 10.3.

The colored traces of pen recorders generally provided good contrast, but multipoint recorder printouts were often difficult to read. The small, overlapping numerals tended to result in indistinct printouts. Where the multipoint format is opted for, consideration should be given to expanded use of fast speed and point select capabilities.

Labels for multipen recorders do not always clearly define the correlation of pen color to input parameter. Four cases were noted:

- Pen assignments are not specified at all.
- Pen inputs are specified but are not assigned in alphabetical order.
- Pen inputs are listed in reverse order relative to the actual pen sequence.
- Pen inputs are listed on a label on the recorder face in reverse order relative to the engraved recorder nameplate.

Chart papers and ink supplies are reportedly easy to replace in all recorders at WNP-2. Labels on the recorders usually, but not always, identify the correct size and style of replacement chart paper. Notwithstanding, several recorders were observed to have an incorrect style of chart installed at the time of the survey.

11.2 FAVORABLE ASPECTS OF RECORDER DESIGN

11.2.1 Multipen recorder traces are color coded and generally appear visually distinctive. (B3.4)

11.2.2 Recorder paper and ink supplies are easily replaced. (B3.8, B3.9)

11.2.3 Chart papers reportedly travel freely and are free from binding. (B3.11)

11.2.4 Requirements for recorder chart marking and retention are specified in Administrative Procedure 1.3.4. (B3.12, B3.13)

11.2.5 Recorders were observed to be free of glare and parallax. (B3.14)

11.3 DEVIATIONS FROM CHECKLIST CRITERIA PERTAINING TO RECORDERS

11.3.1 The printouts of multipoint recorders are difficult to read. The printed numerals are small, overlapping, and indistinct. (B3.1)

Response: Multipoint recorders are not used for parameters requiring process control. Computer monitoring and/or annunciator alarms are available for points of concern. Upgrade or changeout of multipoint recorders is not considered cost effective based on the limited operating experience to date. These will be reassessed prior to the Final Report.

11.3.2 At the time of the survey, an incorrect style of chart paper was installed in the following recorders: (B3.2)

Post-Accident monitors, panel 601

RPV pressure/steam flow recorder, panel 603

RHR temperature recorder, panel 614

Holdup line inlet flow recorder, panel 672

Adsorber vault temperature recorder, panel 672

Adsorber outlet flow recorder, panel 672

Reactor building differential pressure recorder, panel 812

Suppression chamber temperature recorder, panel 814

Turbine-generator temperature and vibration recorders, panel 820

Response: Correct chart paper has been ordered and will be installed upon delivery.

11.3.3 Alarm points and operating limits are not identified on recorder scales. (B3.3, B3.15)

Response: See item 10.3.1 for response.

11.3.4 Multispeed capability is provided only for the post-accident monitors on panel 601 and the nuclear instrumentation recorders on panel 603. Consideration should be given to providing fast speed capability on other recorders. (B3.5)

Response: Engineering design provided two speed capability only to those recorders requiring the capability. Other recorders are driven at specific rates (one, two, three, or four inches per hour) based on their specific requirements. Computer monitoring is also available for essential points. No action required.

11.3.5 Multipoint recorders are not equipped with point select capability. (B3.6)

Response: Engineering has provided point select capability where design required (e.g., Area Radiation Monitoring Recorder) and where excessively large number of points are being recorded on one recorder (e.g., Generator Stator Temperature Recorder). Point select capability is not required for most applications, and computer monitoring capability exists for parameters of concern. No action required.

11.3.6 Recorders on the following panels are not marked to indicate the correct size and style of chart paper: (B3.7)

Panel 603: (core differential pressure and total flow recorder)

Panel 614:

Panel 672:

Panel 820:

Panel 831:

Panel 840: (hotwell conductivity)

Response: This will be corrected prior to fuel load.

11.3.7 The correlation of pen color to input parameter is not specified on the following multipen recorder labels: (B3.10)

RWCU inlet conductivity recorder, panel 602

Computer trend recorders, panels 602, 603, and 840

RFW turbine vibration/eccentricity recorders, panel 840

Blowdown flow recorder, panel 840

Hydrogen analyzer electronics recorder, panel 672

Prefilter inlet temperature recorder, panel 672

All recorders on panels 814, 826, and 831

Response: Pen color to input parameter will be noted on the new labels to be installed prior to fuel load where feasible. For some multipoint recorders, insufficient labeling room exists to identify Point Number, color, and parameter being measured. Most recorders will have color pen designations. No further action required.

11.3.8 Pen inputs are listed in reverse order relative to the actual pen sequence on the reactor building differential pressure recorder on panel 812. (B3.10)

Response: New legend plate to be installed prior to fuel load will correct the concern.

11.3.9 Monitored inputs are not assigned to recorder pens in alphabetic sequence on the recirculation flow recorders on panel 602, the SRM recorder on panel 603, or the adsorber outlet flow recorder on panel 672. (B3.10)

Response: P602 recorder legend plate will be corrected prior to fuel load. P672 recorder will be left as is. Red pens are consistently the upper pen on two pen recorders, and pen designation plates will consistently be orientated top pen/upper description and then bottom pen/lower description. No further action required.

11.3.10 The label specifying pen assignments for the RPV level recorder on panel 603 list pens in reverse order relative to the engraved recorder nameplate. (B3.10)

Response: New recorder nameplates will be installed prior to fuel load.

12.0 INDICATING LIGHTS

12.1 GENERAL DISCUSSION

Indication lights were judged to be of adequate brightness on most panels. Some on panel 800, however, appeared rather dim.

Single indicating lights have been used in a variety of applications, including alarm lights, initiation and isolation signal lights, interlock lights, and manual override indications. In these instances, an extinguished light is generally associated with a "normal" condition. Consequently, if a bulb were expended, an abnormal condition might not be detectable. Currently, only the bulbs in the annunciator panels and the soon-to-be-installed out-of-service indications may be tested.

Sets of indicating lights of similar function should be physically aligned, if possible, to facilitate rapid evaluation of the system status. In contrast, the full core display on panel 603 consists of a large matrix of multicolored lights corresponding to the core cross sections. This arrangement precludes a rapid visual scan of rod positions, accumulator status lights, and LPRM alarms. Similarly, the isolation valve lights on panel 601 are not grouped to facilitate visual confirmation of automatic isolations.

Indicating lights should furnish direct displays (as opposed to implied information) of the states of the associated components. A valve position indication, for example, should be activated from a limit switch on the valve itself rather than from a contact in the actuator. Direct indication was found to be used in the majority of systems, but several lights, including the safety/relief valve position indications on panels 001 and 601, display only the condition of the actuating solenoid.

12.2 FAVORABLE ASPECTS OF INDICATING LIGHT DESIGN

12.2.1 Most indicating lights are of adequate birghtness. (B4.1, (4.3)

12.2.2 Indicating light bulbs are reportedly easy to replace. (B4.5)

12.3 DEVIATIONS FROM CHECKLIST CRITERIA PERTAINING TO INDICATING LIGHTS

12.3.1 Red and green indicating lights on panel 800 appeared rather dim. (B4.1)

Response: Operators have extensively used the Electrical Board (P800) and have expressed no problems discerning lit from unlit

states. The same design, lamp socket, lamp, and lense are used as on other panels. This will be reassessed for the Final Report.

12.3.2 Single indicating lights have been used in the following applications. This design should be avoided, as an abnormal condition might not be detectable, if the bulb were expended. (B4.2)

Panel 001	RCIC alarm lights
Panel 601	RCIC initiation light
	RCIC F064 isolation light
	ECCS logic and manual override lights
Panel 602	Recirculation system interlock lights
Panel 603	RFW interlock lights
Panel 672	Hydrogen analyzer alarm lights
Panel 800	Disconnect lights
	Generator lockout lights
Panel 811/827	Heater trip lights
Panel 820	Auto-stop trip latch light
	Seal water pump lights and air purge lights associated with the circulating water system

Response: The use of dual-filament bulbs was researched. Sixteen lamp manufacturers were contacted. Dual-filament bulbs of the size used in the control room are not currently on the market, and manufacturers noted that it was not feasible to manufacture them, because the globe size is too small to accommodate two filaments.

The use of lamp test or filament monitoring circuits were reviewed. There are approximately 6500 indicating lamps that are not testable. Approximately 3900 of these are in safety-related (Class IE) systems. Installation would require 80-90 test switches, thousands of additional wires in already congested panels, and two or three additional panels to house the test logic. Estimated cost is $1 to $2 million.

Changeout of the present indicating lights to a dual-lamp style or push-to-test style would require extensive wiring changes,

panel hole resizing, labeling, mimicking, and redesign of Class IE system interfaces. Estimated cost is $0.5 to $1 million.

Square engraved color coded lenses will be installed on the single lights prior to fuel load. One function of the square lenses is to help the operator define the normal light condition (white lamps should always be on and amber off). Shift turnover procedures require a check of all indicating lamps for burnt-out bulbs and immediate replacement or tag-out of the control. This coupled with normal surveillance tests and control manipulation for viewing normally unlit lamps, reduces the potential for undetected burnt-out bulbs. No further action required.

12.3.3 No positive means of testing most panel indicating lights is provided (annunciators and out-of-service displays are exceptions). (B4.4)

Response: See item 12.3.2 for response.

12.3.4 The following sets of indicating lights could be better arranged to facilitate evaluations of system status. (B4.6)

12.3.4.a Safety relief valves, panels 001 and 601

12.3.4.b Sample valves, panel 601

12.3.4.c Steam line drain valves F033, F069, and F073, panel 602

12.3.4.d RFW testable check valve actuator, panel 602

Response:

12.3.4.a Relief valves on P001 will be demarcated and hierarchy labeled prior to fuel load. See item 5.3.16.a for response on the relief valve controls for P601.

12.3.4.b Present demarcation provides adequate distinction. New label plates with improved clarity of wording will be installed prior to fuel load. No further action required.

12.3.4.c Steam line drains have been mimicked, demarcated, and new legend plates with improved clarity of wording will be installed prior to fuel load. No further action required.

12.3.4.d RFW testable check valves are being relocated to P840 and grouped with the RFW system controls. The indicating light sets are consistent in arrangement with all other testable check valves on P601. Improved legend plates will be installed prior to fuel load. No further action required.

13.0 SWITCHES

13.1 GENERAL DISCUSSION

Accepted conventions, known as "population stereotypes," dictate the preferred directions of switch motion. Most controls are in compliance with these standards, but a few exceptions were noted, as listed in section 13.3.

Some types of switch handles found at WNP-2 tend to obscure the switch pointers, position marks, and labels when viewed from certain angles. The oval handled switches used on panels 603 and 820 are of particular concern in this regard. The pointers of pushbutton arming collars on P601 and P603 are also difficult to see from the normal viewing position.

With few exceptions, switch position options are marked on the escutcheons provided for each switch. However, the font and method of application vary throughout the control room.

Inconsistent use is made of escutcheons for pushbutton switches. Some are labeled "push to trip" (or "test" or "reset"), while others have no escutcheons provided. Consistency in this regard would produce a more uniform panel appearance and obviate possible misinterpretations of switch labels.

A rectangular style of switch not found on the main benchboards is used on panels 813 and 824. In these designs, the position of the switch pointer did not always appear to correspond to the actual position of the associated valve. The pointer might indicate "closed" while the valve was open or vice versa. In some of these switches, the center, or "normal" position, was not labeled.

A special handle has been provided for the scram reset switch on panel 603, leading to the conclusion that this switch is difficult to operate. While operators reported no difficulty turning any other switches, their present lack of operating experience must be taken into account.

A plastic guard has been installed at the end of panel 800 to prevent inadvertent actuation of control panel switches by passersby. Switches with projecting handles near the edges of the benchboard apron sections, however, may still be prone to inadvertent actuation. Installation of additional protective devices may, therefore, be desirable.

Shape coding of switch handles can be a valuable operator aid, serving to distinguish between pumps and valves, valve types, etc. This can be particularly valuable where functionally distinct switches are placed in close proximity to each other. Consideration should be given to employing such coding techniques at WNP-2.

Rectangular indicating lights, such as those used on the DEH console, may or may not incorporate a switching function. It is recommended that those which do be distinguished from those which do not, through some form of identification technique.

It is desirable that the operator be able to immediately locate certain potentially important switches, such as turbine trip, system isolation, and manual initiation pushbuttons. At WNP-2, most of these "emergency" switches have been distinctively marked with red pushbuttons and escutcheons. Several exceptions were noted, however, including the RFW turbine emergency trip switches on panel 840 which are visually identical to the immediately adjacent governor controls. The similar appearances of these controls introduces a potential for unintentional turbine trips.

13.2 FAVORABLE ASPECTS OF SWITCH DESIGN

13.2.1 Switch handles are generally durable and of adequate size. (B5.6)

13.2.2 Switching action is responsive and precise in all types of switches. (B5.7)

13.2.3 Associated displays are not obscured by the hand when switches are operated. (B5.8)

13.2.4 Adequate hand space is provided between most switches. (B5.9)

13.2.5 Most emergency switches are protected against inadvertent actuation but remain easily accessible. (B6.2, B6.3)

13.2.6 The use of emergency switches is addressed in plant operating procedures. (B6.4)

13.2.7 Keys for keylock switches are conveniently stored in the shift supervisor's office, labeled for specific use. (B7.2, B7.3)

13.2.8 Key use is controlled by administrative procedure 1.3.23 and by specific system operating procedures. (B7.4, B7.5)

13.3 DEVIATIONS FROM CHECKLIST CRITERIA PERTAINING TO SWITCHES

13.3.1 The sequence of positions of the following switches do not conform to population stereotypes: (B5.1)

13.3.1.a Power supply switch RPS-1P-1, panel 100 (right for off, left for on)

13.3.1.b IRM bypass switches, panel 603

13.3.1.c Switches for the following valves on panel 813 (left to open, right to close):
CEP-V-1A, 1B, 2A, 2B, 3A, 4A, and 4B
CSP-V-1 and 3
RCC-V-71A, 71B, 71C, 72A, and 72B

13.3.1.d Switches for many valves on panel 832 (open pushbutton on top, close pushbutton on bottom)

Response: Item 13.3.1.a and c will be corrected prior to fuel load. Item 13.3.1.b controls are unique and have distinctive joy-stick style handles. Normal conventions are difficult to apply due to switch design. Discussions with the operators have indicated no convention orientation concerns. No action required.

Item 13.3.1.d uses rectangular style control switches with internal backlighted position indication. This is a nonsafety Feedwater Heater Vent and Drain panel, which requires only minor surveillance after startup. The existing sequence has no precedent with the control room as this switch style is not used elsewhere. Therefore, the arrangement is not inconsistent within the WNP-2 design. No action required.

13.3.2 Inconsistent use is made of escutcheons on pushbutton switches. (B5.2)

Response: A review was completed of all switch escutcheons with the following results:

- Forty-eight escutcheons will be changed prior to fuel load to provide accurate and consistent information to the operator.
- Eight new escutcheons will be installed prior to fuel load where none existed before.

No further action required.

13.3.3 The following switches appear to be supplied with incorrect escutcheons: (B5.2)

Recirculation fans 51A and 51B controls, panel 826

Unit overall trip, panel 800

Response: Correct escutcheons will be installed prior to fuel load.

13.3.4 The center positions of many switches on panels 813 and 824 are not marked. (B5.2)

Response: These are rectangular style switches with internal position indicating lamps. P824, Cooling Tower Fan Control panel, is a nonsafety panel. Operators have operated these controls for some time and no operability concerns have been expressed. Valve position is clear by use of the internal indicating lights. No action required for P824.

Controls for P813 are rectangular in style and will be replaced prior to fuel load with a style consistently in use throughout the control room. See item 13.3.1.c for a listing of these controls.

13.3.5 Switch positions are marked with only temporary labels on the RCIC barometric condenser pump controls on panel 601 and the plant service water pump controls on panel 840. (B5.2)

Response: New escutcheons will be installed prior to fuel load.

13.3.6 The lowest switches on panels 001, 100, 821, 831, and 832 were judged to be somewhat difficult to reach. (B5.3)

Response: See item 3.3.2 for response. No further action required.

13.3.7 Switches with projecting handles near the edges of the benchboard apron sections may be prone to inadvertent actuation. (B5.4)

Response: A switch panel edge review was completed. Only three areas of concern resulted from potential inadvertent operation:

13.3.7.a: Two MSIV valve controls on P601 would cause a reduction in plant output if a valve were closed.

13.3.7.b: Two recirculation pump breaker controls on P602 would cause a reduction in plant output if a breaker were opened.

13.3.7.c: One main condenser vacuum valve control on P820 would cause a reactor scram if the valve were opened.

Resolution of items 13.3.7.a and b will be deferred until the Final Report. The J-style switch handle on item 13.3.7.c will be replaced prior to fuel load with a more oval style and color coded for distinction. Changeout of the switch for item 13.3.7.c could not be performed due to the large number of wire contacts on the switch. The recommended change is considered adequate. No further action required.

13.3.8 The following switches are reportedly difficult to operate: (B5.5)

RPS reset switch, panel 603

Absorber train bypass valve control, panel 672

Response: An extension handle was installed on the RPS reset switch to improve leverage and grip. Changeout of the switch was not considered practical due to the special internal electrical separation design of the switch. No replacement is available. The absorber train bypass valve is a J-style handle keylocked switch. Its frequency of use is minimal and normally only during an outage. The valve has automatic interlocks to close the valve if required. The switch is considered acceptable as is. No further action required.

13.3.9 The handle at the bottom left transfer switch on panel 001 is broken. (B5.6)

Response: The handle has been replaced.

13.3.10 The feedwater injection valves on the vertical section of panel 602 are mounted very close to the junction with the apron section. The minimal clearance provided between the handles and the panel surface does not allow comfortable operation. (B5.9)

Response: The feedwater switches will be removed from P602 and relocated with the feedwater controls on P840 prior to fuel load. These will be included in the feedwater system mimic. No further action required.

13.3.11 Rectangular indicating lights, some of which are also push-button switches, are used on panel 820. No coding or identification method is provided to distinguish those which are switches from those which are simple indicating lights. (B5.10)

Response: A review of the vendor light status and control displays will be performed prior to fuel load. Resolution will be noted in the Final Report.

13.3.12 Switch handles are not shape coded to distinguish component types. (B5.10)

Response: Shape coding does exist for J-handle switches to a limited extent for special applications. Synchronization switches use star-style handles on P800, reset switches use oval handles, and remote shutdown panel power transfer switches use oversize J-handles for distinction from control switches. With the addition of demarcation lines, hierarchy labeling, and limited use of switch color coding, the need for shape coding has not be identified. No action required.

