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October 29, 1985
Fort St. Vrain
Unit No. 1
P-85384

Director of Nuclear Reactor Regulation
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Attention: Mr. E.J. Butcher, Jr., Acting Chief
Operating Reactors Branch No. 3

Docket No. 50-267

SUBJECT: Fort St. Vrain Control Room Design Review Summary Report

REFERENCES: 1) PSC Letter (P-85142) Warembourg to Johnson, Dated 4/30/85

2) NRC Letter (G-85363) Hunter to Lee Dated 8/27/85

Dear Mr. Butcher:

The purpose of this letter is to provide you with Public Service Company's submittals in response to the requests of Reference 2 above.

The purpose of these submittals is to provide you with additional and/or specific information relative to the Control Room Design Review. This information is submitted under cover of "Public Service Company's Response to the Nuclear Regulatory Commission's 'request for additional information'". Attachments 1 thru 7b correspond directly to the requests listed in the summary provided by Reference 2. Attachments 8 & 9 are submitted in response to questions raised during the July 16, 1985, meeting in Bethesda.

If you have any questions, please contact M. H. Holmes at (303) 480-6960.

Very truly yours,

D. W. Warembourg

D. W. Warembourg
Manager, Nuclear
Engineering Division

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DWW:DJG/sld

Attachments

Public Service Company
Response to the
Nuclear Regulatory Commission's
"request for additional information"
(Detailed Control Room Design Review Summary Report)

On April 30, 1985, Public Service Company (PSC) submitted a Summary Report (SR) of the Detailed Control Room Design Review (DCRDR) as required by NUREG-0737. PSC staff members met with the Nuclear Regulatory Commission (NRC) staff in Bethesda, MD, on July 16, 1985, to discuss this SR. An NRC letter dated August 27, 1985, (D. R. Hunter to O. R. Lee), requested a Supplemental Summary Report and provided minutes of the July 16, 1985, meeting. An included Summary listed the documentation considered "necessary to complete NRC review". A telephone conference was held between PSC and NRC staff members on September 19, 1985, to clarify certain of the requests.

This document lists by corresponding numerical reference, each item addressed in the summary and describes PSC's submittal.

1. Qualifications and Structure of the DCRDR Team

- The resume of the human factors specialist.

PSC submittal - The resume of the human factors specialist, Michael E. Maddox, Ph.D., is included as Attachment 1.

2. Function and Task Analysis, and 3. Comparison of Control and Display Requirements With a Control Room Inventory

- Sample filled-in data forms of the analysis and identification of information and control needs.

- Sample filled-in data forms of the verification of the needs being satisfied in the control room.

- Sample filled-in data forms of the validation of EOP steps, actions, information and control needs, traffic patterns, and component locations.

PSC submittal - The first two bulleted items comprise the "Information Control Requirements" schedule included as Attachment 2. The third bulleted item is included as Attachment 3. The "information and control needs" request included in this third item is redundant to the

first bulleted item.

4. Control Room Survey

- Sample documentation which is sufficient in content and scope to clearly demonstrate how the following activities have considered dynamic criteria or principles:

  - operator survey questionnaires (several samples)
  - EOP walk-throughs (several samples)
  - CRSRG Review (human factors guidelines)
  - detailed study of all control and indicator arrangements and groupings

- Those criteria in NUREG-0700, Section 6, that were not covered in the FSV control room survey.

PSC submittals - A complete copy of the Operator Survey Questionnaire and a sample of the operator response summary applicable to dynamic criteria is provided as Attachment 4a (Parts 1 and 2).

- A Sample of EOP walk-throughs are included as Attachment 3. While specific text is not directed to dynamic criteria or principles, Operator positions, Instrument locations, and traffic patterns were observed (and recorded) as an integral part of the task analysis effort.

- A copy of the Administrative procedure, EMAP-1, which defines the operation of the Control Room Systems Review Group (CRSRG) is included as Attachment 4b. This document contains a listing of those items the designer must consider and 9 items that the CRSRG addresses. In addition the check list provided for the designer in ensuring consideration of instrument and control conventions, labeling and locations is included as Attachment 4c.

- A sample package assembled from the preliminary study of control and indicator arrangements and groupings is included as Attachment 4d. Note: The Summary request indicated "-detailed study of <u>all</u> control ...". Clarifications during the telephone conference on September 19, 1985, indicated that only a sample of the detailed study was required. In addition, attachments 6b-1 thru 6b-4 provide a general description of the improvement design process and include finalized layouts.

- A computerized listing of NUREG-0700 guidelines, which were not specifically addressed (or addressed indirectly) is included as Attachment 5. The basis for not addressing each item is also noted.

6. Selection of Design Improvements, 7. and 8. Verification That Improvements Will Provide the Necessary Corrections Without Introducing New HEDs

- The 12 Design Directives.
- The human factors guidelines the CRSRG uses in its review.
- A clear description of each HED, its fix, and any documentation such as control panel drawings which illustrates the panel design before and after its reconfiguration according to the control room improvement package.

PSC Submittals

- The 12 Design Directives are included as Attachment 6a.
- The human factors guidelines used by the CRSRG are included as Attachment 4b.
- A Summary of the Control Room improvement design process as applicable to I-01, I-02 and other related tasks are included as Attachments 6b-1 thru 6b-4. These submittals include copies of the applicable HEDs, drawings showing the original and proposed configurations, as well as a summary of the changes. Similar packages for other control boards and divisions of work will be sumbitted as available.

9. Coordination of the DCRDR With Other Improvement Programs

- A description of how the DCRDR is being coordinated with training and staffing (other than to resolve HEDs) and the SPDS.
- A schedule outlining the dates for completion of its NUREG-0737, Supplement 1 initiatives since the integration of improvement programs impacts the DCRDR schedule.

PSC Submittals

- Attachment 7a is a synopsis of the methods employed and efforts to coordinate the DCRDR with training and staffing.

- A detailed schedule for completion of NUREG-0737, Supplement 1 initiatives, is included as Attachment 7b.

Additional Submittals

In addition to the above listed submittals as requested by the NRC letter dated August 27, 1985, PSC is providing additional information in response to NRC questions raised during the meeting on July 16, 1985. These submittals are:

Attachment 8 - A detailed listing of those HEDs shown in Attachment B of the Summary Report with a Disposition (Resolution) of "Referred".

Attachment 9 - A listing of HEDs applicable to I-01 and I-02 having final dispositions different from the proposed disposition shown in Attachment B of the Summary Report. Similar lists will be included with the design process packages to be submitted for other control boards.

ATTACHMENT 1

RESUME OF HUMAN FACTORS SPECIALIST
MICHAEL E. MADDOX, Ph.D.

Michael E. Maddox
266 Watkins Glen Dr.
Kennesaw, GA 30144

Off: 404-441-1457 (Search Technology, Inc.)
Hm: 404-928-8150

Professional Interests:

Visual display development and evaluation
Visual psychophysics
Control system design and layout
Computer software development
Experimental design

Education:

BS Virginia Polytechnic Institute and State University (VPI&SU), 1972, Physics, Minor in Mathematics and Psychology

MS VPI&SU, 1977, IEOR (Human Factors)

PhD VPI&SU, 1979, IEOR (Human Factors)

Professional Appointments:

1983-present Senior Scientist, Search Technology, Inc., Norcross, GA.

Conduct applied research for government agencies and commercial clients in the areas of computer-generated display design, computer-based training, human-computer interaction, decision aiding, and general human factors design. Act as a consultant to clients in the areas of human performance measurement and evaluation, product evaluation, nuclear power plant control room design, and display design and evaluation.

1980-1982 Project Manager in Operations Engineering Division, Institute of Nuclear Power Operations, Atlanta, GA.

Manage projects which: develop human factors evaluation criteria and recommend operating practices for the nuclear power industry; evaluate nuclear power plants for conformance to good human engineering practices; develop computerized human engineering data bases for utility and internal use; review and coordinate computerized displays for new applications; and provide timely human engineering data to the nuclear industry. Present workshops and seminars on human factors topics for utility personnel. Represent INPO at national and international professional society and standards meetings. Serve as an expert consultant to nuclear utilities.

1978-1980 Research Associate, Virginia Polytechnic Institute and State University, Blacksburg, VA.

Responsible for experimental design and execution of research under contract to the Air Force Office of Scientific Research experimental program to evaluate the effects of various image enhancement algorithms upon photo-interpreter performance. In addition to laboratory computer systems, equipment included International Imaging Systems Model 70E digital imaging system.

Consultant to Texas Instrument Company - evaluation of prototype displays.

Consultant to Pitney-Bowes Company - evaluation of copy print quality.

1975-1978 Graduate Research Assistant, Virginia Polytechnic Institute and State University, Blacksburg, VA.

Performed studies on the effects of parameters of computer-generated dot-matrix displays on human performance. Responsibile for computer software and experimental design in support of research sponsored by the Army Research Office and the Air Force Office of Scientific Research. This research dealt mainly with the assessment of the quality of computer-generated displays.

1974-1975 Instrumentation Engineer, Babcock and Wilcox Company, Nuclear Power Generation Division, Lynchburg, VA.

Responsible for plant computer systems for several B&W nuclear plants. Responsible for configuring final specification for computer system and all peripherals to be installed at certain B&W plants. Included in this specification was the data base for monitoring all important functions within the plant. This necessitated familiarization with virtually all instrumentation for the entire system.

1972-1974 Instrumentation Engineer, Goodyear Atomic Corporation, Piketon, OH.

Responsible for the design, development, and implementation of instrumentation systems for gaseous diffusion process control and quality assurance. Involved with computer-oriented data acquisition and control systems. During this period worked with HP and DEC computer systems. In addition to computer-based systems, was involved in conventional control and instrumentation, both pneumatic and electronic. Much of this work was classified by the AEC. Maintained Atomic Energy Commission Q-Clearance.

1968-1972 Co-operative Education Student, Goodyear Atomic Corporation, Piketon, OH.

Assisted professional staff in research, laboratory, and development work. Worked one academic quarter each in Health Physics, Physical Measurements (Electron Microscopy and X-Ray Analysis), and Mass Spectrometry. Worked three academic quarters in Instrumentation Development Department. While in Physical Measurements, authored an internal technical report on X-Ray fluorescence analysis of binary and tertiary metal mixtures. During the work quarters in Instrumentation Development, assisted in the preparation of a report on a new computer-based automatic test stand.

PUBLICATIONS

1. Turpin, J.A. and Maddox, M.E. Subjective ranking of facsimile document quality scanned at different resolutions. Proceedings of the 28th Annual Meeting of the Human Factors Society, San Antonio, TX, October, 1984. (In press)

2. Johnson, W.B., Maddox, M.E., and Kiel, G.C. Simulation-oriented computer-based instruction for training of nuclear plant personnel. Proceedings of the 28th Annual Meeting of the Human Factors Society, San Antonio, TX, October, 1984. (In press)

3. Hunt, R.M., Maddox, M.E., and Kiel, G.C. Computer-generated display system guides, Vol. 3: Display design, Palo Alto, CA: Electric Power Research Institute, 1983.

4. Maddox, M.E. The interpretation of human factors design criteria for nuclear power plant control room reviews. Proceedings of the 27th Annual Meeting of the Human Factors Society, Norfolk, VA: October, 1983.

5. Johnson, W.B., and Maddox, M.E. Status of diagnostic training in the nuclear utility industry. Proceedings of the 27th Annual Meeting of the Human Factors Society, Norfolk, VA: Human Factors, October, 1983.

6. Zebroski, E.L., Maddox, M.E., and Dietz, P.E. Establishing priorities in control room design review. Nuclear Engineering International, 1982, 27, 30-34.

7. Maddox, M.E. The integration of human factors methodology into nuclear power plant control room reviews. Proceedings of the 26th Annual Meeting of the Human Factors Society, Seattle,WA: October, 1982.

8. Maddox, M.E. Human factors implications in the introduction of computer aids into existing control rooms. Proceedings of the Edison Electric Institute Engineering and Operating Computer Forum, Denver, Colorado, September, 1982.

9. Maddox, M.E. and Brickey, M.C. INPO/TVA pilot systems review. Atlanta, Georgia: Institute of Nuclear Power Operations, June, 1982, INPO-82-14.

10. Snyder, H.L., Shedivy, D.I., and Maddox, M.E. Quality metrics of digitally-derived imagery and their relation to interpreter performance III - Subjective scaling of hard-copy digital imagery. Blacksburg, Virginia: Virginia Polytechnic Institute and State University, 1981, HFL-81-3.

11. Snyder, H.L., Turpin, J.A., and Maddox, M.E. Quality metrics of digitally-derived imagery and their relation to interpreter performance II - Effects of blur and noise on hard copy interpretability. Blacksburg, Virginia: Virginia Polytechnic Institute and State University, August, 1981, HFL-81-2.

12. Maddox, M.E. Two-dimensional spatial frequency content and confusions among computer-generated dot-matrix characters. SID Proceedings, 1980, 21, 31-40.

13. Maddox, M.E. Two-dimensional spatial frequency content and confusions among computer-generated dot-matrix characters. Proceedings of the 23rd Annual Meeting of the Human Factors Society, Boston, MA: October, 1979. Runner-up in the student paper competition.

14. Snyder, H.L., and Maddox, M.E. Image quality for dot-matrix displays. SID Proceedings, 1979, 21, 3-8.

15. Snyder, H.L. and Maddox, M.E. Legibility optimization of computer-generated dot-matrix alphanumerics. Proceedings of the 1978 International Conference on Cybernetics and Society, Tokyo, Japan: November, 1978.

16. Snyder, H.L. and Maddox, M.E. Information transfer for computer-generated dot-matrix displays. Blacksburg, Virginia: Virginia Polytechnic Institute and State University, October, 1978, HFL-78-3/ARO-78-1.

17. Maddox, M.E., Burnette, J.T., and Gutmann, J.C. Font Comparisons for 5 X 7 dot-matrix characters. Human Factors, 1977, 19, 89-93.

18. Maddox, M.E. Prediction of information transfer from computer-generated dot-matrix displays. Proceedings of the 21st Annual Meeting of the Human Factors Society, San Francisco, CA: October, 1977.

19. Maddox, M.E. Font comparisons for 5X7 dot-matrix characters. Proceedings of the 84th Annual Meeting of the American Psychological Association, Division 21, Washington, D.C.: 1976.

Professional Associations:

Human Factors Society

Optical Society of America

ATTACHMENT 2

A.) Columns 1, 2, & 3 of attached forms:

Sample filled-in data forms of the analysis and identification of information and control needs.

B.) Column 4 of attached form:

Sample filled-in data forms of the verification of the needs being satisfied in the control room.

C.) Column 5 of attached form:

Additional remarks.

ADEQUATE CORE COOLING - GENERAL

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INFORMATION & CONTROL REQUIREMENTS

TASK/STEP	INFORMATION & CONTROL REQUIREMENTS	SPECIFIC REQUIREMENTS (RANGE/SCALE/RESOLUTION)	EXISTING INSTRUMENT/ CONTROL	2nd Verification 4/4/84 REMARKS
IDENTIFY ABNORMAL CORE TEMP	AVERAGE CORE OUTLET TEMP	0-1000°F	HS1187 (Selects fuel to be read on digital meter)	Hourly dose of computer 0-999°F
	REGION DEVIATION FROM TAVE	± 50°F	must be calculated	± 50 from Data Logger Hand Calc or Observation
IDENTIFY ABNORMAL STEAM TEMP	PROGRAM VALUE OF REHEAT	0-1000°F	TC 2256 (Avg)	Program value derived, from TC-2256 (Setpoint & null) if controller in Auto.
	CURRENT " " "	0-1000°F	TR 2255	
	DEVIATION FROM PROGRAM	± 10°F	must be calculated	
VERIFY ABNORMAL TEMP	NEUTRON FLUX & TREND	0-110%	NR1133-1	No He flow Trend Avail.
	He FLOW TREND	INCREASING/ DECREASING	SI 2109/SI 2110/15/16	
	FW FLOW TREND	INCREASING/ DECREASING	PR 2205/06	
	ELEC OUTPUT TREND	INCREASING/ DECREASING	MW/MVAR Records (2109)	← HED 803 on functional GRPH
IDENTIFY LOSS OF He CIRCULATION	He FLOW RATE	< 2% ONLY 1 CIRC. RUNNING.	SI 2109/10/15/16.	FI-1157-1 (Typ) MIN. 5% INCREMENT.
	STATUS OF CIRCULATORS	TRIPPED		CIRC SPEED INDICATIVE
VERIFY LOSS OF He CIRCULATION	He FLOW RATE	< 2% ANY CIRC.		FI-1157-1 (Typ) MIN. 5% INCREMENT.
	He CIRC SPEED	< 3000 ± 300 rpm ANY CIRC.	SI 2109/10/15/16	CIRC SPEED INDICATIVE
VERIFY He CIRCS AVAILABLE	BRAKE STATUS	SET	HS 21206 Release/Set	QUAL CHECK.
	SEAL STATUS	SET	HS 21194 Release/Set	
	BUFFER He PRESSURE		FI 2170 (PDI 21392)	
	BEARING H_2O "		PDI 21286-2	

EXSITE CORE COOLING - PRIMARY FLOW

INFORMATION & CONTROL REQUIREMENTS

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TASK/STEP	INFORMATION & CONTROL REQUIREMENTS	SPECIFIC REQUIREMENTS (RANGE/SCALE/RESOLUTION)	EXISTING INSTRUMENT/ CONTROL	REMARKS
1D. INCREASE CIRCULATOR SPEED BY STARTING FIREWATER SYSTEM	CIRCULATOR SPEED	3000 ± 500 rpm.	SC 2109 (SI) SC 2110 SC 2115 SC 2116	
D1 VERIFY WATER IS AVAILABLE IN FIREWATER PUMP SUMP	FIREWATER SUMP LEVEL		LIC 4107	Indicates if level is high or low from preset level
D2. ALIGN DISCHARGE OF ELEC. FIRE PUMP TO EMERGENCY COND. HEADER	DISCHARGE BLOCK VALVE CONTROL BLOCK VALVE STATUS INDICATION	OPEN/CLOSE OPEN/CLOSED	Local valve and indication HS - 31122 & LIGHTS ASSOC. WITH SWITCH	Spool piece needs to be installed
D3. START ELECTRIC FIRE PUMP	PUMP MOTOR CONTROL MOTOR STATUS INDICATION	ON/OFF RUNNING/STOPPED	HS 4504-2 Trip/Close II 4504 / PI 4502 Discharge Lights	SOURCES OF ELECTRICITY ONSITE - NORMAL & EMERG. OFFSITE ACM
D4 MONITOR CIRC. SPEED INCREASE TO MINIMUM	CIRC. SPEED	3000 ± 500 rpm	SC 2109 (SI) SC 2110 SC 2115 SC 2116	
D5. ALIGN DISCHARGE OF DIESEL FIREPUMP TO EMER. COND. HEADER	DISCHARGE BLOCK VALVE CONTROL BLOCK VALVE STATUS INDICATION	OPEN/CLOSE OPEN/CLOSED	Local valve and indication D2 SAME AS	THE DIESEL FIREPUMP WOULD BE STARTED ONLY IF NO ELECTRICITY AVAILABLE. (Start pump)

ENSURE CORE COOLING - PRIMARY FLOW

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INFORMATION & CONTROL REQUIREMENTS

TASK/STEP	INFORMATION & CONTROL REQUIREMENTS	SPECIFIC REQUIREMENTS (RANGE/SCALE/RESOLUTION)	EXISTING INSTRUMENT/ CONTROL	REMARKS
D6. START DIESEL	DIESEL MOTOR CONTROL MOTOR STATUS INDICATION	START/STOP RUNNING/STOPPED ENGINE RPM	P4504-1 OFF/Start PI 4502 (Control Rm) Local INDICATION	- CAN'T STOP FROM CR RED LIGHT ABOVE SWITCH
D7. MONITOR CIRC SPEED INCREASE TO MINIMUM	CIRC SPEED	3000 ± 500 rpm	SC 2109 (SI) SC 2110 SC 2115 SC 2116 ↓	D
I8. VERIFY MINIMUM He Flow	Loss PURGE He Flow INSTRUMENTATION	≥ 1% OF MAX MASS FLOW RATE OF CIRC.		
I9. ESTABLISH MINIMUM CIRC. SPEED WITH FEEDWATER FROM COND. DEMIN ("B") BFP	CIRCULATOR SPEED	3000 ± 500 rpm	SC 2109 (SI) SC 2110 SC 2115 SC 2116 ↓	
E1. VERIFY OIL FLOW FOR "B" BFP	AUX. OIL PUMP STATUS AUX. OIL PUMP CONTROL OIL FLOW INDICATION	RUNNING/STOPPED START/STOP ? gpm	INDICATING LIGHTS HS 31137 AUTO/STOP Close Pressure on filters Sight glass on bearing	
I2. VERIFY RECIRC. VALVE FOR "B" BFP OPEN	RECIRC VALVE CONTROL RECIRC VALVE STATUS	OPEN/CLOSE OPEN/CLOSED	HS 3102 AUTO/OPEN Indicating Lights	- CANNOT CLOSE MANUALLY DIRECT INDICATION

ENSURE CORE COOLING - PRIMARY FLOW

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INFORMATION & CONTROL REQUIREMENTS

TASK/STEP	INFORMATION & CONTROL REQUIREMENTS	SPECIFIC REQUIREMENTS (RANGE/SCALE/RESOLUTION)	EXISTING INSTRUMENT/ CONTROL	REMARKS
E3. ALIGN "B" BFP SUCTION TO DEAERATOR	SUCTION VALVE CONTROL SUCTION VALVE STATUS	OPEN/CLOSE OPEN/CLOSED	Local control Local Indication	NORMALLY OPEN TO DEAERATOR
E4. VERIFY "B" BFP DISCHARGE TO ENER. FW. HEADER CLOSED	DISCHARGE VALVE CONTROL " " STATUS	OPEN/CLOSE OPEN/CLOSED	HS 31119 Close/Open Indicating lights	Operator opens this after he starts pump - flow if pump is started
E5 START "B" BFP	"B" BFP MOTOR CONTROL MOTOR CURRENT INDICATION DISCHARGE PRESSURE INDIC.	START/STOP 0 - 800 AMPS 0 - 4000 PSI	HS 3107 Trip/Close II 3107 PI 3102	CI CIC
E6 SLOWLY OPEN "B" BFP DISCHARGE TO ENER. FW. HEADER	DISCHARGE VALVE CONTROL " " POSITION ENER FW FLOW	THROTTLE % OPEN 0 - 100%	HS 31119 Throttle FI 3102 (KLB/hr) HC 31209 (Bypass HV31119) 0-100% valve travel	CIC HV valve
E7. BRING CIRC SPEED TO MINIMUM	CIRC WATER RECIR SPEED CONTROL CIRC. SPEED INDICATION	0 - 100% 3000 ± 300 rpm	SC 2109 (SI) SC 2110 SC 2115 SC 2116	
E8. VERIFY MINIMUM He FLOW	LOW RANGE He FLOW INSTRUMENTATION	≥ 1% OF MAX MASS FLOW RATE OF CIRC.		

EMSUBE CORE COOLING - PRIMARY FLOW
INFORMATION & CONTROL REQUIREMENTS

TASK/STEP	INFORMATION & CONTROL REQUIREMENTS	SPECIFIC REQUIREMENTS (RANGE/SCALE/RESOLUTION)	EXISTING INSTRUMENT/ CONTROL	REMARKS
F6 VERIFY TURBINE STOP VALUE CLOSED	TURBINE STOP VALVE CONTROL	OPEN/CLOSE	HS 31161 ~~TRIP/Reset~~ Reset HS 31162 TRIP HS 31163 Reset HS 31164 TRIP Indicator lights	
	TURBINE STOP VALVE STATUS	OPEN/CLOSED		
F7 VERIFY TURBINE CONTROL VALVE CLOSED	TURBINE CONTROL VALVE CONTROL	OPEN/CLOSE	HS 31165 Raise/Manual/Lower HS 31166 ↓ HC 21127 Open/Close HC 21128 ↓	} Motor Speed Control } Steam Cond. control
	TURBINE CONTROL VALVE STATUS	OPEN/CLOSED		
F8 VERIFY TURBINE DRAINS OPEN	TURBINE DRAIN VALVE(S) CONTROL	OPEN/CLOSE	HS 31184 OPEN/close HS 31185 HS 31186 HS 31187-89 ↓ Indicating lights	Spring return to mid position
	DRAIN VALVE(S) STATUS	OPEN/CLOSED		
F9 ADMIT STEAM TO TURBINE CONTROL VALVE	TURBINE STOP VALVE CONTROL	OPEN/ CLOSE	See F6	
	STOP VALVE STATUS	OPEN/CLOSED		
F10 ADJUST TURBINE SPEED TO ~~2500~~ 3000 rpm	TURBINE CONTROL VALVE CONTROL	THROTTLE	See F6	
	TURBINE SPEED INDICATION	0 - 5000 rpm	Indicating 0-5000 RPM (NO ✱)	
F11 VERIFY TURBINE DRAINS CLOSED	TURBINE DRAIN VALVE(S) CONTROL	OPEN/CLOSE	See F8	
	TURBINE DRAIN VALVE(S) STATUS	OPEN/CLOSED		

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(17)

INFORMATION & CONTROL REQUIREMENTS

TASK/STEP	INFORMATION & CONTROL REQUIREMENTS	SPECIFIC REQUIREMENTS (RANGE/SCALE/RESOLUTION)	EXISTING INSTRUMENT/ CONTROL	REMARKS
F12. ALIGN BFP DISCHARGE TO EMERG. FEEDWATER HEADER	BFP TO EMER. FW HEADER ISOLATION VALVE CONTROL ISOLATION VALVE POSITION	OPEN/CLOSE OPEN/CLOSED	HS 31118 Close/Open HS 31120 ↓ Indicating Lights PI 31129 0-5000#	
F13. ADJUST CIRC SPEED TO MINIMUM	CIRC SPEED CONTROL CIRC SPEED	THROTTLE 3000 ± 100 rpm	SC 2109 (SI) SC 2110 SC 2115 SC 2116 ↓	IF SPEED NOT ATTAINABLE, PUT OTHER TURBINE-DRIVEN BFP ON LINE BY RESTARTING F1 THEN F12.
F10. VERIFY MINIMUM He FLOW	LOW RANGE He FLOW INSTRUMENTATION	≥ 1% OF MAX MASS FLOW RATE OF CIRC.		IF He FLOW NOT ATTAINED, HAVE EXHAUSTED RESOURCES FOR H_2O TURBINE MOTIVE FORCE.

ADEQUATE CORE COOLING - GENERAL

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INFORMATION & CONTROL REQUIREMENTS

TASK/STEP	INFORMATION & CONTROL REQUIREMENTS	SPECIFIC REQUIREMENTS (RANGE/SCALE/RESOLUTION)	EXISTING INSTRUMENT/ CONTROL	REMARKS
VERIFY STEAM AS SOURCE OF CIRC POWER	STEAM PRESSURE AT CIRC TURBINE INLET	0 - 200 PSI	PI 2243 | 0-1000 psi PI 2244 | ↓	THIS IS NOT A TECHNICALLY VIABLE OK
RESTART CIRCS ON STEAM	STEAM BLOCK VALVES " CONTROL VALVES CIRC SPEED He FLOW	OPEN/CLOSED THROTTLE 3000 ± 500 rpm 30%	HS 2245-8 OPEN/CLOSE SC 2103/6/11/12 Throttle SI 2103/6/11/12	ALTERNATIVE UNDER EMERGENCY CONDITIONS. OK
VERIFY H_2O AS SOURCE OF CIRC POWER	WATER PRESSURE AT CIRC. TURBINE INLET	PSI	HDR Press from Supplying Source	SEE EXPANDED INFO. AND CONTROL REQMTS OK
RESTART CIRCS ON H_2O	H_2O BLOCK VALVES H_2O CONTROL VALVES CIRC SPEED He FLOW	OPEN/CLOSED THROTTLE 3000 ± 500 rpm ≥ 1% Flow.	HS-2109-1/2 Close/open SC-2109/10/15/16 SI-2109/10/15/16 ~~Flow~~ to Flow Value displayed	FORMS FOR H_2O CIRC RESTART. CIRC Speed Taken as indication of Flow
IDENTIFY LOSS OF SECONDARY FLOW	FW FLOW STEAM FLOW	25% EITHER LOOP 25 % EITHER LOOP	FR 2205/06 (?) FR-2205/6	- OK NO Steam Flow indication Use FW Flow OR STM PRESS
VERIFY LOSS OF SECONDARY FLOW	FW FLOW FW PUMP STATUS STEAM FLOW STATUS OF STM ISOL. VALVES	25% TRIPPED 25% OPEN/CLOSED	FR2205/06 PI 3112 (Output of purge) HS-2201/2 F.W HS-2203/4 M S HS-2249/50 CRNT HS-2251/4 MRNT	OK - Indicating lights for pumps PI-342 OK) for F.W. PUMPS. USE PI-31129 For Emerg Feature. OK.

ENSURE CORE COOLING - PRIMARY FLOW

INFORMATION & CONTROL REQUIREMENTS

TASK/STEP	INFORMATION & CONTROL REQUIREMENTS	SPECIFIC REQUIREMENTS (RANGE/SCALE/RESOLUTION)	EXISTING INSTRUMENT/ CONTROL	REMARKS
A5. Connect H_2O turbine to condensate source for circ to be started	Circ condensate supply valve	OPEN/CLOSE control " indication	HS 21257 HS 21258 HS 21259 HS 21260 open/close DN	No indication of valve position until you try to raise speed & circ
A6. Increase circ speed	H_2O turbine control valve control valve position indication Circ speed indicator	Throttle control valve position % open 3000 ± 500 rpm	SC 2109 (SI) SC 2110 SC 2115 SC 2116	May not be able to get ECP's speed. If not, go to steps in 1B.
A7. Verify minimum He flow	Low range He flow indication.	≥ 1% of max mass flow rate of circ.		Pressure taps used since % flow indications not reliable at very low Δp
1B Increase circulator speed by increasing condensate flow	Circulator speed	3000 rpm ± 500	SC 2109 (SI) SC 2110 SC 2115 SC 2116 DVP	OK
B1 Put high capacity steam traps in service	Steam trap inlet/outlet valve controls	Inlet/outlet valves open/close controls " indication	Local control & indication	
B2 Open steam turbine trap bypass valves	Steam trap bypass valve controls	Open/close controls " indication	HS 2109-1 HS 2110-1 HS 2115-1 HS 2116-1 open/close OK	Lights for indication - No separate controls for these. They work in conjunction w/ inlet & outlet block valves

FAILURE CORE COOLING - PRIMARY FLOW (PATH 1)

INFORMATION & CONTROL REQUIREMENTS

TASK/STEP	INFORMATION & CONTROL REQUIREMENTS	SPECIFIC REQUIREMENTS (RANGE/SCALE/RESOLUTION)	EXISTING INSTRUMENT/ CONTROL	REMARKS
1 VERIFY MINIMUM He FLOW	LOW RANGE He FLOW INDICATION	≥ 1% OF MAX MASS FLOW RATE OF CIRC		PRESSURE TAPS USED SINCE % FLOW INDICATIONS NOT RELIABLE AT VERY LOW FLOWS.
1 A START ONE CIRC IN ONE LOOP ON WATER TURBINE DRIVE	CIRCULATOR SPEED CONTROL CIRC SPEED INDICATION	THROTTLE 2000 ± 200 rpm	SI 2109 SI 2105 SI 2110 SI 2106 SI 2115 SI 2111 SI 2116 SI 2112	THIS ENTRY SUPPOSED ASSUMES NO FEEDWATER AVAILABLE. STARTUP IND SHOULD MATCH
A1. ESTABLISH OUTLET PATH FOR WATER TURBINE - BOTH CIRCS -	TURBINE H_2O DRAW VALVE CONTROLS	OPEN/CLOSE CONTROLS " INDICATIONS	HS-2109-2 open/close HS 2110-2 op/cls HS-2115-2 HS-2116-2 ↓	Lights use for indication & Speed indication
A2. ISOLATE SPEED CONTROL FOR H_2O TURB. ON NON-OPERATING CIRC.	H_2O TURBINE CONTROL VALVE CONTROL CONTROL VALVE POSITION INDICATION	OPEN/CLOSE CONTROL OPEN/CLOSED STATUS % OPEN	SC-2109 SC 2110 SC 2115 SC 2116	
A3. ISOLATE H_2O SUPPLY FOR NON OPERATING CIRC.	H_2O BLOCK VALVE CONTROL	OPEN/CLOSE CONTROL " INDICATION	HS 2109-1 open/close HS-2110-1 HS-2115-1 HS 2116-1 ↓	Lights for indication & Speed indication
A4 ALIGN H_2O TURBINE TO H_2O SUPPLY FOR CIRC TO BE STARTED	H_2O BLOCK VALVE CONTROL	OPEN/CLOSE CONTROL " INDICATION	SAME AS ABOVE	

(5)

(19)

ADEQUATE CORE COOLING - GENERAL

INFORMATION & CONTROL REQUIREMENTS

TASK/STEP	INFORMATION & CONTROL REQUIREMENTS	SPECIFIC REQUIREMENTS (RANGE/SCALE/RESOLUTION)	EXISTING INSTRUMENT/ CONTROL	REMARKS
VERIFY STEAM GENERATORS AVAILABLE	LOOP DUMP STATUS	DUMPED	~~HS 2115 17~~ INDICATING LTS HS-2215 & HS-2217 Dump valve alarm (Hi Low Level/press/temp)	INDICATIVE OF Loop Dump INDICATIVE of a Dump.
VERIFY H_2O AVAILABLE FOR SECONDARY COOLANT	CONDENSATE LEVEL ELEC POWER AVAIL STEAM AVAILABLE	% 600 VOLTS PSI	CI 3138/41 0-100% Volt meters PI-5312/0 TO BFP Turbine PIC-5207 (150# HDR Press)	OK - OK. PIC-5201 controls to HDR
ESTABLISH H_2O FLOW STEAM GENERATORS	FW/COND ISOLATION VALVES FW/COND CONTROL VALVES FW/COND PUMP CONTROL STEAM ISOL. VALVES	OPEN/CLOSED THROTTLE ON/OFF OPEN/CLOSED	HV-2203/4 FV-2205/6 HS-3130/1 (07-BBFP) SI-5318/26 MS-2223 MS. 2253/4 HRHT	← USE FLOW AS FEEDBACK ← Indic. Lights ARE BREAKER POSITION (USE Press or Flow) (OR Speed on 1A, 1C)
MONITOR CORE TEMPERATURES	INCORE HELIUM TEMP	0-5000°F	TI 11139-41 (Region Outlet)	(Computer can be used NO INCORE Temp Indic. Use Region Outlet.

ENSURE CORE COOLING - TERTIARY Flow

(9)

INFORMATION & CONTROL REQUIREMENTS

TASK/STEP	INFORMATION & CONTROL REQUIREMENTS	SPECIFIC REQUIREMENTS (RANGE/SCALE/RESOLUTION)	EXISTING INSTRUMENT/ CONTROL	REMARKS
B3 VERIFY APPROPRIATE CONDENSATE HEADER PRESSURE	CONDENSATE HEADER PRESSURE	≥ 240 PSI	PI 3149 (Non Cond) PI 3111 (EMERG Cond)	OK
B4 VERIFY BOTH C&D CONDENSATE PUMPS OPERATING & 1 BOOST PUMP	CONDENSATE PUMP CONTROLS " " STATUS INDICATION BOOST PUMP CONTROLS	START/STOP RUNNING/STOPPED START/STOP	HS 3130 (Trip/Close) HS 3131 (Trip/Close) II 3130 (AMPS) II 3131 (AMPS)	IF STILL NOT ENOUGH CIRC SPEED, HAVE TO PUT AUX BOILER FEED PUMPS ON LINE
B5 ALIGN AUX BFP SUCTION TO CONDENSATE STORAGE TANKS	SUCTION VALVE CONTROLS SUCTION VALVE POSITION INDICATION	OPEN/CLOSE OPEN/CLOSE	Local operation & Local Indication HS-3127	WRITTEN UP BECAUSE OF LABELING
B6 ALIGN AUX BFP DISCHARGE TO EMERGENCY CONDENSATE HEADER	DISCHARGE VALVE CONTROLS DISCHARGE VALVE POSITION INDICATION	OPEN/CLOSE OPEN/CLOSE	HS 31121 OPEN/Close Indicating lights	OK —
B7 START AUX BFPs	AUX BFP MOTOR CONTROLS BFP STATUS INDICATION	START/STOP RUNNING/STOPPED	HS 8402 Trip/Close HS 8404 Trip/Close Indicating lights	OK OK
B8 VERIFY CIRCULATOR SPEED INCREASING MINIMUM	CIRC SPEED INDICATOR	3000 ± 500 rpm	SC 2109 (SI) SC 2110 SC 2115 SC 2116	OK

ENSURE CORE COOLING - PRIMARY FLOW

(19)

INFORMATION & CONTROL REQUIREMENTS

TASK/STEP	INFORMATION & CONTROL REQUIREMENTS	SPECIFIC REQUIREMENTS (RANGE/SCALE/RESOLUTION)	EXISTING INSTRUMENT/ CONTROL	REMARKS
B9. VERIFY MINIMUM He FLOW	LOW RANGE He FLOW INDICATION	± 1% OF MAX MASS FLOW RATE OF CIRC		PRESSURE TAPS USED SINCE ΔP FLOW INDICATORS NOT RELIABLE AT VERY LOW ΔP.
1C INCREASE CIRCULATOR SPEED BY DECREASING UNNECESSARY CONDENSATE FLOW TO SECONDARY	CIRCULATOR SPEED	3000 ± 500 rpm	SC 2109 (SI) SC 2110 SC 2115 SC 2116	THIS IS THE LAST STEP TO DO BEFORE GOING TO FEEDWATER SYSTEM.
C1. REDUCE MAIN STEAM PRESSURE	MAIN STEAM FLOW CONTROL VALVE CONTROL VALVE POSITION INDICATION MAIN STEAM PRESS INDICATOR	THROTTLE 0-100% OPEN ≤ 250 psig	PC 22129-1 PC 22130-1 PR 22129	PRESSURE can be obtained on controller also
C2. REDUCE CONDENSATE FLOW TO EES OF SGs.	CONDENSATE FLOW CONTROL VALVE CONTROL CONDENSATE FLOW INDICATION	THROTTLE 115 klb/hr ± 20 klb/hr.	FC 2205 FC 2206 FR 2205/FR 2206	
C3. VERIFY CIRCULATOR SPEED INCREASING TO MINIMUM	CIRC SPEED INDICATOR	3000 ± 500 rpm.	SC 2109 (SI) SC 2110 SC 2115 SC 2116	
C4. VERIFY MINIMUM He FLOW	LOW RANGE He FLOW INDICATION	± 1% OF MAX MASS FLOW RATE OF CIRC.		SEE REMARK AT B9 ABOVE.

ENSURE CORE COOLING - PRIMARY FLOW

INFORMATION & CONTROL REQUIREMENTS

TASK/STEP	INFORMATION & CONTROL REQUIREMENTS	SPECIFIC REQUIREMENTS (RANGE/SCALE/RESOLUTION)	EXISTING INSTRUMENT/ CONTROL	REMARKS
1F ESTABLISH MINIMUM CIRC. SPEED WITH FEEDWATER FROM STEAM DRIVEN BFPs				
F1. VERIFY STEAM PRESSURE ADEQUATE TO ROLL ONE BFP TURBINE	STEAM HEADER PRESSURE	~ 150 psig 0-200 psig RANGE	PI 5315 - Supply to turb 0-200 psig PIC 5201 - Aux Stm to 150# hdr (± from setpoint) PI 5318 - Supply to turb 0-200 psig	
F2. VERIFY TURBINE OUTLET ALIGNED TO GLAND SEAL CONDENSER	STEAM DISCHARGE ISOLATION VALVE CONTROL ISOLATION VALVE STATUS	OPEN/CLOSE OPEN/CLOSED	Local Control & Indication	? MUST HAVE MAIN CONDENSER AVAILABLE.
F3. VERIFY BFP SUCTION ALIGNED TO DEAERATOR	BFP SUCTION ISOLATION VALVE CONTROL SUCTION VALVE POSITION	OPEN/CLOSE OPEN/CLOSED	Local Control & Indication	NORMAL ALIGNMENT
F4. VERIFY RECIRC FLOW PATH ESTABLISHED	BFP RECIRC VALVE CONTROL RECIRC VALVE STATUS	OPEN/CLOSE OPEN/CLOSED	Auto/Close HS3101 Auto/Close HS3103 Indicating lights	CANNOT CLOSE w/ CR HANDSWITCH DIRECT INDICATION)
F5. VERIFY OIL FLOW FOR BFP	AUX. OIL PUMP CONTROL " " " STATUS OIL FLOW, INDICATION	START/STOP RUNNING/STOPPED ? gpm.	HS 31136 Stop/Start HS 31138 Stop/Start Indicating lights	[illegible]

ATTACHMENT 3

Sample filled-in data forms of the validation of EOP steps, action, information and control needs, traffic patterns, and component locations.

