Westinghouse Electric Corporation

Energy Systems

Box 355
Pittsburgh Pennsylvania 15230-0355

NTD-NRC-96-4624
DCP/NRC0449
Docket No.: STN-52-003

January 23, 1996

Document Control Desk
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

ATTENTION: MR. T. R. QUAY

SUBJECT: KEY ELEMENTS OF THE AP600 WGOTHIC PCS DBA APPROACH

Dear Mr. Quay:

The attachment provides tables identifying key elements of the AP600 WGOTHIC PCS Design Basis Analysis (DBA) approach. Table 1 provides an item-by-item response based on an outline of issues provided by the NRC at the June 29, 1995 Senior Management Meeting. Table 2 summarizes the WGOTHIC input pa ameter groupings and how each is bounded.

The original versions of these tables were provided to the NRC at the July 27, 1995 meeting with NRC staff. Changes were made to the tables to reflect changes in the PCS DBA approach as discussed at this meeting.

Please contact John C. Butler (412-374-5268) if you have any questions concerning this submittal.

Cynthia L Haag for BAM.

Brian A. McIntyre, Manager
Advanced Plant Safety and Licensing

/nja

Attachment

cc: T. Kenyon, NRC (w/o Attachment)
D. Jackson, NRC (1A)
E. Throm, NRC (1A)
J. Kudrick, NRC (1A)
P. Boehnert, ACRS (1A)
B. A. McIntyre, Westinghouse (w/o Attachment)
N. J. Liparulo, Westinghouse (w/o Attachment)

Table 1 Key Elements of the AP600 WGOTHIC PCS DBA approach

Topic	SSAR AP600 PCS DBA approach	Reports and sections addressing the topic
0. Overview of PCS DBA approach		
• Overall PCS DBA objectives	A bounding analysis has been provided for DBA which addresses all important phenomena and conservatively accounts for uncertainties including those due to correlations and models, computer code, and scale, to examine the following criteria: - $P_{peak} \leq$ 45 psig - $P_{24\ hours} \leq$ 50% (45 psig) - $\Delta P_{subcompartment} \leq$ internal wall structural capability - $\Delta P_{external} \leq$ structural capability - $T(t) \leq T(t)_{equipment\ qualification}$	P_{peak}, $P_{24\ hours}$ SSAR 6.2.1.1 - 6.2.1.3 $\Delta P_{subcompartment}$ SSAR 6.2.1.2.1 $\Delta P_{external}$ SSAR 6.2.1.1.4 $T(t)_{eq}$ SSAR 3.11 (To be revised) NTD-NRC-94-4166 "AP600 PCS Design Basis Analysis (DBA) and Margin Assessment," pp. 3-10. NTD-NRC-95-4459 "Stratification and Mixing Effects on AP600 Passive Containment Cooling System DBA," §2.0 and §4.2 through 4.5
• Definition and selection of design limits for pressure and EQ	The bases for design limits have been provided. Margin between design limits and failure limits is consistent with current operating plants. The containment shell material provides margin between design and failure pressure similar to that for current plants (see section 3. of July 27, 1995 presentation.	P_{peak}, $P_{24\ hours}$ SSAR 3.8.2, 6.2.1.1.2 $\Delta P_{subcompartment}$ SSAR 3.8.3.3, 6.2.1.2.1 $\Delta P_{external}$ SSAR 6.2.1.1.4 $T(t)_{eq}$ SSAR 3.11 Margin from design limits to failure limits SSAR 3.8.2.4.1.2, 3.8.2.4.2