13.3.13 The engraved indicating line on the arming collars of the pushbutton switches used on panels 601 and 603 cannot be seen from a normal viewing position. (B5.11)

Response: These will be corrected prior to fuel load. The locking collars and red pushbuttons rotate together. White directional arrows will be placed on the pushbuttons to indicate locking collar position.

13.3.14 The handles of the following switches obscure the respective pointers or labels when viewed from a normal operating position: (B5.11)

13.3.14.a Feedwater element and level sensor selector switches, panel 603.

13.3.14.b Oval-handled switches on panels 603 and 820.

13.3.14.c Main generator exciter field ground test switch, panel 800.

13.3.14.d Main generator ground test, field breaker, and voltage regulator switches, panel 800.

Response: Items 13.3.14.a and b are oval-handled reset switches, single action, with spring return to normal. Reset lights to determine trip and reset condition are located above each switch. Switch handles are consistent and unique in shape to indicate that the switch is a reset control. No action required.

Items 13.3.14.c and d controls will be reviewed after operating experience is obtained. Resolution of these items will be noted in the Final Report.

13.3.15 Pointers for the transfer switches on panels 001 and 100 are simply engraved in the handle and are not pigmented. This design is not considered as effective as a separate pointer at the base at the handle. (B5.11)

Response: Transfer switches are to be painted white prior to fuel load to differentiate them from control switches. The engraved arrows will be blacked to provide contrast and visual direction prior to fuel load. No further action required.

13.3.16 The pointers at many valve control switches on panel 813 indicate "closed" when the valve is actually open. Examples include: (B5.11)

CEP-V-1A, 1B, 2A, 2B, 3A, 3B, 4A, and 4B

14.0 ANNUNCIATORS

14.1 GENERAL DISCUSSION

The evaluation of the annunciator system included analyses of window arrangements, legend content, annunciator maintenance, audible and visual alarms, and the usefulness of the annunciators provided. The review of annunciator location and legends was accomplished by reference to annunciator modification prints provided by the WNP-2 plant staff. Other aspects of this review were evaluated based on as-installed equipment.

14.1.1 Annunciator Organization

Annunciator matrices are generally arranged by system above the associated controls and displays. Within this convention, however, inconsistencies are apparent, although much fewer were noted in the drawings for the modified annunciator panels. Several individual annunciators are separated from related alarms, and some windows are not located directly above the related controls and displays.

Many types of alarms may be found within the annunciator panels, including trips, warnings, diagnostics, and informational displays. "Out-of-Service" alarms are found in the bottom row, and system initiation (or other major alarms, such as scram) are located in the top row of each box. No other organization by alarm type is apparent. Trips, warnings, and informational displays are interspersed among each other throughout the control room. One alternative for enhancing the annunciator system might be to reposition the alarm windows into hierarchical arrangements; i.e., place the most significant trips and warnings together at the top of the panel, and informational and advisory displays segregated in the lower rows.

The positional relationships of comparable alarms in repetitive subsystems should be maintained. This was observed in placement of recirculation system and reactor protection system alarms but not for other systems such as RHR.

The WNP-2 annunciator windows are identified by a numerical reference system for both the x and y axes. Alpha-numeric window codes are recommended, particularly when all annunciator panels do not contain the same number of rows and columns. Identification of windows would be further enhanced by placement of index codes on the annunciator panels.

14.1.2 Annunciator Legend Content

No inconsistencies were found in the use of abbreviations, indicating that considerable effort has already been expended in this area.

Annunciator window font was observed to be quite varied throughout the control room. Presumably this will be corrected when the new windows are procured. Modification drawings correct many checklist deficiencies regarding annunciator legend and syntax. Annunciator legends were found to be well worded, with a few exceptions as noted later. Some legends rely on numerical component designations rather than the preferred functional descriptions.

Several alarms are associated with parameters having multiple trip and alarm levels. These include, among others, reactor water level and reactor and containment pressure. The wording of these legends must, therefore, clearly specify which level is involved, either by inclusion of the numerical setpoint or by precise nomenclature.

Many annunciators are associated with more than one abnormal condition, such as the "high/low" and "trouble" alarms. While acceptable in some applications, this type of alarm should not be used if the operator must be immediately aware of the exact state of the system.

Annunciator syntax is not always consistent. The normal syntax employed at WNP-2 is to state the parameter first and the condition second, as in "HPCS CST SUCTION VALVES CLOSED" or "STEAM TO RCIC PRESSURE LOW." Many examples of the reverse were found as in "RCIC PUMP SUCTION HIGH PRESSURE."

14.1.3 Visual Alarms

Annunciator windows at WNP-2 were considered difficult to read, especially those with split windows (two alarms per window). The number of words on the windows and the lettering font both contribute to this effect. The alarms on the fire control panel are particularly difficult to read due to the lettering size and their low height on the panel.

Amber windows were often difficult to distinguish from white windows. This reduces the effectiveness of the color prioritization system.

CSP-V-1, 2,3,4, and 8

Response: These switches were noted during earlier reviews. Correction is pending new switch procurement. These switches will be replaced prior to fuel load.

13.3.17 The RFW turbine emergency trip switches on panel 840 are not distinctively marked and are visually identical to the immediately adjacent governor controls. (B6.1 and B6.2)

Response: The J-handles of the RFW turbine trip switches were color coded red to provide distinction and indicate importance. No further action required.

13.3.18 Most manual trip and initiation buttons are red with red escutcheons. The following exceptions were noted: (B6.1)

RCIC turbine trip, panel 601 (silver button)

RCIC steam isolation, panel 601 (black button)

Generator trips, panel 800 (black escutcheons)

Diesel trips, panel 800 (black escutcheons)

Response: See item 6.3.5 for response. No further action required.

13.3.19 Keylock controls are used for the reactor mode switch and the scram discharge volume high level bypass switch on panel 603. Prompt activation of these controls may be required during plant operation, suggesting that keylocks may not be the most convenient protective measure in these applications. (B7.1)

Response: Resolution will be noted in the Final Report.

13.3.20 The mode switch on panel 603 is difficult to turn. (B7.6)

Response: The mode switch is not used for precise control, and frequency of use is minimal. Operators are aware of the extra tension needed to operate the switch, as this switch is common to most plants. The internal design of the switch and its unique application makes replacement impossible without extensive redesign. Replacement is not considered cost effective. No action required.

14.1.4 Audible Alarms

The annunciator system should provide some indication of the location of the panel containing the alarm. This may be accomplished through the use of distinctive tones or by simply locating individual horns in close proximity to the related panels. At WNP-2, three horns are provided. One, for panels 601, 602, and 603, is located behind panel 603 on the right side. One, for vertical panel 672, is located inside the panel. The other, for panels 800, 820, and 840 and all the back panels, is located behind BOP panel 820. This arrangement does not provide adequate audible distinction for any control room alarms. The use of different horns should be considered to more precisely define alarm locations.

14.1.5 Alarm Response System

The annunciator response system considered optimum in terms of convenience, versatility, and useability incorporates four separate buttons for each panel-silence, acknowledge, reset, and test. A window should flash for an alarm condition, remain steadily lit when the alarm is acknowledged, reflash for a second alarm input (for multi-input alarms), and automatically blink at a slower rate when the alarm clears. The WNP-2 annunciator system utilizes a three-button response format, with the acknowledge button also doubling as a silence button. Reflash capability is not installed.

The placement of the response buttons varies from panel to panel, and the arrangement of the buttons on panel 601 is different from the rest. The response buttons should be identically arranged and located on each panel.

14.2 FAVORABLE ASPECTS OF ANNUNCIATOR SYSTEM DESIGN

14.2.1 Annunciators are generally grouped by system within each annunciator box. (C1.1)

14.2.2 Some groups of annunciators which are repeated (such as Recirc A and B, or A and B scram signals) are generally identically arranged. (C1.1)

14.2.3 Annunciators are generally located above related controls. (C1.2)

14.2.4 Abbreviations used are consistent throughout the control room. (C2.1)

14.2.5 Nomenclature is consistent throughout the control room. (C2.1)

14.2.6 The new annunciator windows will be succintly worded. (C2.5)

14.2.7 A color standard for prioritization of alarm responses has been issued. (C2.8)

14.2.8 Alarms are tested once per shift, in accordance with plant procedure 1.3.1. (C.4, C8.3)

14.2.9 Audible alarms are loud enough to be heard but not excessively so. (C.4)

14.2.10 Annunciator window tiles do not have to be removed to replace bulbs. (C8.1)

14.3 DEVIATIONS FROM CHECKLIST CRITERIA PERTAINING TO ANNUNCIATOR SYSTEM DESIGN

14.3.1 The following aspects of annunciator window grouping could be improved: (C1.1)

Panel 601

The division between the leak detection and RHR B/C alarms on box A2 could be more logically defined.

The leak detection Division II alarms are divided between boxes A2 and A12.

"RHR PUMP B ROOM WATER LEVEL HIGH" panel 601-A2 window 2-8 should be moved to a position adjacent to the other RHR B/C alarms.

RCIC alarms "RCIC TO RHR B STEAM TRAP HIGH LEVEL" and "RCIC TO RHR AB STEAM TRAP HIGH LEVEL," panel 601-A2 windows 5-3 and 6-3 should be moved with the other RCIC alarms. RCIC alarm 602-A4 window 4-1 is also out of place.

Response: Leak detection and RHR B/C alarms have been grouped by system to the extent panel configuration and space allowed. Further rearrangement would not enhance group recognition sufficiently to be cost effective. No action required.

System alarms, such as RHR, ADS, and LPCS, are of primary importance, and emphasis was placed on their location adjacent to related system controls. Leak detection alarms were considered secondary in importance and were grouped to the extent available space allowed. No action required.

Resolution as to the location for window A2-2.8 will be noted in the Final Report.

RCIC to RHR steam trap alarms were located on A2 and A4 per Operations request. These alarms could be grouped with either system, but operators relate them to the steam condensing mode of RHR. No action required.

14.3.2 The RHR alarms for system A are not located in a similar arrangement to those for system B. (C1.1)

Response: RHR system A and systems B and C are powered by electrical Divisions 1 and 2, respectively. RHR systems B and C share some common trips and unique alarms, while RHR A system shares some common trips and alarms with the LPCS system. Differences between the systems make similar arrangements impossible. No action required.

14.3.3 Alarm windows are not grouped by type; i.e., warning and diagnostic alarms are intermixed with informational and advisory alarms. (C1.3)

Response: Alarms were grouped to provide good system grouping and positioning over related controls. Additional grouping by type of alarm was not considered cost effective or a significant addition to prioritization by color code. Wire codes are keyed to alarm location. Changes in location require cable coding changes to engineering drawings, such as elementary drawings, termination drawings, wiring diagrams, cable coding documents, etc. Where design changes allow, similar arrangements and location by type have been considered. But changes to specifically create similarity or type grouping was not considered cost effective. No further action required.

14.3.4 Annunciator legend syntax is not always consistent. Some windows list the parameter first and the condition second. Numerous examples of this can be found on most annunciator panels. (C2.1)

Response: New alarm windows will be installed prior to fuel load and will provide for consistent syntax.

14.3.5 Several type styles (font) were found throughout the control room. The new windows will presumably all be the same type style. (C2.2)

Response: New alarm windows will be installed prior to fuel load and will be engraved to one specification.

14.3.6 The annunciator windows installed at the time of the survey are difficult to read even when standing directly in front of the panel. The use of split windows (two annunciators per window) further compounds this problem. (C2.3)

Response: Vertical panels alarm windows are split windows presently using 0.125-inch character heights with a maximum of six lines of description. New specifications call for a 0.187-inch character height using a maximum of four lines of description. P601, P602, and P603 benchboards windows are single windows using 0.187-inch character heights. These are being increased to a 0.25-inch character height. Potential for increasing the 0.187-inch character height for the split windows on P800, P820, and P840 benchboards is presently under review. New windows will be installed prior to fuel load. Along with improved wording and items 14.3.4 and 14.3.5, above, no further action is required.

14.3.7 The annunciator windows on the fire control panels (although not evaluated as part of this survey) are extremely difficult to read due to the small letter size and the low height of some of the windows. (C2.3)

Response: Resolution will be provided in the Final Report.

14.3.8 The wording of the following alarms do not clearly define the intent of the alarm: (C2.5)

14.3.8.a "SRM PERIOD" panel 603-A7 window 5-6 should be "high" or "fast" period.

14.3.8.b "REACTOR VESSEL WATER LEVEL HIGH" panel 601-A1 window 2-6 is a HPCS trip.

14.3.8.c "ABNORMAL" used in several annunciator legends (601-A3 window 5-3; 820-B1 windows 3-5 and 3-6) does not specify whether the related parameter is "high" or "low."

14.3.8.d "TURB GEN MONITORING" panel 820-B1 is not clear.

14.3.8.e "HPCS SUPPRESSION POOL HIGH LEVEL" panel 601-A1 window 6-6 signifies a suction transfer.

14.3.8.f "REACTOR SCRAM A1 AND B1 LOGIC" panel 603-A7 window 1-2 could be better worded.

14.3.8.g "REACTOR SCRAM A2 AND B2 LOGIC" panel 603-A8 window 1-2 is not clear.

14.3.8.h "NEUTRON MONITORING SYSTEM TRIP" window 3-3 on panels 603-A7 and 603-A8 is not descriptive relative to the system tripped.

14.3.8.i "TURB GEN RELATCH ABNORMAL" panel 820-B1 window 3-5 is not clear.

14.3.8.j "TURB GEN VAC TRIP LATCH ABNORMAL" panel 820-B1 window 3-6 is not clear.

14.3.8.k "OSCILLOGRAPH OPERATION" panel 800-C4 window 4-3 is not clear.

14.3.8.l All of the NSSSS alarms on panel 601 boxes A11 and A12 are deficient in that they do not identify the action that automatically results from the alarm.

Response: New alarm windows to be installed prior to fuel load will resolve all items except those noted below. Items 14.3.8.f, g, and h have been reviewed by plant operations, and the existing wording is requested. No further action required.

14.3.9 Numerical, rather than descriptive, component descriptions are relied upon in many windows. (C2.5)

Response: Numerical component descriptions will be used only on readily recognizable components to the operators. This provides in some cases a cleaner and concise description. Application is limited to where needed and where improved clarity results. New alarm windows to be installed prior to fuel load will correct any overuse of numerical component descriptions.

14.3.10 Some parameters, such as reactor vessel water level, have several different trip levels. In such cases, the annunciator legend should clearly define the intent of the alarm through inclusion of the set point or a description of the applicable action level. The following examples were noted: (C2.6)

Panel 601-A1 windows 1-7, 2-6

Panel 601-A2 window 1-5

Panel 601-A3 window 6-2

Panel 601-A4 window 5-6

Panel 601-A11 windows 5-1, 4-2, 3-3

Panel 601-A12 window 1-2

Response: New alarm windows to be installed prior to fuel load will clarify the concerns with improved wording and some set points included.

14.3.11 Many annunciators may possess multiple inputs. (C2.7)

Response: A "Multiple Alarm Input Standard" was prepared, and all alarms were reviewed against the following criteria: priority of alarm, diverse operator, or system action requirements and available control room backup information. Nine alarms failed to meet the criteria, and diverse alarms are being installed prior to fuel load. No further action required.

14.3.12 No alpha-numeric location code is provided on the annunciator panels for identification of alarm windows. (C2.9)

Response: Numeric x-y axes are used to agree with the cable coding scheme and engineering wire standards specific to WNP-2. See item 14.3.3, above, for details. A numeric-numeric system coding will be applied to the panels prior to fuel load. The left vertical side of the panel will be marked with the row numbers (x-axis) from top to bottom (1, 2, 3, etc.). The top horizontal edge of the panel will be marked with the column numbers (y-axis) from left to right (-1, -2, -3, etc.). A dash will be used as an operator aid for identifying the x-y sequence (1-3). Character size and material selection are presently under review. No further action required.

14.3.13 Lit annunciator windows are distinguishable from extinguished ones, but the as-installed amber windows are virtually indistinguishable from white windows. (C3.1)

Response: Amber and white windows do not have adequate contrast when lit. Color lamp boots and several types of colored film are being tried. Resolution will be noted in the Final Report.

14.3.14 The divided alarm windows (previously mentioned as being difficult to read) are also too small to command attention in such a large control room. (C3.2)

Response: See item 14.3.6 for response. No further action required.

14.3.15 The following aspects of the annunciator audible alarm system are not in compliance with checklist criteria: (C.4; see also section 18.3)

- The location of alarms can only be determined to be either NSSS or BOP.
- Audible alarms are not prioritized.

Response: See items 14.5.2 and 14.5.3, WNP-2 Task Force Annunciator System Review, for response.

14.3.16 No silence button is provided. (C5.1)

Response: See item 14.5.5, WNP-2 Task Force Annunciator System Review, for response.

14.3.17 Response buttons are placed in horizontal arrays on all panels except 601, where they are arranged vertically. Using the left-to-right, top-to-bottom convention, the vertically arranged buttons on panel 601 are reversed in order from the rest of the annunciator response buttons.

The response button arrays are not consistently placed in the same location on each panel. (C5.5)

Response: See item 14.5.5, WNP-2 Task Force Annunciator System Review, for response.

14.3.18 No "first-out" feature is provided. (C5.6)

Response: See item 14.5.2, WNP-2 Task Force Annunciator System Review, for response.

14.3.19 No "reflash" feature is provided for annunciation of a second input from a multiple input alarm. (C6.3)

Response: See item 14.3.11 for response.

14.3.20 An administrative procedure for prompt recognition of an out-of-service annunciator has not yet been finalized. (C8.2)

Response: An administrative procedure will be approved prior to fuel load.

14.4 WNP-2 TASK FORCE REVIEW - INDIVIDUAL ALARM WINDOWS

The purpose of this review was to evaluate individual annunciator windows for grouping, color prioritization, window wording, general or multiple actuation input concerns, and the need for adding or deleting annunciators. The review covered all the annunciators in the Control Room and the Remote Shutdown Panels. In addition, the proposed RG-1.47 and RG-1.97 changes were factored in.

14.4.1 Annunciator Grouping

Annunciator windows were reviewed within each annunciator panel for grouping by major system or function and for location relative to respective controls, displays, and operator response requirements.

