Attachment 27

TVA Design Criteria Document WB-DC-30-7,
"Post Accident Monitoring Instrumentation," Revision 23

TENNESSEE VALLEY AUTHORITY

Division of Nuclear Engineering

N
E

RIMS
QA RECORD

N/A
DESIGN CRITERIA DOCUMENT

No. WB-DC-30-7

WATTS BAR
NUCLEAR PLANT
UNIT 1 / UNIT 2

TITLE: POST ACCIDENT MONITORING INSTRUMENTATION

*Signatures on original

REVISION	R0	R21	R22	R23		
DATE:	*	1-29-2007	8-27-2008	10-12-2010		
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TITLE: POST ACCIDENT MONITORING INSTRUMENTATION		REVISION LOG WB-DC-30-7
REVISION NO.	DESCRIPTION OF REVISION	DATE APPROVED
1	Revisions were required to remove the "holds" originally placed on the unresolved portions of this criteria. Other minor changes were also incorporated. The "hold" shown on paragraph 3.4.1.6 will be resolved when information requested from NEB is received per memorandums from F. W. Chandler to J. A. Raulston dated August 31, 1984 (EEB 840904 980), and November 15, 1984 (EEB 841115 918).	12/18/84
2	This is a general revision of the Design Criteria which complies with the requirements of Supplement 1 to NUREG-0737 and the guidance of Regulatory Guide 1.97 Rev 2. The revision introduces Type and Category definitions which are consistent with R.G. 1.97 Rev. 2. The category "Support Instrumentation" is no longer included or defined : references to Support Instrumentation have been deleted. Included in the revision are changes which were introduced through revision of the set of design input calculations listed in the References (Section 9). The substantial number of changes in this revision has made it impractical to indicate the changes with lines in the margin. This revision incorporated Commitments and Requirements in the C/R Data Base as of May 16, 1986. Type D variables will be identified at a later date.	09/22/88
3	This is a general revision of the design criteria which complies with the requirements of supplement 1 to NUREG - 0737 and the guidance of Regulatory Guide 1.97 revision 2. The following Design Input Memorandums have been incorporated with editorial changes where required. DIM-WB-DC-30-7-2 (B26 890405 014) DIM-WB-DC-30-7-3 (B26 891025 077) DIM-WB-DC-30-7-4 (B26 890814 076) DIM-WB-DC-30-7-5 (B26 891215 076) DIM-WB-DC-30-7-6 (B26 900419 077) DIM-WB-DC-30-7-7 (B26 900426 076) DIM-WB-DC-30-7-1 does not exist and is an invalid number. Other editorial changes were made throughout the document to clarify the requirements for post accident monitoring instrumentation and its circuitry. Also included in this revision are changes which were introduced through revision of the design input calculations listed in the reference section. (Section 9.0) The revision levels have been deleted from the calculations referenced in the reference section. (Section 9.0)	06/15/90

3 (cont'd)	Appendix B "Required Accuracies" has been deleted. **The Category 1 required accuracies are given in calculation WBN-OSG4-111. (Reference 9.1.14). [PL-08-0485 thru -0489]** The substantial changes in this revision have made it impractical to indicate the changes with revision bars in the margin.	
DCN S-12931-A	DCN RIMS No. B26 900928 801 Revised Sections 3.4.1.4, 3.5.1.1, 3.5.1.4, 3.5.1.5, and 4.3.1.1 to correct discrepancies and clarify the language regarding separation and isolation. Paragraph3.4.1.4 was changed to delete an improper reference and clarify that isolation devices shall be 1E qualified for that application. Paragraphs 3.5.1.1, 3.5.1,4, 3.5.1,5, and 4.3.1.1 were revised to clarify the requirements for separation of PAM channels 1, 2, and 3 (PAM 1, PAM 2, and PAM 3). Revised Appendix A, Table A-1 to specify a third SG NR level loop instead of using the SG WR level as the SG level PAM 3 channel and changed the diverse parameter for auxiliary feedwater flow from SG NR level to SG WR level. Revised pages: 12, 16, 21, Appendix A, Table A-1 (see revision bars).	09/28/90
4	This is a general revision of the design criteria. Minor changes, corrections, and editorial comments were incorporated. References 9.1.5, 9.1.16, 9.1.17, and 9.3.4 were deleted. In Table A-1, "Steam Generator Power Operated Relief and Safety Valves Status" was revised to read "Main Steam Flow", as allowed by R.G. 1.97. Revised 3.4.1.5, 3.4.1.6, and 3.4.2.6 to clarify recording requirements. Added recording requirements for Category 3 variables. Added requirements for instrument accuracy calculation. Revised Section 6.0 "Quality Assurance" and added the requirement to identify Category 2 non-Class 1E cables in CCRS as required by CAQR WBP 90021P. Added Appendix B - Table B-1. Incorporated OIDB-288 7-R00. No pages were deleted in this revision. The following pages were revised: 2-4, 7, 10-15, 18-24, 26-28, A-1, A-2, Table A-1, page numbers 1, 2, 3, 6, 8, 9, 10, 11, 12, and 14.	05/28/91

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REVISION NO.	DESCRIPTION OF REVISION	DATE APPROVED
DCN M-18087-A	DCN RIMS NO T56920410957 Revised Appendix A Table A-1 Page 5 VAR NUM 36 to have an Analog Scale Range from 6400 to 7400 and a digital display from 0 to 9999 and a Non-1E Power Supply. Page added: Revision Log - V	04-10-92
DCN S-20605-A	DCN RIMS NO. T56920918899 Revised Appendix A Table A-1 Page 5 VAR NUM 36 to have a digital display from 6400 to 7400.	09-18-92
DCN M-21497-A	DCN RIMS NO. T56921116957 Revise variable number 70 pressurizer relief tank temperature to show vertical line "range to" to read 400. PP revised: Rev Log P. V, P. 8 of Appendix A, Table A-1	11-16-92
DCN M-18200-A	DCN RIMS NO. T56921116962 Revised Appendix A, Table A-1, Pages 1 & 14, to rescale Auxiliary Feedwater Flow Transmitters to 0-700 GPM. Pages revised: V, Page 1 & 14 of Appendix A, Table A-1	11-16-92
DCN S-21610-A	DCN RIMS NO T56 921124 882 Revised Section 3.4.1.7 to clarify accuracy calculation requirements for PAM Category 2 instruments. Revised Page 12 and Page V. Total pages affected equals 2.	11-24-92
DCN S-23452-A	DCN RIMS No. T56 930222 930 Revised Post Accident Monitoring Variables List, Appendix A Table A-1, VAR NUM 17.	02-21-93
DCN S-25193-A	DCN RIMS No. T56 930529 805 Appendix A, Table A-1 revised to correct range units for variables 92, 94 and 99. (Pages 10, 11 & 12). Appendix B, Table B-1 revised to add variable 92, Auxiliary Building Vent Flow Rate (Page B-1).	05-08-93
DCN M-09964-A	DCN RIMS No. T56 930618 892 Revised Post Accident Monitoring Instrumentation Component Qualification Matrix, Appendix A, Page A-1 and Section 3.5.2.2 to indicate PAM Category 2 control power requirements as "highly reliable (diesel or battery backed) non-divisional power sources." Revised Appendix A, Table A-1 to revise Type/Category requirements for Main Steam Line Radiation, Variable Number 7, from A1, C1, E2" to "C2, E2".	06/18/93
DCN W-25945-A	DCN RIMS No. T56 931124 971 **Revised Table B-1 to correct the variable names, primary elements, and computer addresses to agree with the ERFDS I/O List (45B901) [PL-08-0490]** and **the PAM Category 2 Variable calculation (WBPEVAR9202003). [PL-08-0491 thru -0500]** Added page vii and revised Page B-1 of Appendix B.	11/23/93

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REVISION NO.	DESCRIPTION OF REVISION	DATE APPROVED
5	Revised to add Source Notes 1 and 2. Made minor administrative changes throughout the document. Pages Revised: i, Coordination Log, vi, 4, 5, 8, 12, 13, 14, 20, 22, 27, 28, 30, 32, through 46. Pages Added: 48 Pages Deleted: None	11/30/93
6	Revised to delete the MCR Particulate Monitor and to delete deviation 14 by meeting the R.G. 1.97 required range. Revised Sections 3.4.1.6 and 3.4.2.4 to clarify category 2 isolation. Pages Revised: 12, 14, 39, 42, 46 No Pages added or deleted.	01/27/94
DCN S-30679-A	DCN RIMS No. T56 940519 812 Revised name, primary element, and computer address for Variable 94. Added Page: via Revised Page: 47	05/18/94
DCN S-31881-A	DCN RIMS No. T56 940926 882 Revised to add Source Note 3. CATD 22911-WBN-01 Revised Pages: via, 48 Added Pages: None Deleted Pages: None	09/23/94
DCN S-35446-A	DCN RIMS No. T56 950408 838 Revised Sheet 12, Section 3.4.1.7 to add additional detail found in the FSAR. Revised Pages: via, 12 Added Pages: None Deleted Pages: None	04/08/95
7	Revised to add deviations to Reg Guide 1.97 R2, add additional references, added variable 95 to the ERFDS PAM display, and **to make revisions to the ranges for variables 95 & 96 are a result of revision to WBNAPS3-048 R8. [PL-08-0501]** Pages Revised: i, vii, Coordination Log, (viii), 4, 28, 32, 43, 47 Pages Added: 49 thru 67 Pages Deleted: None	05/08/95
DCN S-36511-A	DCN RIMS No. T56 950526 960 Revised Table B-1 to correct instrument I. D. number and Table A-1 to correct range. Revised Pages: via, 44, 47	05/26/95

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REVISION NO.	DESCRIPTION OF REVISION	DATE APPROVED
DCN S-36997-A	DCN RIMS No. T56 950617 869 **Revised sheet 43, to revise the range of the condenser vacuum pump exhaust vent (noble gas) to agree with Revision 10 of WBNAPS3-048. [PL-08-0501]** Pages Revised: vii, 43 Pages Added: None Pages Deleted: None	06/17/95
8	**Revised to add deviation 14 per Revision 11 of WBNAPS3-048 [PL-08-0501]** and correct typographical error on page 33. Pages Revised: vii, viii, 28, 32, 33, 42, 46, 55 Pages Added: ix Pages Deleted: None	09/11/95
9	Revised to clarify Appendix A, Component Qualification Matrix, added note 12 to Appendix A, Table A-1, and correct typographical errors in Table A-1. Revised instrument number in Table B-1. Pages Revised: viii, 28, 30, 33, 34, 39, 46, 47, 55 Pages Added: 46a Pages Deleted: None	10/13/95
DCN S-38398-A	DCN RIMS No. T56 951107 810 Revised to clarify Appendix A, Component Qualification Matrix and Appendix A, Table A-1, Post Accident Monitoring Variables List per DCN S-38398-A. Pages Revised: 30, 44, 45, viii Pages Added: None Pages Deleted: None	11/07/95
10	Revised to change Appendix A, table A-1, Variable Number 29 (Accumulator Tank Level), Range From to 7450 Gallons and Range To to 8080 Gallons. This change was incorporated in the field based on DCN W-26189-A. Corrected typographical errors and pages numbers. Correctly identified Appendix C. Deviation 15 (in Table C) justified a large deviation from the Range recommended in RG 1.97 for this Variable. The new range is slightly different from that discussed in the justification, but the basis for the acceptability of the deviation from the RG 1.97 Recommended Range does not change. Therefore, no revision to Deviation 15 is necessary. Pages Revised: viii, ix, 4, 36, 45, 50 through 68, 46a to end of the document renumbered to delete page number 46a. Pages Added: None Pages Deleted: None	04/03/96

11	• DCN E-50024-A (T56 981023 800) changed DS-E18.1.20, "Instrumentation and Control, Labeling of Components" to DS-E18.1.24, "Human Factors Engineering" in Section 3.4.1.3, 3.4.2.3, 4.3.2.5, and 9.3.11, added Deviation 37 and other minor corrections. • Renumbered entire document, which changed page numbers on Table of Contents (pages xi through xiv). Pages Revised: All Total Pages: 79 (includes i through xiv and 1-65)	12/11/98
11A Admin Change	In accordance with PER 99-010239, administrative change to add effective date of Revision 11 on Coversheet and Revision Log page ix, and to add names on Coversheet of Preparer, Verifier, and Approver. Deleted RIMS No. on Coversheet Total Pages: 79 (includes i-xiv and 1-65)	7/27/99
12	Incorporates DCNs as follows: • DCN M-39608-A (T56 980407 801) revised design criteria to change Appendix C, Table C, Deviation 32, transmitter range from 20 ft. to 200 inches. This change will be reflected upon field completion of DCN M-39608-A. Regulatory Guide 1.97, Post Accident Monitoring Variable List, Appendix A, Table A-1, variable number 5, Containment Sump Level (Wide Range) range to 20 ft. has been changed to 200 inches. Added Reference 9.1.29. • DCN M-39911-A (T56 981215 803): Modification M-39911-A replaces the obsolete Unit 1 Westinghouse P2500 Plant Process Computer with a new Plant Integrated Computer System. This Plant Computer System provides an operator friendly, state of the art, real time process computer system for the WBN plant operators. After this modification, the new Plant Computer will be operational and performing all the functions of the existing Plant Computer (WB-DC-30-29) and Emergency Response Facilities Data System (ERFDS) (WB-DC-30-8). Therefore, Design Criteria's WB-DC-30-8 and WB-DC-30-29 have been combined into one Design Criteria WB-DC-30-29, "Plant Integrated Computer System." Design Criteria WB-DC-30-7 has been revised to incorporate this change by removing references to the Emergency Response Facilities Data System (ERFDS), Technical Support Center Computer or P2500 and replacing them with Plant Computer references. Revised Section 3.4.2.4, Appendix A, and Appendix B - Table B-1. • Deleted Coordination Log, which is not required per NEDP-10. • Renumbered entire document, which changed page numbers on the Table of Contents (pages x-xii). Total Pages: 74 (includes i-xii and 1-62)	8/24/99
13	Incorporates DCN as follows: • DCN 50885-A revised Section 3.4.1.4 to clarify that the requirement for isolation from components which perform automatic safety control functions applies to non-Class 1E components. • Reformatted and renumbered pages i-x. Total Pages: 72 (includes i-x and 1-62)	10/25/2001

14	Incorporates DCN as follows: • DCN 50917-A revised TABLE B-1 for PAM variable 46. Variable 46 was changed from recorder points to Plant Computer System for MCR indication. • Renumbered pages i-xi due to adding page to the Revision Log. Total Pages: 73 (includes pages i-xi and 1-62)	3-29-2002
15	Incorporates EDC as follows: • EDC 51161-A revised design criteria to include a requirement to identify Category 3 components in MEL and to define high quality for Category 3 components. Added Note 14 and made minor corrections to Appendix A, Table A-1. Revised Sections 3.4.3.1, 4.3.1.4, 4.3.3, added Section 4.3.3.1, revised Section 6.3 and Appendix A Table A-1. • Renumbered pages 1-62 due to adding Section 4.3.3.1, which changed page numbers on the Table of Contents (pages ix-xi). Total Pages: 73 (includes pages i-xi and 1-62)	9-6-2002
16	Incorporates DCN as follows: • DCN 50189-A revised design criteria to delete reference to Note 8 for Variable Number 23 (Containment Pressure - Wide Range) in Appendix A, Table A-1, Page No. 4. Total Pages: 73 (includes pages i-xi and 1-62)	10-30-2003
17	Incorporates DCNs as follows: • DCN 50933-A revised Appendix A, Component Qualification Matrix, to clarify recording requirements for Category 1 variables. Revised Appendix A, Table A-1, for variable number 4 to delete trending on non-divisional trend recorder. Revised Appendix B, Table B-1, to add variable number 4 and 96. • DCN 51075-A revised Appendix A, Table A-1, and Appendix C, Table C, for Variable Number 41 and Deviation 7 to change the WBN recommended range from 50 to 30 Deg F. Total Pages: 73 (includes pages i-xi and 1-62)	4-22-2004
18	Incorporates DCN as follows: • DCN 51239-A revised Appendix A, Component Qualification Matrix, and Appendix A, Table A-1, Post Accident Monitoring Variables List. Total Pages: 73 (includes pages i-xi and 1-62)	8-31-2004
19	Incorporates EDC as follows: • EDC 51787-A revised Appendix A Table A-1 and **Appendix C Deviation 14 to change the lower range for particulates in accordance with calculation WBNAPS3-048 Revision 15. [PL-08-0501]** Total Pages: 73 (includes pages i-xi and 1-62)	5-26-2005
20	Incorporates EDC as follows: • EDC 51723-A revised Appendix A to add footnote 15 for variable Number 18. Added References 9.1.30 and 9.1.31. Total Pages: 73 (includes pages i-xi and 1-62)	11-29-2006