Topic	SSAR AP600 PCS DBA approach	Reports and sections addressing the topic
• Road map of DBA approach	Road maps have been provided and updated as required during the review process *(see table of meetings provided at July 27, 1995 NRC PCS meeting)*. *A road map to PCS DBA bounding analysis methods has been provided.*	SSAR 6.2.1.1.1 through 6.2.1.1.2 describe the overall PCS DBA approach. The report, "Application of WGOTHIC to AP600 PCS DBA," will provide an integrated overview of information provided to NRC during closure negotiations, including - text discussion according the outline in this Table. - text covering each accident phase and discussing resolution of each identified phenomenon. *(NTD-NRC-95-4545, 8/31/95)* - bounding values used for input such as shown in Table 2.
1. Complete description of WGOTHIC		
Contents should be sufficient to fully describe - the derivation of the conservation equations Include: Mass equation Energy equation Momentum equation Equation of state	• WGOTHIC is derived from the EPRI sponsored GOTHIC code. A complete description of GOTHIC has been provided within EPRI documents, including a discussion of the conservation equations. • The GOTHIC code has undergone a peer review, and results have been provided. • All conservation equations for Climes have been described.	NTD-NRC-94-4260 GOTHIC Containment Analysis Package, Version 3.4e, Volumes I-III *The applicability of GOTHIC 4.0 documentation and peer review results to WGOTHIC has been provided, NTD-NRC-95-4577, NTD-NRC-95-4563 and NTD-NRC-95-4595.* NTD-NRC-95-4462 EPRI Report RA-93-10, GOTHIC Design Review, Final Report WCAP-14382 § 2.0 Complete description of WGOTHIC upgrades to GOTHIC
- the individual models incorporated into the code Include: Empirical correlations (e.g. Uchida) Identify fixed licensing model models and numerical values	Heat and mass transfer correlations have been described and validated with separate effects and integral tests. The set of equations necessary to accurately model the PCS have been added as a subroutine set, and are collectively called "Climes." All models have been documented.	WCAP-14382, §2.2, 2.3, and 2.4 and WCAP-14326 §2.0 WCAP-14382, §2.5, 2.6

Topic	SSAR AP600 PCS DBA approach	Reports and sections addressing the topic
- the numerical methods used to solve the equations	The numerical methods used to solve the WGOTHIC volume and junction conservation equations are identical to GOTHIC and are given in the GOTHIC Technical Manual. The numerical techniques for Climes subroutines have been provided.	op. cit., GOTHIC Technical Manual §12 WCAP-14382, Sections 2.5 and 2.6, and Appendix C.

Topic	SSAR AP600 PCS DBA approach	Reports and sections addressing the topic
2. Justification of the Individual Models		
The models should at a minimum include - the heat and mass transfer correlations Example: Brief description of test and test purpose What parameters were measured How does test geometry relate to AP600 Treatment on entrance effects Plot WGOTHIC results versus measured data Uncertainty analysis	The Phenomenon Identification and Ranking Table (PIRT) describes all phenomena relevant to containment DBA and provides a ranking of their importance. A road map of the phenomena in the PIRT and how each is addressed in the DBA has been provided. The heat and mass transfer correlations for the external shell surface contain small, conservative biases based on separate effects tests. Scatter for the dominant phenomenon, mass transfer has been discussed. Nominal correlations (with known conservative biases) have been incorporated into the DBA evaluation model. *In addition, a conservative multiplier to bound separate effects data is applied to the heat and mass transfer correlations on inside and outside containment.*	The applications report will ~~summarize~~ *include* the PCS DBA methods in tables similar to the AP600 PCS Road Maps (NTD-NRC-95-4545) for each accident/phase. WCAP-14326, §4.2 for evaporation, §4.3 for condensation. WCAP-14382, §9 *NTD-NRC-95-4570 provides the bases for correlation biases.*
- the air annulus model Example: Pressure drop Flow and air temperature effects Uncertainty analysis	Based on momentum and energy scaling at prototypic AP600 driving forces, the external annulus is modelled as a 1D flow path. Because of the large downcomer flow area and small fraction of heat deposited through the baffle, 2D effects are adequately accounted for implicitly in the loss coefficient obtained from ~1/6 scale air flow tests *Since the downcomer represents only 10% of the momentum in the external flow path, performance is not sensitive to relatively large changes in downcomer characteristics. Sensitivities to external loss coefficiant show that large changes do not significantly impact containment pressure. These sensitivities will be documented in Section 7.*	WCAP-14382, §6 and A-3 describe the modelling methods WCAP-14190, p.2-6 addresses downcomer NTD-NRC-95-4414 RAI 952.102 response referencing specific scaling WCAP-14190 sections.