Entry Conditions

REDUCTION

A. Abnormal Flux Indication
- Continuous Reg Rod Insertion
- Reg Rod "In" Limit Light Flashing
- Analog Reg Rod Position Indication Approaching Zero
- Digital Reg Rod Position Indication
- Flux Deviation Meter >5%

Verify Abnormal Flux
- Positive Rate of Change
- Recorder Trace Increasing
- Runback Rods Inserting
- Reheat Temp. Increasing

Flux Abnormal ? — NO → Rx Shutdown not Required → END

Flux Abnormal ? — YES

B. Alarms Indicating Abnormal Flux
- Rod Withdraw Prohibit
- High Flux
- High Flux Rate of Change
- Start Up Count Rate

C. Automatic Scram

In Reheat Mode? — NO → Manually Scram Rx → Turn Bus to "Off" and Remove Key + Tech Spec Req'mt # → E

In Reheat Mode? — YES → Notify Fuel Floor of Scram → Manually Scram Rx

D. Other Conditions Requiring Rx Shutdown → Manually Scram Rx

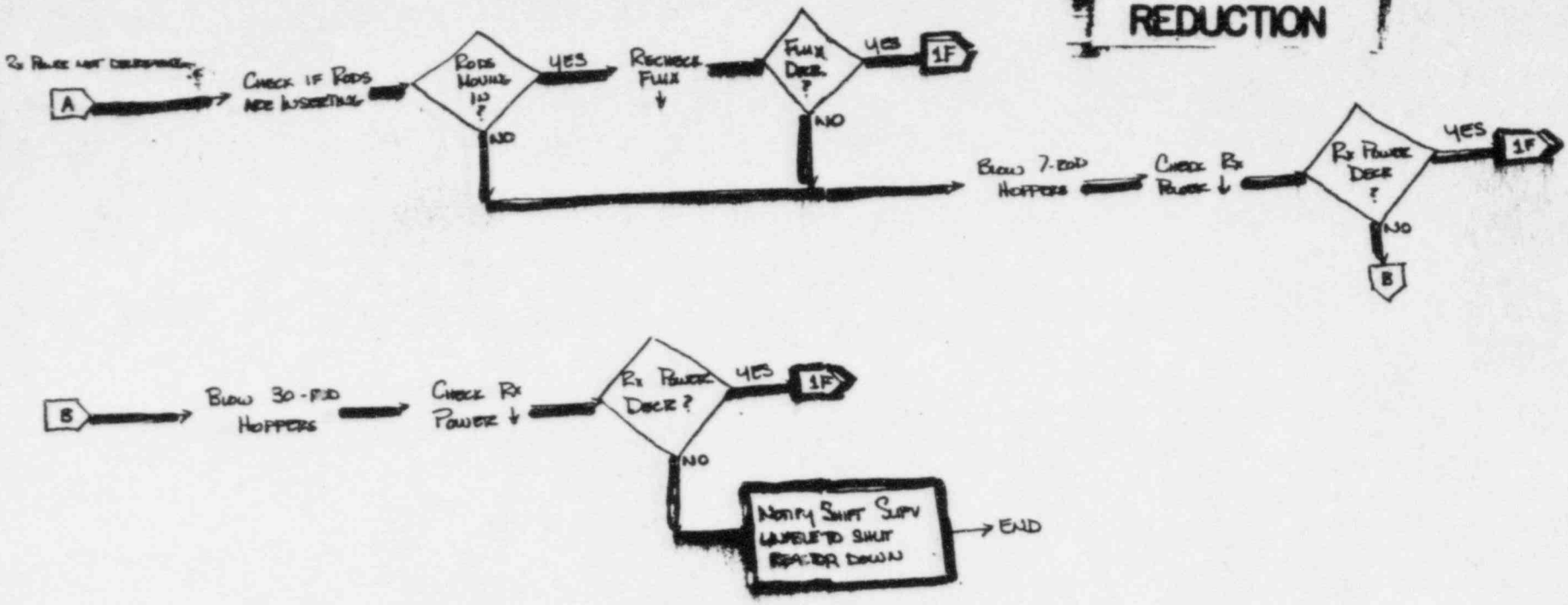
E → Verify Rx Power Decreasing → Rx Power Decreasing ? — NO → 2A

Rx Power Decreasing ? — YES → Monitor as Temperature Decreases (F) → Verify Rx Power Continues at Minimum → Rx Power Steady at Minimum ? — NO → E

Rx Power Steady at Minimum ? — YES → Reactor is Shutdown → END

Rx Shutdown

REDUCTION



REDUCTION

FORT ST. VRAIN
CONTROL ROOM DESIGN REVIEW
TASK ANALYSIS WALKTHRU

PROCEDURE	OPERATOR	REVIEW TEAM	DATE
Rx SHUTDOWN	SG	[illegible]	12-NOV-87

GENERAL STEP	CUE	INSTR.	ALM'S	COMM.	REMARKS
INITIAL CONDITIONS • 70% POWER • ~~RANDOM OTHER~~	TELL OPERATOR CONDITIONS				
1 ABNORMAL FLUX CONDITIONS	WHAT ARE YOUR FIRST INDICATIONS OF ABNORMAL FLUX?	CLICKING OF REC ROD ON Ø CONTROLLER ROD IN/OUT LIGHT.	NONE.		
ABNORMAL FLUX VERIFICATION	HOW WOULD YOU VERIFY THAT YOU HAD ABNORMAL FLUX?	RECHART SIM TR2238 MAIN STM 2212, 122 FEED FLOWS FR 2205, 06 MAYBE POWER RANGE RECORDER 1132-2.		ASK EAST BOD OPERATOR ABOUT RUBBLE (1ST MIN)	
3. AUTOMATIC SCRAM	HOW WOULD YOU KNOW YOU HAD AN AUTO SCRAM? WHAT WOULD YOU DO?	ROD OUT LIGHTS - OUT ANALOG POSITION. CIRC SPEEDS SI 2105, 2111, 2110, 2110 FEED FLOWS FF 2205, 2206 SILENCE THE ANNUN (ON I-08) LOOK FOR FIRST OUT	SCRAM HORN SINGLE CHAN TRIP LIGHTS ON I-03A REASON FOR SCRAM ON I-03B		SILENT SCRAM IS OBVIOUS

REDUCTION

FORT ST. VRAIN
CONTROL ROOM DESIGN REVIEW
TASK ANALYSIS WALKTHRU

PROCEDURE	OPERATOR	REVIEW TEAM	DATE
FX SHUTDOWN	SS	MANFOX - COMPOSITE	17-NOV-83

GENERAL STEP	CUE	INSTR.	ALM'S	COMM.	REMARKS
3a AUTO SCRAM IN REFUEL MODE	WHAT WOULD YOU DO DIFFERENTLY IF YOU HAD AN AUTO SCRAM IN REFUEL MODE?			HOOK REFUEL BOOTH PHONE W/ CONVENTIONAL PHONE	
4. CONFIRM THE RX	MANUALLY SCRAM THE REACTOR.	SCRAM SWITCH AS-9350	SILENCE ALARMS EXCEPT TO GET MANUAL SCRAM ANNUNCIATORS BUT DON'T CARE		
5. SILENCE RESULTING ALARMS.	SILENCE ANY ALARMS THAT RESULT FROM THE SCRAM.		SILENCE JUST FOR I&E, NOT EITHER PANELS		
6. TURN RMS TO "OFF" & REMOVE THE KEY	PLACE THE RMS IN THE CORRECT POSITION.	RMS SWITCH HS-1216			WON'T REMOVE KEY

REDUCTION

FORT ST. VRAIN
CONTROL ROOM DESIGN REVIEW
TASK ANALYSIS WALKTHRU

PROCEDURE	OPERATOR	REVIEW TEAM	DATE
Rx SHUTDOWN	JS	MADDOX - COMPOSITE	17-NOV-82

GENERAL STEP	CUE	INSTR.	ALM'S	COMM.	REMARKS
7. VERIFY Rx POWER ↓	VERIFY THAT THE SCRAM HAS TAKEN EFFECT.	ROD OUT LIGHTS OUT ROD IN LIGHTS FLASHING ROD PERMISSIVE INDICATION (IE GREEN LIGHTS NOT FLASHING) NIR POWER DECREASE NR 1131, 1131-1 REMCAT TR 2275 MAIN STEAM 22121, 122			
8. JUDGE Rx SHUTDOWN	HOW WOULD YOU DECIDE THAT THE REACTOR IS SHUTDOWN?	IF RODS ARE GOING IN, THEN JUDGE REACTOR TO BE SHUTDOWN ROD IN LIGHTS FLASHING FLUX POSITION ANALOGS			
9. REACTOR POWER NOT ↓	ASSUME THAT THE REACTOR POWER IS NOT DECREASING. HOW WOULD YOU KNOW?	TEMPERATURE REMCAT TR 2275 MAIN STM 22121, 122	TOR/PLO ALARM 2-7 I-03 A.		DOESN'T USE FLUX INDICATION EXCEPT AS A BACKUP. MIGHT CHECK COMPUTER SCREEN. MORE LIKELY TO USE COMPUTER FOR FLUX INDICATION THAN I-03

REDUCTION

FORT ST. VRAIN
CONTROL ROOM DESIGN REVIEW
TASK ANALYSIS WALKTHRU

PROCEDURE	OPERATOR	REVIEW TEAM	DATE
Rx SHUTDOWN	SS	MANNOX - COMPOSITE	17-NOV-83

GENERAL STEP	CUE	INSTR.	ALM'S	COMM.	REMARKS
10. CHECK THAT THE RODS ARE MOVING IN.	HOW WOULD YOU VERIFY THAT THE RODS ARE INSERTING?	PANEL RP INDICATIONS (RED) ROD BOTTOM LIGHTS I-03 DIGITAL INDICATION: PI 1206, 07, 08, 09, 10, 11			IF NOT INSERTING, THEN PUT THIS SWITCH SHOULD BE RESET PULL BEFORE PUSH ON I-10.
11. IF RODS ARE NOT INSERTING OR Rx POWER NOT ↓ DUMP THE 7-ROD HOPPERS	DUMP THE 7-ROD HOPPERS	7-ROD HOPPER HS 1102-1, 1104-1	NOT AWARE OF THE ALARMS I-01A 1-9, BUT WOULD IGNORE.		LIGHTS COME ON (RED) BUT DON'T KNOW WHY.
12. VERIFY Rx POWER ↓.	HOW WOULD YOU VERIFY THAT THE HOPPERS HAVE HAD AN EFFECT?	WIDE RANGE RECORDER 1133, 1135-1. RATE OF CHANGE 1133, 34, 35-2 BACKUP WOULD BE PLANT COMPUTER, 3 MAIN STEAM 2281, 87.			

REDUCTION

FORT ST. VRAIN
CONTROL ROOM DESIGN REVIEW
TASK ANALYSIS WALKTHRU

PROCEDURE	OPERATOR	REVIEW TEAM	DATE
Rx SHUTDOWN	SS	MADDOX	17-NOV-83

GENERAL STEP	CUE	INSTR.	ALM'S	COMM.	REMARKS
3. IF POWER NOT ↓, DUMP THE 50-ROD HOPPERS.	DUMP THE 50-ROD HOPPERS.	50-ROD GROUP HOPPER SWITCHES HS 1102, 1102-2			
4. VERIFY Rx POWER.	HOW WOULD YOU VERIFY THAT THE HOPPERS HAVE HAD NO EFFECT?	SAME AS 12	EXCEPT J01A 1-9 WOULD NOT RE-ALARM.		
5. IF Rx POWER NOT ↓, NOTIFY THE SHIFT SUPERVISOR.	WHAT WOULD YOU DO IF THE REACTOR POWER IS STILL NOT DECREASING?				SEND BOP OPERATORS TO RESERVE SHUTDOWN PANELS TO BLOW BALLS.
	HOW WOULD YOU NOTIFY THE SHIFT SUPERVISOR?	TELEPHONE ON DESK INTERCOM IS QUESTIONABLE.			

FORT ST. VRAIN
CONTROL ROOM DESIGN REVIEW
TASK ANALYSIS WALKTHRU

REDUCTION

PROCEDURE	OPERATOR	REVIEW TEAM	DATE
Rx SHUTDOWN	GM	MADDOX - COMPOSITE (POST-WALKTHRU)	16-NOV.-83

GENERAL STEP	CUE	INSTR.	ALM'S	COMM.	REMARKS
INITIAL CONDITIONS • 70% POWER ~~• TURBINE ON LINE~~ • STEADY STATE CTL W/S BEING MAID • ALL OTHER SYSTEMS NORMAL • EQUIL THERE FOR 1 WEEK.	TELL OPERATOR CONDITIONS				
ABNORMAL FLUX CONDITIONS	WHAT ARE YOUR FIRST INDICATIONS OF ABNORMAL FLUX?	FLUX CONTROLLER • CLICK • REG ROD LIGHT • FLUX DEVIATION	I-03 4-2 RUNBACK 3-3 REG ROD OUT OF LIMITS		FOR FIRST 2 or 3 MINUTES, THE ONLY INDICATION IS THE FLUX CONTROLLER.
ABNORMAL FLUX VERIFICATION	HOW WOULD YOU VERIFY THAT YOU HAD ABNORMAL FLUX?	HE CIRC SPEEDS HE-2109, 2115, 2110, 2116 FEEDFLOW RECORDERS FR-2205, FR 2206 FEEDWATER PRESS RECORDS PR-22129, PR 22130	I-05A 1-3, 1-4, 1-5 POWER RANGE CHANS. HI.	ASK OTHER OTHER OP ABOUT TURBINE LOAD.	USE STEAM TURBINE SPEED, IF H_2O TURBINE OUT. FLOW CONTROLLERS HAVE 2 PENS, BUT THE SAME SCALE.
AUTOMATIC SCRAM	HOW WOULD YOU KNOW YOU HAD AN AUTO SCRAM? WHAT WOULD YOU DO?	SILENCE BOTH AT I-03	SCRAM HORN ANNUNCIATOR HORN) 2 SINGLE-CHAN TRIP ANNUNCIATORS ON I-02A		IN ABSENCE OF HORNS, LOTS OF CHANGES IN INSTRUMENTS WOULD CUE - ALSO TURBINE RUNBACK.

FORT ST. VRAIN
CONTROL ROOM DESIGN REVIEW
TASK ANALYSIS WALKTHRU

REDUCTION

PROCEDURE	OPERATOR	REVIEW TEAM	DATE
Rx SHUTDOWN	GM	HUMIDOX - COMPOSITE	16-NOV-83

GENERAL STEP	CUE	INSTR.	ALM'S	COMM.	REMARKS
3a. AUTO SCRAM IN REFUEL MODE	WHAT WOULD YOU DO DIFFERENTLY IF YOU HAD AN AUTO SCRAM IN REFUEL MODE?			CALL REFUELING FLOOR ON GAITRONICS AND NOTIFY OF SCRAM.	
4. SCRAM THE Rx	MANUALLY SCRAM THE REACTOR.	SCRAM SWITCH HS-9330	I-03B MANUAL SCRAMS I-03A SINGLE (ANY) SCRAMS		
5. SILENCE RESULTING ALARMS.	SILENCE ANY ALARMS THAT RESULT FROM THE SCRAM.	ANNUNC. SILENCE SWITCH ON I-05			WOULD NOT TRY TO SILENCE ALARMS ON OTHER BOARDS - CAN BECOME CONFUSED.
6. TURN RMS TO "OFF" & REMOVE THE KEY	PLACE THE RMS IN THE CORRECT POSITION.	HS-1216			TECH SPEC REQUIREMENT

FORT ST. VRAIN
CONTROL ROOM DESIGN REVIEW
TASK ANALYSIS WALKTHRU

REDUCTION

PROCEDURE	OPERATOR	REVIEW TEAM	DATE
Rx SHUTDOWN	GM	MARTON - COMPOSITE	16-NOV-83

GENERAL STEP	CUE	INSTR.	ALM'S	COMM.	REMARKS
VERIFY Rx POWER ↓	VERIFY THAT THE SCRAM HAS TAKEN EFFECT.	ROD OUT LIGHTS EXTINGUISH ROD POSITION INDICATORS SHOW ACCORDINGLY IN.			PROCEDURE SAYS CHECK POWER DECREASING, BUT RODS ARE BETTER INDICATION.
JUDGE Rx SHUTDOWN	HOW WOULD YOU DECIDE THAT THE REACTOR IS SHUTDOWN?	POWER RANGE ↓ NI 1133, 34, 35-3 NI 1136, 37, 38 INT. RANGE ↓ NI 1135, 34, 35-1 SOURCE RANGE IN NI 1131, 32-1 NR 1133-2, 1131, 1134-1 TR 2256 PERMIT BKUP TR 28121, 122 MAIN SYM.			
REACTOR POWER NOT ↓	ASSUME THAT THE REACTOR POWER IS NOT DECREASING. HOW WOULD YOU KNOW?	COMPARE LINEAR & LOG POWER CHANNELS NIE 1133, 34, 35-3 1136, 37, 38 NIE 1133, 34, 35-1 NIC 1199 FLUX CONTROL DEVIATION POWER RANGE			

REDUCTION

FORT ST. VRAIN
CONTROL ROOM DESIGN REVIEW
TASK ANALYSIS WALKTHRU

PROCEDURE	OPERATOR	REVIEW TEAM	DATE
Rx Shutdown	GM	MADDOX - COMPOSITE	16-NOV-83

GENERAL STEP	CUE	INSTR.	ALM'S	COMM.	REMARKS
CHECK THAT THE RODS ARE MOVING IN.	How would you VERIFY THAT THE RODS ARE INSERTING?	ROD POSITION LIGHTS " " DIGITAL ON I-08 " " " ON I-04			
IF RODS ARE NOT INSERTING OR Rx POWER NOT ↓ DUMP THE 7-ROD HOPPERS	DUMP THE 7-ROD HOPPERS	HS 1102-1, 1104-1 7-ROD HOPPERS LIGHTS LIGHT WHEN HELD LONG ENOUGH			GRABBED 30-ROD HOPPER SWITCHES. DIDN'T MENTION HOPPER INSERTION ALARM I-01A, 1-9
VERIFY Rx POWER ↓.	How would you VERIFY THAT THE HOPPERS HAVE HAD AN EFFECT?	SAME AS STEP 9.			MIGHT SEND SOMEONE TO CHECK SCRAM ROOM POWER SUPPLY ON J-10. WOULD NOT USE COMPUTER.

FORT ST. VRAIN
CONTROL ROOM DESIGN REVIEW
TASK ANALYSIS WALKTHRU

REDUCTION

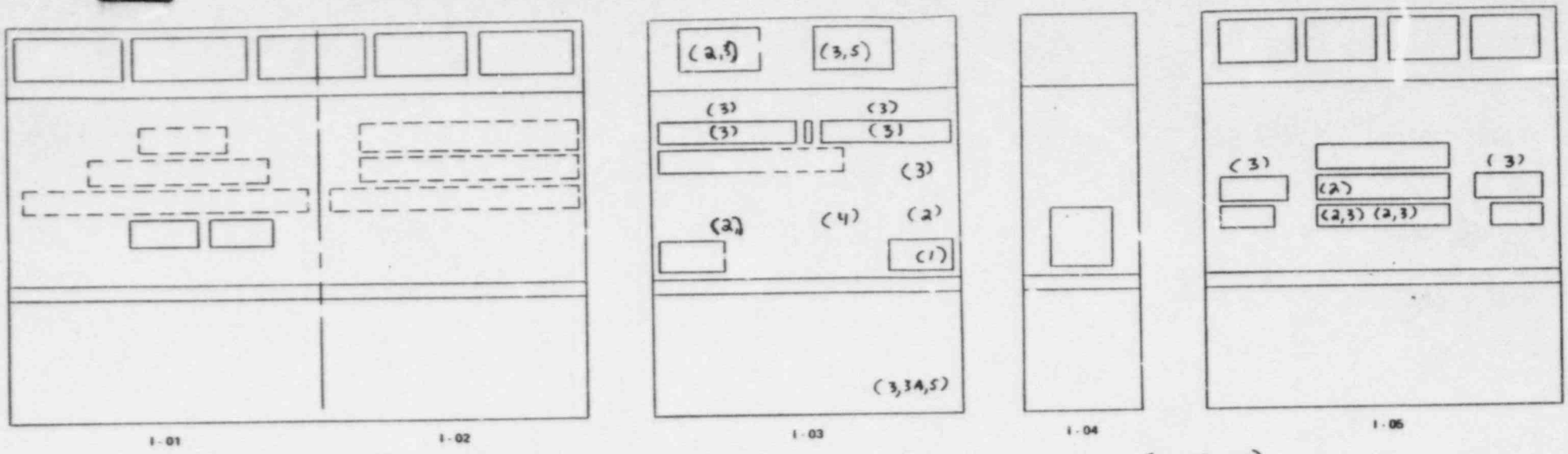
PROCEDURE	OPERATOR	REVIEW TEAM	DATE
Rx SHUTDOWN	6M	MADDOX - COMPOSITE	16-NOV-83

GENERAL STEP	CUE	INSTR.	ALM'S	COMM.	REMARKS
3. IF POWER NOT ↓, DUMP THE 90-ROD HOPPERS.	DUMP THE 90-ROD HOPPERS.	HS-1102-2, 1104-2 LIGHTS ABOVE GO AMBER WHEN TIME PERIOD UP.			
4 VERIFY Rx POWER.	HOW WOULD YOU VERIFY THAT THE HOPPERS HAVE HAD AN EFFECT?	SAME AS STEP 12.			
5 IF Rx POWER NOT ↓, NOTIFY THE SHIFT SUPERVISOR.	WHAT WOULD YOU DO IF THE REACTOR POWER IS STILL NOT DECREASING?				SHIFT ATTENTION TO CORE COOLING
	HOW WOULD YOU NOTIFY THE SHIFT SUPERVISOR?	PHONE SHIFT SUPV ON CAI-TRONICS ON I-04.			

PUBLIC SERVICE COMPANY OF COLORADO

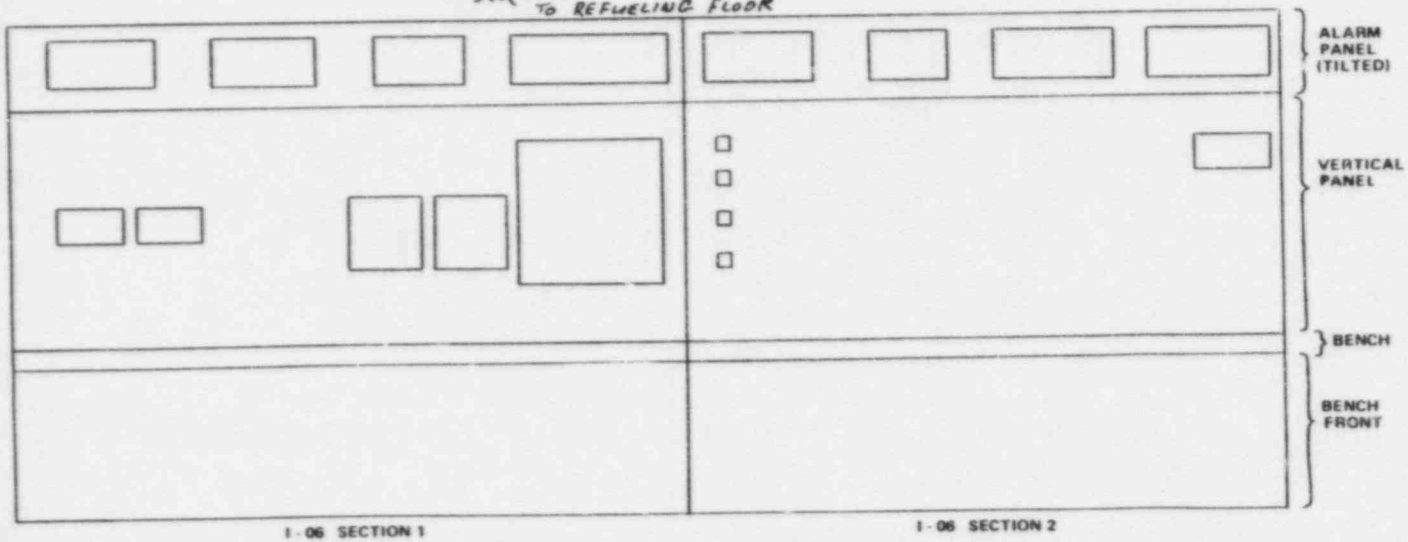
FORT ST. VRAIN NUCLEAR GENERATING STATION

FRONT PANEL ELEVATION MAP



3A (TELEPHONE)

SOUND POWER
3A (SPECIAL PHONE SYSTEM)
TO REFUELING FLOOR



REDUCTION

STEPS 1, 2, 3, 4

0 3"
SCALE

MAP NO. CRE SS

REFERENCE Ex Shutdown

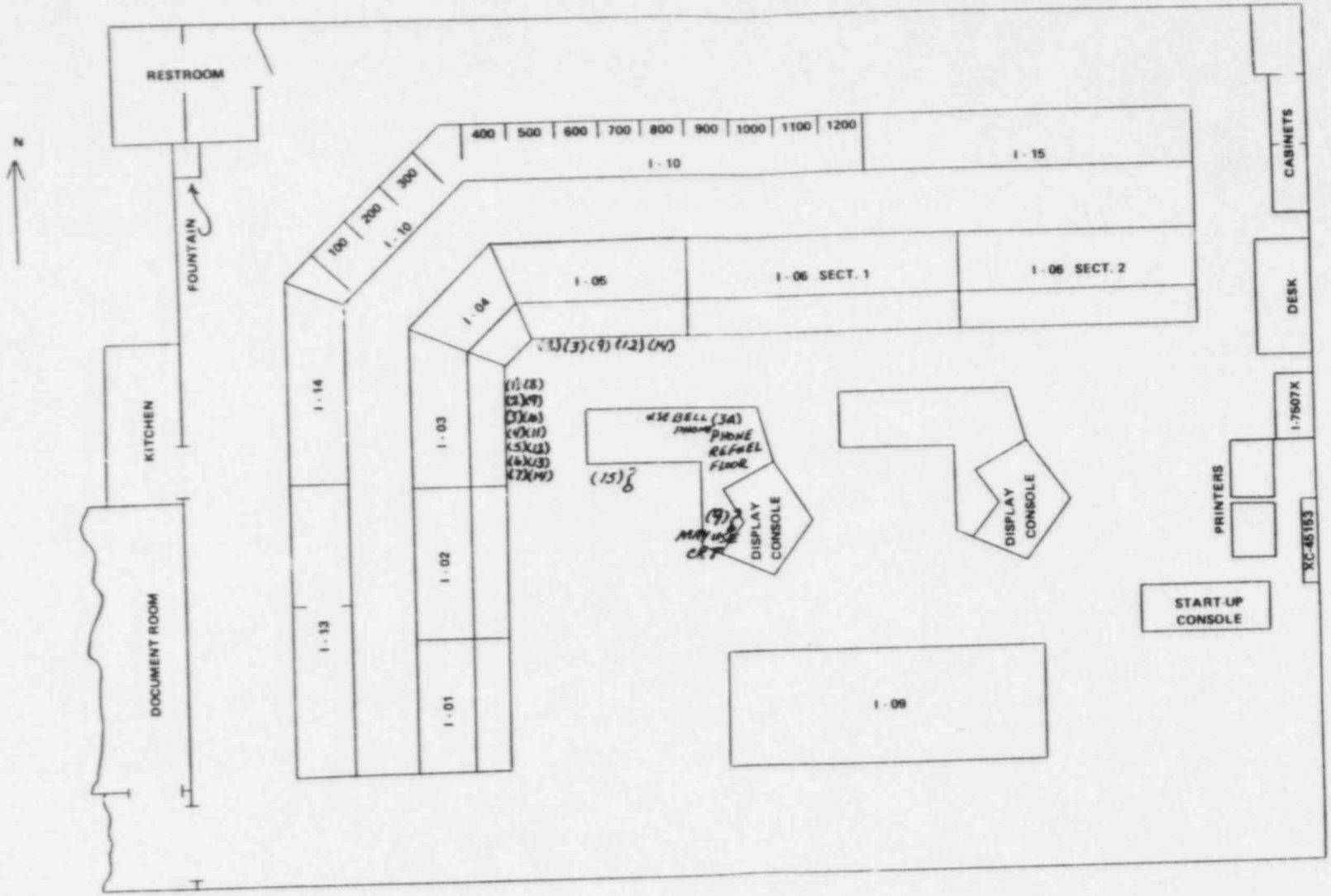
Form 344 24 4253

PUBLIC SERVICE COMPANY OF COLORADO

FORT ST. VRAIN NUCLEAR GENERATING STATION

CONTROL ROOM PLAN VIEW

REDUCTION



0 6'

SCALE

MAP NO. OFF SS

REFERENCE D. SHADOW

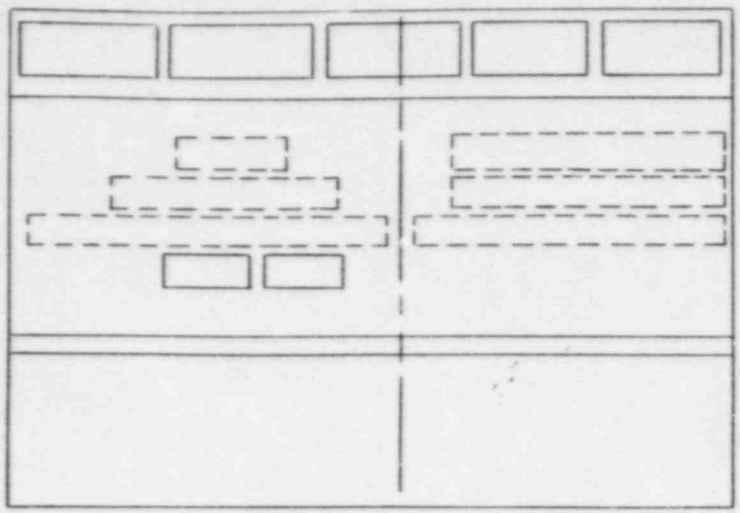
Form 344 24 4238

PUBLIC SERVICE COMPANY OF COLORADO

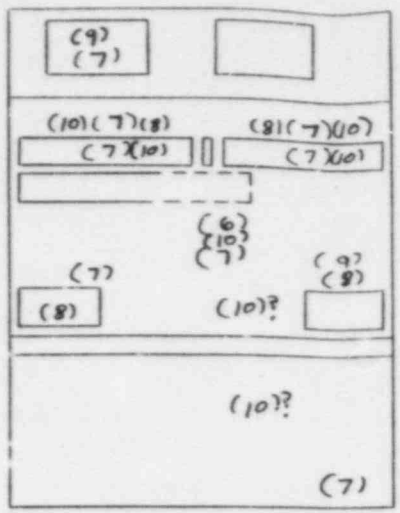
FORT ST. VRAIN NUCLEAR GENERATING STATION

FRONT PANEL ELEVATION MAP

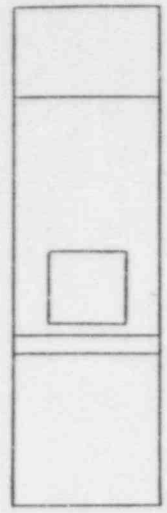
REDUCTION



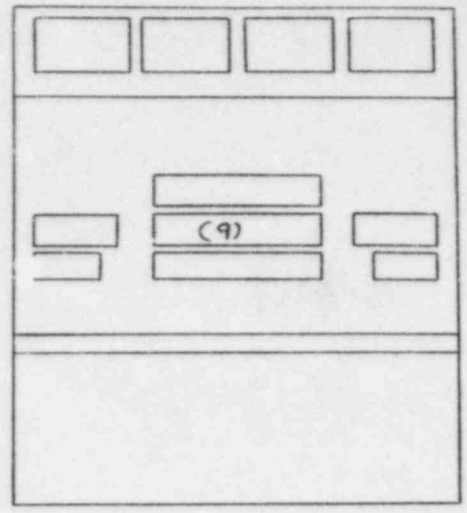
I-01 I-02



I-03

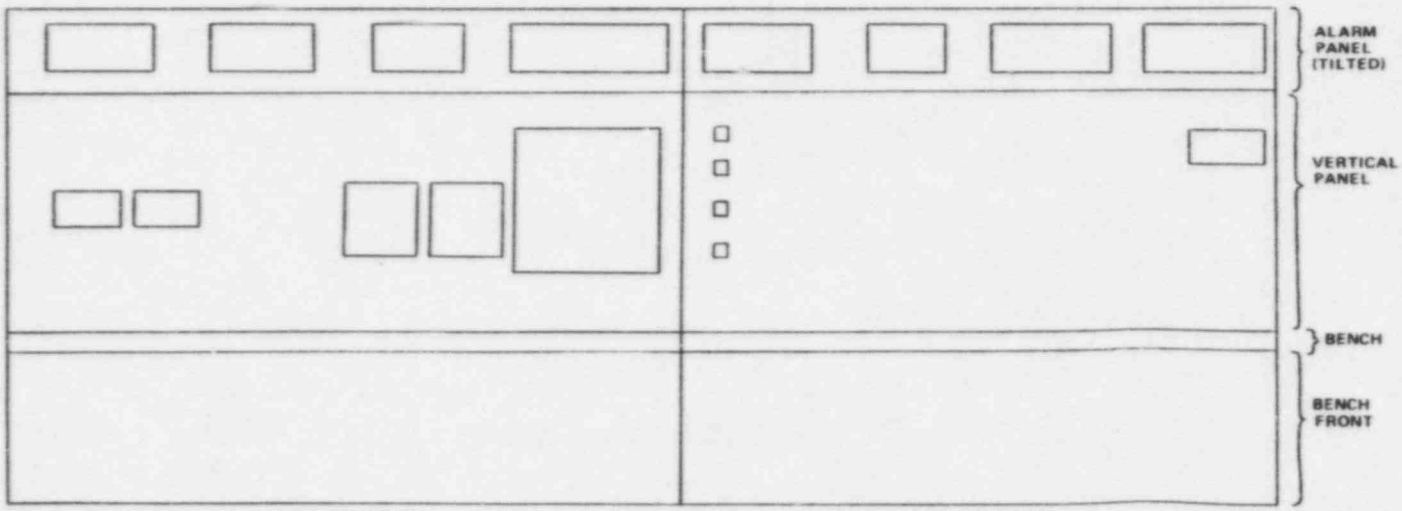


I-04



I-05

(9) MAYBE
CRT



I-06 SECTION 1 I-06 SECTION 2

STEPS 6, 7, 8, 9, 10

0 3'
SCALE

MAP NO. ONE SS

REFERENCE Bx SHUTDOWN

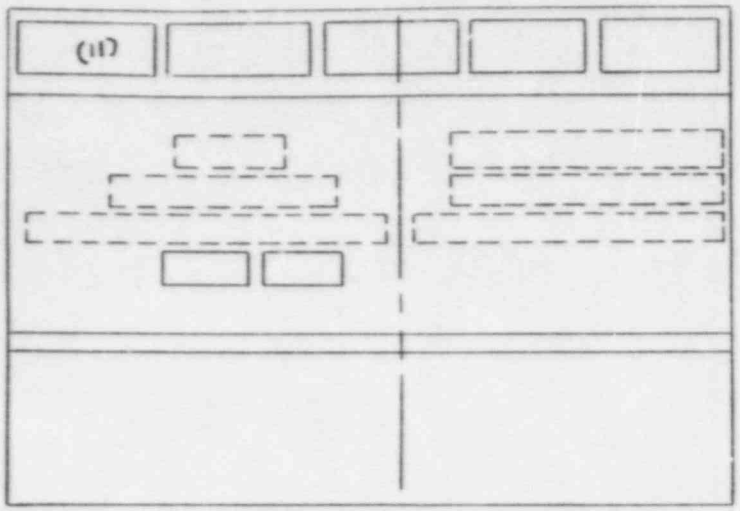
Form 344-24-4253

PUBLIC SERVICE COMPANY OF COLORADO

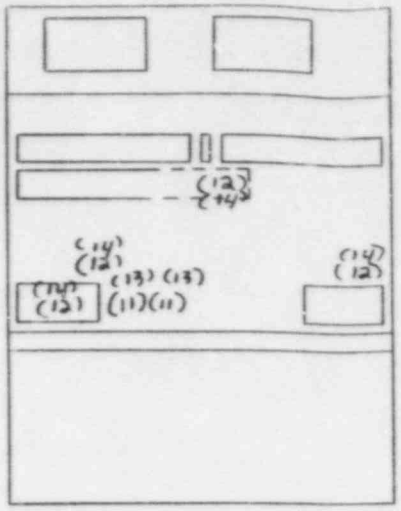
FORT ST. VRAIN NUCLEAR GENERATING STATION

FRONT PANEL ELEVATION MAP

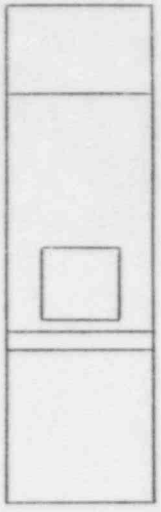
REDUCTION



I-01 I-02

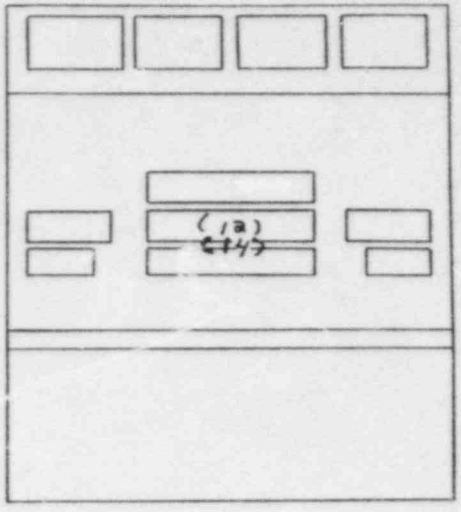


I-03



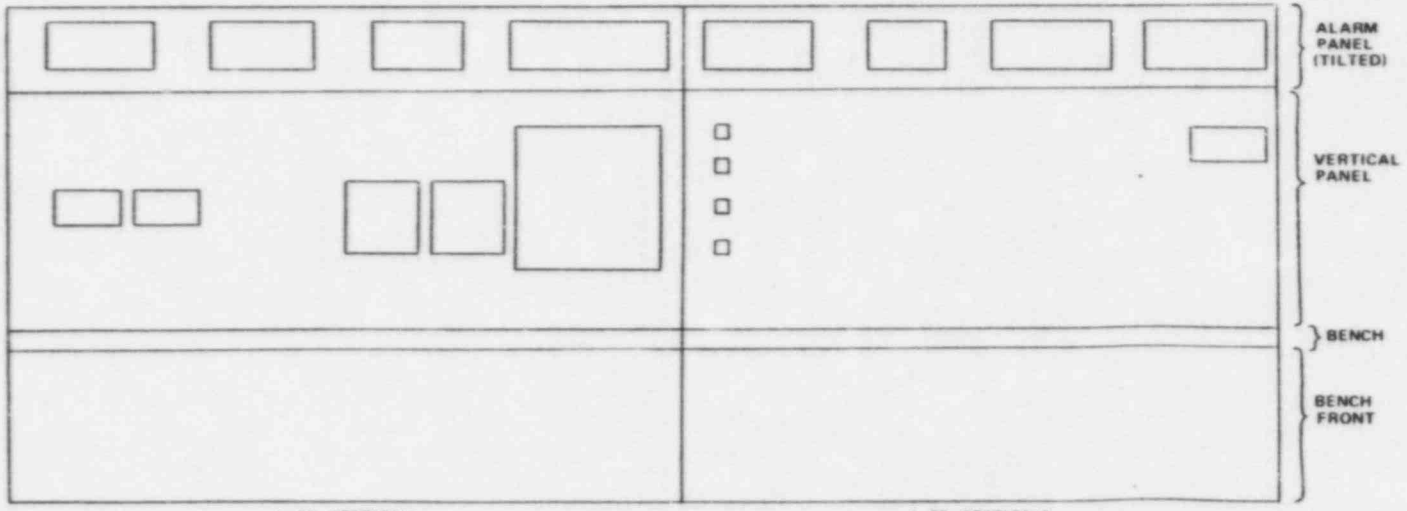
(15) TELEPHONE OR GAITRONICS

I-04



I-05

(15) TELEPHONE OR GAITRONICS



I-06 SECTION 1 I-06 SECTION 2

STEPS 11, 12, 13, 14

0 3'

SCALE

MAP NO. Attr 95

REFERENCE Rx Simulator

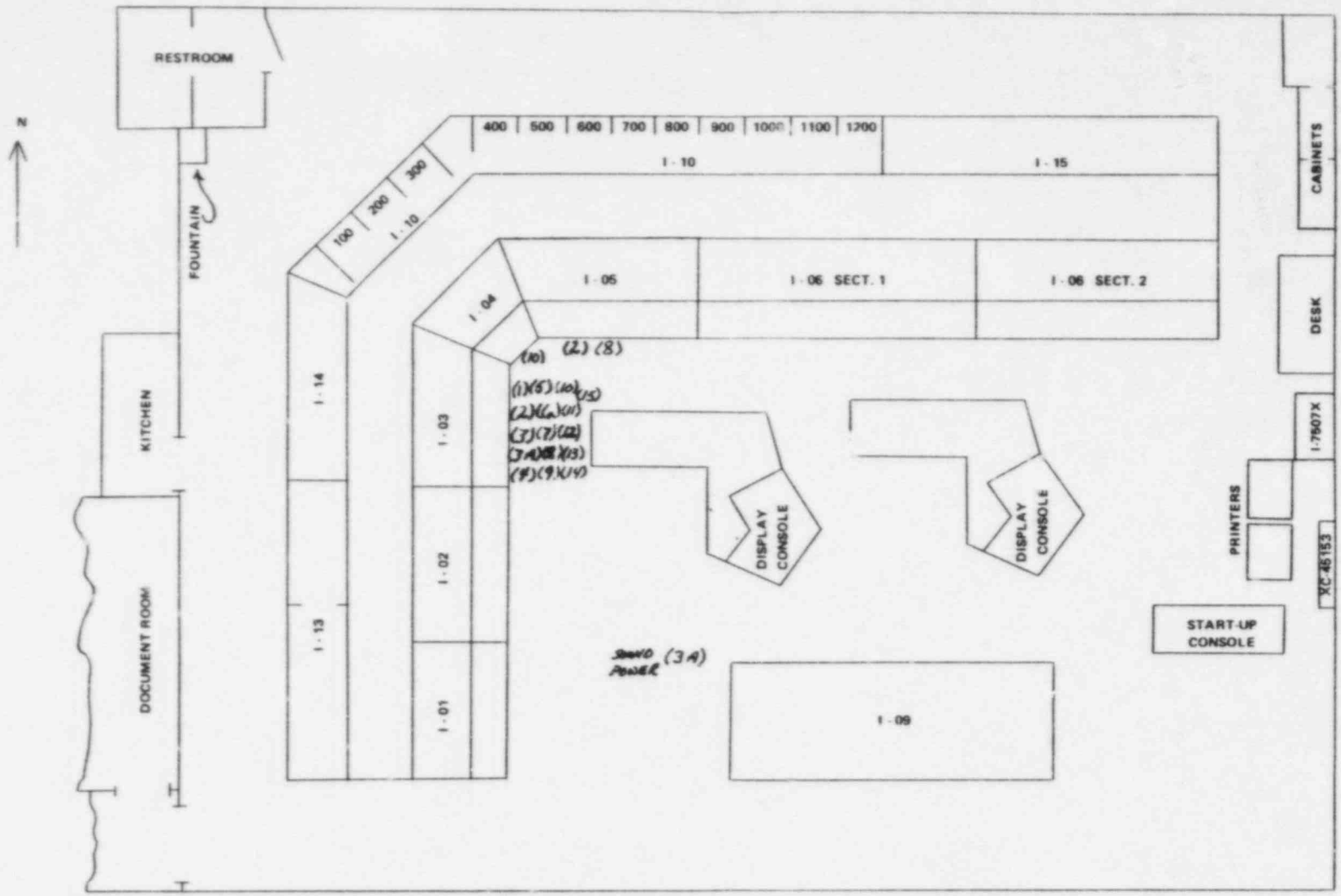
Form 344-24-4253

PUBLIC SERVICE COMPANY OF COLORADO

FORT ST VRAIN NUCLEAR GENERATING STATION

CONTROL ROOM PLAN VIEW

REDUCTION



0 6'

SCALE

MAP NO. OFF 6M

REFERENCE RE SHUTDOWN

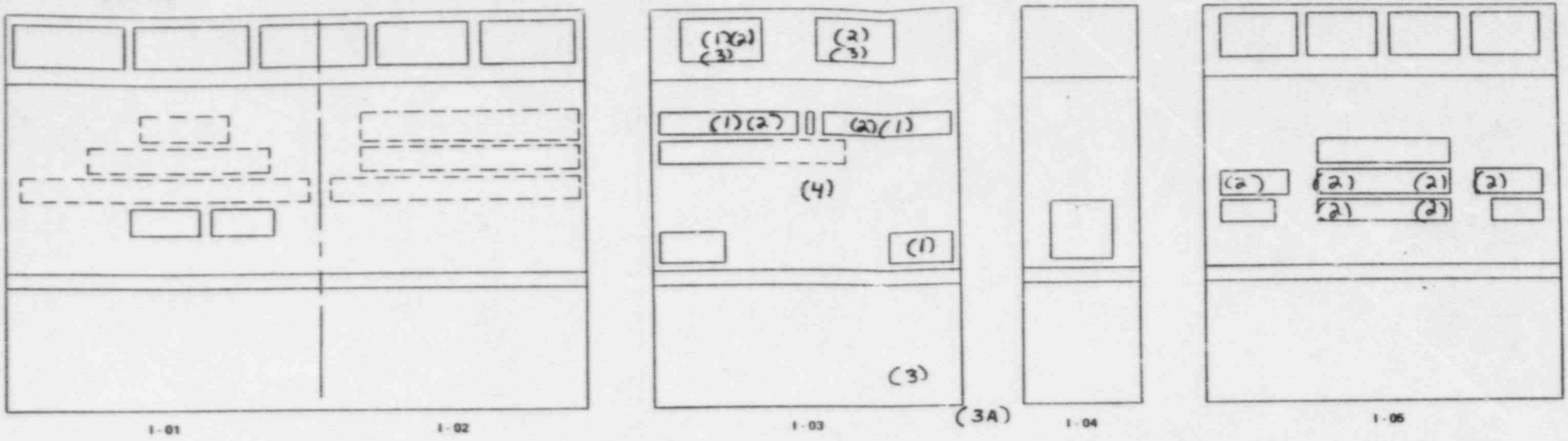
Form 344 24 4238

PUBLIC SERVICE COMPANY OF COLORADO

FORT ST. VRAIN NUCLEAR GENERATING STATION

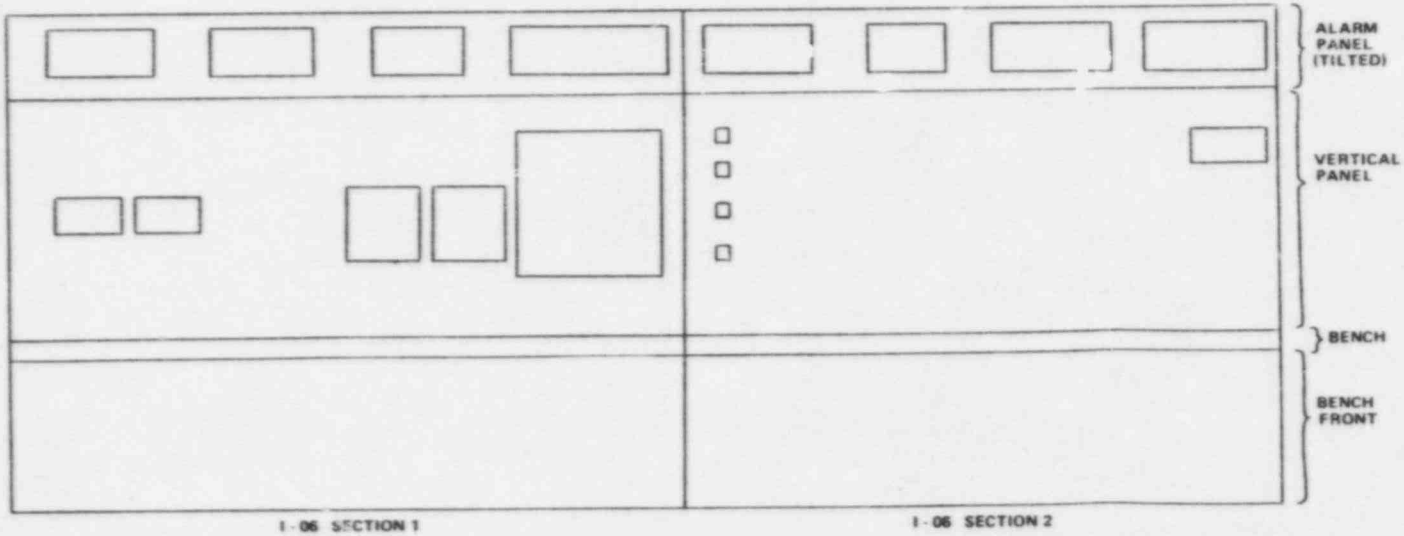
FRONT PANEL ELEVATION MAP

REDUCTION



I-01 I-02 I-03 (3A) I-04 I-05

(3A) SEPARATE PHONE (SOUND) SYSTEM



I-06 SECTION 1 I-06 SECTION 2

STEPS 1, 2, 3, 3A, 4

SCALE 0 3"