14.4.2 Annunciator Window Color Prioritization

A "WNP-2 Control Room Annunciator Window Color Standard" was prepared and approved by the Task Force in November 1981. The original design had only NSSS benchboards P601, P602, and P603 prioritized by color. The Task Force approach was to prepare a uniform WNP-2 standard and apply it to all annunciator panels under the scope of this review.

14.4.3 Annunciator Window Wording

Each annunciator was traced to its originating source to verify its function and determine the informational requirements for the operator. Besides wording and clarification changes, windows were reviewed against the "WNP-2 Standard List of Acronyms and Abbreviations for Control Room Labels and Legend Plates." The standard was prepared and approved by the Task Force in October 1981.

14.4.4 General/Multiple Input Annunciators

A "WNP-2 Annunciator System Multiple Input Alarm Standard" was prepared and approved by the Task Force in November 1981. The WNP-2 annunciator system does not have relfash circuitry installed. The standard provides guidance for determining the acceptability of annunciator alarms with multiple inputs and acceptable methods of corrective actions to resolve multiple input concerns.

14.4.5 Addition and/or Deletion of Annunciators

This area of review covers RG-1.97 and RG-1.47 integration with its resulting additions and/or deletions of alarms; relocation of windows between control room benchboards and vertical panels, or to remote local panels outside the control room; identifying outstanding design changes; and other additions, deletions, or circuit modifications noted by the Task Force.

There are over 1500 annunciator alarms in the WNP-2 Control Room, with about 1200 in the primary operating area. These are located on 47 annunciator panels.

The Task Force has completed its review of all annunciator windows. Table 14.1 has a summary of the findings. All changes will be completed prior to fuel load.

Table 14.1

INDIVIDUAL ALARM WINDOW REVIEWS

SUMMARY OF CHANGES

	Main Benchboards	Vertical Panels
Grouping Changes:		
Relocation Between Panels	40	2
Relocation Within Panels	134	14
Color Code Changes:	89	74
General/Multiple Input Alarm Changes:	7	2
Deletion of Alarms:	6	18
Addition of Alarms:	4	0
Window Wording and Engraving Improvements: (about 1500 windows total)	All	All

14.5 WNP-2 TASK FORCE REVIEW - ANNUNCIATOR SYSTEM DESIGN

14.5.1 General Discussion

The purpose of this review was to evaluate the design of the WNP-2 Annunciator System against NUREG-0700. Only those items of a system design nature are included. This review covered both the Control Room and Remote Shutdown Panels.

14.5.2 General System Characteristics

14.5.2.1 Alarm Parameter Selection

14.5.2.1.a Set points or limits for initiating the annunciator warning system should not occur so frequently as to be considered a nuisance and should be established to give the operator adequate time to respond.

Response: Present design to be reviewed during startup testing and verified during subsequent plant operation. No further action required.

14.5.2.1.b General and multichannel or shared alarms.

Response: An approved "Annunciator System Multiple Input/General Alarm Standard" was prepared for WNP-2 and review results are noted in items 14.3.11 and 14.4.

14.5.2.2 First-out annunciators should be provided for identifying the initiating event associated with automatic plant shutdowns. Separate first-out panels should be provided for the reactor systems and the turbine-generator systems. The panels should be placed directly above the main control stations for the respective systems and should consist of separate annunciator windows for each of the automatic trip functions. No first-out panels exist.

Response: The sequence of events printer provides a printout of annunciator alarms for reactor systems, identifying both the initiating event and the sequence of events associated with plant shutdowns. Buffer capacity computer speed and printout speed are such that operator information will not be lost,

and the response time is adequate for immediate operator access for first-out identification in the primary operating area. To ensure visibility of the initiating event, the printer provides a distinctive coding to sequence of event alarms versus other alarm printouts, assigns the program priority printout status, and prints the sequence in order of initiating input.

A review for first-out annunciator versus the existing sequence-of-events listing indicated that only turbine generator first-out points were not included. The following sequence-of-events points were added:

Computer Point	Annunciator	Trip
C0332	B1-1.7	Overspeed trip
C0336	B1-1.5	Auto-stop trip
C0338	B1-1.6	Low vacuum trip
C0340	B2-1.1	Trust bearing wear trip
C0345	B2-1.2	Low bearing oil press. trip

Also, the Graphic Display System CRT displays have a first-out alarm identification incorporated. Thus, the operator can check the CRT display or the sequence of events printout for the originating event alarm. No further action required.

14.5.2.3 Auditory signal coding of alarm priority is also "appropriate" along with color, shape, or symbolic coding.

Response: Present color prioritization and the auditory changes noted in item 14.5.3.2 provide adequate coding throughout the primary operating area on main benchboards. Audible prioritization would not add to directivity or operator response significantly to warrant modification. No action required.

14.5.2.4 Cleared Alarms

14.5.2.4.a Cleared alarm auditory signals should have a dedicated, distinctive, audible signal which should be of finite duration.

Response: No duration control exists. To provide duration control for the "Clear" tone, the audio response circuits in each annunciator control card would need to be modified. This would be a major change and possibly schedule impacting. An alternative is to modify the Reset controls to allow the operator to silence the "Clear" tone from any set of response controls in the primary operating area. Resetting the flashing "Clear" light would only be allowed at the specific panel. Thus, the reset "Clear" circuit would be identical to the acknowledge "Alert" circuit noted in item 14.5.3, below. This would provide the operators the added advantage of consistency of control function and control over the audible "Clear" tone. Implementation will be after fuel load, and upon resolution of item 14.5.5.1.a, an Implementation Schedule will be noted in the Final Report.

14.5.2.4.b The visual signal should have a special flash rate equal to either twice or one-half the alert flash rate to allow discrimination.

Response: Design in compliance. Uses one-half the alert flash rate, one flash per second, with about equal times on and off. No action required.

14.5.3 Auditory Alarm Subsystem

14.5.3.1 Signal detection and intensity reviews cannot be reviewed until sound measurements are performed later. These will be reported in the Final Report.

14.5.3.2 Signal identification should be such that the operator is able to identify the operator work station or the system where the auditory alert signal originates. Separate auditory signals at each work station within the primary operating area are recommended.

- Signal identification for the P601/P602/P603 work area, computer system, and the fire panels meet design. However, the P800/P820/P840 work station area and the back vertical panels have one common auditory system. This design does not comply.

- Auditory horn for P601, P602, and P603 alarm grouping is located at the right side of P603. This may distract operators away from P601 alarms.

Response: The off-gas panel P672 has a separate

audible alarm system of its own. P851 and the back vertical panels will be wired into the P672 alarm system to provide another tone system. This places the main operating work area P800/P820/P840 onto one audible/visual system and places P851 and all the bank panels out of the primary area onto one independent system. A general trouble alarm for P672 will be incorporated onto P851. This will be installed prior to fuel load.

A separate audible alarm system for P601 panel alarms will be located in the middle of the panel to increase audible directivity between P601, P602, and P603. This will be installed prior to fuel load.

Thus, four audible alarm systems will be available to improve operator directivity (P601, P602/P603, P800/P820/P840, and back vertical panels). No further action required.

14.5.3.3 Localization coding should be used when the operator work station associated with the alarm is not in the primary area. The P800/P820/P840 work station area does not have separate auditory location coding but is in common with the back vertical panels.

Response: See item 14.5.3.2 for response. No further action required.

14.5.4 Visual Alarm Subsystem

14.5.4.1 Lamp replacement should not require the removal of legend windows or subject the operator to a shock hazard.

Response: Present design complies.

14.5.4.2 Flash rates should be from three to five flashes per second with approximately equal on-and-off times.

Response: The present "alert" flash rate is two cycles per second with about equal on-and-off times. Present design is close to the minimum guideline, and operator has no trouble discerning "alert" flashes from "clear" flashes. No action required.

14.5.4.3 In case of flasher failure, the alarm window should immediately light and burn steadily.

Response: Present design complies.

14.5.4.4 A "dark" annunciator panel concept should be used.

Response: The design intent is to provide a "dark" panel concept at WNP-2. It is expected, however, that some alarms will not comply and some circuit modifications may be necessary. The extent of conformance cannot be ascertained at this time. Verification of design will occur during subsequent plant operation and results noted in the Final Report.

14.5.4.5 Out-of-service alarm recognition cues should be designed into the system.

Response: Benchboard panels have "Loss of 125VDC" annunciators and automatic backup power from separate AC sources. The alarms identify overall system power loss for each audible/visual alarm system. Individual panel and window alarm power loss can be verified by use of the individual panel "test" control. Present benchboard panel design complies.

14.5.4.6 Blank or unused annunciator windows should not be illuminated (except during testing).

Response: Present design complies.

14.5.4.7 The operator should be able to read all the annunciator windows from the position at the work station where the acknowledge control is located.

Response: Panels P601, P840, P820, and P800 are not in compliance. Addition and relocation changes of response controls noted in item 14.5.5.2, below, and changes in character heights noted in item 14.3.6 will minimize this concern. Implementation of these changes will be based on resolution of item 14.5.5.1.a and noted in the Final Report.

14.5.5 Operator Response Subsystem

14.5.5.1 Control Functions

14.5.5.1.a Controls should include a separate silence pushbutton for the "alert" auditory system. Separate alert tone silence controls do not exist.

Response: Modifying the present control set design to add separate "silence" controls for the audible "alert" signals does not appear feasible on the main ECCS, RFW, and T-G panels where the feature may most be wanted.

Layout changes on these panels would be necessary to provide room, which would adversely affect system configuration control and layout. The addition of the silence control to other panels would cause inconsistency in design and layout and be of little added value without incorporation on the ECCS, T-G, and RFW panels.

To reduce the potential of inadvertent acknowledging of alarms while silencing the alert tone, the audio alarm system is being modified as noted in item 14.5.3. By splitting the audio tone groups into four areas (P601, P602/P603, P800/P820/P840, and back panels), the operator is less prone to be focusing outside the alarms audio group when silencing the alarm.

Resolution as to the adequacy of the existing response control arrangement, with the added directional tone grouping changes, will be noted in the Final Report after operational experience is obtained.

14.5.5.1.b It should be possible to silence an auditory alert signal from <u>any</u> set of controls in the primary operating area.

Present design does not comply. Only within the tone grouping for panels does this apply. Silencing between tone groupings does not exist within the primary operating area.

<u>Response</u>: The Acknowledge Controls will be modified after fuel load to enable the operator to silence any control room "alert" tone from any acknowledge control in the primary operating area. Acknowledging from any back vertical panel will only silence the back vertical panel audible alarm system and not a primary area alarm. The fire system and computer alarms are to remain separate and independent. Implementation schedule is based on the resolution of item 14.5.5.1.a, above, and will be noted in the Final Report.

14.5.5.1.c Lamp illumination acknowledge should only be possible at the work station where the alarm originated.

<u>Response</u>: Present design complies.

14.5.5.1.d Reset controls should "silence" the audible signal indicating clearance and should extinguish window illumination only at work station where the alarm initiated.

Response: Present design complies. However, see item 14.5.2.4 for proposed audio signal changes. No further action required.

14.5.5.1.e A "test" control should be provided to test the auditory signal and flashing illumination of all windows.

Response: Present design complies.

14.5.5.2 Control Set Design

14.5.5.2.a Control sets should have the same arrangement and relative location at different work stations. Deviations noted are:

P601 Arranged on vertical section of benchboard rather than horizontal area along panel edge. Located on right side of panel rather than center.

P820 Located on left side of panel rather than center.

P840 Located on right side of panel rather than center, very close to P820 controls. Operators have responded erroneously to the opposite panel controls due to their closeness.

Fire Panels Sequence of controls for panels 1 and 2 is "ACK/Test/Reset" instead of "ACK/Reset/Test" as used throughout the control room. Panel 3 only has "ACK" and "Test" controls, no "Reset" control exists.

P851 System status monitoring panels SD-1, 2, and 3 are being deleted due to RG-1.47 redesign. The new SRV acoustic monitoring system subpanels will replace SD-1 and SD-2. This leaves the Division I and Division II annunciator panels and associated controls in a configuration that places the Division I

	Controls closer to the Division II Panel than the Division II Controls and separated by the new acoustic monitoring system subpanels.
Back Vertical Panels	Control locations are generally below anthropometric limits and are not all consistent in location.

Response:

P601 No horizontal room is available on the front panel edge to provide for location and arrangement consistency without affecting panel configuration and control symmetry. Vertical orientation was selected as the only plausible alternative without significant relocation changes.

The existing set was relocated to be horizontal portion of the panel and arranged in a vertical alignment with the Acknowledge Control at the edge of the panel to allow quick and easy operator access. No further action required.

A redundant set will be provided due to the length of the panel to improve visibility of the annunciator windows from the Acknowledge Control. See attached control location drawings. A second test control is not required. One test pushbutton per panel is considered adequate. Implementation will be after fuel load and based on resolution of item 14.5.5.1.a, above. Implementation schedule will be noted in the Final Report.

P820 The response controls will be relocated to the center of the panel, along the panel edge for consistency. See attached layout drawing. Besides improving alarm visibility, controls for P820 and P840 were placed too close together confusing operators as to which set of response controls to initiate. The proposed relocation will improve both annunciator readability from the Acknowledge Control and avoid confusion with the P840 controls. Implementation will be after fuel load and based on resolution of item 14.5.5.1.a, above. Implementation schedule will be noted in the Final Report.

P840 A redundant set of response controls will be provided near the RFW systems to increase visibility of annunciator windows and to increase

operator access and response to RFW alarms from P603 without having to leave the P603 area. See attached layout drawings. A second test control is not required. One test pushbutton per panel is considered adequate. Implementation will be after fuel load and based on resolution of item 14.5.5.1.a, above. Implementation schedule will be noted in the Final Report.

Fire Panels The controls for panels 1 and 2 will be resequenced to an "ACK/Reset/Test" sequence prior to fuel load.

Addition of a reset control for panel 3 is not required. Alarms are supervisory only and not "fire" alarm trips. Panel 3 presently has an automatic reset circuit design. Operational experience does not presently warrant the major circuit changes necessary to incorporate a manual reset control over the present automatic system. No action required.

P851 Response controls have been rearranged per the attached drawing. This provided contrast and grouping recognition between Division I and Division II annunciator panels and response controls. No further action required.

Back Vertical Panels See item 3.3.2 for response.

14.5.5.2.b Control coding techniques for easy recognition of controls should be used. Recommended techniques are color, color shading, demarcation, and shape.

Controls are not distinguishable in shape.

Color coding is inconsistent.

- 24 controls have black bushbuttons with silver collars.
- 61 controls have silver pushbuttons with silver collars.
- One control has a silver pushbutton with a yellow collar.
- The fire control panels use "red" escutcheon plates for the "ACK" control rather than black, and the shutdown panel P100 has no escutcheon plates.

Response:

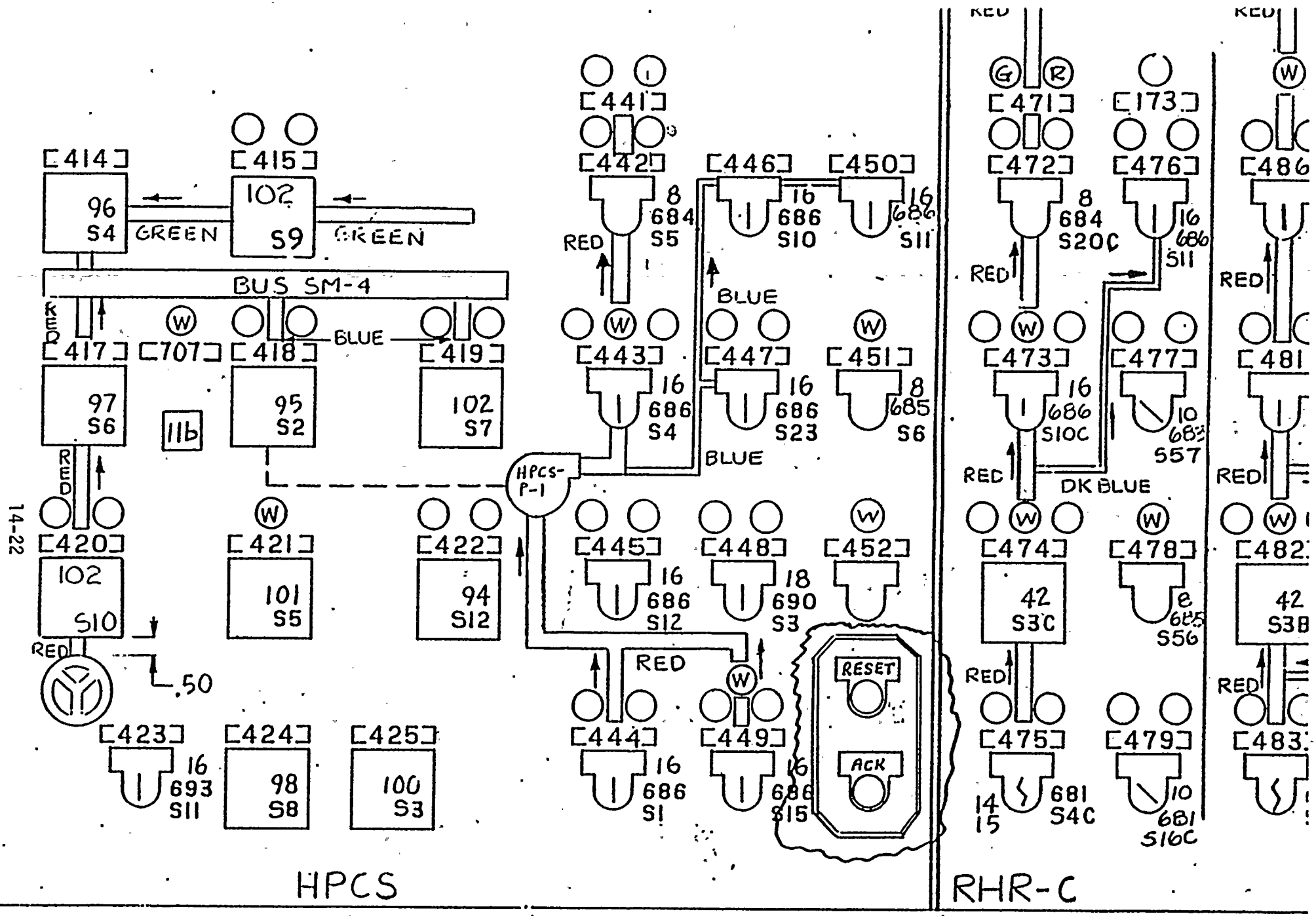
Shape: White mushroom heads will be installed prior to fuel load on Acknowledge Controls on the main benchboards. Placement of additional mushroom heads on vertical panels will be based on operational experience and noted in the Final Report.