21	Incorporates DCN as follows: • DCN 51856 replaces the mineral insulated cable inside containment from the reactor vessel head to the containment penetrations. The reference junction boxes are also removed including the cold reference RTDs in the boxes. The cold reference RTDs are replaced by RTDs which are integral with the cable at the transition from chromel and alumel to copper in the Incore Instrument Room (IIR). The replacement cable is routed in the same raceways, conduit, and reactor vessel refueling cavity wall penetration as the existing cable, no change in routing of the cable is occurring and mineral insulated cable is routed to the IIR. Appendix C Table C, Deviation 30: Revised to delete reference junction boxes. • Renumbered pages i-xii, due to adding a page to the Revision Log. Total Pages: 74 (includes pages i-xii and 1-62)	1-29-2007
22	This DCD has been reviewed and determined to be fully applicable to both Unit 1 and Unit 2. Outstanding WITEL Punchlist items are listed below: • PL-08-0482, see Section 9.2.10 • PL-08-0483, see Appendix A, Table A-1, Note 15 • PL-08-0484, see Appendix B, Table B-1 • PL-08-0485, see Rev. 3 and Section 9.1.14 • PL-08-0486, see Rev. 3 and Section 9.1.14 • PL-08-0487, see Rev. 3 and Section 9.1.14 • PL-08-0488, see Rev. 3 and Section 9.1.14 • PL-08-0489, see Rev. 3 and Section 9.1.14 • PL-08-0490, see Rev. DCN W-25945-A • PL-08-0491, see Rev. DCN W-25945-A • PL-08-0492, see Rev. DCN W-25945-A • PL-08-0493, see Rev. DCN W-25945-A • PL-08-0494, see Rev. DCN W-25945-A • PL-08-0495, see Rev. DCN W-25945-A • PL-08-0496, see Rev. DCN W-25945-A • PL-08-0497, see Rev. DCN W-25945-A • PL-08-0498, see Rev. DCN W-25945-A • PL-08-0499, see Rev. DCN W-25945-A • PL-08-0500, see Rev. DCN W-25945-A • PL-08-0501, see Rev. 7; Rev. DCN S-36997-A; Rev. 8; Rev. 19; Section 9.1.15; Appendix A, Table A-1, Note 7 and Appendix C, Table C • PL-08-0502, see Section 4.1, and Section 9.1.11 • PL-08-0503, see Section 4.3.1.3; and Section 4.3.2.2 • PL-08-0504, see Section 4.3.1.4; and Section 4.3.2.3	8-27-2008

22 (cont'd)	• PL-08-0505, see Section 9.1.7 • PL-08-0506, see Section 9.1.8 • PL-08-0507, see Section 9.1.9 • PL-08-0508, see Section 9.1.9 • PL-08-0509, see Section 9.1.9 • PL-08-0510, see Section 9.1.9 • PL-08-0511, see Section 9.1.9 • PL-08-0512, see Section 9.1.9 • PL-08-0513, see Section 9.1.9 • PL-08-0514, see Section 9.1.9 • PL-08-0515, see Section 9.1.9 • PL-08-0516, see Section 9.1.9 • PL-08-0517, see Section 9.1.12 • PL-08-0518, see Section 9.1.13 • PL-08-0519, see Section 9.1.13 • PL-08-0520, see Section 9.1.18 and Section 9.1.30 • PL-08-0521, see Section 9.1.18 and Section 9.1.30 • PL-08-0522, see Section 9.1.18 and Section 9.1.30 • PL-08-0523, see Section 9.1.18 and Section 9.1.30 • PL-08-0524, see Section 9.1.18 and Section 9.1.30 • PL-08-0525, see Section 9.1.18 and Section 9.1.30 • PL-08-0526, see Section 9.1.18 and Section 9.1.30 • PL-08-0527, see Section 9.1.18 and Section 9.1.30 • PL-08-0528, see Section 9.1.18 and Section 9.1.30 • PL-08-0529, see Section 9.1.18 and Section 9.1.30 • PL-08-0530, see Section 9.1.23 • PL-08-0531, see Section 9.1.23 • PL-08-0532, see Section 9.1.23 • PL-08-0533, see Section 9.1.23 • PL-08-0534, see Section 9.1.23 • PL-08-0535, see Section 9.1.23 • PL-08-0536, see Section 9.1.23 • PL-08-0537, see Section 9.1.23 • PL-08-0538, see Section 9.1.23 • PL-08-0539, see Section 9.1.23 • PL-08-0540, see Section 9.1.31 and Appendix A, Table A-1, Note 15 • PL-08-0541, see Section 9.2.1 Pages Revised: Coversheet, iii, iv, v, vi, viii, ix, x, 14, 16, 17, 20, 21, 22, 39, 40, 41, 60 Total Pages: 75 (includes pages i-xiii and 1-62)	

23	In accordance with PER Number 209225, an Administrative Change is made to this Design Criteria to revise the percent and range of Accumulator Tank Level in APPENDIX C, TABLE C, DEVIATION 15, PAGE 55. These values were changed by DCN W-26189-A but this Design Criteria was not listed as an affected document by this DCN. Revision 23 was also necessary to incorporate the Regulatory Guide 1.97 Consolidation Analyses as Appendix D to comply with NRC Commitment LDC0000D30. Pages Revised: Coversheet, xi, 55 Pages Added: xi, xv, 68-73 Pages renumbered: xi to xiii became xi to xv (due to added page) Total Pages: 88 (includes pages i-xv and 1-73)	10-12-2010

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1.0 SCOPE

This document establishes the requirements for instrumentation used to assess plant and environs conditions during and following an accident at Watts Bar Nuclear Plant.

1.1 Purpose

This document establishes the method of meeting several requirements derived from General Design Criteria 13, 19, and 64 of Appendix A to Title 10 Code of Federal Regulations Part 50 (10CFR50), and of Supplement 1 to NUREG-0737 "Requirements for Emergency Response Capability." In particular, it specifies WBN's approach to satisfying the intent of Regulatory Guide 1.97 (R2)1,2 as required by Supplement 1.

This document is not a governing document for all plant monitoring instrumentation. Some instrumentation may have more stringent requirements placed upon it to perform a function outside the scope of this criteria. Instrumentation with specifications less stringent than those placed on it by the requirements of this criteria must be upgraded as appropriate or have an approved exception entered in either Section 7.0 or Appendix A of this criteria. Per NEP 3.2, approval will require independent review of the exception request by both Electrical Engineering and Nuclear Engineering.

1.2 Scope of Coverage

Instrumentation used by plant operators to assess plant and environs conditions during and following an accident includes a subset of instrumentation used for normal plant operation plus instrumentation for specific accident monitoring functions. The plant parameters included in this Design Criteria are listed in Appendix A.

The Category 1 instrumentation provides essential information required by the operator to diagnose and monitor significant accident conditions.

Category 2 and Category 3 instrumentation provide additional nonessential information to the operator to diagnose and monitor significant accident conditions as well as information required to determine the magnitude of radioactive material releases and continually assess such releases.

2.0 DEFINITIONS

2.1 Type A Variables

Those variables to be monitored that provide the primary information required to permit the control room operator to identify events and take specific manually-controlled actions required by the emergency instructions for which no automatic control is provided and that are required for safety systems to accomplish their safety functions for design basis events.

2.2 Type B Variables

Those variables that provide information to monitor the process of accomplishing critical safety functions.

2.3 Type C Variables

Those variables that indicate the potential for breaching or the actual breach of barriers to fission product release (including high level radioactive release through identifiable release points; i.e., plant vents).

2.4 Type D Variables

Those variables that provide information to indicate the operation of individual safety systems and other plant systems. These variables are to help the operator make appropriate decisions in using the individual systems in mitigating the consequences of an accident.

2.5 Type E Variables

Those variables to be monitored as required for use in determining the magnitude of the release of radioactive materials and continually assessing such releases.

2.6 Immediately Accessible Information

Information that is available to an operator within human response time once the decision that the information is needed has been made.

2.7 Primary Information

Primary information is information that is essential for the direct accomplishment of the specified safety functions; it does not include those variables that are associated with contingency actions that may also be identified in written procedures.

2.8 Key Variable

A key variable is that single variable (or minimum number of variables) that provides primary information and most directly indicates the accomplishment of a safety function (in the case of Types B and C) or the operation of a safety system (in the case of Type D) or radioactive material release (in the case of Type E.).

2.9 Backup Variable

Additional variables beyond those classified as key, that provide diagnostic or confirmatory information.

2.10 Categories 1, 2, and 3

Regulatory Guide 1.97 classifies the qualification criteria for instrumentation into three categories: Category 1 for the most stringent requirements, Category 2 for less stringent requirements, and Category 3 for the remainder of instrumentation. The discussion of specific instrumentation requirements is contained in Section 3.4.

2.11 Diverse Variable

Where failure of a Category 1 channel results in information ambiguity that can lead the operator to defeat or fail to accomplish a required safety function, a second variable shall be identified to allow the operators to deduce the actual condition in the plant. The second variable, qualified identically to the first, is called a diverse variable. It is an independent channel to monitor the different variable that bears a known relationship to the multiple channels.

A diverse variable may be an additional channel of the same variable or of a different variable of a known relationship.

Diverse variables are identified in Table A-1. Additional, redundant instrumentation is discussed in Sections 3.5.1.1 and 3.5.1.5.

2.12 Critical Safety Functions

Those safety functions that are essential to prevent a direct and immediate threat to the health and safety of the public. These are the accomplishing or maintaining of:

1. Reactivity Control

2. Reactor core cooling and heat removal from primary system

3. Reactor coolant system integrity

4. Radioactivity control

5. Containment

3.0 DESIGN BASES

3.1 Functional Requirements

The function of post accident monitoring instrumentation is to provide data to assist control room operators in mitigating the consequences of design basis events.

Among the data to be provided are those plant parameters necessary to the operator to execute WBN Emergency Instructions. Specifically, the instrumentation provides information needed to:

a. Enable the operator to monitor plant conditions or take the correct manual action during the course of a Condition II, III, or IV event or during recovery from a Condition II, III, or IV event.

b. Maintain safe shutdown

Type B and C variables will also provide monitoring capability beyond Condition II, III, or IV events as addressed by the emergency instructions.

3.1.1 Variable Type Determination

Variable types are defined in Section 2. Calculations have been performed in which the definitions are used to identify the type to be assigned to specific plant parameters. The following calculations and R.G. 1.97 provide input to the Type and Category column of Table A-1.

Type	Reference
A	9.1.7
B and C	9.1.8
D	9.1.9
E	9.1.15

A variable included as a type A does not preclude it from being included as a Type B, C, D, or E or vice versa.

3.1.2 Selection of Variable Category

Description of the type determination method is given in Section 3.1.1. The definitions for key and backup variables are given in Section 2. The sections below provide selection criteria for Category 1, 2, and 3 variables and are based on guidance provided in Reference 9.1.1.

3.1.2.1 Selection Criteria for Category 1

The selection criteria for Category 1 variables are subdivided according to the variable type. Type A variables are all key variables and are used for accident diagnosis and providing information necessary for manual operator action and shall be designated as Category 1.

For Type B, those key variables which are used for monitoring the process of accomplishing or maintaining critical safety functions shall normally be designated as Category 1. For Type C, those key variables which are used for monitoring the potential for breach or actual breach of a fission product barrier shall normally be designated as Category 1. For Type D, these variables are not designated Category 1 unless required by R.G. 1.97 R2. Exceptions to the Category 1 designation of Type B and C variables shall be allowed for those Type B and C variables identified in RG 1.97 R2 as having either a Category 2 or 3 classification. The variables category assignments will be identified in Table A-1. Category 1 accident monitoring instrumentation is designed with redundant or diverse channels so that a single failure does not prevent the operator from determining the need for operator action and the response of the plant to the safety measures in operation.

3.1.2.2 Selection Criteria for Category 2

The selection criteria for Category 2 variables are subdivided according to the variable type. No Type A variables shall be identified as Category 2. For Types B and C, those variables which provide backup information for safety related functions shall be designated as Category 2. For Type D, those key variables used for monitoring the performance of safety systems shall be designated as Category 2. For Type E, those key parameters to be monitored for use in determining the magnitude of the release of radioactive materials and for continuously assessing such releases shall be designated Category 2.

3.1.2.3 Selection Criteria for Category 3

The selection criteria for Category 3 variables are subdivided according to the variable type. No Type A variables shall be identified as Category 3. For Types B, C, D and E, those variables which provide backup information shall be designated Category 3.

3.2 Design Basis Events

3.2.1 Indication of Type A variables is required for mitigation of design basis events (Condition II, III, and IV events as analyzed in Chapter 15 of the Watts Bar Nuclear Plant Final Safety Analysis Report, Reference 9.2.2) where manual action is required.

Indication of Type B and C variables provides support to control room operators in the mitigation of design basis events and events beyond the design basis. The ranges of some of the instruments monitoring Type C variables shall be selected to extend beyond the range of the parameter's expected value during design basis events.

3.3 Plant Environmental Conditions

3.3.1 The environmental conditions for normal operation and design basis event conditions are defined in Reference 9.2.1.

3.4 Specific Instrumentation Requirements

3.4.1 Category 1 Instrumentation

3.4.1.1 General Qualification Requirements

Category 1 instrumentation located in a harsh environment and required to function for the 10 CFR 50.49 events shall satisfy the requirements in WB-DC-40-54 (Ref. 9.3.5).

Category 1 instrumentation located in a mild environment shall be suitable for operation within the environmental conditions for which it is located. Refer to WB-DC-40-54 for the definition of harsh and mild environments.

Category 1 instrumentation shall be qualified in accordance with the Watts Bar Nuclear Plant Design Criteria (Reference 9.3.3 (WB-DC-40-31.2) "Seismic Qualification of Category I Fluid System Components and Electrical or Mechanical Equipment."). Qualification applies to the complete instrumentation channel from the sensor to the display where the display is a direct reading meter or recording device.

Refer to "Component Qualification Matrix," Appendix A

3.4.1.2 Single Failure Criteria

No single failure within the Category 1 instrumentation, its auxiliary support equipment, or its power sources, shall result in the loss of the information provided by the instrumentation. Refer to WB-DC-40-64 (Ref. 9.3.6).

Any single failure within the Category 1 instrumentation shall not result in the loss of the monitoring function. To provide for a single failure proof design, additional redundant channels may be provided, one or several diverse channels (see Section 2.11) may be provided, or it shall be demonstrated by analysis that the operator will take conservative action to resolve ambiguity (see Reference 9.1.11). 'Single failure' includes such events as the shorting or open circuiting of interconnecting signal or power cables. It also includes single credible malfunctions or events that cause a number of consequential component, module, or channel failures. For example, the overheating of an amplifier module is a 'single failure' even though several transistor failures result. Mechanical damage to a mode switch would be a 'single failure' although several channels might become involved.

3.4.1.3 Unique Identification in the MCR

Category 1 variable main control room (MCR) display devices shall be specifically identified on the control panels so that the operator can easily discern that they are displaying information from a Category 1 channel. The symbol C1 shall be engraved on the nameplate per design standard DS-E18.1.24. (Reference 9.3.11)

3.4.1.4 Interface to Non-Class 1E Components

Transmission of Class 1E Category 1 signals to or from components that are non-1E shall only be through an isolation device which is classified as part of a Class 1E instrumentation system. This isolation device shall be accessible to operations and maintenance personnel during the worst-case post-accident environment of the area where the isolation device is located. The function performed by these isolators is to prevent electrical faults in nonqualified circuits, which derive their signals from qualified portions of Class 1E circuits, from propagating to the Class 1E circuit.

In addition, transmission of Category 1 signals to Non-Class 1E components from components which perform automatic safety control functions (i.e., Reactor Protection System) shall only be through isolation devices which are qualified as Class 1E instruments.

3.4.1.5 Display Means

Category 1 instrumentation signals shall be displayed on an individual continuous display and immediately accessible in the main control room. Category 1 parameters which are displayed on displays that are continuously available (reactor vessel level and core exit temperature) are considered continuously displayed and therefore meets the requirements of this section.

3.4.1.6 Recording Requirements

Parameters which have safety related trends are identified in Reference 9.1.12, "Determination of R.G. 1.97 Variables Requiring Trend Indication." Reference 9.1.13 "Determination of Devices Required for Indicating Safety Related Trends for WBNP PAM" determines the hardware required to display the trends. At least one of the channels used to monitor each Category 1 analog parameter shall be recorded in an immediately accessible manner to provide a historical record. Non-1E recorders or a computer-based data acquisition and display system may be used where primary indication is provided by a qualified meter or other qualified display. Non-Class 1E recorders provided for the latter function shall be isolated from the instrument circuit as described in Section 3.4.1.4 above and qualified to Category 2 isolation requirements[2] in accordance with Section 3.4.2.

3.4.1.7 Instrument Accuracy Calculations

Where two or more instruments are needed to cover a particular range, overlapping of instrument spans and accuracies will be provided to ensure one of the two instruments will be on scale at all times.

All Category 1 or 2 instruments located in a 10CFR50.49 harsh environment shall have a demonstrated instrument accuracy calculation performed.

Category 2 instruments which receive their input signal from a Category 1 loop do not require an accuracy calculation.

Range and accuracy requirements are determined through the analysis of Condition II, III, or IV events as described in FSAR Chapter 15. The display system meets the following requirements:

a. The range of the readouts extends over the maximum expected range of the variables being measured.

b. The combined indicated accuracies are within the errors used in the safety analysis.

3.4.2 Category 2 Instrumentation

3.4.2.1 General Qualification Requirements

Category 2 instrumentation located in harsh environments and required to function for 10CFR50.49 events shall be qualified in accordance with WB-DC-40-54 (Reference 9.3.5)[2]. Seismic qualification is required per seismic Category I requirements, (see Section 3.6.2), if the instrument is part of a safety-related system. Where the channel signal is to be processed or displayed on demand, qualification applies to the complete instrumentation channel from the sensor through the isolator/input buffer. The location of the isolation device or input buffer should be such that it shall be accessible for maintenance during accident conditions. Category 2 instrumentation which does not experience harsh environmental conditions may be designed and installed according to Category 3 requirements (See Section 3.4.3).

A variable designated as Category 2 shall be designed and installed to the higher of the qualification requirements determined in this design criteria or in the respective system description.

Refer to "Qualification Matrix," Appendix A

3.4.2.2 Single Failure Criteria

The single failure criteria do not apply to Category 2 instruments.

3.4.2.3 Unique Identification in the MCR

Category 2 MCR instruments shall be specifically identified on the control panels so that the operator can easily discern that they are displaying information from a Category 2 channel. The designation C2 shall be engraved on the nameplate per design standard DS-E18.1.24 (Reference 9.3.11). Section 4.3.2.1 contains identification requirements for computer or annunciator based Category 2 displays.

