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SBWR Test and Analysis Program Description

Supplement 1 - Discussion of PIRT Parameters

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ABBREVIATIONS AND ACRONYMS

ABWR	Advanced Boiling Water Reactor
AC	Alternating Current
ADS	Automatic Depressurization System
APRM	Average Power Range Monitor
ARI	Alternate Rod Insertion
ASME	American Society of Mechanical Engineers
ATLAS	GE's 8.6 MW Heat Transfer Loop
ATWS	Anticipated Transients Without Scram
Bldn	Blowdown
BO	Boiloff
BWR	Boiling Water Reactor
CACS	Containment Atmospheric Control System
CCFL	Counter Current Flow Limiting
CISE	Centro Informazioni Studi Esperienze
COL	Combined Operating License
CPR	Critical Power Ratio
CRD	Control Rod Drive
CTP	Core Thermal Power
CRIEPI	Central Research Institute of Electric Power Industry
CSAU	Code Scaling, Applicability and Uncertainty
CSHT	Core Spray Heat Transfer
DBA	Design Basis Accident
DC	Downcomer
DPV	Depressurization Valve
DW, D/W	Drywell
EBWR	Experimental Boiling Water Reactor
ECCS	Emergency Core Cooling System
EOPs	Emergency Operating Procedures
FAPCS	Fuel and Auxiliary Pool Cooling System
FIST	BWR Full Integral Simulation Test
FIX	Swedish Test Loop Used for Testing External Pump Circulation
FMCRD	Fine Motion Control Rod Drive
FRIGG	Research Heat Transfer Loop Operated for Danish Atomic Energy Commission
FW	Feedwater
FWCS	Feedwater Control System
GDCS	Gravity-Driven Cooling System
GE	General Electric Company

ABBREVIATIONS AND ACRONYMS (Continued)

GEXL	General Electric Critical Quality Boiling Length Correlation
GIRAFFE	Gravity-Driven Intergral Full-Height Test for Passive Heat Removal
GIST	GDCS Integral System Test
HCU	Hydraulic Control Unit
HVAC	Heating, Ventilating and Air Conditioning
IC	Isolation Condenser
ICS	Isolation Condenser System
INEL	Idaho National Engineering Laboratory
LASL	Los Alamos Scientific Laboratory
LB	Large Break
LOCA	Loss-Of-Coolant Accident
LOOP	Loss Of Offsite Power
LPCI	Low Pressure Coolant Injection
MCPR	Minimum Critical Power Ratio
MIT	Massachusetts Institute of Technology
MPL	Master Parts List
MSIV	Main Streamline Isolation Valve
MSL	Main Steamline
MW	Megawatt
NBS	Nuclear Boiler System
NRC	Nuclear Regulatory Commission
ORNL	Oak Ridge National Laboratory
P&ID	Process and Information Diagram
PANDA	Passive Nachwarmeabfuehr-und Drueckabbau-Testanlage (Passive Decay Heat Removal and Depressurization Test Facility)
PANTHERS	Performance Analysis and Testing of Heat Removal Systems
PAR	Passive Autocatalytic Recombiners
PCCS	Passive Containment Cooling System
PCT	Peak Cladding Temperature
PIRT	Phenomena Identification and Ranking Tables
PSTF	Pressure Suppression Test Facility
QDB	Qualification Data Base
RC&IS	Rod Control and Information System
RPV	Reactor Pressure Vessel
RWCU	Reactor Water Cleanup
SB	Small Break

ABBREVIATIONS AND ACRONYMS (Continued)

SBWR	Simplified Boiling Water Reactor
S/C	Suppression Chamber (wetwell)
SDC	Shutdown Cooling
SIET	Societa Informazioni Esperienze Termoidrauliche
SLCS	Standby Liquid Control System
SPERT	Special Power-Excursion Reactor Tests
SRV	Safety/Relief Valve
SSAR	Standard Safety Analysis Report
SSLC	Safety System Logic Control
SSTF	Steam Sector Test Facility
TAPD	Test and Analysis Program Description
TCV	Turbine Control Valve
THTF	Thermal-Hydraulic Test Facility
TLTA	Two-Loop Test Apparatus
TPS	Turbine Protection System
TRAC	Transient Reactor Analysis Code
TRACG	Transient Reactor Analysis Code, GE version
TT	Turbine Trip
UCB	University of California, Berkeley
VB	Vacuum Breaker
WW	Wetwell

S1.0 Introduction

S1.1 Purpose

The process of Top-Down analysis and qualification of the performance of the SBWR starts with the identification of the important physical phenomena. For this purpose, Phenomena Identification and Ranking Tables (PIRT) were developed. This was done by assembling a team of experts knowledgeable about thermal-hydraulics and transient analysis, and obtaining consensus on the relative importance of various phenomena. Phenomena were given a rank between 0 and 9 based on their importance. The ranking was done on a conservative basis (i.e., generally, phenomena were given a higher rank if there was any uncertainty as to its importance). This resulted in a large number of highly ranked phenomena. It is expected that a much smaller subset will actually prove to be "important" after the tests and sensitivity studies are completed. Tables were developed for small break LOCAs, large break LOCAs, pressurization transients, depressurization transients and reactivity insertion due to cold water injection. Plant startup was also treated as a category of operational transients because of the focus on the potential for geysering. Tables were also developed for ATWS (pressurization events) and for stability during normal operation and transients. In each case, the importance of the phenomena was evaluated for each reactor region: lower plenum, core, upper plenum/chimney, downcomer, etc., as well as for the containment. For the LOCA events, the tables were further subdivided into the blowdown, GDCS and long-term periods of the transients.

Additional information regarding the PIRT process is provided by [4].