Control Color: Silver pushbuttons will be used except for the Shutdown Panel P100, fire panels, and P851; these will use black. Locking ring and escutcheon colors will be consistent with other plant controls. Since the fire panels and P851 form one panel area (row) and all controls are consistently black and are about the only controls on these panels, no conflicts or confusion is expected. The same rational applies to panel P100. These corrections will be completed after fuel load and noted in the Final Report.

Color Padding: To provide contrast and improved visibility, color padding will be applied around the annunciator response controls prior to fuel load.

14.5.5.2.c Annunciator design should not allow the operator to defeat the controls.

Response: Use of mushroom heads as noted in item 14.5.5.2.b will prevent defeating the most important of the controls, the Acknowledge pushbuttons. No further action required.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GREEN
BUS SM-4
RED
[417] 97 S6
[707] W
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BLUE
[419] 102 S7
RED
[420] 102 S10
RED
.50
[421] 101 S5
[422] 94 S12
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[424] 98 S8
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[452]
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RED
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RED
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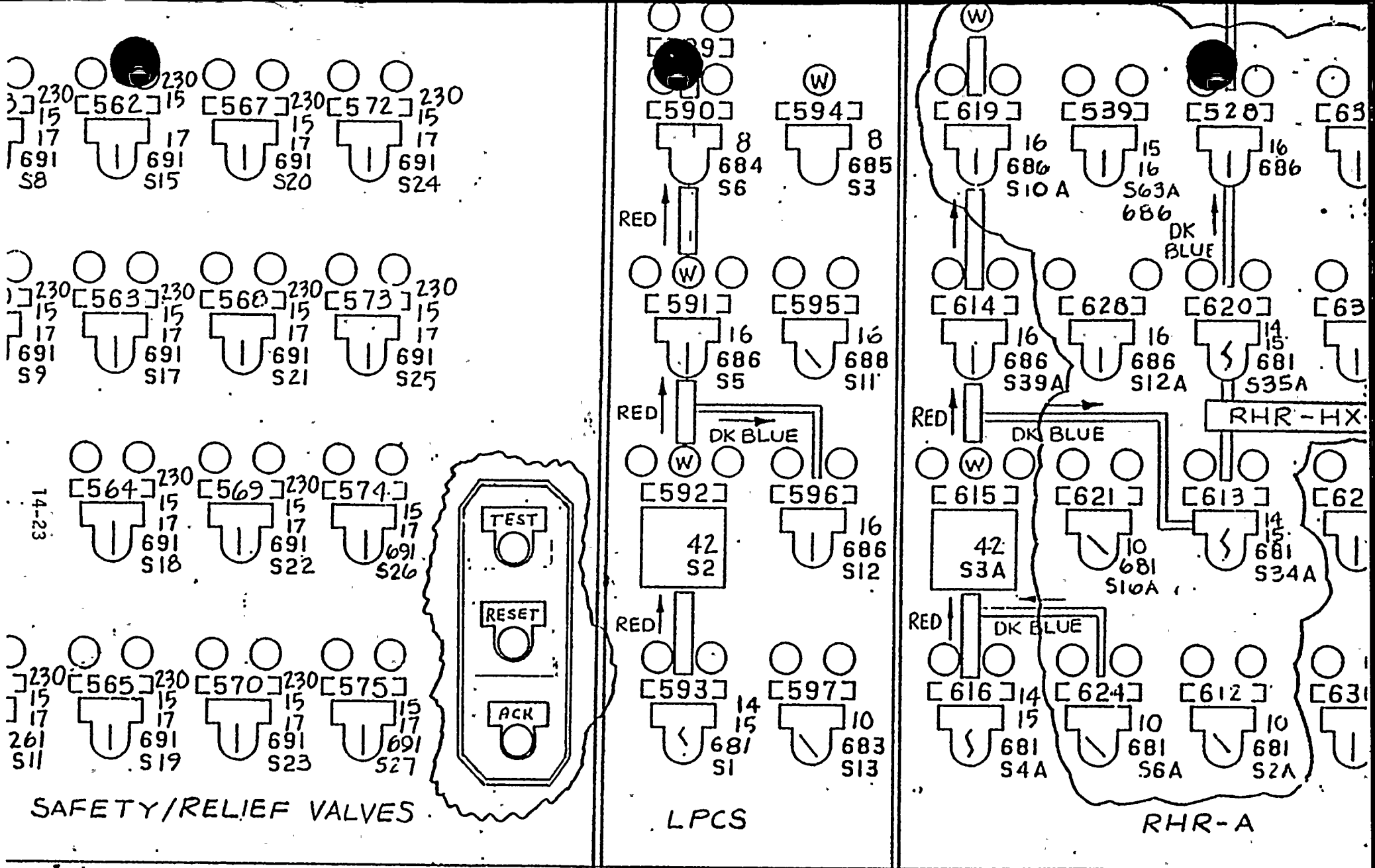
HPCS
RHR-C
PANEL P601


SAFETY/RELIEF VALVES
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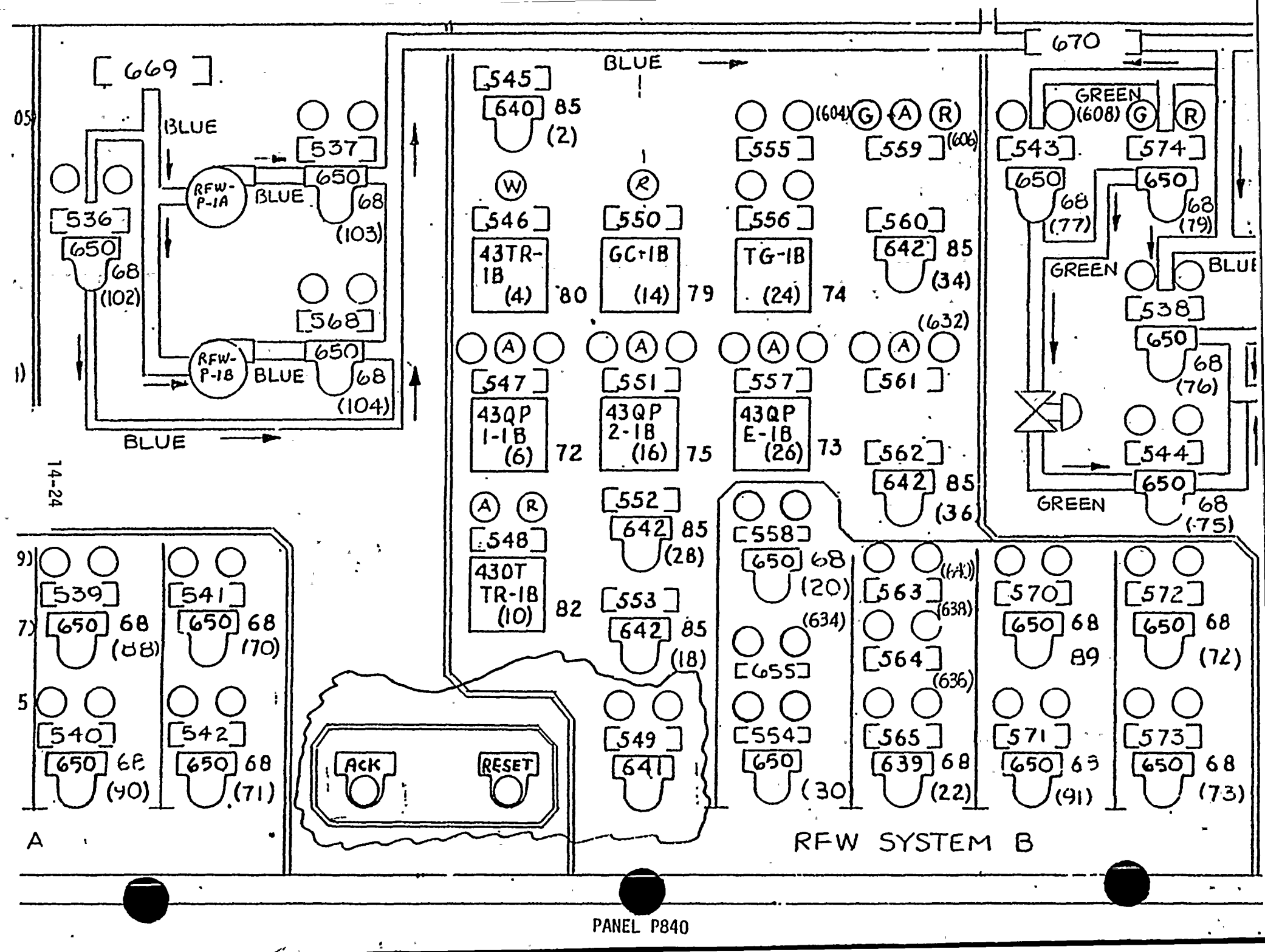
RESET
ACK
LPCS
RHR-A
RHR-HX
RED
DK BLUE
PANEL P601
14-23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TG-1B
(24)
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557
561
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(6)
72
43QP 2-1B
(16)
75
43QP E-1B
(26)
73
562
642
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(36)
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(28)
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68
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(10)
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554
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ACK
RESET
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(22)
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GREEN
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G
R
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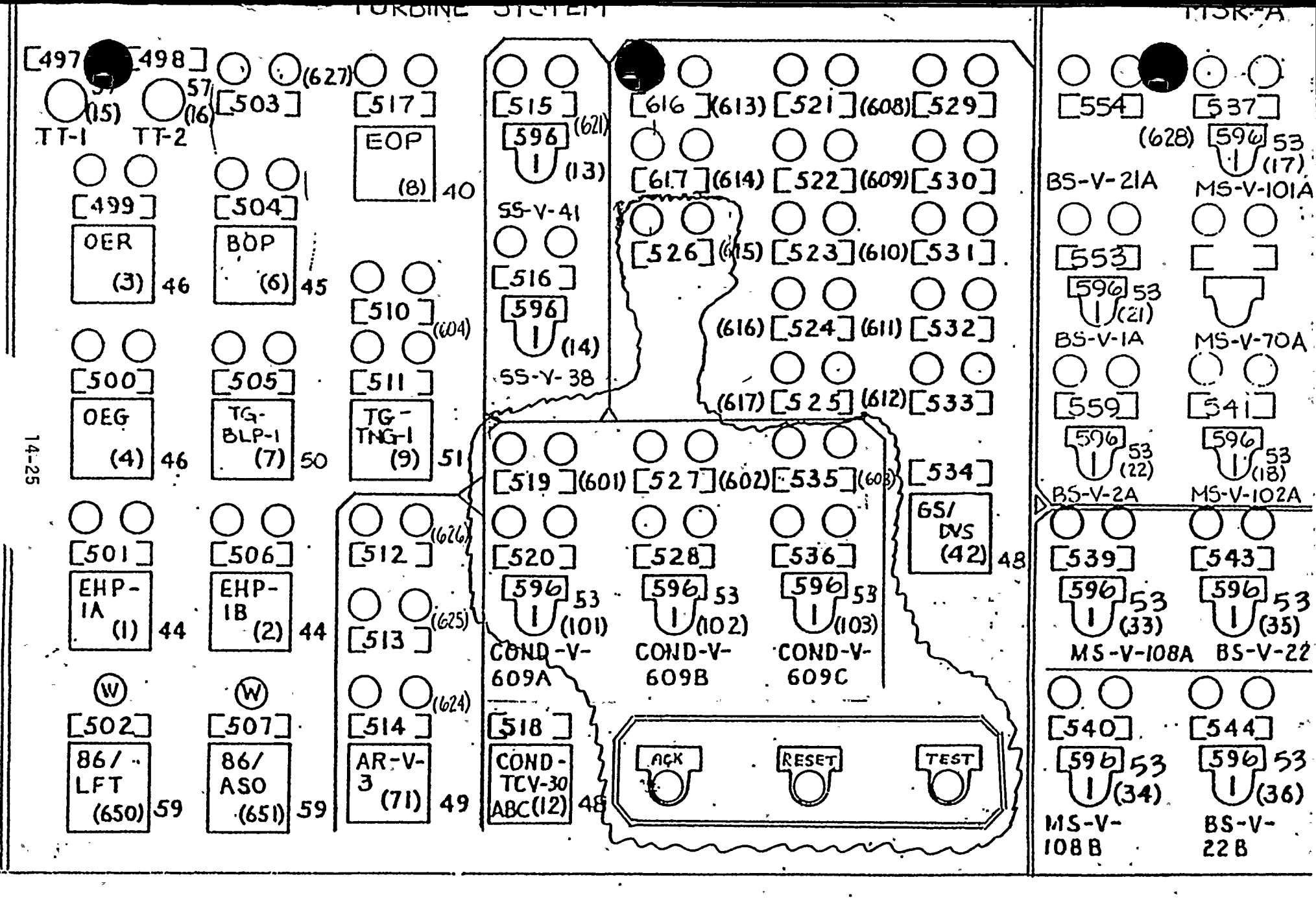
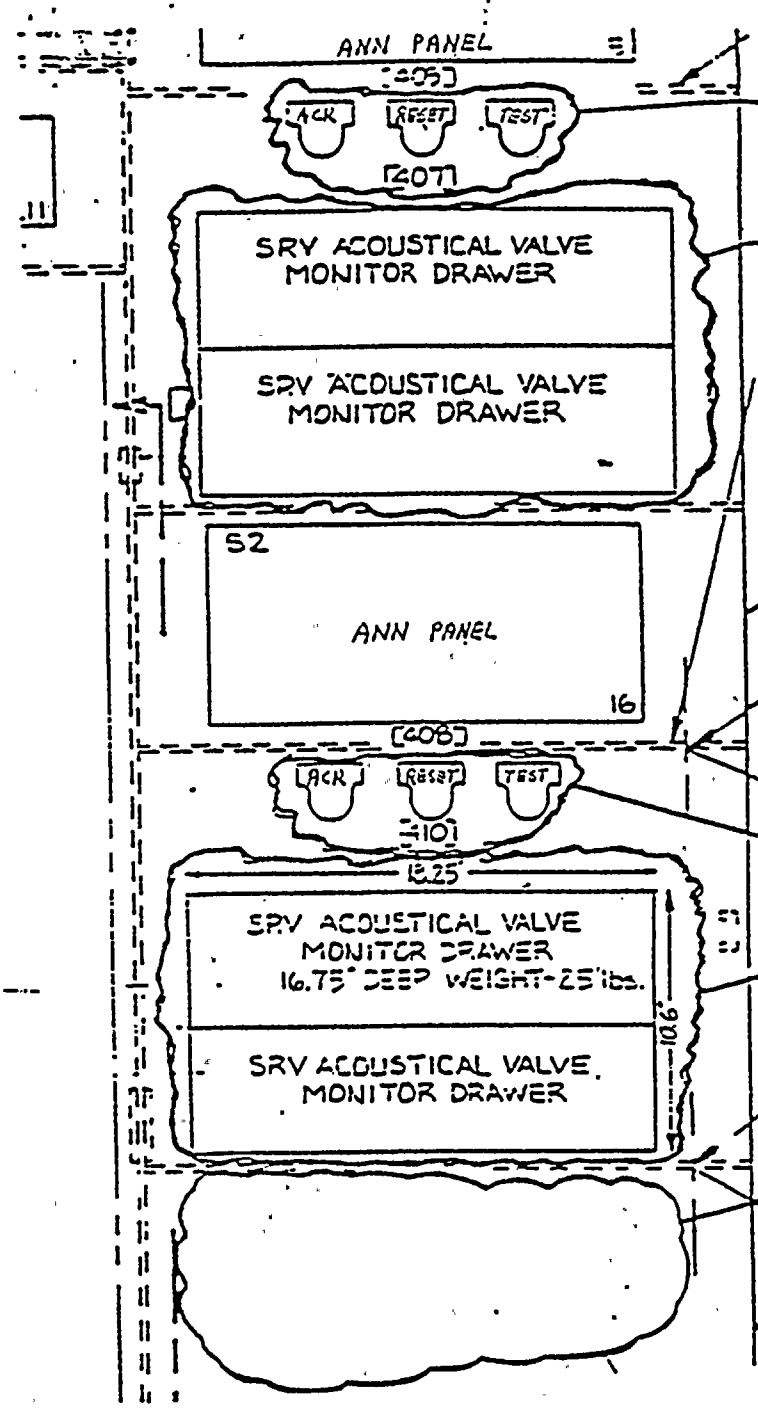
(73)
A
RFW SYSTEM B
PANEL P840



14-25

PANEL P820



Revised location for S1 annunciator controls.

Existing Annunciator SD1 to be dele by R.G.-1.47 changes. SRV Acoustica Monitors (R.G.-1.97) proposed locat

Revised locations for S2 Annunci tor controls.

Existing Annunciator SD2 e d leted by R.G.-1.47 changes. SRV Acoustical Monitors (R.G.-1.97) proposed location.

Existing Annunciator SD3 to be deleted by R.G.-1.47 changes.

P851 (Board "S")

Reference Drawing - E537-IVF-38, Rev. 0

15.0 COMPUTERS

15.1 GENERAL DISCUSSION

WNP-2 is equipped with a Honeywell 4010 process computer. Operator interface is provided by a console (presently temporarily located in the back of the main operating area), two pairs of Cathode Ray Tubes (CRT), five typers, and five trend recorders. A Transient Data Acquisition System (TDAS) and Plant Data Information System (PDIS) are planned but are not yet installed.

The reviews of the computer system consisted of an evaluation of selected aspects of human factors design, including computer consoles, capabilities, printers, and CRT displays. Our review of the WNP-2 computers was necessarily abbreviated due to the construction status of the plant. Good compliance with several checklist items was noted, but many items were not evaluated, because equipment was not yet installed or operational.

