From:	Krepel, Scott
To:	Russell, Andrea; Patton, Rebecca
Cc:	Lukes, Robert
Subject:	RE: Another AP1000 STS Question: STS Bases 3.1.2
Date:	Monday, May 03, 2021 2:35:26 PM

There are actually two separate revisions to the TS Bases, and Becky is correct that this isn't unique to Vogtle—it could apply to any PWR in the operating fleet.

The first revision updates the text to indicate that the hot excess reactivity (HEXR) is "changing" rather than "decreasing (with the possible exception of near BOC). That is generally accurate, and I can see how the older wording may be a little misleading because core designs developed for longer cycles at EPU-type conditions in conventional PWRs can end up with high enrichment fuel and a large amount of burnable absorbers. That can cause the HEXR to increase from equilibrium-xenon BOC conditions to roughly midcycle, when the burnable absorbers are mostly depleted and then the natural reactivity reduction from U-235 depletion takes over. This is something that didn't happen decades ago when the STS for conventional PWRs were written, since the core energy requirements weren't large enough to pursue these kinds of core design strategies.

The second revision seems to suggest that the basis for the boron concentration should be the boron concentration calculated using "a calculational model consistent with the design analysis," using "consistent core conditions," rather than directly comparing it to the predicted boron letdown curve. To understand the distinction, it's helpful to understand that legacy PWR approaches in monitoring the boron letdown typically include a boron letdown curve calculated at hot full power (HFP) conditions, plus a whole slew of tables that provide reactivity adjustments for off-nominal conditions. Thus, if a plant does their monitoring when their core is not at nominal HFP conditions, they can use these adjustments to "correct" the critical boron concentration and use that value to compare to the predicted boron letdown curve. Today, advances in computing power mean that it is pretty easy to just directly calculate the critical boron concentration within minutes for any core condition you want. So, doing the monitoring against an "updated reference calculation" for the critical boron concentration makes sense. That said, I don't know the details of how the Vogtle TS requirements are written or the internal plant procedures for meeting the requirement. There is some caution advisable in the statement "a calculational model consistent with the design analysis." Core monitoring models used by plants are typically built based on the design analysis models, but during core operations, the models are "corrected" to reflect various small deviations that may accumulate in the depletion characteristics of the core based on differences between the measured vs predicted power distributions. This is appropriate for thermal limits monitoring, since you want to ensure that your model used to verify thermal limits is the best possible fit to the actual conditions. However, these models may not be good models to use in doing a critical boron concentration comparison because the intent of this comparison is to ensure that the core reactivity does not deviate too much from the core reactivity used in the safety analyses. You'd need to use the actual design analysis models, not "corrected" models, since much of the potential deviation that you're looking for may already have been eliminated from the "corrected" model. This is an important distinction that isn't always obvious to operators/reactor engineers at the plant.

To summary, the change seems reasonable, as long as they aren't getting too loose with their definitions on how the boron concentration monitoring is done.

Scott Krepel
SNSB Branch Chief
OWFN 10-H12
423-331-0893 (text message)

From: Russell, Andrea <Andrea.Russell@nrc.gov>
Sent: Monday, May 03, 2021 2:05 PM
To: Patton, Rebecca <Rebecca.Karas@nrc.gov>
Cc: Krepel, Scott <Scott.Krepel@nrc.gov>; Lukes, Robert <Robert.Lukes@nrc.gov>
Subject: RE: Another AP1000 STS Question: STS Bases 3.1.2

Thanks Rebecca. I appreciate any help.

Bob – I copied you on this to bring you in on the question. I have an AP1000 STS question that I sent to Rebecca. She provided to Scott and thought maybe you may have some input. See e-mail thread below.

Any help with this would be appreciated.

From: Patton, Rebecca <Rebecca.Karas@nrc.gov>
Sent: Monday, May 03, 2021 1:57 PM
To: Russell, Andrea <Andrea.Russell@nrc.gov>
Cc: Krepel, Scott <Scott.Krepel@nrc.gov>
Subject: RE: Another AP1000 STS Question: STS Bases 3.1.2

So, just on a quick read – the new language is probably more accurate. There's nothing unique about AP1000 with respect to this, though. They are probably using "changing" instead of "decreasing" because its more accurate. It's not always decreasing. I would actually suggest this should maybe be looked at by someone in another branch, as whatever we do here should probably be done for the op fleet also. Cc'ing Scott for suggestions – or maybe Bob's branch?

From: Russell, Andrea <Andrea.Russell@nrc.gov>
Sent: Monday, May 03, 2021 1:12 PM
To: Patton, Rebecca <Rebecca.Karas@nrc.gov>
Subject: Another AP1000 STS Question: STS Bases 3.1.2

Rebecca

I have another AP1000 STS question. Not sure who on your staff would be able to assist, but here goes…

TS 3.1.2 for the Vogtle TS Bases was revised in Revision 48. I could not find any LAR associated with the changes so have no information regarding the justification for the changes. Craig asked that I determine the validity of the changes and whether those changes should be incorporated into the STS. I have looked in the UFSAR for Vogtle and the Westinghouse STS and have not been able to determine whether the language in the Vogtle bases should be adopted into the standard and the justification for that language. The third and fourth columns below are Craig's comments to me and my response. Below this e-mail is my initial e-mail to Craig and his response (for background).

Here's the generic CAC if needed: A11008/ /L-2018-PSS-0000

Any help would be appreciated in determining whether the Vogtle language should be adopted into the STS and if you know of the reasoning behind the changes.