MAP NO. OTCA GM

REFERENCE RE SIMULATOR

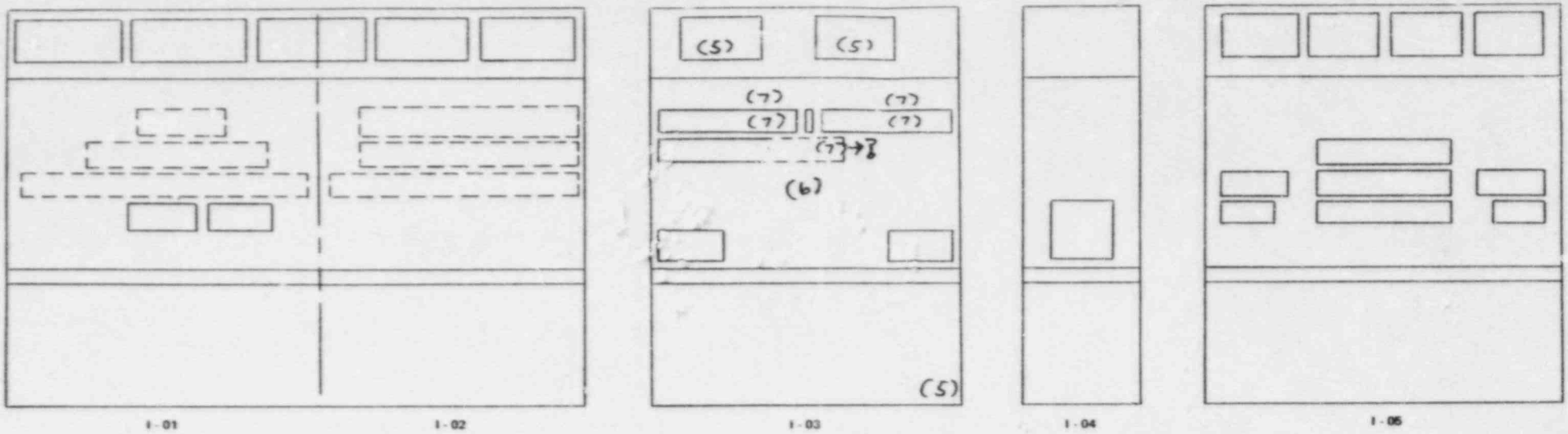
Form 344-24-4253

PUBLIC SERVICE COMPANY OF COLORADO

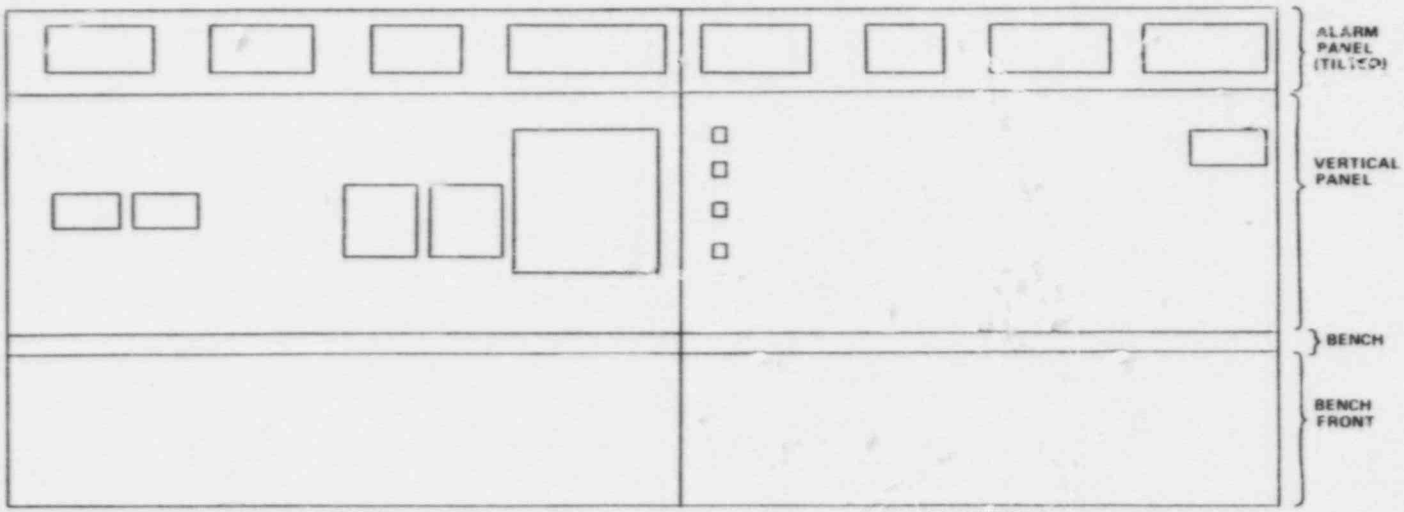
FORT ST. VRAIN NUCLEAR GENERATING STATION

FRONT PANEL ELEVATION MAP

REDUCTION



I-01 I-02 I-03 I-04 I-05



I-06 SECTION 1 I-06 SECTION 2

STEPS 5,6,7

SCALE 0 3"

MAP NO. OPER GM

REFERENCE RX SHUTDOWN

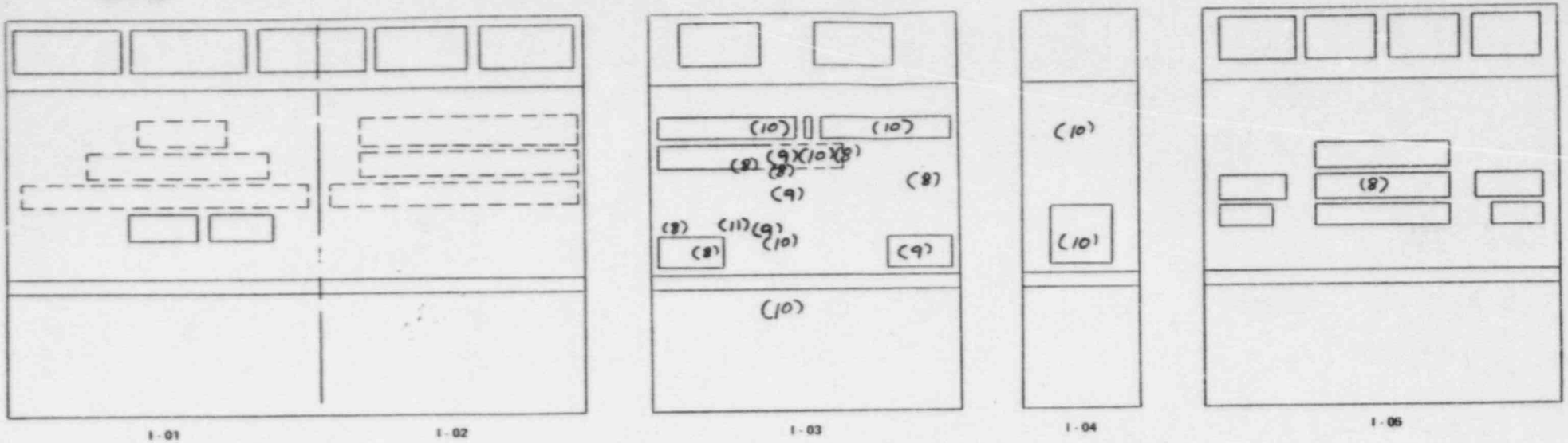
Form 344 24 4253

PUBLIC SERVICE COMPANY OF COLORADO

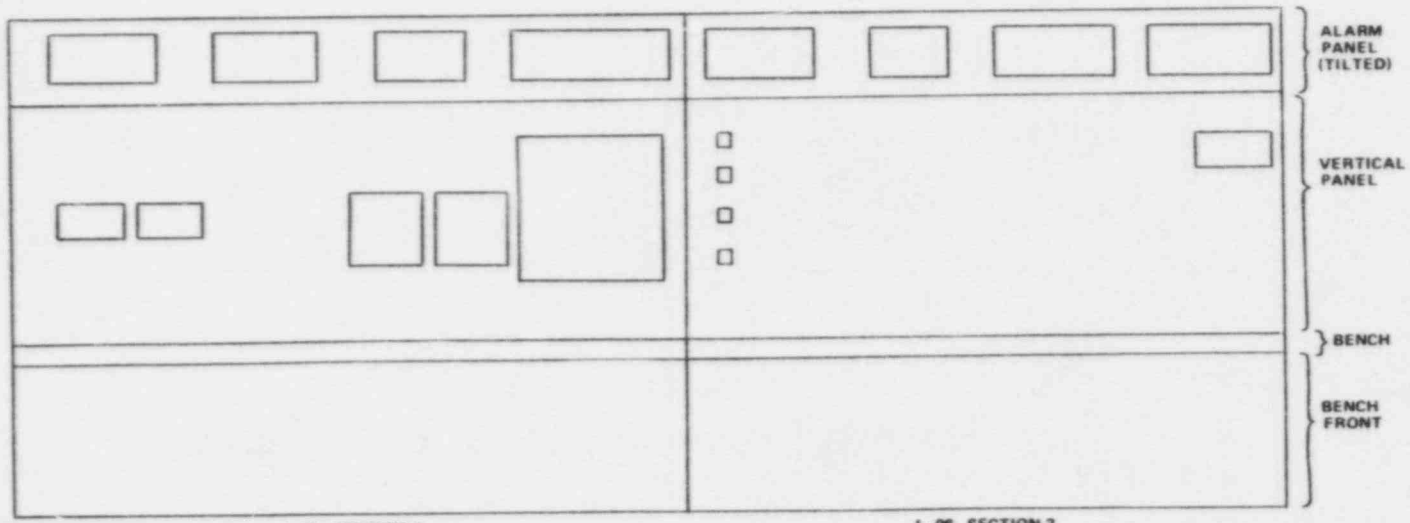
FORT ST. VRAIN NUCLEAR GENERATING STATION

FRONT PANEL ELEVATION MAP

REDUCTION



I-01 I-02 I-03 I-04 I-05



I-06 SECTION 1 I-06 SECTION 2

STEPS 8, 9, 10, 11

0 3'

SCALE

MAP NO. OPGZ GH

REFERENCE RX SHUTDOWN

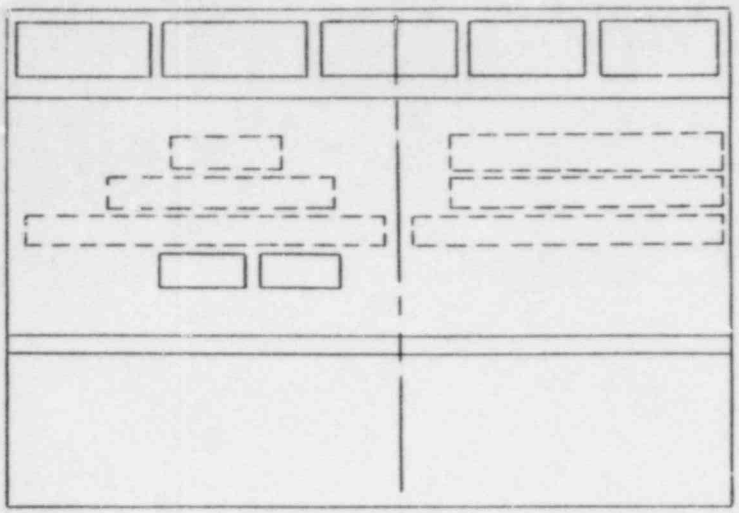
Form 344-24-4253

PUBLIC SERVICE COMPANY OF COLORADO

FORT ST. VRAIN NUCLEAR GENERATING STATION

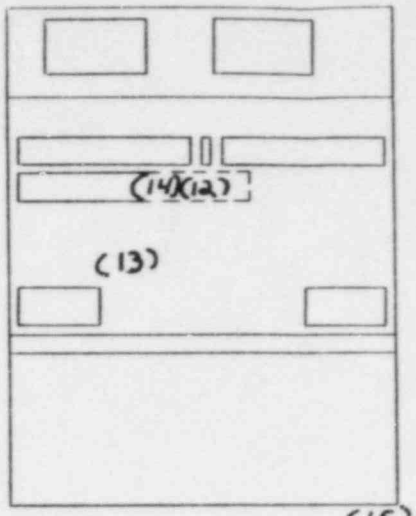
FRONT PANEL ELEVATION MAP

REDUCTION



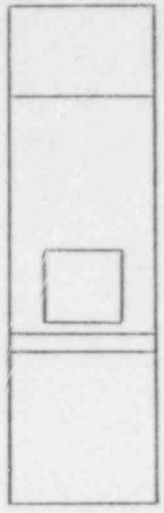
I-01

I-02

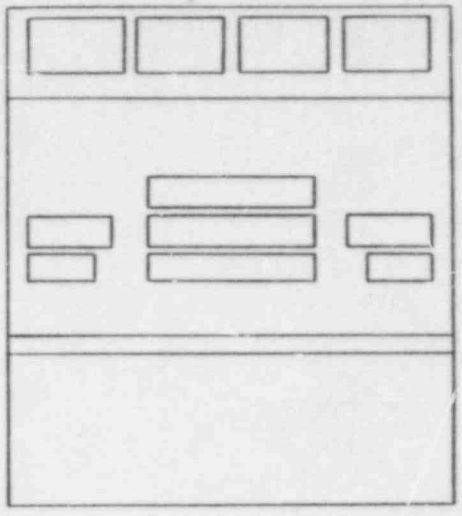


I-03

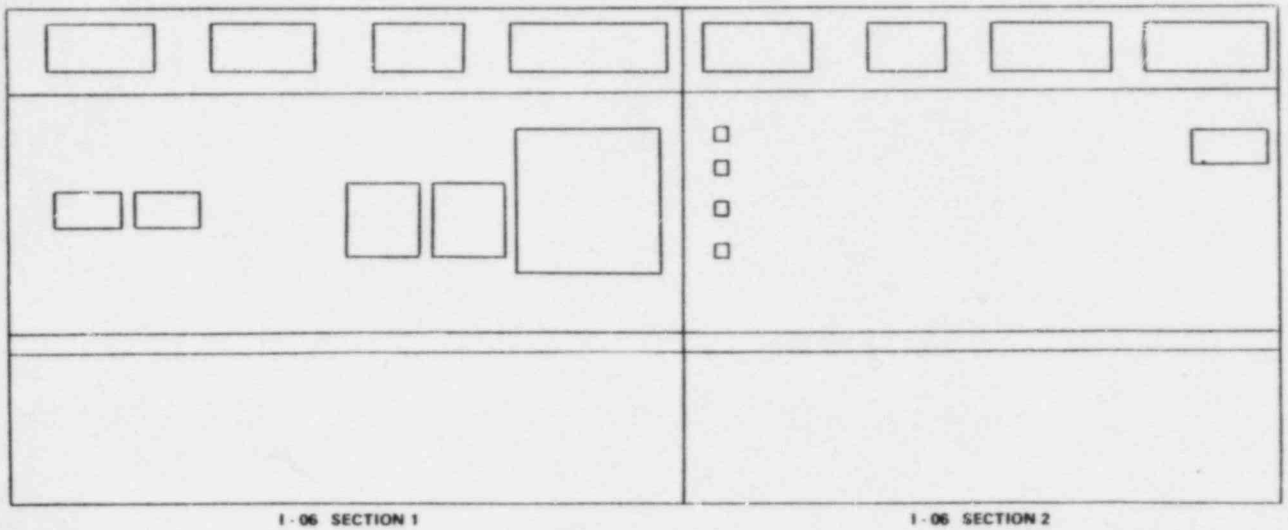
(15)



I-04



I-05



I-06 SECTION 1

I-06 SECTION 2

STEPS 12, 13, 14, 15

SCALE 0 3"

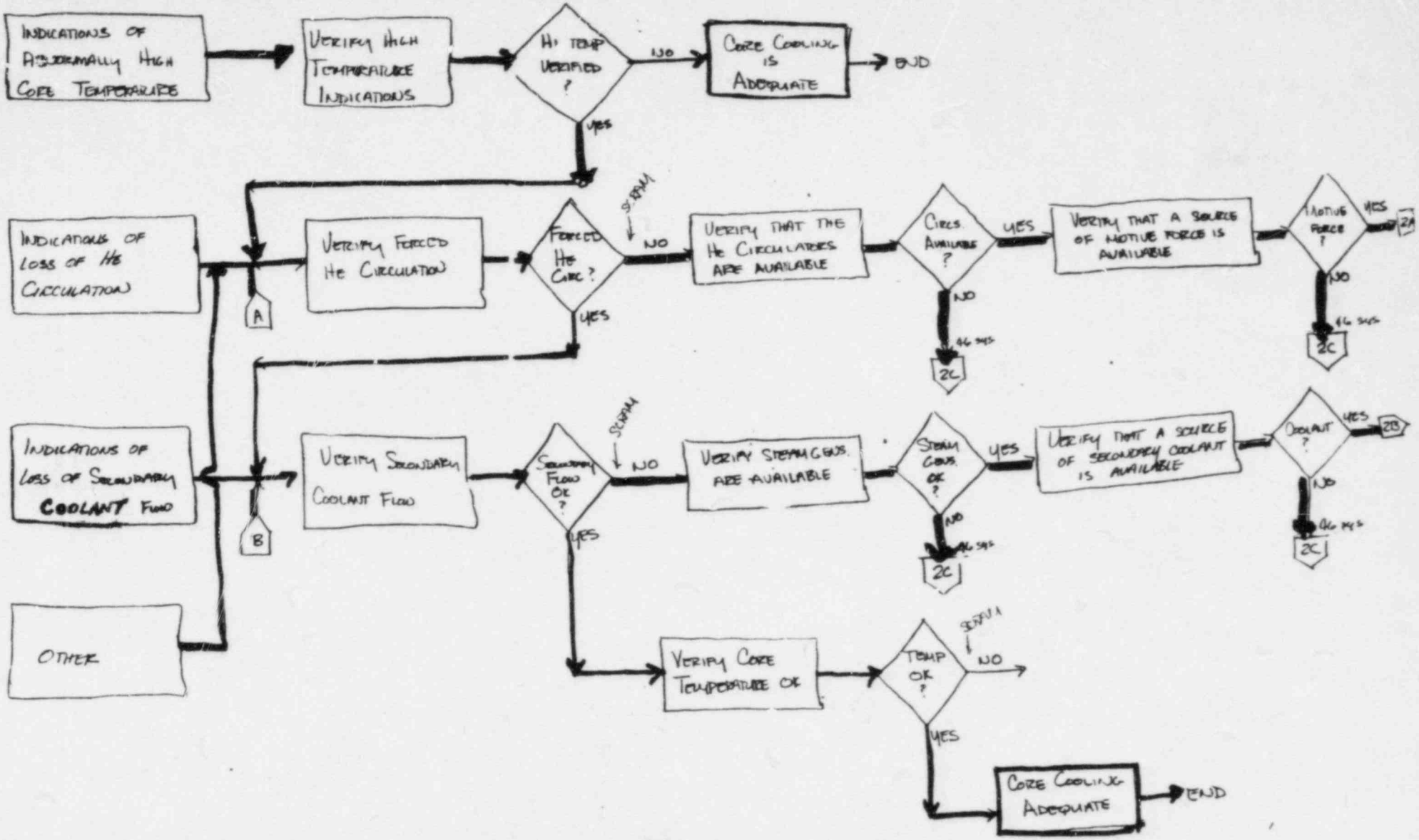
MAP NO. DITZ 6M

REFERENCE Fx Shutdown

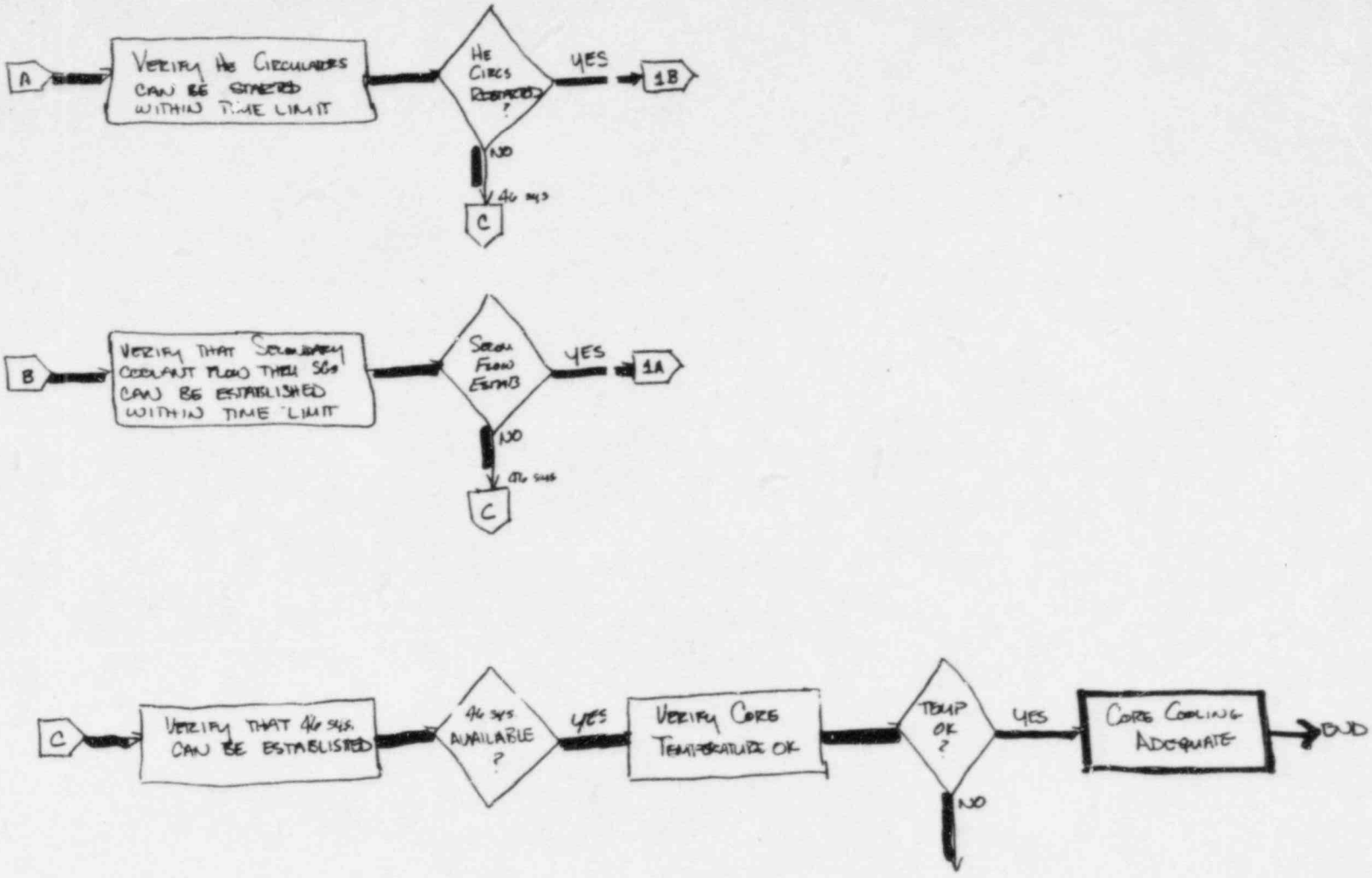
Form 344-24-4253

ENTRY CONDITIONS

REDUCTION



REDUCTION


A
VERIFY HOT CIRCULATORS CAN BE STARTED WITHIN TIME LIMIT
HOT CIRCS RESTARTED ?
YES
1B
NO
C
B
VERIFY THAT SECONDARY COOLANT FLOW THRU SGs CAN BE ESTABLISHED WITHIN TIME LIMIT
SGFW ESTAB ?
YES
1A
NO
C
C
VERIFY THAT 4kv SYS. CAN BE ESTABLISHED
4kv SYS AVAILABLE ?
YES
VERIFY CORE TEMPERATURE OK
TEMP OK ?
YES
CORE COOLING ADEQUATE
DUO
NO

FORT ST. VRAIN
CONTROL ROOM DESIGN REVIEW
TASK ANALYSIS WALKTHRU

REDUCTION

PROCEDURE	OPERATOR	REVIEW TEAM	DATE
ADEQUATE CORE COOLING	SS	MADDOX - COMPOSITE	17-NOV-83

GENERAL STEP	CUE	INSTR.	ALM'S	COMM.	REMARKS
INITIAL CONDITIONS • 70% POWER • TURBINE ON LINE	TELL OPERATOR CONDITIONS.				
1 ABNORMAL TEMPERATURE CONDITIONS	WHAT ARE YOUR FIRST INDICATIONS OF ABNORMAL TEMPERATURE?	MODULE TEMP RECORDER TR-2227 COMPUTER DISPLAY IF LOOKING AT THE CRT. REHEAT TEMP RECORDER TR-2256 REG ROD PICKING UP ON FLUX CONTROLLER DIGITAL REG ROD IND ZI-1202	CORE MAP REGION ALARM 1-5 ON I-03A 3-1 ON I-05C REACTOR PRESS HI 2-4 ON I-03A		ONE OR TWO MODULE DEVIATION ↑ ENTIRE CORE HEATING UP. ↑
2 ABNORMAL TEMP. VERIFICATION	HOW WOULD YOU VERIFY THAT YOU HAD HI TEMP?	CORE REGION DIGITAL TEMP IND. TI-11139, 140, 141 COMPUTER CORE OUTLET TEMP. MAP. SG MODULE TEMPS TR 2227			NOT AN EMERGENCY SITUATION. WOULD ATTEMPT TO CORRECT BY RE-ORIFICING.
3 LOSS OF He. CIRCULATION	WHAT ARE YOUR FIRST INDICATIONS OF LOSS OF He. CIRCULATION?	KNOWLEDGE OF SETPOINT TEMP FOR REHEAT TR-2256 →	He CIRC TRIPS ON I-05 A&D SPEED/FEEDFLOW MISMATCH ON A&D		STAY IN ERG'S PROCEDURE

CONTROL ROOM DESIGN REVIEW
TASK ANALYSIS WALKTHRU

REDUCTION

PROCEDURE	OPERATOR	REVIEW TEAM	DATE
ADEQUATE CORE COOLING	SS	MADDOX - COMPOSITE	17-NOV-83

GENERAL STEP	CUE	INSTR.	ALM'S	COMM.	REMARKS
4. VERIFICATION OF LOSS OF He CIRCULATION	HOW WOULD YOU VERIFY A LOSS OF He CIRCULATION?	He CIRC. SPEED SI-2109, 2115, 2110, 2116 He FLOW INDICATION FI-1157, 1159, 1158, 1160-2 ΔP INDICATION PDI-1157, 1159, 1158, 1160-2	TRIP LIGHTS ON CIRC SPEED INDICATORS		
5. VERIFY He CIRCULATORS ARE AVAILABLE.	HOW DO YOU DETERMINE IF THE He CIRCULATORS CAN BE USED?	ERACE & SEAL INDICATORS ON I-02 LIGHTS ABOVE HS-21203, 205, 204, 206 HS-21191, 193, 192, 194			ERACE AND SEAL INDICATORS ONLY MEAN IT WILL TAKE A FEW MINUTES TO RESIDUE THE CIRCS. USUALLY WOULD TRY TO RESTART THE NON-ISOLATED LOOP, SINCE ONE LOOP WILL BE ISOLATED ON A 4-CIRCULATOR TRIP.
6. VERIFY A SOURCE OF MOTIVE FORCE FOR THE He. CIRCULATORS.	WHAT IS THE FIRST SOURCE OF MOTIVE FORCE FOR THE He CIRCS YOU LOOK FOR?	STEAM		IMMEDIATELY SEND EQPT. OPERATOR START AUX BOILER.	* 6 & 7 ARE VERY SIMILAR FOR OPERATORS SS & GM. ONLY DIFFERENCES WILL BE NOTED HERE. SEE ATTACHMENTS FOR OPERATOR GM.

CONTROL ROOM DESIGN REVIEW
TASK ANALYSIS WALKTHRU

REDUCTION

PROCEDURE	OPERATOR	REVIEW TEAM	DATE
ADEQUATE CORE COOLING	SS	MADDOX - COMPOSITE	17-NOV-83

GENERAL STEP	CUE	INSTR.	ALM'S	COMM.	REMARKS
6. CONT. DO THIS FOR ALL SOURCES OF MOTIVE FORCE.	HOW DO YOU KNOW IF ITS AVAILABLE?				
7. VERIFY THAT He CIRCULATORS CAN BE RESTARTED.	HOW DO YOU DETERMINE IF THE He CIRCULATORS CAN BE RESTARTED?				SEE NOTE ON #6, PREVIOUS PAGE. ULTIMATE FEEDBACK IS MAIN STEAM TEMP IN OPERATING LOOP.
8. LOSS OF SECONDARY COOLANT FLOW	WHAT ARE YOUR FIRST INDICATIONS OF LOSS OF SECONDARY COOLANT FLOW?	RAPID TURBINE LOAD REDUCTION - GEN OUTPUT INDICATOR ON I-06-2. REG ROD RUNBACK ON FLUX CONTROLLER RUNBACK ROD LIGHTS SHOW MOVING IN.	MIGHT GET 2-6, I-06-2 INITIAL PRESSURE RUNBACK LOW FLOW ALARMS 5-1 & 5-4 ON I-06-A		

CONTROL ROOM DESIGN REVIEW
TASK ANALYSIS WALKTHRU

REDUCTION

PROCEDURE	OPERATOR	REVIEW TEAM	DATE
ADEQUATE CORE COOLING	SS	MADDOX - COMPOSITE	17-NOV-83

GENERAL STEP	CUE	INSTR.	ALM'S	COMM.	REMARKS
9. VERIFY SECONDARY COOLANT FLOW	HOW WOULD YOU VERIFY A LOSS OF SECONDARY FLOW?	FEEDFLOW RECORDERS FR 2205-2206 FEEDPUMP DISCH VALVES HS-3108, 3110 STEAM OUTLET VALVES HS-2253, 2254 HS 2223, 2224 STEAM PRESS TO FP TURB PI-5315, 5318 TURBINE SPEEDS FP DISCH PRESS & FLOW FI 3104, 3106 FI 3101, 3103			
10. VERIFY STEAM GENERATORS AVAILABLE.	HOW DO YOU DETERMINE IF THE STEAM GENERATORS CAN BE USED?	LOOK AT VALUES ON ISOLATED LOOP TO MAKE SURE IN CORRECT POSITION.			ASSUME SGs ARE USEABLE. TRY TO USE NON-ISOLATED LOOP FIRST.
11 VERIFY A SOURCE OF SECONDARY COOLANT.	WHAT IS THE FIRST SOURCE OF SECONDARY COOLANT YOU LOOK FOR?	FEEDWATER			* 11 & 12 ARE VERY SIMILAR FOR OPERATORS SS & GM. ONLY DIFFERENCES WILL BE NOTED HERE. SEE ATTACHMENTS FOR OPERATOR GM.

CONTROL ROOM DESIGN REVIEW
TASK ANALYSIS WALKTHRU

REDUCTION

PROCEDURE	OPERATOR	REVIEW TEAM	DATE
ADEQUATE CORE COOLING	SS	MADDOX - COMPOSITE	17-NOV-83

GENERAL STEP	CUE	INSTR.	ALM'S	COMM.	REMARKS
11. CONT. ⋮ DO THIS FOR ALL SOURCES OF SECONDARY COOLANT.	HOW DO YOU KNOW IF ITS AVAILABLE?				
12 VERIFY THAT SECONDARY COOLANT FLOW THRU SGs CAN BE ESTABLISHED.	HOW DO YOU DETERMINE IF SECONDARY COOLANT FLOW CAN BE ESTABLISHED?				SEE NOTE ON #11, PREVIOUS PAGE. FINAL DETERMINATION OF HEAT REMOVAL IS MAIN STEAM TEMP, SINCE NO TREND ON REGION OUTLETS.
13. VERIFY THAT 4kv SYSTEM CAN BE ESTABLISHED.	HOW DO YOU PUT THE 4kv SYSTEM INTO SERVICE?		NOT APPLICABLE		

CONTROL ROOM DESIGN REVIEW
TASK ANALYSIS WALKTHRU

REDUCTION

PROCEDURE	OPERATOR	REVIEW TEAM	DATE
ADEQUATE CORE COOLING	SS	MADDOX - COMPOSITE	17-NOV-83

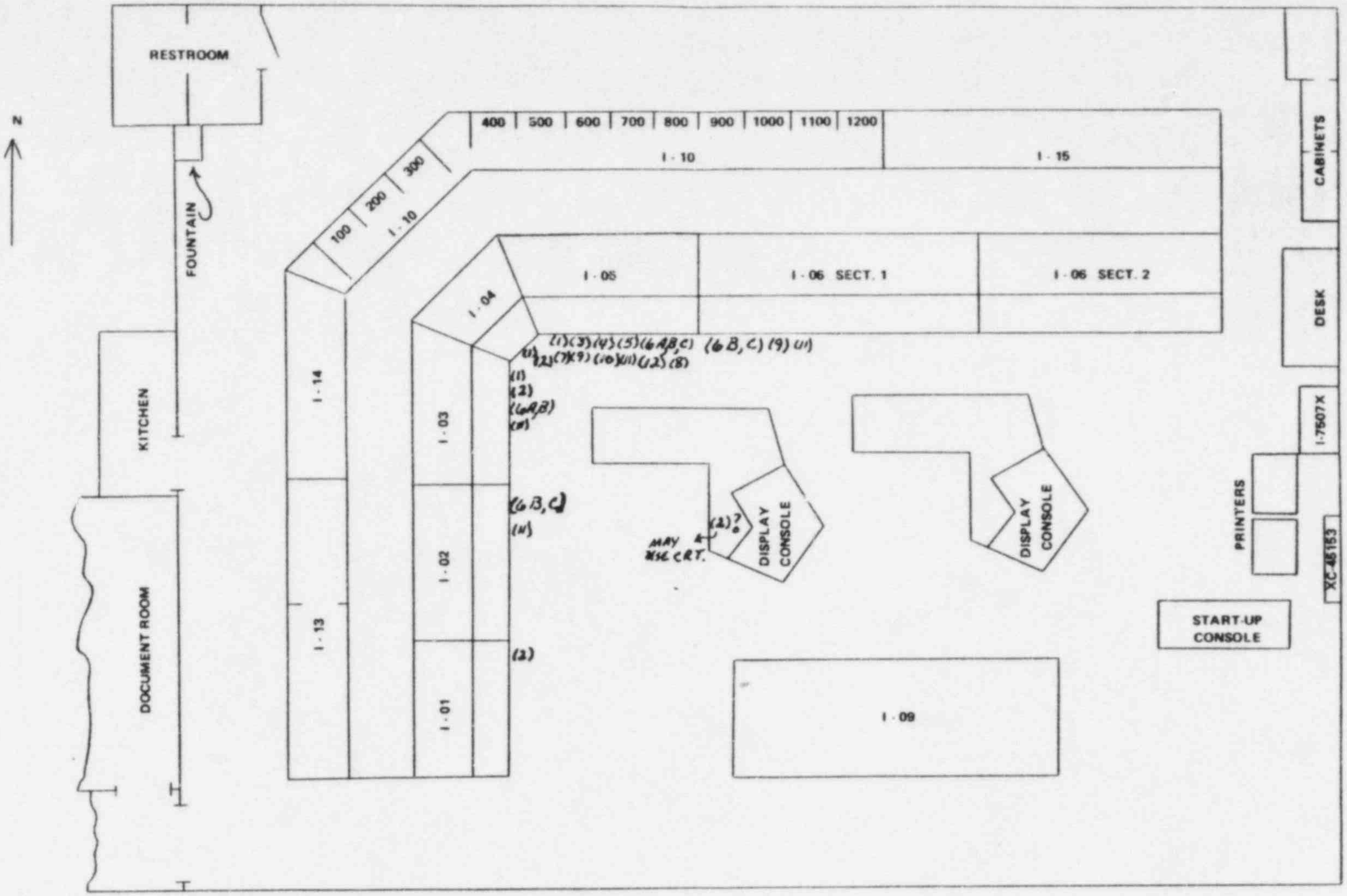
GENERAL STEP	CUE	INSTR.	ALM'S	COMM.	REMARKS
A. ESTABLISH ULTIMATE TEMPERATURE.	WHAT IS YOUR INDICATION THAT THE CORE IS REALLY BEING COOLED?				

PUBLIC SERVICE COMPANY OF COLORADO

FORT ST. VRAIN NUCLEAR GENERATING STATION

CONTROL ROOM PLAN VIEW

REDUCTION



0 6'

SCALE

MAP NO. OTE SS

REFERENCE Attachment 3.1 Carolyn

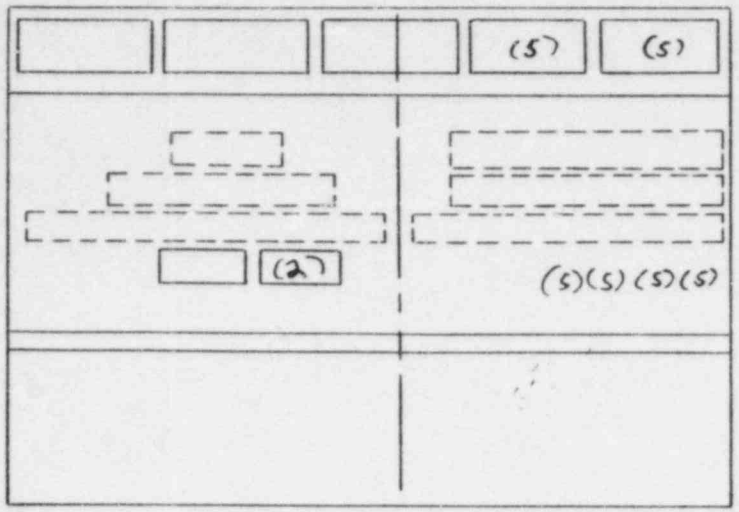
Form 344 24 4238

PUBLIC SERVICE COMPANY OF COLORADO

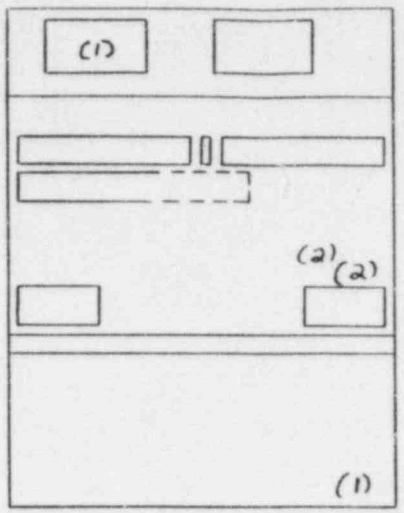
FORT ST VRAIN NUCLEAR GENERATING STATION

FRONT PANEL ELEVATION MAP

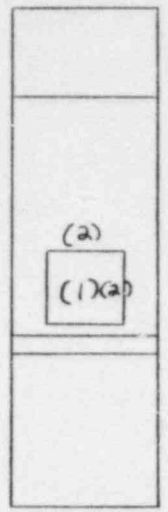
REDUCTION



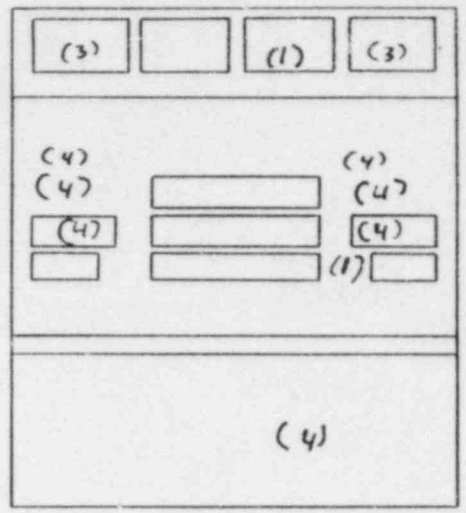
I-01 I-02



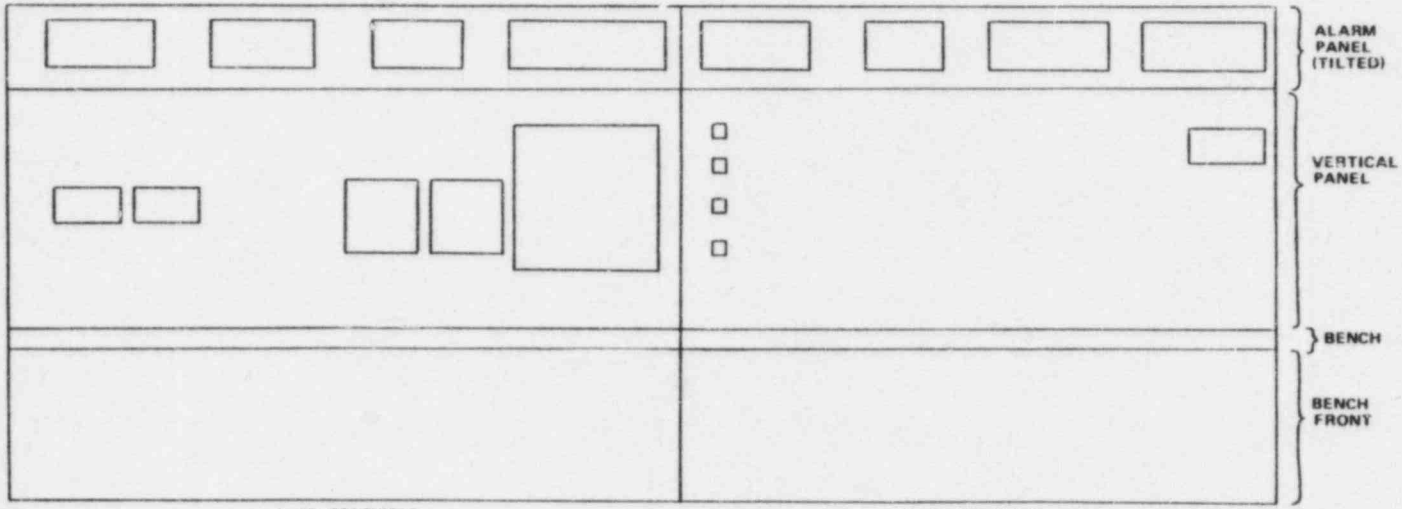
I-03



I-04



I-05



I-06 SECTION 1 I-06 SECTION 2

STEPS 1,2,3,4,5

0 3'