Topic	SSAR AP600 PCS DBA approach	Reports and sections addressing the topic
- the water distribution for coverage and Example: Basis for area coverage Lack of full scale heated test data Uncertainty analysis	Based on cold full scale tests with maximum manufacturing tolerances, cold water coverage as a function of flow rate is bounded. Using a scalable (nondimensional) correlation, the effect of heat flux is established, and heated LST data for coverage is bounded. The DBA also conservatively use a constant flow throughout the transient equivalent to the 24 hour value. Sensitivities have shown that the containment pressure performance is not sensitive to water coverage fraction assumed in the DBA. This is because of the high sensitivity of evaporation rate with increases in containment surface temperature, coupled with the thermal capacitance of internal structures as heat sinks. Even reducing the already conservatively bounded SSAR water coverage fraction by a factor of 2 does not cause the design pressure to be exceeded.	SSAR 6.2.1.1.3 gives DBA water coverage assumptions. NTD-NRC-94-4247 "Method for Determining Film Flow Coverage for the AP600 Passive Containment Cooling System," shows the correlation chosen and its validation, bounding heated LST data (Figure 2, p.11) NTD-NRC-94-4286 "Supplemental Information on AP600 PCS Film Flow Coverage Methodology," includes water coverage sensitivities (Figure 3, p.11)
- film flow rates.	The PCS DBA film flow rate as a function of time conservatively assumes failure of one train of PCS tank drain valves, *in addition to single failures assumed in mass and energy releases.*	SSAR 6.2.1.1.3
- film delay time	Delays in wetting due to heated surface application are negligible with respect to the conservatism in the assumed delay time.	SSAR 6.2.1.1.3 provides the SSAR analysis assumptions. The applications report will provide the chronology of events leading to external wetting and provide plots of the relevant external containment temperatures. Justification of the assumed delay time, accounting for the heated surface, will be documented.
Justification should include the results of - separate effects and	Validation with separate effects tests is complete.	WCAP-14382, §3.2.1, 3.2.2, 4 for summaries. WCAP-14326 describes separate effects validation and also validation using LST internal data as a separate effects test.
- integral testing.	Validation with integral tests (LST) is complete.	WCAP-14382, Sections 6, 7, 8, and 10 present integral test comparisons

Topic	SSAR AP600 PCS DBA approach	Reports and sections addressing the topic
These comparisons should provide both - steady state and	Comparisons with steady state periods during the LST series have been completed. These are tests which validate heat and mass transfer predictions after blowdown, during quasi-steady portions of the transient.	Integral test validation is presented in WCAP-14382, §8 and Appendix A
- transient results. Differences should be evaluated and reasons for the deviations provided.	Transient results have been provided for initial pressurizations and for subsequent transients imposed per the test matrix.	WCAP-14382, Sections 6, 7, 8, and 10 present integral test comparisons.
Separate effects and integral tested configuration differences from the AP600 design need to be addressed and demonstrated to be applicable.	The ranges of parameters in AP600 and separate effects and integral tests are stated in both WCAP-14326 and WCAP-14382. Scaling of the LST relative to the AP600 has shown that the LST can be used for validation of PCS heat and mass transfer correlations, and that large scale circulation through lower compartment is not well represented by the LST. The potential for large scale circulation affects the axial non-condensible distribution and can be accommodated based on sensitivities to those distributions. See also discussion in box below.	WCAP-14382, Section 9.2 shows the range of mass transfer parameters validated by the LST. WCAP-14326 shows the range of parameters covered by separate effects tests. See also discussion in box below.
Where no separate effects or integral tests for special features such as the air annulus exists, theoretical justification should be provided to demonstrate conservative results will be obtained.	Air annulus: see above. Liquid film subcooling: Represents a negligible (5%) heat removal mechanism for AP600. The impact of large scale circulation on the PCS DBA is limited to the axial density gradient effect on mass transfer. *The effects of large scale circulation through the lower compartments and jet entrainment are conservatively bounded:* *- for the short term LOCA and MSLB by conservatively minimizing steam access to heat sinks ; and* *- for the long term LOCA 24 hours by using lumped parameter which overmixes noncondensibles from below deck, penalizing PCS heat transfer.*	WCAP-14190 identifies all atypicalities associated with the LST. Since large scale circulation affects the axial density gradient, it will be addressed by the sensitivities to *factors which affect internal heat sink efficiency during the second pressure peak.*