3.4.2.4 Interface to Non-Class 1E Components

Category 2 instrumentation that is Class 1E for its normal system function shall be isolated from non-Class 1E circuits in accordance with Section 3.4.1.4.

Category 2 instrumentation that is non-1E shall have isolation from other non-1E circuits by means of typical industry methods (optional isolation, transformer or resistor networks, etc.). This isolation is to ensure that other non-IE circuits will not affect Category 2 instrumentation loops. An example of adequate isolation is provided by the annunciator system that uses optical isolation of all inputs coming into the system. This prevents any input failure or fault from affecting the annunciator system and other loops. Another example is the plant computer system which uses transformer and optical isolation.

3.4.2.5 Display Means

The instrumentation signal may be displayed on an individual instrument or it may be processed for display on demand by a computer based data acquisition and display system or by other appropriate means.

The display device need not be Class 1E. If a non-class 1E display device is used on a Class 1E channel, the interface requirements of Section 3.4.2.4 above shall be met.

3.4.2.6 Recording Requirements

Category 2 effluent radioactivity monitors and area radiation monitors shall be recorded. No other safety-related recording is required for Category 2.

3.4.3 Category 3 Instrumentation

3.4.3.1 General Qualification Requirements

The instrumentation shall be of high-quality commercial grade. A high quality device demonstrates superiority and excellence in attributes that are determined to be critical characteristics such as reliability, durability, long life, safety, physical construction, and design. Refer to "Qualification Matrix," Appendix A

3.4.3.2 Display Means

The instrumentation signal may be displayed on an individual instrument or it may be processed for display on demand by a computer based data acquisition and display system or by other appropriate means.

3.4.3.3 Recording Requirements

Category 3 meteorology data shall be recorded either on a recorder or on the computer. No other recording is required for Category 3.

3.4.4 Common Requirements

3.4.4.1 Human Factors

Human factors principles shall be used in determining type and location of displays. (See Reference 9.3.7, WB-DC-30-23 "Human Factors")

3.4.4.2 Direct Measurement

To the extent practical, monitoring instrumentation inputs shall be from sensors that directly measure the desired variables. An indirect measurement shall be made only when it can be shown by analysis to provide unambiguous information.

3.4.4.3 Routine Use

To the extent practical, the same instruments shall be used for accident monitoring as are used for the normal operations of the plant to enable the operators to use, during accident situations, instruments with which they are most familiar. However, where the required range of monitoring instrumentation results in a loss of instrumentation sensitivity in the normal operating range, separate instruments shall be used.

Means shall be provided for checking, with a high degree of confidence, the operational availability of each system input sensor during reactor operation.

This may be accomplished in various ways, for example:

(1) By perturbing the monitored variable; or (2) By introducing and varying, as appropriate, a substitute input to the sensor of the same nature as the measured variable; or (3) By cross checking between channels that bear a known relationship to each other and that have readouts available.

3.5 Electrical Requirements

3.5.1 Category 1

3.5.1.1 Redundancy

Normally, Category 1 circuits shall be required to have two redundant channels, post-accident monitoring channel 1 (PAM 1) and post-accident monitoring channel 2 (PAM 2). The single failure analysis (Reference 9.1.11) may require a third redundant post-accident monitoring channel 3 (PAM 3) to be used.

3.5.1.2 Signal Isolation

Transmission of Class 1E category 1 signals to components that are non-1E shall only be through isolation devices which are classified as part of the Class 1E instrumentation and meet all the requirements of the system. No credible failure at the output of an isolation device shall prevent the associated monitoring system channel from meeting the minimum performance requirements considered in the design bases. Examples of credible failure include short circuits, open circuits, grounds, and the application of the maximum credible AC or DC potential (140 V DC or 118 V AC).

3.5.1.3 Control Power

Control power for Category 1 variables shall be supplied from the station standby power sources, meaning Class 1E battery backed power. Circuits requiring 125 VDC power shall be supplied by the 125 VDC vital battery boards. Circuits requiring 120 VAC power shall be supplied by the 120 VAC vital instrument power boards.

Control power for PAM 1 circuits shall be supplied from either an A-train source, 125 VDC battery boards I or III, or 120 VAC vital instrument power boards I or III.

Control power for PAM 2 circuits shall be supplied from either a B-train source, 125 VDC battery boards II or IV, or the 120 VAC vital instrument power boards II or IV.

Control power for PAM 3 circuits shall be supplied from any of the 125 VDC battery boards I, II, III, or IV, or the 120 VAC vital instrument power boards I, II, III, or IV but shall not be from the same power supply as the PAM 1 or PAM 2 channels for that same variable.

See Table 1 "Category 1 Power Requirements."

3.5.1.4 Separation and Isolation

Redundant channels shall be electrically independent and physically separated from each other and shall meet the requirements set forth in WB-DC-30-4, "Separation/Isolation" (Reference 9.3.1). The same requirements apply to separation of PAM 3 cables from PAM 1 and PAM 2 cables.

3.5.1.5 Third Channels

Specific variables which require three channels (identified in the single failure analysis Reference 9.1.11 and designated in Table A-1) of information to be displayed in the MCR shall have the third channel cables routed and separated as described in Section 3.5.1.4. The control power supply for these channels shall be derived as described in Section 3.5.1.3 above.

3.5.2 Category 2

3.5.2.1 Redundancy

Redundant circuitry is not required.

Channel	125V DC Control Power						120 V AC Control Power			
PAM 1	TRAIN A		BATTERY BD-I		BATTERY BD-III		120V AC VITAL INSTR POWER BD-I		120V AC VITAL INSTR POWER BD-III	
PAM 2		TRAIN B		BATTERY BD-II		BATTERY BD-IV		120V AC VITAL INSTR POWER BD-II		120V AC VITAL INSTR POWER BD-IV
PAM 3			BATTERY BD-I*	BATTERY BD-II*	BATTERY BD-III*	BATTERY BD-IV*	120V AC VITAL INSTR POWER BD-I*	120V AC VITAL INSTR POWER BD-II*	120V AC VITAL INSTR POWER BD-III*	120V AC VITAL INSTR POWER BD-IV*

*Must not be the same power supply as PAM 1 or PAM 2 for that same variable.

TABLE 1

CATEGORY 1 INSTRUMENT POWER REQUIREMENTS

3.5.2.2 Control Power

If Class 1E power is required due to system functional requirements as specified in the respective system description, then the channel shall be installed in the Class 1E division selected by the designer and shall satisfy the requirements appropriate to that division. (See Reference 9.3.2) Where non-Class 1E power is used, then control power shall be derived from highly reliable (diesel or battery backed) non-divisional power sources.

3.5.2.3 Separation

Separation is not required by Regulatory Guide 1.97 for Category 2 instrumentation. However, separation may be required because of other regulatory, functional, power, or system requirements. In those cases, the most stringent requirements shall be met and separation shall be implemented according to WB-DC-30-4, "Separation/Isolation" (See Reference 9.3.1).

3.5.2.4 Additional Requirements

Some circuits have more stringent requirements placed upon them due to other design or regulatory requirements. The most stringent requirements shall apply (i.e., PAM may allow non-1E power and no QA but the normal system function requires 1E power and full QA.).

3.5.3 Category 3

3.5.3.1 Separation and Redundancy

Separation and redundant circuitry are not required for PAM. The cable routing shall be in accordance with the requirements for non-divisional circuits from Reference 9.3.1. However, separation may be required because of other regulatory, functional, power, or system requirements.

3.5.3.2 Control Power

The control power supply for these circuits may be derived from non-divisional power sources.

3.5.3.3 Additional Requirements

Some circuits may have more stringent requirements placed upon them due to other design or regulatory requirements. The most stringent requirements shall apply.

3.6 Mechanical Requirements

References 9.3.3 and 9.3.8 describe the requirements outlined in the following sections.

3.6.1 Category 1

3.6.1.1 Category I Structures

Components located in seismic Category I structures shall continue to perform the required function following a design basis seismic event.

3.6.2 Category 2

No specific requirements exist for seismic operability due to the guidance of Reference 9.1.1. However, specific system requirements may exist for seismic operability; if so, the instrumentation shall be qualified as described below or as specified in the instrument's respective system description.

3.6.2.1 Seismic Operability Required

Components required to be operable after a seismic event due to normal system requirements shall be qualified to Seismic Category I requirements (Reference 9.3.3).

3.6.2.2 Seismic Operability Not Required

Components not required to be operable after a seismic event shall be designed and mounted such that they do not have an adverse effect on safety systems during or following a design basis seismic event. This shall be accomplished through qualification to Seismic Category I (L) requirements for components located in Category I structures (Reference 9.3.8).

3.6.3 Category 3

3.6.3.1 Components shall be designed and mounted such that they do not have an adverse effect on safety systems during or following a design basis seismic event. This shall be accomplished through qualification to Seismic Category I (L) requirements for components located in a Category I structure (Reference 9.3.8).

4.0 LAYOUT AND ARRANGEMENT

4.1 General Description

Category 1 parameters shall be monitored by at least two redundant channels PAM 1 and PAM 2. **The single failure analysis calculation (WBN-OSG4-051 Reference 9.1.11) defines the variables that require a third redundant channel. [PL-08-0502]** The third redundant channel will be designated as PAM 3. Instrumentation for Category 2 and 3 variables shall consist of at least one channel, but the instrumentation may have redundant channels if they have been provided to satisfy other regulatory or design requirements.

4.2 Location

4.2.1 Category 1

All Category 1 variables shall be displayed on individual instruments located in the MCR.

4.2.2 Category 2 and 3

Category 2 and 3 variables may be displayed on individual instruments or the variables may be displayed on one of the computer-based displays.

Some Category 2 and 3 variables will not be required to be in the MCR. The types of instrumentation not required to be displayed in the MCR can be categorized as portable or post-accident sampling instrumentation. Additional instrumentation not requiring a display in the MCR is identified in Table A-1 with the entry "local indication" and meet the following guidelines:

1. The information displayed is of a non-critical or diagnostic nature.

2. The local panel display is accessible under accident conditions.

3. The information can be retrieved in a timeframe necessary to support the operator's action.

4. The parameter changes slowly such that only infrequent updates are needed.

4.2.3 Control - Display Integration

Individual display instruments shall be located with related system controls and displays. Human factors principles shall be used in the configuration of the control board layout (See Reference 9.3.7).

4.3 Identification

4.3.1 Category 1

4.3.1.1 Derived Indication

In general, PAM Category 1 components and cables shall be identified by the unique identifier and separation suffix as assigned for their normal safety function from the sensor to the indicator and shall conform to the requirements of WB-DC-30-4 "Separation/Isolation" (Reference 9.3.1).

Where a PAM indication is derived from the reactor protection system, the signal to the indicator shall be isolated from the protection instrumentation at the protection rack. The isolated cables and indicators shall be designated "J" for PAM 1 or "K" for PAM 2 and shall follow the separation criteria in WB-DC-30-4. The isolated cables and indicators of the third PAM channel PAM 3, where required, shall be separated and identified with a suffix as specified in WB-DC-30-4. Indicators shall bear the same suffix as their cables.

Where an instrument loop is designed and installed specifically for a PAM Category 1 variable and has no other safety function the components and cables shall use the separation suffix "J" for PAM 1 and "K" for PAM 2 from the sensor to the indicator and shall be purchased, designed, qualified, and installed as 1E equipment.

4.3.1.2 Unique Identification in the MCR

Category 1 display devices shall be uniquely identified in the main control room. The symbol C1 shall be engraved on the nameplate. (Reference Table 2)

4.3.1.3 Control Diagrams

Category 1 PAM instrumentation loops shall be identified on the control diagrams (47W610-series) [PL-08-0503]. The symbol P1, P2, or P3 shall be placed on the drawing adjacent to the loop indicator symbol and the symbol shall be enclosed in a small box to accent its appearance. P1, P2, and P3 shall correspond with PAM 1, PAM 2, and PAM 3 respectively. (Reference Table 2)

4.3.1.4 Components

Each Category 1 variable loop component shall be identified on the instrument tabulation drawings (47B601-series) [PL-08-0504]. The words PAM 1, PAM 2, or PAM 3 shall be placed in the remarks field for each component that is required to meet Category 1 qualification requirements. (Reference Table 2) Those components shall only include the ones required to provide indication for the post accident monitoring function including transmitters, modifiers, power supplies, isolators, and indicators. Those components not required for indication such as isolated outputs to other systems, isolated local indicators, isolated controllers, and other devices not in the indicating circuit shall not be identified as PAM. The isolator separating non-PAM devices from the PAM portion of the loop shall be identified as PAM.

Each Category 1 and 2 variable in the 50.49 program shall be identified as PAM on the "10CFR 50.49 List" similar to the instrument tabulation except that only the word "PAM" is used. It is not required to identify cables as PAM on the "10CFR 50.49 List". (Reference Table 2)

CATEGORY	PAM DEVICE	I TAB	CONTROL DIAGRAM	MCR TAG	Q LIST	50.49 EQUIP*
1	CHANNEL 1	PAM 1	[P1]	C1	**	PAM
1	CHANNEL 2	PAM 2	[P2]	C1	**	PAM
1	CHANNEL 3	PAM 3	[P3]	C1	**	PAM
2	ANY	PAM C2	--	C2	***	PAM
3	ANY	PAM C3	--	--	--	--

* Not required for the cable "10CFR 50.49 List".
** Device shall be listed on the Q-list as "Q".
*** Device shall be listed on the Q list as "Q" if it is required to be in the 10CFR 50.49 program.

IDENTIFICATION SYMBOLS FOR PAM DEVICES
TABLE 2

4.3.1.5 Cables

PAM 1, PAM 2, and PAM 3 cables shall be identified and separated according to Section 4.4.5 of Reference 9.3.1 "Separation/Isolation."

4.3.1.6 Color Coded Nameplate

Nameplates and tags on Category 1 components shall be consistent with the requirements of DS-E1.2.2 "Electrical Equipment Nameplates, Sequoyah and subsequent Nuclear Plants," with the exception of the main control room tags which shall be consistent with DS-E18.1.20 "Instrumentation and Control, Labeling of Components." (Reference 9.3.10 and 9.3.11)

Cable tags and labeling shall be consistent with standard drawing SD-E15.3.4. (Reference 9.3.9)

4.3.2 Category 2

4.3.2.1 Unique Identification in the MCR

Category 2 display devices shall be uniquely identified in the main control room with the symbol C2 engraved on the nameplate or annunciator window. Where Category 2 variables are displayed on a computer screen, they shall be uniquely identified on the screen as Category 2 parameters. A special screen may be used to display all post accident monitoring variables in one display and in such cases it is not required to additionally identify variables as PAM where they are used on other screens for normal system requirements. (Reference Table 2)

4.3.2.2 Control Diagrams

There is no requirement to identify Category 2 devices on the 47W610-series drawings. [PL-08-0503]

4.3.2.3 Components

Each Category 2 variable component shall be identified on the instrument tabulation drawings (47B601-series) [PL-08-0504]. The words PAM C2 shall be placed in the remarks field for each component that is required to meet Category 2 qualification requirements (Reference table 2). Those components shall only include the ones required to provide indication for the post accident monitoring function including transmitters, modifiers, power supplies, isolators, and indicators. Those components not required for indication such as isolated local indicators or local controllers shall not be identified. Any isolators separating non-PAM devices from the PAM portion shall be identified as PAM. (Reference Table 2)

Each Category 2 variable that has been included in the 10CFR50.49 program shall be identified as PAM on the "10CFR 50.49 List" similar to the instrument tabulation except that only the word "PAM" is used. It is not required to identify cables as "PAM" on the cable "10CFR 50.49 List" (Reference Table 2)

4.3.2.4 Cables

Cables for Category 2 PAM circuits shall follow the requirements imposed by their normal system functions. Additionally, Category 2 non-Class 1E cables that are not in the 10CFR 50.49 program shall be identified as PAM in the computerized cable routing system (CCRS) data base in accordance with Reference 9.2.10.

4.3.2.5 Color Coded Nameplate

Nameplates and tags on Category 2 components shall be consistent with the requirements of DS-E1.2.2 "Electrical Equipment Nameplates, Sequoyah and subsequent Nuclear Plants," with the exception of the main control room tags which shall be consistent with DS-E18.1.24 "Human Factors Engineering" (Reference 9.3.10 and 9.3.11).

4.3.3 Category 3

4.3.3.1 Components

Each Category 3 variable component shall be identified in the Master Equipment List (MEL) on the instrument tab of the component specification template. The words "PAM C3" shall be placed in the remarks field for each component that is required to meet Category 3 qualification requirements (Reference Table 2). Those components shall only include the ones required to provide indication for the post accident monitoring function including transmitters, modifiers, power supplies, isolators, and indicators. Those components not required for indication such as isolated local indicators or local controllers shall not be identified. Any isolators separating non-PAM devices from the PAM portion shall be identified as PAM. Components required to meet Category 1 or Category 2 requirements should not be identified as Category 3 (PAM C3) in MEL.

5.0 TESTING AND SURVEILLANCE REQUIREMENTS

5.1 General Servicing, Testing, and Surveillance Requirements

5.1.1 Programs

Servicing, testing, and calibration programs shall be specified to maintain the capability of the monitoring instrumentation. For those instruments where the required interval between testing will be less than the normal time interval between generating station shutdowns, a capability for testing during power operation shall be provided.

5.1.2 Channel Removal From Service

Whenever a means for removing channels from service is included in the design, the design shall facilitate administrative control of the access to such removal means. The system shall be designed to permit any one channel to be maintained when required during power operation. During such operation, the active parts of the system need not themselves continue to meet the single failure criterion. As such, monitoring systems comprised of two redundant channels are permitted to violate the single failure criterion during channel bypass provided that acceptable reliability of operation can be otherwise demonstrated. The bypass time interval allowed for a maintenance operation is specified in the plant technical specifications. Bypass indication is applied either administratively or automatically.