SCALE

MAP NO. DTE SS

REFERENCE NEGATIVE DTE 20 ML

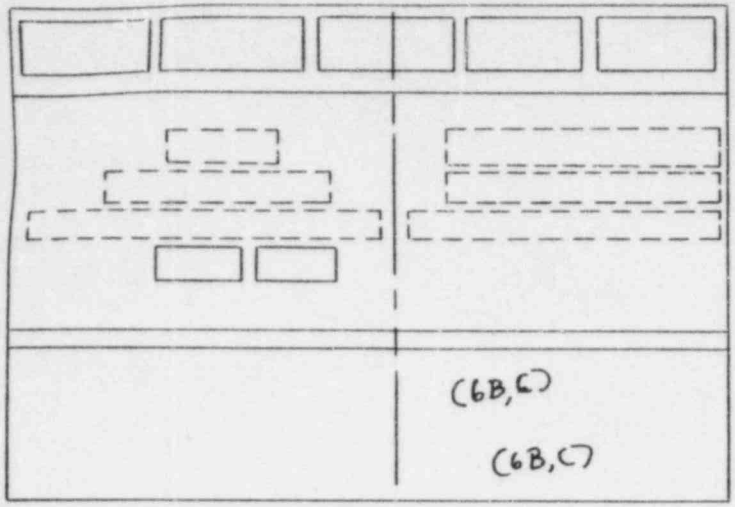
Form 344-24-4253

PUBLIC SERVICE COMPANY OF COLORADO

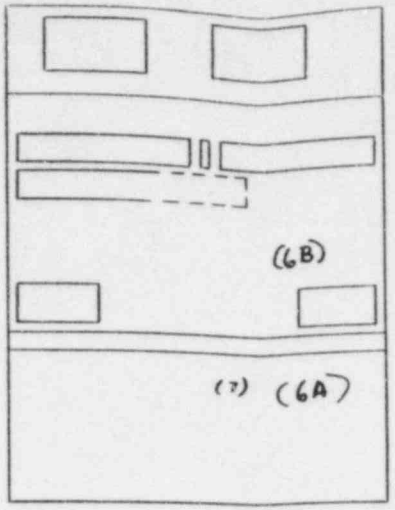
FORT ST. VRAIN NUCLEAR GENERATING STATION

FRONT PANEL ELEVATION MAP

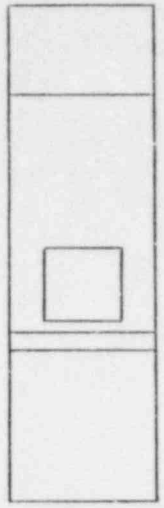
REDUCTION



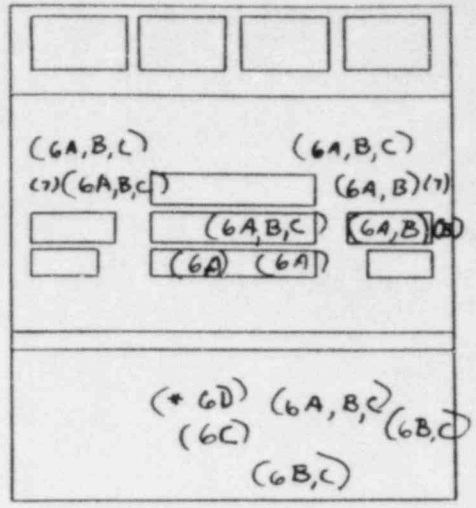
I-01 I-02



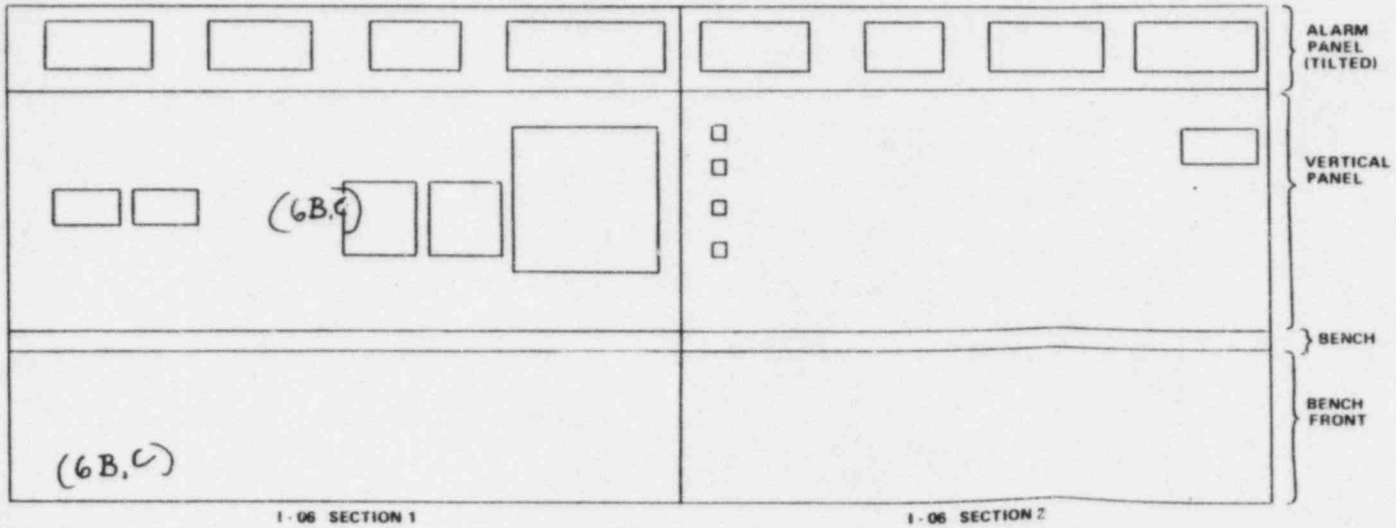
I-03



I-04



I-05



I-06 SECTION 1 I-06 SECTION 2

6A. - STEAM
6B. - FEEDWATER OR CONDSATE
6C. FIREWATER
6D. AUX BOILER (MAY USE - BUT NOT REQUIRED)

0 3'
SCALE

MAP NO. QTEC. SS

REFERENCE ADEQUATE LOC COX114

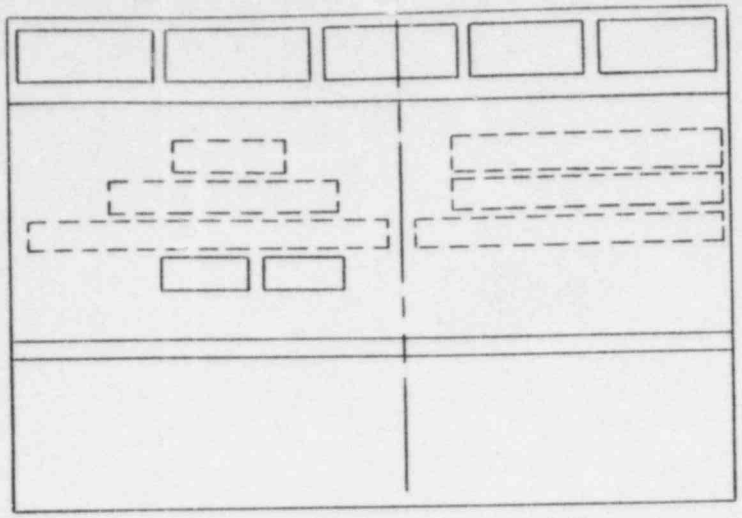
Form 344-24-4253

PUBLIC SERVICE COMPANY OF COLORADO

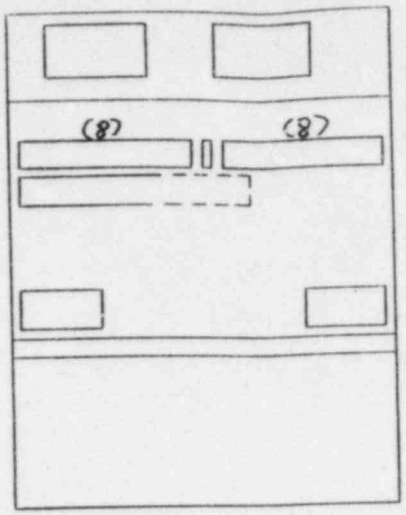
FORT ST. VRAIN NUCLEAR GENERATING STATION

FRONT PANEL ELEVATION MAP

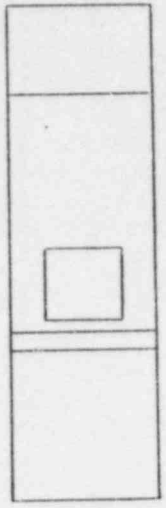
REDUCTION



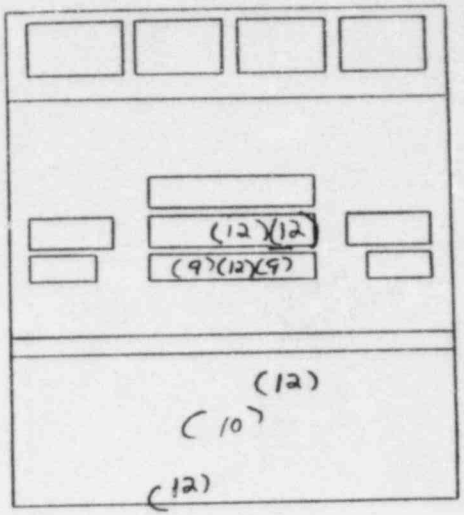
I-01 I-02



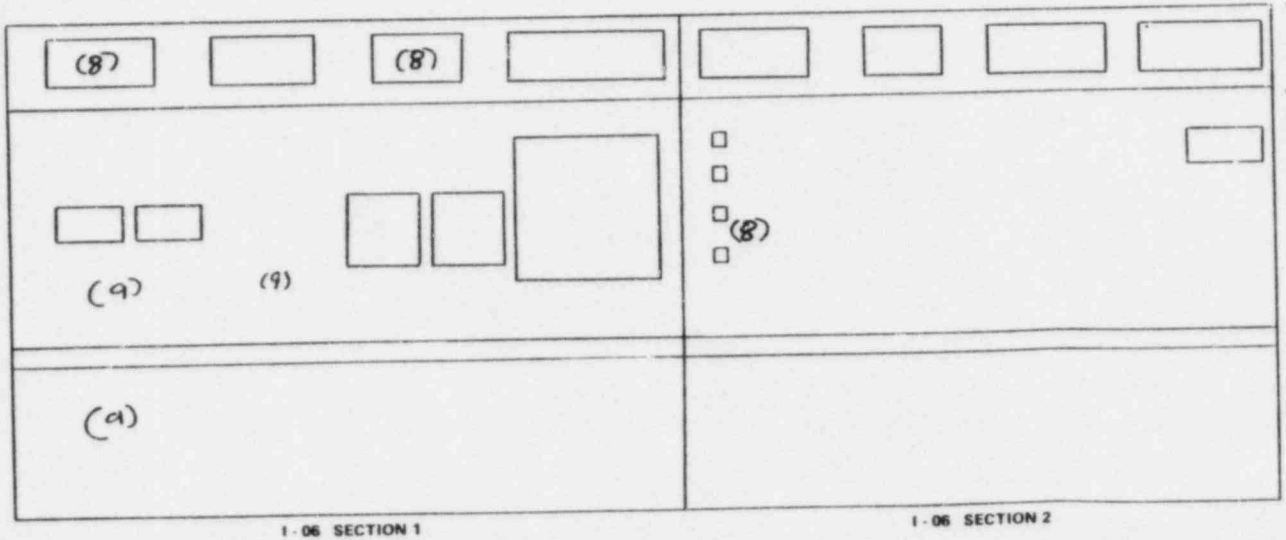
I-03



I-04



I-05



I-06 SECTION 1 I-06 SECTION 2

* STEP 11 SAME AS 6B PROCEDURE

STEPS 8, 9, 10, *11, 12

0 3'

SCALE

MAP NO. OTER SS

REFERENCE Adequate Core Cooling

Form 344-24-4253

ATTACHMENTS TO ENSURE ADEQUATE CORE COOLING. OPERATOR - GM

6A. FIRST SOURCE OF MOTIVE FORCE — STEAM

[redacted] OF STEAM AVAILABILITY

STEAM TURBINE INLET PRESSURE PI 2243-1, 2244-1

STEAM TURBINE OUTLET PRESSURE PI 2243-2, 2244-2.

"RESET OUTPUT" LIGHTS (AMBER) ON STEAM TURBINE SPEED CONTROLLERS SC-2105, 2111, 2106, 2112.

FLASH TANK PRESSURE PI-5225 on I-06. - CHECK ONLY IF NO PRESSURE SHOWN ON STEAM TURBINE INLET/OUTLET.

7.A. HOW ARE CIRCULATORS RESTARTED ON STEAM?

- RESET ISS TO "LO-POWER" HS-1217
- CLOSE CIRC BLOCK VALVES HS-2249, 2251, 2250, 2252
- PUT SPEED CONTROLLERS IN MANUAL AND RUN OUTPUT TO ZERO SC-2105, 2111, 2106, 2112.
- BUMP STEAM TRAP ISOLATION VALVE HS-2211, 2213, 2212, 2214 TO "CLOSE" AND THEN BACK TO "OPEN"
- MANUALLY RUN ONE SPEED CONTROLLER BACK UP SC-2105, OR 2111, OR 2106, OR 2112.

*NOTE - ONE ENTIRE LOOP WILL BE ISOLATED IF ALL FOUR CIRCULATORS HAVE TRIPPED

FOR FEEDBACK - USE WATER TURBINE SPEED INDICATORS SI 2109, 2115, 2110, 2116

MAIN STEAM TEMPS TR 2121, 122

STM GEN MODULE TEMPS TR 2227 CON I-01

OPERATOR - GM

6B SECOND SOURCE OF MOTIVE FORCE - FEEDWATER / CONDENSATE

INDICATIONS OF FEEDWATER AVAILABILITY

EMERGENCY BEARING WATER HEADER PRESSURE PI-21189 ON I-01

MUST HAVE EITHER A OR C FEEDPUMP ON - WOULD CHECK IF NO HEADER PRESSURE

- BFP TURBINE SPEED INDICATORS
- BFP 1A & 1C DISCHARGE PRESSURE & FLOW

  PI-3104, 3106 FI-3101, 3103
- BFP 1A & 1C DISCHARGE VALVES HS-3108, 3110 OPEN

THE AVAILABILITY OF CONDENSATE IS NOT CHECKED BEFORE IT IS VALVED INTO THE WATER TURBINES. IF CIRCULATOR SPEED DOESN'T COME UP AFTER CONDENSATE IS VALVED IN, THEN THE CONDENSATE PUMP CONTROLS ARE CHECKED. HS-3128, 3129, 3130, 3131 ON I-06A

7B. HOW ARE CIRCULATORS RESTARTED ON FEEDWATER?

- CLOSE STEAM TURBINE OUTLET BLOCK VALVES TO GIVE A STEAM TRIP. HS 2249, 2251, 2250, 2252
- AMBER LIGHTS ON THE STEAM TURB. SPEED CONTROLLERS SHOULD LIGHT TO SHOW TRIP. SC-2105, 2111, 2106, 2112.
- PUT WATER TURBINE SPEED CONTROLLERS IN MANUAL SC-2109, 2115, 2110, 2116.
- OPEN WATER TURBINE INLET AND OUTLET BLOCK VALVES FOR ONE CIRCULATOR.

  INLET - HS-2109, 2115, 2110, 2116-1

  OUTLET - HS-2109, 2115, 2110, 2116-2
- RUN ONE WATER TURBINE SPEED CONTROLLER TO FULL OPEN. SC-2109, 2115, 2110, 2116.

OPERATOR - GM.

7B. (CONTINUED)

- [redacted] CIRCULATOR SPEED AND CORE HEAT REMOVAL AS IN 7A.

- FOR CONDENSATE VS. FEEDWATER JUST VALVE CONDENSATE INTO WATER TURBINES WITH HS-21257, 259, 258, 260

*NOTE - THERE IS NO VALVE POSITION INDICATION FOR THESE VALVES. FEEDBACK IS CIRCULATOR WATER TURBINE SPEED INDICATION.

- 6D. - THIS IS OUT OF ORDER, BUT IT AGREES WITH THE OUTLINE AND BOARD DIAGRAMS.

AUXILIARY BOILER FEED PUMPS

INDICATIONS OF AVAILABILITY

- AUX BOILER FEED PUMPS MUST BE STARTED HS-8402, 8404 I-06, 2

2D HOW IS AUX BOILER FEED VALVED INTO CIRCULATORS?

HS-31121 PUTS AUX BFP TO CONDENSATE HEADER. FROM THERE ON, EVERYTHING IS THE SAME AS FOR 7B.

6C. FIREWATER - THIS IS A LAST RESORT. THERE IS ALSO A TIME CONSTRAINT, SINCE AN OPERATOR MUST BE SENT OUT INTO THE PLANT TO CLOSE A TELL-TALE DRAIN AND OPEN A BLOCK VALVE. ALTHOUGH OPERATOR DIDN'T MENTION IT, FIREWATER AVAILABILITY CAN BE CHECKED ON I-06-2 WITH PI-4502, LI-4505 AND FIREWATER PUMP SWITCHES HS-4504-1 & 4504-2.

7C. HOW IS FIREWATER VALVED INTO THE CIRCULATORS?

[redacted] PUTS FIREWATER TO THE CONDENSATE HEADER. FROM THERE ON, EVERYTHING IS THE SAME AS IN 7B.

11A. FIRST SOURCE OF SECONDARY COOLANT - FEEDWATER.
INDICATIONS OF FEEDWATER AVAILABILITY - SAME AS FOR 6B.

12A ESTABLISH FEEDWATER FLOW THRU SGs.

- OPEN FEEDWATER INLET VALVES HS-2201, 2202
- OPEN HOT REHEAT STEAM STOP VALVES HS-2253, 2254
- OPEN MAIN STM BYPASS STOP VALVES HS-2292, 2293
- USE FEED WATER FLOW RECORDERS FR-2205, 2206 AS FEEDBACK.
- ALSO MAIN STEAM TEMP TR-22121, 122

11B. FOR CONDENSATE, DON'T BOTHER TO CHECK AVAILABILITY, USE PRESENCE OF FLOW THRU SG's AS INDICATION OF AVAILABILITY.

12B. • OPEN EMERGENCY CONDENSATE INLET VALVES HS-2237, 2238
THESE ARE INTERLOCKED WITH FEEDWATER & EMERGENCY FEEDWATER INLET VALVES.

• USE SAME FEEDBACK AS IN 12A.

11.C. AUX BOILER FEED PUMPS

SAME AS FOR 6D.

12.C. SAME AS FOR 7D. EXCEPT CONDENSATE HEADER MUST BE VALVED INTO SGs, AS IN 12B.

11.D. FIREWATER

SAME AS FOR 6C.

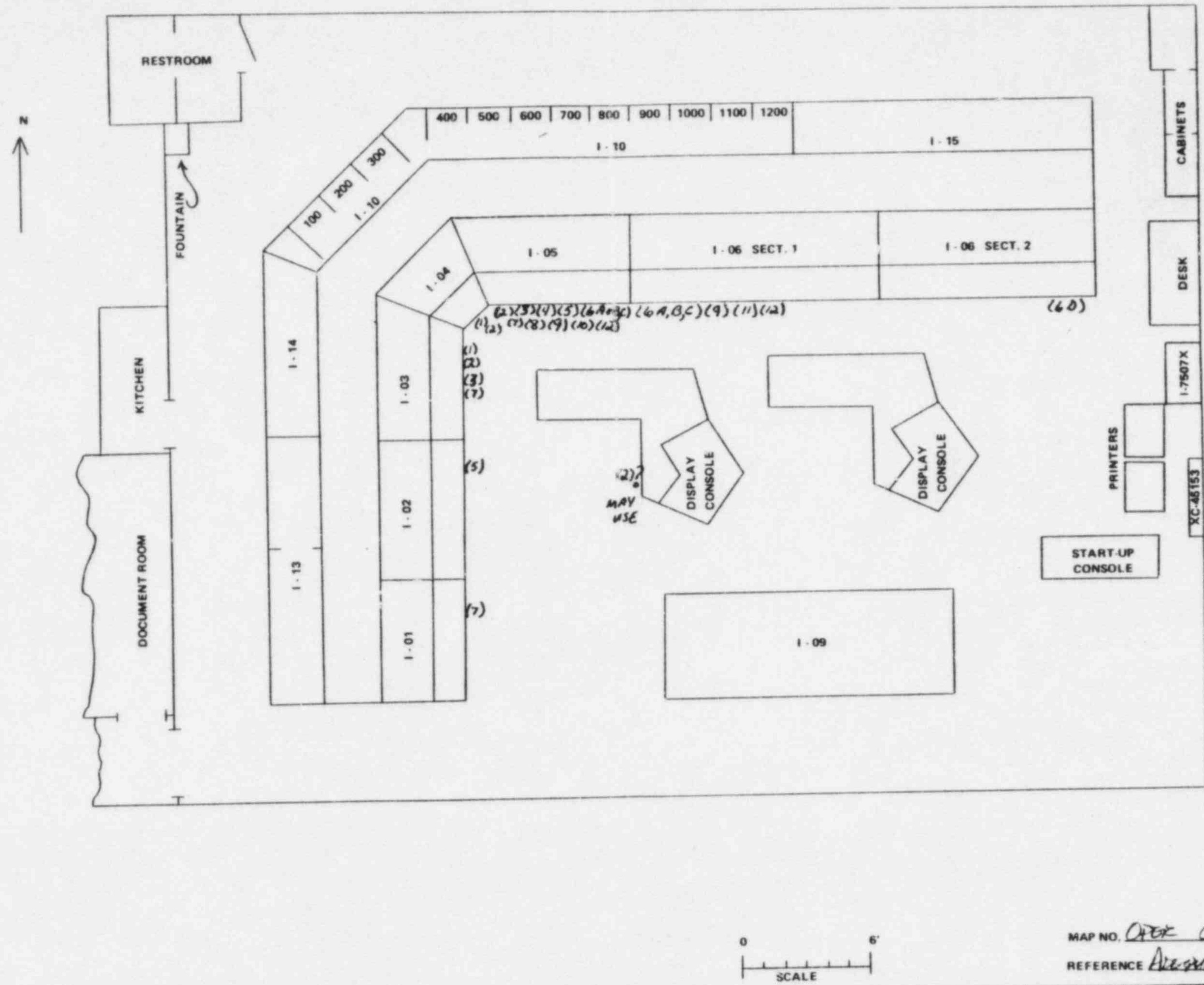
12.D. SAME AS FOR 7C. EXCEPT CONDENSATE HEADER MUST BE VALVED INTO SGs, AS IN 12B.

REDUCTION

PUBLIC SERVICE COMPANY OF COLORADO
FORT ST VRAIN NUCLEAR GENERATING STATION

CONTROL ROOM PLAN VIEW

A - STEAM
B - FEEDWATER
C - FIREWATER
D - AUX. BOILER (STEAM)



MAP NO. OPEK GM

REFERENCE Adequate Core Cooling

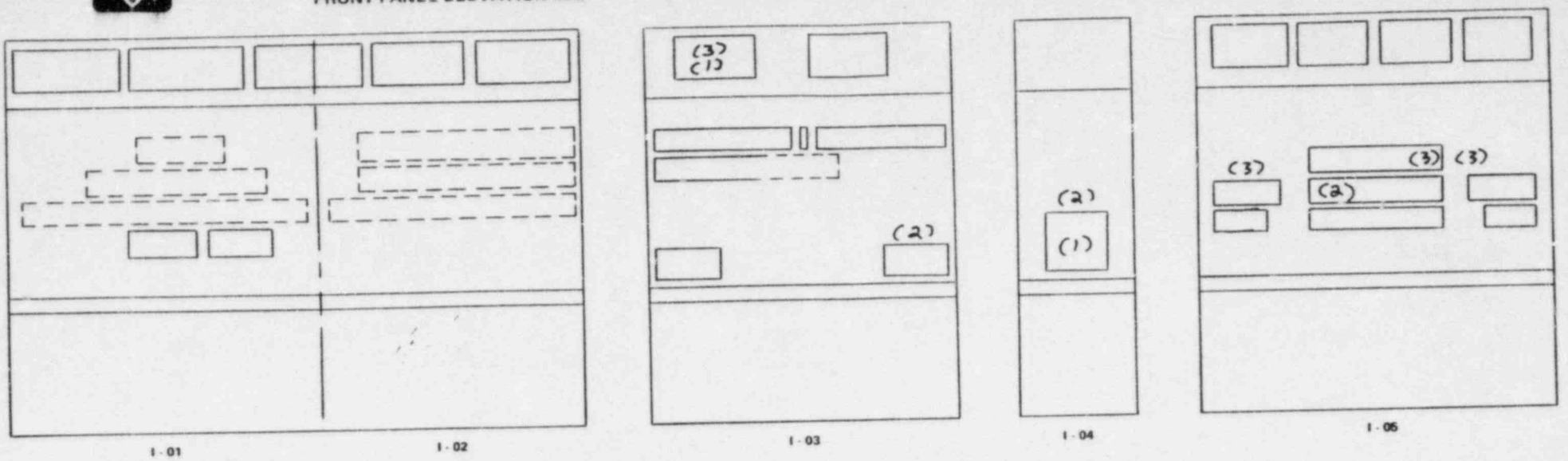
Form 344 24 4238

PUBLIC SERVICE COMPANY OF COLORADO

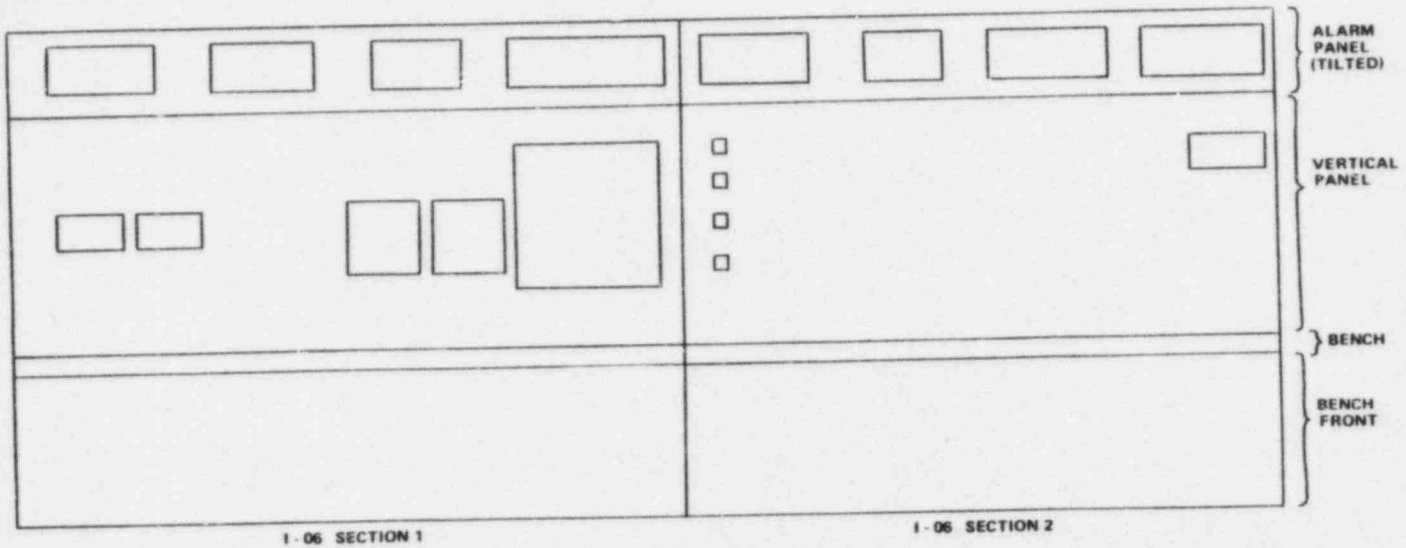
FORT ST. VRAIN NUCLEAR GENERATING STATION

FRONT PANEL ELEVATION MAP

REDUCTION



I-01 I-02 I-03 I-04 I-05



I-06 SECTION 1 I-06 SECTION 2

STEPS 1, 2, 3

0 3'

SCALE

MAP NO. OTDL GM

REFERENCE Adequate Int. Cooling

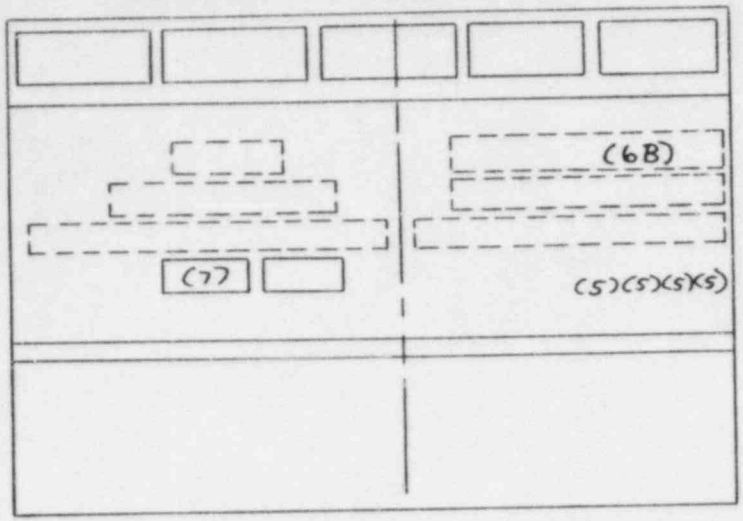
Form 344-24-4253

PUBLIC SERVICE COMPANY OF COLORADO

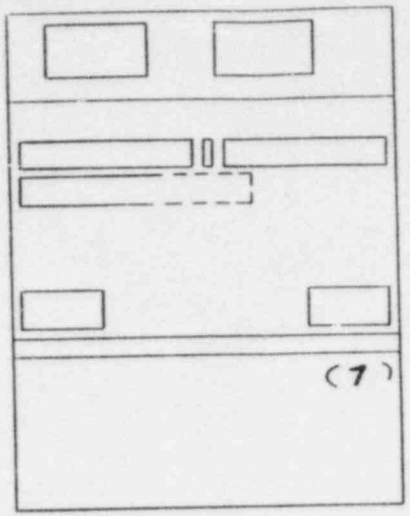
FORT ST. VRAIN NUCLEAR GENERATING STATION

FRONT PANEL ELEVATION MAP

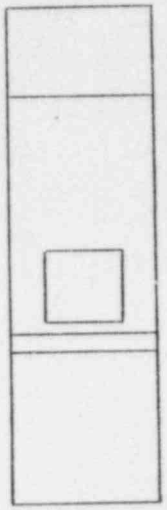
REDUCTION



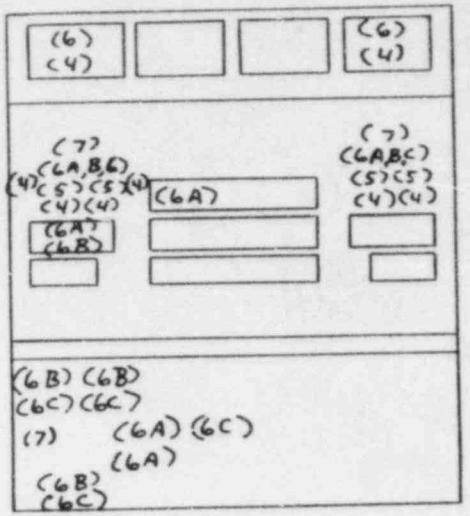
I-01 I-02



I-03

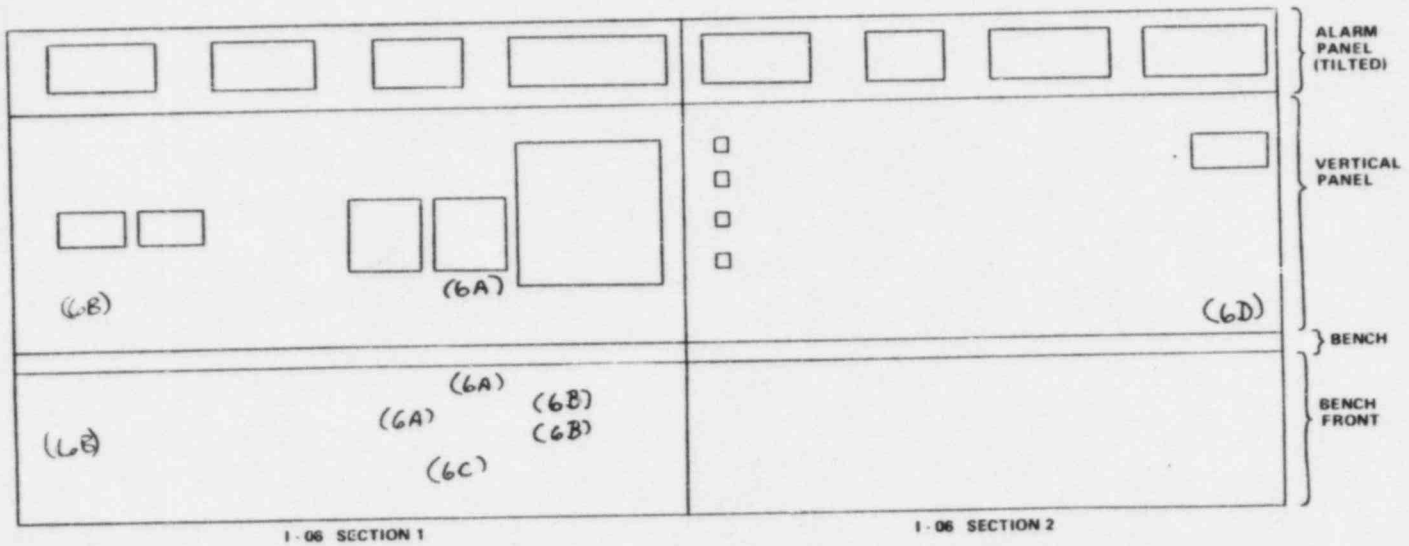


I-04



I-05

A - STEAM
B - FEEDWATER
C - FIREWATER
D - AUX. BOILER (STEAM)



I-06 SECTION 1 I-06 SECTION 2

STEPS 4, 5, (6A, B, C, D), 7

0 1" SCALE

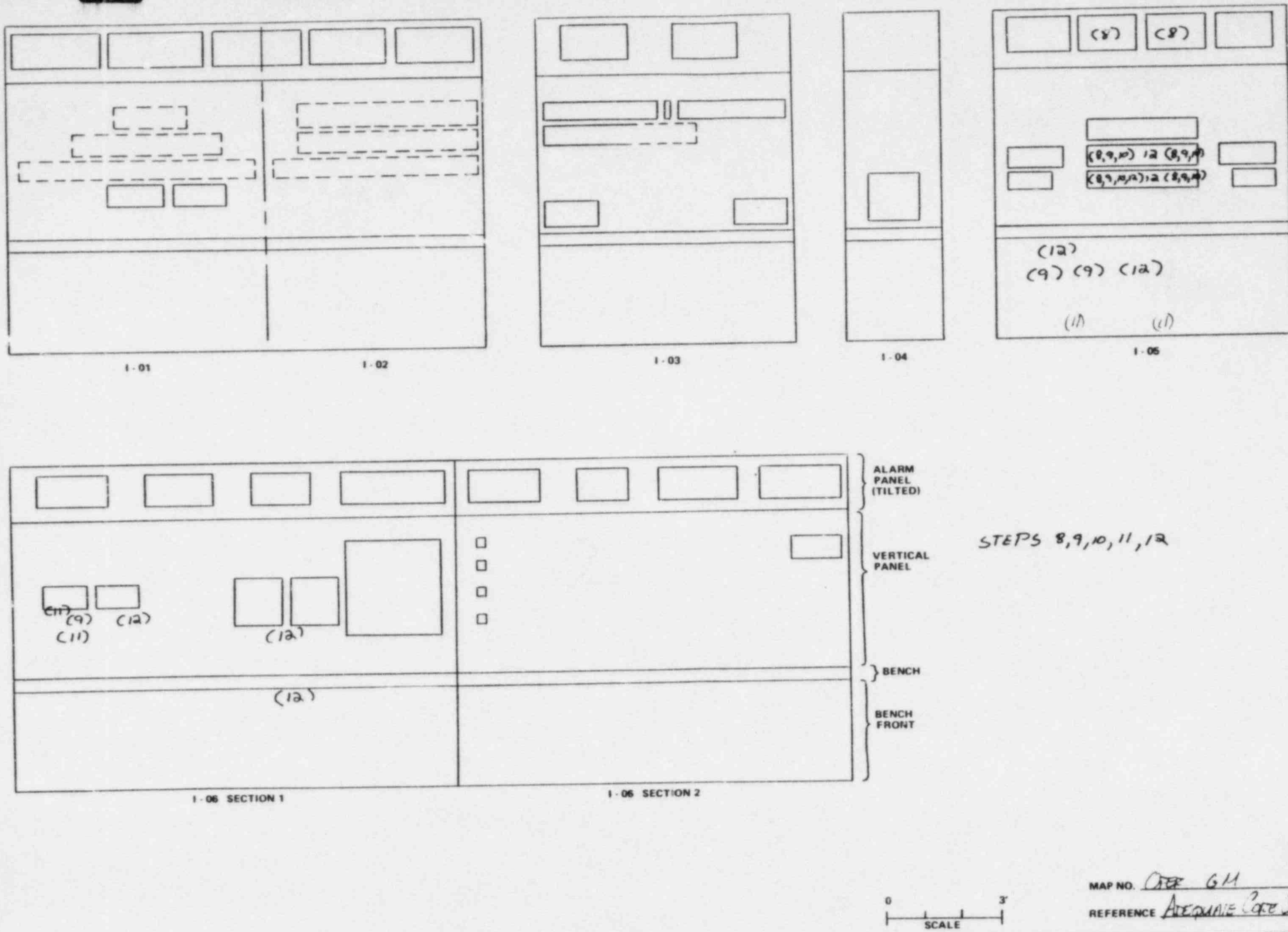
MAP NO. OPER GM

REFERENCE ADEQUATE CORE COOLING

Form 344 24 4253

PUBLIC SERVICE COMPANY OF COLORADO
FORT ST. VRAIN NUCLEAR GENERATING STATION
FRONT PANEL ELEVATION MAP

REDUCTION



MAP NO. CORE GM

REFERENCE ADEQUATE CORE COOLING

Form 344-24-4253

CONTROL ROOM DESIGN REVIEW
TASK ANALYSIS WALKTHRU

REDUCTION

PROCEDURE	OPERATOR	REVIEW TEAM	DATE
ADEQUATE CORE COOLING	GM	MADDOX COMPOSITE	16-NOV-83

GENERAL STEP	CUE	INSTR.	ALM'S	COMM.	REMARKS
INITIAL CONDITIONS • 70% POWER • ~~TURBINE ON LINE~~ STEADY STATE	TELL OPERATOR CONDITIONS.				
1 ABNORMAL TEMPERATURE CONDITIONS	WHAT ARE YOUR FIRST INDICATIONS OF ABNORMAL TEMPERATURE?	CORE DISPLAY ALARMS I-04	5-6 I-03 A FUEL REGION TEMP		
2 ABNORMAL TEMP. VERIFICATION	HOW WOULD YOU VERIFY THAT YOU HAD HI TEMP?	MAIN STEAM TR 22121, 22122 REHEAT 2286 DIGITAL REGION TEMP DISPLAY TI 1139, 1140, 1141			MIGHT USE COMPUTER IF CAN'T RECONCILE DIGITAL AND RECORDER VALUES
3 LOSS OF He. CIRCULATION	WHAT ARE YOUR FIRST INDICATIONS OF LOSS OF He. CIRCULATION?	He CIRC SPEED IND. SI 2109, 2110, 2115, 2116	2-7 I-03 A PWR/FLO MISMATCH		

CONTROL ROOM DESIGN REVIEW
TASK ANALYSIS WALKTHRU

REDUCTION

PROCEDURE	OPERATOR	REVIEW TEAM	DATE
ADEQUATE CORE COOLING	GM	MADDOX - COMPOSITE	16-NOV-83

GENERAL STEP	CUE	INSTR.	ALM'S	COMM.	REMARKS
4. VERIFICATION OF LOSS OF He CIRCULATION	HOW WOULD YOU VERIFY A LOSS OF He CIRCULATION?	He FLOW INDICATORS FI 1157, 1159, 1158, 1160 PDI 1157, 1159, 1158, 1160 CIRC SPEED INDICATORS SI 2109, 2115, 2110, 2116	He CIRC TRIP ALARMS ON I-05A & D HI/LO SPEED, etc ON SAM PANELS.		TRIP ANNUNCIATORS ARE CONFUSING
5. VERIFY He CIRCULATORS ARE AVAILABLE.	HOW DO YOU DETERMINE IF THE He CIRCULATORS CAN BE USED?	SELF-TUBBING SI 2109, 2115, 2110, 2116 SPACE & SEAL CONTROLS HS 21205, 205, 204, 206 HS 21191, 193, 192, 194			CAN RETURN TO SERVICE AFTER SOME TIME EVEN IF SET. MIGHT BE TAGGED OUT FOR MAINT.
6. VERIFY A SOURCE OF MOTIVE FORCE FOR THE He CIRCULATORS	WHAT IS THE FIRST SOURCE OF MOTIVE FORCE FOR THE He CIRCS YOU LOOK FOR? (STEAM)	STEAM TURB. INLET PRESSURE PI 2243-1, 2249-1 STEAM TURB OUTLET PRESSURE PI 2243-2, 2249-2	LIGHTS ON CIRC SPEED CONTROLLERS SC 2105, 2111, 2106, 2112		SEE ATTACHED SHEETS.

CONTROL ROOM DESIGN REVIEW
TASK ANALYSIS WALKTHRU

REDUCTION

PROCEDURE	OPERATOR	REVIEW TEAM	DATE
ADEQUATE CORE COOLING	GM	MADDOX - COMPOSITE	16-NOV-83

GENERAL STEP	CUE	INSTR.	ALM'S	COMM.	REMARKS
6. CONT. ⋮ DO THIS FOR ALL SOURCES OF MOTIVE FORCE.	HOW DO YOU KNOW IF ITS AVAILABLE?	FLASH TANK PRESSURE PI 5225 I-06.			CHECK IF NOT SHOW PRESSURE ON STEAM TURBINE INLET/OUTLET.
7. VERIFY THAT He CIRCULATORS CAN BE RESTARTED.	HOW DO YOU DETERMINE IF THE He CIRCULATORS CAN BE RESTARTED?	RESET ISC 115-1217 CLOSE CIRC BLOCK VALVES PUT SC IN "MAN" & CLOSE BUMP STM TRAP ISOL. VALVE OPEN BLOCK VALVES RUN SC BACK UP MAIN STM TEMPS TR 22121, 122 MODULE TEMPS TR2227			PROBABLY PUT ONLY 1 CIRC UP ON STEAM. SEE ATTACHED SHEETS.
8. LOSS OF SECONDARY COOLANT FLOW	WHAT ARE YOUR FIRST INDICATIONS OF LOSS OF SECONDARY COOLANT FLOW?	MAIN STEAM PRESS PR 22129, 130 FR 2205, 2206	SINGLE CHAN He CIRC TRIP I-05 B,C MAIN STEAM PRESS HI/LO I-05B 2-2 I05C 2-4		

CONTROL ROOM DESIGN REVIEW
TASK ANALYSIS WALKTHRU

REDUCTION

PROCEDURE	OPERATOR	REVIEW TEAM	DATE
ADEQUATE CORE COOLING	GM	MADDOX - COMPOSITE	16-NOV-83

GENERAL STEP	CUE	INSTR.	ALM'S	COMM.	REMARKS
9. VERIFY SECONDARY COOLANT FLOW	HOW WOULD YOU VERIFY A LOSS OF SECONDARY FLOW?	BFP INSTRUMENTS PI 3104, 3105, 3106 FI 3101, 3102, 3103 A'C SPEED INDICATION FEEDWATER INLET VALVES MS 2201, 2202 FLOW RECORDERS 2205, 2206 MAIN STM TEMP TR 2821, 122 " PRESS PR 2829, 130			
10. VERIFY STEAM GENERATORS AVAILABLE.	HOW DO YOU DETERMINE IF THE STEAM GENERATORS CAN BE USED?	ASSUME THEY CAN. EXCEPT DON'T TRY TO USE ISOLATED LOOP FIRST.			
11 VERIFY A SOURCE OF SECONDARY COOLANT.	WHAT IS THE FIRST SOURCE OF SECONDARY COOLANT YOU LOOK FOR?	FEEDWATER CONDENSATE AUX BFPs. FIREWATER			SEE ATTACHED SHEETS.

CONTROL ROOM DESIGN REVIEW
TASK ANALYSIS WALKTHRU

REDUCTION

PROCEDURE	OPERATOR	REVIEW TEAM	DATE
ADEQUATE CORE COOLING	GM	MADDOX - COMPOSITE	16-NOV-83

GENERAL STEP	CUE	INSTR.	ALM'S	COMM.	REMARKS
11. CONT. ⋮ DO THIS FOR ALL SOURCES OF SECONDARY COOLANT.	HOW DO YOU KNOW IF ITS AVAILABLE?				SEE ATTACHED SHEETS.
12 VERIFY THAT SECONDARY COOLANT FLOW THRU SGs CAN BE ESTABLISHED.	HOW DO YOU DETERMINE IF SECONDARY COOLANT FLOW CAN BE ESTABLISHED?				SEE ATTACHED SHEETS
13. VERIFY THAT 4kV SYSTEM CAN BE ESTABLISHED.	HOW DO YOU PUT THE 4kV SYSTEM INTO SERVICE?	NOT	USED.		