Topic	SSAR AP600 PCS DBA approach	Reports and sections addressing the topic
3. Large Scale Test (LST) Facility		
Complete description of the facility including instrumentation (location and accuracy) and test matrix.	The PCS final test report provides complete details. The most significant measurement error is the steam flow rate during rapid transients *and transient water coverage fractions.* *Measurement uncertainties are understood and bounding approaches for AP600 DBA evaluation models have been developed.*	WCAP-14135, Section 2 is test facility description, including instrumentation location and accuracy is given in Table 2.2-1
Final presentation of all test results including an evaluation of the data. The presentation of the tests results should be sufficient to allow consideration of not only pressure profiles but also velocity, stratification, temperature distributions, heat and mass transfer rates, and noncondensible distributions. Need to address: • Instrumentation uncertainty in developing boundary input data - steam inlet M&E (fluctuations) - PCS water flow and temperature (fluctuations) - condensate flow, when applicable • Instrumentation uncertainty in comparisons of dependent variables • Need to discuss difference in calculation versus test data - transient portions of tests need to be considered - need to present "***actual***" test data matrix	Validation of distributed parameter modeling with LST shows - pressure is well predicted with a slightly positive bias - boundary conditions used as input to clime heat and mass transfer correlations are well predicted based on comparisons of measured axially distributed temperatures and velocities near the shell and non-condensibles at several elevations - internal temperature field is well predicted based on 3D temperature rake measurements - axially distributed wall heat fluxes are well predicted Validation of lumped parameter modelling with LST shows that lumped parameter overpredicts velocities inside the vessel and a resultant overmixing of non-condensibles. Using free convection eliminates the velocity effect. The inherent over-mixing results in conservative predictions for the 24 hour criterion. *The LST data evaluations and calculations have confirmed the PIRT important phenomena.* *The WGOTHIC validation with LST has provided input to develop a bounding approach for the AP600 PCS DBA evaluation model.*	WCAP-14382, Sections 6, 7, 8, and 10 present integral test comparisons for parameters relevant to the heat and mass transfer correlations near the vessel shell. Also included are 3D temperature distributions to show reasonableness of the predicted internal fields.
4. Other experimental comparisons		
What role can the small scale test program play in WGOTHIC validation?	The Small Scale Test program was used in the initial development of AP600 PCS DBA methodology, primarily to examine external heat transfer, as discussed in WCAP-13246. Since the LST provides prototypical aspect ratio for inside containment and it has been the subject of extensive scaling evaluations, the LST is the focus of final validation of AP600 PCS DBA methodology.	WCAP-13246 (superseded by WCAP-14382)

Topic	SSAR AP600 PCS DBA approach	Reports and sections addressing the topic
What role does the EPRI experimental test data base play in the AP600 model development? •How do the EPRI comparisons justify the distributed parameter modeling techniques for the AP600? •How do the EPRI comparisons justify the lumped parameter modeling techniques for the AP600? •To what extent does Westinghouse rely on EPRI development modeling guidelines and how do they apply to the AP600?	The EPRI comparisons to an extensive test database, as well as the GOTHIC code capability to perform the more detailed, distributed parameter calculations, were used by Westinghouse in the decision to use GOTHIC as the starting point for WGOTHIC development. The distributed parameter modeling methodology developed for AP600 using WGOTHIC is validated by Westinghouse. The AP600 PCS DBA evaluation model validation is based entirely on scaling evaluations and comparisons to tests performed by Westinghouse and provided to the NRC. The EPRI guidelines for GOTHIC have been used to develop Westinghouse user guides for AP600 analysis, and are used in setting up input other than Climes. In addition to licensing documentation submitted to NRC, guidance to analysts is given by the WGOTHIC User's Guide and the collection of supporting calc notes giving final, specific input item definitions for AP600. Certainly, since the GOTHIC conservation equations have not changed, the GOTHIC Technical and Programmer's manuals continue to provide background. Thus, while the EPRI GOTHIC User Guide provides valuable background, the AP600 methodology is frozen by Westinghouse documentation.	