15.2 FAVORABLE ASPECTS OF COMPUTER DESIGN

15.2.1 The computer console and output devices are standard computer hardware. (D1.3)

15.2.2 The process computer, TDAS, and PDIS are capable of displaying selected input information. (D2.1)

15.2.3 The process computer, TDAS, and PDIS are equipped with display change capability. (D2.2)

15.2.4 The process computer, TDAS, and PDIS are available for on demand use by the control room operator. (D2.3)

15.2.5 All computer systems are available after power transients or accidents and are capable of use in post-transient evaluations. (D2.5, D2.6)

15.3 DEVIATIONS FROM CHECKLIST CRITERIA PERTAINING TO COMPUTERS

15.3.1 The plant computers are not capable of automatic or manual switchover in the event of a processor failure. (D2.7)

Response: WNP-2 has three computer systems. Redundant processors within each system do not exist. The present design and selection of plant computer systems and periphals were selected to meet as high an availability and reliability standard as market equipment availability allowed.

Further upgrade of the existing system will be based on operational experience. No further action required.

15.3.2 The TDAS and PDIS are not provided with verification that the computer is operational or that the data are being updated on a periodic basis. (D3.9)

Response: Verification of operation and data update will be visually identifiable to the operator in two ways:

- The rate of change directional arrows on the graphic displays will be flashing.
- The seconds displays on the time readout will be incrementally changing.

No further action required.

16.0 PROCEDURES

16.1 GENERAL DISCUSSION

The evaluation of the WNP-2 operating procedures addressed the areas of availability, format, content, use of references, and revision methods. Administrative procedures controlling logkeeping practices and the availability of system drawings and schematics were also considered.

The concerns noted were derived from a general examination of the procedure binders and a detailed analysis of the selected procedures listed in Table 16-1.

Table 16-1

LIST OF PROCEDURES EVALUATED

The evaluation of the WNP-2 operating procedures was based primarily upon a detailed review of the following procedures:

1.2.2	Plant Procedure Preparation
2.2.1	Reactor Recirculation System
2.2.4	Main Condensate and Feedwater System
2.3.1	Primary Containment Venting, Purging and Inerting
2.3.2	Primary Containment Cooling System
2.3.5	Standby Gas Treatment System
2.4.1	Standby Liquid Control System
2.4.2	Residual Heat Removal System
2.4.3	Low Pressure Core Spray System
2.4.4	High Pressure Core Spray System
2.4.5	Standby Service Water System
2.4.6	Reactor Core Isolation Cooling System
3.1.2	Reactor Plant Cold Startup
3.3.1	Reactor Scram
4.5.7.1	Main Turbine Generator Trip
4.3.1.2	High Unidentified Reactor Leakage
4.12.1.1	Control Room Evacuation
5.1.1	RPV Level Control
5.1.2	RPV Pressure Control
5.1.3	Reactor Power Control
5.2.1	Suppression Pool Temperature Control
5.2.2	Drywell Temperature Control
5.2.3	Primary Containment Pressure Control
5.2.4	Suppression Pool Level Control
5.3.1	Level Restoration
5.3.2	Emergency RPV Depressurization
5.3.3	Steam Cooling
5.3.4	Core Cooling Without Level Restoration
5.3.5	Alternate Shutdown Cooling
5.3.6	RPV Flooding
5.3.7	Level/Power Control

Annunciator Response Procedures:

4.601.A1
4.601.A2
4.601.A3
4.601.A4
4.601.A11
4.601.A12
4.603.A7
4.603.A8

16.2 FAVORABLE ASPECTS OF PROCEDURES

16.2.1 A complete set of operating procedures and drawings is available in the control room. (E1)

16.2.2 Index tabs are included in all procedure binders. (E2.6)

16.2.3 A procedure governing the procedure preparation process is in effect. Procedure format, contents, and numbering conventions are specified. (E3, E4)

16.2.4 Page layouts and step arrangements are usually effective. (E3.4, E3.5)

16.2.5 Revisions are clearly identified and easily recognized. (E3.9)

16.2.6 Most procedures are succintly and unambiguously written. Extraneous information is generally omitted. (E4.1, E4.2, E4.5, E4.18)

16.2.7 Where appropriate, deviations from prescribed step sequences are allowed. (E4.6)

16.2.8 Annunciator set points are specified in the annunciator procedures. (E4.14)

16.2.9 Extremely degraded conditions are addressed by the Volume 5 procedures. (E4.16, E4.22)

16.2.10 Use of multiple indications is stressed in the ECCS operating procedures. (E4.17)

16.2.11 Conditions under which instrumentation may be inaccurate are discussed in the Volume 5 procedures. (E4.21)

16.2.12 Reference material identified in the procedures is easily identified and readily available.

16.2.13 PPMs 1.2.4, 1.2.5, and 1.2.6 address most aspects of the recommended procedure revision process. (E6)

16.2.14 Logkeeping practices are generally in accordance with recommendations. (E7)

16.3 DEVIATIONS FROM CHECKLIST CRITERIA PERTAINING TO PROCEDURES

16.3.1 Procedure Storage, Availability, and Identification

16.3.1.a Procedure binders could be more explicitly labeled, specifying the constituent procedures by number. (E2.2)

Response: Binders are presently labeled by volume number and function (i.e., Administrative Procedures, Abnormal Procedures, Emergency Procedures, etc.). The need for additional labeling will be based on operational experience. No action required.

16.3.1.b A table of contents is provided only in the first book of each volume of procedures. (E2.3)

Response: A controlled procedure index is available separate from the Plant Procedures Manual for operator access. The inclusion of a table of contents for the first book of each volume is an additional operator aid. Expansion to each book is not necessary. No action required.

16.3.1.c Distinctive coloring or labeling should be considered for the emergency, abnormal, and annunciator response procedure binders. (E2.4)

Response: Resolution will be based on operational experience and noted in the Final Report.

16.3.1.d Annunciator response procedures are not in a separate binder. (E2.5)

Response: See item 16.3.1.c for response.

16.3.2 Procedure Format and Content

16.3.2.a The administrative procedure controlling the procedure preparation process (PPM 1.2.2) does not address the selection of type size and style. Many inconsistencies were noted in the use of upper case letters. (E3.1)

Response: Plant procedures preparation and review are a continual process at this stage of plant construction. Changes in annunciator window wording, label plate wording, instrument set points, establishing of standard abbreviations, and

additions of new hardware require a continual review and updating process. Minor typographical and editorial variations between procedures—such as type size, syntax, capitalization, nomenclature, wording, phraseology, etc.—are allowable per PPM 1.2.2, as long as clarity and procedure intent are not reduced. Regulatory requirements endorse ANSI standards which require a two-year review cycle on all plant procedures. As procedures are reviewed and updated, corrections will be incorporated as needed. These reviews and resulting update will be based on operational experience and comparisons against existing plant design and layout. No action required.

16.3.2.b PPM 1.2.2 does not address the use of nomenclature, terminology, or abbreviations in operating procedures. (E3.2)

Response: See item 16.3.2.a, above, for response.

16.3.2.c The phraseology of steps directing the operator to verify valve positions is not always consistent. (E3.2)

Response: See item 16.3.2.a, above, for response.

16.3.2.d The use of as-labeled designations in operating procedures is not specifically required by PPM 1.2.2. (E3.3)

Response: See item 16.3.2.a, above, for response.

16.3.2.e The numbering system as prescribed by PPM 1.2.2 produces rather lengthy page, section, and step numbers. A more manageable system would result if the PPM numbers were deleted from each of these designations (e.g., "page 2.2.1-1 of 27" could be shortened to "page 1 of 27"). (E3.4, E3.5)

Response: NRC Region V inspectors and INPO reviews have highly endorsed the practice as an improvement. No action required.

16.3.2.f The step numbering convention used in the Volume 5 procedures differs from that used in the other volumes. (E3.4)

Response: Volume 5 procedures will comply to PPM 1.2.2 requirements prior to fuel load.

16.3.2.g Cautionary statements are inconsistently numbered in the Volume 5 procedures. (E3.4)

Response: Volume 5 procedures will comply to PPM 1.2.2 prior to fuel load.

16.3.2.h The format of the section 5.3 procedures does not correspond to that required by PPM 1.2.2. (E3.4)

Response: Volume 5 procedures will comply to PPM 1.2.2 prior to fuel load.

16.3.2.i The numbering of substeps within step F.1 of PPM 2.2.1 is inconsistent with the numbering system at other steps. (E3.4)

Response: This will be corrected during the procedures normal review cycle noted in item 16.3.2.a, above.

16.3.2.j The numbering, arrangement, and organization of steps could be improved in the following instances: (E3.5)

Substeps within steps F and F.2 at PPM 2.2.1

Substeps within step I of PPM 5.1.3

Steps A and B of PPM 5.3.1 should be aligned

The table included in step D of PPM 5.3.1

Substeps within steps A, C, and D of PPM 5.3.7

Response: See item 16.3.2.a for response.

16.3.2.k The page layouts in PPM 2.4.3 are inconsistent with those of other procedures. (E3.5)

Response: This will be corrected during the procedures normal review cycle noted in 16.3.2.a, above.

16.3.2.l The wording of the "purpose" sections of most Volume 2 procedures implies that all listed operations, both normal and abnormal, are described by the procedures. "Abnormal operations," however, are addressed in the Volume 4 procedures and might, therefore, be more appropriately included in the "Reference" sections. (E3.6)

Response: Resolution will be noted in the Final Report.

16.3.2.m The wording of the "Purpose" section is inconsistent between procedures (of PPMs 2.2.1, 2.2.4, 2.4.2, 2.4.3, and 2.4.4). (E3.6)

Response: See item 16.3.2.a for response.

16.3.2.n PPM 1.2.2 does not require a "Purpose" section for the Volume 4 procedures (abnormal and annunciator procedures). A "Purpose" section is probably unnecessary for annunciator procedures but may be desirable for abnormal procedures. (E3.6)

Response: PPM 1.2.2 does not require a "Purpose" section for Volume 4 procedures, and no ANSI requirements exist for inclusion of a "Purpose" section for these procedures. Past experience indicates none is warrented. No action required.

16.3.2.o The lists of references in some procedures (e.g., PPMs 3.1.2 and 3.3.1) are too broad. Lists of specific procedures are preferred. (E3.8)

Response: Referencing of specific procedures versus general references are left to the procedure preparer's discretion based on the applicable need of detail. Reference sections are reviewed, along with the rest of the procedure, by the Plant Operating Committee (POC) to ensure clarity and operability. Operational experience will define the need of further detailing or lessening of reference sections. Changes will be incorporated per the normal review cycle.

16.3.2.p The Volume 5 procedures do not include a list of references, though PPM 1.2.2 prescribes a "References" section. (E3.8)

Response: Volume 5 procedures will comply with PPM 1.2.2 prior to fuel load.

16.3.2.q Technical specifications are usually referenced only by section number. A summary of the specific limitations might be more useful. (E3.8, E4.15)

Response: See item 16.3.2.o for response.

16.3.2.r Inclusion of additional cross-references may be desirable in some instances, particularly in the Volume 5 procedures. Examples include: (E3.8)

PPM 4.5.7.1 should cross-reference the turbine shutdown procedure.

Step I.3 of PPM 5.1.3 should cross-reference specific procedures for alternate methods of boron injection.

A procedure for defeating the isolation interlocks should be cross-referenced by Step I of PPM 5.2.3.

System operating procedures should be cross-referenced where applicable (e.g., Step F of PPM 5.1.1, Step H of PPM 5.1.2, Step I of PPM 5.1.3, and Steps B and C of PPM 5.3.1).

PPM 3.1.2 should cross-reference Step F of PPM 2.2.1, which must be performed in parallel.

Response: Resolution will be noted in the Final Report.

16.3.2.s A-few procedures could be more succintly written. The following examples are provided: (E4.1, E4.2)

PPM 2.2.1, Steps E and F

PPM 2.3.1

PPM 2.4.4

PPM 3.1.2, Precaution Y

PPM 3.1.2, "Purpose" section

Response: Resolution will be noted in the Final Report.

16.3.2.t The wording of the following steps could be improved: (E4.1, E4.2)

PPM 2.2.1, Step F.1 and Limitations E and L

PPM 2.3.1, Limitation E, Steps A.4, A.5, and C.10, and the note accompanying Step C.9

PPM 2.4.2, Limitation A, F, D, K, and Steps A.1.gg and H.43

PPM 2.4.3, Limitations A and C, Steps C.1 and F.2, and the note accompanying Step F.6

PPM 2.4.4, Limitation H, Steps C.1, C.3, C.5, and the caution accompanying Step E.5

PPM 2.4.6, Step A.6.d

PPM 3.1.2, Precautions M, N, O, R.4, DD, FF, HH, KK, MM, OO, PP, and Step 37

PPM 3.3.1, Steps 4, 8, 9, 10, and 11

PPM 5.1.3, Step J.6

Response: Resolution will be noted in the Final Report.

16.3.2.u The wording of the pump start limitations could be clarified in PPMs 2.4.2, 2.4.3, and 2.4.4. The wording of the comparable limitation in PPM 2.2.1 is much clearer, though "rated temperature" might be defined. (E4.2)

Response: Resolution will be noted in the Final Report.

16.3.2.v A few imprecise words and phrases are used, including "adequate" (PPM 2.4.2), "as necessary" (PPM 2.4.2), "acceptable" (PPM 2.4.2), "bump open" (PPM 2.4.2), "desired" (PPM 2.4.4), "when pressure permits" (PPM 2.4.6), "if required" (PPM 2.4.6), "regular intervals" (PPM 2.4.6), and "about" (PPM 3.1.2). (E4.2)

Response: Resolution will be noted in the Final Report.

16.3.2.w Information is not always appropriately allocated between operator actions, cautions, limitations, and notes. The following examples are provided: (E4.3)

Operator actions are included in the "Prerequisites" section of PPM 2.2.1.

Prerequisites are included in the "Limitations" section of PPM 2.3.1.

Operator actions are included in the "Limitations" section of PPMs 2.4.2 and 3.3.1.

Operator actions are presented as notes in PPMs 5.3.6 and 5.3.7.

Response: Resolution will be noted in the Final Report.

16.3.2.x The formats of a few steps in the Volume 5 procedures could be improved. (E4.3)

Response: Volume 5 procedures will comply to PPM 1.2.2 prior to fuel load.

16.3.2.y The format of cautions in the Volume 5 procedures differs from that in the other volumes. (E4.4)

Response: Volume 5 procedures will comply to PPM 1.2.2 prior to fuel load.

16.3.2.z The association between cautionary statements and related steps in the Volume 5 procedures is not always clear. (E4.4)

Response: Volume 5 procedures will comply to PPM 1.2.2 on placement of cautionary steps prior to fuel load.

16.3.2.aa Cautions in the Volume 2 and Volume 3 procedures normally follow the applicable step. In some cases, it may be appropriate to place the caution before the steps. (E4.4)

Response: PPM 1.2.2 specifies placement of cautions prior to the applicable procedure steps. Resolution will be noted in the Final Report.

16.3.2.ab Though prescribed by PPM 1.2.2, no "Automatic Actions" section is included in the Volume 5 procedures. A list of automatic actions might also be useful in PPM 3.3.1. (E4.7)

Response: Volume 5 procedures will comply to PPM 1.2.2 prior to fuel load. Resolution as to PPM 3.3.1 will be noted in the Final Report.

16.3.2.ac PPM 1.2.2 specifies that diagrams, drawings, and figures be attached to the procedures when appropriate, but none was found in the procedures reviewed. Figures which may be desirable include the power-flow map in PPM 2.2.1, Technical Specification Figure 3.4.6.1-1 in PPM 3.1.2, and the SLC tank volume and temperature limit curves in PPM 2.4.1. (E4.11)

Response: It is generally considered not appropriate for most procedures to include drawings, diagrams, and figures due to frequency of changes. Addition of such will be based on operational experience and included, where advisable, during the procedures normal review cycle.

16.3.2.ad Though required by PPM 1.2.2, valve and annunciator locations are generally not specified. (E4.12)

Response: Resolution will be noted in the Final Report.

16.3.2.ae Normal or expected parameter values are not always specified. Instances in which this may be desirable include: (E4.13)

Normal pump speeds in PPM 2.2.1, Sections A and D

Normal operating values of system parameters in PPM 2.2.1.

Normal system pressure and flow in PPM 2.4.1, Section C

Normal operating ECCS parameter values in PPMs 2.4.2, 2.4.3, and 2.4.4

Indications of run-out conditions in PPMs 2.4.2 and 2.4.5

Indications of the siphon effect and air binding in PPM 2.4.3

Response: Resolution will be noted in the Final Report.

16.3.2.af The set points of the annunciators referenced in the system operating procedures and the abnormal operating procedures are not always specified. (E4.14)

Response: Resolution will be noted in the Final Report.

16.3.2.ag Some of the precautions and limitations listed in the fronts of the procedures might be more appropriately incorporated into individual steps. (E4.15)

Response: The POC has recognized this concern, and corrective action has been initiated. Applicable procedures will be corrected prior to fuel load.

16.3.2.ah More specific guidance on operational limits might be appropriate in some instances. Examples include: (E4.15)

Activity limits in Steps A.5 and C.4 of PPM 2.3.1.5

SLC tank level in Step D.1 of PPM 2.4.1

CST, suppression pool, and RPV water level values in PPM 2.4.4

RPV water level and RPV pressure control bands in PPM 3.3.1

Maximum LPCS and RHR injection pressures in Caution No. 3 of PPM 5.1.1

The ADS timer reset interval in PPM 5.1.3

Response: See items 24.4.1 and 24.4.5 for response relative to Volume 5 procedures. Resolution of all other items will be noted in the Final Report.

16.3.2.ai Contingency actions are not addressed by the scram procedure. (A4.16)

Response: Resolution will be noted in the Final Report.

16.3.2.aj Use of multiple indications is not stressed in the Volume 5 procedures. (E4.17)

Response: Generally, applicable operator precautions which are applicable at all times are contained in one Volume 5 procedure. Specific precautions include:

Caution 2: "Monitor RPV water level and pressure and primary containment temperatures and pressure from multiple indications."

Caution 3: "If a safety function initiates automatically, assume a true initiating event has occurred unless otherwise confirmed by at least two independent indications."

Caution 10: "Do not secure or place ECCS in manual mode unless, by at least two independent indications, ..."

Use of multiple indications is stressed. No action required.

16.3.2.ak The following procedural steps may be extraneous or redundant: (E4.18)

Section 2.4.2.5.B of PPM 2.4.2

References to the RPV saturation curve in the Volume 5 procedures

Three appearances of one caution in PPM 5.1.2

Step C of PPM 5.1.3

Caution 2 of PPM 5.3.4

Step F.3.b of PPM 5.3.7

Response: Concerns will be resolved prior to fuel load.