CONTROL ROOM DESIGN REVIEW
TASK ANALYSIS WALKTHRU

REDUCTION

PROCEDURE	OPERATOR	REVIEW TEAM	DATE
ADEQUATE CORE COOLING			

GENERAL STEP	CUE	INSTR.	ALM'S	COMM.	REMARKS
14 ESTABLISH ULTIMATE TEMPERATURE.	WHAT IS YOUR INDICATION THAT THE CORE IS REALLY BEING COOLED?				

ATTACHMENT 4A

PART 1

Complete copy of the Operator Survey Questionnaire.

CODE # _____

Fort St. Vrain Control Room
Design Review
Human Factors Engineering Survey

The objective of this survey is to provide an aid for systematically gathering Human Factors data regarding Control Room work space, work station, controls, displays communications and environmental aspects of the Fort St. Vrain Control Room, and specific information about the operators who perform their functions in that Control Room.

This survey is divided into 3 parts. Part 1 asks for information about you personally and your experience. This information is needed to fully represent the entire Control Room operating staff in a statistical summary. The results of this statistical summary will be used in evaluating Control Room problem areas and potential changes.

Part 2 contains groups of questions pertaining to the Control Room environment and layout. This information will be used to ensure that the operating environment is conducive to good operating practice and in accordance with acceptable human factors principles.

Part 3 pertains to the Control Room panels, alarms, instruments and controls. This information will be used in evaluating areas of operator concern and operational problems. Certain part 3 items are repeated for each panel or combination of panels. Please position yourself in front of each panel as you answer the questions for a particular panel. Be as specific as possible listing instrument numbers where possible.

Part 1 - Please provide the following information about yourself and your experience:

OQ-1) Total years of Power Plant Experience _____

OQ-2) Total years of Nuclear Power Plant Experience _____

OQ-3) Total months of Nuclear Navy experience _____

OQ-4) Total years of experience at Fort St. Vrain _____

OQ-5) Total years of Control Room experience _____

OQ-6) Total years of experience as an Operator _____

OQ-7) Total years of experience as an Operator at FSV _____

OQ-8) Are you <u>currently</u> serving as an Operator _____

OQ-9) Date (month & year) of last requalification training _____

OQ-10) Job title _____

OQ-11) Height _____

OQ-12) Age _____

OQ-13) Do you wear glasses ☐ yes ☐ no

- ☐ At Work
- ☐ Monofocal
- ☐ Bifocal
- ☐ Trifocal
- ☐ For Reading Only

Part 2 - This section contains questions which are incident related and designed to identify negative or adverse aspects of the control room layout and environment. If you wish to make additional comments or suggestions about the control room layout or environment, please do so in the space provided or use the back of each sheet.

WORKSPACE LAYOUT AND ENVIRONMENT

OQ-13) Has the layout of the control panels in the control room ever caused you, or someone you have seen, to either misoperate or be unable to operate any plant system? If so, please describe. (This question refers only to the placement of the panels themselves, not to the arrangement of controls and displays on the panels.)

OQ-14) Has the layout of control room equipment other than panels (e.g. computer console) ever caused you or someone you have seen either to misoperate or be unable to operate any plant system? If so, please describe.

OQ-15) Has the arrangement of furniture in the control room ever hindered your access to the operating area or obstructed your view of important displays? If so, please describe.

OQ-16) Has the lighting in the control room, either normal or emergency, ever caused you or someone you have seen to either misoperate or be unable to operate any plant system? If so, please describe. This question refers to both the level of control room lighting and to other characteristics such as glare, color, etc.

OQ-17) Has the noise level in the control room ever caused missed verbal communication or misinterpretation of instructions between you and other members of the operating staff? If so, please describe. This question refers both to the ambient (plant) noise and to the noise caused by alarms, phones, etc.

OQ-18) Has the temperature and/or humidity in the control room ever reached a level, either high or low, at which you were very uncomfortable? Please describe.

OQ-19) Has the temperature/humidity ever reached the level, either high or low, that control room instrumentation or equipment malfunctioned? Please describe.

PANEL DESIGN

OQ-20) Has the layout of controls and displays on any particular panel(s) ever caused you or someone you have seen to misoperate any plant system? If so, please describe.

OQ-21) Have you ever had to put temporary labels, Dymo tape, grease pencil markings, or other clarification on a control room panel to make systems easier to operate and understand? If so, please describe.

OQ-22) Have you ever activated a piece of plant equipment by accidently bumping a control that is placed in a precarious location? If so, please describe.

OQ-23) Have you ever had to leave the main operating area to activate a control or read a display during an emergency or time critical situation? If so, please describe. This question refers mainly to back panel controls and indicators.

TRAINING

OQ-24) Has the training you received ever led you or someone you have seen to misoperate or be unable to operate any plant system? If so, please describe.

OQ-25) Has the training you received been applicable to the operating situations you have encountered? If not, please describe the deficiencies.

OQ-26) Has your training placed to much or too little emphasis on emergency operation? Please suggest a balance between normal and emergency emphasis during training (e.g. 60/40, etc.).

OQ-27) Have there been instances when the transients you see during requalification actually occur at the plant? Please cite an example.

OQ-28) Do you feel that more practice handling transients would be beneficial for operation during such transients? Can you give an example where such practice was or would have been helpful?

STAFFING

OQ-29) Has the number of people on duty in the control room ever caused you or someone you have seen to misoperate or be unable to operate any plant system? Please describe.

OQ-30) Has the division of responsibility in the control room ever left you in doubt as to what you should do next or who was in charge? If so, please explain.

OQ-31) Have you, or someone you have seen, ever been mislead by anything the Shift Tech Advisor said? Please explain.

OQ-32) In your experience, has the Shift Tech Advisor provided worthwhile input to the operations staff during transients.

PROCEDURES

OQ-33) Has using a procedure ever caused you or someone you have seen to misoperate any plant system? If so, please describe.

OQ-34) Are the emergency procedures usable as they are now written? Please explain.

OQ-35) Has a procedure, normal or emergency, ever left you in doubt as to what your next action should be? If so, which procedure(s)?

COMMUNICATIONS

OQ-36) Has the plant communication system ever caused you or someone you have seen to misoperate any plant system? If so, please describe. This question refers to the telephones, soundpowered phones, walkie-talkies, and PA system in the plant.

OQ-37) Is there any general problem with the plant communcation system that degrades its usefulness during plant operation (for example, absence of a protocol requiring walkie-talkie users to identify themselves)? If so, please describe.

OQ-38) Has the use of the communication system ever caused control room instrumentation to operate improperly (e.g., nuclear instrumentation picking up walkie-talkie signals)? If so, please describe.

MAINTENANCE

OQ-39) Has maintenance performed in the control room ever caused you or someone you have seen to misoperate or be unable to operate any plant system? If so, please describe. This question refers to such activities as surveillance testing, indicator light replacement, chart paper replacement, etc.

OQ-40) Has miscommunication between you or other operations people, and maintenance ever caused the misoperation or unavailability of a plant system? If so, please describe.

OQ-41) Do you use job aids to perform the required maintenance in the control room? For example, is a special tool provided for indicator light replacement?

PLANT COMPUTER SYSTEM

OQ-42) In general, have you used the plant computer system more for normal, abnormal, or emergency operation?

OQ-43) Do you believe that you understand how the plant computer system works well enough to use the system to its potential? Please explain.

OQ-44) Although it is not absolutely required, do you think the plant computer system is necessary for normal operation? How about emergency operation?

OQ-45) Has the plant computer system ever mislead you as to what is happening in the plant? Please describe. This question refers to computer output that is misleading because of inaccuracies, incorrect status indications, time delays, etc.

OQ-46) Has any feature of the FSV plant computer system ever caused you or someone you have seen to misoperate any plant system? If so, please describe.

Part 3 - The first 15 items are repeated for individual control boards. Please position yourself in front of each board while responding to each entry. If you are not familiar with a particular board, please state "NOT CURRENT" and do not answer the entries for that board.

The following items apply to I-01

I-01-1 List any systems or subsystems you operate in which a particular control or display is too far away from others you have to use with it, or is on another panel.

_____

_____

_____

_____

List the particular instruments.

_____

_____

_____

_____

I-01-2 List any controls that are difficult to adjust as precisely as they need to be adjusted.

_____

_____

_____

_____

I-01-3 List any switches that do not "snap" into position. List any switches that can be left halfway between positions. List any switches that are difficult to turn (or actuate).

_____

_____

_____

_____

I-01-4 List any controls that are too large or small to operate easily.

I-01-5 List any meters that are scaled in different units than the procedures you have to use with them. (For example, do you have to use nomographs or conversion factors other than power of 10?)

I-01-6 List any controls and displays that work together in unusual ways. (example: meter shows increase for a counterclockwise controller adjustment.

I-01-7 List any instruments that are difficult to compare with backups because of differences in scale units, elevated zeros, etc.

I-01-8 List any indicators, recorders, or controls that are hard to use because they have to be read more precisely than the scale allows.

I-01-9 List any recorders for which it is particularly difficult to change paper or ink.

I-01-10 List any difficulties with lamp replacement, such as shock, accidental activation.

I-01-11 List any labels that are unclear about what is being displayed, what a control does, or what position a control is in.

I-01-12 List any labels that are difficult to associate with the related control.

I-01-13 List any key switches where the key can be removed when the switch is not in its "off" or "safe" position.

I-01-14 List any indicating light or light displays for which the meaning is not clearly indicated or described.

I-01-15 List any control that is difficult to reach.

The following items apply to I-02

I-02-1 List any systems or subsystems you operate in which a particular control or display is too far away from others you have to use with it, or is on another panel.

_____

_____

_____

_____

List the particular instruments.

_____

_____

_____

_____

I-02-2 List any controls that are difficult to adjust as precisely as they need to be adjusted.

_____

_____

_____

_____

I-02-3 List any switches that do not "snap" into position. List any switches that can be left halfway between positions. List any switches that are difficult to turn (or actuate).

_____

_____

_____

_____

I-02-4 List any controls that are too large or small to operate easily.

I-02-5 List any meters that are scaled in different units than the procedures you have to use with them. (For example, do you have to use nomographs or conversion factors other than power of 10?)

I-02-6 List any controls and displays that work together in unusual ways. (example: meter shows increase for a conterclockwise controller adjustment.

I-02-7 List any instruments that are difficult to compare with backups because of differences in scale units, elevated zeros, etc.

I-02-8 List any indicators, recorders, or controls that are hard to use because they have to be read more precisely than the scale allows.

I-02-9 List any recorders for which it is particularly difficult to change paper or ink.

I-02-10 List any difficulties with lamp replacement, such as shock, accidental activation.

I-02-11 List any labels that are unclear about what is being displayed, what a control does, or what position a control is in.

I-02-12 List any labels that are difficult to associate with the related control.

I-02-13 List any key switches where the key can be removed when the switch is not in its "off" or "safe" position.

I-02-14 List any indicating light or light display for which the meaning is not clearly indicated or described.

I-02-15 List any control that is difficult to reach.

The following items apply to I-03

I-03-1 List any systems or subsystems you operate in which a particular control or display is too far away from others you have to use with it, or is on another panel.

List the particular instruments.

I-03-2 List any controls that are difficult to adjust as precisely as they need to be adjusted.

I-03-3 List any switches that do not "snap" into position. List any switches that can be left halfway between positions. List any switches that are difficult to turn (or actuate).

I-03-4 List any controls that are too large or small to operate easily.

I-03-5 List any meters that are scaled in different units than the procedures you have to use with them. (For example, do you have to use nomographs or conversion factors other than power of 10?)

I-03-6 List any controls and displays that work together in unusual ways. (example: meter shows increase for a conterclockwise controller adjustment.

I-03-7 List any instruments that are difficult to compare with backups because of differences in scale units, elevated zeros, etc.

I-03-8 List any indicators, recorders, or controls that are hard to use because they have to be read more precisely than the scale allows.

I-03-9 List any recorders for which it is particularly difficult to change paper or ink.

I-03-10 List any difficulties with lamp replacement, such as shock, accidental activation.

I-03-11 List any labels that are unclear about what is being displayed, what a control does, or what position a control is in.

I-03-12 List any labels that are difficult to associate with the related control.

•

I-03-13 List any key switches where the key can be removed when the switch is not in its "off" or "safe" position.

I-03-14 List any indicating light or light display for which the meaning is not clearly indicated or described.

I-03-15 List any control that is difficult to reach.

The following items apply to I-04

I-04-1 List any systems or subsystems you operate in which a particular control or display is too far away from others you have to use with it, or is on another panel.

_____

_____

_____

_____

List the particular instruments.

_____

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I-04-2 List any controls that are difficult to adjust as precisely as they need to be adjusted.

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I-04-3 List any switches that do not "snap" into position. List any switches that can be left halfway between positions. List any switches that are difficult to turn (or actuate).

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_____

I-04-4 List any controls that are too large or small to operate easily.

I-04-5 List any meters that are scaled in different units than the procedures you have to use with them. (For example, do you have to use nomographs or conversion factors other than power of 10?)

I-04-6 List any controls and displays that work together in unusual ways. (example: meter shows increase for a conterclockwise controller adjustment.

I-04-7 List any instruments that are difficult to compare with backups because of differences in scale units, elevated zeros, etc.

I-04-8 List any indicators, recorders, or controls that are hard to use because they have to be read more precisely than the scale allows.

I-04-9 List any recorders for which it is particularly difficult to change paper or ink.

I-04-10 List any difficulties with lamp replacement, such as shock, accidental activation.

I-04-11 List any labels that are unclear about what is being displayed, what a control does, or what position a control is in.

I-04-12 List any labels that are difficult to associate with the related control.

I-04-13 List any key switches where the key can be removed when the switch is not in its "off" or "safe" position.

I-04-14 List any indicating light or light display for which the meaning is not clearly indicated or described.

I-05-15 List any control that is difficult to reach.

The following items apply to I-05

I-05-1 List any systems or subsystems you operate in which a particular control or display is too far away from others you have to use with it, or is on another panel.

List the particular instruments.

I-05-2 List any controls that are difficult to adjust as precisely as they need to be adjusted.

I-05-3 List any switches that do not "snap" into position. List any switches that can be left halfway between positions. List any switches that are difficult to turn (or actuate).

I-05-4 List any controls that are too large or small to operate easily.

I-05-5 List any meters that are scaled in different units than the procedures you have to use with them. (For example, do you have to use nomographs or conversion factors other than power of 10?)

I-05-6 List any controls and displays that work together in unusual ways. (example: meter shows increase for a conterclockwise controller adjustment.

I-05-7 List any instruments that are difficult to compare with backups because of differences in scale units, elevated zeros, etc.

I-05-8 List any indicators, recorders, or controls that are hard to use because they have to be read more precisely than the scale allows.

I-05-9 List any recorders for which it is particularly difficult to change paper or ink.

I-05-10 List any difficulties with lamp replacement, such as shock, accidental activation.

I-05-11 List any labels that are unclear about what is being displayed, what a control does, or what position a control is in.

I-05-12 List any labels that are difficult to associate with the related control

I-05-13 List any key switches where the key can be removed when the switch is not in its "off" or "safe" position.

I-05-14 List any indicating light or light display for which the meaning is not clearly indicated or described.

I-5-15 List any control that is difficult to reach.

The following items apply to I-06

I-06-1 List any systems or subsystems you operate in which a particular control or display is too far away from others you have to use with it, or is on another panel.

_____

_____

_____

_____

List the particular instruments.

_____

_____

_____

_____

I-06-2 List any controls that are difficult to adjust as precisely as they need to be adjusted.

_____

_____

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_____

I-06-3 List any switches that do not "snap" into position. List any switches that can be left halfway between positions. List any switches that are difficult to turn (or actuate).

_____

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I-06-4 List any controls that are too large or small to operate easily.

I-06-5 List any meters that are scaled in different units than the procedures you have to use with them. (For example, do you have to use nomographs or conversion factors other than power of 10?)

I-06-6 List any controls and displays that work together in unusual ways. (example: meter shows increase for a conterclockwise controller adjustment.

I-06-7 List any instruments that are difficult to compare with backups because of differences in scale units, elevated zeros, etc.

I-06-8 List any indicators, recorders, or controls that are hard to use because they have to be read more precisely than the scale allows.

I-06-9 List any recorders for which it is particularly difficult to change paper or ink.

I-06-10 List any difficulties with lamp replacement, such as shock, accidental activation.

I-06-11 List any labels that are unclear about what is being displayed, what a control does, or what position a control is in.

I-06-12 List any labels that are difficult to associate with the related control.

I-06-13 List any key switches where the key can be removed when the switch is not in its "off" or "safe" position.

I-06-14 List any indicating light or light display for which the meaning is not clearly indicated or described.

I-06-15 List any control that is difficult to reach.

The following items apply to I-7307X

I-07X-1 List any systems or subsystems you operate in which a particular control or display is too far away from other you have to use with it, or is on another panel.

_____

_____

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_____

List the particular instruments.

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_____

I-07X-2 List any controls that are difficult to adjust as precisely as they need to be adjusted.

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I-07X-3 List any switches that do not "snap" into position. List any switches that can be left halfway between positions. List any switches that are difficult to turn (or actuate).

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I-07X-4 List any controls that are too large or small to operate easily.

I-07X-5 List any meters that are scaled in different units than the procedures you have to use with them. (For example, do you have to use nomographs or conversion factors other than power of 10?)

I-07X-6 List any controls and displays that work together in unusual ways. (example: meter shows increase for a conterclockwise controller adjustment.

I-07X-7 List any instruments that are difficult to compare with backups because of differences in scale units, elevated zeros, etc.

I-07X-8 List any indicators, recorders, controls that are hard to use because they have to be read more precisely than the scale allows.

I-07X-9 List any recorders for which it is particularly difficult to change paper or ink.

I-07X-10 List any difficulties with lamp replacement, such as shock, accidental activation.

I-07X-11 List any labels that are unclear about what is being displayed, what a control does, or what position a control is in.

I-07X-12 List any labels that are difficult to associate with the related control.

I-07X-13 List any key switches where the key can be removed when the switch is not in its "off" or "safe" postion.

I-07X-14 List any indicating light or light display for which the meaning is not clearly indicated or described.

I-07X-15 List any control that is difficult to reach.

The following items apply to I-09

I-09-1 List any systems or subsystems you operate in which a particular control or display is too far away from others you have to use with it, or is on another panel.

_____

_____

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_____

List the particular instruments.

_____

_____

_____

_____

I-09-2 List any controls that are difficult to adjust as precisely as they need to be adjusted.

_____

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_____

I-09-3 List any switches that do not "snap" into position. List any switches that can be left halfway between positions. List any switches that are difficult to turn (or actuate).

_____

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_____

_____

I-09-4 List any controls that are too large or small to operate easily.

I-09-5 List any meters that are scaled in different units than the procedures you have to use with them. (For example, do you have to use nomographs or conversion factors other than power of 10?)

I-09-6 List any controls and displays that work together in unusual ways. (example: meter shows increase for a conterclockwise controller adjustment.

I-09-7 List any instruments that are difficult to compare with backups because of differences in scale units, elevated zeros, etc.

I-09-8 List any indicators, recorders, or controls that are hard to use because they have to be read more precisely than the scale allows.

I-09-9 List any recorders for which it is particularly difficult to change paper or ink.

I-09-10 List any difficulties with lamp replacement, such as shock, accidental activation.

I-09-11 List any labels that are unclear about what is being displayed, what a control does, or what position a control is in.

I-09-12 List any labels that are difficult to associate with the related control.

I-09-13 List any key switches where the key can be removed when the switch is not in its "off" or "safe" position.

I-09-14 List any indicating light or light display for which the meaning is not clearly indicated or described.

I-09-15 List any control that is difficult to reach.

The following items apply to I-10

I-10-1 List any systems or subsystems you operate in which a particular control or display is too far away from others you have to use with it, or is on another panel.

_____

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_____

List the particular instruments.

_____

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I-10-2 List any controls that are difficult to adjust as precisely as they need to be adjusted.

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_____

I-10-3 List any switches that do not "snap" into position. List any switches that can be left halfway between positions. List any switches that are difficult to turn (or actuate).

_____

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_____

I-10-4 List any controls that are too large or small to operate easily.

I-10-5 List any meters that are scaled in different units than the procedures you have to use with them. (For example, do you have to use nomographs or conversion factors other than power of 10?)

I-10-6 List any controls and displays that work together in unusual ways. (example: meter shows increase for a conterclockwise controller adjustment.

I-10-7 List any instruments that are difficult to compare with backups because of differences in scale units, elevated zeros, etc.

I-10-8 List any indicators, recorders, or controls that are hard to use because they have to be read more precisely than the scale allows.

I-10-9 List any recorders for which it is particularly difficult to change paper or ink.

I-10-10 List any difficulties with lamp replacement, such as shock, accidental activation.

I-10-11 List any labels that are unclear about what is being displayed, what a control does, or what position a control is in.

I-10-12 List any labels that are difficult to associate with the related control.

I-10-13 List any key switches where the key can be removed when the switch is not in its "off" or "safe" postion.

I-10-14 List any indicating light or light display for which the meaning is not clearly indicated or described.

I-10-15 List any control that is difficult to reach.

The following items apply to I-13

I-13-1 List any systems or subsystems you operate in which a particular control or display is too far away from others you have to use with it, or is on another panel.

_____

_____

_____

_____

List the particular instruments.

_____

_____

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_____

I-13-2 List any controls that are difficult to adjust as precisely as they need to be adjusted.

_____

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I-13-3 List any switches that do not "snap" into position. List any switches that can be left halfway between positions. List any switches that are difficult to turn (or actuate).

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I-13-4 List any controls that are too large or small to operate easily.

I-13-5 List any meters that are scaled in different units than the procedures you have to use with them. (For example, do you have to use nomographs or conversion factors other than power of 10?)

I-13-6 List any controls and displays that work together in unusual ways. (example: meter shows increase for a conterclockwise controller adjustment.

I-13-7 List any instruments that are difficult to compare with backups because of differences in scale units, elevated zeros, etc.

I-13-8 List any indicators, recorders, or controls that are hard to use because they have to be read more precisely than the scale allows.

I-13-9 List any recorders for which it is particularly difficult to change paper or ink.

I-13-10 List any difficulties with lamp replacement, such as shock, accidental activation.

I-13-11 List any labels that are unclear about what is being displayed, what a control does, or what position a control is in.

I-13-12 List any labels that are difficult to associate with the related control.

I-13-13 List any key switches where the key can be removed when the switch is not in its "off" or "safe" position.

I-13-14 List any indicating light or light display for which the meaning is not clearly indicated or described.

I-13-15 List any control that is difficult to reach.

The following items apply to I-14

I-14-1 List any systems or subsystems you operate in which a particular control or display is too far away from others you have to use with it, or is on another panel.

_____

_____

_____

_____

List the particular instruments.

_____

_____

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_____

I-14-2 List any controls that are difficult to adjust as precisely as they need to be adjusted.

_____

_____

_____

_____

I-14-3 List any switches that do not "snap" into position. List any switches that can be left halfway between positions. List any switches that are difficult to turn (or actuate).

_____

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_____

I-14-4 List any controls that are too large or small to operate easily.

I-14-5 List any meters that are scaled in different units than the procedures you have to use with them. (For example, do you have to use nomographs or conversion factors other than power of 10?)

I-14-6 List any controls and displays that work together in unusual ways. (example: meter shows increase for a conterclockwise controller adjustment.

I-14-7 List any instruments that are difficult to compare with backups because of differences in scale units, elevated zeros, etc.

I-14-8 List any indicators, recorders, or controls that are hard to use because they have to be read more precisely than the scale allows.

I-14-9 List any recorders for which it is particularly difficult to change paper or ink.

I-14-10 List any difficulties with lamp replacement, such as shock, accidental activation.

I-14-11 List any labels that are unclear about what is being displayed, what a control does, or what position a control is in.

I-14-12 List any labels that are difficult to associate with the related control.

I-14-13 List any key switches where the key can be removed when the switch is not in its "off" or "safe" position.

I-14-14 List any indicating light or light display for which the meaning is not clearly indicated or described.

I-14-15 List any control that is difficult to reach.

The following items apply to I-15

I-15-1 List any systems or subsystems you operate in which a particular control or display is too far away from others you have to use with it, or is on another panel.

_____

_____

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_____

List the particular instruments.

_____

_____

_____

_____

I-15-2 List any controls that are difficult to adjust as precisely as they need to be adjusted.

_____

_____

_____

_____

I-15-3 List any switches that do not "snap" into position. List any switches that can be left halfway between positions. List any switches that are difficult to turn (or actuate).

_____

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_____

I-15-4 List any controls that are too large or small to operate easily.

I-15-5 List any meters that are scaled in different units than the procedures you have to use with them. (For example, do you have to use nomographs or conversion factors other than power of 10?)

I-15-6 List any controls and displays that work together in unusual ways. (example: meter shows increase for a conterclockwise controller adjustment.

I-15-7 List any instruments that are difficult to compare with backups because of differences in scale units, elevated zeros, etc.

I-15-8 List any indicators, recorders, or controls that are hard to use because they have to be read more precisely than the scale allows.

I-15-9 List any recorders for which it is particularly difficult to change paper or ink.

I-15-10 List any difficulties with lamp replacement, such as shock, accidental activation.

I-15-11 List any labels that are unclear about what is being desplayed, what a control does, or what position a control is in.

I-15-12 List any labels that are difficult to associate with the related control.

I-15-13 List any key switches where the key can be removed when the switch is not in its "off" or "safe" position.

I-15-14 List any indicating light or light display for which the meaning is not clearly indicated or described.

I-15-15 List any control that is difficult to reach.

GENERAL SURVEY ITEMS

G-OQ-1 List any equipment affected by radio interference.

G-OQ-2 List any chart recorders where fast tracking rates or trends are periodically required that lack Hi/Lo speed capability.

G-OQ-3 List any important parameters that are not presently "alarmed" and should be.

G-OQ-4 List any controls that are shaped, located, or have a legend that has contributed to your inadvertent operation of that control.

G-OQ-5 List any control that has been inadvertently operated by anyone, and describe the method or incident.

G-OQ-6 List any keyswitches not required by the present day operating philosophy.

G-OQ-7 List any keyswitches operable by keys designated for a different function.

G-OQ-8 List any keyswitches where the key is removable in the non-lock or non-secured position.

G-OQ-9 List any "failed" instruments that have resulted in your improper operation of a system.

G-OQ-10 List any indication requiring the use of nomographs, charts, or conversions which present a problem in using.

ANNUNCIATORS

G-OQ-11 Do you get nuisance alarms when a system is secured?

List

G-OQ-12 List any particular recurring invalid alarms.

G-OQ-13 List any alarms insignificant from an operational point of view.

G-OQ-14 List any "blank" or "unassigned" alarm windows that are on.

G-OQ-15 How do you detect alarm Flasher failure?

Additional Comments

ATTACHMENT 4A

PART 2

Sample operator survey questionnaires

HUMAN FACTORS ENGINEERING SURVEY

HED 557 ~~Adam Ardibb Sands~~

QUESTION NO. OQ-20)	Has the layout of controls and displays on any particular panel(s) ever caused you or someone you have seen to misoperate any plant system? If so, please describe.
001	
HE-0613 002	Yes, see question OQ-14 also 'A' circulator was inadvertantly shutdown when an operators hand bumped the HS for the steam inlet valve.
HED-0636 HED-0681 003	Yes, convention is the biggest problem. the 46 system pumps, Loop I are up and down on the panel. The 23 system, Loop I is in line left to right. Controllers which operate valves "backward" from other controllers, etc.
004	
005	No
006	No
007	
008	

Individual operator code numbers

HUMAN FACTORS ENGINEERING SURVEY

QUESTION NO. I-01-1	List any systems or subsystems you operate in which a particular control or display is too far away from others you have to use with it, or is on another panel.
001	
002	Reheater and main steam module temperatures (recorders). HED-0504 Particular instruments: TR-2227 and TR-2255
003	None. Particular instruments: N/A
004	
005	TC-4637 and TC-4638 on I-01 TR-4637 and TR-4638 on I-13 . ~~HED~~ ~~HED0504~~ HED-0695
006	DID NOT ANSWER QUESTION
007	No board experience.
008	

Individual operator code numbers

HUMAN FACTORS ENGINEERING SURVEY

QUESTION NO. I-01-2	List any controls that are difficult to adjust as precisely as they need to be adjusted.
001	Not particularly responsive to Question - No apparent probb
002	HED-0697 46 system surge tank level, regen. k.o. pot level, purified He flow when pumping up (HC-11214). HED-0698
003	FC-2402, HC-11214, HS-2401, HS-2403, and HS-2407. HED 0698
004	
005	DID NOT ANSWER QUESTION
006	DID NOT ANSWER QUESTION
007	DID NOT ANSWER QUESTION
008	

Individual operator code numbers

HUMAN FACTORS ENGINEERING SURVEY

QUESTION NO. I-01-3	List any switches that do not "snap" into position. List any switches that can be left halfway between positions. List any switches that are difficult to turn (or actuate).
001	
002	Some spring operated handswitches are hard to hold in a position for any length of time (Ex. HS-4609 and 4610). HED-0697
003	None
004	
005	DID NOT ANSWER QUESTION
006	DID NOT ANSWER QUESTION
007	DID NOT ANSWER QUESTION
008	

Individual operator code numbers

HUMAN FACTORS ENGINEERING SURVEY

QUESTION NO. I-01-4	List any controls that are too large or small to operate easily.
001	
002	N/A
003	None
004	
005	Reset buttons on HS-2337 and HS-2338. HED 006, 0608 color coding & labeling 0700
006	DID NOT ANSWER QUESTION
007	DID NOT ANSWER QUESTION
008	

Individual operator code numbers

HUMAN FACTORS ENGINEERING SURVEY

QUESTION NO. I-01-6	List any controls and displays that work together in unusual ways. (Example: meter shows increase for a counterclockwise controller adjustment).
01	
002	HED-0201 Bypass controller operates backwards from every other controller.
003	HED-0278 since changed HS-4704 and HS-4705, one works backward from the other.
004	
005	DID NOT ANSWER QUESTION
006	DID NOT ANSWER QUESTION
007	DID NOT ANSWER QUESTION
008	

Individual operator code numbers

HUMAN FACTORS ENGINEERING SURVEY

QUESTION NO. I-01-15	List any control that is difficult to reach.
001	
002	DID NOT ANSWER QUESTION
003	None
004	
005	DID NOT ANSWER QUESTION
006	DID NOT ANSWER QUESTION
007	DID NOT ANSWER QUESTION
008	

Individual operator code numbers

DESI REVIEW

HUMAN FACTORS ENGINEERING SURVEY

QUESTION NO. G-OQ-4	List any controls that are shaped, located, or have a legend that has contributed to your inadvertent operation of that control.
001	
002	DID NOT ANSWER QUESTION
003	Speed controls on He circs (mirror image), Auxiliaries on He circs (too many controllers lined up making it hard to find the "right one").
004	
005	DID NOT ANSWER QUESTION
006	DID NOT ANSWER QUESTION
007	DID NOT ANSWER QUESTION
008	

1

Individual operator code numbers

General Comment Typical HED - 499 - 500

4

DESI REVIEW

HUMAN FACTORS ENGINEERING SURVEY

Individual operator code numbers

QUESTION NO. G-OQ-5	List any control that has been inadvertently operated by anyone, and describe the method or incident.
001	
002	DID NOT ANSWER QUESTION
003	In any array where controllers or switches are lined up with no spacing or mirror imagery is used, I have seen inadvertent operation.
004	
005	DID NOT ANSWER QUESTION
006	DID NOT ANSWER QUESTION
007	DID NOT ANSWER QUESTION
008	

General Comment — Sufficiently addressed by existing HEDS

ATTACHMENT 4b

EMAP-1

Administrative procedure

Public Service™

FORT ST. VRAIN NUCLEAR GENERATING STATION

PUBLIC SERVICE COMPANY OF COLORADO

CONTROL ROOM SYSTEMS REVIEW GROUP OPERATING GUIDELINES

ISSUANCE AUTHORIZED BY			
PORC REVIEW			EFFECTIVE DATE

FOREWORD: NUREG-737 requires each licensee to conduct a comprehensive study of the control room in an effort to "improve the ability of nuclear power plant control room operators to prevent accidents or cope with accidents if they occur by improving the information provided to them".

In response to this regulatory requirement Public Service Company has expended and will continue expending considerable time and resources in improving the man/machine interface thru operational and functional grouping of controls, labeling, control and indicator conventions, procedural changes and training.

An on-going design control program is necessary to ensure continuation of the design basis established as a result of NUREG-0737. PSC's on-going design control program is an integral part of the design process and is assured through design reviews at the documentation and systems operational levels. Design Process reviews are defined by the applicable engineering procedures.

Systems Operational reviews are to be conducted in accordance with this document.

1.0 PURPOSES

1.1 This procedure provides administrative guidelines for the organization and activities associated with the Fort St. Vrain Control Room Systems Review Group activities (CRSRG).

1.2 The purpose of the CRSRG is to ensure that any change, addition, or modification to control room equipment and to the control room environment is in fact necessary, will not degrade operations and conforms to the design convention established as a result of the control room design review effort.

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PUBLIC SERVICE COMPANY OF COLORADO

2.0 APPLICABILITY

2.1 This procedure is applicable to all reviews performed by the CRSRG concerning Fort St. Vrain control room modification activities.

2.2 Control room modification activities include the following:

2.2.1 The addition, deletion, or alteration of control board controls, instruments, indicators, and equipment.

2.2.2 The addition, deletion, or alteration of control room enviromental support and control equipment.

2.2.3 The addition, deletion, or alteration of operating support equipment including CRTs, keyboards consoles, control room furnishings, and layout.

2.2.4 The addition, deletion, or alteration of non-operating support equipment and furnishings.

3.0 GENERAL

3.1 The Nuclear Engineering Division (NED) is responsible for completing all design activities, in conformance with all applicable standards, specifications and design directives per Administrative Procedure Q-3.

3.2 The CRSRG is responsible for reviewing proposed plant modification activities that involve control room additions or alterations and determining the acceptability of these proposed changes as defined by this procedure.

3.3 NED will coordinate CRSRG activities.

3.4 A determination of acceptability (or unacceptability) of a control room change by the CRSRG shall be provided to the Station Manager for consideration in the evaluation/approval of proposed modifications.

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PUBLIC SERVICE COMPANY OF COLORADO

4.0 MEMBERSHIP

The CRSRG shall be comprised of representatives from the following departments:

a. Operations
b. Nuclear Betterment Engineering
c. Technical Services
d. Training
e. NED Site
f. NED Denver
   - Nuclear Design
   - Control Room Improvement Group

5.0 QUORUM

A quorum for the CRSRG shall consist of the chairperson or designee, and four (4) members or alternates.

6.0 PROCEDURE

The CRSRG shall review all proposed control room modification activities. It is preferable to review all proposed changes during the Design Change Action Request (DCAR) phase as a means of addressing potential problems early in the design process. However, a preliminary review shall not preclude the requirement for reviewing the proposed modification in the final Change Notice (CN) form.

6.1 Preparation

The design change or CN coordinator shall be responsible for presenting each proposed change to the CRSRG. The coordinator shall make preparation for this presentation by:

6.1.1 Addressing each question contained in Attachment EMAP-1A to establish a preliminary compliance with basic human factors principles and to ensure that the change is necessary.

6.1.2 Addressing each question listed on the Action Record (Attachment 1, EMAP-1B).

6.1.3 Gaining a thorough understanding of the purpose and operation of the proposed change.

6.2 Scheduling CRSRG Activities

6.2.1 The design change or CN coordinator shall upon completion of all preparatory activities notify the Nuclear Design Manager of the need for a CRSRG review.

6.2.2 The Nuclear Design Manager shall then schedule a CRSRG meeting and notify all representatives by memorandum as to the agenda, location, date and time of such meeting.

6.3 Review Activities

6.3.1 CRSRG Meetings shall be chaired by the Nuclear Design Manager or an individual so designated. Minutes of the meeting shall be recorded by the chairperson or an appointed recorder.

6.3.2 Each proposed change shall be presented by the design change coordinator or a designee. It shall be the responsibility of this coordinator to provide sufficient information for evaluating the proposed change.

6.3.3 The CRSRG shall:

- ensure that the purpose of the proposed change is defined and that a control room change is required.
- evaluate the potential value and use of any control room change or addition.
- review the proposed change for impact on operator work load during normal and emergency operations.
- ensure that all available options or alternatives have been fully assessed.
- verify that the design activity includes consideration of established human factors principles.

6.3.4 Following a review of a proposed change, the CRSRG chairperson shall complete an "Action Record", and poll each representative as to the acceptability of the proposed change.

A majority approval of the CRSRG shall be required to indicate acceptability of a proposed change.

6.3.5 The chairperson or the designee shall be responsible for preparing and distributing a report summarizing the actions of the CRSRG during each scheduled meeting.

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PUBLIC SERVICE COMPANY OF COLORADO

6.3.6 The Station Manager shall consider the determination made by the CRSRG in the evaluation/approval of a proposed modification.

7.0 REFERENCES

7.1 NUREG-0737

7.2 ENG-2

8.0 ATTACHMENTS

EMAP-1A Control Room Design Analysis considerations (Attachment 2 from Procedure ENG-2)

EMAP-1B Control Room Systems Review Group Action Record

CONTROL ROOM DESIGN ANALYSIS CONSIDERATIONS

The following considerations should be addressed by the cognizant designer when preparing the Blue Package of a CN which affects control room indications, operations, or activities:

1. Does the proposed change(s) or addition(s) have a definite and essential operational purpose?

2. Does the operational purpose(s) require that any instruments, equipment items, or devices be located in the control room?

   a. What information will the operator receive?

   b. Are there existing sources for the same information? YES NO

   c. Are there alternatives to locating each control in the control room or on control room boards? YES NO

   d. Was each alternative fully reviewed and evaluated? YES NO

3. Is each instrument, equipment item, or device primarily for operator use in controlling a plant system? YES NO

   a. Will the operator actually perform a manipulation in response to information received?

   b. If control manipulations are not made as a result of information presented, what other action must the operator take?

   c. How will the temporary loss or failure of this instrument, equipment item, or device affect operations?

4. Will any required operation impact other control operations during an emergency?

   a. Are there time constraints associated with this change (how quickly must the operator react to a given stimuli)?

b. What effect does this change have on the operator work load during normal operations?

5. Are there regulatory requirements for this proposed change or addition?

6. Does the instrument, control, or device configuration, operation, and structure conform to established Human Factors principles?

7. Is (are) the instrument(s), equipment item(s), or device(s) functionally grouped?

8. What are the training requirements associated with this change? What are the time considerations for training?

9. What procedures and document changes are required for operation of the additional instruments, controls, or devices?

10. What effect if any will this change have on the control room environment?

    a. Sound Levels

    b. Light Levels

    c. Space Envelopes

    d. Isle Widths

    e. HVAC

    f. Fire Protection

11. Will required maintenance activities adversely impact operations?

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CONTROL ROOM SYSTEMS REVIEW GROUP
ACTION RECORD

CN or AR Number _____

Proposed Change Presented By: _____

(Note - Further review action shall be suspended if a single question is answered "no")

1. Was the purpose and scope of the proposed change clearly and adequately presented? YES NO

2. Was the necessity for the proposed control room change(s) established? YES NO

3. Was the effect on the operator work load addressed? YES NO

4. Was training requirements addressed? YES NO

5. Were Procedural or Technical Specification changes addressed? YES NO

6. Were the effect of Maintenance activities on operational requirements considered? YES NO

7. Were provisions made to ensure compliance with established Human Factors principles? YES NO

Review Group Action

Shall the proposed change be approved?

Operations	YES	NO
Site Engineering	YES	NO
Training	YES	NO
Tech. Services	YES	NO
Nuclear Betterment Engineering	YES	NO
NED (Denver)	YES	NO
CRDR Coordinator	YES	NO

Disposition: Recommend Accpetance YES NO

Remarks: _____

_____

_____

Record By: _____ Date: _____

ATTACHMENT 4c
Check List

Public Service™

FORT ST. VRAIN NUCLEAR GENERATING STATION

PUBLIC SERVICE COMPANY OF COLORADO

CN _____
BY _____
PAGE _____

CONTROL ROOM DESIGN ANALYSIS

Does this activity affect Control Room design? ☐ Yes ☐ No
If NO, sign and date below. If YES, complete remainder of form.

ANALOG & DIGITAL INDICATORS

YES	NO	N/A	
☐	☐	☐	Is the indicator of the same type and design presently utilized in the Control Room?
☐	☐	☐	Does the scale envelope the expected operating range?
☐	☐	☐	Is the scale increment consistent with other scales displaying the same or a related parameter?
☐	☐	☐	Is the scale increment consistent with the instrument or loop accuracy?
☐	☐	☐	Do selected indicators conform to DD-AIS-1?

CONTROL

☐	☐	☐	Is (are) the control(s) of the same type and design presently utilized in the Control Room for similar functions?
☐	☐	☐	Is the control action per design directive DD-CSN-1 (i.e. left - close, right - open)?
☐	☐	☐	Is the display legend and increment consistent with other scales displaying the same or a related parameter?
☐	☐	☐	Do the physical characteristics of control knobs, dials, and/or switches conform to DD-CSN-1?

SWITCHES

☐	☐	☐	Are the physical switch characteristics in accordance with design directive DD-SWI-1 or accepted human factors criteria?
☐	☐	☐	Is (are) the operating sequence(s) in accordance with design directive DD-SWI-1?
☐	☐	☐	Are all switch positions clearly discernable and marked according to function?

INDICATOR LIGHTS

☐	☐	☐	Does light color selection conform to DD-ILS-1?
☐	☐	☐	Do indicator and legend lights conform to DD-ILS-1?
☐	☐	☐	Does functional assignment and legend conform to DD-ILS-1?

LABELING

☐	☐	☐	Are hierarchial labeling requirements met? (See DD-LAB-1)
☐	☐	☐	Is each instrument, equipment item, or device labeled functionally and with an appropriate tag number?
☐	☐	☐	Do legend and identification tag and letter sizes conform to DD-LAB-1?
☐	☐	☐	Do functional legends clearly indicate the parameter or action controlled or indicated? Is the legend located in accordance with DD-CBL-1?
☐	☐	☐	Are alarm window legends clear, concise, and consistent with associated instruments and equipment functions? (See DD-AAS-1 and DD-APL-1)

LOCATION

☐	☐	☐	Are instruments, equipment items, or devices functionally grouped? (See DD-CBL-1)
☐	☐	☐	Are vertical locations in accordance with design directive DD-CBL-1?
☐	☐	☐	Are indicating light locations consistent with design directive DD-ILS-1?
☐	☐	☐	Are instruments located logically for operator use?

Comments _____

List other design directives not specifically listed on this form that apply to this change or addition:

Does this proposed change or addition conform to all applicable design directives? ☐ Yes ☐ No
If NO, list exceptions _____

_____
SIGNED

ATTACHMENT 4d

Sample Documentation
of the Study of Control and
Indicator Arrangements and
Groupings

This sample documentation package consists of three (3) examples of documentation which illustrates the process(es) by which the control and indicator arrangements and groupings were studied.

Example 1: The primary documentation of this effort was produced as described in section 4.5.4.3 of Public Service Company's (PSC's) CRDR Summary Report. Selected samples of this primary documentation were copied, shaded, and enhanced to illustrate the process. The original work package drawings were color coded and not reproducible in quantity. Additional drawing sections are included to provide continuity and illustrate the conclusion to the process. Primary factors considered in this study were:

1. Human Engineerings Discrepancies. (See page 1 for listing).

2. PSC's integrated improvement approach.

3. Operational considerations (positions, access, manipulation and sight link patterns).

4. Design Directives. (Design guidance and requirements).

   DD-AAS-1 A Abbreviation, Symbol, and Acronym Selection

   DD-AIS-1 A Analog Indicator Selection

   DD-APL-1 A Annunciator Panel Legends

   DD-CBL-1 Control Board Layout

   DD-ILS-1 A Indicator Light Selection and Location

   DD-LAB-1 B Panel and Component Labeling

   DD-SWI-1 A Switch Selection

5. Operating Procedure Steps.

Example 2: This in-depth study of the functional relationship of Boiler Feed Pump (BFP) Controls HS-31165, HS-31171, and HC-22127 was initiated as a result of investigative efforts into the general functional labeling concerns cited by HED 616. This evaluation considered the function of each control and the relationship between the three controls.

HED-825 was initiated to document the more specific functional labeling problem clarified by this Study.

It should be noted that this example represents a small segment of an overall system study of feedwater controls and indications.

Example 3: Is an "Operational Analysis" conducted in support of a "Task Analysis" effort prior to the "Improvement Design Program" as defined by section 4.5.4.3 of PSC's Summary Report.

