Plan to Resolve AP600 PRA MAAP4 Success Criteria Issues

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1.0 INTRODUCTION

Many of the AP600 Level 1 PRA success criteria are supported by plant analyses performed with MAAP4. These success criteria are for accident sequences that necessitate the actuation of ADS lines to depressurize the RCS and provide long-term cooling via IRWST gravity injection or RNS pumps. The initiating events considered in the analyses are LOCAs up to approximately 9" equivalent diameter, loss of heat sink transients that include the loss of PRHR and startup feedwater, and steam generator tube ruptures.

Three major issues about these analyses have arisen: 1) MAAP4 benchmarking, 2) T&H uncertainty for passive system reliability, and 3) documentation of systematic analyses. Each of these issues is briefly summarized below. The process for bringing these issues to closure is the subject of this document.

MAAP4 benchmarking is to provide assurance that the code is adequately predicting the plant response. Although there is no requirement for using a validated or NRC-approved code to perform success criteria analysis, the AP600 model used in MAAP4 should be confirmed to provide reasonable results. The benchmarking issues focus on MAAP4's ability to perform adequate inventory tracking of water entering and leaving the RCS, and MAAP4's ability to predict the heatup of the core when it is partially uncovered.

T&H uncertainty for passive system reliability is also an issue in the MAAP4 analyses. The MAAP4 analyses are based on nominal plant performance. Because of the passive nature of the AP600 safety systems, the NRC has expressed concern that the consideration of uncertainty in the thermal-hydraulic analyses might significantly impact whether an accident sequence is credited as successful core cooling.

The final major issue about the MAAP4 success criteria analyses is the documentation of a systematic approach that thoroughly examines the different initiating events, break locations, and systems assumed to function. Although several sets of documentation have already been submitted to the NRC, they are to be considered "preliminary." The final set of success criteria analyses will be completed as described within this document.

These three issues are inter-related with the outcome of one issue potentially impacting the others. For example, the results of the benchmarking could change the MAAP4 parameter file used in the success criteria analyses. The benchmarking may also impact the T&H uncertainty issue since the accuracy of the MAAP4 code is a factor in the T&H uncertainty concerns. However, the benchmarking is also impacted by these other issues, since the success criteria analyses and T&H uncertainty concerns define the needs and context of interpretation of the benchmarking.

Therefore, although each issue must be addressed separately, they must be addressed in context of their impact on one another. This relationship is illustrated in Figure 1, which also includes how these three MAAP4 issues fit into larger AP600 issues. The resolution of the T&H uncertainty issue will be a final piece of a passive system reliability program. The completion of the final MAAP4 success criteria analyses will be a significant portion of the support for the Level 1 PRA success criteria definitions.

2.0 MAAP4 BENCHMARKING

This section describes the benchmarking that will demonstrate that the MAAP4 code models the AP600 plant response adequately enough to be used to select success criteria for the Level 1 PRA. The benchmarking focuses on MAAP4 accurately predicting success (no core damage) for the hardware configurations in the accident scenarios defined by the success paths on the PRA event trees. Models that impact the success criteria results are identified and designated "key models", and parameters that can be used to evaluate the performance of the key models are identified. Direct comparisons of these parameters for MAAP4 and NOTRUMP benchmark the performance over a range of core uncovery scenarios. An assessment of the MAAP4 code results with respect to OSU multiple-failure tests results provides additional support for the benchmarking.

2.1 Focus of the Benchmarking

MAAP4 was used as one of the tools to assist in the Level 1 PRA success criteria definitions for multiple-failure, beyond-design-basis scenarios. The purpose of the MAAP4 benchmarking is to determine if the MAAP4 code, as applied for AP600, is good enough to support the success criteria definitions. Although the issues to be addressed are thermal / hydraulic system response questions, the context of the issues is in support of the PRA. Since it is recognized that MAAP4 does not provide detailed thermal / hydraulic modeling, the PRA success criteria MAAP4 cases provide significant margin (on the order of hundreds of degrees) to the 2200°F peak clad temperature used to define core damage. The AP600 MAAP4 calculations only need to be justified to the extent that they accurately predict success (no core damage) for the given multiple-failure accident scenarios with respect to the NOTRUMP results for the same sequence.