Topic	SSAR AP600 PCS DBA approach	Reports and sections addressing the topic
5. Application of LST comparisons to AP600		
A complete scaling analysis should be provided to show how the comparisons can be applied to AP600. It should reveal areas of mis-scaled parameters as well as the credible ranges of parameters of interest. In general, the discussion should provide an understanding of how scaling was considered in the evaluation of the data.	A complete scaling analysis has been provided, showing that the facility is well scaled for validating heat and mass transfer correlations for application to AP600. Only one significant atypicality is identified. That is the lack of a flow path into the simulated steam generator compartment of the LST. This affects large scale circulation through below deck regions. These effects can be directly addressed with sensitivities to axial non-condensible gradient. The scaling of AP600 with respect to the integral LST is used to address the relationship of the plant and test with respect to all relevant phenomena and geometries. *Sufficient instrumentation was included in the LST to show that the potential for compensating errors has been adequately addressed.*	WCAP-14190, is the final scaling report. A revision is in progress to address comments received, including RAI's. *To date, the PIRT remains complete for high and medium importance phenomena. The PIRT is being revised to include low importance phenomena for completeness. Revisions to the pressure rate of change equation, currently underway, are expected to confirm the conclusions in §10.0 of WCAP-14190.* Scaling conclusions and identification of what can and cannot be validated with the LST *has been provided (NTD-NRC-95-4561).* Supporting sensitivities to parameters which affect mixing, will be provided.
Provide WGOTHIC comparisons with the test data. A description and evaluation of the results and an explanation of differences should be provided. The presentations should include a discussion of the experimental inaccuracies and uncertainties, (i.e., inlet steam flow).	Comparisons to separate effects tests and integral tests have been provided. The 375 node distributed parameter evaluation model is validated in detail with 13 LST steady state points from 6 test runs, including 13 transient pressure increases or decreases. Transient results are presented for detailed local parameters at various elevations, and 3D internal temperature rake comparisons for one test are provided. An extensive discussion of the steam flow measurement uncertainty for the blind test prediction is provided in WCAP-14382, Appendix B.	WCAP-14382, §4 summarizes separate effects tests, and §7 and 8 provide integral test validation.

Topic	SSAR AP600 PCS DBA approach	Reports and sections addressing the topic
Provide an explanation of how these comparisons will be used in the development of the methodologies to be used in the required SSAR analyses for the containment performance. In particular, the methods used to assure conservative DBA analyses should be provided.	WCAP-14382 §6.4 describes the specific noding for AP600 as determined from LST. The methods to assure conservative DBA analyses are shown in *the AP600 PCS DBA road maps provided for internal and external containment processes and for all accident phases.*	WCAP-14382 §6.4 §9.6 NTD-NRC-95-4545, AP600 PCS DBA Road Maps
6. Model development for LST and AP600		
Nodalization studies for both LST and AP600 should be provided to support the actual AP600 models. The discussion should include whether the lumped parameter or the distributed parameter version of the code is used and the justification for its use during the selected time period for each class of accidents (LOCA and MSLB). Nodal sensitivity analyses should be provided for each model to demonstrate convergence.	The noding studies in WCAP-14382 §5 and Appendix A show that the 375 node LST evaluation model is well away from any cliffs related to either increased <u>or</u> decreased noding *to indicate the effect of noding and determine if any cliffs due to noding exist.* WCAP-14382 §6.2.1 describes distributed parameter noding methodology in detail. §6.4.1 describes its application to AP600. The effects of using coarsely noded lumped parameter are discussed in WCAP-14382 §5.3. §6.3.1 describes lumped parameter noding methodology. §6.4.2 describes its application to AP600.	WCAP-14382 Confirmatory noding studies for the AP600 are being performed using WGOTHIC. *A summary report of AP600 noding study conclusions and application to the PCS DBA will be provided.*

Topic	SSAR AP600 PCS DBA approach	Reports and sections addressing the topic
Time step sensitivity analyses should be provided to demonstrate convergence for hoth the LST and the AP600 models.	The WGOTHIC time steps are controlled based on several criteria, including the Courant condition and changes of key variables from old time step values.	op. cit. GOTHIC Technical Manual, page 12-7.