The purpose was to establish exact manipulation and sight link patterns followed in circulator start-up operations as presently performed and to evaluate alternate arrangements.

The function of each control and the inter-relationship between the different controls and indicators was addressed by this effort.

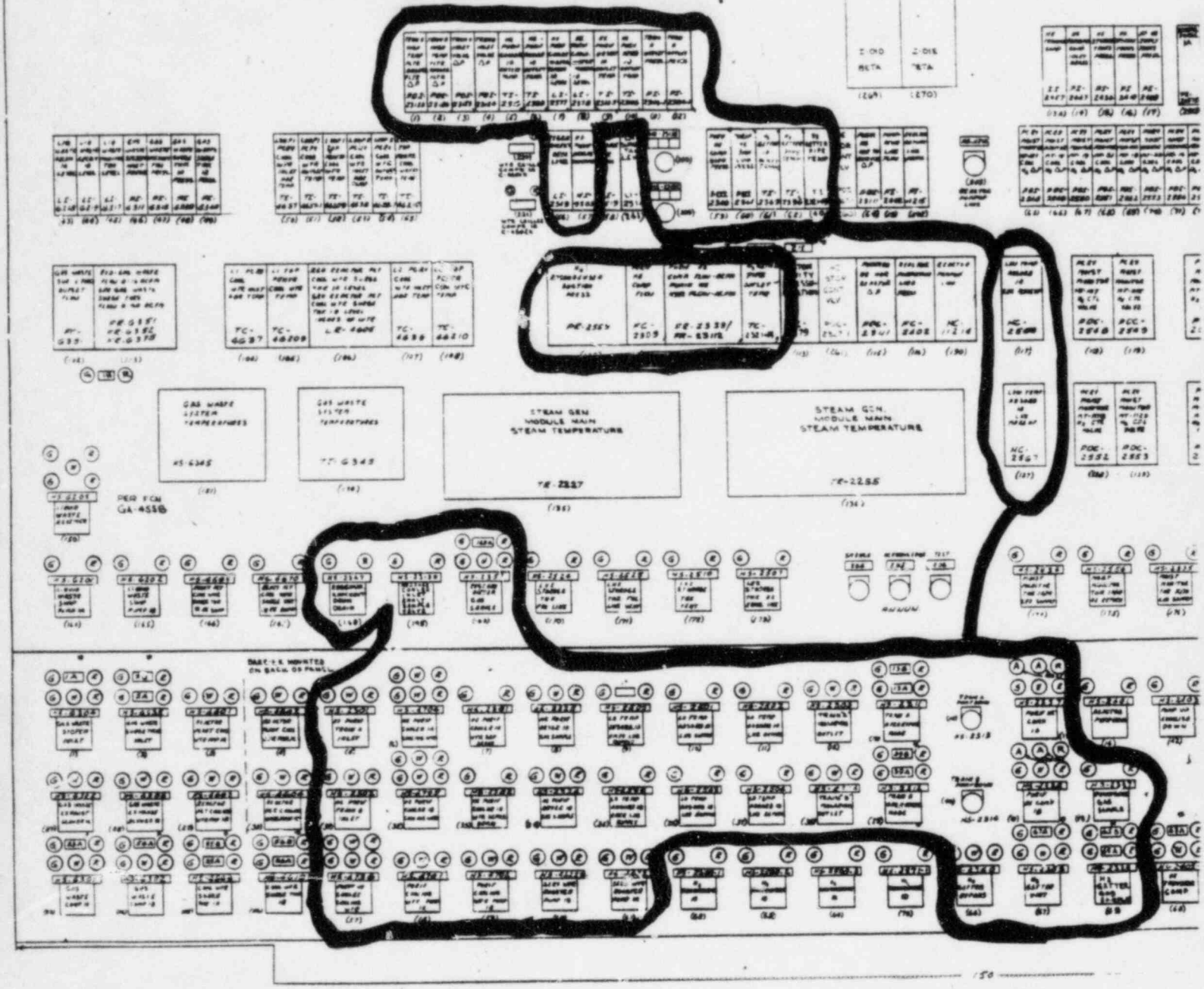
EXAMPLE #1

Sample Documentation

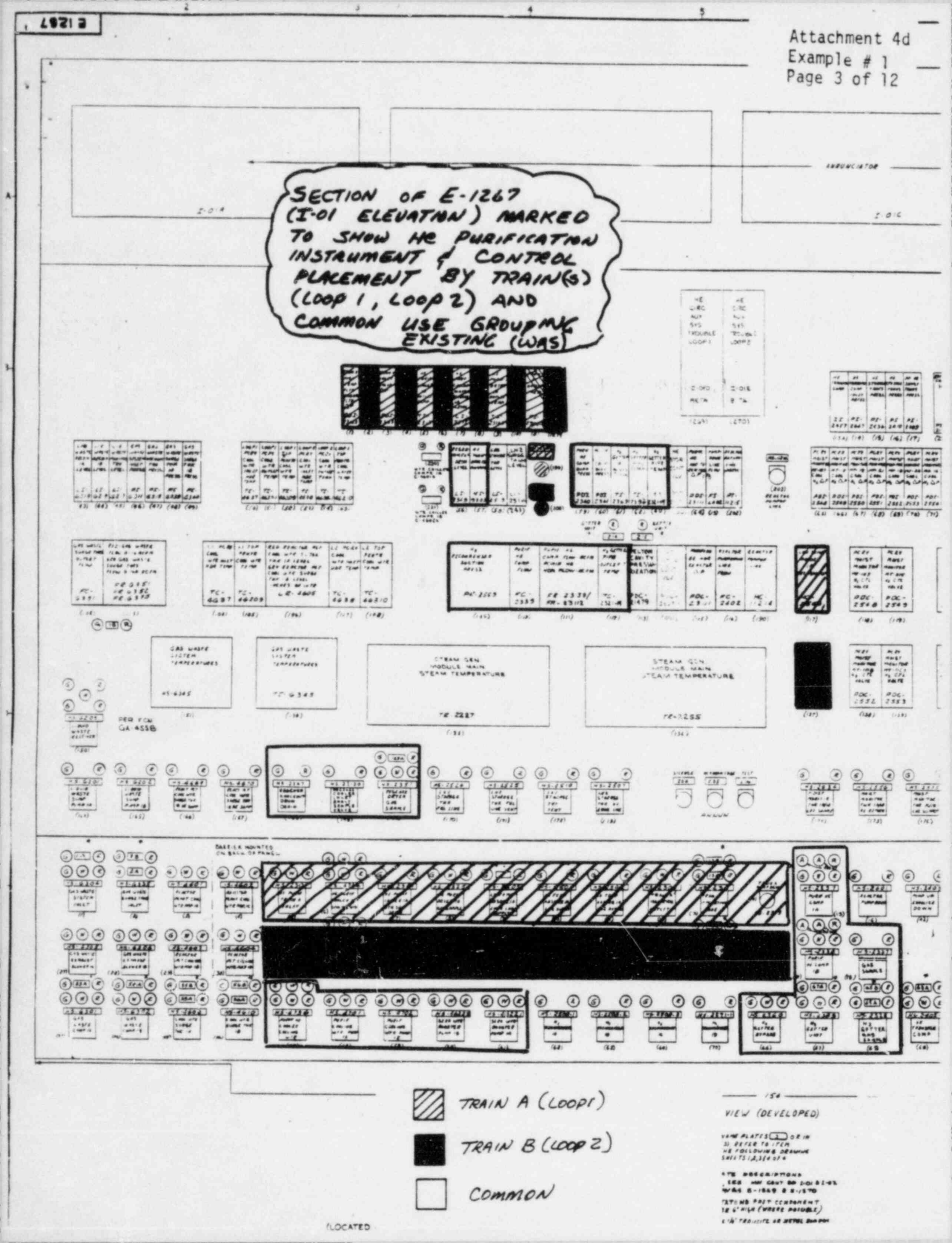
Human Engineering Discrepancies (HEDs) applicable to the Helium Purification System Controls & Indicators on I-01

HED#	Description
005	Indicating Light Functional Description
006	Indicating Light Lettering & Tagging Convention
007	Purification Helium Controls Legends
047	Lettering Sizes
048	Lettering Sizes
060	Labeling
061	Lettering Sizes
062	Lettering Sizes
063	Lettering Sizes
064	Lettering Sizes
065	Lettering Sizes
069	Lettering Sizes
070	Lettering Sizes
072	Lettering Sizes
073	Lettering Sizes
074	Lettering Sizes
075	Lettering Sizes
076	Lettering Sizes
090	Lettering Sizes
091	Lettering Sizes
093	Lettering Sizes
0133	Label Readability
0157	Switch Position Labeling
0278	Switch Operating Sequence
0382	Control Elevation
0488	Abbreviations and Acronymns
0544	Functional Label Equipment Name Spelling
0555	Extraneous Marking on Indicator Scales
0558	Indicator Scale Increment Markings
0570	Indicator Scale Marking Convention
0574	Indicator Scale Marking Convention
0582	Indicator Scale Marking Convention
0587	Indicator Elevations
0638	Controller Functional Labeling
0653	Recorder Scaling Convention
0655	Recorder Scale Readability
0681	Alarm & Control Grouping
0682	Scale Parameter & Scale Convention
0707	Functional Labeling
0709	Indicating Light Functional Labeling & Location
0710	Functional Labeling
0820	Operational Methods

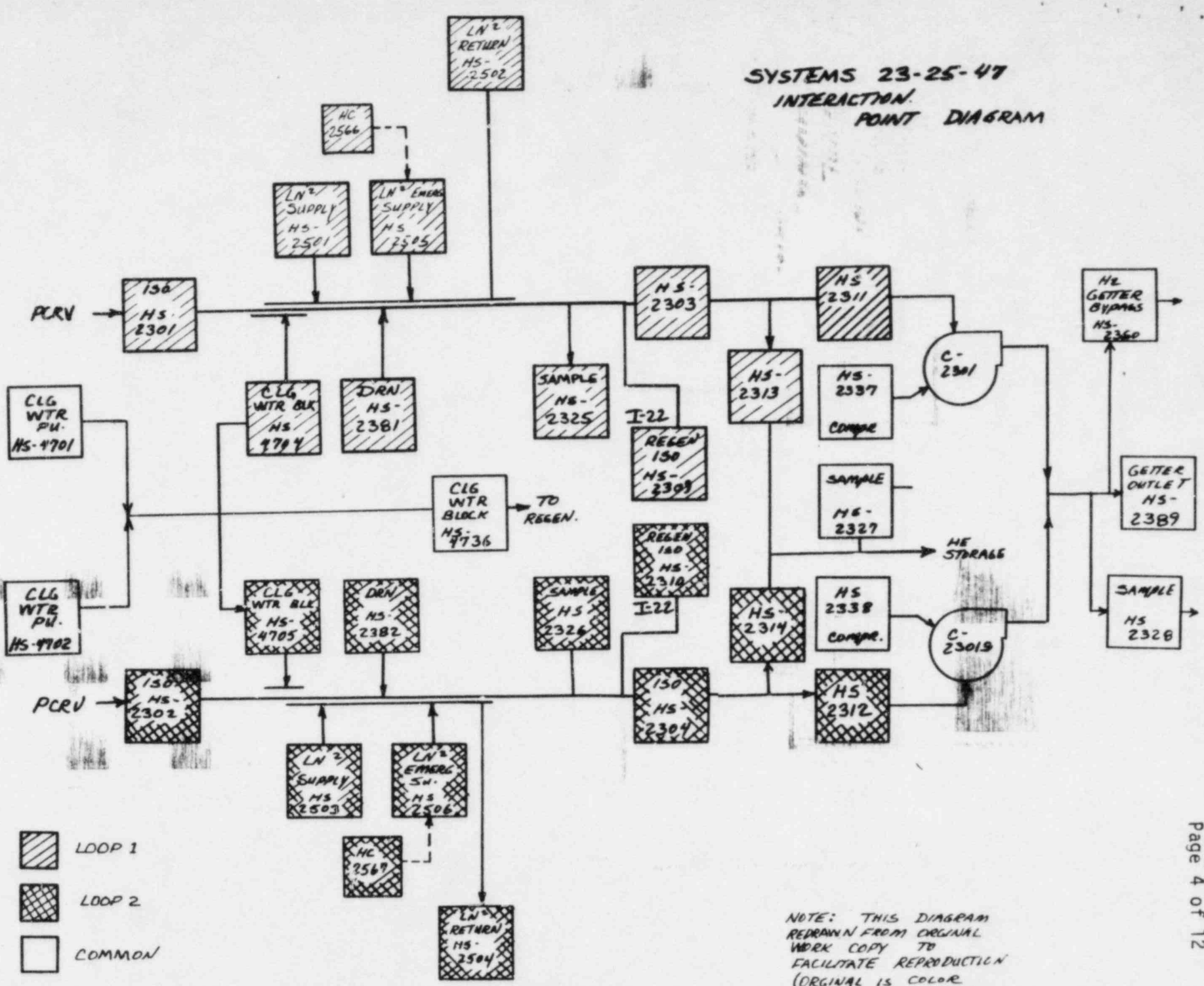
SECTION OF E-1267
(I-01 ELEVATION)
MARKED TO SHOW
HE PURIFICATION SYSTEM
INSTRUMENT & CONTROL
PLACEMENT (EXISTING) (WAS)



SECTION OF E-1267 (I-01 ELEVATION) MARKED TO SHOW HR PURIFICATION INSTRUMENT & CONTROL PLACEMENT BY TRAIN(S) (LOOP 1, LOOP 2) AND COMMON USE GROUP MK. EXISTING (WAS)

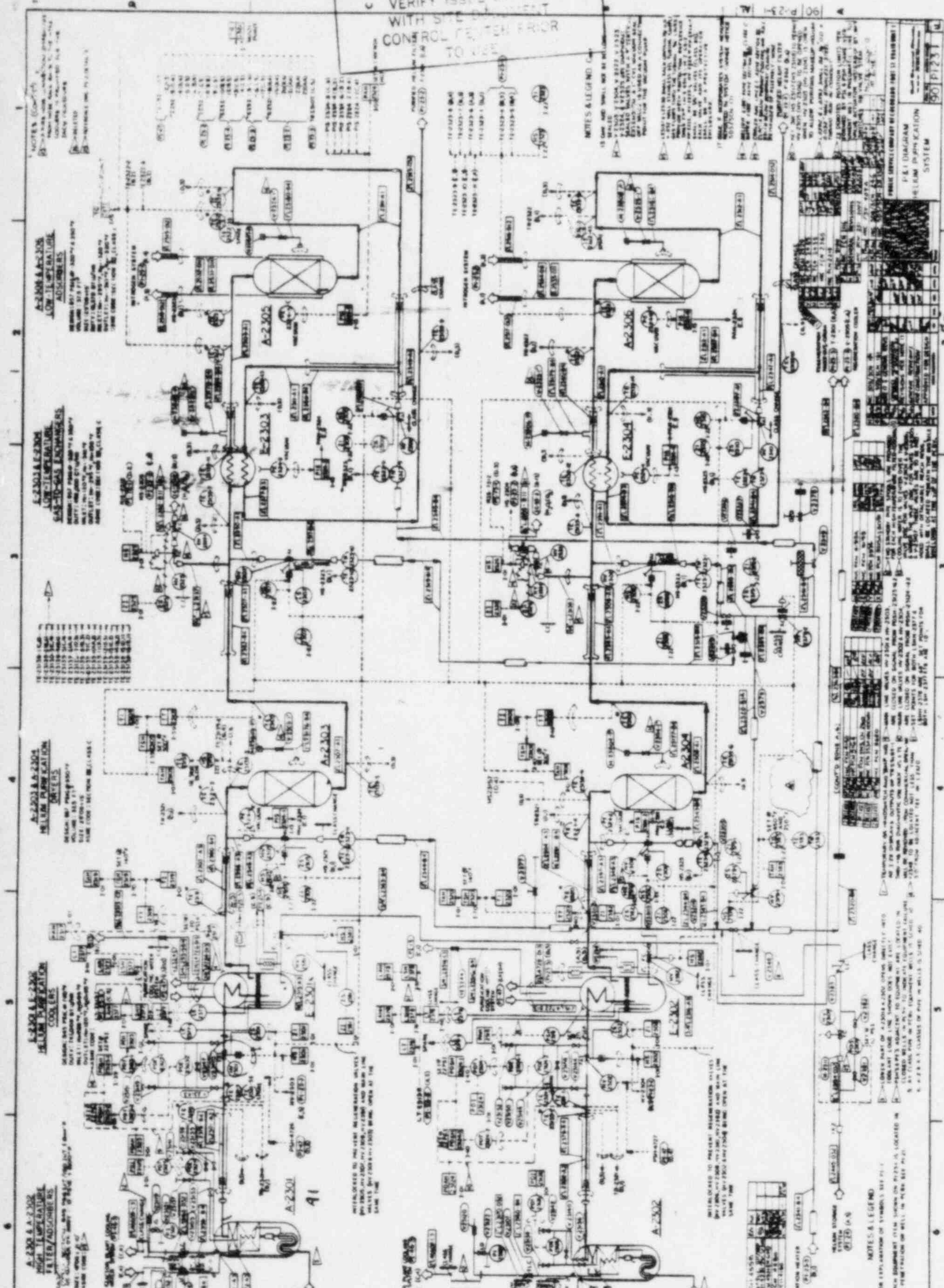


SYSTEMS 23-25-47 INTERACTION POINT DIAGRAM



NOTE: THIS DIAGRAM REDRAWN FROM ORGINAL WORK COPY TO FACILITATE REPRODUCTION (ORGINAL IS COLOR CODED BY LOOP)

9/27/85



P1-23-1

2.2.1.7 Normal operation of MG set:

200 volts	As indicated by meters
420 cps	on compressor control panels
~ 60 amp max.	

2.3 Startup of Purification Train A

2.3.1 Complete pre-operational standby valve lineup (Appendix I).

2.3.2 Complete pre-operational service valve lineup (Appendix I) for purified helium header.

2.3.3 Complete pre-operational service valve lineup (Appendix I) for Hydrogen getters, put HS-2389 in isolate position.

Prerequisites: All key operated switches (13, 14, N-9246, 23, 24, N-9247) on transfer boxes are in the normal position. Reset buttons have been pushed (I-01).

2.3.4 Initiate cooling water flow to helium purification cooler. SOP 47 purification cooling water (Refer to SOP 47).

2.3.4.1 Put HS-4704 in Loop 1 position. (Loop 1 Sys. 47 Operative)

2.3.4.2 Put HS-4704 in Loop 2 position. (Loop 2 Sys. 47 Operative)

2.3.4.3 Put HS-4736 in either Loop 1 or Loop 2 position as appropriate.

2.3.4.4 Open inlet isolation valve HV-2301.

2.3.4.5 Open outlet isolation valve HV-2303.

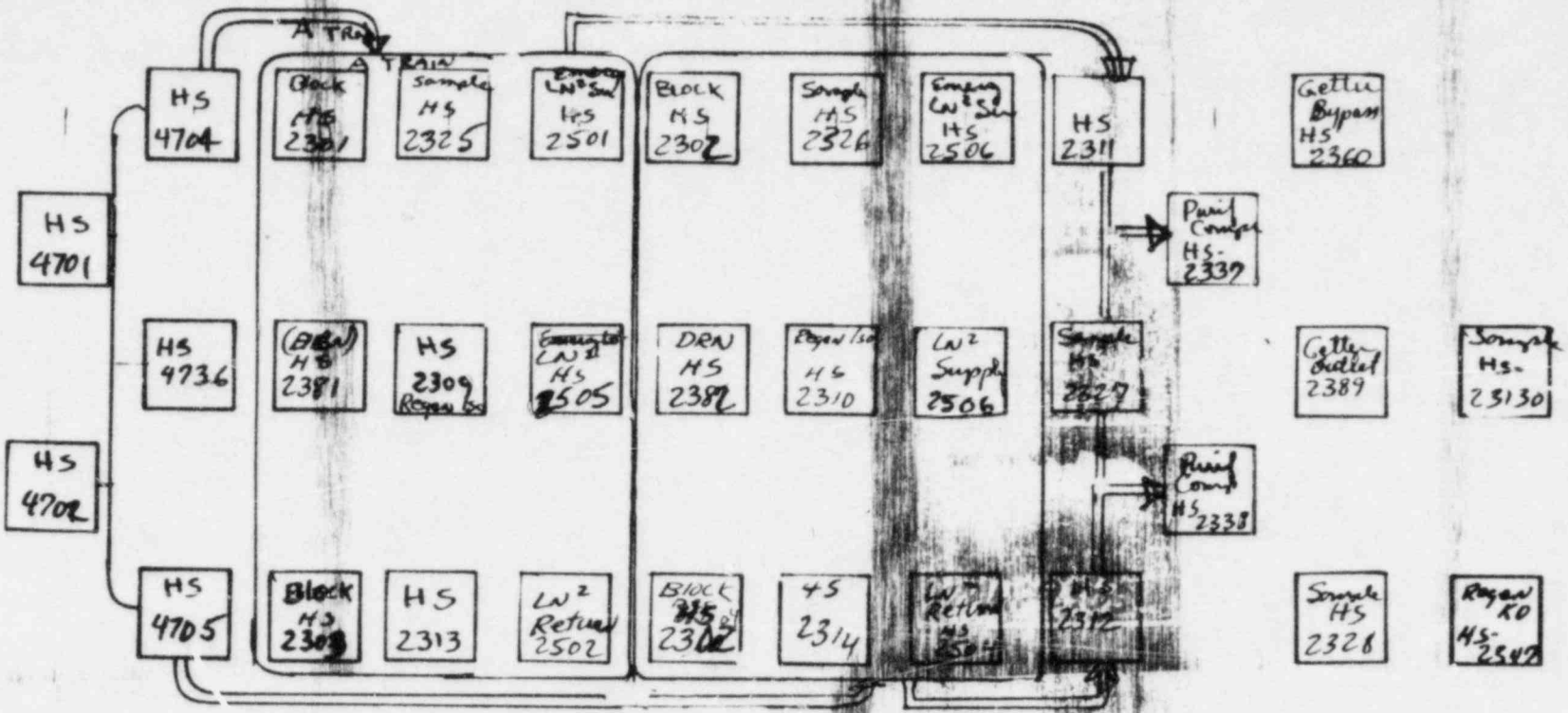
2.3.4.6 Put HS-2311 in normal position.

2.3.4.7 Select a Getter for service by putting HS-2389 in the desired position.

2.3.4.8 Select a purified helium compressor for service, the other compressor for standby. (Check FV-2339 fully open.).

2.3.4.9 Put HS-2338 in the trip position and let it spring back.

PROPOSED LAYOUT
HORIZONTAL ORIENTATION (COMMON)
WITH TRAINS VERTICAL (LOOP RELATED)



PROPOSED LAYOUT (VERTICAL ORIENTATION)

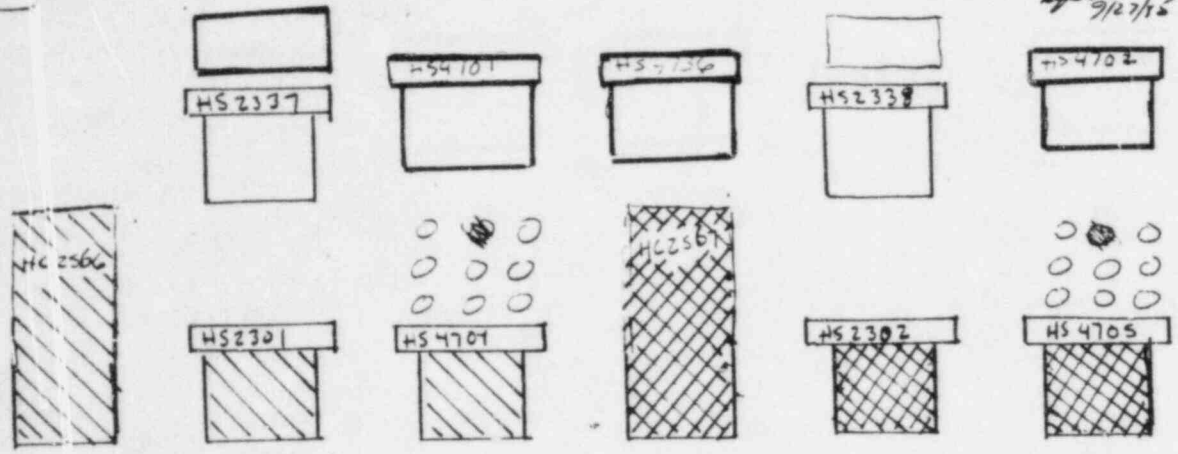
LOOP 1

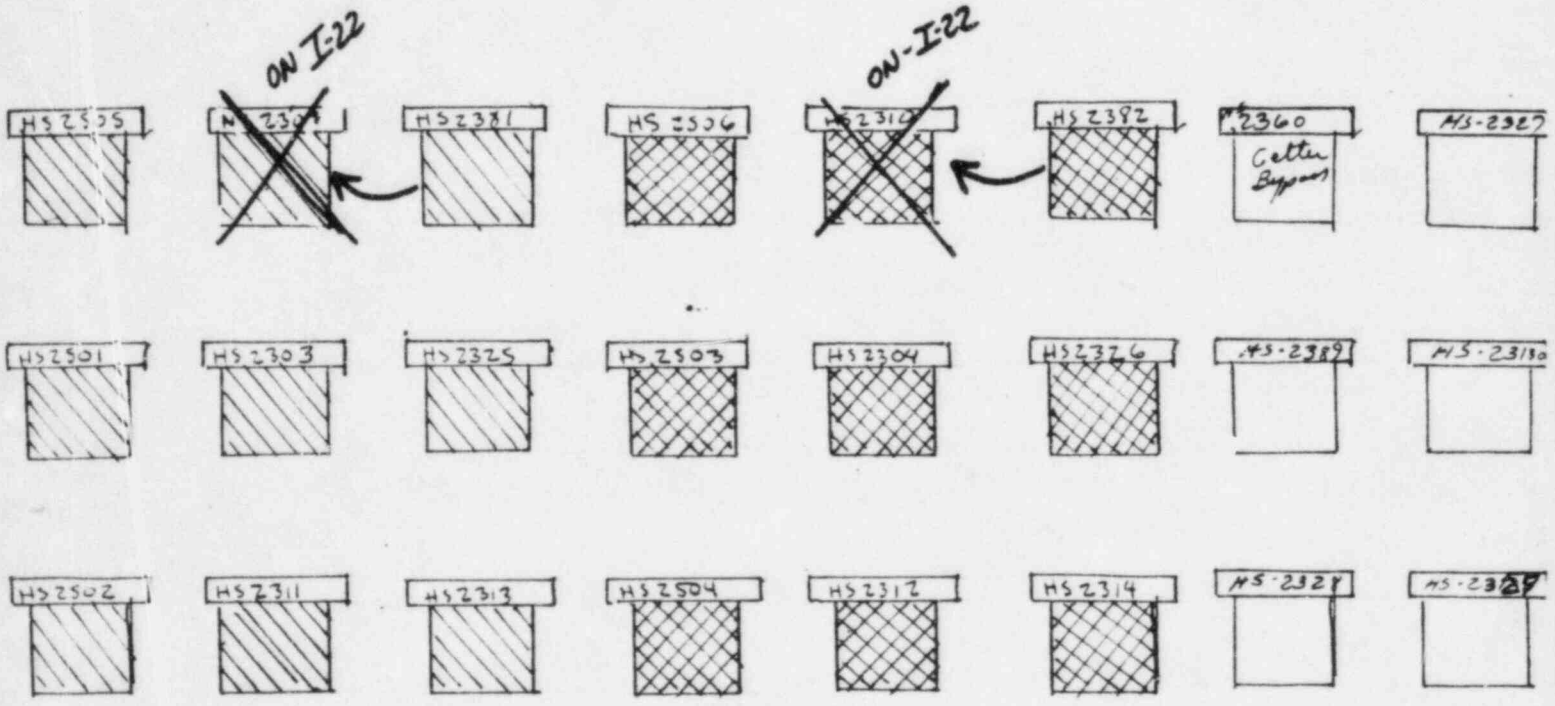
LOOP 2

COMMON

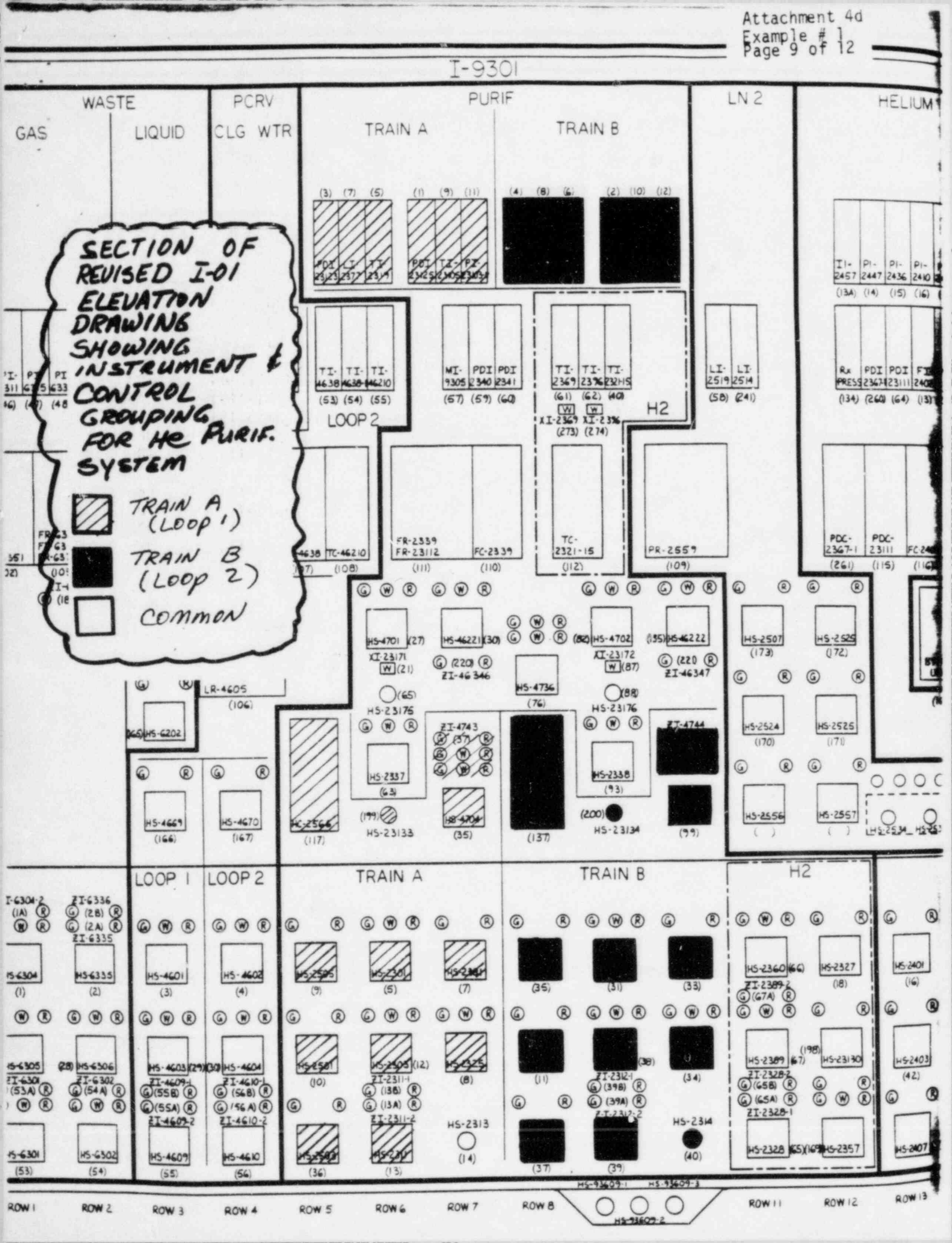
NOTE: HASHING ADDED TO ORIGINAL SKETCH TO ENABLE IDENTIFICATION OF LOOP RELATED COMPONENTS. (ORGINAL COLOR CODED)

9/27/96

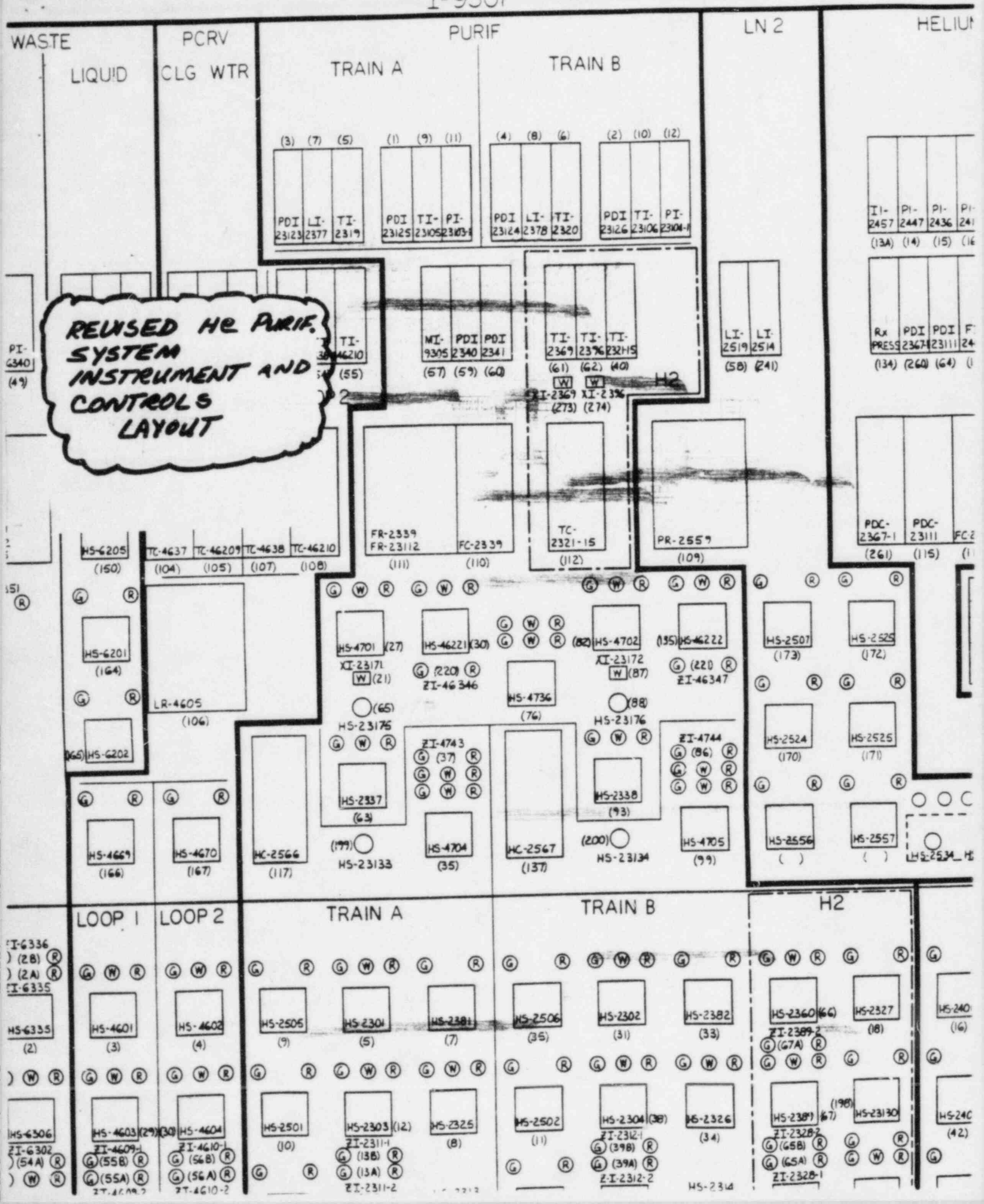


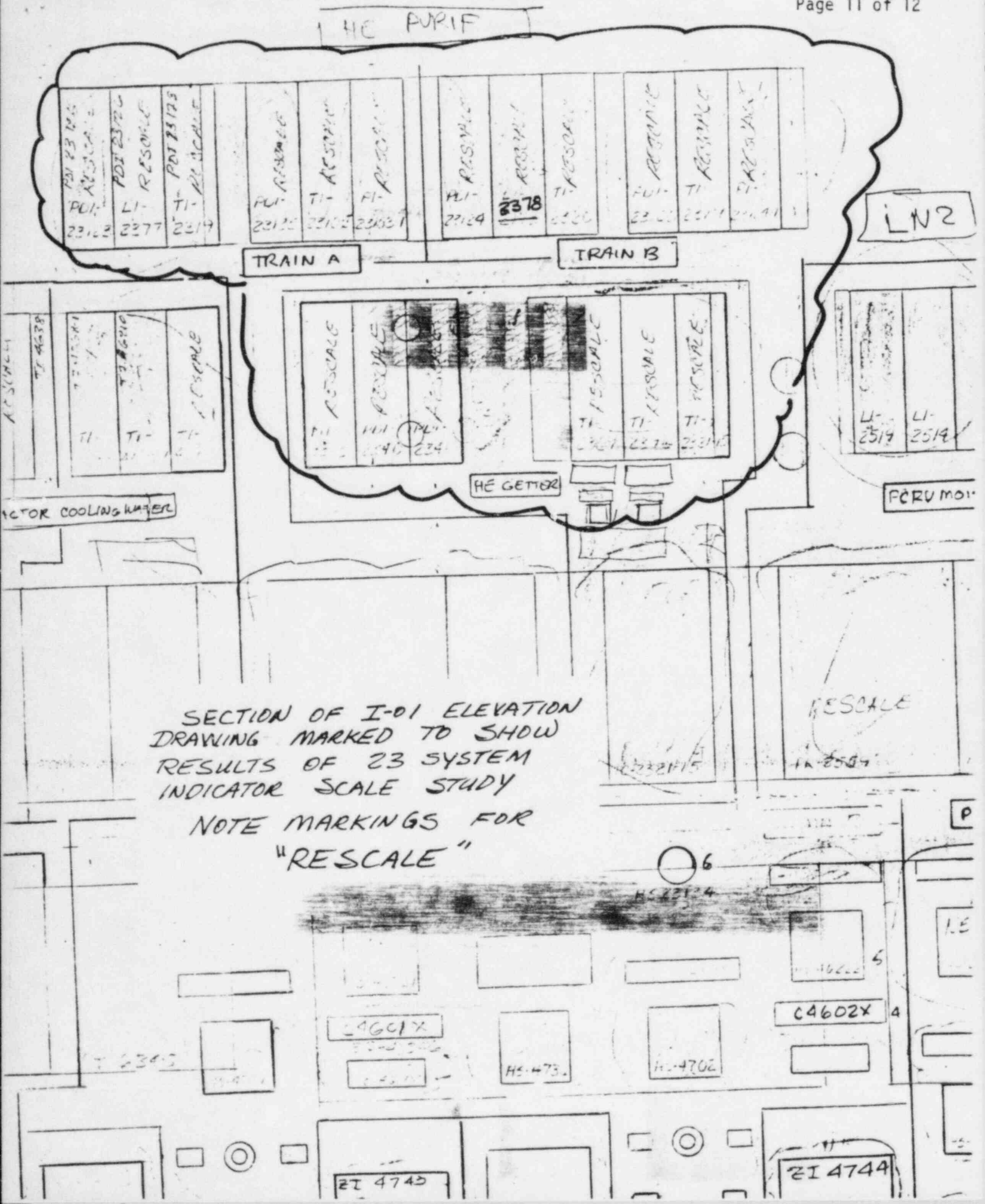


I-9301


WASTE
GAS
LIQUID
PCRV
CLG WTR
PURIF
TRAIN A
TRAIN B
LN 2
HELIUM
SECTION OF REVISED I-01 ELEVATION DRAWING SHOWING INSTRUMENT & CONTROL GROUPING FOR HE PURIF. SYSTEM
TRAIN A (LOOP 1)
TRAIN B (LOOP 2)
COMMON
LOOP 2
H2
LOOP 1
TRAIN A
TRAIN B
H2
ROW 1
ROW 2
ROW 3
ROW 4
ROW 5
ROW 6
ROW 7
ROW 8
ROW 11
ROW 12
ROW 13

I-9301


WASTE
LIQUID
PCRV
CLG WTR
PURIF
TRAIN A
TRAIN B
LN 2
HELIUM
REUSED He PURIF. SYSTEM INSTRUMENT AND CONTROLS LAYOUT
LOOP 1
LOOP 2
TRAIN A
TRAIN B
H2



SECTION OF I-01 ELEVATION DRAWING MARKED TO SHOW RESULTS OF 23 SYSTEM INDICATOR SCALE STUDY

NOTE MARKINGS FOR "RESCALE"

HELIUM PURIFICATION SYSTEM

TRAIN A

INLET VALVE ΔP HIGH ISOLATION 1-1	LOOP 1 BUBBLER He SUPPLY MALFUNCTION 1-9
DRUM WATER LEVEL EMERG HIGH 1-3	OUTLET TEMP High 1-5
Drum WATER Level HIGH	OUTLET PRESS HIGH 1-6
OUTLET TEMP HIGH 1-4	FILTER 1A ΔP HIGH 1-7

TRAIN B

INLET VALVE ΔP HIGH ISOLATION 2-1	LOOP 2 BUBBLER He SUPPLY MALFUNCTION 2-8
DRUM WATER LEVEL EMERG HIGH 2-3	1B OUTLET TEMP High 2-5
DRUM WATER Level HIGH 1-2	OUTLET PRESS HIGH 2-6
OUTLET TEMP HIGH 2-4	FILTER 1B ΔP HIGH 2-7

COMMON

COMPR 1A TRIP 2-10	COMPR 1B TRIP 2-10	COOLING WTR EXPANSION TK 1A LEVEL LOW 5-5
COMPR 1A HIGH ΔP TRIP 2-8	COMPR 1B HIGH ΔP TRIP 2-8	COOLING WTR EXPANSION TK 1B LEVEL LOW 5-6
COMPR FLOW LOW STANDBY START FAL-2337	SYSTEM FLOW LOW 4-7	CHILLER 54602 TRIP 4-4
[illegible]	H_2 GETTER UNIT HIGH ΔP BYPASS 5-9	PURIF COOL WTR PUMP DIFF PRESS LOW 5-1

PURIF COOL WTR PUMP 1A TRIP 4-3	PURIF COOLER 1A COOL WTR HIGH PRESS ISOLATION 3-5	PURIE COOL WTR EXPAN TK 1A PRESS HIGH-LOW 3-6	PURIF COOL WTR EXCH 1A OUTLET TEMP HIGH 3-1	PURIF COOL WTR PUMP 1B TRIP	PURIF COOLER 1B COOL WTR HIGH PRESS ISOLATION 4-5	PURIF COOL WTR EXPAN TK 1B PRESS HIGH-LOW 4-6

COPY OF ALARM WINDOW ORGANIZATION AND GROUPING PASTE-UP GENERATED DURING THE ALARM STUDIES

10/3/85

I-01B

Attachment 4d
Example # 1
Page 12 of 12

EXAMPLE #2

Sample Documentation

PUBLIC SERVICE COMPANY OF COLORADO

FORT ST. VRAIN NUCLEAR GENERATING STATION

Log Number 0825

HUMAN ENGINEERING DISCREPANCY EVALUATION
HEDE - 1

Page 1 of 5

Form 344-22-4228

REVIEWER NAME D. Glenn

DATE 6/9/84

A. HED TITLE Labeling Functional

B. ITEMS INVOLVED

ITEM TYPE	NOMENCLATURE	LOCATION	INSTRUMENT DATA FILE NO. PHOTO NO.
HS-31165	BFP-Turb 1A Mtr Spd Chrge	I-06A	D-84
HS-31171	BFP Turb 1A Hyd Spd Reset	I-06A	D-84
HC-22127	BFP 1A Stm Turb Cntl	I-06A	F-59
HS-31166	BFP-Turb 1C Mtr Spd Chrge	I-06A	D-85
HS-31172	BFP Turb 1C Hyd Spd Rset	I-06A	D-85
HC-22128	BFP 1C Stm Turb Cntl	I-06A	N/A

C. PROBLEM DESCRIPTIONS (GUIDELINES VIOLATED) BFP Speed controls functional labeling is not descriptive of control action (See separate write up-attached.)

D. LIST THE PROCEDURES OR OPERATIONS THAT USE THE LISTED ITEMS IN A MANNER TO INDUCE THE OPERATOR ERROR

The existing functional labeling for HC-22127/8, HS-31171/2, & HS-31165/6 implies an option between "air" and "Hydraulic" speed control for the BFPs 1A & 1C, i.e. "Normal Air" and "Emergency Hydraulic".

The Vendor information available and a close field inspection of a disassembled unit in March 1984 does not support this existing concept.