The focus of the benchmarking will be on the core uncovery cases, since they are the most limiting. The benchmarking cases have been selected to address the important system responses that occur during the transients. Through the examination of core uncovery cases, the MAAP4 prediction of inventory loss and gain will also be addressed to confirm the validity of the no core uncovery cases. Complete listings of the key MAAP4 models that are of interest, and the benchmarking cases that will be used to confirm them, are discussed further in the next sections.

2.2 Key Models

The MAAP4 benchmarking plan is developed around the need to test key models within the MAAP4 code as they are applied for the AP600 success criteria analyses. The key models, the importance of the models and special concerns related to the MAAP4 implementation of the model are provided in Table 1. For each key model, the final column in Table 1 lists the parameters that will be used to examine the validity of the model based on the importance and concerns. The parameters of interest are defined as the minimum set of parameters that will provide an assessment of the adequacy of each of the MAAP4 key models. Each of the key models will be confirmed through at least one MAAP4 / NOTRUMP comparison case, unless otherwise noted on Table 1.

The key models encompass the systems that are actuated in the AP600 success criteria scenarios and their performance. The importance and concerns for the key models are based on the behavior of the AP600 plant, the limitations of the MAAP4 code modeling, and factors that were found to be important in the preliminary success criteria analyses. Additionally, a review of the small LOCA PIRT was performed so that no important phenomena would be excluded from the benchmarking (see Table 2).

2.3 Selection of Cases

This section describes the sequences that are selected to benchmark MAAP4 to NOTRUMP results. For each of these cases, MAAP4 and NOTRUMP analyses will be performed and the important parameters for the key phenomena will be compared.

Based on the preliminary success criteria analyses, the core uncovery cases can be grouped into three general categories.

1) Automatic ADS cases, small end of SLOCA and Transient initiating events. These cases are at the pressurizer safety valve setpoint pressure when ADS is actuated due to a low CMT level signal. Without crediting accumulators, the opening of the ADS valves causes the core to briefly uncover before the RCS pressure is reduced low enough for IRWST gravity injection.

2) Manual ADS cases, NLOCA initiating event. In these cases, the break is small enough to maintain the RCS pressure above the accumulator pressure until the core uncovers. After the core uncovers, accumulators play a role in limiting the depth of the uncovery.

3) Manual ADS cases, MLOCA initiating event. In these cases, the RCS depressurizes so

that the accumulator can inject to prevent core uncovery. However, when the accumulator empties, core uncovery can occur if the operator does not manually actuate ADS within a certain period of time.

The accident scenarios to be used for the MAAP4 benchmarking were chosen with the following considerations:

- to address the three types of core uncovery cases
- to best exhibit the key models as defined in Table 1
- to minimize the total number of cases.

The cases that were chosen are summarized in Table 3. For each case, Table 3 provides a description of the accident scenario (initiator and hardware assumptions), and identifies which of the key models will be examined for the case. Not every case is intended to be analyzed through IRWST injection. For example, case 4 is an 8.75" break that will be used to confirm that the cold leg break is not as limiting as an identical hot leg break (case 3). Case 4 will be analyzed with MAAP4 and NOTRUMP to show that the cold leg break uncovers the core later than the same hot leg break. Once this is demonstrated, the purpose of case 4 is fulfilled.

The cases selected for MAAP4 benchmarking are a representative sample of the more challenging cases from the success criteria analyses. They tend to be the more limiting cases, but are not chosen only for this reason. Although it is an advantage to have direct support of NOTRUMP analyses for the success criteria for the more limiting cases, it is primarily important that they efficiently exhibit the key models defined in Table 1. Not only can the more limiting cases be used to benchmark the core uncovery / heatup / recovery of MAAP4, they can also be used to examine MAAP4's predictions of inventory loss and additions. This method provides a reasonable assurance for the successful core cooling predictions by MAAP4 for other, less-limiting accident scenarios.

2.4 Standard of Comparison for the Benchmarking

By combining information in Table 1 and Table 3, a comprehensive list of the parameters that will be used for benchmarking can be obtained for each case. The MAAP4 and NOTRUMP analyses will be performed with system assumptions as similar as possible. The comparison will be limited to the parameters that are specified for the key models that are to be examined for each case. The standard of comparison will be based on the following questions:

- Does NOTRUMP predict successful core cooling for this accident scenario?