5.1.3 Administrative Control

The design shall facilitate administrative control of the access to all setpoint adjustments, module calibration adjustments, and test points. Access to all setpoint adjustments, module calibration adjustments, and test points shall be administratively controlled.

5.1.4 Minimize Anomalous Indications

The monitoring instrumentation design should minimize the development of conditions that would cause meters, annunciators, recorders, alarms, etc., to give anomalous indications potentially confusing to the operator.

5.1.5 Repair

The instrumentation shall be designed to facilitate the recognition, location, replacement, repair, or adjustment of malfunctioning components or modules.

5.1.6 Capability for Verifying Operability

Means shall be provided for verifying the operability of the monitoring system channels. Where channels exhibit a dynamic response during normal plant operation or are required frequently for normal plant operation, verification of operability is inherent in the normal functioning of the channels. For channels which monitor a normally static parameter, provisions shall be included to allow periodic testing thereby verifying channel operability. Identification of malfunctions are adequately identified by cross checking between duplicate redundant channels or cross checking between channels that bear a known relationship to each other during normal plant operation.

5.2 Surveillance Requirements Category 1 and 2 Instrumentation

Category 1 channels shall have an out of service interval specified in the plant technical specifications. Category 2 and Category 3 channels do not have such a requirement unless required by the normal system requirements.

6.0 QUALITY ASSURANCE

6.1 Category 1 Variables

A description of the Quality Assurance Program for Category 1 instrumentation is given in TVA Nuclear Quality Assurance Plan TVA-NQA-PLN89-A (Reference 9.2.5). Each Category 1 device identified as a PAM 1, PAM 2, or PAM 3 component shall be listed in the Watts Bar Q-list and be designated as "Q". (Reference Table 2)

6.2 Category 2 Variables

For Category 2 instrumentation, the need for quality assurance requirements will be limited to components located in a harsh environment. In general, quality assurance program requirements are not required to be imposed on nonsafety-related Category 2 instrumentation unless the instrumentation is part of the 10 CFR 50.49 Environmental Qualification Program (see Section 3.4.2 and Reference 9.3.5). Devices identified as PAM C2 shall be included in the Watts Bar Q-list if they have been included in the 10 CFR 50.49 program and shall be designated as "Q." Other Category 2 devices shall follow normal system requirements. (Reference Table 2)

6.3 Category 3 Variables

The instrumentation should be of high-quality commercial grade and should be selected to withstand the specified environment. See Section 3.4.3.1 for a definition of "high quality." (Reference Table 2)

7.0 EXCEPTIONS

None

8.0 ADDITIONAL REQUIREMENTS

None

9.0 REFERENCES

9.1 Design Input

9.1.1 NRC Regulatory Guide 1.97 R2 and R3, "Instrumentation for Light-Water-Cooled Nuclear Power Plants to Assess Plant and Environs Conditions During and Following an Accident."

9.1.2 Deleted

9.1.3 American Nuclear Society Report ANS-4.5-1980, "Functional Requirements for Post Accident Monitoring Capability for the Control Room Operator of a Nuclear Power Generating Station." Paragraph 6.3.6.

9.1.4 NRC Regulatory Guide, 1.89 R1, "Qualification of Class 1E Equipment for Nuclear Power Plants."

9.1.5 Deleted

9.1.6 USNRC, Supplement 1 to NUREG-0737, "Requirements for Emergency Response Capability" Generic Letter 82-33, December 1982.

9.1.7 **WBN, "PAM Type A Variables Determination," (WBN-OSG4-047). [PL-08-0505]**

9.1.8 **WBN, "Basis for R.G. 1.97 R2 Type B and C Variables Determination," (WBN-OSG4-082). [PL-08-0506]**

9.1.9 **WBN, "R.G. 1.97 Type D Variable Selection." (WBN-OSG4-112) [PL-08-0507 thru -0516]**

9.1.10 Deleted.

9.1.11 **WBN, "Single Failure Analysis for R.G. 1.97 Category 1 Variables," (WBN-OSG4-051). [PL-08-0502]**

9.1.12 **WBN, "Determination of R.G. 1.97 Variables Requiring Trend Recording," (WBN-OSG4-076). [PL-08-0517]**

9.1.13 **WBN, "Determination of Devices Required for Indicating Safety Related Trends." (WBEVAR8902002) [PL-08-0518 and -0519]**

9.1.14 **WBN, "R.G. 1.97 Cat 1 and Type A, B, C, D Required Range and Acc Determ" (WBN-OSG4-111) [PL-08-0485 thru -0489]**

9.1.15 **WBN, "Range and Accuracy Requirements and Demonstrated Range of Instrumentation Provided to Measure Regulatory Guide 1.97 Type E Variables" (WBN-APS3-048) [PL-08-0501]**

9.1.16 Deleted

9.1.17 Deleted

9.1.18 **WBN, "R.G. 1.97 Determination of Containment Isolation Valves Required Position Indication (WBN-OSG4-114) [PL-08-0520 thru -0529]**

9.1.19 10 CFR50.49 "Environmental Qualification of Electric Equipment Important To Safety For Nuclear Power Plants"

9.1.20 10 CFR 50 Appendix A, "General Design Criteria for Nuclear Power Plants", Criteria 13, 19, and 64.

9.1.21 TVA letter to NRC dated August 31, 1990, Watts Bar Nuclear Plant (WBN) Conformance to Regulatory Guide (RG) 1.97 Revision 2 (L44 900831 804).

9.1.22 TVA letter to NRC dated October 29, 1991, Watts Bar Nuclear Plant (WBN) - Emergency Response Capability, Regulatory Guide 1.97, Revision 2 - Request for addition information response (T04 911029 848).

9.1.23 **WBN "PAM Instrumentation Evaluation and Verification Methodology, Standards, and Guidelines" (WBPEVAR8809048). [PL-08-0530 thru -0539]**

9.1.24 WBN Unit 1 and 2 - Supplemental Safety Evaluation Report (SSER)-9 (RIMS Number T03 920722 912)

9.1.25 TVA letter to NRC dated May 9, 1994, "Watts Bar Nuclear Plant (WBN) Units 1 and 2 - Regulatory Guide (RG) 1.97, Revision 2, Post-Accident Monitoring System (PAM) - Supplemental Response (RIMS T04940509901)

9.1.26 TVA letter to NRC dated April 21, 1995, "Watts Bar Nuclear Plant (WBN) Units 1 and 2 - Regulatory Guide (RG) 1.97, Revision 2, Post-Accident Monitoring System (PAM) - Supplemental Response (RIMS T04950421117)

9.1.27 WBN Units 1 & 2 - Supplemental Safety Evaluation Report NUREG-0847 Supplement No. 14 and 15.

9.1.28 Licensing Request, dated October 6, 1995, for Deviation 14. (RIMS No. T24 951006 479)

9.1.29 TVA Letter to NRC dated October 12, 1995, "Watts Bar Nuclear Plant (WBN) Unit 1 & 2" - Regulatory Guide (RG) 1.97, Revision 2, Post-Accident Monitoring System (PAM) - Supplemental Response (T04 951012 228)

9.1.30 **Regulatory Guide 1.97 - Determination of Containment Isolation valves Requiring Position Indication (WBNOSG4-114) [PL-08-0520 thru -0529]**

9.1.31 **Flooding Levels in the North and South Valve Vaults (WBNAPS2001) [PL-08-0540]**

9.2 Background

9.2.1 **Watts Bar Nuclear Plant Environmental Drawings 47E235-Series. [PL-08-0541]**

9.2.2 Watts Bar Nuclear Plant Final Safety Analysis Report.

9.2.3 R.G. 1.97, Revision 2, "Type A Variables Determination" (NEB 820402 268).

9.2.4 Memorandum from J. A. Raulston to F. W. Chandler (NEB 820322 260).

9.2.5 TVA-NQA-PLN89-A, TVA Nuclear Quality Assurance Plan

9.2.6 "Single Failure Analysis for PAM Variables" (NEB 820319 251).

9.2.7 Letter from J. A. Domer to E. Adensam dated September 19, 1985 (L44 850919 806).

9.2.8 Memorandum from L. M. Mills to E. Adensam dated January 30, 1984 (27 840130 016).

9.2.9 L. M. Mills letter to E. Adensam of USNRC dated June 7, 1983.

9.2.10 **EAI-3.15, "Cable and Conduit Record Development and Issue Procedure". [PL-08-0482]**

9.3 Design Criteria and Standards

9.3.1 WB-DC-30-4, "Separation/Isolation."

9.3.2 WB-DC-30-27, "AC and DC Control Power System."

9.3.3 WB-DC-40-31.2, "Seismic Qualification of Category I Fluid System Components and Electrical or Mechanical Equipment".

9.3.4 Deleted

9.3.5 WB-DC-40-54 "Environmental Qualification to 10CFR50.49".

9.3.6 WB-DC-40-64 "Design Basis Events Design Criteria" (Appendix B), "Single Failure"

9.3.7 WBN-DC-30-23 "Human Factors"

9.3.8 WB-DC-40-31.13 "Seismic Qualification of Category I(L) Fluid System Components and Electrical or Mechanical Equipment"

9.3.9 SD-E15.3.4 "Electrical Standard Drawing, Raceways, and CA&W Identification Tags (Sequoyah Nuclear Plant and all subsequent nuclear projects)

9.3.10 DS-E1.2.2 "Electrical Equipment Nameplates, (Sequoyah and subsequent nuclear plants)."

9.3.11 DS-E18.1.24 "Human Factors Engineering"

APPENDIX A
POST ACCIDENT MONITORING INSTRUMENTATION
COMPONENT QUALIFICATION MATRIX
(See Note)

Criteria	Category 1	Category 2	Category 3
Redundancy	At least 2 channels required	Not Required	Not Required
EQ (10 CFR 50.49)	Qualify Per WB-DC-40-54, components placed in 10CFR50.49 Program	Qualify per WB-DC-40-54, components placed in 10CFR50.49 Program	Not Required
Seismic	Must function after seismic event per WB-DC-40.31.2	Not Required	Not Required
QA	Yes - See Section 6.1	Yes - See Section 6.2	Not required
Power Supply	Class-1E Per WB-DC-30-27	Non-Class 1E, diesel or battery-backed	Non-Class 1E
Physical Separation	Required per WB-DC-30-4	Not required	Not Required
Electrical Separation	Non-1E circuit interfaces shall be through qualified isolation devices. (See WB-DC-30-4)	Not required	Not Required
Indication	Hardwired indicator (RVLIS and CET use plasma display and recorder), light	Meter, indicator light, computer display, or annunciator window	Meter, indicator light, computer display, or annunciator window
Special Labeling on MCR Board	C1 engraved on MCR label or window.	C2 engraved on MCR label or window.	Not Required
Testing and Maintenance	Required	Required	Required
Isolation Device Accessibility	Required	Required for loops with isolation devices	Not required
Recording	At least 1 channel per analog variable shall be recorded.	Effluent and area radiation monitors shall be recorded. Not required for others	Recorder or computer for meteorology.
	Where primary indication is provided by qualified meter or display, non-divisional trend recorders or computer based data acquisition & display system may be used for at least 1 of the redundant loops of the variables indicated in Table A-1. Recording shall be qualified to Category 2 requirements.		Not required for others.

Note: These are only post accident monitoring requirements. Normal system requirements may impose more stringent qualification requirements on components selected for PAM use and in those cases the most stringent requirements shall be met.

APPENDIX A

POST ACCIDENT MONITORING INSTRUMENTATION REQUIREMENTS

Table A-1 provides a listing of specific design requirements which are identified in Reference 9.1.6. The table represents minimum requirements. Additional instrumentation or qualification may be provided as a result of other plant, system, or design requirements. The topics described are:

- Variable Name
- Type and Category
- Redundant Channels
- Range, Range Units
- Environmental qualification (EQ)
- Seismic Qualification (SQ)
- Quality Assurance (QA)
- Power Supply

Type and Category

The variable's type(s) and associated category are identified. Entries in this column are derived from the Type selection calculations (References 9.1.7 through 9.1.10) and R.G. 1.97 (Reference 9.1.1).

Redundancy - The number of instrument channels required to monitor the variable. For Category 1 variables, the number of channels is determined from Section 3.4.1.2 and Reference 9.1.11. Diverse indication used to supplement or replace redundant information is also identified in Reference 9.1.11 and in Note 1.

Range - The required range and engineering units of the instrumentation are developed in the Type selection calculations, the required range and accuracy calculation, (Reference 9.1.14) or are identified in Reference 9.1.1.

Qualification (EQ) and Seismic (SQ)

Environmental and Seismic Qualification requirements are derived from the assignment of variable category. The qualification requirements for each category are listed in Section 3. The environmental operating times for Category 1 and Category 2 are specified in the Category and Operating Times Calculations.

Quality Assurance (QA) - A "Yes" entry indicates that the instrumentation must be included in the WBN QA program. A "No" entry indicates that the instrumentation is not required to be included in the QA program. The determination of "Yes" or "No" is made from the variable's assigned category.

Category 2 equipment requiring environmental qualification to 10CFR50.49 shall be included in the QA program, while other Category 2 equipment need not be placed in the QA program to satisfy requirements of this Design Criteria.

Power Supply - The minimum required source of electrical power for post accident monitoring is identified as follows:

1E - Class 1E power
Non-1E - Non-Class 1E*
Batteries installed in portable instrumentation

The requirement for electrical power source is derived from the variable's category and the design criteria of Section 3.

* Instrumentation shall be powered from 1E sources if system function requires it.

Deviations

The deviations are given in Appendix C. These deviations are found in References 9.1.21, 9.1.22, 9.1.25, 9.1.26 and 9.1.28. The deviation number is given in the "Notes" column of Table A-1.

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Post Accident Monitoring Variables List
Appendix A Table A-1
WB-DC-30-7

VAR NUM	Variable Name	Type/Category	Redundant Channels	Range From	Range To	Range Units	EQ	SQ	QA	Power Supply	Notes
1	Auxiliary Feedwater Flow	A1 D2	P1 P2 2 Channels Per Loop	0	700	GPM	YES	YES	YES	1E	(See Note 1)
2	Containment Lower Compartment Atmosphere Temperature	A1 D2	P1 P2 2 Channels	0	350	Deg F	YES	YES	YES	1E	Deviation #8
3	Containment Pressure (Narrow Range)	A1 B1 C1 D2	4 Channels (See Note 14)	-2	15	PSIG	YES	YES	YES	1E	Deviation #24 Note 8
4	Containment Radiation	A1 C3 E1	P1 P2 2 Upper 2 Lower	1	1.0E7	R/hr	YES	YES	YES	1E	Deviation #36
5	Containment Sump Level (Wide Range)	A1 B1 C1 D2	P1 P2	0	200	Inches	YES	YES	YES	1E	Deviation #32
6	Core Exit Temperature	A1 B1 C1 D2	P1 P2 8 PAM 1 8 PAM 2	200	2300	Deg F	YES	YES	YES	1E	Minimum of 16 Operable Thermocouples, 4 From Each Quadrant (See Note 1,8,&10) Deviation #30 & #37

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VAR NUM	Variable Name	Type/Category	Redundant Channels	Range From	Range To	Range Units	EQ	SQ	QA	Power Supply	Notes
7	Main Steam Line Radiation	C2 E2	1 Channel Per Steam Generator	1.0E-1	1.0E3	uCi/cc	YES	NO	YES	NON-1E	(See Note 7)
8	Nuclear Instrumentation (Source Range)	A1 B1 D2	P1 P2	1.0E-1	2.0E5	CPS	YES	YES	YES	1E	Note 8
9	RCS Pressurizer Level	A1 D1	P1 P2 P3	0	100	%	YES	YES	YES	1E	Note 8 & 12
10	RCS Pressure Wide Range	A1 B1 C1 D2	P1 P2 P3	0	3000	PSIG	YES	YES	YES	1E	Note 8 & 12
11	RCS Temperature T Cold	A1 B1 C1 D2	4 Channels 1 Per Loop	50	700	Deg F	YES	YES	YES	1E	(See Note 1 & 8) Deviation #1
12	RCS Temperature T Hot	A1 D2	4 Channels 1 Per Loop	50	700	Deg F	YES	YES	YES	1E	(See Note 1 & 8) Deviation #1
13	Refueling Water Storage Tank Level	A1 D2	P1 P2	0	100	%	YES	YES	YES	1E	Note 8
14	Steam Generator Level (Narrow Range)	A1 B1	P1 P2 P3 3 Channels Per Steam Generator	0	100	%	YES	YES	YES	1E	(See Note 1, 8 & 12

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VAR NUM	Variable Name	Type/Category	Redundant Channels	Range From	Range To	Range Units	EQ	SQ	QA	Power Supply	Notes
15	Steam Generator Pressure	A1 B1 D2	P1P2 2 Channels Per SG	0	1300	PSIG	YES	YES	YES	1E	Deviation #3 Notes 1 & 8
16	Subcooling Margin Monitor	A1 B2 C1 D2	P1 P2	200	35	Deg F	YES	YES	YES	1E	200 Deg. Subcooling to 35 Deg. Superheat Notes 8 & 10
17	Auxiliary Building Passive Sump Level	B1 C1	P1 P2	12.5	72.5	Inches	YES	YES	YES	1E	Note 8
18	Containment Isolation Valve Position Indication	B1 D2	1 Per Valve	Closed	Not CLOSED	N/A	YES	YES	YES	1E	Deviation #20 Note 15
19	Containment Hydrogen Concentration	B1 C1 D2	P1 P2	0	10	%	YES	YES	YES	1E	Deviation #2
20	Control Rod Position	D3	1 Channel Per Bank	0	235	Steps	NO	NO	NO	Non-1E	Deviation #35
21	Nuclear Instrumentation (Intermediate Range)	B1 D2	P1 P2	1.0E-8	200	% Power	YES	YES	YES	1E	Note 8
22	REACTOR VESSEL LEVEL	B1 C1 D2	P1 P2	See Note 5			YES	YES	YES	1E	(See Note 5, 8, & 10)
22a	Static Mode (Pumps Not Running)			0	100	%					0% Represents Reactor Vessel Empty. 100% represents reactor vessel full.