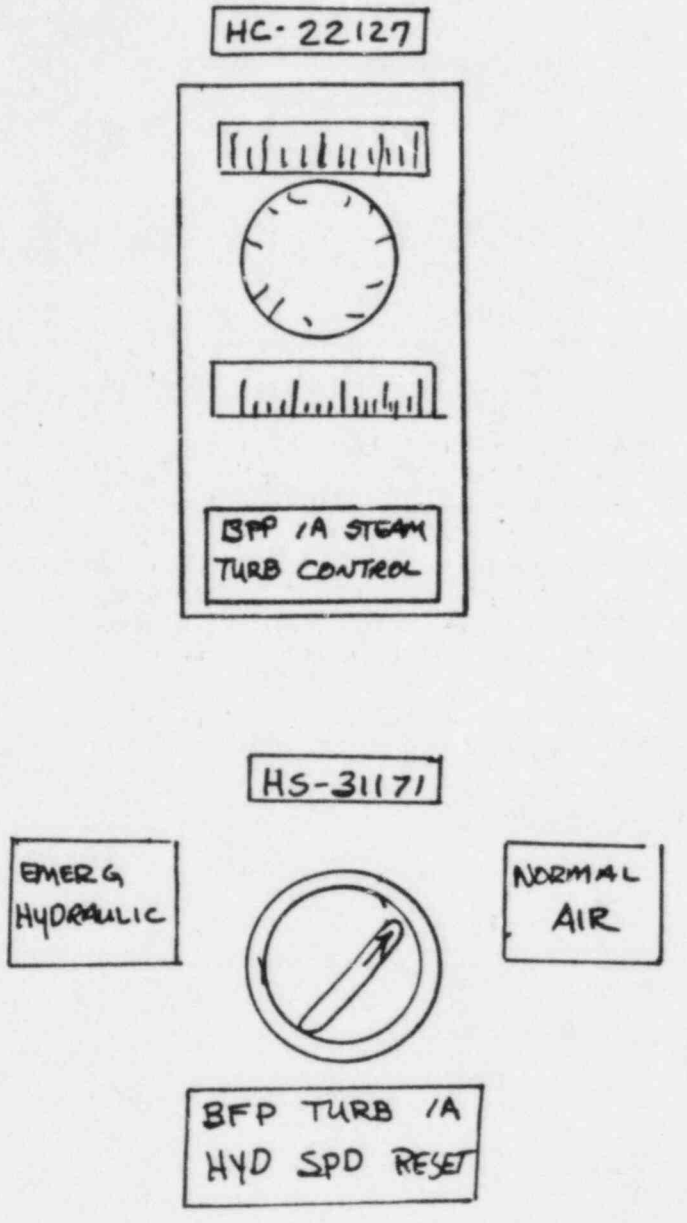
The normal operation appears to be one of setting the setpoint or desired speed by HC-22127, an air (a 10-50ma output controlling an air input to the air portion of the loading cylinder. In order to enable the action of this air control the Hydraulic pressure must be vented, or relieved, from the Hydraulic section of the loading cylinder. This is accomplished by HS-31171(2) supplying an electric signal to a solenoid. The Existing markings on HS-31171 imply ~~and~~ a reset action and also emerg hydraulic. Again this concept is incorrect. The Hydraulic pressure is supplied by the BFP and is constant at the speed control mechanism. The hydraulic positioning force is negated on the loading cylinder only to enable the effect of the Air Control and is

not an optional control means selectable in the event of air failure.

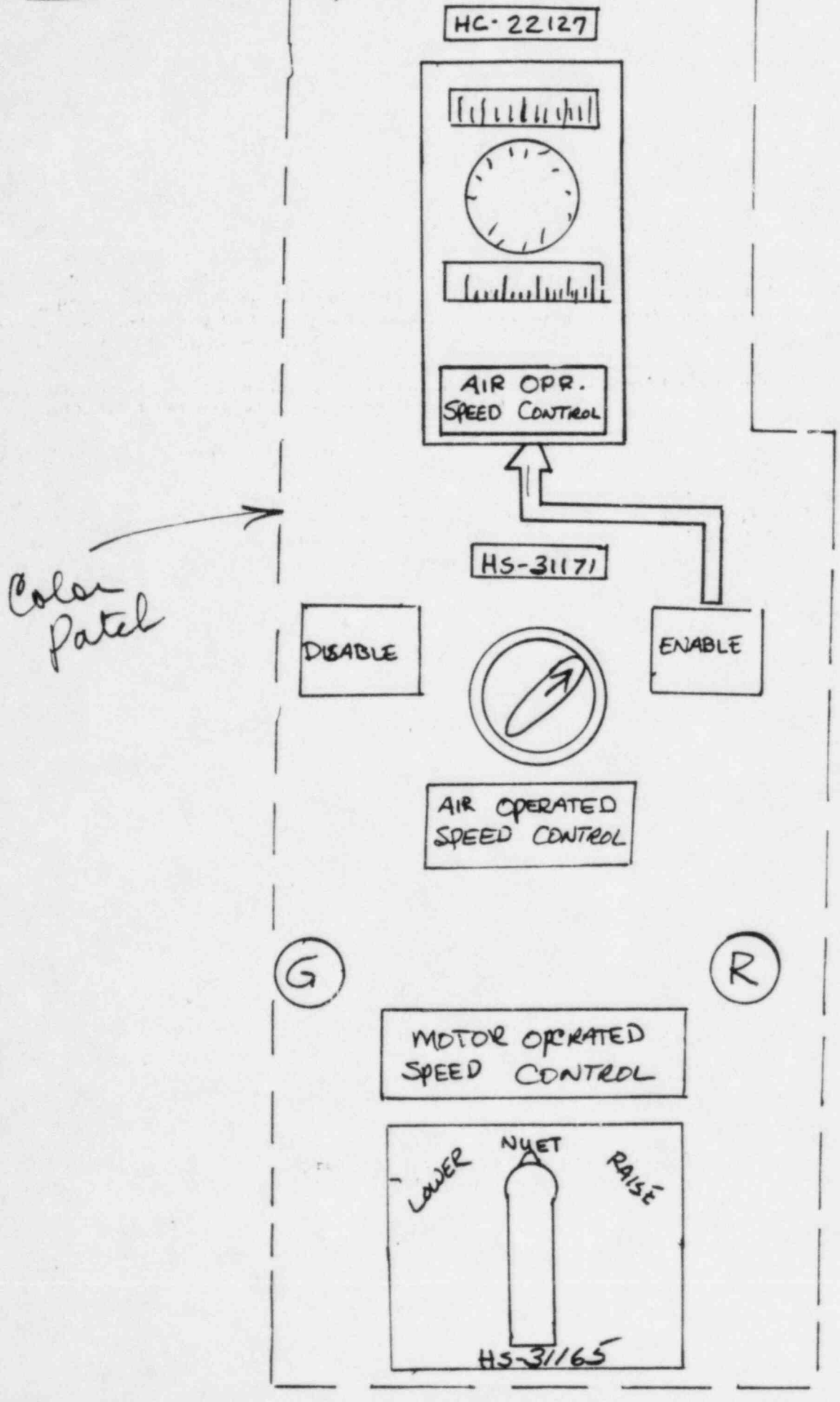
the Markings for HS-31171 might imply that "Energ Hydraulic" qualifies the control action of HS-31165 while the "Normal Air" position Qualifies the control action of HC-22127. This is partially True. HS-31171 qualifies the control action of HC-22127, but neither qualifies nor disqualifies the action of HS-31165. (The motor driven speed changer is effective any the time the BFP is running. It is important to note that if HC-22127 is enabled, any action by the motor speed control will be compensated for by HC-22127 up to the mechanical limit of the mechanism.

the attached Sheets 3 and 4 show existing and proposed functional labeling for these controls

EXISTING


HC-22127
BFP 1A STEAM TURB CONTROL
HS-31171
EMERG HYDRAULIC
NORMAL AIR
BFP TURB 1A HYD SPD RESET
G
R
BFP TURB 1A MTR SPD CHNGR
LOWER
NYET
RAISE
HS-31165

PROPOSED


HC-22127
AIR OPR. SPEED CONTROL
Color Patel
HS-31171
DISABLE
ENABLE
AIR OPERATED SPEED CONTROL
G
R
MOTOR OPERATED SPEED CONTROL
LOWER
NYET
RAISE
HS-31165

Info Attachment to HED 0825

ing. The key cannot be inserted into the pushbutton until the door is returned to its closed position. Until the key is back in the pushbutton, there is an alarm indicating the thrust wear circuit is blocked.

VALVE GEAR TRIP

A normally open hydraulically actuated two-way dump valve (see DV1, Fig. 19), located in the front standard, is piped so that the dump valve receives its signal oil pressure from the emergency trip hydraulic circuit. The control side of the valve is piped to the primary relay hydraulic circuit, between the primary pilot valve and primary operating cylinder. When the emergency trip operates, the dump valve opens to drain pressure oil from the primary operating cylinder. As release of oil from the primary operating cylinder closes the steam control valves, the control valves are tripped closed when the emergency trip operates. When the emergency trip is reset and oil pressure builds up in the supply line, the dump valve automatically closes, and oil pressure can again build up in the primary relay operating cylinder.

With the arrangement just descrioed, the control valves are used to back up the stop valve when the turbine is tripped.

CONTROL (GOVERNING) VALVES AND VALVE GEAR

The steam control (governing) valves, shown assembled in the cover (15), Fig. 28, are double-lift, venturi-seated valves with spherical seating surfaces. An assembled valve contains an inner (pilot) poppet valve, which is integral with the valve stem, assembled in an outer valve. As the stem is raised, the inner valve opens to permit steam flow through its seat in the outer valve, and to build up steam pressure on the downstream side of the valve. The inner valve then contacts and lifts the outer valve. The inner poppet valve reduces the pressure differential across the outer valve and, hence, the hold-down forces against which the outer valve must open. Reduced valve opening forces permit the use of a smaller, faster acting power cylinder for the valve lifting gear.

The valves are assembled in a lift beam (5), Fig. 28, with the valve stem passing through clearance holes in the beam. The limit of travel (lift) of an assembled valve is set by a spherical nut threaded onto the valve stem (see valve (8), Fig. 28). The main valve seats are seal-welded into the H. P. head section of the turbine casing, as indicated in Fig. 28.

The spherical seating surfaces provide for tightseating of the loosely guided self-seating valves. Differential pressures, and the resultant steam forces, in addition to the weight of the valve parts, are in a direction which seat the valves as the lift beam is lowered. As the valve stems are loosely guided in the clearance holes in the lift beam, the possibility of valve stem binding is eliminated.

The contact surfaces on the valves and seats, including the inner poppet seat, are protected against wear and erosion by the use of hard metal inlays deposited by welding. Hard metal inlays in the top surface of the lift beam, and in the contact surfaces of each valve stem nut, protect against wear. The valve stems are surface hardened along their lengths for further wear protection.

The valve lifting gear includes the lift beam (5), Fig. 28, in which the valves are assembled, two lift rods (4) which pass through bushings (11) in the cover (15), and the torque bar (14) lever assembly. The lift rods are connected to the torque bar lever assembly through link assemblies (37) and clevises (31). The beam (5) lifts the valves in sequence, as indicated in the table on Fig. 28, to control the flow of steam into the turbine. The valve gear assembly operates in conjuction with the secondary and primary relays (discussed later in this section of the book) to position the steam control valves.

With all valves seated, the lift beam seats on the outer valves at each end of the beam. There is a small clearance between the beam and the remaining valves. There is a slight radial clearance between the lift rods and the beam, to permit the beam to seat itself without binding the lift rods, in case the lift beam is slightly out of square with the rods.

A limit switch (59) (LS7) is used as an interlock to prevent energizing the emergency trip reset solenoid (S3) and turning gear engagement solenoid (S1) unless the control valves are closed.

SECONDARY (POWER) RELAY SYSTEM

The secondary (power) relay system which positions the valve gear, includes a hydraulic (secondary) cylinder, with a spring and hydraulic biased operating piston assembled in the cylinder. A secondary pilot valve slidable in a fixed bushing controls the hydraulic oil pressure above the piston. The secondary pilot valve and operating cylinder are assembled in the front standard intermediate section, as indicated in Fig. 26A, Sheet 2. The assembly breakdowns of the pilot valve and cylinder are shown in Fig. 26B, Sheet 1.

The piston assembly (12), Fig. 26B, which positions the valve gear, through the connection of clevis (7) and the connecting rod (46), Fig. 28, is a single acting piston, with the hydraulic oil biasing force being applied above the piston. The springs (14) and (15) are assembled so that the spring biasing force is applied upward, in the direction which closes the control valves upon release of oil pressure above the piston.

The secondary operating piston is positioned by the oil pressure in the secondary cylinder as controlled by the secondary pilot valve (43), Fig. 26B. Oil to the pilot valve is from the turbine high pressure hydraulic oil system. Oil drain ports in the upper portion of the pilot valve bushing (38) open directly into the front standard. The ports in the lower portion of the bushing are the supply oil inlet ports. The central space in the bushing connects to the secondary operating cylinder.

The secondary pilot valve is of the double cut-off type, with the lower cut-off edge controlling inlet oil to the secondary cylinder, and the upper cut-off edge controlling drain from the cylinder. The secondary pilot valve is positioned by the primary relay (discussed below), through connecting linkage. In steady-state operation, the secondary pilot valve is positioned over the control ports in its bushing to allow just enough oil flow into the secondary cylinder to hold the secondary piston stationary, and to make up any leakage flow in the secondary control circuit. Should the primary relay call for more steam flow, the secondary pilot valve will be lowered to increase oil flow and pressure to the operating cylinder, and the operating piston moves downward, lifting the steam control valves to increase steam flow. In reverse, when the primary relay calls for less steam the secondary pilot valve will be lifted, closing off oil inlet to the secondary piston and opening the piston to drain, and the piston moves upward causing a closing down of the steam control valves.

Each time that the secondary pilot valve is adjusted to compensate for a change in steam requirements, the pilot valve is repositioned (position restored), through restoring linkage connecting the pilot valve to the secondary piston (lever (67), Fig. 26B, and its connecting linkage), until the pilot valve is again positioned over its control ports to hold the operating piston stationery for the new operating conditions.

Refer to the schematic diagrams Fig. 19 and Fig. 38 for the hydraulic and mechanical connections at the secondary relay.

SPEED SENSING (PRIMARY) RELAY

Speed Governor

The speed governor (2) Fig. 22, is of the flyweight type and is mounted on the upper extension of the governor drive shaft. The only work required of the governor is to rotate the primary (speed setting) pilot valve and to move the pilot valve up and down in the bushing (18), Fig. 30. The use of a rotating pilot valve eliminates static friction.

A fixed relationship between the axial position of the pilot valve and the position of the flyweights (3) and (4), Fig. 35, is maintained by a spring loaded strut pin (pivot rod) the tips of which engage the upper flyweight arm and the pilot valve. The spring coupling, which loads the strut pin to prevent axial back lash, also serves to transmit rotary motion while providing for slight misalignment between the strut pin and the axis of the pilot valve. The spring coupling does not lessen the need for maintaining concentricity and alignment between the pilot valve and speed governor.

Friction between the two arms of the governor weights is lessened by using a roller on one arm. A flat surface on the other arm bears on this roller. The rolling contact surfaces are hardened to prevent wear. All governor parts are thoroughly lubricated by the oil discharged through the pilot valve and by the oil mist in the atmosphere inside the turbine front standard which encloses the governor.

The factory adjustment of the governor is permanent and should not be changed. Damaged governors should be returned to the factory for repair, and to be retested.

mary Relay

The speed sensing (primary) relay system which positions the pilot valve of the secondary relay system, includes: a hydraulic operating cylinder, at view A-A, Fig. 26B, with a single acting spring loaded piston (25) assembled in the cylinder (piston spring load is applied in a direction corresponding to the closing of the control valves on loss of oil pressure) and a single cut-off pilot valve (9), Fig. 26A, which is positioned in an adjustable bushing (18), Fig. 30, by the speed governor. The primary relay system is enclosed in the front standard, as indicated in Fig. 26A.

The speed setting of the turbine is determined by the position of the primary pilot valve bushing as set by the pressure relay or electric motor operated speed changer. (The pressure relay and motor operated speed changer are discussed later.) A change in bushing position will result in a change in operating speed level. Once the speed level is set, the primary relay will automatically control the secondary relay to maintain the set speed.

Constant pressure oil from the high pressure hydraulic system is fed to the primary pilot valve and operating cylinder through an orifice inserted in the supply line (refer to the schematic diagram, Fig. 19, in tracing the oil flow through the primary relay).

The primary relay operating cylinder oil pressure is controlled by the combination of the pilot valve and its bushing, and the orifice inserted in the pressure line ahead of the pilot valve. Ports in the pilot valve bushing open to drain, and a cut-off land on the pilot valve can open or close off these ports. Oil pressure in the primary relay operating cylinder is determined by the position of the pilot valve cut-off edge relative to the drain ports in the bushing.

With the speed setting of the bushing unchanged, the pilot valve cut-off edge relative to the ain ports is such that the pressure in the operating cylinder is constant. The operating piston will be positioned such that the spring force and opposing hydraulic force are balanced, and

the turbine steam flow and speed remain constant. When the pilot valve is lowered by the speed governor (as a result of increased turbine speed), the lower (drain) ports in the pilot valve bushing are uncovered. This lowers the pressure in the operating cylinder and the piston moves down to again balance the opposing forces in the cylinder. In reverse, when the pilot valve is raised by the speed governor (as a result of lowered speed), the drain ports are closed off, raising the oil pressure in the operating cylinder and the piston moves up until the forces in the cylinder are balanced. The primary relay piston position change is transmitted to the secondary relay pilot valve, through connecting linkage, to reposition the valve gear and steam control valves, decreasing steam flow and turbine speed in the first case, and increasing steam flow and turbine speed in the second instance. Similar actions occur when the primary pilot valve bushing is raised or lowered by the pressure relay. Raising the bushing decreased turbine speed, and lowering the bushing increases turbine speed.

During normal operation, the position of the primary pilot valve cut-off edge relative to the bushing ports is such that an oil pressure is established in the operating cylinder which will position the primary piston to maintain a set speed. In any change in relay piston position, the pilot valve bushing is adjusted, through connecting (restoring) linkage (clevis (36), Fig. 26B, connected to lever (19), Fig. 30, at connecting rod (17)), to counteract the change in operating cylinder oil pressure caused by the initial pilot valve or bushing movement. This is called restoring and is built into the system to prevent excessive overshoot under changing (transient) conditions, and to prevent speed hunt, or wander, under settled conditions.

The free end of the primary pilot valve and the corresponding portion of the pilot valve bushing form a dashpot to counteract any tendency for the relay system to "bobble".

PRESSURE SENSING HYDRAULIC RELAY

As previously described, turbine speed is determined by the position of the primary pilot valve bushing. For automatic control of turbine speed in response to changes in load, the primary pilot valve bushing position is set by a pressure sensing relay.

Normal open.

The pressure relay consists of an air motor assembly, Fig. 31A, linked to a hydraulic pilot valve and piston assembly (shown at view D-D, Fig. 26B). The schematic lever diagram Fig. 38, shows the mechanical connection between the air motor, the pressure relay hydraulic piston and the primary relay. The air motor assembly includes a handjack (parts assembled to shaft (3), Fig. 31A) to provide for local manual controlled adjustment of the air bellows to simulate air loading on the bellows, and a hydraulic jack, at piston (19), which can position the air bellows by oil pressure being applied to the piston (pressure oil is from the turbine hydraulic system as controlled by a solenoid valve SV7).

The pressure relay pilot valve assembly (31), Fig. 26B, and spring biased hydraulic piston (25) combination operates on pressure oil from the turbine control oil system, as indicated in Fig. 19. Signal air pressure to the air motor bellows (26), Fig. 31A, is the output pressure of a pneumatic controller. Release of controlled air pressure corresponds to zero turbine speed.

The pressure relay is arranged so that its pilot valve (31), Fig. 26B, can be offset from its equilibrium position by the air bellows. Offset of the pilot valve causes a change in pressure at the pressure relay piston. As the piston moves, the pressure relay pilot valve is restored to its equilibrium position through connecting linkage, and the piston will stabilize at a new operating position. The piston will remain in this new position until the pressure relay pilot valve is again offset by the air bellows. Since the pressure relay piston is lever connected to the primary relay pilot valve bushing, any change in the pressure relay piston position causes a change in the primary pilot valve bushing position, resulting in a change in turbine speed.

The handjack or the hydraulic jack at the air motor assembly can be used to simulate air loading on the air bellows. With a loss of air signal to the air bellows, the handjack or hydraulic jack, can be used for control of turbine speed. With no air signal, and with the handjack or hydraulic jack positioned to bring the air bellows to its high speed stop (to simulate full air loading pressure) the turbine speed can be controlled from high speed stop to zero speed by means of an electric/manual speed changer. The handjack must be returned to its zero speed position and hydraulic pressure to the hydraulic jack must be cut off when air signal pressure to the air motor is established. The electric/manual speed changer must be positioned at its high speed stop during normal operation of the turbine (under pneumatic (pressure) control).

When the turbine is under air pressure control, the electric/manual speed changer is an over-riding provision for closing the control (governing) valves. When the electric/manual speed changer is controlling turbine speed, the jacking arrangement at the air motor is an over-riding provision for closing the control valves.

The manual handjack and the manual attachment (handwheel) on the electric/manual speed changer provide for local manual control of turbine speed.

ELECTRIC/MANUAL SPEED CHANGER

A motor/hand operated speed changer, Fig. 39, is provided as a means of controlling turbine speed at any time air loading to pressure sensing relay is off. The motor speed changer (MSC) is mounted in the pressure relay to primary relay lever system, as indicated in Fig. 38, and is shown assembled in the pressure relay linked in Fig. 26B.

Limit switches are provided at each end of the motor speed changer working range (high s t stop and low speed stop) to indicate when either stop has been reached.

As previously described, the speed of the turbine is determined by the positioning of the primary pilot valve (speed) bushing. The MSC is connected into the primary relay linkage and can be operated manyally at the turbine by means of its hand wheel, or it can be electrically controlled from a remote station.

The MSC must be at its high speed stop (H.S S.) when the turbine is on air motor control. The handjack at the air motor must be at its H.S.S. (turned all the way in) or oil pressure must be applied to the hydraulic jack when the turbine is on MSC control (no air signal to air motor).

The MSC (Limitorque) is furnished by the Philadelphia Gear Corporation, and descriptive material on the speed changer is filed with the "Bulletins" at the back of this book.

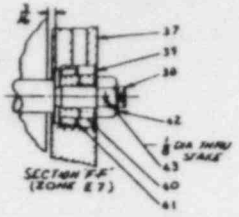
Limit switches (GSL) are provided in the MSC, for the purposes indicated on Fig. 19.

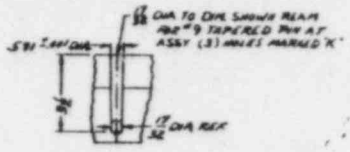
TURNING GEAR

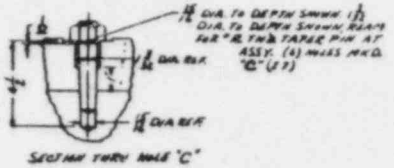
The turning gear is included in the reduction gear assembly. A solenoid (S-1) is used to engage the turning gear to put the turbine on turning gear. A limit switch (LS-3) indicates when turning gear is engaged. A low speed indicator (ZS-1), included in the turbine front end assembly, is wired to start the turning gear motor when turbine rotor speed drops below a preset value, and to indicate that speed is low enough to engage turning gear.

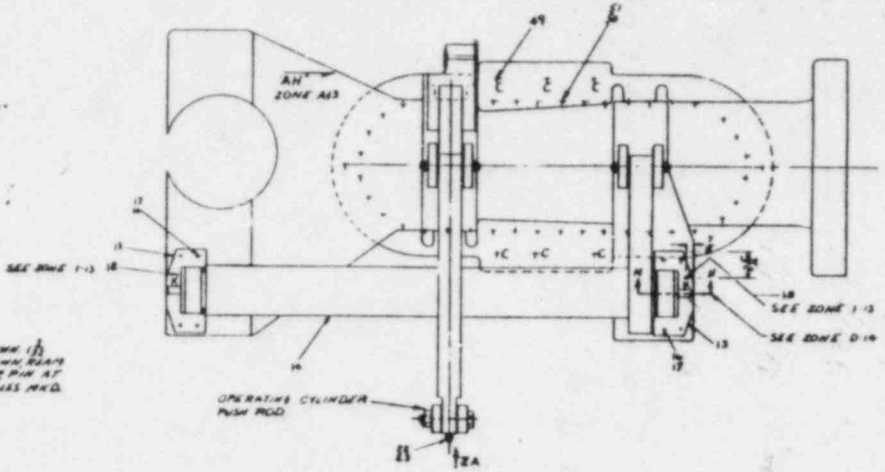
The turning gear is included to provide low speed turning of the turbine rotor (with no steam admitted into casing), for cooling down the turbine before complete shutdown or for pre-start rotation of the turbine rotor before steam is admitted to the turbine wheels.

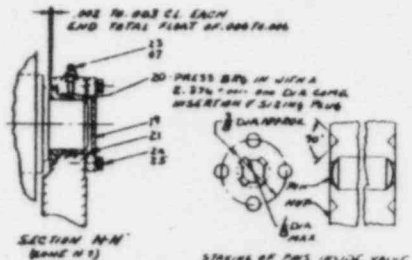
For further description of the turning gear, refer to the Turning Gear instructions filed with the "Bulletins" at the back of this book.

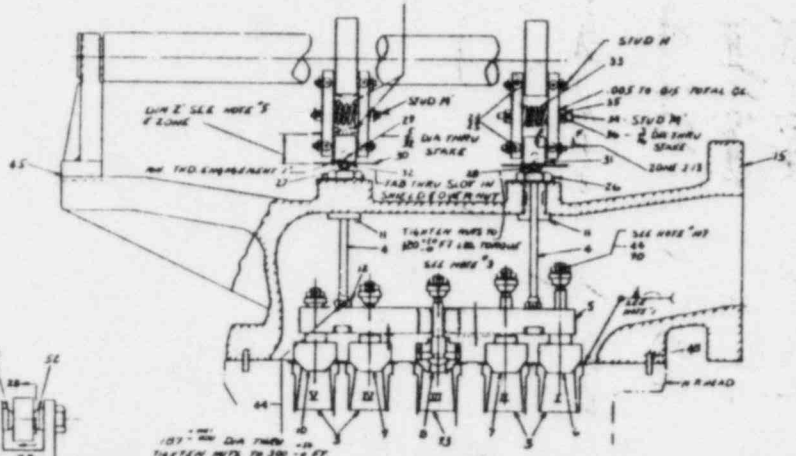


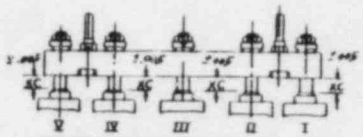












VALVE NO	V	IV	III	II	I
SHEET 4 DIM.	1	2	3	4	5
XA	0	SEE NOTE "5"			0
XB	12.5	9.90	6.90	2.325	3.059
XC	12.5	SEE NOTE "10"			3.055

DIM X B : LIFT TO SETTING

VALVE SETTING NOTES

10 WITH LIFT BEAM RESTING ON TWO END VALVES AS SHOWN AT D 7 MEASURE DISTANCE 'XA' FROM SHOULDER OF EACH INNER VALVE TO BOTTOM OF LIFT BEAM.

11 OBTAIN DIM 'XC' BY ADDING DIM 'XA' TO 'XB' WITH ALL VALVES HANGING FREE ON LIFT BEAM, MEASURE DIM 'XC' FROM THE SHOULDER OF EACH INNER VALVE TO BOTTOM OF LIFT BEAM.

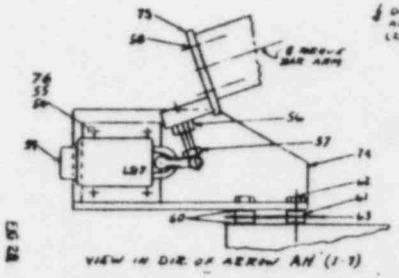
10.5 ADJUST SPHERICAL NUT ON VALVES TO OBTAIN DIM 'XC'

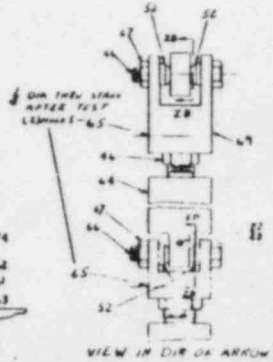
10.6 TIGHTEN LOCK NUTS AGAINST SPHERICAL NUTS USING TORQUE OF 30 ± 5 FT. LBS.

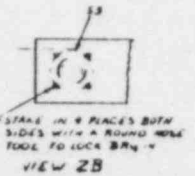
11.5 REMEASURE DIM X & READJUST NUTS IF NECESSARY.

11.6 BEND ONE CORNER OF LOCK WASHER OVER VALVE NUT & TWO OVER HEX NUT

14.7 .187 +.001 -.005 DIA THRU (PIN STAKE AS SHOWN AT ZONE F 13







NOTES

1 WELDING OF VALVE SEATS TO BE IN ACCORDANCE WITH G.E. HOLD INSP. DRG. 4.3 DIA. AFTER WELDING, HYDRO TEST FOR 15 MIN. AT PRESS. STAMPED ON INLET FLG. TO ASSURE SEAL BETWEEN SEAT & NIP GASKET.

2 BLOW CHECK AND LAP SEATS TO OBTAIN PROPER VALVE SEAT SEAL. A CONTINUOUS LINE CONTACT IS REQUIRED.

3 WITH ALL VALVES RESTING ON SEATS & WITH LIFT BEAM RESTING ON END VALVES, THE REMAINING VALVES SHOULD BE FREE TO ROTATE, BUT AXIAL CL. MUST NOT EXCEED .030. REMACHINING BASE OF SOME VALVES IS NECESSARY TO OBTAIN THIS DIM.

4 FOR VALVE LIFT SETTING SEE INSTALLATION & NOTES AT ZONE C-4

5 TIGHTEN NUTS ON STUD 'M' UNTIL LINKS ARE TIGHT AGAINST GAGES 'F' (ZONE F 9).

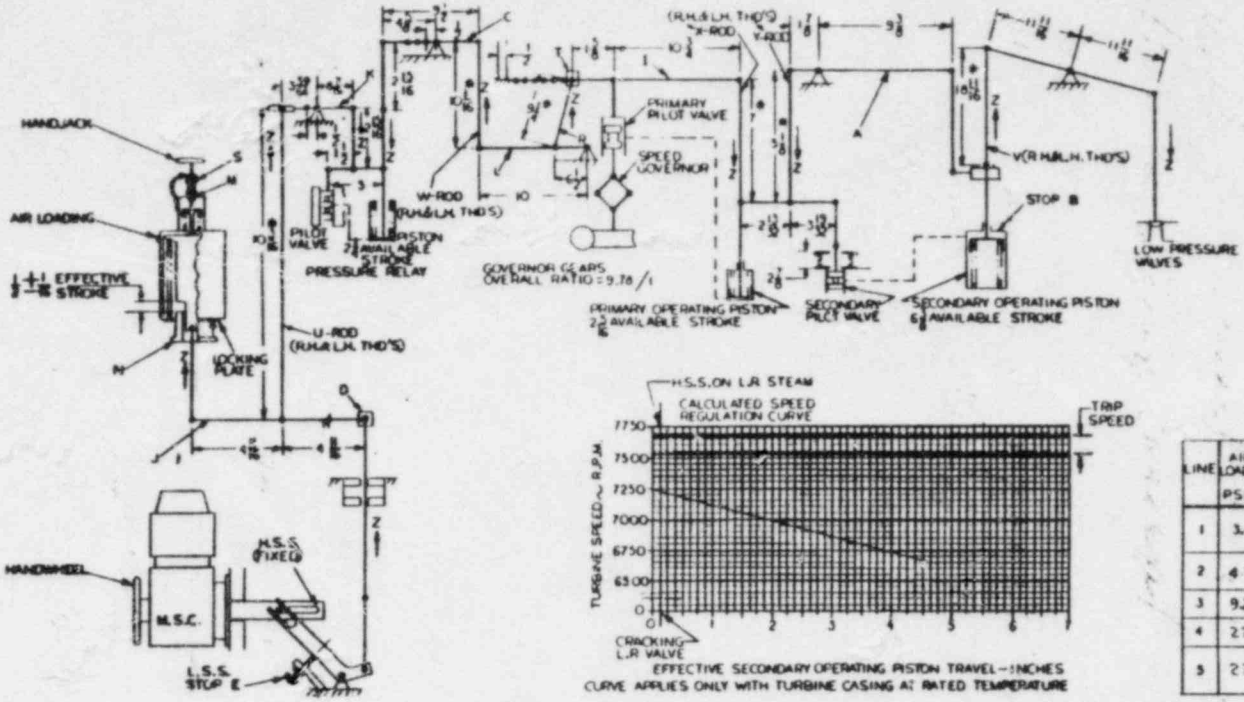
6 TIGHTEN NUTS ON STUD 'H' (V & I) UNTIL DBG'S. ARE SNUG.

7 UNLOCK NUTS ON STUD 'M' TO SPECIFIED CL. (F 4) AND PIN ALL NUTS.

8 ⚠ ADJ SCREW AE TO ACTUATE LIMIT SWITCH LS 7 BEFORE L.H. VALVES ARE RAISED.

⚠ IF LS-7 IS SUB-ASSEMBLED, IT SHOULD BE ASSEMBLED IN RETRACTED POSITION TO AVOID DAMAGE.

	(V GEAR ASSY)
	VALVE GEAR ASSY
E	501E4588EF



ALL TABULATION BELOW ARE MEASURED FROM THESE O-EFFECTIVE TRAVEL POSITIONS

VALVE LIFT TABULATIONS ARE WITH TURBINE CASING AT RATED TEMPERATURE

LINE	AIR LOADING PSIG	M.S.C. POSITION	PRESS. RELAY PISTON STROKE INCHES	TURBINE SPEED R P M	1/16 OFF BOTTOM PRIMARY PISTON STROKE INCHES	1/16 OFF STOP B SECONDARY OPER. CYLINDER PISTON STROKE INCHES	VALVE LIFT INCHES	REMARKS
1	3.0	AGAINST H S S	ON BOTTOM	0	ON BOTTOM	HELD 1/8 HOT (1/16 COLD) OFF STOP B BY VALVE GEAR	C O T	C O T
2	4.7	AGAINST H S S	0	0	0	HELD 1/16 OFF STOP B BY VALVE GEAR COLD - 0 HOT	C O T	EFFECTIVE ZERO
3	9.2	AGAINST H S S	.335	0	1.52	4.56 HOT	MAX AREA LIFT	MAX AREA LIFT H S S (NO LOAD)
4	27	AGAINST H S S	1.67	7250	.042	0125 HOT	C O T	
5	27	AGAINST L S S	ON BOTTOM	0	ON BOTTOM	HELD 1/8 HOT (1/16 COLD) OFF STOP B BY VALVE GEAR	C O T	C O T

LEVER RATIOS DO NOT HOLD BETWEEN LINE 1 OR LINE 5 AND ANY OTHER LINE BECAUSE OF OVER TRAVEL AT PILOT VALVE.

GENERAL INSTRUCTIONS AND NOTES

ARROWS ↕ INDICATE OPERATOR'S DIRECTION TO CLOSE VALVES.

I SET ALL LEVERS AND LINKAGE CONNECTIONS TO DIMENSIONS SHOWN. THE ASTERISKED (*) DIMENSIONS MAY BE VARIED TO MEET THE FOLLOWING REQUIREMENTS:

II PRIMARY AND SECONDARY LEVERS:

1. DISCONNECT V-ROD. SET LEVER A LEVEL WITH PISTON OF SECONDARY OPERATING CYLINDER AT MID STROKE.
2. DISCONNECT V-ROD. WITH PRIMARY PISTON HELD AT LINE 2, ADJUST Y-ROD TO SET PISTON OF SECONDARY OPERATING CYLINDER AT LINE 2.
3. WITH PRIMARY PISTON HELD AT LINE 1 AND VALVE LIFT AT LINE 1, ADJUST V-ROD TO SET PISTON OF SECONDARY OPERATING CYLINDER AT LINE 1.
4. WITH PRIMARY PISTON HELD 1 3/4 OFF BOTTOM BY POSITIONING LEVER L, ADJUST X-ROD TO SET LEVER I LEVEL. THIS SETS LEVER I LEVEL WITH PRIMARY PISTON AND PRIMARY PILOT VALVE AT MID STROKE.
5. SET PRIMARY PISTON TO LINE 3. CHECK THAT PISTON OF SECONDARY OPERATING CYLINDER IS AT LINE 3.

III AIR MOTOR, M.S.C. AND PRESSURE RELAY

1. SET LEVERS K, C, AND L LEVEL WITH PRESSURE RELAY PISTON HELD AT MID STROKE.
2. BACK HANDJACK ALL THE WAY OUT. ADJUST THREADED SLEEVE M SO AIR MOTOR STEM BREAKS AWAY AT AIR LOADING OF LINE 1 (INCREASING AIR LOADING) LOCK WITH JAM NUT.
3. ADJUST THREADED SLEEVE N SO AIR MOTOR STEM BREAKS AWAY AT AIR LOADING OF LINE 4 (DECREASING AIR LOADING). LOCK WITH LOCKING PLATE AND JAM SCREW.
4. EXHAUST AIR LOADING FROM AIR MOTOR. PULL OUT HANDJACK LOCK OUT PIN. ADJUST NUT S TO LIMIT HANDJACK STROKE TO THAT REQUIRED TO MAKE AIR MOTOR STEM JUST ENGAGE THREADED SLEEVE N. LOCK WITH JAM NUT.
5. APPLY AIR LOADING OF LINE 4 TO AIR MOTOR. RUN M.S.C. TO ITS FIXED H.S.S. SET LEVER J LEVEL WITH TRUNION BLOCK D.
6. RUN M.S.C. AGAINST FIXED H.S.S. ADJUST LENGTH OF LEVER K AND U-ROD SO PRESSURE RELAY PISTON IS AT LINE 1 WITH AIR LOADING OF LINE 1 APPLIED TO AIR MOTOR AND PRESSURE RELAY PISTON IS AT LINE 4 WITH AIR LOADING OF LINE 4 APPLIED TO AIR MOTOR.
7. APPLY AIR LOADING OF LINE 4 TO AIR MOTOR. ADJUST L.S.S. (STOP E) TO LIMIT UPWARD STROKE AT TRUNION BLOCK D TO 1/16 INCH MORE THAN IS REQUIRED TO BOTTOM PRESSURE RELAY PISTON.
8. SET M.S.C. H.S.S. GEARED LIMIT SWITCH TO ACTUATE 1/8 TO 1/4 TURN OF HANDWHEEL BEFORE REACHING FIXED H.S.S. CHECK THAT M.S.C. STEM IS AGAINST H.S.S. WHEN M.S.C. IS RUN TO H.S.S. WITH CONTROL SWITCH IN CONTROL ROOM. RESET GEARED LIMIT SWITCHES AS REQUIRED.
9. SET M.S.C. L.S.S. GEARED LIMIT SWITCH TO ACTUATE 1/8 TO 1/4 TURN OF HANDWHEEL BEFORE REACHING L.S.S. (STOP E). CHECK THAT M.S.C. IS AGAINST L.S.S. (STOP E) WHEN M.S.C. IS RUN TO L.S.S. WITH CONTROL SWITCH IN CONTROL ROOM. RESET GEARED LIMIT SWITCHES AS REQUIRED.

IV SPEED REGULATION:

SPEED REGULATION IS 5.0% BASED ON FULL LOAD SPEED OF 6500 RPM AND FULL LOAD LIFT OF 2.645 INCHES EFFECTIVE PISTON STROKE OF SECONDARY OPERATING CYLINDER. ADJUST AT LEVER I AS REQUIRED.

DUMP VALVE DV-1 WILL TRIP CONTROL VALVES WHEN STOP VALVES ARE TRIPPED. DUMP VALVE DV-1 MAY BE TEMPORARILY BLOCKED FOR PURPOSE OF CHECKING SPEED REGULATION BY SCREWING A PIPE PLUG IN ITS EXHAUST PORT.

V H.S.S.

UNCOUPLE FAN FROM TURBINE. RUN M.S.C. TO LINE 4. APPLY AIR LOADING OF LINE 4 TO AIR MOTOR. SET TURBINE SPEED TO LINE 4 BY ADJUSTING POSITION OF BLOCK T ON ROD R. WHEN BOTH STEPS V AND VI ARE SATISFIED, PIN TOP NUT ON ROD R.

PURPOSE OF NUTS BELOW BLOCK T ARE TO ALLOW TEMPORARY RAISING OF H.S.S. TO TEST EMERGENCY GOVERNOR.

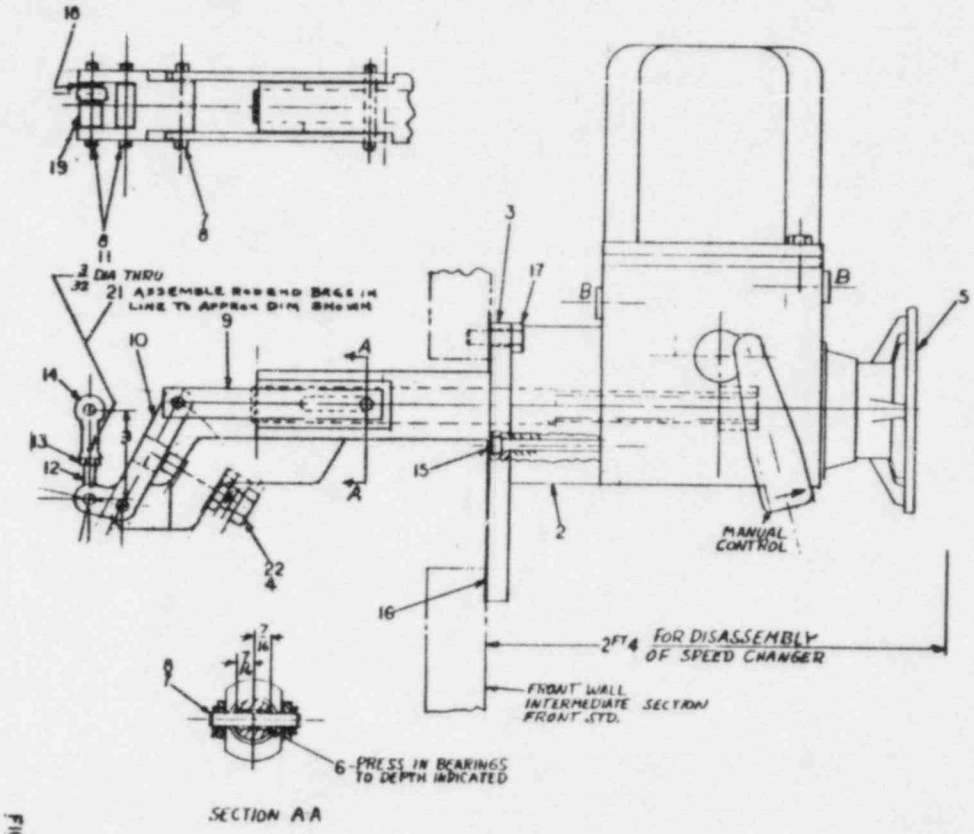
VI L.S.S.

RUN M.S.C. TO LINE 1. APPLY AIR LOADING OF LINE 1 TO AIR MOTOR. TURBINE SHOULD BE AT STAND-STILL WITH CONTROL VALVES CLOSED AND OVER TRAVELED.