- Is there a major difference between MAAP4 and NOTRUMP's prediction that would give reason to doubt MAAP4's successful core cooling prediction of other accident scenarios?

- Do differences in accident timing predictions impact the operator action times that are credited in the MAAP4 analyses for the PRA?

2.5 Role of NOTRUMP

The NOTRUMP code is an approved Appendix K computer code for small-break LOCA transients. NOTRUMP is a one-dimensional computer code that has the capacity to analyze the thermal-hydraulic behavior of LOCAs with break areas up to 1.0 ft^2 (13.5" equivalent diameter). Preliminary validation documentation has been submitted to the NRC to license NOTRUMP for use on AP600.

NOTRUMP is used to calculate the overall reactor coolant system response to a LOCA. For core uncovery scenarios, output from NOTRUMP is used as input to the LOCTA computer code. LOCTA determines the temperature transient for an average rod in the hot assembly and the hot rod in the hot assembly. The calculations for the hot rod will be used for comparison to MAAP4 in the core uncovery cases.

For MAAP4 benchmarking, NOTRUMP will be used with nominal plant assumptions to match the MAAP4 analysis assumptions. This includes:

- Best estimate 1979 ANS decay heat
- Best estimate break flow
- Nominal accumulator conditions
- Nominal CMT conditions
- Nominal IRWST and injection line conditions

ADS parameters will remain at conservative values to minimize the depressurization capability, which is the same assumption used in the MAAP4 analyses for success criteria and for benchmarking.

The comparison between MAAP4 and NOTRUMP will be performed using the current version of NOTRUMP. If any changes are made to NOTRUMP in the final validation process, the code changes will be reviewed for applicability to and impact on the MAAP4 benchmarking.

2.6 Role of OSU Tests

A series of integral system tests were performed at Oregon State University (OSU). The tests were scaled to the AP600 plant, including the passive safety systems. The OSU test matrix was developed to investigate the AP600 passive safety system behavior and to provide data for safety analysis computer code validation. The majority of the tests that were run are for the validation of the NOTRUMP computer code. Two multiple-failure tests, SB26 and SB28, were designated for PRA purposes. Both tests experience limited core uncovery.

Similarities in the PRA tests include the failure of the PRHR and failure of all stage 4 ADS. The failure of the PRHR is important since the MAAP4 success criteria analyses do not credit the operation of the PRHR. The non-functioning of the PRHR also separates the two PRA OSU tests from all the others, which include PRHR operation. For this reason, the MAAP4 / OSU test assessment will be limited to the two multiple-failure scenarios without the PRHR. The two PRA scenarios are:

SB26 Inadvertent ADS
2 CMTs
2 Accumulators
All stage 2,3 ADS
2 lines IRWST

SB28 DEG DVI Line
1 CMT
1 Accumulator
All stage 1,2,3 ADS
1 line IRWST

The OSU tests are semi-scale, while the MAAP4 model is based on the full-scale AP600 plant. To assess MAAP4's AP600 model against the OSU tests, the output from MAAP4 will be scaled. This provides the advantage of being able to use the same AP600 MAAP4 model that is being used for the success criteria analyses. The OSU test scenarios will be run with the AP600 MAAP4 model. The output from MAAP4 will be scaled (e.g., 1/2 time, 1/96 mass flowrates) to assess the ability of the code to predict the same general conclusions found in the tests. The focus will be on water inventory and MAAP4's ability to predict core uncovery. Specifically, the parameters for comparison will be:

- Break flowrate (liquid and vapor)
- ADS flowrate (liquid and vapor)

- Injection flowrates from CMT(s), accumulator(s), and IRWST
- Water inventory of pressurizer, CMT and accumulator -- comparisons to be made based on fraction of initial level
- Heat-up of core

These parameters will be assessed for the short-term transient until the IRWST injection is able to recover the core. The standard of the assessment will be that MAAP4 is able to predict whether successful core cooling occurs.

In addition to the assessment of MAAP4's capability to predict the outcome of the two OSU PRA scenarios, the lessons learned at the OSU test facility will be reviewed for potential applicability to the MAAP4 success criteria analyses. Phenomena observed at the OSU test facility includes thermal stratification, rapid condensation, and flow reversal in the IRWST injection lines.