16.3.2.al Inclusion of the following directions in the operating procedures may be appropriate: (E4.19)

PPM 2.2.1 Directions for recirculation pump shutdown from low speed operation.

PPM 2.4.2 Directions to remove the spool pieces and hoses installed in Step A.1.

Instructions for verifying the reset of isolation relays in Step H.3.

Contingency actions of RPV water level decreases in Steps H.18 and H.42.

More specific guidance on resetting the RHR initiation logic.

Additional guidance on initiating suppression pool cooling in Step J.10.

A discussion of standby service water system operation.

PPM 2.4.4 A discussion of standby service water system operation.

PPM 2.4.6 A discussion of RCIC operation in emergency situations.

PPM 3.1.2 Additional guidance in Step 54.

PPM 3.3.1 Guidance on RPV pressure control within the body of the procedure.

Guidance on performing a manual scram.

PPM 4.5.7.1 A discussion of the operation of the electrical distribution system.

A greater level of detail in the "Operator Actions" sections.

PPM 5.1.3 Directions for defeating the RSCS interlock.

PPM 5.3.1 Additional instructions for aligning the condensate flush connections.

Response: Resolution will be noted in the Final Report.

16.3.2.am Operating procedures do not address the new recorders to be installed on panel 601 for the containment parameters. (E4.19)

Response: See item 16.3.2.a for response. Volume 5 emergency procedures will address these prior to fuel load.

16.3.2.an Guidance on manual control and reset of ECCS may be appropriate in PPM 3.3.1. (E4.20)

Response: Resolution will be noted in the Final Report.

16.3.2.ao Guidance on manual control and reset of the RCIC system following automatic operation may be appropriate in PPM 2.4.6.

Response: Resolution will be noted in the Final Report.

16.3.2.ap The following inconsistencies in cross-referencing were noted:

Annunciators referenced in PPMs 2.4.1, 2.4.3, 2.4.4, and 3.1.2 are not listed in the revised annunciator procedures.

Step 8 of PPM 2.4.2 and Step C.7 of PPM 2.4.4 may not be consistent with the Volume 5 procedures.

The RPV high pressure and drywell high pressure scram set points as listed in the Volume 5 procedures do not correspond to those listed in the Volume 4 procedures.

The sequence of Steps A through C in PPM 5.1.3 is inconsistent with that of the corresponding steps in PPM 5.1.2.

The action levels defined in Caution 1 of PPM 5.2.4 are inconsistent with those defined in PPM 5.1.1.

The level control band defined in PPM 5.3.7 is inconsistent with that defined in PPM 5.1.1.

Incorrect references are listed in the following steps:

PPM 2.4.6, Step 12
PPM 3.1.2, Steps 32, 43, and 100
PPM 5.3.1, Steps A, I.5, and I.2
PPM 5.3.6, Step E.3

Response: Resolution will be noted in the Final Report.

16.3.3 Procedure Revision Practices

The administrative procedures controlling the procedure revision process do not specifically require prompt procedure revisions to incorporate design changes. (E6.5)

Response: Design changes specify affecting procedures and drawings which require changing. These changes are recorded as a POC action item for correction. No specific update cycle, except the two-year review is required at present. Resolution will be noted in the Final Report.

16.3.4 Logkeeping Practices

The administrative procedure controlling plant logkeeping practices does not specifically require the recording of verbal instructions and confirmation of their execution. (E7.4)

Response: Experience indicates that recording of all verbal instructions and execution confirmations can cause an excessive

administrative burden on control room personnel and reduce the effectiveness of logkeeping practices. Operator discretion is allowed in this area. No action required.

16.3.5 Annunciator Procedures

16.3.5.a Nonstandard abbreviations are used in the text of annunciator procedures. (C7.1)

Response: See item 16.3.2.a for response.

16.3.5.b Some nomenclature inconsistencies are apparent in the annunciator procedures. (C7.1)

Response: See item 16.3.2.a for response.

16.3.5.c Aspects of the content of annunciator procedures are not in compliance with recommended criteria. (C7.2, C7.3)

Response: Resolution will be noted in the Final Report.

17.0 COMMUNICATIONS SYSTEMS

17.1 GENERAL DISCUSSION

The communications system could not be thoroughly evaluated at the time of the control room design review due to the incomplete status of the plant. The system will reportedly incorporate diverse components, including a PA system, telephones, sound powered phones, radios, a microwave, and direct lines to the emergency response facilities, but the ultimate configuration of these defices could not be observed. While the communications interface should, therefore, be re-evaluated at a later date, it must be stressed that the equipment should be easily accessible from all panels, yet unobstructive, and well organized. Several instances were noted during the review of long phone cords being stretched from the operator's desk to the wing panels.

Though the planned communications network will apparently satisfy most recommended criteria, 62% of the operators interviewed were dissatisfied with some aspect of the present system. The majority of the comments received appeared related to frustrations experienced using the PA system. Concurrent use by large numbers of construction personnel and alledgedly incomplete speaker coverage have reportedly led to difficulties in contacting equipment operators. More speakers, a system exclusively for operators, and use of radios were suggested as remedies. These comments should be considered as the design of the communications system is finalized.

17.2 FAVORABLE ASPECTS OF COMMUNICATIONS SYSTEM DESIGN

17.2.1 The permanent communications network will reportedly incorporate diverse subsystems, including walkie-talkies, telephones, sound powered phones, a microwave, and a multi-channel paging system. All will be available following a loss of normal power. (F1.1, F1.2, F1.7)

17.2.2 The paging system is available to the control room operators on a priority basis through an override feature. (F1.4)

17.2.3 Headsets are adjustable for individual users. Handfree operation is possible if necessary. (F1.6, F1.8)

17.2.4 Direct lines will be provided to all emergency response facilities. (F1.9)

17.2.5 Communications devices will reportedly be color coded.

17.2.6 Operators report no difficulty understanding messages transmitted over the paging or phone systems. (F1.11)

17.2.7 Multiple pushbutton phones allow transfer of communications responsibilities between operators. (F6.7)

17.3 DEVIATIONS FROM CHECKLIST CRITERIA PERTAINING TO COMMUNICATIONS SYSTEMS

17.3.1 The PA system reportedly cannot be heard in all plant locations. (F1.5)

Response: The existing PA system is being redesigned with new amplifiers and additional speakers. Present design has a high failure rate on amplifiers, and some areas do not have adequate coverage. It should be noted that the design of 10 db over background noise cannot be achieved in certain areas, such as the diesel generator rooms. The PA system will be preoperationally tested prior to fuel load.

Also, two additional systems will be available to the operator. A two-way radio system with a distributive antenna system will be installed prior to fuel load to allow operator communications throughout the plant and the sound powered system presently installed.

No further action required.

18.0 AUDIBLE ALARMS

18.1 GENERAL DISCUSSION

Refer to section 14.0 of this report for a discussion of audible alarms. Applicable checklist items are detailed below.

18.2 FAVORABLE ASPECTS OF AUDIBLE ALARMS

18.2.1 Alarms are tested once each shift, in accordance with Administrative Procedure 1.3.1. (F2.3)

18.2.2 Alarms are sufficiently loud to be audible in all parts of the control room, in spite of the relatively high noise levels associated with plant construction. (F2.4, F2.6)

18.2.3 Audible alarms are not so loud as to be irritating. (F2.5)

18.3 DEVIATIONS FROM CHECKLIST CRITERIA PERTAINING TO AUDIBLE ALARMS

18.3.1 It is presently not possible to determine the location of an alarm from auditory cues alone. Currently, only two horns are used, one assigned to the NSSSS panels and the other to the BOP panels and all backpanels. Provision should be made for distinguishing backpanel alarms from BOP alarms. (F2.1)

Response: See item 14.3.15 for response.

18.3.2 No form of audible prioritization of alarms is currently used. (F2.2)

Response: See item 14.3.15 for response.

19.0 CONTROL ROOM HABITABILITY

19.1 GENERAL DISCUSSION

Control room habitability includes such factors as illumination, noise levels, ventilation, accommodations, and overall cleanliness. Each of these areas was evaluated by the survey team.

19.1.1 Illumination

Lighting in the WNP-2 control room is provided by ceiling-mounted fluorescent fixtures powered from the diesel buses and equipped with diffusers and a dimmer control. Though plant activities kept one section of lights de-energized for the duration of the survey, normal illumination levels nevertheless exceeded the recommended minimum of 30-foot candles at all panels. Even with half the lights de-energized, as would occur with the loss of one diesel bus, illumination levels were adequate at most panels, though slightly low at several of the benchboards. Emergency lighting, supplied by ceiling-mounted DC incandescent fixtures, could not be measured at the time of the review. Experience from other plants with similar systems, however, suggests that the illumination levels provided by the DC lights may be less than the recommended minimum of 20-foot candles.

Lighting for the Remote Shutdown Panel is currently provided by undiffused fluorescent fixtures, probably contributing to the glare evident on this panel. It is, therefore, recommended that diffusers be installed on these fixtures.

Minimal glare was evident on indicator and recorder faces in the main control room, the one exception being some indicators on the upper sections of the BOP panels. However, glare was found to detract from the readability of some labels on the apron sections of the main benchboards, particularly the BOP panels.

19.1.2 Noise Levels

Sound levels were not measured during the review, since the high noise levels associated with plant construction cannot be considered representative of the typical control room environment.

19.1.3 Heating, Ventilation, and Air Conditioning

The temperature and relative humidity in the control room

measured 76°F and 40%, respectively, at the time of the survey. This temperature slightly exceeds the recommended maximum of 75°F, but the humidity is within the recommended comfort band.

The HVAC system is reportedly complete and functional, but the air felt somewhat stagnant to the survey team. Construction activities may have some effect on the environment, as the control room door is kept open and several ceiling sections were removed. It is, therefore, recommended that the measurements be repeated when the plant is operational.

19.1.4 Accommodations, Access Control, and Housekeeping

A kitchen and restroom have been placed along one wall of the control room but are outside of the control room boundary as defined by a strict interpretation of Administrative Procedure 1.3.2. These facilities cannot, therefore, be used by the on-shift operators unless a relief is first obtained. Extension of the control room boundary in Procedure 1.3.2 would obviate this inconvenience.

Storage areas for spare parts and personal effects have not yet been designated, but operators have apparently begun to feel the need for these provisions, as several complained of inadequate storage space. Control room furnishings, workspace, and housekeeping practices are impractical to evaluate at the present stage of construction.

Access to the control room is restricted in accordance with Administrative Procedures 1.3.1 and 1.3.2 but must necessarily be somewhat lax during plant construction. One-fourth of the operators interviewed felt that access should be more strictly controlled when the plant is operational.

19.2 FAVORABLE ASPECTS OF CONTROL ROOM HABITABILITY

19.2.1 Normal illumination levels exceed the minimum recommended at all panels. (F3.1)

19.2.2 Diffusers are installed on all control room lighting fixtures. Minimal glare was observed on indicator and recorder faces. (F3.2)

19.2.3 Control room access is administratively controlled in accordance with Administrative Procedures 1.3.1 and 1.3.2. (F6.1)

19.2.4 Kitchen and restroom facilities are available in the back of the control room. (F6.6)

19.2.5 Smoking and eating areas are controlled in accordance with Administrative Procedure 1.3.1.

19.3 DEVIATIONS FROM CHECKLIST CRITERIA PERTAINING TO CONTROL ROOM HABITABILITY

19.3.1 Glare was observed in the following instances:

19.3.1.a Indicators mounted on the upper sections of the BOP panels.

19.3.1.b Indicators on the Remote Shutdown Panel.

19.3.1.c Labels on the apron sections of the benchboards, particularly the BOP benchboards.

Response: See item 10.3.2 for response to items 19.3.1.a and b, above. The new labels to be installed prior to fuel load will use low glare material. Present labels use a glossy finish. No further action required.

19.3.2 At the time of measurement, the temperature in control room registered 76°F, slightly above the recommended maximum of 75°F. (F4.1)

Response: The temperature and humidity readings will be retaken prior to fuel load and noted within the Final Report.

19.3.3 Accommodations are currently not provided for the storage of protective gear, spare parts, and personal belongings. (A7.3)

Response: Accommodations will be provided prior to fuel load. No further action required.

20.0 EMERGENCY EQUIPMENT

20.1 GENERAL DISCUSSIONS

The control room must be equipped with sufficient emergency equipment to enable the operators to respond and effectively operate the plant in the event of a disturbance. The inventory should include fire fighting equipment, breathing apparatus, protective clothing, and radiation monitoring instruments. At WNP-2, fire extinguishers and emergency breathing masks are provided (though permanent storage areas have not yet been designated), but protective clothing and radiation monitors are not available.

The special clothing and breathing apparatus designated for control room applications must be designed so as not to prevent the operators from performing required functions. The air masks at WNP-2 are of standard design and appear to be compatible with normal activities, but the usability of special clothing could not be evaluated, since none is currently provided. It is recommended that the training program include simulations requiring the use of emergency equipment so that operators can become accustomed to its use.

20.2 FAVORABLE ASPECTS OF EMERGENCY EQUIPMENT DESIGN

20.2.1 Fire extinguishers are readily available in the control room. (F5.1)

20.2.2 An automatic fire alarm is installed. (F5.2)

20.2.3 Emergency breathing apparatus is available in the control room. (F6.3)

20.3 DEVIATIONS FROM CHECKLIST CRITERIA PERTAINING TO EMERGENCY EQUIPMENT

20.3.1 No protective clothing is currently available in the control room. (F6.2)

Response: The Final Safety Analysis Report (FSAR), section 12.5.2, requires protective clothing to be stored in the control room prior to fuel load.

20.3.2 Radiation monitoring equipment is not available in the control room. (F6.4)

Response: The FSAR, section 12.5.2, requires portable radiation monitoring equipment to be stored in the control room prior to fuel load.

21.0 MAINTENANCE AND SURVEILLANCE ACTIVITIES

21.1 GENERAL DISCUSSION

Maintenance and surveillance activities were reviewed only in those areas that directly involve control room operating personnel. Included were evaluations of operator maintenance responsibilities, jumper and lifted lead control, tagout procedures, spare part availability, and general maintenance procedures. With three exceptions, the practices stipulated in Administrative Procedures 1.5.1 (surveillance testing), 1.3.9 (jumpers and lifted leads), and 1.3.8 (tagouts) satisfy all recommendations which could be considered in these areas.

As discussed in section 19.0, storage space has not yet been designated in the WNP-2 control room. In the near future, the utility should adopt well-organized storage methods for operational space parts, including fuses, light bulbs, recorder charts, and recorder pens.

The danger and caution tags in use in the control room often tend to obscure adjacent controls and indications. The utility reportedly has ordered new tags, however, of a different design, which should correct this situation. Provision should also be made for attaching tags to components on the vertical panels, as some tags did not appear to be secure.

21.2 FAVORABLE ASPECTS OF MAINTENANCE AND SURVEILLANCE ACTIVITIES

21.2.1 Responsibilities for surveillance testing are defined in Administrative Procedure 1.5.1. (G1)

21.2.2 The use of jumpers and lifted leads is controlled by Administrative Procedure 1.3.9. Lifted leads are tagged, jumpers are numbered and color coded, and tags are maintained. (G3)

21.2.3 The use of danger and caution tags is controlled by Administrative Procedure 1.3.8. The tags are readily available, color coded, easily read, and logged. (G4)

21.2.4 Maintenance and surveillance practices are defined by Administrative Procedure 1.5.2 conform to recommendations. Checklists and status boards are used. (G6)

21.3 DEVIATIONS FROM CHECKLIST CRITERIA PERTAINING TO MAINTENANCE AND SURVEILLANCE ACTIVITIES

21.3.1 Tags affixed to control panel components sometimes obscure adjacent controls and indications. (G4.3)

Response: New smaller tags have been procured and are now in use. These tags snap over J-handle style controls or slip snuggly around circular controls. The use of dangling tags held in place by tied string has been minimized. No further action required.

21.3.2 Storage space for operational spare parts has not yet been provided. (G5.4)

Response: Accommodations will be provided prior to fuel load. No further action required.

22.0 TRAINING AND MANNING

22.1 GENERAL DISCUSSION

Training methods and shift manning practices received only limited attention during the control room review, as other regulatory requirements mandate specific, detailed analyses of these areas. As described by plant personnel and plant Administrative Procedures, all aspects of the training program, shift manning, and shift turnover considered during this review conformed to recommendations. It should be noted, however, that 75% of the operators interviewed were dissatisfied with the present training program (see section 23.0).

22.2 FAVORABLE ASPECTS OF TRAINING AND MANNING PRACTICES

22.2.1 Procedure revisions are automatically incorporated in the training program through the distribution process detailed in Administrative Procedure 1.2.5. (H1.1)

22.2.2 The WNP-2 training program reportedly includes instruction in instrumentation characteristics, use of the computer and CRT displays, and periodic review and walkthrough of emergency procedures. (H1.2, H1.3, H1.4)

22.2.3 Administrative Procedure 1.3.2 limits the number of hours an operator may work in a given period of time. (H2.1)

22.2.4 The physical and mental condition of on-coming operators is routinely evaluated in accordance with Administrative Procedure 1.3.6. (H2.2)

22.2.5 The duties, responsibilities, and authority of shift members are defined by plant Administrative Procedures. (H2.3)

22.2.6 The shift turnover procedure is described in detail by Administrative Procedure 1.3.6. Disruptive situations are avoided, logs are reviewed, and written checklists are employed. (H3)

22.3 DEVIATIONS FROM CHECKLIST CRITERIA PERTAINING TO TRAINING AND MANNING

All aspects of training and manning considered in this review were in compliance with checklist criteria.

23.0 OPERATOR INTERVIEW SUMMARY

23.1 GENERAL DISCUSSION

Operator interviews were included in the control room design review to obtain information concerning plant design directly from the user population. Written questionnaires were administered to operators, including equipment operators, control room operators, shift supervisors, and shift managers. In addition, oral interviews were conducted with eight operators, representing approximately one-third of the total number employed at WNP-2.

23.2 OPERATOR SUMMARY

The following issues were mentioned most frequently (four or more operators) and, therefore, deserve particular attention:

23.2.1 Twelve operators were generally dissatisfied with the present training program. Specific comments (paraphrased) included:

- The training program is not responsive to the needs of operators.
- Not enough detail is provided.
- The quality of instructions needs improvement.
- The training manuals need to be updated.
- Training should be provided in refueling and radioactive waste processing activities, operating procedures, and the computer system.