VEGP TS Bases up to Rev 59	AP1000 STS Bases draft Rev. 1	Differences	Disposition / Action
Bases Subsection B 3.1.2 Rev. 48		-	-
Background paragraph 4 When the core is producing THERMAL POWER, the fuel and burnable absorbers are being depleted and excess reactivity is changing. As the fuel and burnable absorbers deplete, the RCS boron concentration is periodically adjusted to compensate for the net core reactivity change ... and to reposition the Control Banks within the limits defined in LCO 3.1.6, "Control Bank Insertion Limits." A predicted RCS boron concentration can be determined for any core condition using a calculational model consistent with the design analysis. Therefore, deviations from the predicted RCS boron concentration with otherwise consistent core conditions may indicate deficiencies in the design analysis, deficiencies in the	**Background** paragraph 4 When the core is producing THERMAL POWER, the fuel and burnable absorbers are being depleted and excess reactivity (except possibly near beginning of cycle (BOC)) is decreasing. As the fuel and burnable absorber deplete, the RCS boron concentration is adjusted to compensate for the net core reactivity change while maintaining constant THERMAL POWER. The boron letdown curve is based on steady state operation at RTP. ... ... Therefore, deviations from the predicted boron letdown curve may indicate deficiencies in the design analysis, deficiencies in the calculational models, or abnormal core conditions, and must be evaluated.	Need to verify that VEGP Unit 3 FSAR supports differences in PTS Bases introduced by Rev. 48, and which, if any, LAR was associated with Rev. 48 changes. Response (apr): Could not find any LAR associated with Rev. 48 changes. I have looked at the UFSAR and while I find some information regarding the changes in the PTS in Chapter 4 and Chapter 15, I do not know enough about this system to determine whether the text should be	**Action (apr):** Determine validity of PTS Bases changes in Rev. 48 and whether the

calculational models, or abnormal core conditions, and must be evaluated.		incorporated into the STS. I could not find any written justification for the changes. W-STS Bases says this: When the core is producing THERMAL POWER, the fuel is being depleted and excess reactivity is decreasing. As the fuel depletes, the RCS boron concentration is reduced to decrease negative reactivity and maintain constant THERMAL POWER. The boron letdown curve is based on steady state operation at RTP. Therefore, deviations from the predicted boron letdown curve may indicate deficiencies in the design analysis, deficiencies in the	revised text should be incorporated in STS Bases. Ensure written justification for changes is included in new GTST for Subsection 3.1.2, if PTS text is adopted. **Disposition:** **Action (BNL):** Implement disposition in new GTST for Subsection 3.1.2	

		calculational models, or abnormal core conditions, and must be evaluated.	

From: Harbuck, Craig <Craig.Harbuck@nrc.gov>
Sent: Monday, May 03, 2021 10:38 AM
To: Russell, Andrea <Andrea.Russell@nrc.gov>
Subject: RE: STS Bases 3.1.2

I suggest looking at W-STS 3.1.2 Bases Background section corresponding paragraph(s)

Also, suggest asking for opinion of reactor systems branch reviewer who helped us before.

From: Russell, Andrea <Andrea.Russell@nrc.gov>
Sent: Monday, May 03, 2021 8:27 AM
To: Harbuck, Craig <Craig.Harbuck@nrc.gov>
Subject: STS Bases 3.1.2

Craig

I have looked at the FSAR for Vogtle and do not know enough about this system to make the finding that the PTS bases language should be adopted. I found some supporting information in Chapter 4 and 15 of their FSAR, but it is like finding a needle in a haystack and following bread crumbs for me to try and determine whether their language is supported by what is in their FSAR. Below is what I provided in the comparison document for you to look at and let me know how you want me to proceed.

3.1.2 Background Paragraph 4

VEGP TS Bases up to Rev 59	**AP1000 STS Bases draft Rev. 1**	Differences	**Disposition / Action**
Bases Subsection B 3.1.2 Rev. 48			
Background paragraph 4 When the core is producing THERMAL POWER, the fuel and burnable absorbers are being depleted	**Background** paragraph 4 When the core is producing THERMAL POWER, the fuel and burnable absorbers are being depleted and excess reactivity (except possibly near		

and excess reactivity is changing. As the fuel and burnable absorbers deplete, the RCS boron concentration is periodically adjusted to compensate for the net core reactivity change … and to reposition the Control Banks within the limits defined in LCO 3.1.6, "Control Bank Insertion Limits." A predicted RCS boron concentration can be determined for any core condition using a calculational model consistent with the design analysis. Therefore, deviations from the predicted RCS boron concentration with otherwise consistent core conditions may indicate deficiencies in the design analysis, deficiencies in the calculational models, or abnormal core	beginning of cycle (BOC)) is decreasing. As the fuel and burnable absorber deplete, the RCS boron concentration is adjusted to compensate for the net core reactivity change while maintaining constant THERMAL POWER. The boron letdown curve is based on steady state operation at RTP. … … Therefore, deviations from the predicted boron letdown curve may indicate deficiencies in the design analysis, deficiencies in the calculational models, or abnormal core conditions, and must be evaluated.	Need to verify that VEGP Unit 3 FSAR supports differences in PTS Bases introduced by Rev. 48, and which, if any, LAR was associated with Rev. 48 changes. Response (apr): Could not find any LAR associated with Rev. 48 changes. I have looked at the UFSAR and while I find some information regarding the changes in the PTS bases language in Chapter 4 and Chapter 15, I do not know enough about this system to determine whether the text should be incorporated into the STS. I could not find any written justification for the changes.	**Action (apr):** Determine validity of PTS Bases changes in Rev. 48 and whether the revised text should be incorporated in STS Bases. Ensure written justification for changes is included in new GTST for Subsection 3.1.2, if PTS text is adopted. **Disposition:** **Action (BNL):** Implement disposition in new GTST for Subsection 3.1.2

conditions, and must be evaluated.			

Andrea Russell
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