3.0 T&H UNCERTAINTY

Within the benchmarking process of the MAAP4 code and the success criteria analysis for the AP600 PRA, the issue of thermal / hydraulic uncertainty and its effect on the reliability of the passive systems is addressed with three major components:

1. The benchmarking of the MAAP4 code provides assurance that the models and the methodology applied in the success criteria analysis produce accurate results with respect to predicting the system behavior and core damage.

2. Significant margin (on the order of hundreds of degrees) to the 2200°F peak clad temperature used to define "core damage" is provided for the most thermal / hydraulically restrictive accident sequence represented on each success path in the PRA.

3. Sensitivity cases performed to demonstrate that the small uncertainties related to the physical plant do not produce large differences in the results with respect to successful core cooling. Given the large degree conservatism provided in the success criteria by the methodology used in the analysis, no such cliffs are expected.

    a. LOCTA will be used to perform sensitivities on core peaking factors that impact the calculation of PCT for the hot pin. Because the overall peaking factor, F_q and axial power shapes vary during a fuel cycle, it is difficult to define nominal values. It is anticipated that the benchmarking cases will be defined to have a conservative core model, but not necessarily the worst possible conditions that are assumed for Chapter 15 safety analyses. Therefore, sensitivity analyses will be performed with

LOCTA to show the effect of varying the core peaking factors. These sensitivity analyses will only be performed on core uncovery cases that are identified to benchmark the MAAP4 core heatup model.

b. MAAP4 will be used to perform several sensitivity studies for each benchmarking case. The sensitivity cases will be similar to those presented at the October 24-25, 1995 meeting between Westinghouse and the NRC. Anticipated sensitivities are:

- Minimum and maximum accumulator flowrate
- Minimum and maximum CMT flowrate
- Minimum and maximum IRWST flowrate
- Maximum ADS flowrate (minimum ADS flowrate is in the parameter file)
- 1971 ANS + 20% Decay Heat

4.0 MAAP4 SUCCESS CRITERIA ANALYSES

The final MAAP4 success criteria analyses will incorporate any insights or parameter changes from the benchmarking effort. The analyses will also include any plant design modifications that were incorporated into the parameter file. The cases will encompass the type of cases presented in the September 12-14, 1995 meeting between Westinghouse and the NRC. These cases include consideration of:

- Initiating event
- Range of break sizes and locations
- Number of CMTs and/or accumulators
- Different ADS assumptions
- Containment isolation
- Operator action times

The documentation will demonstrate a systematic process of grouping the event tree sequences into cases for MAAP4 analyses. Plots of PCT versus break size will be provided for each of the four major groupings of ADS success criteria.

5.0 SUMMARY OF BENCHMARKING PROCESS

This document has identified an overall closure process to address outstanding issues related to the use of MAAP4 for the AP600 success criteria analyses. The plan includes:

- MAAP4 benchmarking against NOTRUMP to examine key models

- MAAP4 / OSU assessment to further support the validity of MAAP4's predictions
- Performing sensitivity analyses to address uncertainties in system performance
- Analysis and documentation of MAAP4 cases supporting AP600 success criteria

Figure 2 shows a schematic of the process that will be used to bring the outstanding issues to closure. The closure process consists of 11 steps, as illustrated in Figure 2. Each of the steps are explained below.

1. Select benchmarking cases based on the key MAAP4 models and how they are important or why they are a source of concern.

2. Update the MAAP4 parameter file. There have been several plant design modifications since the MAAP4 success criteria analyses were begun in mid-1994. Although none of the changes are expected to effect the outcome of success, they will be factored into the MAAP4 parameter and input files. Plant parameters will be updated to correspond to the most recent nominal data. An exception is the ADS valve data, that will remain at the minimum flow area values.

3. Run NOTRUMP / LOCTA for cases selected in step 1. For each benchmarking case, parameters of interest are identified. NOTRUMP will be run for each case to capture these parameters of interest. For core uncovery and heatup cases, LOCTA will be run to determine the temperature response of the hot fuel pin.

4. Run MAAP4 and compare results to NOTRUMP / LOCTA.

5. Examine insights from the OSU tests. The OSU test facility was extensively exercised to demonstrate the response of a scaled AP600 plant design. Through this process, insights were gained into the behavior of the RCS and associated components. Results from the OSU tests will be reviewed for applicability to the MAAP4 analyses.