Topic	SSAR AP600 PCS DBA approach	Reports and sections addressing the topic
7. AP600 evaluation model		
Justification of initial and boundary conditions (i.e., containment temperature, pressure and humidity; PCS water temperature, PCS inlet air temperature; LOCA and MSLB spectrum of mass and energy release rates). Sensitivity analyses for individual models need to be provided. Include the PCS water film flow rate, PCS water coverage model, PCS effluent recirculation and shadowing, mixing and stratification, and heat sinks.	Sensitivities have shown that the PCS system is well away from any cliffs in performance, even beyond the bounding DBA assumptions. The PCS is self compensating in that increases in containment surface temperature result in increased driving forces for external cooling, and the containment contains a significant amount of thermal capacity due to internal structures.	*Sensitivities using WGOTHIC 1.0 and the June 1992 PCS evaluation model showed no significant cliffs in the design for the most important parameters. (March 17, 1994 NRC PCS Meeting).* *Confirmatory sensitivities using WGOTHIC 1.2 and the SSAR evaluation model will be provided.* The application report will provide sensitivities to - time step size - initial humidity - initial air mass - initial temperature - initial pressure - initial PCS water temperature - LOCA and MSLB spectrum of M&E releases The sensitivities will be performed for both LOCA and MSLB and will range parameters about the bounding SSAR values. Sensitivities will also be confirmed for the following, which may extend beyond the DBA ranges - PCS water coverage fractions - PCS water film flow rate - PCS effluent recirculation - degree of internal mixing - internal heat sink area

Topic	SSAR AP600 PCS DBA approach	Reports and sections addressing the topic
Uncertainty analyses for individual models also need to be provided. Include also heat and mass transfer correlations.	*Bounding DBA calculations are performed using the evaluation model as described in the AP600 PCS DBA Road Maps.*	All uncertainties in significant heat removal processes have been identified *and bounded (NTD-NRC-95-4545).*
8. Major issues and concerns		
(1) Acceptance of some LST tests for WGOTHIC validation. If the instrumentation was not properly ranged and boundary conditions had to be developed after the test, then there is concern that too much uncertainty exists is the validity of the analysis. To the extreme, program the measured pressure response as the "boundary" condition and calculate the remaining boundary conditions to obtain the response. The usefulness of the Blind Test as a validation of WGOTHIC comes into question.	The issue of steam flows occurs only for tests wherein the steam flow meter was out of range. The most significant deviation is in the blind test. Post test data was used to assess the effects. As requested by the NRC, the PCS blind test process was established to provide control of the input and code changes. Agreement was made to perform blind test predictions earlier than planned and to provide the input deck and identify any code changes throughout the blind test exercise. Westinghouse has met this commitment. *The LST program has provided sufficiently accurate information to develop a bounding approach for analyzing AP600.*	A complete discussion of the blind test steam flows is given in WCAP-14382 Appendix B.

Topic	SSAR AP600 PCS DBA approach	Reports and sections addressing the topic
(2) It is expected that the margins in the AP600 are not to be reduced from those of current generation LWRs. (a) Demonstration of this might include an analysis of the AP600 (up to the time of PCS flow) with a currently approved licensing model to show that WGOTHIC is at least as conservative as an approved model. This would necessarily include a comparison of two computer programs to account for different correlations including an assessment of what could be deemed a conservative correlation versus what could be called a best estimate correlation. It might even be necessary to alter WGOTHIC models to be similar to those in the approved model. WGOTHIC in both the lumped and the distributed parameter modes would have to be evaluated.	Discussions of the specifics of AP600 PCS methodology and the use of bounding parameters for all inputs have been ongoing since early 1994. All inputs used in the PCS DBA are conservative bounds *similar to the approach for existing licensed plants.* Margins (conservatisms) have been applied to calculations that are sufficient to bound calculation uncertainty when predicting PCS DBA performance curves, for comparison to design limits. Margin between the design limits and failure limits are maintained similar to existing operating plants.	A sensitivity run using AP600 input with Standard Review Plan (SRP) *style* methods will be made for LOCA through blowdown to provide a snapshot relative to SRP methods. Discussion of the SSAR references to the various DBA are in §0 of this Table. NTD-NRC-95-4545, AP600 PCS DBA Road Maps
(b) If WGOTHIC is a best estimate computer program (to be used with conservative boundary condition) then a statistical uncertainty analysis (similar to that expected for a revised Appendix K analysis) is required to quantify uncertainty. Included must be a consideration of conservative forcing functions. For example, if the conservative forcing functions drive a well-mixed containment, then no conclusion regarding uncertainty due to stratification can be drawn. A best estimate evaluation would include best estimate forcing functions and the uncertainty in those values would be factored into the overall uncertainty.	As presented in June 29, 1995 Senior Management Meeting, the AP600 PCS DBA is *not* a best estimate approach. *All significant processes have been bounded.*	NTD-NRC-95-4545, AP600 PCS DBA Road Maps