TAPD Supplement 1 [5] provides a discussion of the Phenomena Identification and Ranking Tables (PIRT) parameters described in Section 2 of the SBWR Test and Analysis Program Description (TAPD) [1].

This supplement is organized as follows: first, a short definition of each parameter is provided in the TAPD Supplement 1, Section S1.2; then parameters for each of the categories of transients are discussed and the rationale for their ranking is outlined; finally, a master list of all parameters considered in TAPD Sections 2 and 3 is presented. The master list also shows the correspondence of the parameters derived from the Top-Down (PIRT) and Bottom-Up processes.

S1.2 Definition of PIRT Phenomena Listed in TAPD Section 2

This section provides definitions of phenomena considered in TAPD Section 2.

TAPD Supplement 1 Table S1.1 is a listing of all the phenomena considered in TAPD Section 2. The phenomena are labeled according to the convention of TAPD Tables 2.3-1 to 2.3-5. A definition of each phenomenon is provided in the third column.

S1.3 Discussion of PIRT Phenomena and Rankings

This section provides a discussion of PIRT Phenomena and Rankings.

This section discusses the PIRT phenomena and provides a basis for the rankings. This is done by referring to the event scenario detailed in TAPD Section 2.2. It should be recognized that PIRTs are based on engineering judgment and experience. The discussion that follows should be considered in that context. The importance of individual items is subject to re-evaluation if future tests or analysis provide different insights.

S1.3.1 Loss-of-Coolant Accidents (Reactor Vessel and Core)

This section provides a discussion of the detailed phenomena considered for the LOCA (Reactor Vessel and Core).

The detailed phenomena considered for the LOCA scenario are listed in TAPD Table 2.3-1. They are grouped in the table by the regions of the reactor vessel and containment. In describing the phenomena, it is convenient to group them into major categories.

S1.3.2 Loss-of-Coolant Accidents (Containment)

This section provides a discussion of the detailed phenomena considered for the LOCA (Containment).

In TAPD Table 2.3-2, the phenomena are grouped by the various regions of the containment. The TAPD Supplement 1 discussion provides a description of the individual phenomena and their importance.

S1.3.3 Transients

This section provides a detailed discussion of the phenomena considered for transients.

In TAPD Table 2.3-3, the PIRT parameters applicable to transients are listed by the region of the reactor vessel. Because of the neutronic coupling, the core region is by far the most important region for the operational transients. The TAPD Supplement 1 discussion provides a description of the individual phenomena and their importance.

S1.3.4 Anticipated Transients Without Scram (Pressurization Transients)

This section presents a discussion of the detailed phenomena considered in ATWS (Pressurization Transients).

The PIRT for a pressurization event (MSIV closure, turbine trip) with failure to scram is shown in TAPD Table 2.3-4. Because the event is initiated as a normal pressurization event, a large number of phenomena typical of the early phases of the transient are the same as those in the first column of TAPD Table 2.3-3 for operational transients. The description of these common phenomena and their relevance will not be repeated here. Only those phenomena that are different, or have a different significance, are discussed in TAPD Supplement 1.

S1.3.5 Stability

This section provides a discussion of the detailed phenomena related stability as provided in TAPD Sections 2.2.4 and 2.3.4.

The phenomena affecting decay ratio and the likelihood of oscillations are summarized in TAPD Table 2.3-5.

S1.4 Synopsis of the Identified Phenomena and SBWR Unique Features and Interactions

This section provides further discussions of the PIRT evaluations in TAPD Sections 2 and 3.

Based on the results of the ranking evaluation in the PIRT (Top-Down approach, TAPD Section 2) and the results of the identification of the SBWR-unique features (Bottom-Up approach, TAPD Section 3) a composite list was developed. Items ranked high were carried through for further analysis in TAPD Section 4. In addition, those ranked medium in importance were also examined, but in less detail. This consolidation is documented in TAPD Supplement 1, Table S1-9. The table also includes a complete evaluation of all phenomena for the specific scenarios, while in TAPD Tables 2.3-1 to 2.3-5, only the most important ones are presented.

S1.5 Correspondence Between Sections in TRACG Model Description Reports (NEDE-32176P Rev. 0 and Rev. 1)

This section provides discussions relating the TRACG Model descriptions to those provided n TAPD Section 2.

In TAPD Tables 2.3-1 to 2.3-6, the right-hand column indicates the sections of the TRACG Model Description Report (NEDE-32176) [3] that pertain to the particular phenomenon. This TAPD section provides the corresponding numbers from NEDE-32176, Rev. 0. The models are described in Revision 0, and they will be amplified in Revision 1, particularly with respect to documentation of the basis and the range of applicability. The correspondence is shown in TAPD Supplement 1, Table S1-10.

S1.6 References

[1] *SBWR Test and Analysis Program Description,* NEDC-32391P, Revision C, August 1995.

[2] *TRACG Qualification,* J.G.M. Andersen, Md. Alamgir, J.S. Bowman, Y.K. Cheung, L.A. Klebanov, W. Marquino, M. Robergeau, D.A. Salmon, J.C. Shaug, B.S. Shiralkar, F.D. Shem, K.M. Vierow. NEDE-32177P, Licensing Topical Report, January 1993.

[3] *TRACG Model Description,* J.G.M. Andersen, Md. Alamgir, Y.K. Cheung, L.A. Klebanov, J.C. Shaug. NEDE-32176P, Licensing Topical Report, January 1993.

[4] *SBWR Test and Analysis Program Description,* NEDO-32391, Revision C, August 1995.

[5] *SBWR Test and Analysis Program Description,* NEDC-32391P, Supplement 1, August 1995.