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From: "Jim Stewart" <Jim.Stewart@dft.gsi.gov.uk>
To: GWIA:dft.gsi.gov.uk:Clive.Young, GWIA:dft.gsi.gov.uk:Clive.Young
CC: Andrew Murphy
Subject: Re: package performance study comment
Attachments: Mime.822 (Save As: Binary, Size=10631 bytes)

2/21/03
68 FR 8530
239

Message: Rob,
Comments from one of our engineers follows. He makes several comments on the presentation in the report (playing Devil's advocate by doing the sort of thing that he expects critics will do to your final report). I think the point he is trying to make is that if you decide to go ahead with this you will need to be really careful - probably much more so than you would reasonably expect to be in normal cases. A small mistake could have a massive impact (forgive the pun) on the business you regulate. This leverage (small mistake = large consequence) is not something that sits comfortably with us.

From my point of view (having been involved in scale model validation of FE impact codes) I know that there are some fairly obvious pitfalls. My interest, as you know, lies with criticality.

The sort of reasoning we went through was:
What are the safety requirements being tested? (e.g. criticality)
What failure modes can affect that requirement? (for criticality deformation leading to larger free space is an obvious one)
Does the actual drop identify failure modes not covered by the FE?
Are the "key" aspects of the FE predictions (i.e. those that affect the safety features being tested) accurate.
What is accurate - well it is something that relates to the safety requirement being tested.
Having done all this reasoning you think you are in a good position to look at the tests. However, the practical problems of defining a suitable reference point to measure from (i.e. one that relates to the safety requirement, absolute or relative) should not be underestimated.
What are the key parameters you want to measure (do you want to consider the width, area or volume? - or possibly shape?).
I think the guide I would give is that you are going to get a calculated/measured result. You need to be able to assess any variation from 1 in terms of the safety requirement. The case I was involved with looked at flux trap closure - flux trap width was one key parameter we agreed on. What we were able to see in the end was that the accuracy of the code was sufficient to model the feature we were looking at to a level of accuracy that was unimportant compared to the safety feature.

In our case the company went on to test the irradiated fuel in full scale impact tests (to validate FE work). This was actually the area that was most significant (the fuel failed in a way that had not been predicted). It was quite interesting, I know the company then went on to develop a surrogate material for irradiated cladding. Since then we have a joint programme by UK/French industry to look at irradiated fuel, which is overseen by a joint regulatory group (UK/France transport and facility regulators). I think if I were being asked to look at the

E-RIDS = ADM-03
Add = A. Snyder (AMS3)
A. J. Murphy (ASM1)

Template - ADM-013

safety of 30+ year pond stored fuel this is the area I would feel least confident with models.

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From an engineering perspective the scope of the work has to be applauded -it will only serve to increase our understanding of package performance.
However...
The obvious danger is that this work will show that numerical analysis as a predictive tool is not up to the task and/or ratcheting up of the regulations will be called for. Unless fairly unambitious criteria are declared with which to demonstrate correlation between the numerical analysis and physical testing then there is a good chance of this danger being realised.
The above risk is real and would have a major effect on UK industry.

Comments as they occur:

1. pg 1 - Are there no plans to look at the IAEA punch test?
2. pg 1 - Will testing be cumulative i.e. impact followed by fire?
3. pg 5 - Will details (drawings) of the flask designs be available to confirm numerical models etc?
4. pg 10 - What is the rationale for modelling (or not modelling) details such as welds or other points of strain concentration?
5. pg 10 û measurements of *0.0254mm seem a bit optimistic û cask body deformations should be significant.
6. pg 11 û what is the basis for acceleration values of *20% being 'acceptable' and *10% being 'very good'?
7. pg 12 - What allowances (if any) have you made for residual stresses as a result of welding, forging etc? The automotive industry has found these stresses to be significant with respect to predicting some deformations.
8. pg 18 û have these material models been validated against tests?
9. pg 18 û the yield stress values in table 3 should be in GPa (not Mpa) and the last column should be headed "n" (not N).
10. pg 19/20 û In figures 7 and 8 shouldn't the impact limiter conform to the shape of the target i.e. be flat as opposed to rounded as it is shown?
11. pg 23 û A lid-flange gap of 0.8mm does not seem to be commensurate with a bolt strain of 1.35E-03 (Fig 11).
12. pg 28 û typo û first sentence should say "....detailed impact limiter..."
13. pg 29 will these 'pipe gussets' be included in the final model? If they cause numerical problems then maybe there is a case for saying that the tools are not up to the job?
14. pg 30 Figure 20 shows a significant 'thermal path' past the displaced impact limiter. This would be targeted in the IAEA punch test and also in the fire test.
15. pg 32 û typo û line third from bottom û "....experienced strains..."
16. pg 32 - Are there any plans to investigate extremely low temperatures e.g. û40oC and below?
17. pg 34 û Figure 27 û the position of the maximum plastic strain seems odd. What has caused this?
18. pg 39 û Figures 34 and 35 û the contents seem to be suffering from 'hourglassing'.
19. pg 40 and elsewhere û typo û "Gs" or "g's" or something else! Usually symbolised as "g".

20. pg 41 û with mesh refinement the plastic strain level is likely to rise. Is the material model adequate to account for complex tri-axial stresses and strains and the resulting material damage?
21. pg 43 û what is the effect on loss of shielding as a result of DU fracture?
22. pg 49 û if results fall outside the indicative 'good' range then a reasonable explanation as to why this has happened should be offered.

Other general comments:

23. As much of this work relies on producing accurate numerical analysis then some effort could be expended on producing a 'How to' guide or maybe an international standard on what constitutes a reasonable numerical analysis.
24. Following on from [23] is the problem of analyst accreditation i.e. ensuring that they are suitably qualified and experienced to produce analyses, which are fit for purpose.
25. Several codes are used to produce results. Could one code be developed which can do all the work?
26. Accurate material properties and their modelling are of utmost importance. Tests to determine uni-, bi- and tri-axial tensile properties, compression tests, fracture toughness testing û all at different temperatures and strain rates may need to be considered.
27. From a statistical point of view is this proposed testing (2 impact and 2 thermal) significant?
28. The post-test predictions could be turned into an international round-robin exercise.
29. How are the computer codes QA'd?
30. A rigid target is not always the worst case.
31. Could more than one numerical code be used to test code variability? None of the codes used are common to UK applications.
32. In trying to predict damage, then you will need accurate rather than conservative data.
33. Can preliminary analyses be made available (input decks/ result files) on the web site for further scrutiny?
34. Will these flasks have enough 'features' to cover other relevant designs of flasks e.g. valves, fins etc?
35. Could testing also be done at 1/3 scale and reconciled with full scale results to prove or otherwise the assumption that scale models are ok?

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>>> "Robert Lewis" <RXL1@nrc.gov> 18/06/03 16:18:57 >>>
Greetings Jim,

In Stockholm, you mentioned that you had some review comments on Nureg-1768. Were you planning to provide them to NRC? We'd be especially interested in any details you have regarding the technical approach to finite element modeling.

Hope all is well, & see you in 2 weeks.

- Rob