6. Run the AP600 plant model with MAAP4 to simulate selected accident scenarios from OSU tests. The AP600 MAAP4 results will be assessed against the results from the same scenario at the low-pressure, scaled OSU test facility. The output from the AP600 MAAP4 model will be scaled based on the OSU test facility scaling. This will allow an assessment to be made of MAAP4's capability to predict the overall plant behavior, such as CMT injection, accumulator injection, IRWST injection, core uncovery, and heatup of the core.

7. Determine if the EPRI-recommended MAAP4 model parameters are adequate. This determination will be based on the MAAP4 / NOTRUMP comparison and the MAAP4 / OSU assessment. If MAAP4 is predicting the important system responses well enough to support the success criteria definitions, the resolution process will move forward with steps 8 and 10 in parallel. If, however, there is not a good comparison between the codes, MAAP4 model parameters (e.g., VFSEP, HTSTAG, FVOL) will be modified. The MAAP4 model parameters are currently set to EPRI-recommended values. Any modification of these parameters will be done in a systematic manner that either changes the value for all cases, or is based on phenomena that are specific to a set of cases.

8. Perform sensitivities. The benchmarking cases will have been analyzed with both MAAP4 and NOTRUMP based on nominal plant conditions. Sensitivity analyses will be presented for each benchmarking case to show the effect of varying physical plant parameters over a minimum and maximum range. The goal of the sensitivity analyses is to show the effect of varying individual or related groups of parameters. In all cases, the effect will be shown to be small enough to have no impact on the conclusions of the success criteria analyses.

9. Document the MAAP4 benchmarking and sensitivities in a WCAP.

10. Run the final MAAP4 success criteria cases with the MAAP4 parameter file confirmed by the benchmarking. This step can be started when step 7 is successfully completed.

11. Document the success criteria analyses in a revision to Appendix A of the PRA. The documentation will demonstrate a systematic process of grouping the event tree sequences into cases for MAAP4 analyses. Plots of PCT versus break size will be provided for each of the four major groupings of ADS success criteria.

Table 1 Key MAAP4 Models Used in Success Criteria Analysis		
Model	**Importance / Concerns**	**Parameters of Interest**
Core Uncovery and Heatup	• The peak core temperature is used to determine whether a sequence is defined as "success" or "damage." • MAAP4's core model does not simulate the hot pin; therefore MAAP4's peak temperature prediction needs to be compared to a more detailed model. • Approximately half of the success criteria analyses result in partial core uncovery. They are primarily manual ADS scenarios that rely on operator action.	• Core mixture level • Peak core temperature • Decay heat
ADS Stage 4	• Credited in full depressurization cases to depressurize the RCS so that IRWST gravity injection can occur. 2 out of 4 stage 4 ADS lines is the success criterion for all full depressurization cases.	• ADS liquid flow rate • ADS vapor flow rate • RCS pressure
CMT	• CMT provides cooling and inventory make-up for LOCAs • CMT level determines the time of ADS actuation	• CMT injection flow rate • CMT recirculation flow rate • CMT level • Time CMT recirculation transitions to CMT injection • Time CMT low level setpoints are reached
IRWST Injection	• IRWST injection is the mechanism for long-term cooling in the full depressurization cases • IRWST injection recovers the core, or keeps the core from uncovering • IRWST injection is sensitive to the ΔP between containment and the RCS.	• IRWST injection flow rate • RCS pressure • Containment pressure • Core mixture level
Break	• Inventory loss through the break determines whether core is covered • System depressurization defines break size ranges for LOCA categories • Location of break at bottom of hot leg was a major consideration in defining success criteria, particularly for larger breaks	• Liquid break flow rate Vapor break flow rate • RCS water inventory • RCS pressure
RCS Natural Circulation	• MAAP4's VFSEP model can have an impact on: - whether the break location is covered with water - the end of CMT recirculation and the start of CMT injection	• Liquid break flow rate • Vapor break flow rate • Time CMT recirculation transitions to CMT injection
Accumulator (1)	• The accumulator injection prevents core uncovery for larger (> 6") breaks. • The accumulator injection plays a role in limiting the PCT for breaks around 3" to 5". • The accumulator and CMT share the DVI line, and interaction between the tanks must be considered. • The MAAP4 accumulator model is isothermal.	• Accumulator injection flow rate • Core mixture level • RCS pressure