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VAR NUM	Variable Name	Type/Category	Redundant Channels	Range From	Range To	Range Units	EQ	SQ	QA	Power Supply	Notes
22b	Dynamic Mode (Pumps Running)			20	100	%					100% Represents Reactor Vessel Full
23	Containment Pressure (Wide Range)	C1	P1 P2	-5	60	PSIG	YES	YES	YES	1E	
24	Shield Building Vent (Noble Gas Activity)	C2 E2	1 Channel	1.0E-6	1.0E4	uCi/cc	YES	NO	YES	NON-1E	
25	ABGTS High Pressure Alarm	D2	1 Channel Per Fan	NA	-0.2	In.H20	YES	NO	YES	NON-1E	
26	ACAS Pressure	D2	1 Channel Per Train	0	150	PSIG	YES	NO	YES	NON-1E	
27	AFW Valve Status	D1	1 Channel Per Valve	Open	Closed	NA	YES	YES	YES	1E	
28	Accumulator Flow Alarm Valve Status	D3	1 Channel Per Valve	Open	Closed	NA	NO	NO	NO	NON-1E	Deviation #16
29	Accumulator Tank Level	D3	1 Channel Per Tank	7450	8080	GAL	NO	NO	NO	NON-1E	Deviation #15
30	Accumulator Tank Pressure	D3	1 Channel Per Tank	0	700	PSIG	NO	NO	NO	NON-1E	Deviation #6
31	Annulus Pressure	D2	1 Channel	-10	0	In. H20		YES	NO	YES	NON-1E

32	Aux. Feed Pump Turbine Steam Supply Isolation Valve Status	D3	1 Channel Per Valve	Open	Closed	NA	NO	NO	NO	NON-1E

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VAR NUM	Variable Name	Type/Category	Redundant Channels	Range From	Range To	Range Units	EQ	SQ	QA	Power Supply	Notes
33	Battery Current (125V dc Vital)	D2	1 Channel Per Battery	-200	+600	AMPS	YES	NO	YES	N/A	
34	Bus Voltage (125V dc Vital)	D2	1 Channel Per Battery	75	150	VOLTS	YES	NO	YES	N/A	
35	Bus Voltage (480V Shutdown)	D2	1 Channel Per Train	0	600	VOLTS	YES	NO	YES	N/A	
36	Bus Voltage (6.9KV Shutdown)	D2	1 Channel Per Train	6400	7400	VOLTS	YES	NO	YES	NON-1E	Analog Scale, Digital Display
37	CCS Surge Tank Level	D3	1 Channel Per Train	0	100	%	NO	NO	NO	NON-1E	
38	Centrifugal Charging Pump Total Flow	D2	1 Channel	0	1000	GPM	YES	NO	YES	NON-1E	
39	Charging Header Flow	D3	1 Channel	0	110	GPM	NO	NO	NO	NON-1E	Deviation #17
40	Component Cooling Water To ESF Flow	D2	1 Channel Per Hx	0	5561	GPM	YES	NO	YES	NON-1E	
41	Component Cooling Water Supply Temperature	D2	1 Channel Per Train	30	150	Deg F	YES	NO	YES	NON-1E	Deviation #7
42	Condensate Storage Tank Water Level	D3	1 Channel Per Tank	0	385,000	GAL	NO	NO	NO	NON-1E	Not Primary Source of Aux. Feedwater. See Variable 27

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VAR NUM	Variable Name	Type/Category	Redundant Channels	Range From	Range To	Range Units	EQ	SQ	QA	Power Supply	Notes
43	Containment Air Return Status	D2	1 Channel Per Fan	On	Off	NA	YES	NO	YES	NON-1E	(Breaker Status)
44	Containment Cooling Valve Status	D3	1 Channel Per Valve	Open	Closed	NA	NO	NO	NO	NON-1E	
45	Containment Spray Flow	D2	1 Channel Per Train	0	4400	GPM	YES	NO	YES	NON-1E	
46	Containment Spray HX Outlet Temperature	D2	1 Channel Per HX	0	200	Deg F	YES	NO	YES	NON-1E	
47	Containment Sump Water Level (Narrow Range)	D3	1 Channel	2	66	Inches	NO	NO	NO	NON-1E	Deviation #12
48	Containment Sump Water Temperature	D2	1 Channel	50	400	Deg F	YES	NO	YES	NON-1E	Used RHR Inlet Temperature Loop
49	Diesel Generator Power	D2	1 Channel Per DG	0	4.84	MWATTS	YES	NO	YES	N/A	
50	Diesel Generator Volts	D2	1 Channel Per DG	0	6900	VOLTS	YES	NO	YES	N/A	
51	ECCS Valve Status	D2	1 Channel Per Valve	Open	Closed	NA	YES	NO	YES	NON-1E	

52	ERCW Header Flow	D2	1 Channel Per Header	0	20,000	GPM	YES	NO	YES	NON-1E

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VAR NUM	Variable Name	Type/Category	Redundant Channels	Range From	Range To	Range Units	EQ	SQ	QA	Power Supply	Notes
53	ERCW Supply Temperature	D2	1 Channel Per Header	32	200	Deg F	YES	NO	YES	NON-1E	
54	Emergency Gas Treatment Damper Position	D2	1 Channel Per Damper	Open	Closed	NA	YES	NO	YES	NON-1E	
55	Emergency Ventilation Damper Status	D2	1 Channel Per Damper	Open	Closed	NA	YES	NO	YES	NON-1E	
56	Hydrogen Recombiner Status	D3	1 Channel Per Recombiner	On	Off	NA	NO	NO	NO	NON-1E	
57	Igniter Group Status	D3	1 Channel Per Group	On	Off	NA	NO	NO	NO	NON-1E	
58	Inverter Current (120V ac Vital)	D2	1 Channel Per Inverter	0	167	AMPS	YES	NO	YES	N/A	Local Indication Note 9 & 13
59	Inverter Voltage (120V ac Vital)	D2	1 Channel	115	125	VOLTS	YES	NO	YES	N/A	Local Indication Note 9 & 13
60	Letdown Flow	D3	1 Channel	0	144	GPM	NO	NO	NO	NON-1E	Deviation #18
61	MCR Pressure	D3	1 Channel	0	0.50	In. H20		NO	NO	NO	NON-1E
62	MCR Radiation Level	D2	1 Channel	1.0E-1	1.0E4	MR/Hr	YES	NO	YES	NON-1E	

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VAR NUM	Variable Name	Type/Category	Redundant Channels	Range From	Range To	Range Units	EQ	SQ	QA	Power Supply	Notes
63	Main Feedwater Flow	D3	1 Channel Per Loop	0	4,372,720	lb/hr	No	No	No	NON-1E	
64	Normal Emergency Boration Flow	D2	1 Channel	0	150	GPM	YES	NO	YES	NON-1E	Deviation #4
65	THIS LINE INTENTIONALLY LEFT BLANK										
66	Pressurizer Heater Status (Electric Current)	D2	1 Channel Per Group	0	50.5	AMPS	YES	NO	YES	NON-1E	(See Note 3)
67	Pressurizer Pressure Relief Valve Position (PORV, Block, and Code)	D2	1 Channel Per Valve	Closed	Not Closed	N/A	YES	NO	YES	NON-1E	
68	Pressurizer Relief Tank Level	D3	1 Channel	0	100	%	NO	NO	NO	NON-1E	
69	Pressurizer Relief Tank Pressure	D3	1 Channel	0	100	PSIG	NO	NO	NO	NON-1E	
70	Pressurizer Relief Tank Temperature	D3	1 Channel	50[2]	400[2]	Deg F	NO	NO	NO	NON-1E	Deviation #11
71	RCP Seal Injection Flow	D3	1 Channel Per RCP	0	13.2	GPM	NO	NO	NO	NON-1E	
72	RCS Head Vent Valve Status	D2	1 Channel Per Valve	Closed	Not Closed	NA	YES	NO	YES	NON-1E	
73	RHR Heat Exchanger Outlet Temperature	D2	1 Channel Per HX	50	400	Deg F	YES	NO	YES	NON-1E	Deviation #9

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VAR NUM	Variable Name	Type/Category	Redundant Channels	Range From	Range To	Range Units	EQ	SQ	QA	Power Supply	Notes
74	RHR Pump Flow (RHR System Flow)	D2	1 Channel Per Pump	0	5500	GPM	YES	NO	YES	NON-1E	
75	RHR Valve Status	D3	1 Channel Per Valve	Open	Closed	NA	NO	NO	NO	NON-1E	
76	Reactor Coolant Pump Status (Motor Current)	D3	1 Channel Per Pump	0	712	AMPS	NO	NO	NO	NON-1E	
77	Safety Injection Pump Flow	D2	1 Channel Per Pump	0	715	GPM	YES	NO	YES	NON-1E	
78	Safety Injection System Valve Status	D3	1 Channel Per Valve	Open	Closed	N/A	NO	NO	NO	NON-1E	
79	Spent Fuel Pool Level Alarm	D2	1 Channel	748'11-1/2	749'2-1/2	ft,in	YES	NO	YES	NON-1E	Range Reflects Low and High Alarm Setpoints
80	Spent Fuel Pool Temperature Alarm	D2	1 Channel		127	Deg F	YES	NO	YES	NON-1E	Upper range Is Alarm Setpoint
81	Steam Generator Blowdown Isolation Valve Status	D2	1 Channel Per Valve	Closed	Not Closed	NA	YES	NO	YES	NON-1E	
82	Steam Generator Level (Wide Range)	D1	4 Channels 1 Per SG	0	100	%	YES	YES	YES	NON-1E	Deviation #10 Notes 1 & 8
83	Main Steam Flow	D2	1 Channel Per SG	0	4,500,000	lb/Hr	YES	NO	YES	NON-1E	

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VAR NUM	Variable Name	Type/Category	Redundant Channels	Range From	Range To	Range Units	EQ	SQ	QA	Power Supply	Notes
84	Tritiated Drain Collector Tank Level	D3	1 Channel Per Train	4	96	%	NO	NO	NO	NON-1E	Local Indication Deviation #25
85	Volume Control Tank Level	D3	1 Channel	0	100	%	NO	NO	NO	NON-1E	Deviation #19
86	Waste Gas Decay Tank Pressure	D3	1 Channel Per Tank	0	150	PSIG	NO	NO	NO	NON-1E	Local Indication Deviation #23
87	Radiation Exposure Meters	E3	NA	NA	NA	NA	NA	NA	NA	NA	Deviation #22
88	Airborne Radiohalogens and Particulates	E3	Portable	1.0E-9	1.0E-3	uCi/cc	NO	NO	NO	NA	Airborne I-131 and particulates
89	Plant and Environs Radiation	E3	Portable	1.0E-3[2]	1.0E4[2]	R/hr	NO	NO	NO	NA	
90	Plant and Environs Radioactivity	E3	Portable	NA	NA	NA	YES	NO	YES	NA	Multi Channel Gamma Ray Spectrometer
91	Auxiliary Building Vent (Noble Gas)	E2	1 Channel	1.0E-6	1.0E-2	uCi/cc	YES	NO	YES	NON-1E	Deviation #13
92	Auxiliary Building Vent (Flow Rate)	E2	1 Channel	0	250,800	CFM	YES	NO	YES	NON-1E	
93	Auxiliary Building Vent (Particulates and Halogens	E3	1 Channel	Note 11	Note 11	uCi/cc	NO	NO	NO	NON-1E	Sampling with Onsite Analysis Capability Deviation #14

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VAR NUM	Variable Name	Type/Category	Redundant Channels	Range From	Range To	Range Units	EQ	SQ	QA	Power Supply	Notes
94	Condenser Vacuum Pump Exhaust Vent (Flow Rate)	E2	1 Channel	0	45	SCFM	YES	NO	YES	NON-1E	
95	Condenser Vacuum Pump Exhaust Vent (Noble Gas)	C3 E2	1 Channel	4.0E-7	2.4E3	uCi/cc	YES	NO	YES	NON-1E	Deviation #33
96	ERCW Radiation Monitors	E2	1 Channel Per Discharge Point	3.3E-4	1.65E-2	uCi/cc	YES	NO	YES	NON-1E	
97	POST ACCIDENT SAMPLE SYSTEM	E3	1 System	See below			NO	NO	NO	NON-1E	Sampling with Onsite Analysis Capability
97a	Reactor Coolant Chloride Concentration	E3	NA	1	20	ppm					Deviation #29
97b	Reactor Coolant Dissolved Hydrogen	E3	NA	10	2000	cc/kg (STP)					Deviation #21
97c	Reactor Coolant Dissolved Oxygen	E3	NA	1	20	ppm					Deviation #34
97d	Reactor Coolant Total Dissolved Gas	E3	NA	100	2000	cc/kg (STP)					Deviation #34
97e	Reactor Coolant Boron	E3	NA	50	6000	ppm					Deviation #26

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VAR NUM	Variable Name	Type/Category	Redundant Channels	Range From	Range To	Range Units	EQ	SQ	QA	Power Supply	Notes
97f	Reactor Coolant PH	E3	NA	1	13	pH					
97g	Reactor Coolant Sample Activity	C3 E3	NA	10uCi/ml	10Ci/ml	Ci/ml					Deviation #5
97h	Reactor Coolant Gamma Spectrum	E3	NA	NA	NA	NA					Isotopic Analysis
98	CONTAINMENT AIR										
98a	Containment Air Hydrogen	E3	NA	0	10	% by Volume	NO	NO	NO	NON-1E	Also Measured by Hydrogen Analyzer Deviation #2
98b	Oxygen Content		NA	NA	NA	NA	NA	NA	NA	NA	Deviation #27
98c	Gamma Spectrum Sample	E3	NA	NA	NA	NA	NO	NO	NO	NA	Isotopic Analysis
99	Shield Building Vent Flow	E2	1 Channel Per Unit	0	28,000	CFM	YES	NO	YES	NON-1E	
100	Shield Building Vent Monitor (Particulate And Iodine)	E3	1 Channel Per Unit	1.0E-3	1.0E-2	uCi/cc	NO	NO	NO	NON-1E	Sampling with Onsite Analysis Capability
101	Steam Generator Discharge Vent (Flow Rate and Noble Gas)	E2	1 Channel Per Release Point	Note 4	Note 4	Note 4	YES	NO	YES	NON-1E	

Regulatory Guide 1.97
Post Accident Monitoring Variables List
Appendix A Table A-1
WB-DC-30-7

VAR NUM	Variable Name	Type/Category	Redundant Channels	Range From	Range To	Range Units	EQ	SQ	QA	Power Supply	Notes
102	METEROROLOGY										
102a	Vertical Temperature Difference	E3	1 Channel	-9	+18	Deg F	NO	NO	NO	NON-1E	
102b	Wind Direction	E3	1 Channel	0	360	Deg	NO	NO	NO	NON-1E	
102c	Wind Speed	E3	1 Channel	0	50	MPH	NO	NO	NO	NON-1E	Deviation #28
103	Radiation Exposure Rate	E3	Portable	1.0E-3	1.0E4	R/Hr	NO	NO	NO	NA	Deviation #31

APPENDIX A
POST ACCIDENT MONITORING VARIABLES LIST
TABLE A-1

Notes:

1. The following parameters are identified as diverse in Reference 9.1.11.

Parameter	Diverse Parameter
T (Hot)	Core Exit Temperature
Core Exit Temperature	T (Hot)
T (Cold)	SG Pressure
Auxiliary Feedwater Flow	SG NR/WR Level

2. Deleted

3. Pressurizer Heater Status required only for safety-related heater banks (backup heater 1A-A and 1B-B). Range is given in amps per element.

4. Recorder shall be provided for duration of release from all discharge points.

Noble Gas Activity	(See Main Steam Line Radiation, Var No. 7)
Steam Flow Rate	0 to 4945200 lb/hr PORV and Safety Valves
	0 to 63375 lb/hr To Aux. Feedwater Pump Turbine

5. Vessel level on the plasma display is the compensated actual vessel level derived from a microprocessor algorithm using the upper range, lower range, dynamic range differential pressure, wide range temperature, and wide range pressure.

6. Deleted.

7. Also monitors steam generator discharge vent noble gas activity. Required range of sensitivity specified is met by indication displaying in units of dose rate. **Conversion to required range is performed using conversion factor specified in Calc. WBNAPS3-048. [PL-08-0501]**

8. At least one of the redundant loops is trended on a non-divisional trend recorder qualified to meet Category 2 requirements.

9. Justification for local indication is found in Reference 9.1.22.

10. The Core Exit T/C Temperature (hottest), reactor vessel level, and Saturation Margin are trended on redundant Class 1E plasma displays (the last 30 minutes trending only) in the Main Control Room.

APPENDIX A
POST ACCIDENT MONITORING VARIABLES LIST
TABLE A-1

Notes:

11. The ranges for particulates and halogens: $5x10^{-10}$ to 10^{-5}uCi/cc for particulates, 10^{-9} to 10^{-4}uCi/cc for halogens (iodine).

12. The requirements for Category I variables which require a third independent channel to resolve ambiguity resulting when redundant displays disagree are being implemented at WBN as follows:

    The loop instrumentation for each channel is assigned to a redundant protection set (I, II, III, and IV) and electrical independence is maintained from sensor to display. Physical separation is maintained from the sensor to the isolator in the Auxiliary Instrument Room. From the isolator to the indicator in the Main Control Room, third channel (PAM 3) cables may be routed with either PAM 1 or PAM 2 cables (but not both) depending on its associated protection set.

