

**From:** Paul, Jamie [jpaul@STPEGS.COM]  
**Sent:** Saturday, September 17, 2011 1:26 PM  
**To:** Singal, Balwant; Tregoning, Robert  
**Cc:** 'fleming@ti-sd.com'; Harrison, Albon; Grantom, Carl  
**Subject:** Responses to LOCA frequency questions / information requests

Rob, below are Karl's responses to your information request. Balwant has asked that he be in the loop for all communications between us and the staff on this topic. We have asked our contract technical experts to comply with this request.

Respectfully,  
Jamie

Rob:

We are in the late stages of finalizing our report on LOCA frequencies and yes we have in fact made some changes to our approach based on recommendations made by Ali Mosleh who is performing an independent review of our approach. Here are some highlights of what you will see in this report that is different.

1. We have adopted a Geometric Mean (GM) method of forming composite distributions from the NUREG-1829 questionnaires that is similar to what we believe was done in NUREG-1829. We have done this for the hot leg, cold leg, surge line, and HPI line (version with volume injection). We have also investigated the Mixture Distribution method and rejected it as it is too heavily influenced by the most pessimistic and optimistic experts.
2. Our Target LOCA frequencies are now based on a Mixture distribution of the GM distributions (item 1) and the results of the Lydell Base Case analysis for the same components. This has the effect of broadening the distributions somewhat compared to just using the GM distributions alone. This approach also has input from Dr. Mosleh.
3. We have developed a two page flow chart that maps out all the steps in our procedure on Dr. Mosleh's recommendation. This should help the NRC with its review of the report.
4. We have now completed the development of failure rates LOCA frequencies for 41 categories of pipe welds including quantification of epistemic uncertainties. These categories cover the different combinations of systems, weld types, damage mechanisms, and pipe sizes for the STP piping. For each case the LOCA frequencies span from 0.5in. (lower bound for a small LOCA) to the equivalent break size of a DEGB for each pipe size. There is a great degree of component to component variability across the component categories – more than 2 orders of magnitude in the mean value variations. This stems primarily from the variability in the failure rates. Bimetallic welds and small bore pipes have relatively high failure rates, and similar metal welds with no identified damage mechanisms and larger bore pipes have relatively low values.
5. We have also calculated the total LOCA frequencies for Small Medium and Large LOCAs and for each of the six LOCA categories defined in NUREG-1829. When comparing against the NUREG-1829 results for pipe caused LOCAs (we will address non-pipe contributions next year), our results are very close for Categories 1-4 and somewhat higher for 5 and 6. Most of the delta for

categories 5 and 6 comes from rather recent evidence of unusually high failure rates for B-F Hot leg welds at the SG inlet – based on data collected following SG replacement.

6. We are holding off on applying the Markov model (used to adjust the frequencies to reflect the impact of NDE inspections) until we understand which locations are most important to debris formation.
7. Now that we have had a chance to exercise our approach through the complete set of pipe components and the fact that our total LOCA frequencies are in reasonable agreement with previous estimates of LOCA frequencies we believe that we have a reasonable approach to location specific LOCA frequencies. We found suggestions made by Dr. Mosleh to be helpful. His report on his independent review will be made available when its completed.

Once our report gets through the internal review process we hope to make it available to the NRC so its available in advance to support the planned phone meeting first week of October.

Regards:

Karl

On Jul 11, 2011, at 7:56 AM, "Tregoning, Robert" <[Robert.Tregoning@nrc.gov](mailto:Robert.Tregoning@nrc.gov)> wrote:

Karl:

I also took a quick look at your spreadsheet and noted several other errors and or questions I have.

1. The distributions that you calculate for getting the 40-year estimates are not correct. While the medians from the two input distributions can be simply multiplied to get the median of the composite distribution, the 5<sup>th</sup> and 95<sup>th</sup> percentiles are not obtained by simply multiplying the 5<sup>th</sup> and 95<sup>th</sup> percentiles from the two input distributions.
2. I don't see how you get composite distributions. You simply identify the median of the cumulative distributions in Column AA. You summarize these medians in the table (columns AD – AJ) and then use the lookup function to always use participant 4's result (Participant E) in columns AK – AQ. I don't see how this represents a composite distribution. Can you explain?