Table 1
Key MAAP4 Models Used in Success Criteria Analysis

Model	Importance / Concerns	Parameters of Interest
ADS Stage 1 - 3 (2)	• For high pressure scenarios, credited to reduce pressure so that stage 4 ADS can open • Credited in partial depressurization cases to depressurize the RCS below RNS shutoff head. • Location is at top of pressurizer, and entrainment of water into pressurizer could affect depressurization capability.	• ADS liquid flow rate • ADS vapor flow rate • Pressurizer inventory • RCS pressure
SG Heat Transfer	• Heat transfer to SGs plays a role in Transients and SLOCAs; RCS inventory loss starts or increases when SGs dry out	• SG heat transfer
PRHR	• ADS success criteria with the PRHR operable are not directly supported by MAAP4 analyses.	Not Applicable

Notes:

(1) Interaction between accumulator and CMT will not be shown in MAAP4 / NOTRUMP comparison. The MAAP4 / OSU assessment will address this issue.

(2) The MAAP4 / NOTRUMP comparison will only examine ADS Stage 1 - 3 as a precursor to ADS Stage 4. The behavior of ADS 1 -3, by itself, can be seen through the MAAP4 / OSU assessment.

Table 2 Comparison of SBLOCA PIRT to MAAP4 Key Models	
High Importance Components / Phenomena from Final PIRT for SBLOCA	**Key Model in MAAP4 Benchmarking Plan Through Which Phenomena / Parameter is Examined**
Decay Heat	Core Uncovery and Heatup
Vessel/Core Mixture Level Mass Inventory	Core Uncovery and Heatup
ADS Stage 4 Critical flow	ADS Stage 4
CMT Draining Effects • Interfacial condensation on CMT water surface • Dynamic effects of steam injection and mixing with CMT liquid and condensate • Thermal stratification and mixing of warmer condensate with colder CMT water	CMT (2)
CMT Recirculation • Natural circulation of CMT and CL balance line • Liquid mixing of CL balance leg, condensate, and CMT liquid	CMT (2)
CMT Balance Lines • Pressure Drop • Flow Composition	CMT (2)
IRWST • Pool Level • Gravity Draining	IRWST
Break Critical flow	Break
Cold Legs • PBL-to-Cold Leg Tee • Phase Separation	See Note 1
Accumulator Injection flow rate	Accumulator
ADS Stage 1 - 3 • Critical Flow • Two-phase pressure drop • Valve loss coefficients	ADS Stage 1 - 3 (3)
Downcomer / Lower Plenum Level	See Note 1
Pressurizer Flashing	ADS Stage 1 - 3 (4)

Table 2 Comparison of SBLOCA PIRT to MAAP4 Key Models	
High Importance Components / Phenomena from Final PIRT for SBLOCA	**Key Model in MAAP4 Benchmarking Plan Through Which Phenomena / Parameter is Examined**
Upper Head / Upper Plenum Mixture Level	See Note 1

Notes:

1. Not directly addressed because MAAP4 has a simplistic mass inventory distribution.
2. The CMT phenomena will be addressed in the broader context of how they impact recirculation and injection flow rates.
3. The ADS stage 1 - 3 valve loss coefficients and two-phase pressure drop will be addressed through the effect on the ADS flow rate.
4. Pressurizer flashing only plays a significant role in the MAAP4 analyses during depressurization through stages 1 - 3

Table 3
Key Models for MAAP4 Benchmarking

Case	Comparison Basis	Model to be Confirmed								
		Break	CMT	ADS 1-3	ADS 4	Core	IRWST	Acc	SG	Additional Features
1. 0.5" cold leg 1 CMT No Accumulators 1 stage 3, 2 stage 4 ADS 1 line IRWST	NOTRUMP / LOCTA	x	x	x	x	x	x		x	
2. 3.0" hot leg No CMT 1 Accumulator 2 stage 4 ADS - 30 minute op action 1 line IRWST	NOTRUMP / LOCTA	x			x	x	x	x		
3. 8.75" hot leg No CMT 1 Accumulator 2 stage 4 ADS - 30 minute op action 1 line IRWST	NOTRUMP / LOCTA	x			x	x	x	x		
4. 8.75" cold leg No CMT 1 Accumulator Stop when core uncovers	NOTRUMP	x						x		Confirms that inventory loss from cold leg is not as limiting as hot leg
A. Inadvertent ADS 2 CMTs 2 Accumulators All stage 2,3 ADS 2 lines IRWST	OSU Test SB26		✓	✓		✓	✓	✓		
B. DEG DVI Line 1 CMT 1 Accumulator All stage 1,2,3 ADS 1 line IRWST	OSU Test SB28	✓	✓	✓		✓	✓	✓		

Notes:

x - The parameters to compare these models to NOTRUMP results are identified in Table 1.
✓ - The parameters to compare these models to OSU test results are identified in Section 2.6.