13. The 120V AC Vital Inverter has a trouble alarm in the MCR which notifies of trouble on the bus.

14. Four channels are provided for this variable. Two channels are designated as PAM 1, and two channels are designated as PAM 2. Reference 9.1.11 evaluated three channels for this variable and determined that three channels are adequate for eliminating ambiguous readings.

15. In accordance with Technical Specification Bases B 3.3.3, PAM position indication is not required for containment isolation valves when the valves are closed and power removed. **MSIV bypass valves (Main Steam warming valves, 1-FCV-147, -148, -149, and -150) are normally closed during power operation (modes 1 and 2) with power removed. Consequently, position indication is not required for the valves in this configuration. The valves are powered and open during modes 3 and 4. Thus, position indication is required in this operational configuration. However, valves 1-FCV-147, -150, [PL-08-0483]** and associated position indication instrumentation are subject to flooding subsequent to a feedwater line break. **As evaluated in Reference 9.1.31 (WBNAPS2001, Rev. 4), the valves will close prior to flooding [PL-08-0540].** Flooding will result in power being removed from the valves and instrumentation. Consequently, valve position indication is only required for these valves prior to loss of power due to flooding.

APPENDIX B
TABLE B-1
POST ACCIDENT MONITORING VARIABLES UTILIZING THE
PLANT COMPUTER SYSTEM FOR MCR INDICATION

VAR NUM	VARIABLE NAME	TYPE/ CATEGORY	PRIMARY ELEMENT	COMPUTER ADDRESS
46	CONTAINMENT SPRAY HX OUTLET TEMPERATURE	D2	1-TE-72-31 1-TE-72-6	T0168A T0169A
47	CONTAINMENT SUMP WATER LEVEL (NARROW RANGE)	D3	1-LT-77-125	L0471A
53	ERCW SUPPLY TEMPERATURE	D2	1-TE-67-455 1-TE-67-456 2-TE-67-455 2-TE-67-456	T2612A T2613A T2614A T2615A
61	MCR PRESSURE	D3	0-PDT-31-1D	P4002A
66	PRESSURIZER HEATER STATUS	D2	1-EM-68-341A 1-EM-68-341D	E4003A E4004A
92	AUXILIARY BUILDING VENT (FLOW RATE)	E2	0-EM-90-300C	F2704A
94	CONDENSER VACUUM PUMP EXHAUST VENT (FLOW RATE)	E2	1-FT-2-256	F2700A
95	CONDENSER VACUUM PUMP EXHAUST VENT (NOBLE GAS)	C3 E2	1-RE-90-404A, 1-RE-90-404B	R9061A R9062A
101	STEAM GENERATOR DISCHARGE VENT FLOW RATE	E2	1-XE-1-300 A-F, 1-ZE-1-5 1-PT-1-5-G	F9051A
			1-XE-1-301 A-F, 1-ZE-1-12 1-PT-1-12-F	F9052A
			1-XE-1-302 A-F, 1-ZE-1-23 1-PT-1-23-F	F9053A
			1-XE-1-303 A-F, 1-ZE-1-30 1-PT-1-30-G	F9054A
			1-FT-1-17	F9050A
			1-FCV-1-15	FD9300
4	Containment Radiation	A1 C3 E1	1-RE-90-271 1-RE-90-272 1-RE-90-273 1-RE-90-274	R9018A R9019A R9020A R9021A
96	ERCW RADIATION MONITORS	E2	0-RE-90-133A 0-RE-90-134A 0-RE-90-140 0-RE-90-141	R1032A R1033A R1035A R1036A

[PL-08-0484]

SOURCE NOTES

SOURCE NOTE NUMBER	SOURCE NOTE TRACKING NUMBER/DOCUMENT	APPLICABLE SECTION
1	Letter to the NRC dated August 31, 1990 (L44 900831 804)	1.1
2	Letter to the NRC dated October 29, 1991 (T04 911029 848)	1.1, 3.4.1.6, 3.4.2.1, and App. A, Table A-1 (Pages 40 & 42)
3	CATD 22911-WBN-01	Various, not specifically noted in text

APPENDIX C

TABLE C

REG GUIDE 1.97 R2 DEVIATION AND
JUSTIFICATION FOR DEVIATIONS

DEVIATION 1

VARIABLES (11 AND 12)

Reactor Coolant System (RCS) Cold- and Hot-Leg Water Temperatures

DEVIATION FROM REGULATORY GUIDE (RG) 1.97 GUIDANCE

The range recommended in RG 1.97, Revision 2, is 50 to 750 F; the recommendation for Watts Bar Nuclear Plant (WBN) is 50 to 700 F.

JUSTIFICATION

The Reactor Coolant System Description N3-68-4001 states that the design temperature of the RCS is 650 F. The RG 1.97, Revision 2 recommended range is 50-750 F. However, NRC has revised its position on this range and RG 1.97, Revision 3, now recommends a range of 50-700 F will provide a 50 F margin over the design limit for both temperatures, which should provide the operator with adequate information for all transients. NRC concurs with WBN that an upper limit of 700 F is acceptable. (Reference: NRC letter from Youngblood to White dated July 24, 1986.)

DEVIATION FROM RG 1.97 GUIDANCE

RG 1.97, Revision 2, recommends that the RCS hot-leg water temperature (Variable 12) parameter be a B1 variable. WBN recommends that this be an A1 and D2 variable.

JUSTIFICATION

Type B variables provide information to indicate whether plant safety functions are being accomplished. WBN's position is that RCS pressure (Type A1, B1, C1 and D2), core exit temperature (Type A1, B1, C1, and D2), reactor vessel level (Type B1, C1, and D2), and subcooling margin (A1, B2, C1, and D2) are sufficient to monitor for adequate core cooling and the approach to superheat conditions in order to determine the margin by which the core cooling safety function is being accomplished. Therefore, it is WBN's position the RCS hot-leg water temperature be required only as a Type A1 and D2 variable.

DEVIATION 2

VARIABLE (19)

Containment Hydrogen Concentration

APPENDIX C

TABLE C
REG GUIDE 1.97 R2 DEVIATION AND
JUSTIFICATION FOR DEVIATIONS

DEVIATION FROM RG 1.97 GUIDANCE

The range recommended in RG 1.97, Revision 2, is 0 to 30 percent, whereas WBN has provided instrumentation for this variable with a range of 0 to 10 percent.

JUSTIFICATION

WBN has performed an analysis that shows the worst-case hydrogen concentration will be less than 4 percent post-loss-of-coolant (LOCA) with one of the hydrogen recombiners operating. Also, the hydrogen igniter system handles degraded core hydrogen releases as specified in 10 CFR 50.44 and will also keep the hydrogen concentration below 10 percent for these events. Therefore, the instrumentation will always be on scale. The hydrogen recombiner status is indicated by a PAM D3 variable.

DEVIATION 3

VARIABLE (15)

Steam Generator (SG) Pressure

DEVIATION FROM RG 1.97 GUIDANCE

The range recommended in RG 1.97, Revision 2, is 0 psig to 20 percent above the lowest safety valve setting (corresponding to 1422 psig at WBN); the recommended range for WBN is 0-1300 psig.

JUSTIFICATION

The design pressure for the main steam system at WBN is 1185 psig. The main steam safety valves are designed to maintain system pressure less than 110 percent of design pressure, which is 1303.5 psig. RG 1.97, Revision 2, recommends a range of 0 psig to 20 percent above the lowest safety valve set pressure, which corresponds to a range of 0 to 1422 psig. The highest main steam safety valve set pressure is 1224 psig and the accumulation pressure for each of the highest pressure safety valves is 1284 psig. Therefore, since the accumulation pressure is below 1300 psig and the 110 percent design pressure of approximately 1300 psig, the WBN recommended range of 0-1300 psig is adequate to cover the design range. The RG 1.97, Revision 2 range is well above the design requirements for the system and the ASME Code requirements for relief valves. Thus it is concluded that the WBN SG pressure range provides adequate feedback to the operator on SG pressure response to accidents or transients, and should be acceptable.

DEVIATION 4

VARIABLE (64)
Normal/Emergency Boration Flow (Boric Acid Charging Flow)

Title: POST ACCIDENT MONITORING INSTRUMENTATION	WB-DC-30-7

DEVIATION FROM RG 1.97 GUIDANCE

WBN recommends that this variable not be environmentally qualified (as required for RG 1.97, Revision 2, Category 2 variables) since other variables perform the required emergency boration monitoring function.

APPENDIX C

TABLE C
REG GUIDE 1.97 R2 DEVIATION AND
JUSTIFICATION FOR DEVIATIONS

JUSTIFICATION

The flow path monitored by this variable is a normally isolated path that requires operator action to utilize. This path is used for manual boration of the RCS. This path is not required for mitigation of any event. Postaccident reactivity control is accomplished by the Emergency Core Cooling System (ECCS) injecting borated water from the refueling water storage tank (RWST) into the RCS. Manual boration is not utilized. The ECCS flow is monitored by the centrifugal charging pump total flow (high pressure injection flow), the safety injection (SI) pump flow (low pressure injection flow), and the residual heat removal (RHR) pump flow (RHR System flow)/ These three variables are in the environmental qualification program and meet the 110 percent design flow measurement requirement.

DEVIATION 5

VARIABLE 97g

Radiation Level in Circulating Primary Coolant (Reactor Coolant Sample Activity).

DEVIATION FROM RG 1.97 GUIDANCE

This variable has been identified in RG 1.97, Revision 2, as Type C, Category 1, whereas WBN has identified this variable as Type C, Category 3.

JUSTIFICATION

For the fuel cladding integrity safety function, RG 1.97 recommends core exit temperature and RCS activity as key variables and gamma spectrum analysis of the reactor coolant as a Category 3 variable. Core-exit temperature provides primary indication of a significant breach or potential breach of fuel throughout the emergency instructions (EIs), functional restoration guidelines (FRGs), and Final Safety Analysis Report (FSAR). Therefore, this variable was included as the Category 1 or key indication. Radiation level in circulating primary coolant was considered; however, it indicates conditions following fuel damage and provides less timely information. Thus, this variable is considered to be less useful to the operators and was included as a backup variable. TVA meets the intent of the RG 1.97 recommended range by monitoring this variable using the gross activity analysis of primary coolant samples taken in the post accident sampling facility.

DEVIATION 6

VARIABLE (30)

Safety Injection (Cold-Leg) Accumulator Tank Pressure

DEVIATION FROM RG 1.97 GUIDANCE

RG 1.97, Revision 2, recommends that the pressure instruments meet the D2 criteria with a range of 0 to 750 psig. WBN recommends retaining this variable as D3, with a range of 0 to 700 psig.

APPENDIX C

TABLE C

REG GUIDE 1.97 R2 DEVIATION AND
JUSTIFICATION FOR DEVIATIONS

JUSTIFICATION

The primary function of these instruments is to monitor the preaccident status of the accumulators to ensure the passive safety function of the system. By design they do not perform any safety function postaccident. Other seismically and environmentally qualified instruments such as RCS pressure can be monitored to determine if a cold-leg accumulator injection has occurred.

The design pressure of the cold-leg accumulator tanks is 700 psig. The precautions, limitations, and setpoints (PLS) limit the nitrogen cover gas to a maximum pressure of 632 psig. Therefore, WBN's position is that monitoring of the tanks to pressures higher than the relief setpoints is not needed. WBN considers the existing range of 0 to 700 psig to the acceptable.

DEVIATION 7

VARIABLE (41)

Component Cooling Water (CCW) Temperature to Engineered Safety Features (ESF) Equipment

DEVIATION FROM RG 1.97 GUIDANCE

The range recommended in Rg 1.97, Revision 2, is 32 to 200 F; the recommendation for WBN is 30 to 150 F.

JUSTIFICATION

WBN analysis has determined that the highest expected CCW temperature (post-LOCA safety injection) is 120 F.

An upward trend of the CCW temperature above 120 F could be readily detected and would be expected to be slow moving. Thus, there would be sufficient time well within the 150 F upper range to alert the operator to the condition and the need to check other PAM-related variables for potential manual actions.

DEVIATION 8

VARIABLE (2)

Containment Atmosphere Temperature (Containment Lower Compartment Atmosphere Temperature)

DEVIATION FROM RG 1.97 GUIDANCE

The range for this variable is recommended to be 40 to 400 F in accordance with RG 1.97, Revision 2. WBN recommends the range to be 0 to 350 F.

APPENDIX C

TABLE C
REG GUIDE 1.97 R2 DEVIATION AND
JUSTIFICATION FOR DEVIATIONS

JUSTIFICATION

WBN is an ice condenser plant and, therefore, has a lower containment temperature post-accident than dry containments. The maximum temperature expected post-LOCA at WBN is 250 F as compared to 275 to 290 F for dry containments. The maximum temperature expected at WBN after a steam line break is 327 F as compared to 380 to 450 F for dry containments. The minimum expected containment atmospheric temperature will be 60 F. This minimum temperature is due to the minimum allowable RWST water temperature which could be sprayed into containment by inadvertent operation of the containment spray. Therefore, it is WBN's position that a range of 0 to 350 F is adequate.

DEVIATION 9

VARIABLE (73)

Residual Heat Removal (RHR) Heat Exchanger Outlet Temperature

DEVIATION FROM RG 1.97 GUIDANCE

The range recommended in RG 1.97, Revision 2, is 32 to 350 F; the recommendation for WBN is 50 to 400 F.

JUSTIFICATION

NRC letter from Youngblood to White dated July 24, 1986, states that RG 1.97, Revision 3, increased the minimum required range of this variable to 40 F and that WBN's range of 50 to 400 F was acceptable due to the minor deviation.

DEVIATION 10

VARIABLE (82)

SG Level Wide Range

DEVIATION FROM RG 1.97 GUIDANCE

RG 1.97, Revision 2, recommends this variable as a Type D, Category 1 variable, which requires redundancy in the instrumentation. WBN recommends this variable be Category 1, Type D, but utilizing only one wide range transmitter per SG.

JUSTIFICATION

SG wide range level indication is utilized as a diverse variable to auxiliary feedwater (AFW) flow for gross indication of flow to the SGs. The WBN AFW monitors are Types A1 and D2. WBN's position is that since SG wide range level is only used as a backup to redundant AFW flow monitors, it does not require redundancy.

APPENDIX C

TABLE C
REG GUIDE 1.97 R2 DEVIATION AND
JUSTIFICATION FOR DEVIATIONS

DEVIATION 11

VARIABLE (70)

Quench Tank (Pressurizer Reflief Tank [PRT]) Temperature

DEVIATION FROM RG 1.97 GUIDANCE

The range for this variable is recommended to be 50 to 750 F in accordance with RG 1.97, Revision 2. WBN recommends the range to be 50 to 400 F.

JUSTIFICATION

The purpose of this variable is to monitor operation. The PRT rupture disk is designed to operate between 86-100 psig. Assuming that the rupture disk operates at 100 psig and the pressurizer is at 2500 psig at saturated conditions, the maximum temperature during discharge when all valves in the line are open could be approximately 350 F. High temperature due to discharges or leakage into the tank form the pressurizer or other sources would produce an early upward trend in PRT temperature above normal. Temperatures far below the RG 1.97 recommended temperature of 750 F or the 400 F WBN recommended temperature would be sufficient to alert the operator to an abnormal condition and the potential need to check related PAM variables. Therefore, the recommended range of 50 to 400 F is sufficient to permit the operator to monitor plant operation.

DEVIATION 12

VARIABLE (47)

Containment Sump Water Level (Narrow Range)

DEVIATION FROM RG 1.97 GUIDANCE

RG 1.97, revision 2, recommends this variable as Types B and C, Category 2. WBN recommends this variable as Type D, Category 3.

JUSTIFICATION
The operator does not monitor this variable to perform any required safety function. In addition Chapter 15 of the FSAR takes no credit for monitoring this variable for any design bases event. This variable is used primarily to monitor RCS leakage. This variable, along with the lower containment atmosphere particulate radioactivity monitoring systems are used to detect RCS leakage. These small leakages do not cause plant perturbations or detect RCS leakage. These small leakages do not cause plant perturbations or transients that would cause a reactor trip or SI signal to be generated. Therefore, the operator does not enter the emergency procedures to detect or mitigate these leakages and corrective actions based on the emergency procedures and the use of PAM equipment are inappropriate. However, for the purpose of monitoring gross leakage, this variable will be designated as a Type D3 variable.

The containment sump water level (wide range) is a Type A1, B1, C1, and D2 variable and is used at WBN to monitor the containment water level for the mitigation of accidents.

APPENDIX C

TABLE C

REG GUIDE 1.97 R2 DEVIATION AND
JUSTIFICATION FOR DEVIATIONS

DEVIATION 13

VARIABLE (91)

Auxiliary Building Exhaust Vent Radiation Level - Noble Gas Release

DEVIATION FROM RG 1.97 GUIDANCE

The range recommended in RG 1.97, Revision 2, is 10^{-6} to 10^{3} microcuries/cubic centimeter (cc); the recommendation for WBN is 10^{-6} to 10^{-2} microcuries/cc.

JUSTIFICATION

The Auxiliary Building vent monitor is provided to continuously monitor the airborne radioactivity released through the Auxiliary Building exhaust vent. An accident causing Auxiliary Building radiation level to be high will cause all ventilation paths exhausting into the Auxiliary Building vent duct to automatically close and the Auxiliary Building gas treatment system to be activated. Because the isolation function occurs before accident-range activity is reached, a normal-range monitor only is employed to monitor activity in the Auxiliary Building exhaust vent. Therefore, the recommended range of 10^{-6} to 10^{-2} microcuries/cc is adequate for detecting and measuring noble gas concentrations.

