

Mars 2020 SAR/SER Workshop
PTi Collaboration Center
Kirtland Air Force Base, Albuquerque, NM
July 16-17, 2019

Note: These notes only capture highlights. The associated slides should be consulted for more detail.

Day One -

Opening remarks for INSRP – Matt Forsbacka

Opening remarks for DOE-NE – Charlie Maggart

Opening remarks for NASA-SMD – George Tahu

- The heat shield damaged approximately one year ago (in the static test) has now passed the test previously failed (as well as other testing)
 - Concluded that the failure was caused by a combination of design vulnerabilities in the legacy (MSL Shield #1) design, along with changes to the test itself
- Shipments of hardware to the Cape occur December thru February
- Contractor is working through the NEPA implications of risk analysis changes, and NASA may put out an EIS Supplement draft for public comment in September
- Expecting that the new space nuclear launch policy will be issued soon, and that approval authority for Mars 2020 will be delegated down to the NASA Administrator

FSAR Updates – Dan Clayton

- Are referring to the July FSAR as the FSAR for Launch Approval (FSAR-LA), as opposed to the January FSAR for Federal Review (FSAR-FR)
- They are not anticipating changes to the draft FSAR-LA as it goes through Sandia/DOE-NE review, and will communicate to the INSRP any changes that do occur via the routine interactions
- From the FSAR-FR to the FSAR-LA (draft), the health effects risks generally decreased, while the land contamination risks generally increased

Overview of SER Outline – Matt Forsbacka

- Provided an overview of the annotated SER outline circulated by INSRP to Program on July 12th, 2019

Blast and Impact (FSAR) – John Wilkes

- Re-evaluated the stripping flag implementation (resulting in more un-stripped cases), and re-evaluated impacts in Phase 4/5 to account for sand impacts (vice always having impact on hard surfaces)
 - Assumed a representative (rather than geographic-specific) sand type, and assumed dry sand
 - As one might expect, the revised calculations (sand) show significantly less damage
- Assignment of stripping flag remains a manual analyst task, involving visually inspecting the SIERRA results (images, animations) and deciding what stripping bin is appropriate – the majority of cases are clear and easy to bin, while the minority require a lot of effort and judgment
- The net outcome of the stripping flag changes is a general decrease in the estimated damage, and thus the source term – that said, the changes (on the surface) appear to improve the realism of the modeling
- Continue to assume that the assumed ablation applies to all six edges

- The SIERRA simulations, and the application of stripping flags are treated as purely deterministic and thus no uncertainty is directly considered (since model uncertainty isn't addressed)...that said, some aspects of the underlying uncertainty are addressed via uncertainty in the release model

Fire and Thermal (FSAR) – Brian Ehrhart

- PEVACI remains focused on changes to the aerosol size distribution caused by the fire environment, for already-released material (increased vaporization drives aerosols to smaller sizes)
- An outstanding uncertainty (unmodeled potential phenomena) is the chemistry reaction between Pu and Cl particles, and plutonium chloride would be more soluble (from an ingestion/inhalation perspective) than plutonium oxide
- Reverted to an AJ60-specific correlation for the solid propellant fire temperature, which generally results in a lower temperature
 - An error in the previous formulation was also discovered, which also had the general effect of lowering temperature

Reentry (FSAR) – Derek Denzl

- No code or input changes since January – additional analysis was performed
- Continue to predict no GPHS failures during reentry (prior to ground impact)
- Uses a single ablation depth for all cases which is based on twice of the most probable ablation depth
 - Most probable is that associated with circular orbital decay
 - The doubled value was 0.05 inches
 - Doubling was simply an arbitrary choice to encompass more uncertainty, and with the knowledge that failure of the GPHS due to ablation isn't predicted regardless

Release Model (FSAR) – Dusty Brooks

- Re-fit the fractional release model to accommodate the changes in the underlying SIERRA results (though the change – i.e., the re-fit to the underlying analysis – results in a minimal change)
- Separately, the model was broken in to 730C and 900C cases, rather than blending them – this means a better representation, but did require changes to the LASEP implementation of the relationship of clad strain to breach area (uses a quadratic function)
 - The end effect was increased effective mass release (e.g, a factor of 1.2 to 1.4 for RAS 1.5 and 1.6)

Accident Sequence (FSAR) – Dan Clayton

- Changes since January include:
 - Input changes (namely from the Databook)
 - Wind rose change
 - Dense burning zone calculations (correction of units error)
 - Modeling changes in other code suite areas:
 - Stripping flag process
 - Solid propellant fire environment
 - Breach area model changes
 - Etc.
- The correction to the units error on the dense burning zone has no impact on the amount of mass released or its aerosol size distribution – rather, it affects IAT's conditions for plume rise

- The modeling does not account for interactions between the hydrazine liquid propellant fire and any solid propellant fire, and this is based on the Antares accident observation (which included a much larger liquid fireball than a hydrazine-induced fireball would cause)
- Keep in mind that the probability of releases reported are not conditional on hitting land...they include the 'zeros' associated with the failure resulting in a water impact
- The simplifying assumption that any launch pad debris will be preferentially lofted toward the MMRTG does not appear to have much effect on the results

