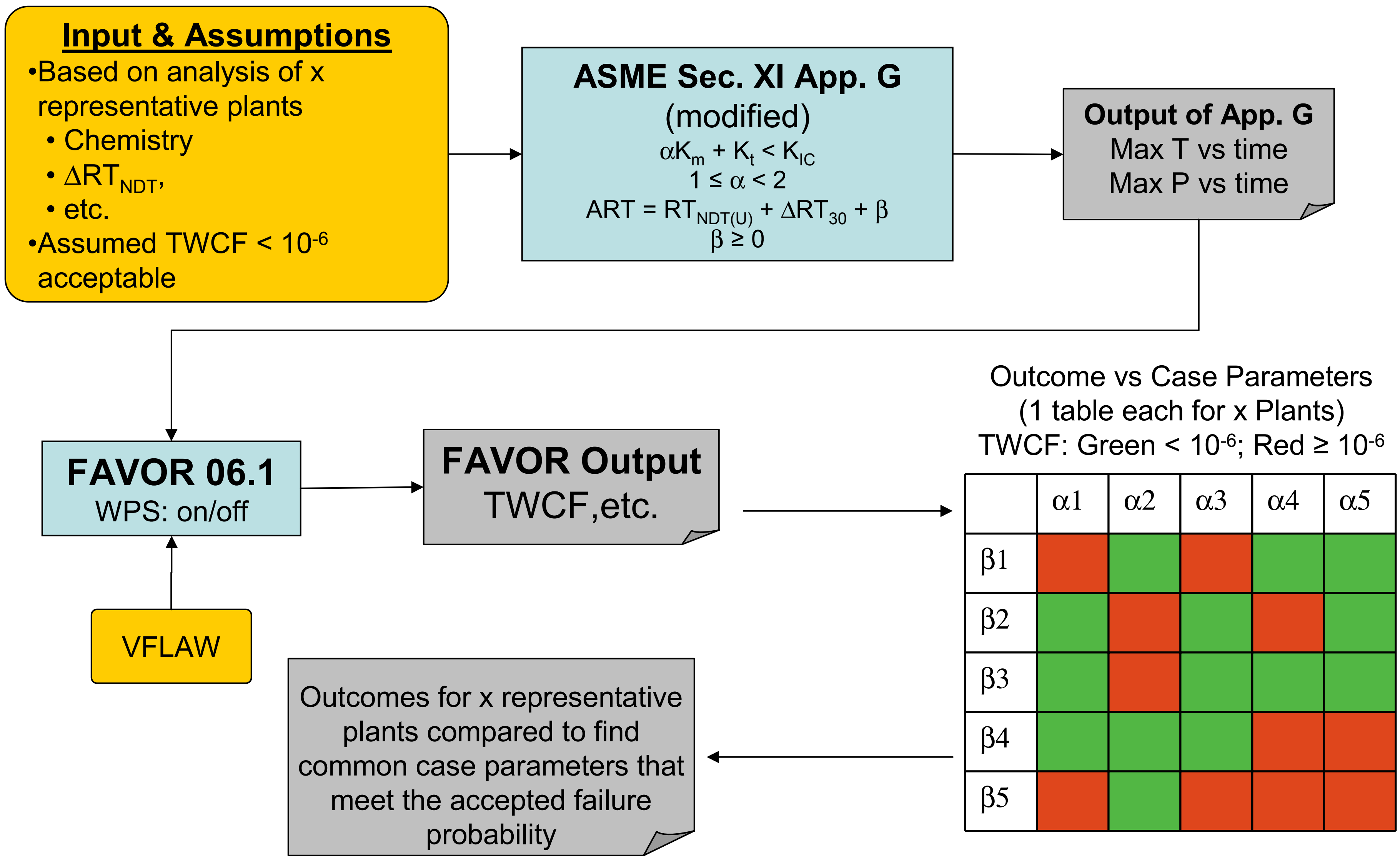
Suggested Topics for Further Discussion Regarding Industry’s Proposed Approach to Risk Informing ASME SEC. XI App. G

Approaches Proposed by Industry at 21 August 2008 Meeting

- Modified Appendix-G approach
- Parameterized transient approach

NRC Understanding of Industry Proposed "Modified App. G Approach"



Modified App. G Approach

It is our understanding that for the "Modified App. G Approach" (our nomenclature):

- The material presented at the 8/21/08 meeting by industry represented work in progress.
- Representative plants were selected for the analyses based on criteria set up to look at plants with high ART at EOL as well as other plants to help represent the wider array of plants in service (i.e. not all plants analyzed were necessarily limiting in some way).
- A maximum through-wall cracking frequency (TWCF) of 10^{-6} was used as the risk metric.
- To estimate TWCF an occurrence rate of y cooldowns per year was assumed.
- The T vs time and P vs time transients that get entered into FAVOR are first generated using the methodology prescribed in ASME Sec. XI App. G, but with a modified factor on Km, a modified margin term from ART (per Reg. Guide 1.99 Rev. 2) and a variety of cooling rates.
  - Warm pre-stress was also toggled "on" or "off"
- The resulting P vs time and T vs time curves were used as the thermal hydraulic input into FAVOR 6.1 to then determine the TWCF for each set of α and β (from previous slide).
  - VFLAW was used as the flaw distribution
- The TWCF of each FAVOR run for each plant was compared to determine the optimum values of the α and β parameters that would result in a risk-informed revision to the methodology in ASME App. G.