23.2.2 Eleven operators pointed out examples of instruments which they found difficult to read. Most frequently noted were those with nonstandard scale progressions. (See sections 10.0 and 11.0.)

23.2.3 Ten operators had experienced difficulties using the existing plant communications systems. Too few speakers, overuse of the PA system by construction personnel, and inability to contact equipment operators were cited as problems. (See section 17.0.)

23.2.4 Certain instruments on the "balance of plant" panels, particularly the three-phase displays of electrical parameters, were thought to be unnecessary by eight operators. (See section 5.0.)

23.2.5 Eight operators considered the present annunciator response system to be inconvenient, reporting that it is difficult to ascertain which panel is alarming. (See section 14.0)

23.2.6 Seven operators listed indications not presently available in the control room which they would find useful, though there was little commonality between responses.

23.2.7 Six operators believed that information flow from management to operations could be improved.

23.2.8 Improvements to the shift turnover procedure were suggested by six operators.

23.2.9 Alternate control room layouts were thought preferable by six operators. While it is impractical to modify the panel arrangement at this time, implementation of other control room enhancements suggested by this report may lessen this concern.

23.2.10 Six operators identified certain control panels which they found to be confusing to operate. Three mentioned the "balance of plant" panels, three various backpanels, one panel 602. One found "most" panels "confusing, poorly designed, and laid out."

23.2.11 Five operators complained of insufficient storage and workspace. Particularly desired was a study area and provision for the storage of training references. (See sctions 19.0 and 21.0.)

23.2.12 Additions to the shift contingent were requested by five operators. Four thought a six-shift rotation to be preferable to the current schedule.

23.2.13 Four operators believed the present control room access restrictions to be too lax.

Response: Control room improvements are continuing as noted throughout this report. Hardware changes and panel enhancements will provide an improved operator-to-hardware interface.

With WNP-2 in a transition phase from construction to operations, it is difficult to evaluate nonhardware items at this time. Plant procedures are in a phase of final development, and their implementation is difficult as construction access is still required, hardware additions and instrument setpoint changes are continuing, and new panel labeling and enhancements are being applied. Also, the training programs performance can be best measured by the number of operators successfully passing their examinations. With certification exams pending, construction and system testing activities increasing, and fuel load approaching, a normal environment could not be measured.

Operator interviews will be conducted again after the first refueling outage and noted in the Final Report.

24.0 EMERGENCY PROCEDURE WALKTHROUGH AND TASK ANALYSIS

24.1 GENERAL DISCUSSION

The operational aspects of the design of the WNP-2 control room were evaluated through task analyses and walkthroughs of the scram procedure (PPM 3.3.1) and initial drafts of emergency procedures developed from Revision 2 of the guidelines formulated by the BWR Owners Group. For each procedure, the following steps were performed:

24.1.1 Operator tasks defined by each sequential procedural step were identified.

24.1.2 Control and instrumentation requirements were specified for each operator task.

24.1.3 The completeness and adequacy of the installed control room instrumentation was evaluated through comparison with the requirements defined by the task analysis.

24.1.4 Walkthroughs of each procedure were performed.

This methodology provided information relative to the availability of information, control/display relationships, and the overall suitability of the control room design.

The level of detail of the task analyses and walkthroughs was limited in some respects due to the status of the plant and the relative unfamiliarity of operational personnel with the systems and procedures involved. The following points should, therefore, be kept in mind when evaluating the results of the task analyses:

24.1.5 The task analyses addressed only hardwired controls and instrumentation. Use of computer-generated CRT displays was not considered.

Response: Integration of the Graphic Display System (GDS) CRT display formats with emergency procedures and plant specific requirements has been extensive. The BWROG graphic display development program was used as the basis for the WNP-2 GDS formats. A WNP-2 report on the GDS system will be issued to NRC per NUREG-0737.

24.1.6 Walking paths could not be evaluated, since the arrangement of furnishings has not been finalized.

Response: An assessment will be provided in the Final Report.

24.1.7 Allowance was made for the planned installation of containment instrumentation on panel 601, but the ranges of the recorder scales and the set points of alarm lights were not known in all cases. The utility should ensure that the instrument ranges, when specified, span the parameter values defined by procedures.

Response: A review will be completed prior to fuel load.

24.1.8 It was assumed that the containment instrumentation presently located on panel 814 would be left in place following the installation of the new recorders on panel 601.

Response: Drywell temperature instrumentation will be left in play on panel P814.

24.1.9 At the time of the survey, numerical values had not been specified for many action levels defined in these procedures. The adequacy of instrumentation ranges with respect to these set points could not, therefore, be evaluated.

Response: A review will be completed prior to fuel load.

24.1.10 Specific procedures for accomplishing certain unusual steps had not been finalized. PPM 5.1.3, for instance, does not specify how the MSIV closure interlocks are to be bypassed in step F.3. The feasibility of such actions could not be evaluated.

Response: Differences between the emergency procedures used for the Task Analysis and Walkthrough and the final approved procedures will be reviewed prior to fuel load.

24.1.11 Plant personnel were relatively unfamiliar with the new emergency procedures and system operations. The analyses were based upon a compilation of operator inputs, system descriptions, and system operating procedures.

Response: Emergency procedure training will be provided to the operators, including use of the GDS system.(see Table 24.1).

24.2 FAVORABLE ASPECT OF PANEL DESIGN

24.2.1 Indicators and recorders displaying RPV level and pressure and the containment parameters have been outlined with red demarcation lines.

24.2.2 RPV level is completely instrumented.

24.2.3 RPV level and pressure indications appear to be conveniently located.

24.2.4 Manual override lights are provided for the ECCS valves and pumps.

24.2.5 The placement of redundant annunciators appears to be consistent between separate annunciator panels.

24.2.6 Containment parameters will reportedly be displayed on new instruments, to be placed on panel 601. This location is considered far more convenient than the existing location on panel 814.

24.2.7 Alarm lights will reportedly be installed on panel 601 for primary containment water level and suppression pool temperature.

24.2.8 Manual initiation buttons are provided for all ECCS.

24.2.9 Manual control of injection flowrates is possible for all ECCS.

24.2.10 Most controls and displays are functionally grouped and well located. The demarcation lines applied to the panels provide an effective visual organization.

24.3 ANNUNCIATOR SYSTEM

As the first step in analyzing the WNP-2 control room design with respect to the emergency procedures, all parameter limits defined as entry conditions were identified. Since the existence of any such condition transfers the operator from normal to emergency procedures, each limit should be annunciated or otherwise called to the operator's attention.

The emergency procedure entry conditions and related annunciators are tabulated in Table 24-2. The comments listed below were derived from consideration of these and other annunciators during the task analyses. (Anticipated changes to the annunciator system were considered in these comments.)

24.3.1 Annunciators are provided for all entry conditions, but in some cases, the set points—as listed in the annunciator procedures—do not exactly correspond to the specified entry conditions. The RPV pressure entry condition is 1043 psig (whereas, the corresponding annunciator set point is 1050 psig) and the drywell pressure entry condition is 1.69 psig (whereas, the corresponding annunciator set point is 2 psig).

Response: Final instrument set points were not available when annunciator procedures were drafted and, therefore, reflect general design settings. Procedures and alarm trip points will be in agreement prior to fuel load.

24.3.2 The annunciator procedures do not list set points for annunciators A11-1-3 and A12-1-3 (suppression pool and drywell temperatures) or A11-2-3 and A12-2-3 (suppression pool level). The utility should verify that the set points of these alarms do, in fact, correspond to the specified entry conditions.

Response: See item 24.3.1, above, for response.

24.3.3 Alarm lights will reportedly be installed on panel 601 for suppression pool temperature, drywell temperature, and primary containment level. It is recommended that the set points selected for these indications correspond to action levels defined by the emergency procedures.

Response: See item 24.3.1, above, for response.

24.3.4 High suppression pool temperatures and high drywell temperatures are annunciated by redundant common alarms on panel 601. While it is generally recommended that such multiple input alarms not be used, especially for the more important parameters, the anticipated installation of alarm lights associated with these parameters may obviate this concern. A similar comment may be made concerning the high/low suppression pool level alarms, though no alarm lights will be associated with this parameter. (The set points of the primary containment level alarm lights are well above the levels defined by the entry conditions.)

Response: Electrical separation criteria and plant design require a diverse and redundant alarm system. No action required.

24.3.5 Redundant annunciators in several locations are provided for some parameters, notably RPV water level (e.g., four separate alarms in four different annunciator matrices actuate at level 3) and primary containment pressure (e.g., eight separate alarms in five different annunciator matrices actuate at 2 psig). While this design may provide confirmatory and diagnostic indications, it also increases the total number of alarm windows and compounds the amount of information which the operator must assimilate during a transient.

Response: Annunciator windows are being reworded to improve trip information by specifying trip level set points as required (see item 24.3.4 for use of multiple alarms). No further action required.

24.3.6 Alarms have generally been placed above the corresponding system operating areas. Separate high drywell pressure initiation alarms, for example, are found above the HPCS, RHR, LPCS, and ADS operating areas. This practice does provide indication useful for each system but, again, compounds the number of annunciator windows and increases the difficulty of mentally integrating all relevant indications. In any case, the practice is not consistently implemented. A high suppression pool level alarm is provided for HPCS (signifying a suction transfer) but not for RCIC. High RPV water level trip alarms are provided for the RFPTs and HPCS but not for RCIC or the main turbine. Low RPV water level initiation signal alarms are provided for HPCS, LPCS, and RHR but not for RCIC.

Response: See ite 24.3.5, above, for response. Also, diversity of alarms were applied to plant essential systems. RCIC is not an essential system, and emergency procedures do not require the specified alarms. Level and pressure displays and other system alarms are available to provide information input for the RCIC system. No action required.

24.3.7 Divisional alarms are provided for most entry condition parameters; i.e., two alarms on separate panels actuate at the same set point each associated with a separate logic division. This practice also compounds the total number of annunciators.

Response: See item 24.3.4 for response.

24.3.8 In addition to the two divisional high RPV pressure scram alarms on panel 603, a third annunciator on the same panel is set to alarm at the same set point.

Response: The third alarm is from the Reactor Feedwater Turbine and Main Turbine Trip Logic. The window will be reworded to reflect its function. Also, the alarm set point has not been finalized but will coincide with the trip logic. No further action required.

24.3.9 As discussed in section 14.0, the terminology and syntax used in annunciator legends could be improved in certain respects. The following concerns were noted:

24.3.9.a RPV level alarm legends do not clearly differentiate the associated action levels. A level 2

condition, for example, is signified by a "low-low" alarm (A11-3-3 and A12-1-2), while a level 1 condition is signified by a "low" alarm (A2-1-5 and A3-6-2).

24.3.9.b Several syntax discrepancies were noted. The legends usually state, in order, the applicable system, the parameter, and the condition as in windows A1-1-7 "REACTOR VESSEL (system) WATER LEVEL (parameter) LOW (condition)," and A8-4-7 "FEEDWATER (system) REACTOR WATER LEVEL (parameter) HIGH TRIP (condition)." In some legends, however, the condition precedes the parameter as in windows A2-1-5 "RHR REACTOR WATER LOW LEVEL" and A8-2-3 "REACTOR VESSEL LOW WATER LEVEL TRIP." Windows A11-1-3 and A12-1-3 do not specify the condition but state only "DRYWELL/SUPP POOL TEMP ALARM."

24.3.9.c Several inconsistencies in nomenclature were noted. Low RPV water level alarms variously refer to "reactor water level" (A8-4-7), "reactor vessel water level" (A1-2-6), and "RPV water" (A2-4-8). "Drywell" and "primary containment" are used interchangeably (e.g., A7-6-2 and A1-1-8), as are "suppression chamber" and "wetwell" (e.g., A11-4-2 and 813A-3-6).

24.3.9.d Certain legends could be made more succint. "FEEDWATER REACTOR WATER LEVEL HIGH/LOW" (window A8-3-7), for instance, could be abbreviated to "Reactor Water Level High Low." "SUPPRESSION POOL CHAMBER PRESSURE HIGH" (window A11-4-2) could be shortened to "Suppression Chamber Pressure High." "REACTOR DRYWELL PRESSURE HIGH" (window A1-1-8) is not more informative than "Drywell Pressure High."

Response: New annunciator windows will be installed prior to fuel load to correct the above deviations. No further action required.

24.4 CONTROL ROOM INSTRUMENTATION

The emergency procedures may be considered, in one respect, as a series of action levels associated with various plant parameters, guiding the operator through increasingly degraded conditions. Easily read displays of these critical parameters should be immediately available in the control room, with the corresponding limits readily discernable. The controls necessary to enact the prescribed responses must similarly be available. Task analyses and walkthroughs of the procedures disclosed the following concerns:

24.4.1 RHR and LPCS pump discharge pressures are not instrumented.

Response: Emergency procedures for WNP-2 do not require RHR and LPCS pump discharge pressure displays. No action required.

24.4.2 The safety/relief valve indicating lights on panel 601 display only the conditions of the actuating solenoids.

Response: Indicating lights will be actuated by an acoustical valve position monitoring system to be installed prior to fuel load. No further action required.

24.4.3 No wide range condenser vacuum instrument has been provided.

Response: Wide range condenser vacuum indicators are being installed on panel P820, adjacent to the main turbine and main condenser system controls, prior to fuel load.

24.4.4 The new instrumentation to be installed on panel 601 will reportedly include a narrow range suppression pool level recorder, spanning ±25 inches referenced to the normal level of 466-foot, 4-3/4-inch elevation, and one wide range recorder, spanning levels from the bottom of the suppression pool to 490-foot elevation. This may be below the level implicit in some limits defined by the emergency procedures, such as the primary containment pressure limit. Alarm lights are to be installed which will provide binary indication at higher levels, but it is not clear whether the planned set points will correspond to procedural action levels.

Response: The wide range level will monitor up to the vacuum breakers in the wetwell as required per WNP-2 Plant Emergency Procedures and RG-1.97. Drywell flooding level binary indication set points were derived from WNP-2 Emergency Procedure requirements. Verification between emergency procedures and instrument set points will be performed prior to fuel load.

24.4.5 Steps I.2 of PPM 5.1.3 and E.2 of PPM 5.3.1 direct the operator to prevent ADS actuation by repeatedly pressing the timer reset buttons. No indication is available to the operator by which he can verify that the logic has been reset.

Response: Emergency procedures have been modified to read "reset every ninety seconds" to qualify the term "repeatedly." Need for further action will be based on operational training and simulator experience. No further action required at this time.

24.4.6 Action levels corresponding to the top of the active fuel are, with one exception, expressed as -167 inches (assumed to be

referenced to an instrument zero of 527.5 inches above the bottom head invert) in the emergency procedures. Since the wide range level instruments read only to -150 inches, these levels should more appropriately be defined in terms of the fuel zone level instrument. This concern is applicable to the following steps:

PPM 5.1.1. Step G

PPM 5.3.1 Steps I.4 and J.3

PPM 5.3.4 Step C

PPM 5.3.7 Steps A, C, E, F, and J

Response: A common reference zero for the RPV level instrumentation will be installed prior to fuel load. Emergency procedures will reference the new levels prior to fuel load. No further action rquired.

24.4.7 Step B of PPM 5.3.3 establishes -277 inches as the RPV water level at which a safety/relief valve is opened if steam cooling is necessary. Assuming a reference of 527.5 inches (instrument zero), -277 inches is below the minimum scale value on the wide range level instruments. Expression of this value in terms of the fuel zone level instrument would, therefore, be more appropriate.

Response: See item 24.4.6, above, for response.

24.4.8 Step E2 establishes an RPV water level of -149 inches as an action level. This value is difficult to read on the installed hardwired instrumentation, since the wide range level instrument is scaled only to -150 inches with graduations of 5 inches. The level 1 annunciators (A2-1-5, A3-6-2) or computer-generated displays might be useful in identifying this action level, however.

Response: This action level has been finalized at -129 inches. Annunciator set points and window wording will reflect the new set point prior to fuel load, and GDS displays and computer outputs are available with the required accuracy. No further action required.

24.4.9 Several steps include a cautionary statement prescribing RPV depressurization below 57 psig unless certain conditions are satisfied. This value would be difficult to discern using existing hardwired instruments, since the wide range level recorders and indicator are scaled in graduations of 20 psig. (This caution may be found on pages 5.2 2-3, 4, 5, 5.2 1-2, 5.2 4-3, 5.3 1-4, and 5.3 2-1.)

Response: GDS displays and computer peripherals are available to the operator with the required accuracy. Need for further action will be based on operational training and simulator experience. No further action required at this time.

24.4.10 The following parameter values identified in the task analyses would be difficult to discern using installed instrumentation, as the instrument scales cannot practically be read to the specified accuracy:

1150 gpm HPCS flow (PPM 2.4.4, Step C.8)

200 gpm standby service water flow (PPM 2.4.5, Step D.2)

145 psig RPV pressure (PPM 5.3.4, Step B.1)

RPV pressure 76 psig above suppression chamber pressure (PPM 5.3.5, Step F.1)

RPV pressure 96 psig above suppression chamber pressure (PPM 5.3.5, Step F.2)

RPV pressure 238 psig above suppression chamber pressure (PPM 5.3.6, Step C.1)

8% reactor power (PPM 5.3.7, Note 1)

Response: See item 24.4.9 for response.

24.4.11 Procedures 5.1.2 and 5.3.7 specify boron injection quantities in pounds; whereas, the SLC tank level indicator on panel 603 is scaled in gallons.

Response: Those sections of the emergency procedures specifying "pounds" of boron injection relate to alternate injection source paths, not the SLC system. Pounds measurement is used to coincide with weight measurements on bags of powdered borax and boric acid. The procedures have been revised to specify borax and boric acid rather than boran. No further action required.

24.4.12 Suppression pool water levels specified throughout the emergency procedures are referenced to the bottom of the suppression pool; whereas, the recorders to be installed on panel 601 will reportedly be referenced to the normal level and to sea level (narrow-range and wide-range instruments, respectively). This convention complicates the evaluation of plant conditions, as the expressed values must be arithmetically converted to a different reference.

Response: The wide-range scale will reference to the bottom of the suppression pool. Sea level will not be used. No action required.