Table 2: PCS DBA Evaluation Model Input Assumptions (see also SSAR 6.2.1.1.3)

GEOMETRIC INPUT PARAMETER	BASIS FOR VALUE IN EVALUATION MODEL
Internal Free Volume	Nominal cold values used which conservatively neglects the 1.5% increase in volume at temperature.
Internal Heat Sinks - Area/Volume	Consistent with Revision 7 of the General Arrangement Drawings. The smaller trays, piping, and miscellaneous structures are conservatively ignored.
Internal Flow Paths - Area/Loss Coefficient	Consistent with Revision 7 of the General Arrangement Drawings. The smaller flow paths are ignored.
External Flow Paths - Loss Coefficient	Consistent with Revision 7 of the General Arrangement Drawings. Loss coefficients based on 1/6 scale annulus pressure drop test.

INITIAL CONDITION INPUT PARAMETER	BASIS FOR VALUE IN EVALUATION MODEL
Initial Internal Atmosphere Temperature	Set at maximum Technical Specification value. This acts to maximize the temperature of the internal heat sinks.
Initial Internal Atmosphere Pressure	Set at maximum Technical Specification value. This maximizes the initial pressure and the amount of air initially inside containment and retards mass transfer.
Initial Internal Atmosphere Humidity	Set at 0% relative humidity. This maximizes the amount of air inside containment.
Initial Internal Heat Sink Temperature	Set at maximum Technical Specification internal atmosphere temperature. This acts to maximize the temperature of the internal heat sinks and minimizes heat storage capacity.

INITIAL CONDITION INPUT PARAMETER	BASIS FOR VALUE IN EVALUATION MODEL
External Atmosphere Temperature	Set to the maximum safety air temperature limit defined by the site interface parameters presented in SSAR Chapter 2.
External Atmosphere Pressure	Set to standard, 14.7 psia
External Atmosphere Humidity	Set to approximately 20% relative humidity based on limits defined by the site interface parameters presented in SSAR Chapter 2.

LOCA MASS & ENERGY INPUT PARAMETER	BASIS FOR VALUE IN EVALUATION MODEL
RCS Initial Conditions	Assumed to be at the maximum expected operating temperature and pressure. Includes allowances for error and instrument dead band.
RCS Volume	RCS coolant volumes increased by 1.4% for uncertainty and 1.6% for thermal expansion.
Core Stored Energy	Core stored energy conservatively increased by 15%.
Steam Generator Mass	Initial mass conservatively increased by 10%.
Initial Power Level	102% of full tech. spec. power, accounting for calorimetric error
Zirc-Water Reaction	1% of the zirconium conservatively assumed to react. Bounds SSAR Chapter 15 results of no appreciable zirc-water reaction.
Steam Generator Heat Release	Assumed to occur over 1 hour, as done in current licensed methodology presented in WCAP-10325-P-A.
LOCA Mass and Energy Releases	SATAN 78, WCAP-10325-P-A
MSLB Mass and Energy Releases	LOFTRAN WCAP-7907-P-A

PCS INPUT PARAMETER	BASIS FOR VALUE IN EVALUATION MODEL
Initial Temperature	Containment shell initialized uniformly to maximum Technical S ·cification value. Conservatively bounds initial temperature profile of shell.
External Film Flow Rate	Film flow rate based on assumed single failure of one of two PCS drain tank headers.
External PCS Liquid Film Temperature	Film temperature set to upper bound value of 120°F. This minimizes the sub-cooling benefit.
Film Coverage Fraction	Coverage fractions held constant at values calculated after 26 hours of transient operation. This neglects earlier higher coverage fractions which would result from the higher earlier PCS flow rates.
PCS Material Properties	Conductivity of the Carbo-Zinc paint reduced to 25% of nominal value for the lumped parameter analyses.
PCS Emissivity	Surface emissivities reduced to 90% of nominal values.
PCS Coatings Thickness	Maximum coating thicknesses used.
PCS Initial Delay Time	No credit taken for partial film coverage and cooling prior to 11 minutes after initiation of event. Conservatively neglects approximately 5 minutes of coverage and cooling when water is first applied and coverage develops.
Internal Heat and Mass Transfer Correlation	Free convection only is assumed.
External Heat and Mass Transfer Correlation	Mixed convection assumed.