Parameterized Transient Approach

Input & Assumptions

- Limiting plant – Indian Point Unit 3
- Assumed TWCF < 10^{-6} acceptable
- Chemistry
- ΔRT_{NDT}, etc.

Transient Input

- Based on design and operational constraints
- Bounding T vs time and P vs time
- Parameterized transients: initial & final cooling rates, hold times for pressure, switchover to RHR, etc..
- Not based on ASME App. G limits

FAVOR 6.1

WPS: on/off

VFLAW

FAVOR Output

TWCF as a function of transient parameters for limiting plant

Parameterized Transient Approach

It is our understanding that for the Parameterized Transient Approach (our nomenclature).

- The material presented at the 8/21/08 meeting by industry represented work in progress.
- One limiting plant was analyzed (Indian Point Unit 3).
- A maximum through-wall cracking frequency (TWCF) of 10^{-6} was used as the risk metric.
- The transients represented more realistic cool-down transients with design and operating constraints being considered.
  - Pressure hold times, initial cooling rates, RHR cooling rates, etc. were parameterized.
- The parameterized transients were used as the thermal hydraulic input into FAVOR 6.1 as bounding transients.
- FAVOR output was used to determine the transient parameters that met the risk metric (WPS on/off, pressure hold times).

NRC Suggestions for Discussion

Based on our understanding of the approaches to risk-informing ASME Section XI Appendix G presented at the August 21, 2008 meeting, NRC staff suggests that the following items be discussed, if possible, at the October 9, 2008 meeting:

- As summarized in the earlier slides, at the meeting on 21 August we understood two different approaches to risk-informing Appendix G to have been presented. Perhaps this understanding was mistaken. We suggest you discuss how what we have identified as two different approaches (this may or may not be true) both contribute in a consistent and integrated manner toward the risk-informed revision of Appendix G. Also, we suggest you comment on / correct any inaccuracies that you see in our explanation of your two different approaches.

NRC Suggestions for Discussion

- As was discussed during our meeting of August 21, 2008, the NRC staff is still debating the risk limit that it is appropriate to use to risk-inform Appendix G. This debate includes a consideration of the appropriate definition of the risk metric (e.g., through wall cracking frequency, crack initiation frequency, LERF, core damage, etc.), and the selection of its numeric value. Based on the information you presented on August 21st , it is our understanding that the risk limit (both metric definition and numeric value) is a key input to the calculations you use to define your "risk-informed margins" on the applied fracture driving force arising due to pressure and on the transition temperature shift. Given these observations, we would be interested in discussing the following matters:

  – We would like to discuss how you to both define and defend the risk limit (both metric definition and numeric value) that you have used in your calculations. Also, should the staff arrive at a different opinion than you regarding the risk limit, it would seem important to ensure that your results are adequately detailed such that different values of "risk informed margins" could be determined should a different risk limit than you recommend be selected in the end.
  – There may be some trade-off between compensatory actions (e.g. ISI to verify flaw distribution) and the definition of the risk limit. For example, it might be possible to avoid the imposition of compensatory actions should an adequately conservative risk-limit be selected. We would be interested in your views on, and on your rationale for, trade-offs between compensatory actions and the definition of the risk limit.

NRC Suggestions for Discussion, cont.

- Is there a limitation on the number of per-plant heat-up and cool-down transients for which the analyses are valid?
- Will cyclic plasticity effects due to multiple heat-up and cool-down transients be incorporated into the analyses?
- How will the effect of multiple HU & CD transients be addressed in terms of allowing crack initiation? Specifically, how will the analysis be affected if the assumed flaw size distribution in FAVOR is no longer valid after a crack initiates?
- Are there any limitations that must be placed on your approach(es) related to materials?
- Are there any parameters associated with your approach that may limit its applicability to all plants?
- Is there a limit on the ART to which the proposed approach will apply? In other words, is the technical basis valid only for an ART up to and including the ART used for the most limiting plant analyzed?
- What were the assumptions regarding flaw distribution?
- How will sub-clad cracking addressed?
- How are the actual flaw size distributions for plants verified to show that they match the one used in FAVOR? Does the proposed methodology assume/impose any limits on the number, size and density of flaws allowed in the vessel?

NRC Suggestions for Discussion, cont.

- If the new P-T limit curves are violated in service, how does that affect ASME SC XI Appendix E requirements?
- Are the results of the analyses invariant with respect to the starting temperature of the transient (both HU and CD)? What were the ranges of values used for the analyses?
- How will nozzles and other ferritic components of the reactor coolant pressure boundary be addressed? Will a different technical basis need to be prepared to address areas other than the beltline?
- For BWRs, will stress corrosion cracking of the cladding be incorporated into the analyses?
- Does the analysis for the BWR leak test assume that both internal and external flaws exist simultaneously in the vessel during the test?