Figure 1

Relationship of MAAP4 Issues and Impact on Larger AP600 Concerns

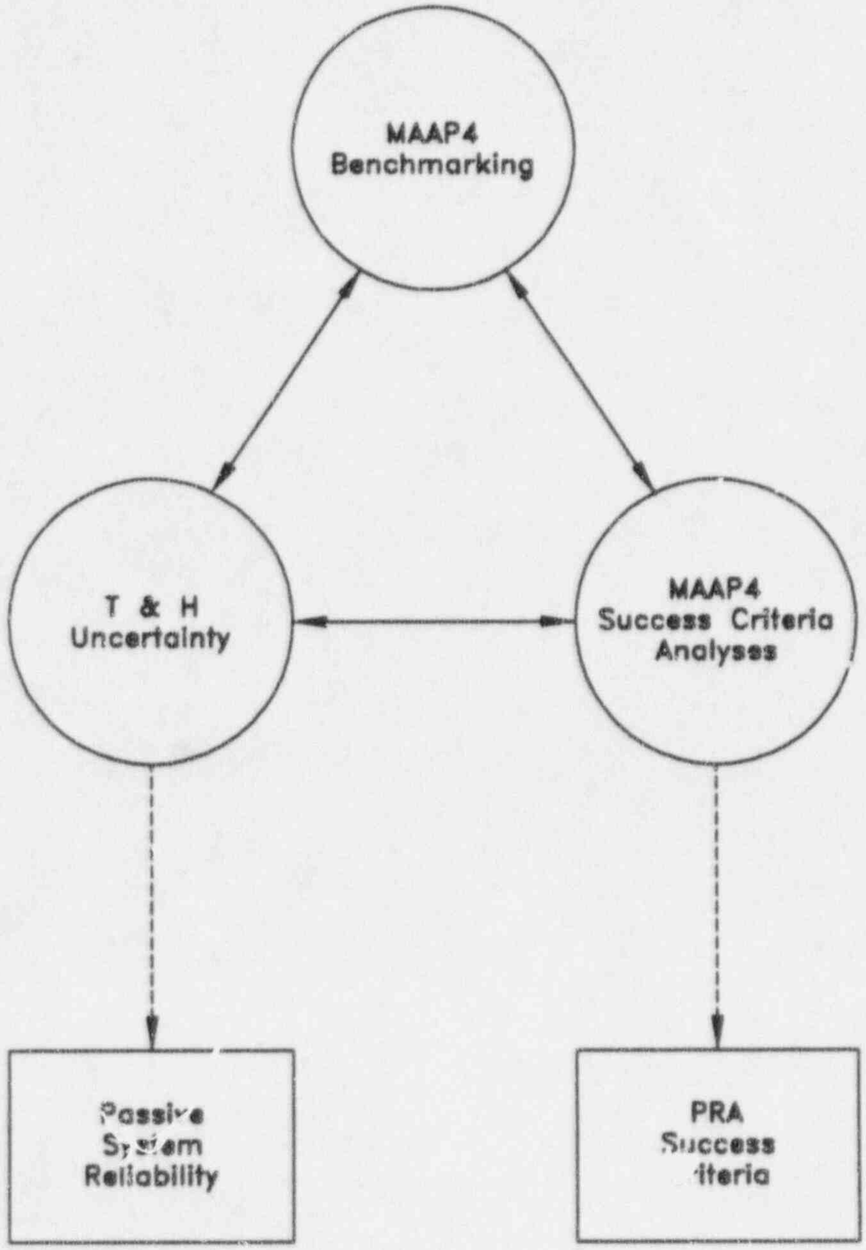

Figure 2
Flow Chart of Closure Process for MAAP4 Issues