DEVIATION 14

VARIABLE (93)

Auxiliary Building Exhaust Vent Radiation Level - Particulates and Halogens

DEVIATION FROM RG 1.97 GUIDANCE

The range recommended in RG 1.97, Revision 2, is 10^{-3} to 10^{2} microcuries/cc; the recommendation for WBN is $5x10^{-10}$ to 10^{-5} for particulates and 10^{-9} to 10^{-4} microcuries/cc for halogens (iodine).

JUSTIFICATION

The Auxiliary Building Exhaust Vent monitor is provided to continuously monitor the radioiodine and particulate radioactivity released through the Auxiliary Building vent. A Design Basis Fuel Handling Accident in the Auxiliary Building or a Design Basis LOCA in the Reactor Building will cause all ventilation paths exhausting into the Auxiliary Building vent duct to automatically close and the Auxiliary Building Gas Treatment system to be activated. Because the isolation function occurs before accident range activity is reached, a normal range monitor only is employed to monitor activity in the Auxiliary Building vent. Therefore, the recommended range of $5x10^{-10}$ to 10^{-5} microcuries/cc for particulates and 10^{-9} to 10^{-4} microcuries/cc for halogens is adequate for detecting and measuring normal operation particulate and radioiodine concentrations. Laboratory analysis of collected samples allows measurement over a wide range.

APPENDIX C

TABLE C
REG GUIDE 1.97 R2 DEVIATION AND
JUSTIFICATION FOR DEVIATIONS

DEVIATION 15

VARIABLE (29)

Safety Injection (Cold-Leg) Accumulator Tank Level

DEVIATION FROM RG 1.97 GUIDANCE

The range recommended in RG 1.97, Revision 2, is 10 to 90 percent volume using a D2 variable. WBN recommends a range of 73 to 80 percent volume, using a D3 variable.

JUSTIFICATION

The present accumulator tank level indication range of 7450 to 8080 gallons corresponds to 73 to 79 percent of volume.

Postaccident level does not serve any safety function since the passive injection of the cold-leg accumulators (CLA) into the RCS would be observed through other qualified instrumentation such as RCS pressure. Hence, level instrumentation which meets the requirements of a D3 variable is appropriate.

DEVIATION 16

VARIABLE (28)

Cold-Leg Accumulator Isolation Valve Position Indication

DEVIATION FROM RG 1.97 GUIDANCE

RG 1.97, Revision 2, recommends that the position indication of the CLA isolation valve be qualified to D2 requirements. WBN recommends designating this variable as D3.

JUSTIFICATION

The CLA isolation valves do not need to change from their normally open position in the event of an accident which requires CLA injection. These valves will already have been opened during startup soon after the RCS pressure sufficiently exceeds the CLA normal operating pressure. Then the associated motive power will be removed.

There is no accident event in which instantaneous emptying of all four CLAs could cause inadequate core cooling or cold overpressurization of the RCS. The steamline break is the only Condition IV event other than a LOCA that causes a rapid depressurization of the RCS. However, even for that accident the RCS depressurizes rapidly down to 900 psi where the pressure stabilizes or rises. Further depressurizations are at a much more controlled rate, giving the operator time to react.

For a Condition III event, such as a 4- or 6-inch break (small break LOCA), the depressurization of the RCS may cause emptying of the CLA. Even under such cases, emptying the CLAs will not cause inadequate core cooling or cold overpressurization of the RCS.

APPENDIX C
TABLE C

REG GUIDE 1.97 R2 DEVIATION AND
JUSTIFICATION FOR DEVIATIONS

Furthermore, closing the CLA isolation valves is not a safety function for accident mitigation that necessitates environmentally qualified valve position indication. Hence, there is no need to environmentally qualify these valves.

WBN recommends designating the position indication of the CLA isolation valve as a D3 variable.

DEVIATION 17

VARIABLE (39)

Chemical and Volume Control System (CVCS) Makeup Flow-In (Charging Header Flow)

DEVIATION FROM RG 1.97 GUIDANCE

The RG 1.97, Revision 2, recommends that the design flow should be monitored using a D2 variable. WBN recommends designating this variable as D3.

JUSTIFICATION
This variable is used to monitor operation. The charging flow is isolated on a SI signal. While certain events may produce a harsh environment for the flow instruments, makeup flow is not required to mitigate these events. Thus, the installed instrumentation qualified to D3 requirements is appropriate for the intended monitoring function at WBN.

DEVIATION 18

VARIABLE (60)
CVCS Letdown Flow-Out (Let Down Flow)

DEVIATION FROM RG 1.97 GUIDANCE
RG 1.97, Revision 2, recommends 0 to 110 percent design flow monitoring using D2 variables to monitor flow. TVA recommends this variable as D3.

JUSTIFICATION
This variable is used to monitor normal operation. The letdown flow isolation valves close on a SI signal, low pressurizer level, or Phase A isolation signal. While certain events may produce a harsh environment for the flow instruments, letdown flow is not required to mitigate these events. Thus, the installed instrumentation qualified to D3 requirements is appropriate for the intended monitoring function at WBN.

DEVIATION 19

VARIABLE (85)
Volume Control Tank (VCT) Level

DEVIATION FROM RG 1.97 GUIDANCE
The RG 1.97, Revision 2, recommends that the VCT level be monitored from top to bottom with a D2 variable. TVA recommends using a D3 variable and a range slightly less than top to bottom.

APPENDIX C

TABLE C

REG GUIDE 1.97 R2 DEVIATION AND
JUSTIFICATION FOR DEVIATIONS

JUSTIFICATION

The VCT is isolated on a SI signal. While certain events may produce a harsh environment for the level instruments, the VCT itself is not required to mitigate the events. Hence the D3 type and category variable is appropriate for its performance requirements.

The present VCT indication reads from 0 to 100 percent over a range of 70 inches which is entirely within the approximately 80-inch cylindrical portion of the tank. Extending the range to include the top and bottom hemispherical portions of the tank would result in nonlinear readings at the extreme ends of the scale. Including the hemisphere and the remaining 10 inches of the vertical cylinder would not add significantly to monitoring capability.

DEVIATION 20

VARIABLE 18

Containment Isolation Valve (CIV) Position

DEVIATION FROM RG 1.97 GUIDANCE

RG 1.97, Revision 2, recommends that the CIV position indication should meet the requirements of a B1 variable (which encompasses position indication for the duration of the event). WBN's reactor coolant system (RCS) letdown CIVs flow control valves (FCV)-62-72, -73, -74, and -76 will be submerged postaccident inside containment. These valves' limit switches are not qualified for operation during post submergence.

In addition, safety relief valves which are also designated as CIVs are not monitored for position.

JUSTIFICATION

The RCS letdown CIVs close on an SI signal, Phase A signal, or a low pressurizer level signal. The valves and associated position indication limit switches are qualified to perform their intended safety functions prior to being submerged. The limit switch for the valve position indication is located on the valve and hence subject to submergence. The limit switch is not qualifiable for submergence. The limit switch performs its intended safety function well before submergence. Valve positions are indicated both in the Main Control Room and the Technical Support Center.

Once the limit switches are flooded, it must be assumed that the control circuit fuses will be blown and position indication will be lost. This indication circuit, however, is isolated from the other CIV indication circuits.

The solenoids for these valves are included in WBN's environmental qualification (EQ) program and will vent to automatically close the FCVs as required under accident conditions. An analysis in WBN's EQ binder demonstrates that once closed, a submergence failure of the solenoid will not cause the FCV to change position. Hence the valves are considered closed and no further indication is required.

APPENDIX C

TABLE C

REG GUIDE 1.97 R2 DEVIATION AND
JUSTIFICATION FOR DEVIATIONS

For safety relief valves, position indication is not necessary since these valves are constantly in their containment isolation position (i.e., closed). Verification that these valves have accomplished their containment isolation function is not necessary since they do not change position to provide this function.

DEVIATION 21

VARIABLE (97B)

Reactor Coolant Dissolved Hydrogen

DEVIATION FROM RG 1.97 GUIDANCE

The RG 1.97, Revision 2 (refer to Table 2, Type E variables), recommends that primary coolant grab sample capability exists for hydrogen analysis.

JUSTIFICATION

The WBN postaccident sampling facility (PASF) will have two independent methods for measuring dissolved hydrogen in the RCS. It will have the capability to measure dissolved hydrogen in the range from 10-2000 cc/kg with an inline ion chromatograph. In addition, it will have a total dissolved gas analyzer to measure the total dissolved gas in the pressurized coolant in the range from 100-2000 cc/kg. Dissolved oxygen will be separately measured with a dissolved oxygen analyzer. These latter two measurements provide another determination of the dissolved hydrogen. The two available methods provide sufficient backup monitoring capability for dissolved hydrogen and will eliminate the need for handling highly radioactive, undiluted, pressurized reactor coolant grab samples. Diluted, unpressurized reactor coolant grab samples may be obtained as necessary at the PASF for other analyses.

DEVIATION 22

VARIABLE (87)

Radiation Exposure Meters

DEVIATION FROM RG 1.97 GUIDANCE

Rg 1.97, Revision 2, recommends that Type E radiation exposure meters with continuous indication be available at fixed locations. No category is specified. WBN recommends not classifying these meters as a RG 1.97 variable.

JUSTIFICATION

RG 1.97, Revision 2, was issued with an outstanding question regarding the practicality of deploying radiation monitors at fixed locations. A study (NUREG/CR-2644) concluded that it is unlikely that a few fixed-station area monitors could provide sufficiently reliable information to be of use in detecting releases from unmonitored containment release points.

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JUSTIFICATION FOR DEVIATIONS

NRC agreed with this conclusion and in Revision 3 of RG 1.97 deleted the environs radiation monitors from the pressure water reactor (PWR) table of variables.

TVA thereby requests a deviation from RG 1.97, Revision 2 specification of this Type E variable.

DEVIATION 23

VARIABLE (86)

Waste (Radioactive) Gas Holdup Tank Pressure (Waste Gas Decay Tank Pressure)

DEVIATION FROM RG 1.97 GUIDANCE

RG 1.97, Revision 2, recommends that waste (radioactive) gas holdup tank pressure be monitored from 0 to 150 percent of design pressure. WBN recommends that the pressure be monitored from 0 to 100 percent of design pressure (150 psig).

JUSTIFICATION

The design pressure of the waste gas decay tanks is 150 psig. The waste gas decay tanks are equipped with pressure relief valves set at 150 psig. Therefore, WBN's position is that monitoring of the tanks to pressures higher than the relief setpoints is not necessary. WBN considers the existing range of 0 to 100 percent of design to be acceptable.

DEVIATION 24

VARIABLE (3)

Containment Pressure (Narrow Range)

DEVIATION FROM RG 1.97 GUIDANCE

RG 1.97, Revision 2, recommends Type B and Type C variable which covers a range of -5 psig to the design pressure. WBN recommends a lower range of -2 psig using a Type A1, B1, C1, and D2 variable (with no deviation to the upper range).

JUSTIFICATION

The WBN containment vessel design net external pressure is 2 psig. Inadvertent containment spray initiation will cause rapid depressurization inside containment. However, for this event the pressure will drop below the minimum design pressure. Another event that can cause a depressurization inside containment is continuous inadvertent air return fan operation. However, this will occur slowly enough to allow the operators sufficient time to observe trending of containment depressurization and afford ample opportunity to terminate the air fan operation and manually open the lower compartment pressure reflief line.

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In addition, the containment pressure wide range instrumentation (-5 to 60 psig) overlaps the -2 psig lower range instrumentation. The -2 psig value is the lower design limit and is consistent with the use of upper range design limit of 15 psig. Hence, a lower range value of -2 psig is appropriate for WBN.

DEVIATION 25

VARIABLE (84)

High Level Radioactive Liquid Tank Level (Tritiated Drain Collector Tank)

DEVIATION FROM RG 1.97 GUIDANCE

RG 1.97, Revision 2, recommends a range for this variable from top to bottom. WBN recommends a range from 11 to 133 inches from the bottom of the tank.

JUSTIFICATION

The capacity of the tank is approximately 24,700 gallons. The quantity of water that is excluded from the range of the indication is approximately 1000 gallons at the bottom and an equal amount at the top. Thus, the present range is capable of monitoring approximately 22,700 gallons which is about 92 percent of the total capacity of the tank. TVA thereby considers the proposed range for the existing level taps (11 to 133 inches from the bottom of the tank) to be sufficient for indicating postaccident storage volume for this tank.

DEVIATION 26

VARIABLE (97E)

Reactor Coolant Boron

DEVIATION FROM RG 1.97 GUIDANCE

RG 1.97, Revision 2, recommends that the analysis range for boron content in the primary coolant and sump be between 0 to 6,000 parts per million (ppm) and be monitored with a Type B3 and E3 variable. WBN recommends that the range be between 50 to 6,000 ppm and be monitored with a Type E3 variable.

JUSTIFICATION

For boron concentrations below 500 ppm, the tolerance for WBN's instrumentation would be limited to plus or minus 50 ppm. This tolerance band is considered by WBN to be acceptable for ensuring that postaccident shutdown margin is maintained. WBN's position is that the current range capability for boron analysis (50 to 6,000 ppm) is sufficient.

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RCS boron concentration used in conjunction with control rod position indication and RCS cold-leg temperature only provides indirect indication. These are backup variables for monitoring reactivity control. Neutron flux is a direct variable that allows the operator to determine if reactivity is under control (i.e., the reactor has tripped and the core is in a subcritical condition). Neutron flux is a Type B1 and D2 variable at WBN. Therefore, the boron concentration is not required for direct reactivity control determination. It is available as a Type E3 variable for backup verification of reactivity control.

DEVIATION 27

VARIABLE (98b)

Containment Air Oxygen Content

DEVIATION FROM RG 1.97 GUIDANCE

RG 1.97, Revision 2 recommends a measurement range of 0-30 percent volume for containment air oxygen content. WBN recommends that the measurement of this variable should not be required.

JUSTIFICATION

The measurement of containment air oxygen content is not required by NUREG-0737. Following a design basis LOCA at WBN, the combustible gas control system will operate as described in System Description N3-83-4001 R1 to maintain the hydrogen concentration in containment below the lower flammability limit of 4 percent volume. Therefore, the oxygen concentration in containment is not important for combustion control. A measurement of the containment oxygen concentration is not needed for any other reason after an accident.

DEVIATION 28

VARIABLE (102c)

Meteorology (Wind Speed)

DEVIATION FROM RG 1.97 GUIDANCE

RG 1.97, Revision 2, recommends that the wind speed measurement range be 0 to 67 mph. WBN recommends that the range be 0 to 50 mph.

JUSTIFICATION

RG 1.97, Revision 3, recommends that the wind speed measurement range be 0 to 50 mph. Also, NRC letter from Youngblood to White dated July 24, 1986, states that since WBN meets the range recommended in RG 1.97, Revision 3, the 0 to 50 mph range is acceptable.

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REG GUIDE 1.97 R2 DEVIATION AND
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DEVIATION 29

VARIABLE 97a

Reactor Coolant Chloride Concentration

DEVIATION FROM RG 1.97 GUIDANCE

RG 1.97, Revision 2, recommends a range of 0 to 20 ppm for reactor coolant chloride concentration. WBN recommends a range of 1 to 20 ppm.

JUSTIFICATION

The WBN recommended range of 1 to 20 ppm accurately represents TVA's commitment to the NRC.

DEVIATION 30

VARIABLE 6

DEVIATION FROM RG 1.97 GUIDANCE

The two channels/trains of the core thermocouple system at the bundling at the common reactor vessel refueling cavity wall penetration do not meet the separation requirement of RG 1.97.

JUSTIFICATION

The design and the installation of the mineral insulated cables used for the core thermocouples within the reactor cavity was completed prior to upgrading the system to satisfy RG 1.97 requirements. The design within the refueling cavity is acceptable because:

1. Only a small self-generated signal exists in the cabling from the thermocouples to the Incore Instrument Room and, therefore, no chance exists for a postulated propagating fault.

2. Due to the interference provided by the rod control mechanisms and rod position indicator stack, no likelihood exists for rendering all thermocouples inoperable.

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REG GUIDE 1.97 R2 DEVIATION AND
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DEVIATION 31

VARIABLE 103

DEVIATION FROM RG 1.97 GUIDANCE

RG 1.97, Revision 2, includes exposure rate monitors as Type E (Category 2) variables. These monitors are required to have a range of 1.0 E-1 Rem per hour (R/hr) to 1.0 E4 R/hr and are to be located inside buildings or areas where access is required to service equipment important to safety. The area monitors are intended for use in detection of significant releases, release assessment, and long-term surveillance.

RG 1.97, Revision 2, also included radiation exposure rate monitors, with ranges of 1.0 E-1 R/hr to 1.0 E4 R/hr as Type C variables (these monitors were to be installed inside buildings or areas in direct contact with primary containment where penetrations and hatches were located). This variable was removed from RG 1.97 in Revision 3 and will not be addressed further.

WBN RG 1.97 monitoring instrumentation does not include installed high-range exposure rate monitors as Type E variables. The intended objectives of such instrumentation will be achieved in a different manner than that described in RG 1.97. The following paragraphs describe how WBN's program is designed to monitor radiation exposure rates.

A large number of useful missions outside the MCR during accident conditions may be postulated. These missions would be for activities, such as equipment maintenance, grab sample acquisition, and laboratory analyses of grab samples, that might enhance accident mitigation. Exposure rates encountered on these missions would vary over a wide range. This variability arises from the fact that most high exposure outside the containment during accident conditions would be attributable to contained sources and, therefore, be strong functions of distance from the sources. Because of the wide exposure rate variability, the installation of even a large number of high-range exposure rate monitoring instruments at selected locations on projected mission routes might not contribute substantially, either to the planning of missions for accident mitigation purposes or to the minimization of dose equivalent to personnel performing the missions.