24.5 CONTROL ROOM ARRANGEMENT

The control room arrangement and the method of organizing controls and displays within panels can directly impact operator efficiency during transient response. Layouts which necessitate frequent trips to back-panels detract from the operability of the control room and may affect shift manning levels; whereas, conveniently located instruments promote rapid evaluation of plant status. Logically arranged, well-thoughtout panel arrangements reduce the chance of operator error and facilitate the location of controls and indications. The following concerns were noted:

24.5.1 The scram solenoid lights are located on backpanels, complicating the verification of scram resetting operations.

Response: New annunciator alarms are being installed on panel P603 to provide both visual and audible alert of scram solenoid channel status. No further action required.

24.5.2 The HPCS service water pump control is located on panel 601, but the discharge valve control switch, pump current indication, and discharge pressure indication are located on panel 840.

Response: See item 5.3.22 for response.

24.5.3 Standby service water pump A and B controls are located on panels 840 and 820, along with the related current and pressure indications, but flow must be measured on panel 601 and the system supply valves are controlled from panel 825.

Response: See item 5.3.23 for response.

24.5.4 No CST level indication is provided in the vicinity of the HPCS or RCIC operating areas (low CST level causes automatic suction transfers).

Response: Low CST level pump suction transfer annunciator alarms are available at the HPCS and RCIC systems on panel P601. CST level indicators are located on panel P840, and data are available from the computer. Additional indicators on panel P601 would not significantly improve operator response. No action required.

24.5.5 Implementation of the RHR steam condensing mode requires operations on panel 601, panel 840 or 820, and panel 614.

Response: Resolution will be noted in the Final Report after operational and simulator experience has been obtained.

24.5.6 The RHR system is divided between two separate areas of panel 601.

Response: See item 5.3.16.f for response.

24.5.7 The standby gas treatment system is divided between panels 811 and 827.

Response: Two redundant SGT filter-and-fan units exist, trains A and B, panels P827 and P811, respectively. Each train can be operated independently without requiring any interaction between the two panels. Panels are approximately 12 feet apart, and operator access between the two panels is unobstructed. No action required.

24.5.8 The feedwater injection valve controls are located on panel 602, separated from the main feedwater system operating area on panel 840.

Response: See item 5.3.10 for response.

24.5.9 The main steam line drain valve controls are divided between panels 601 and 602.

Response: Drain valves on panel P601 are NSSSS isolation valves and grouped for quick verification of main steam line isolation and Group 1 isolation trips. Relocation of controls from or to either panel may cause confusion and degrade safety. No action required.

24.5.10 When the operator is seated at panel 603, viewing angles to the SRM indications and RPV water level indications are acute.

Response: SRM system modifications prior to fuel load will improve operator visibility by moving the indicators and recorders close to the center of panel P603 where the rod pull operator would sit. RPV indicators will be hierarchy labeled and demarcated prior to fuel load. No further action required.

24.6 INSTRUMENTATION, HARDWARE, AND PANEL DESIGN

Key controls and indications identified in the task analyses were compared to pertinent checklist criteria, item by item. Applicable concerns, with the corresponding checklist item referenced in parentheses, are listed below:

24.6.1 The RPV level/pressure recorder on panel 603 is located in the feedwater control operating area, divided from the "RPV monitors." (A2.2)

Response: See item 5.3.1 for response.

24.6.2 The layout of panel 813 was found to be confusing. (A2.7)

Response: See item 5.3.20 for response.

24.6.3 The RCIC trip/throttle and governor valve indicating lights are not integrated into the system mimic. (A2.11)

Response: See item 5.3.8 for response.

24.6.4 The computer trend recorders are intermixed with specific system indicator layouts. (A3.1)

Response: See item 5.3.13 for response.

24.6.5 RHR subsystems are arranged in a C-B-A sequence, left-to-right on panel 601, the reverse of the normal alphabetic convention. (A3.2)

Response: See item 5.3.16.f for response.

24.6.6 The HPCS pressure and flow indications are reversed relative to the sequence specified by the label designation. (A3.3)

Response: See item 5.3.19 for response.

24.6.7 ADS valves are not differentiated from non-ADS valves in the safety/relief valve layout on panel 601. (A3.4)

Response: New panel labels will be installed prior to fuel load and will differentiate ADS from non-ADS controls. No further action required.

24.6.8 Labels are not provided for many single indicating lights. It is, therefore, not always clear whether a light is normally on or off and whether it signifies a reset condition, a manual override, or an automatic initiation. (A4.3, A5.1)

Response: Engraved square lense will be installed prior to fuel load to identify single light functions. Lense color code standard was prepared to enable the operator to determine lights which are normally on from those normally off and the relative priority of importance. See items 7.3.3 and 12.3.2 for further detail. No further action required.

24.6.9 Redundant labels are provided for the RCIC manual trip and isolation pushbuttons. (A5.1)

Response: See item 7.3.7 for response.

24.6.10 The terms "drywell" and "containment" are used interchangeably. (A5.5)

Response: See item 7.3.17 for response.

24.6.11 The application of the terms "suppression pool," "suppression chamber," and "wetwell" does not appear to be completely standardized. (A5.5)

Response: See item 7.3.17 for response.

24.6.12 Labels for the main steam line drain valves, the reactor head vents, and the recirculation pump motor breakers do not clearly differentiate between related controls. (A5.10)

Response: New labels will be installed prior to fuel load.

24.6.13 The nomenclature used on RPV water level instrument levels does not clearly define the applicable instrument ranges. (A5.10)

Response: New labels will be installed prior to fuel load.

24.6.14 A common manual initiation pushbutton is provided for LPCS and RHR A, a fact not evident from the associated label. (A5.10)

Response: A new label will be installed prior to fuel load.

24.6.15 The label for the RPV pressure indicator on panel 603 includes "A" and "B" designations, implying the presence of two indicators; whereas, only one is provided. (A5.10)

Response: A new label will be installed prior to fuel load.

24.6.16 The LPCS pump ammeter is labeled "LRS" amps. (A5.10)

Response: A new label will be installed prior to fuel load.

24.6.17 One generator trip pushbutton on panel 800 is mislabeled. (A5.10)

Response: A new label will be installed prior to fuel load.

24.6.18 One RHR pump ammeter is mislabeled. (A5.10)

Response: A new label will be installed prior to fuel load.

24.6.19 The RFPT trip switches are mislabeled. (A5.10)

Response: A new label will be installed prior to fuel load.

24.6.20 The DEH valve controls are labeled "raise" and "lower" instead of the preferred "open" and "close." (A5.10)

Response: This will be resolved prior to the Final Report.

24.6.21 Labels are not easily associated with the corresponding indicating lights in the SLC system layout on the vertical section of panel 603. (A5.11)

Response: See item 7.3.42 for response.

24.6.22 No units are specified on the post-accident recorders or the recorders on panel 814. (B2.3)

Response: New label plates and recorder pen designation plates will be installed prior to fuel load.

24.6.23 The standby liquid control tank "level" indicator is scaled in "gallons" (a volume).

Response: See item 24.4.11 for response.

24.6.24 The condenser vacuum instruments are scaled in in. -Hg abs.; whereas, low vacuum trips and alarms are generally specified in in. -Hg vac.

Response: Resolution will be noted in the Final Report.

24.6.25 Only a handwritten scale is provided for the LPCS flow indicator. (B2.4)

Response: A new scale will be installed prior to fuel load.

24.6.26 The fuel zone RPV water level instrument relies upon a zero reference different from the other RPV water level instruments. This may complicate the comparison at multiple indications during transients. (B2.8)

Response: See item 24.4.6 for response.

24.6.27 The scale of the SBGT flow controllers does not correspond to that of the related flow indicators. (B2.10)

Response: Resolution will be noted in the Final Report.

24.6.28 The scales of the wide range and fuel zone RPV water level recorders have greater than the recommended number of graduations between numbered subdivisions. (B2.12)

Response: A new fuel zone scale will be installed prior to fuel load. The wide-range scale is acceptable as is. No further action required.

24.6.29 The scale of the HPCS pressure indicator does not conform to recommended standards. (B2.12, B2.13)

Response: Scale is acceptable as is. See items 10.3.17 and 10.3.18 for response. No action required.

24.6.30 The incorrect paper is installed in the RPV level recorder on panel 603 and the post-accident recorders on panel 601. (B3.2)

Response: See item 11.3.2 for response.

24.6.31 Recorder labels on panel 814 do not clearly specify the association of pen color to input parameter. (B3.10)

Response: See item 11.3.7 for response.

24.6.32 The orientation of position options on the RFPT trip switches is opposite to that recommended. (B5.1)

Response: Switches are a spring return-to-center type, with "trip" and "reset" functions (left and right positions, respectively). Trip switches are normally pushbuttons, not rotary style switches. Reset rotary switches normally rotate to the right to reset which is consistent with the above switches. "Stop" position for fan, motor, and diesel generator switches is consistently on the left position. The feedwater turbine "trip" position is essentially a "stop" position and is consistent as is with the rest of the control room. No action required.

24.6.33 The pointers on the arming collars of manual initiation switches are difficult to see from a normal viewing position. (B5.11)

Response: See item 11.3.13 for response.

24.6.34 The RFPT trip switches are not visually distinctive from the immediately adjacent governor controls. (B6.1, B6.2)

Response: See item 13.3.17 for response.

24.6.35 Operation of some electrical breakers requires actuation of a synchronizing switch with a removable handle. The utility should ensure that these handles are clearly marked and readily available. (B6.3)

Response: Synchronization is automatic and does not normally require use of the manual sync selector switch. See item 13.3.12 for further response. No action required.

24.7 PANEL ENHANCEMENT OR MODIFICATIONS

In addition to the concerns listed above, certain modifications or enhancements of existing control panel design should be considered to more effectively support the operator in important decision, evaluation, or action steps identified in the procedures:

24.7.1 The operator is directed by the scram procedure to verify rod insertion using the RSCS display (not yet installed), which consists of a matrix of red indicating lights. It is conceivable that one or more rods not inserted might not be noticed in a time-critical, stressful situation if the operator must rely upon this display.

Response: The Graphic Display System format provides for quick verification of rod insertion. A single Rod Insertion color-filled square will identify all rods in (green) or all rods not in (red). Also, computer printouts of rod position are available. No action required.

24.7.2 No concise display of isolation valve status is provided.

Response: The Graphic Display System will provide verification of isolation. If the system is not operating, a manual check sheet will be available to the operator for isolation verification. No action required.

24.7.3 Additional demarcation lines and summary labels might be used to subdivide the feedwater system indications on panel 840.

Response: The color padding, demarcation, and hierarchy labeling mockup of the feedwater system was reviewed and minor changes made to simplify the enhancement design and improve the visibility of the two subdivisions of the feedwater system. No further action required.

24.7.4 PPM 5.2.2 cautions the operator to question the validity of RPV level indications when elevated drywell temperatures exist in the vicinity of the level instrument reference legs. These temperatures are indicated on panel 814, sensed by four temperature elements referenced by number in the procedure. Some form of distinctive labeling might be beneficial here to facilitate the identification of the specified indications, as a total of 46 temperatures are instrumented on panel 814.

Response: Resolution will be noted in the Final Report based on operational experience.

24.7.5 The actions necessary to manually initiate protective functions and to reset automatic system initiations could be better defined through improved labeling. To manually initiate a scram, for instance, the operator must arm and depress one of two Division I pushbuttons and one of two Division II pushbuttons (one-out-of-two twice logic). In contrast, to manually initiate ADS, the operator must depress both buttons in Division I or both buttons in Division II (two-out-of-two once logic). Similarly, a variety of logic systems and labeling conventions are applied to the reset buttons. While these variations should certainly be addressed in the training program, it may be advisable to reinforce the distinction with panel labels.

Response: Panel labels will be installed prior to fuel load. Also, see item 5.3.16.d response. No further action required.

24.7.6 There is currently no way of definitely determining when the RHR shutdown cooling interlock has cleared, other than attempting to line up the system. A permissive light may be useful in this application.

Response: RPV pressure recorders, adjacent to the RHR systems on panel P601, are available to the operator to determine when pressure is below the interlock point. Addition of annunciator alarms or indicating light would not further enhance the operator's ability to perform. Possible addition of scale set point additions or color banding will be reviewed per item 10.3.1 response. No action required.

24.7.7 The IRM/APRM recorder selector switches incorporate a center "0" position (off) which appears to have no functional value. While its existance would not seem to be detrimental to plant operation, it remains an unnecessary provision. The utility should, therefore, consider deleting this function.

Response: Resolution will be noted in the Final Report.

Table 24-1

WNP-2 EMERGENCY PROCEDURES

TRAINING PROGRAM

Licensed operator candidates have/will have had the following training on WNP-2 Emergency Procedures/Graphic Display System prior to their license exam:

1. Emergency Procedure Guidelines/Bases

   . Reading assignment

2. Classroom walkthrough of EP Flow Chart - eight hours

   . Includes entry conditions, applicability, contingencies, etc.

3. EP/GDS Course - 40 hours

   . Formal classroom training on basis behind WNP-2 EPs, use of the GDS, Classification of Emergencies; also, actual hands-on training using the GDS.

4. Simulator Refresher Training - 40 hours

   . Actual use of WNP-2 EPs during simulator refresher training

5. EP Verification and Validation Program

   . Plant Operations, on each rotating shift, will walk the EPs through the WNP-2 Control Room to verify the level of detail and compatibility to equipment nomenclature, control/indication location, and instrument applicability. This will demonstrate that the actions required by the EPs can be related to the equipment, controls, indications, and the Graphic Display System.

6. Mitigating Core Damage - 40 hours

   . A portion of this course (approximately eight hours) will be devoted to provide instruction to plant personnel in the use of the WNP-2 Emergency Proecedure for recognizing and mitigating the consequences of incidents, transients, and abnormal events.

Table 24-2

HANFORD-2 EMERGENCY PROCEDURE ENTRY CONDITIONS

PROCEDURE	ENTRY CONDITION	ANNUNCIATOR
RPV Level Control	RPV water level below +12.5 inches	Reactor Vessel Low Water Level Trip (A7-2-3) Reactor Vessel Low Water Level Trip (A8-2-3)
	RPV pressure above 1043 psig	Reactor Vessel High Pressure Trip (A7-2-2; setpoint 1050 psig) Reactor Vessel High Pressure Trip (A8-2-2; setpoint 1050 psig) Reactor Vessel Pressure High (A7-6-3; setpoint 1050 psig)
	Drywell pressure above 1.69 psig	Primary Containment High Pressure Trip (A7-6-4; setpoint 2 psig) Primary Containment High Pressure Trip (A8-5-3; setpoint 2 psig)
	An isolation which requires or initiates reactor scram	Main Steam Line Isolation Valves Closure Trip (A7-1-4) Main Steam Line Isolation Valves Closure Trip (A8-1-4)
	A condition which requires reactor scram and	Reactor Scram A1 and B1 Logic (A7-1-2) Reactor Scram A2 and B2 Logic (A8-1-2)
	reactor power above 5% or cannot be determined	APRM Downscale (A8-4-6) APRM downscale lights, P603
RPV Pressure Control	Same as RPV Level Control	Same as RPV Level Control

(cont'd next page)

PROCEDURE	ENTRY CONDITION	ANNUNCIATOR
Reactor Power Control	Any condition which requires reactor scram and	Reactor Scram A1 and B1 Logic (A7-1-2) Reactor Scram A2 and B2 Logic (A8-1-2)
	reactor power above 5% or cannot be determined	APRM Downscale (A8-4-6) APRM downscale lights, P603
Suppression Pool Temperature Control	Suppression pool temperature above 90°F	Drywell/Supp Pool Temp Alarm (A11-1-3; setpoint not specified) Drywell/Supp Pool Temp Alarm (A12-1-3; setpoint not specified) Alarm lights, P601 (not yet installed)
Drywell Temperature Control	Drywell temperature above 135°F	Drywell/Supp Pool Temp Alarm (A11-1-3; setpoint not specified) Drywell/Supp Pool Temp Alarm (A12-1-3; setpoint not specified) Alarm lights, P601 (not yet installed; setpoints @ 160°F, 360°F)
Primary Containment Pressure Control	Primary Containment pressure above 1.69 psig	Primary Containment High Pressure Trip (A7-6-4; setpoint 2 psig) Primary Containment High Pressure Trip (A8-5-3; setpoint 2 psig)
Suppression Pool Level Control	Suppression pool level above 31 ft. 2 in.	Suppression Pool Level Hi/Low (A11-2-3; setpoint not specified) Suppression Pool Level Hi/Low (A12-2-3; setpoint not specified)
	Suppression pool level below 30 ft. 10 in.	Hi/Low (A11-2-3; setpoint not specified) Hi/Low (A12-2-3; setpoint not specified)

25.0 OPEN ITEMS

25.1 GENERAL DISCUSSION

This report, in conjunction with the BWROG Generic Control Room Design Review Program Plan and the WNP-2 Preliminary Control Room Human Engineering Report submitted earlier to the Nuclear Regulatory Commission, forms the basis of the Detailed Control Room Design Review (DCRDR) required by NUREG-0737, Supplement 1.

A WNP-2 Final Control Room Design Review Report will be prepared and issued for those "open" items noted below. The Final Report, when issued in conjunction with the above, is intended to satisfy the requirements of the DCRDR. The WNP-2 Final Report will be prepared and issued in accordance to a schedule to be established between the Supply System and the Nuclear Regulatory Commission.

25.2 OPEN ITEMS - WITHIN THIS REPORT

Responses that specify either "no action required" or "will be completed prior to fuel load" are considered closed items and will not be included in the Final Report unless deviations from resolution occur.

Responses that specify "resolution will be noted in the Final Report" are considered open items and any review, deviations, and resolutions resulting from these items will be included in the Final Report.

25.3 OPEN ITEMS - WITHIN BWROG PROGRAM SURVEY CHECKLISTS

Because WNP-2 was still under construction at the time of the BWROG design review, a complete BWROG survey evaluation of the control room could not be performed. The following BWROG program survey items are considered open. Review and resolution of any deviations will be noted in the Final Report.

25.3.1 BWROG survey checklist items:

A1.3	B3.1	E1.5	F7
A2.5	B3.2	E1.7	G5
A2.6	C9	E2.1	
A2.9	D1.1	F1.3	
A2.12	D1.2	F2.6	
A5.2	D2.4	F4	
A6	D3	F6.5	
A7	D4	F6.8	

25.3.2 The Remote Shutdown panels will be reviewed against BWROG checklist items B4.1 and B4.3, as the panel was not energized at the time of the survey.

25.3.3 The Remote Shutdown panels will be reviewed for lighting, procedure storage, and communications capability.

25.3.4 Hardware items not installed at the time of the survey will be evaluated against section B of the BWROG checklists.