VII EMERGENCY GOVERNOR:

1. TRIP SPEED 7514 TO 7666 RPM
2. OIL SUPPRESSED TRIP OPERATES AT 70 TO 75 % OF OVER SPEED TRIP SETTING. ACTUAL SPEED WILL BE DETERMINED BY TEST.
3. OIL VISCOSITY 150 SSU AT 100°F

GENERAL ELECTRIC
STEAM TURBINE — GENERATORS
LEVER DIAGRAM
509E252CD



SECTION A-A

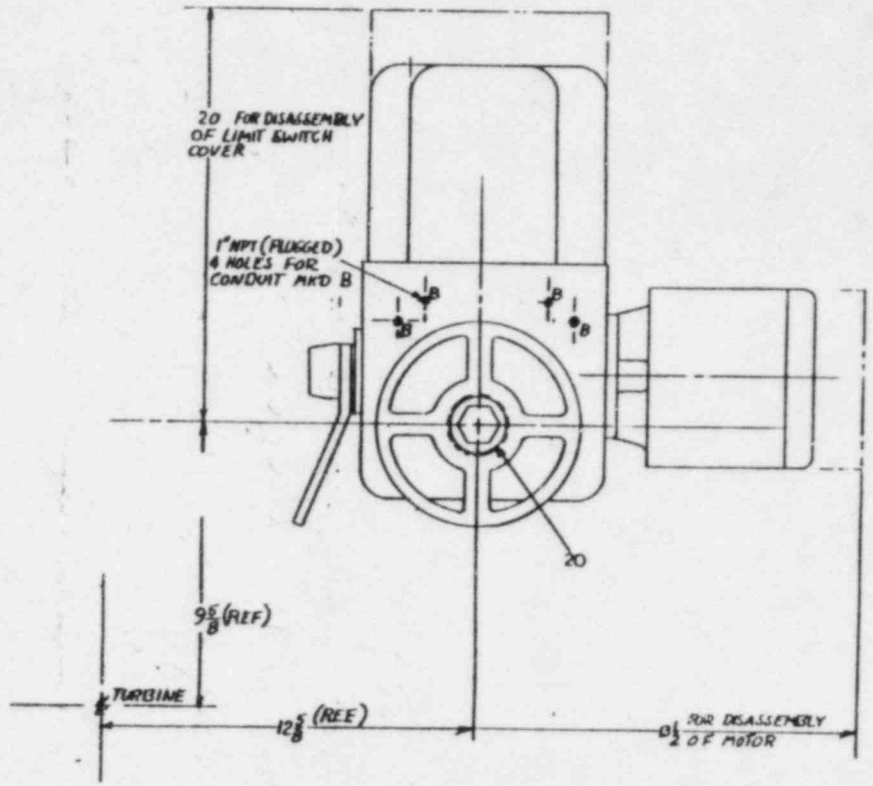


FIG 39

SPEED CHANGER

125D585AX

FORT ST. VRAIN
CONTROL ROOM DESIGN REVIEW

HED CATEGORIZATION
RECORD

HED # 0825

LIKELIHOOD THAT HED WILL CAUSE ERROR

CAT. 4		CAT. 1 OR 3		CAT. 1 OR 2		
DEFINITELY NOT	VERY UNLIKELY	PROBABLY NOT	MAYBE	PROBABLY	VERY LIKELY	DEFINITELY

RESULT OF ERROR (IF UNCORRECTED)

CAT. 3		CAT. 1 OR 2				
NO EFFECT	REQUIRES ADDITIONAL STEPS	REDUCTION IN OPER. PERFORMANCE	LOSS OF COMPONENT FUNCTION	LOSS OF SYSTEM FUNCTION	EXTENDED LOSS OF SYSTEM FUNCTION	EXTENDED LOSS OF PLANT FUNCTION

EFFECT ON MAINTENANCE AND/OR RESTORATION OF A CSF

	CAT. 2			CAT. 1		
NO EFFECT	POTENTIAL REDUCTION TO SAFETY MARGIN	REDUCED SAFETY MARGIN	LOSS OF SAFETY MARGIN	LOSS OF CSF	EXTENDED LOSS OF CSF	PREVENT RESTORATION

REMARKS Above referenced HED is assigned to Category One (1) without detailed assessment

TEAM ACTION

CATEGORIZATION. (1) 2 3 4

NOTE: DISSENTING TEAM MEMBER(S) OPINION NOTED ABOVE

TEAM MEMBER	TEAM MEMBER SIGNATURE	CONCURRENCE		DATE
Team Manager	(T) J W Gahm	(YES)	NO	7 May 84
CRDR Coordinator	(C)	(YES)	NO	7 May 84
man Factors Spec.	(H) Richard E Mosher	(YES)	NO	JUNE 25 May 84
Senior Reactor Operator	(S) Donald P Hood	(YES)	NO	7 May 84
Engineering Technician	(E) M	(YES)	NO	7 May 84

EXAMPLE #3

Sample Documentation

File as Operational Analysis

Summary of He Circ Start up Task analysis Walk Thru

Attachment 4d
Example #3
Page 1 Of 9

Date 11-27-83

Participants: S. Hofer Operator
R. Moler Operator
W. Franklin Shift Supv.
D. Glenn CRR Coordinator

Procedure used 21-02

Task - Start He Circ 1A

- Procedure was read to operator with each step mapped on detail of Board

- Comments and suggestions concerning task & procedure were discussed and analysized.

- Instrument grouping was studied. This included functional grouping and useability considerations.

A re-arranged board was utilized in a second start-up in an effort to determine any improvements in accomplishing procedure The re arrangement grouped instruments in accordance with the order and frequency of use.

Summary - A re-arranged board placed those instruments required for a circ start up in order of use and priority of parameter. This arrangement result in Eng why, seal system and Isolation function being located vertically with the controls and indications. Operator action verified that several instruments are not functionally

or geographically located for the most effective use during a civil staff up.

Several HED's were generated citing:

- Instrument Useability
- Instrument location
- Instrument Labeling
- Instrument Color Coding
- Procedure discrepancies or order problems.
- Nuisance Alarms.
-

Recorded by [redacted]

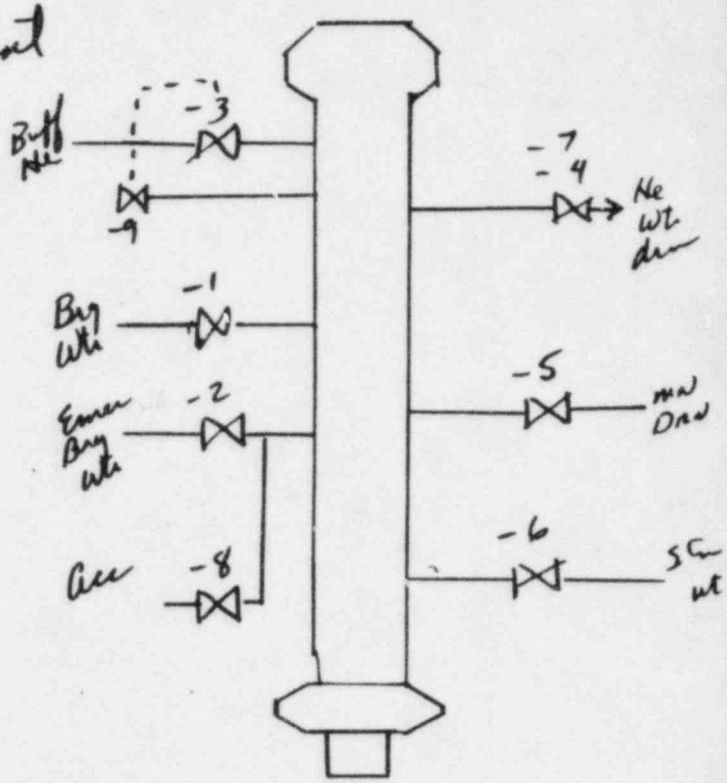
As Exists
Switch
Order of use
in
Procedure

13 -1	51 -2	37 -8	visual status	-1	-2	-8	
3 -3	5 -4	42 21203		-3	-4	21203	
11 -5	31 -6	36 21191		-5	-6	21191	

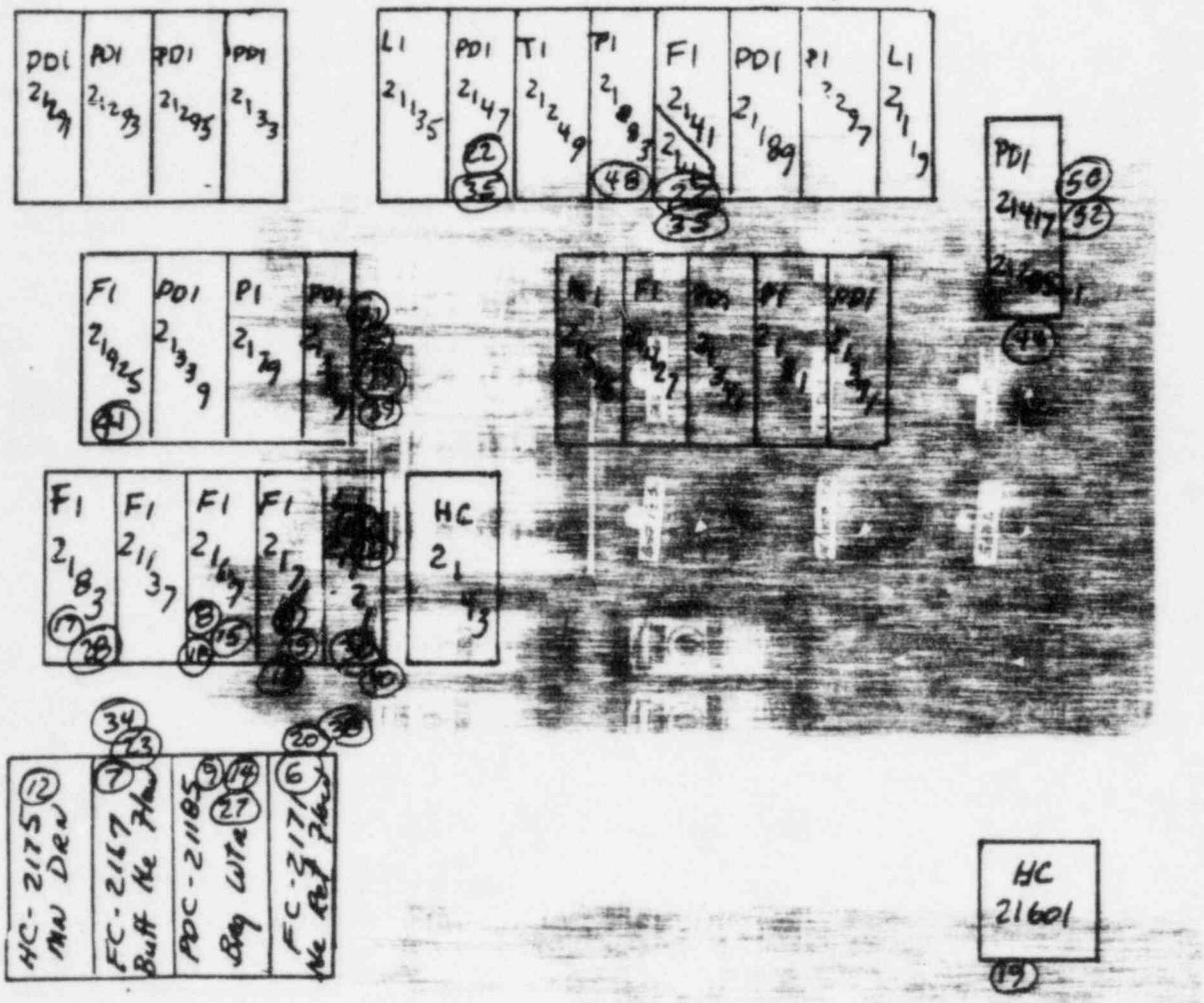
Red - Order in the Start up Procedure

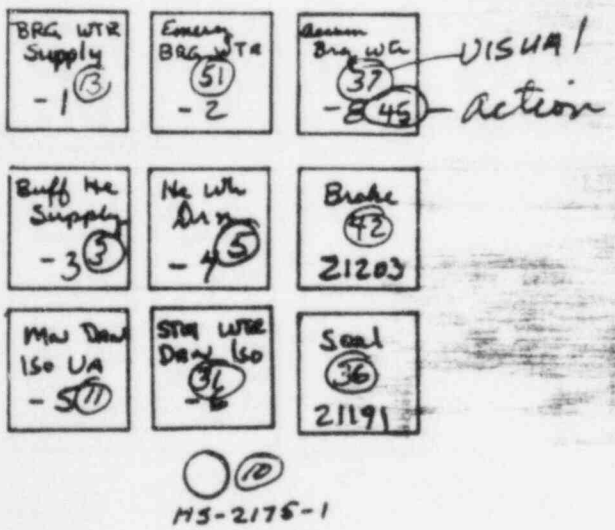
Black is Sw Select

System interaction point



ORGINAL LAYOUT



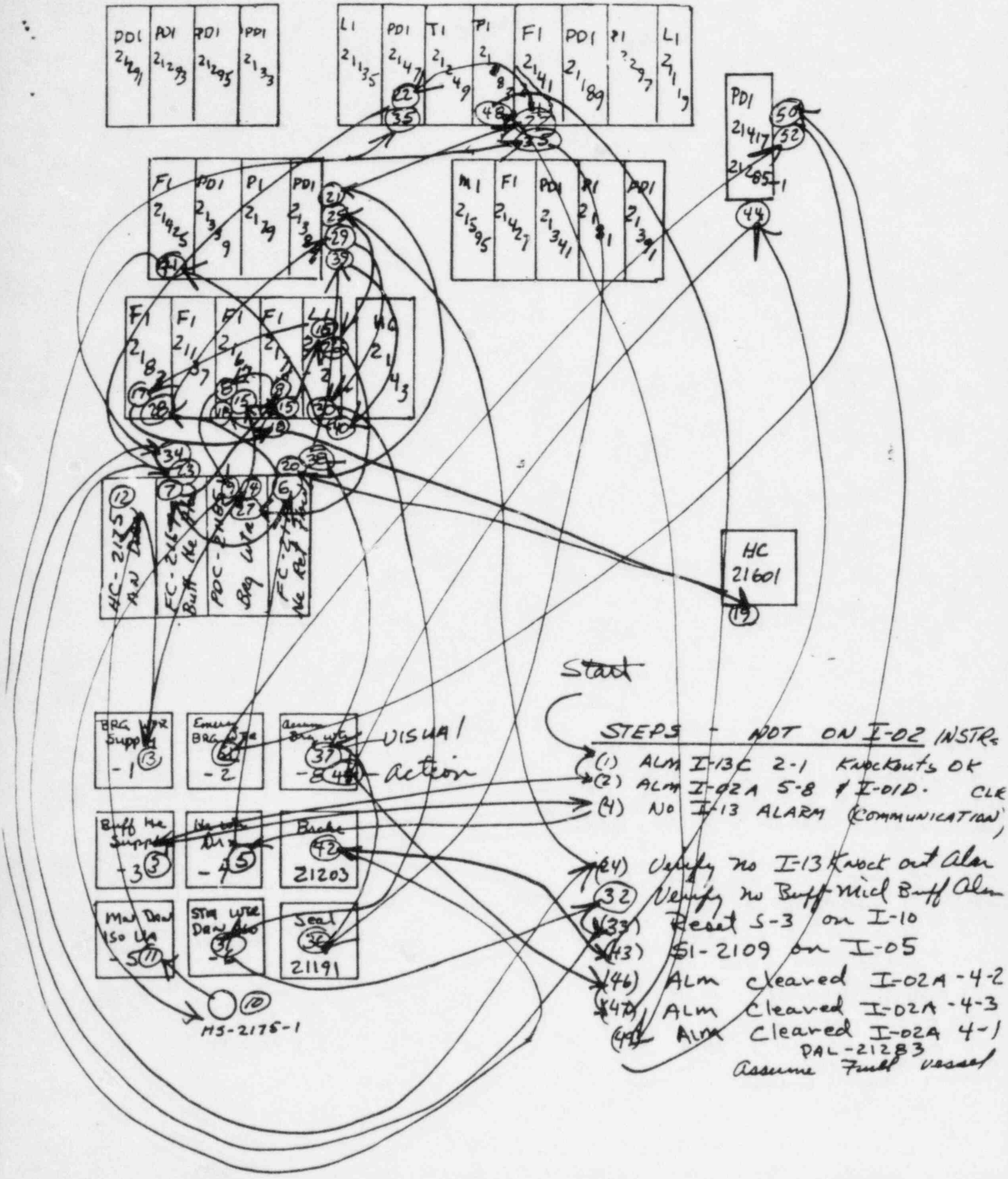


STEPS - NOT ON I-02 INSTR.

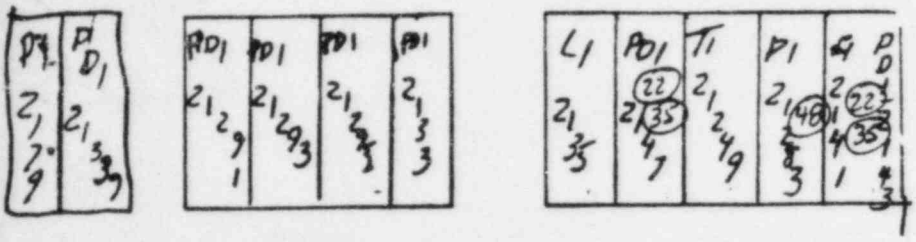
(1) ALM I-13C 2-1 Knockouts OK
(2) ALM I-02A 5-8 & I-01D. CLR
(4) NO I-13 ALARM (COMMUNICATION)

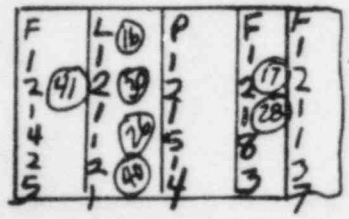
(24) Verify no I-13 Knock out Alarm
(32) Verify no Buff-Mkd Buff Alarm
(33) Reset S-3 on I-10
(43) SI-2109 on I-05
(46) ALM cleared I-02A-4-2
(47) ALM Cleared I-02A-4-3
(49) ALM Cleared I-02A 4-1
PAL-21283
Assume Fuel vessel

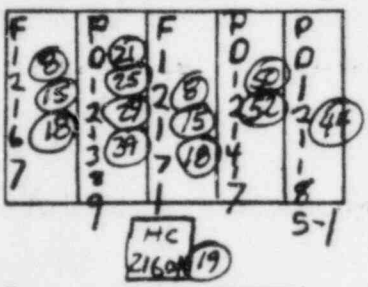
ORGINAL LAYOUT



REARRANGED



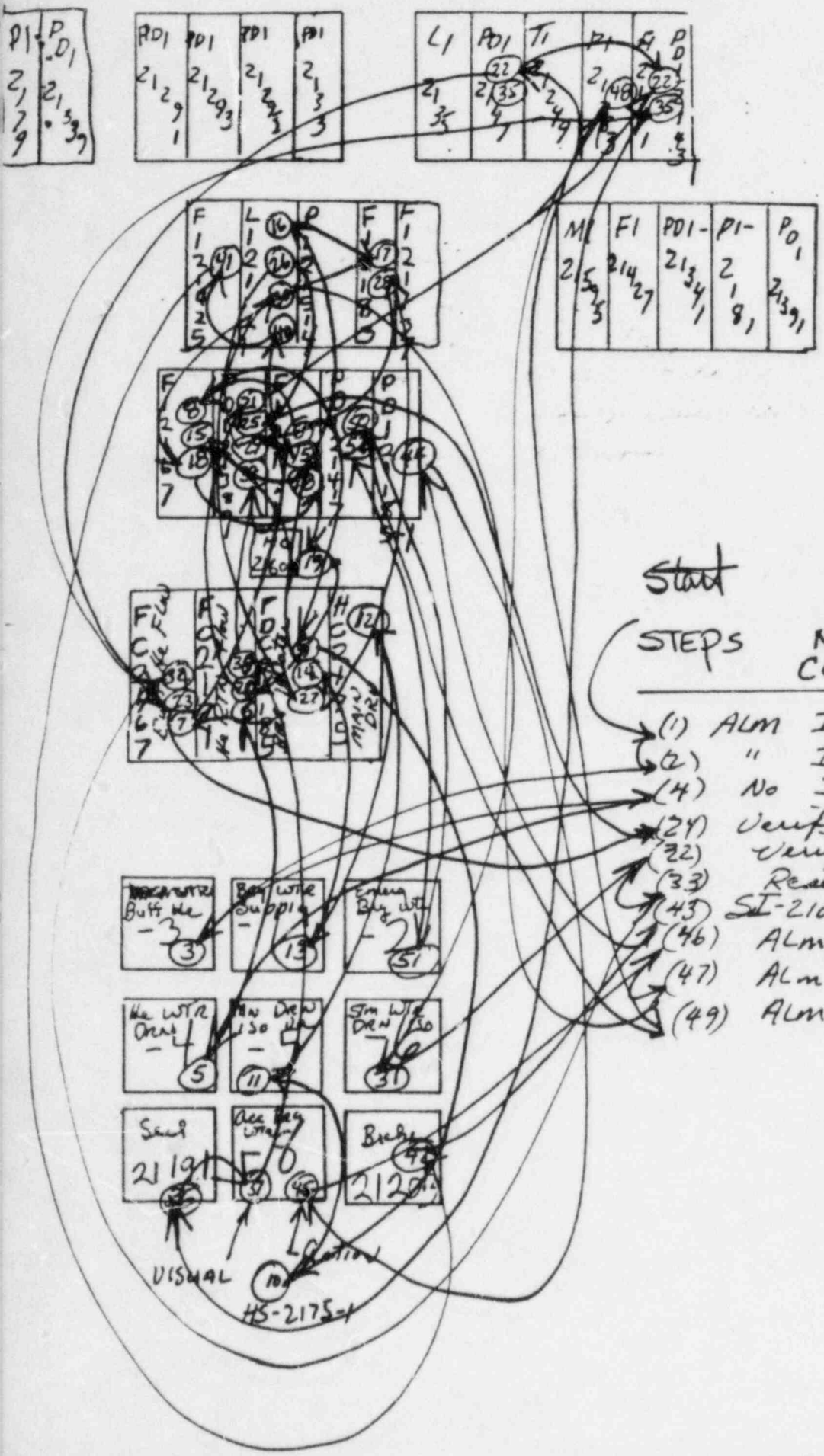




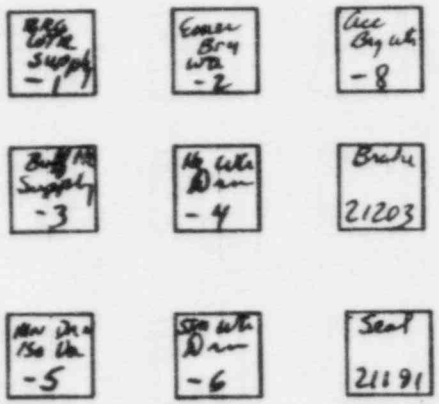
STEPS NOT ON I-02 CONTROL ARRANGEMEN

(1) ALM I-13C 2-1 Knockouts OK
(2) " I-02A 5-8 & I-010 CLR
(4) No I-13 ALM (Communicati
(24) Verify no I-13 Knockout alm
(32) Verify no Buff- Mist Buff al
(33) Reset S-3 on I-10
(43) SI-2109 on I-05
(46) ALM CLR'd on I-02A 4-2
(47) ALM CLR'd on I-02A 4-3
(49) ALM CLR'd on I-02A 4-1
PAL-21283
assume Full
Vessel

RE-ARRANGED

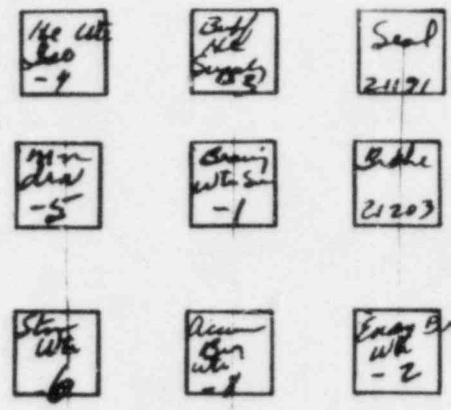

Start
STEPS NOT ON I-02 CONTROL ARRANGEMEI
(1) ALM I-13C 2-1 Knockouts OK
(2) " I-02A 5-8 & I-010 CLR
(4) No I-13 ALM (Communicate
(21) Verify no I-13 Knockout alm
(22) Verify no Buff- Mist Buff al
(33) Reset S-3 on I-10
(43) SI-2109 on I-05
(46) ALM CLR'd on I-02A 4-2
(47) ALM CLR'd on I-02A 4-3
(49) ALM CLR'd on I-02A 4-1
PAL-21283
assume Pulp
Vessel
VISUAL
HS-2175-1

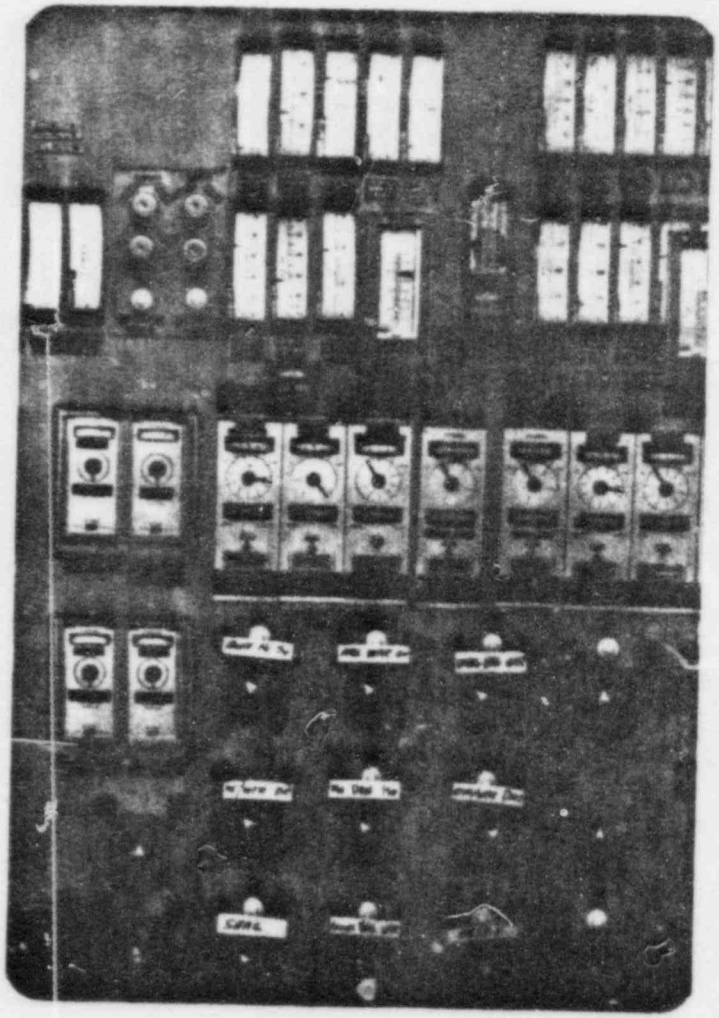
As Exists

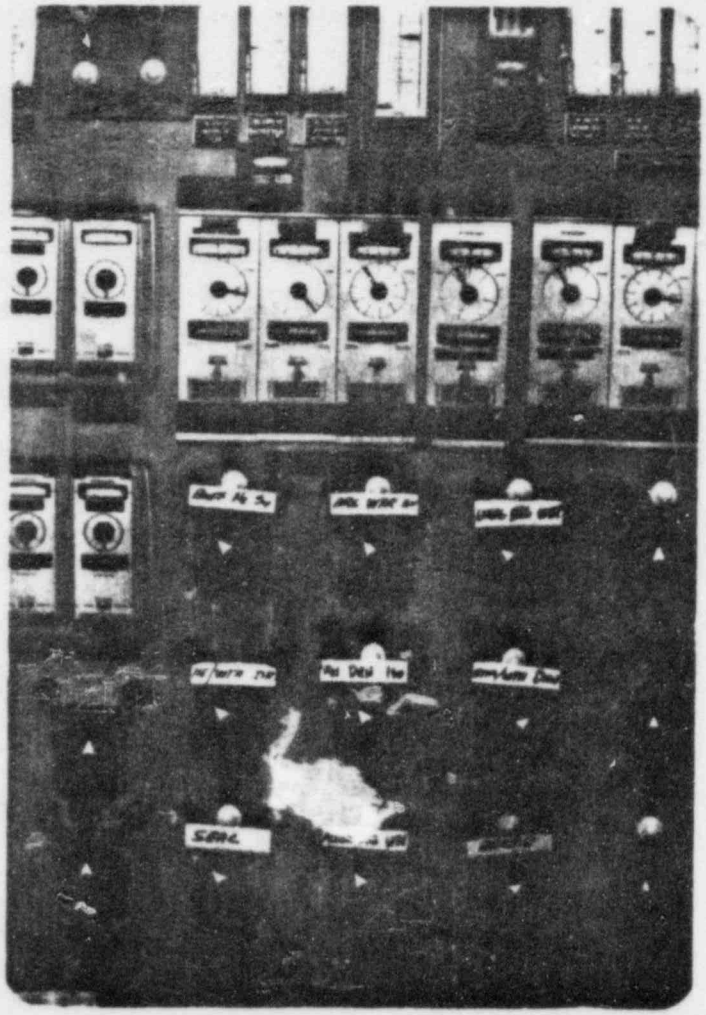


1st operator Team Re-arrangement

2nd Operator Team Re-arrangement







Copy of Photographs showing
OPERATOR Preferred ARRANGEMENTS

12/3/15

ATTACHMENT 5

NUREG-0700 Guidelines Which Were
Not Specifically Addressed
(or Were Addressed Indirectly)

NUREG-0700 Section 6 Guideline #	Guideline	Basis for not specifically Addressing (or alternative)
6.1.5.7.C	REST AREA/LOUNGE-Consideration should be given to providing a rest area (possibly in conjunction with the eating area) conducive to relaxation and revitalization, especially where shifts are long.	This guideline is really a suggestion. The provision of a lounge facility is not directly related to operator performance.
6.4.1.1.B.(All)	ECONOMY-Each control should be necessary, and the simplest effective control for the task concerned. (1) There should be a good reason to require a control for the function concerned. (2) Duplication of controls should not occur, except for a specific reason. (3) The precision and range of a control should not greatly exceed the need. (4) Selected controls should be economic of space.	These "Guidelines" are really general principles and, as such, should not be included in a survey. The specific principles relating to a control room design review and controls are addressed elsewhere.
6.5.1.2.F	SENSITIVITY-Display dynamic sensitivity should be selected to minimize the display of normal random variations in equipment performance.	Useability is dependent on task specific requirements. Information useability is addressd specifically in task analysis & system analysis efforts.
6.6.3.9.B	DANGER, WARNING, AND SAFETY INSTRUCTION LABELS-All danger, warning & safety instruction labels should be in accordance with appropriate safety standards.	Statement is all inclusive and without specific meaning. The adequacy of labels or instructions associated with protective equipment or emergency procedures is reviewed and corrected as necessary as part of the design package affecting the associated equipment.
6.7.1.5.A	CONTROL DESIGN-When dedicated controls are used for selection of computer or display functions or modes, the design of the controls should conform to the appropriate guidelines specified in Sect. 6.4, Controls	Controls are specified per Public Service Service Company's Design Directives. Specifically DD-SWI-1, Switch Selection, which includes applicable NUREG-0700 characteristics.
6.7.2.1.H.2	Adjustment controls should conform to the appropriate guidelines in Sect. 6.4, Controls, & Sect. 6.9, Control-Display Integration.	CRT controls are specified per Public Service Company's Design Directives. Specifically DD-CRT-1, CRT selection, which includes applicable NUREG-0700 characteristics.

NUREG-0700 Section 6 Guideline #	Guideline	Basis for not specifically Addressing (or alternative)
6.7.2.7.F	INVERSE VIDEO-Image reversal (e.g., dark characters on a light background) should be used primarily for highlighting in dense data fields, such as a word or phrase in a paragraph of text, or a set of characters in a table of data.	This is a suggestion rather than a prescriptive statement. Displays were evaluated for clear and concise presentation of information.
6.9.2.2.E	CONTROL/DISPLAY PACKAGES-When controls & related displays are assembled using modular packaged units, the design of the packages will limit the location and arrangement which can be achieved. In this case, modules should be selected and arranged to achieve maximum conformity with the principles described above.	This item represents Design Criteria; however, the principle was considered during system reviews & is being addressed by functionally grouping components during the redesign process.
6.1.1.3.F	EQUIPMENT-TO-OPPOSING-SURFACE DISTANCE-Enough space should be allowed so that personnel can perform all required tasks. The space should accommodate kneeling and bending, simultaneous work by more than one operator, and simultaneous performance of operational & maintenance tasks as may be required. Recommended minimum separations are illustrated in Exhibit 6.1-4.	The primary consideration addressed is as stated "Enough space should be allowed so that the personnel can perform all required tasks". This was addressed as a "requirement" during Task Analysis & Operational Analysis efforts. Specific dimensional criteria will be considered where practical in the design and procurement of new furnishings.
	(1) A minimum separation of 50 inches is recommended between a single row of equipment/panel and a wall or other opposing surface.	
	(2) A minimum separation of 50 inches is also recommended between two rows of facing equipment if both rows are worked by a single operator.	N/A at Ft. St. Vrain
	(3) A minimum separation of 8 feet is recommended between opposing rows of equipment where more than one person must work simultaneously on operational or maintenance tasks and kneeling, bending, or use of test equipment may be necessary.	N/A at Ft. St. Vrain
6.8.2.4.B	SIMULATOR-TO-CONTROL ROOM STANDARDIZATION-Standardization should be maintained where simulators or procedure trainers are used that simulate the actual operational equipment.	N/A at Ft. St. Vrain
6.2.2.3.B	PULSE CODING-Auditory signals may be pulse coded by repetition rate, but the number of codes should be limited (2 or 3). Repetition rates should be sufficiently separated to ensure operator discrimination.	N/A at Ft. St. Vrain

NUREG-0700 Section 6 Guideline #	Guideline	Basis for not specifically Addressing (or alternative)
6.2.2.3.D	DISCRETE FREQUENCY CODING-Discrete frequency codes may be used for audible signal coding. Frequencies should be broad band (±100 Hz) and widely spaced within the 200-5000 Hz range. No more than 5 separate frequencies should be used.	Discrete frequency coding is not presently applied at Ft. St. Vrain
6.4.4.3	a. TEETH: SINGLE ROW-keys with a single row of teeth should be inserted into the lock with the teeth pointing up or forward. b. TEETH:DOUBLE ROW-If keys have teeth on both edges, they should fit the lock with either side up or forward.	These "Guidelines" as stated represent criteria. Existing design was addressed for operability and consistency.
6.5.5.1.A.3	GROUPING OF NUMERALS-If more than four digits are required, they should be grouped and the groupings separated as appropriate by commas, by a decimal point, or by additional space.	Drum counters have limited use at Ft. St. Vrain and are not considered as primary operating informational displays.
6.5.5.1.B.3	The window should be sized to allow no more than one digit per drum to appear in the window at any one time.	
6.5.5.1.C.1	Numbers should change by snap action rather than through continuous movement.	
6.1.2.4.B	CHAIR HEIGHT-The operator should be provided with a high chair so that the seated eye height is approximately the same as standing eye height.	These items are considered inappropriate as written for a CRDR Survey, either because they are not characteristic of the equipment in present day control rooms, violation of the item is highly improbable or because the general principle is more appropriately addressed in a specific manner.
6.2.1.6.B.5	Microphone input should be provided within the Control Room.	
6.2.2.7.A	FAILURE OF ALARM CIRCUITRY-Failure of auditory signal circuitry should not adversely affect plant equipment	
6.3.1.4.A.1	Prioritization should be accomplished using a relatively small (2-4) number of priority levels.	

NUREG-0700 Section 6 Guideline #	Guideline	Basis for not specifically Addressing (or alternative)
6.5.1.6.B.2	The number of colors used for coding should not exceed 11.	These items are considered iappropriate as written for a CRDR Survey, either because they are not characteristic of the equipment in present day control rooms, violation of the item is highly improbable, or because the general principle is more appropriately addressed in a specific manner.
6.5.2.2.A.1	Pointer tips should be selected to minimize concealment of scale graduation marks or numerals.	
6.5.4.1.D	PAPER TAKEUP AND CUTOFF-A takeup spool should be provided to receive completed recordings. On most instruments this is provided as an inherent part of the design. Also, means should be provided for tearing off completed records for storage.	
6.7.1.1.C	EDITING-When caracters, words, or phrases are to be inserted, such items should first be collected and displayed on a buffer area of the screen, and then collectively inserted by one operator command.	These items are considered inappropriate as written for CRDR Survey, either because they are not characteristic of the equipment in present day control rooms, violation of the item is highly improbable, or because the general principle is more appropriately addressed in a specific manner.
6.7.1.4.H	VISUAL FEEDBACK-Data being entered via keyboards should be displayed as it is keyed.	
6.2.2.1.A	DEDICATED USE-Systems used to transmit non-verbal auditory signals should be used only for that purpose.	Guideline not used. This prohibits alerting signals for public address system or walkie-talkie use.
6.5.4.1.H	PLACEMENT OF RECORDERS-As devices which must be verified and attended by the operator, graphic recorders should in principle be located within the primary operating area rather than on back panels.	Guideline not used. The proliferation of displays within the primary operating area is a root problem behind CRDR requirements. Recorders are both bulky and rarely used directly in controlling the plant.

NUREG-0700 Section 6 Guideline #	Guideline	Basis for not specifically Addressing (or alternative)
6.8.3.2.D.1	Large matrices of similar components should have the coordinate axes labeled for identification of any single component within the grid. The left and top sides of the matrix should be used for labeling.	Guideline not used-This organizational scheme is inherently inferior to funcitonal grouping, would clutter the boards, and would cause confusions due to dual identification schemes for items.
6.6.5.1.G	ACTIVATION-Tag-outs should be designed to physically prevent actuation of a control.	Guideline not used-Due to the diversity of control types in a control room, it is impractical to devise tags that would physically prevent actuation. Typically, tagging procedures allow for isolation of secured equipment outside of the control room. When this is done, tags on the control board provide information rather than physical isolation.
6.7.1.1.B	SECURE STORAGE-At least one copy of the current operating software should be stored in a secure remote location.	Guideline not used-Operator does not load the operating Software nor is plant control a function of the Ft. St. Vrain data logger system.
6.9.1.2.C.4	Displays should read off-scale, not zero, when not selected, especially if zero is a possible parameter displayed.	Guideline not used-Requirement of off-scale indication is a design specification. Detection of failure or non-selection mode is a functional issue that is verifiable by other indications or displays.
6.4.4.3.D	ON-OFF ORIENTATION-Locks should be oriented so that the switch is OFF (or SAFE) when the key is in the vertical position.	The position of key removeable should be based on the switch function and not on a radial position. The more important consideration is if the key is "removeable" only in the "OFF" or "SAFE" position, addressed by the Operator Questionnaire.
6.9.3.1.C.1	There should be no time lag between system condition change and display indication.	The reference to "No Time" is subjective and uncharacteristic of control dynamics. The more pertinent consideration is if control characteristics, i.e.,"reset", "proportional bond", and "integral" are correct for a particular control application and result in a responsive control scheme.

NUREG-0700 Section 6 Guideline #	Guideline	Basis for not specifically Addressing (or alternative)
6.9.3.2.D	FEEDBACK-feedback from the display should be apparent for any deliberate movement of a control.	Feedback from a display is dependent on system response and not necessarily proportionate to control movement. The more pertinent consideration is whether the operator has sufficient and timely information to adequately control a system or function. This is a consideration addressed in system analysis.
6.9.3.1.C.2	When there is a time lag between control actuation and ultimate system state, there should be an immediate feedback indication of the process and direction of parameter change.	Again dependent on system function and response. The pertinent question is whether the operator has sufficient and timely information to adequately control a system or function. Addressed in system analysis.
6.6.6.4.B.2	Overlapping of mimic lines should be avoided.	These "guidelines" elude to techniques not previously utilized at Ft. St. Vrain. These items are being considered during the system review and the final design process.
6.8.3.2.C.1	No more than 5 similar componenets should be laid out in an unbroken row or column.	
6.8.3.2.C.2	If more than 5 similar components must be laid out together, the string or cluster should be broken up by techniques such as physical spacing or demarcation	
6.8.3.2.D.2	Large matrices should be subdivided by appropriate demarcation.	
6.6.6.2.A	USE-Lines of demarcation can be used to: (1) Enclose functionally related displays. (2) Enclose functionally related controls. (3) Group related controls and displays.	
6.9.1.2.A.6	Where the above techniques cannot apply, or where for other reasons the relationships are not readily apparent, layout enhancement techniques should be employed-spacing, demarcation, color shading, insert panels, panel relief, and the use of mimics.	These "guidelines" elude to techniques not previously utilized at Ft. St. Vrain. These items are being considered during the system review and the final design process.

NUREG-0700 Section 6 Guideline #	Guideline	Basis for not specifically Addressing (or alternative)
6.9.1.2.A.3	Controls should be grouped in a line or matrix.	These "guidelines" elude to techniques not previously utilized at Ft. St. Vrain. These items are being considered during the system review and the final design process.
6.9.1.2.A.4	If not feasible to mount controls directly below the display, controls should be mounted to the right of the display.	
6.9.1.2.B.1	Displays should be located above the control.	These "guidelines" represent preferred locations and protocols, generally applied on ft. St. Vrain control boards. Specific functional grouping problems were individually cited. These items were considered during the system review and are being addressed during the final design process.
6.9.1.2.B.2	The control should be placed as near as possible to the display, and preferably underneath the center of the display array.	
6.9.1.2.B.4	If it is not feasible to mount displays above the control, they should be mounted to the left of the control.	
6.9.1.2.B.6	Where the above techniques cannot apply, or where for other reasons the control-display relationship is not clearly apparent, layout enhancement techniques should be employed.	
6.9.1.1.C.1	Association of displays with controls.	
6.9.2.2.A.1	Each display should be located directly above its associated control.	
6.6.6.4.B.6	Component representations on mimic lines should be identified.	
6.6.6.9.A.5	No more than 4 mimic lines of the same color should run in parallel if the operator must quickly identify any one of the lines.	N/A at FSV.

NUREG-0700 Section 6 Guideline #	Guideline	Basis for not specifically Addressing (or alternative)
6.4.3.3.C.4	Legend covers should be keyed to prevent the possibility of interchanging the covers.	Keying options are generally limited in numbers and not available for all types covers capable of preventing interchanging covers. Procedures are followed to minimize the possibility of interchanging lenses.
6.5.3.1.C.2	Provisions (design or procedural) should be made to prevent interchanging indicator lenses.	Procedures are followed to minimize the possibility of interchanging lenses. Design or procedures not feasible which prevent interchanging lenses.
6.4.1.1.E.1	Broken, chipped, or crumbled control surfaces should not ordinarily occur.	Guideline not used. Damaged components, equipment and facilities are routinely repaired or replaced thru existing maintenance activities.
6.4.1.2	INTERLOCKING CONTROLS-Controls may be provided with interlocks so that: (1) Extra movement is required (e.g., a side movement out of a detent position or a pull-to-engage clutch). (2) Prior operation of a related or locking control is required.	Guideline states options only and doesn't require action. Circuit configurations on mechanical interlocks similar to options applied as required.
6.6.6.1	NEED FOR LOCATION AIDS-Operator performance can be enhanced through the use of location aids such as demarcation, color, and mimics.	This is a statement and not a guideline. Demarcation is being utilized as part of the integrated design improvement approach.
6.3.1.2.B.1	Alarms that require the control room operator to direct an auxiliary operator to a given plant location for specific information should be avoided.	Guideline not used. The proliferation of alarms for which there is required operator action, within the primary operating area is one root cause of CRDR requirements. Public Service Co. is installing local alarm panels where the CR action is to dispatch an auxiliary operator to investigate and take corrective action.
6.5.3.1.D	USE AS ALERTING INDICATORS-Alerting the operators to unfavorable status should be a function of the annunciator system and not assigned to light indicators.	Guideline not used-"unfavorable status" is subjective. Alarms are used for conditions warranting operator actions, status lights are used to apprise operators of system or component status.

NUREG-0700 Section 6 Guideline #	Guideline	Basis for not specifically Addressing (or alternative)
6.5.4.1.G	USE-As a general rule, recorders should be used to record trend information and material which may be needed for later reference.	This guideline is really a general principle with no supporting criteria. Recorders are considered as secondary display devices only. Suitability of recorders for the intended application is addressed during other CRDR activities.
6.8.1.3	(a) SPACING-Spacing consists of physically separating groups of components on a panel with enough space between groups so that the boundaries of each group are obvious. Spacing between groups should be at least the width of a typical control or display in the group. (b)DEMARCATION-Demarcation consists of circumscribing functional or selected groups of controls and displays with a contrasting line. The application of demarcation techniques should conform to Guideline 6.6.8.2. (c) COLOR SHADING-Color shading may be used to enhance recognition of controls, displays, or functional groups. When color shading is used, colors should provide adequate contrast, and should be consistent with other color coding in the control room.	These guidelines are really suggested control board enhancement methods. Selected enhancement methods are defined by the applicable design directives and applied during the design improvement process.
6.3.1.4.B.2	Auditory signal coding for priority level is also appropriate. See Guideline 6.2.2.3 for recommended coding techniques.	This is a preferred design rather than a Human Engineering Design Principle.

ATTACHMENT 6A

Design Directives