Based on the above considerations, the WBN radiation monitoring system design uses portable high-range exposure rate instruments in lieu of installed high-range exposure rate monitors. Crews attempting missions outside the MCR following an accident would include Radiological Control personnel provided with high-range exposure rate instrumentation. The range of the Type E portable instrumentation available for this purpose is 1.0 E-3 R/hr to 1.0 E4 R/hr, which is consistent with the range required for area exposure rate monitoring.

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Additionally, the TVA radiation monitoring system presently includes normal-range area monitors, each with a range from 1.0 E-1 MR/hr to 1.0E4 MR/hr. These monitors are located throughout the plant in areas where personnel access is common. Although the area monitors are not required to be within the scope of the environmental qualification program and they are not included in the Postaccident Monitoring (PAM) program, monitors located outside the primary containment and other locations of high postaccident exposure rates can be expected to remain on scale and to continue to provide exposure rate indication with required accuracy during accident conditions. The monitors that remain on scale will provide useful input to MCR personnel for assessment of plant exposure rate levels during accident conditions. Based upon this assessment and WBN Radiological Emergency Plan dose limitations, a decision will be made as to whether or not missions outside the MCR would be attempted.

In summary, the WBN position on high-range accident monitoring is that high-range exposure rate instrumentation will not be installed and that high-range monitoring will be provided by portable monitoring instrumentation that meets the RG 1.97 required range.

DEVIATION 32

VARIABLE (5)

Containment Sump Level (Wide Range)

DEVIATION FROM RG 1.97 GUIDANCE

The range recommended in RG 1.97, Revision 2, is "Bottom of containment to 600,000 gallon level equivalent." Watts Bar recommends a range from 0-200 inches (with the "0" level starting at six inches above the reactor floor) (see Note).

JUSTIFICATION

Watts Bar utilizes a containment sump level monitoring system that starts measuring at six inches above the containment floor (level tap located at elevation 703' 3-3/8"). The range of the instrument is 200 inches (719' 11-3/8"). The total volume of water available to flood containment post-LOCA is 844,000 gallons, which is approximately equivalent to 717' 2-2/5" steady state maximum flood level. Therefore, the recommended range is fully adequate to monitor the maximum equilibrium flood level that would be experienced.

Note: The containment sump level monitoring system is utilized only during an accident. During normal operation reactor coolant leakage is monitored by the reactor building floor and equipment drain pocket sump. For post accident monitoring, the operator is aware that the "0" level actually begins at 6" above the floor and will realize that there is extra water inside containment when the sump monitor begins to indicate.

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DEVIATION 33

VARIABLE 95

Condenser Vacuum Pump Exhaust Vent (Noble gas)

DEVIATION FROM RG 1.97 GUIDANCE

The RG 1.97, Revision 2, required range for the condenser vacuum pump exhaust monitors is 1.0 E-6 to 1.0 E+5uCi/cc.

JUSTIFICATION

TVA has determined the total gas required range of the condenser vacuum pump exhaust monitors to be less than the 1.0E-6 value in RG for the low end of the range and 2.4E+3uCi/cc at the upper end of the range.

The steam generator tube rupture (SGTR) is the only credible accident monitored by the condenser vacuum pump exhaust monitor. NUREG-0800, Revision 2 requires that the SGTR accident be analyzed using the highest isotope concentrations allowed by the Watts Bar Technical Specifications. The specific activity of the reactor coolant is limited to:

a) Less than or equal to 1 microcurie per gram dose equivalent Iodine-131, and
b) Less than or equal to 100/EuCi/gm

The dose equivalent I-131 is more than 4 times more restrictive that the 100/E limit. The 100/E is more conservative and is selected to demonstrate that the monitor will remain on scale during the most severe accident. **The highest concentration of mixed noble gas isotopes that can be present under the 100/E limit is 1.45E+3 uCi/cc as determined in TVA calculation WBNAPS3-048 [PL-08-0501].** For the SGTR source spectrum, the maximum measurable concentration for the condenser vacuum pump exhaust monitors is 3.53E+4. Therefore, the Watts Bar required range for the condenser vacuum pump exhaust monitors meets the intent of RG 1.97, Revision 2 based on either the mixed gas or the SGTR specific source spectrum.

DEVIATION 34

VARIABLE 97c & 97d
Primary Coolant Dissolved Total Gas (97d) and Dissolved Oxygen (97c)

DEVIATION FROM RG 1.97 GUIDANCE
RG 1.97, R2 indicates the range for variable 97d is from 0 to 2000 cc/Kg and the range from variable 97c is 0 to 20 ppm. The TVA required range for variable 97d is 100 to 2000 cc/Kg, and 1 to 20 ppm for variable 97c.

JUSTIFICATION
The TVA required ranges for variable 97c and 97d permit adequate assessment of the primary system for these dissolved gases, and therefore, meets the intent of RG 1.97.

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REG GUIDE 1.97 R2 DEVIATION AND
JUSTIFICATION FOR DEVIATIONS

DEVIATION 35

VARIABLE (20)

Control Rod Position

DEVIATION FROM RG 1.97 GUIDANCE

RG 1.97 recommends that control rod position indication be a Type B. Category 3 variable (B3) to monitor for reactivity control. Watts Bar recommends that this variable be a Type D, Category 3 variable (D3).

JUSTIFICATION

Control rod position indication is an indirect variable. It provides backup indication for monitoring reactivity control. Neutron flux (category 1) is a direct variable that allows the operator to determine if reactivity is under control (i.e., the reactor has tripped and the core is in a subcritical condition). Since this provides backup indication, utilizing it as a Type D variable is sufficient.

DEVIATION 36

VARIABLE 4

Containment Area Radiation, High Range

DEVIATION FROM RG 1.97 GUIDANCE

Note 7 of RG 1.97, R2 for the subject variable states, "detectors should respond to gamma photons within any energy range from 60 KeV to 3 MeV with an energy response accuracy of 20 percent at any specific photon energy from 0.1 MeV to 1 MeV. Overall system accuracy should be within a factor of 2 over the entire range. TVA meets the requirements of RG 1.97, R3 Note 7 for the subject variable, which states, "Detectors should respond to gamma radiation photons within any range from 60 KeV to 3 MeV with a dose rate response accuracy within a factor of 2 over the entire range."

JUSTIFICATION

It is acceptable to meet the requirements of RG 1.97, R3.

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JUSTIFICATION FOR DEVIATIONS

DEVIATION 37

VARIABLE 6

Core Exit Temperature

DEVIATION FROM RG 1.97 R2 GUIDANCE

This Type A, Category 1 variable has been provided with a minimum of two independent channels (PAM 1 and PAM 2) for monitoring core exit temperature. Where failure of a channel would present ambiguous or confusing information to the operator, preventing the operator from taking action or misleading the operator, RG 1.97 recommends that an additional redundant (PAM 3) channel be provided. One channel of the WBN core exit temperature indication is subject to direct failure as a result of a specific pipe break jet impingement and/or pipe whip impact on the cable/conduit routed near the safety injection (SI) accumulator cold leg injection line in Loop 1. The WBN design does not include a third redundant channel for this variable.

JUSTIFICATION

The core exit thermocouples were added to the plant design to provide direct indication of degrading core cooling conditions following transient events similar to that experienced at Three Mile Island (TMI). These events typically develop gradually over time and involve a great deal of operator action and control. The core exit temperature indication was intended to prevent erroneous operator termination of emergency core cooling system (ECCS) flow to the reactor coolant system (RCS) after small breaks or transients that do not rapidly depressurize the RCS.

The challenge to the channel redundancy in this case is due to a specific primary loop pipe break at the cold leg injection check valve. The injection line is 10-inches diameter, schedule 140 pipe and the postulated break is a full guillotine rupture which results in a blowdown flow area from the primary loop side of the break of 60 in^2 or 0.4176 ft^2. This break is included in the loss-of-coolant-accident (LOCA) break size spectrum and is considered an intermediate size break. FSAR Chapter 15 analyses show that breaks in this range rapidly depressurize the primary system, causing automatic ECCS response which refloods the core and terminates the core heatup transient. However, should such a break occur, the affected channel is expected to fail open and not give erroneous indication that could confuse the operators.

It is the WBN position that the RG 1.97 R2 indication provided by reactor vessel level, RCS pressure, RCS temperatures T_{hot} and T_{cold}, and containment pressure and temperature will enable the operators to compensate for a loss of one channel of CET due to this specific pipe break plus a single failure of the redundant channel. The operators will be able to correctly assess the accident scenario and determine the effectiveness of postaccident core cooling system response during performance of the Emergency Operating Procedures.

APPENDIX D

Westinghouse Common Q Post Accident Monitoring System (PAMS)
RG 1.97 Revision 3 to Revision 2 Comparison
July 8, 2010

Background

The Westinghouse Common Q, PAMS was designed to meet the requirements of RG 1.97 Post Accident Monitoring, Revision 3. The Watts Bar Project licensing basis is Revision 2. The NRC questioned whether the Westinghouse Common Q, PAMS equipment meets the requirements of Revision 2. This is a comparison of the requirements of Reg. Guide 1.97 Rev. 2 to Rev. 3 requirements as they specifically relate to the Common Q equipment.

Scope

The RG 1.97 variables monitored by the Common Q PAMS are:

- WBN2 FSAR Table 7.5-2 Variable 6, Type A1 – Core Exit Temperature
- WBN2 FSAR Table 7.5-2 Variable 16, Type A1 – Subcooling Margin Monitor
- WBN2 FSAR Table 7.5-2 Variable 22, Type B1 – Reactor Vessel Level

Discussion

An analysis was performed to identify the requirements of Reg. Guide 1.97 Revision 2 to identify those that are applicable to the Common Q PAMS variables. Those requirements were then compared to the corresponding requirements in Revision 3.

Table 1 contains the results of the preceding analysis and demonstrates that there are no differences between the Revision 2 and Revision 3 requirements for the Common Q PAMS equipment.

Conclusions

The Common Q PAMS equipment fully meets RG 1.97 Revision 2 requirements.

No further action is necessary.

References

a) Regulatory Guide 1.97 rev. 2, Post Accident Monitoring
b) Regulatory Guide 1.97 rev. 3, Post Accident Monitoring
c) WB-DC-30-7 rev. 22 Post Accident Monitoring Instrumentation
d) FSAR section 7.5.1 Amendment 99
e) WNA-DS-01617-WBT rev 1 Common Q System Requirement Specifications

M. A. Merten, PE 7/8/10
Prepared by / Date

M. S. Clark 7/12/10
Reviewed by / Date

Title: POST ACCIDENT MONITORING INSTRUMENTATION	WB-DC-30-7

No.	R2 Location	R3 Location	R2 Statement	R3 Statement	Analysis
1	B / 7th para	B / 7th para	"It is essential that the range selections be sufficiently great to keep instruments on scale at all times."	"It is essential that the range selections be sufficiently great to keep instruments on scale *or that one of a set of overlapping instruments will be on scale at* all times."	All instruments will be on scale at all times. No overlapping instruments are required. Common Q PAMS meets the Rev. 2 requirement.
2	C.1.3	C.1.4	"Section 6.1 of ANS-4.5 pertains to General Criteria for Types A, B, and C accident-monitoring variables. In lieu of Section 6.1, the following design and qualification criteria categories should be used:"	"Section 6.1 of ANS-4.5 pertains to general criteria for Types A, B, and C accident-monitoring variables. In lieu of Section 6.1, the design and qualification criteria categories in Table I should be used for the variables in Tables 2 and 3 In general, Category 1 provides for full qualification, redundancy, and continuous real-time display and requires onsite (standby) power. Category 2 provides for qualification but is less stringent in that it does not (of itself) include seismic qualification, redundancy, or continuous display and requires only a high-reliability power source (not necessarily standby power). Category 3 is the least stringent. It provides for high-quality commercial-grade equipment that requires only offsite power"	Provides additional information only. No action needed. Common Q PAMS meets the Rev. 2 requirement.
3	C.1.3.1.a	table 1 / cat1 / #1 / 3rd para	"...qualification applies from the sensor to and includes the channel isolation device."	"...qualification applies from the sensor up to and including the channel isolation device."	Editorial change Common Q PAMS meets the Rev. 2 requirement.

No.	R2 Location	R3 Location	R2 Statement	R3 Statement	Analysis
4	C.1.3.1.b C.1.3.1.g 1st sentence	table 1 / cat1 / #6 / 2nd para	"At least one channel should be displayed on a direct-indicating or recording device." "Recording of instrumentation readout information should be provided"	"Recording of instrumentation readout information should be provided for at least one redundant channel."	Rev 3 clarifies inconsistent guidance. Common Q PAMS meets the Rev. 2 requirement.
5	C.1.3.1.e	table 1 / cat 1/ #5 / last para	"...is being made pending issuance of a regulatory guide (Task RS 002-5) that is under development and will endorse ANSI/ASME NQA-1-1979, 'Quality Assurance Program requirements for Nuclear Power Plants.' "	"...is being made pending issuance of a revision to Regulatory Guide 1.28 that is under development (Task RS 002-5) and that will endorse ANSI/ASME NQA-1-1 979, 'Quality Assurance Program Requirements for Nuclear Power Plants.' "	Wording is the same. Common Q PAMS meets the Rev. 2 requirement.
6	C.1.3.1.f 1st sentence	table 1 / cat1 / #6 / 1st para	"Continuous indication (it may be by recording) display should be provided."	"Continuous real-time display should be provided. The indication may be on a dial, digital display, CRT, or stripchart recorder."	Rev 3 provides more guidance and does not conflict with Rev. 2. Common Q PAMS meets the Rev. 2 requirement.
7	C.1.3.1.g 2nd sentence	table 1 / cat 1 / #6 / 3rd para	"Where direct and immediate trend or transient information is essential for operator information or action, ..."	"If direct and immediate trend or transient information is essential for operator information or action, ..."	Editorial change Common Q PAMS meets the Rev. 2 requirement.
8	C.1.3.1.f 2nd sentence	table 1 / cat 1 / #7 / 1st sentence	"Where two or more instruments are needed to cover a particular range, overlapping of instrument span should be provided."	"If two or more instruments are needed to cover a, particular range, overlapping of instrument span should be provided."	Editorial change Common Q PAMS meets the Rev. 2 requirement.

No.	R2 Location	R3 Location	R2 Statement	R3 Statement	Analysis
9	C.1.4.a 1st sentence	n/a	"Any equipment that is used for either Category 1 or Category 2 should be designated as part of accident-monitoring instrumentation or systems operation and effluent-monitoring instrumentation."	removed	All three variables associated with Common Q PAMS are considered part of "accident monitoring instrumentation" as discussed in WB-DC-30-7. Common Q PAMS meets the Rev. 2 requirement.
10	C.1.5.g 2nd sentence	table 1 / cat 1 / #7 / 2nd sentence	"However, where the required range of monitoring instrumentation results in a loss of instrumentation sensitivity in the normal operating range, separate instruments should be used."	"If the required range of monitoring instrumentation results in a loss of instrumentation sensitivity in the normal operating range, separate instruments should be used. "	Editorial change Common Q PAMS meets the Rev. 2 requirement.
11	C.1.4.b	table 1 / cat 1 / #8	"The instruments designated as Types A, B, and C and Categories I and 2 should be specifically identified on the control panels so that the operator can easily discern that they are intended for use under accident conditions."	"Types A, B, and C instruments designated as Categories I and 2 should be specifically identified with a common designation on the control panels so that the operator can easily discern that they are intended for use under accident conditions."	Editorial change Common Q PAMS meets the Rev. 2 requirement.
12	C.1.4.a 2nd sentence	table 1 / cat 1 / #9	"The transmission of signals from such equipment for other use should be through isolation devices that are designated as part of the monitoring instrumentation and that meet the provisions of this document."	"The transmission of signals for other use should be through Isolation devices that are designated as part of the monitoring instrumentation and that meet the provisions of this document. "	Editorial change Common Q PAMS meets the Rev. 2 requirement.

No.	R2 Location	R3 Location	R2 Statement	R3 Statement	Analysis
13	table 2 / type B / CET	table 3 / type B / CET	Footnote - "A minimum of four measurements per quadrant is required for operation. Sufficient number should be installed to account for attrition. (Replacement instrumentation should meet the 2300° F range provision.)"	Footnote - "Instrumentation that is a part of the final ICC detection system should meet the design requirements specified in Item II.F.2 of NUREG-0737. (When Type K thermocouples become part of the system, they are considered to meet the requirements. However, the remainder of the detection system that is outside the reactor vessel should meet the requirements specified.)"	Reference WB-DC-30-7 appendix A. Type K thermocouples will be used from the CET all the way to the Common Q racks (the reference junction is internal to the rack). The CET range is 32°F - 2300°F which exceeds the rev 2 requirement. CAT 1 is assigned which is higher than the rev 2 requirement. Common Q PAMS meets all Rev 2 requirements concerning CETs.
14	table 2 / type B / Coolant Level	table 3 / type B / Coolant Inventory	Refers to "coolant level in reactor" from "bottom of core to top of vessel".	Refers to "coolant inventory" from "bottom of hot leg to top of vessel"	Both conditions are met. RVLIS measures vessel level from the top to the bottom of the core through three separate differential pressure transmitters. CAT 1 is assigned which meets the rev 2 requirement. Common Q PAMS meets all Rev. 2 requirements concerning RVLIS.

No.	R2 Location	R3 Location	R2 Statement	R3 Statement	Analysis
15	table 2 / type B / Degrees of Subcooling	table 3 / type B / Degrees of Subcooling	n/a	Refers to same footnote mentioned under CETs.	The Common Q PAMS subcooled range is ... 663°F subcooled 675°F superheat This exceeds the rev 2 required range. CAT 1 is assigned which is higher than the rev 2 requirement. Common Q PAMS meets all Rev. 2 requirements concerning subcooled margin.