Rob

Robert Tregoning

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**From:** Karl Fleming [<mailto:fleming@ti-sd.com>]  
**Sent:** Saturday, July 09, 2011 3:55 PM  
**To:** Tregoning, Robert  
**Cc:** 'Bengt O.Y. Lydell'  
**Subject:** RE: Question on NUREG-1829 information

Bob:

Recalling our phone call this week when we discussed the inputs received from the NUREG-1829 experts and the possibility that one (or more?) of the experts may have provided discrete rather than the cumulative values as were expected. When we used the information from the 9 experts who gave component level inputs in the supporting input tables to develop our composite distributions we came to the following ideas about which of these inputs may have not been made on a cumulative basis. The results of the following steps in reviewing the NUREG-1829 supporting data are provided on the attached spreadsheet.

1. We copied the data in the tables in "PWR Piping Raw Data\_NUREG-1829b.pdf" into an excel spreadsheet (attached)

2. We multiplied the base values in the first three columns of data times the multipliers in the third set of 3-column data to compute the equivalent 40-year LOCA frequencies for each of the experts
3. Under the assumption that the result of Step 2 are cumulative with respect to LOCA category, we then calculated the corresponding discrete values.
4. From Steps 1, 2, and 3, we strongly suspect that Participant I did not provide cumulative inputs because his 40 year LOCA frequencies are not monotonically decreasing as they should be and some of the resulting discrete values are therefore negative.
5. From our analysis of Expert E it is not clear whether those inputs were intended by the Participant to be cumulative or discrete. If they were intended to be cumulative it means that he assigned zero chance that the surge line could produce a Category 1 LOCA. Alternatively if his input was intended to suggest that LOCAs in Categories 1 and 2 were equally likely, then it would appear that Expert E also provided discrete rather than cumulative inputs.

We could not locate any information in the actual report that provides this kind of detail. Any insights you could provide to the proper interpretation of which experts provided cumulative v. discrete inputs for distributions would be very helpful to our work.

Thanks

Karl

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**From:** Tregoning, Robert [<mailto:Robert.Tregoning@nrc.gov>]  
**Sent:** Tuesday, July 05, 2011 9:23 AM  
**To:** [fleming@ti-sd.com](mailto:fleming@ti-sd.com)  
**Cc:** Bengt O.Y. Lydell  
**Subject:** RE: Question on NUREG-1829 information

Karl:

The way that the elicitation was conducted, the responses were intended to be cumulative. We asked the experts, in effect, the likelihood that a LOCA greater than a certain size could occur. For smaller LOCAs, this includes the frequency of all the bigger LOCAs as well. This distinction is not that important however, if the frequencies for adjacent categories vary by an order of magnitude or so (which was often the case) such that the cumulative or discrete results are not that different.

Rob

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**From:** Karl Fleming [<mailto:fleming@ti-sd.com>]

**Sent:** Tuesday, July 05, 2011 11:25 AM

**To:** Tregoning, Robert

**Cc:** Bengt O.Y. Lydell

**Subject:** Question on NUREG-1829 information

Bob:

We have a question about the supporting information recently released on the individual inputs for the elicitation. The basic question is: are the inputs for each LOCA category intended to be discrete or cumulative with respect to LOCA

category? In other words is the input that each expert gives for LOCA category 1 for a given component include the frequency of category 1-6 or only that for category 1.

I note that in NUREG/CR-6829 which interprets 1829 information for LOCA frequencies, they assume that the results presented in Table 7.1 are cumulative. I am not sure if that is true or if it is true was the information input as cumulative or perhaps analyzed that way during the aggregation process?

Any insights would be helpful to us.

Thanks

Karl

Karl Fleming

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