Atmospheric Transport (FSAR) – John Fulton, Daniel Villa, Lainy Cochran, and Dan Clayton

- Increased the puff shear criterion and altered other aspects that were not working as intended in the January results (IAT 2.1 vs. IAT 2.0)
- Despite all the changes made, the validation remained the same, which in itself demonstrates the very limited nature of the IAT validation (based solely on the 2014 Antares accident)
- They recognize the need for future work on the handoff of initial conditions from PEVACI to IAT
- Some updates were made to STORM because of code instabilities that were arising (e.g., race condition between the storage node and the compute node)
- STORM now uses both GDAS and NAM (selects the appropriate data), as a step toward resolving some of the limitations with respect to meteorology data
- Lots of discussion about why the crop interdiction results and land contamination are potentially conservative (because they are based on screening values)...yet, no distinction is made on the economic value of the contaminated land (e.g., Port Canaveral)
- The contour plots in the presentation aren't in the FSAR, but they are in the dataset provided along with the FSAR
- A number of changes were made to the FDOSE modeling
- The model follows the FDA guidance which neglects the washing off of plutonium contamination on citrus produce

Risk & Uncertainty (FSAR) – Dusty Brooks

- The Program could readily generate the CCDF of the maximum individual dose (Amber indicated that she was going to formally request this on the DRT), were the INSRP to ask for it for the purpose of providing a full comparison to the new space launch policy safety guidelines
- Acknowledgement that their capturing of 'uncertainty' does not include model uncertainty, and that the change in results between January versus July demonstrates the weakness in this characterization

Day Two -

Launch Abort Working Group (INSRP) – Amber Chang-Armstrong

- Using the result from the FSAR-LA (draft):
 - 0.2 in one million
 - Not meeting the dose goal of 100 mrem maximum individual dose, but this is not a constraint preventing launch
- Unlike MSL, INSRP plans to use its own probabilities of failure (POF)...based on Range experience, the Program POFs seem a bit low
- Continue to believe that the use of solid rocket boosters should be avoided to the extent this is a possibility in the Launch Vehicle award process, because of the aspects it adds to risk

Space Nuclear Systems Working Group (INSRP) – Greg Wyss et al.

- The revision to the Release Model based on SNS analysis of the FSAR-FR is a key example of where INSRP/Program iteration have benefited the realism in the Program's risk estimate

- Looking at how the M2020 Program compares to prior missions in terms of violating key design assumptions that have been consistent across the past 30-40 years of nuclear missions
- The majority of the source term and effective mass release (mission-wide) is tied to the rain of debris model (based on dissecting the contributing insult types in the Program's analysis), which hasn't been a focus of recent reviews
- Observing some oddities with the July total release CCDFs that they are seeking to understand
- Still trying to construct a coherent story for why it makes sense that the dominant risk contributor from MSL (solid propellant fires) is trivial in the Mars 2020 results
- RAS 1.6 seems to have significantly fewer instances of solid propellant fires (co-located with the MMRTG) qualitatively seems too low, compared to other RAS (using the FSAR-FR results, for the moment) – discussion suggested that this could be caused by higher altitude failure generally occurring in 1.6 (vs. 1.5), thus resulting in wider dispersal of debris

Reentry WG (INSRP) – Mike Weaver

- Program's recent work provide a defensible rationale for the use of 900C initial temperature for reentry
- FSAR-LA provides needed clarification on the at-ground-impact recession; will seek clarification on some minor inconsistencies between values cited in different spots in the FSAR-LA

Meteorology Working Group (INSRP) – Will Pendergrass

- Concluded that results should have an attributed uncertainty of plus/minus one order of magnitude
 - Refers to the uncertainty in the concentrations of material at any given location at any given time, solely due to uncertainty associated with ATD modeling and physics
 - Are not yet prescribing what actual distribution points (e.g., 5th/95th) this corresponds to, but it is intended to be the uncertainty about the mean
 - Intended to include both aleatory and epistemic uncertainty, considering both parameter and model uncertainty
- MET and BEES currently have a very different perspective on the importance of resuspension, with MET believing it is not an issue
- The issue of reasonable computation threshold points out that some sectors identified as being above the EPA trigger threshold are being caused by individual particles within that sector – i.e., it leads to a gross over-estimate of the actual impacted land
- Discussion about the aforementioned degree of uncertainty in terms of what a decisionmaker does with that...relative to the level of information that will be available leading up to launch (when actual forecasts are available and higher-fidelity NARAC models are in use)

Biomedical Effects and Environmental Working Group (INSRP) – Bob Nelson

- Some changes have coincided with BEES recommendations, and have been in the right direction, but some un-needed conservatisms persist
- Some second-order concerns about whether the revision to DDREF treatment is really resulting in an applied value of 1.0 in all cases
- Also looking at other pathways, other than ingestion/inhalation

Comments on Plutonium (INSRP) – Marv Goldman

- Recent human epidemiology supports the ICRP values that are being commonly used, including the assumption of linear no-threshold, for plutonium inhalation

Risk Integration & Uncertainty Working Group (INSRP) – Curtis Smith

- Avoided the discounting of failures, which occurs a lot in the Databook
- Repeated LAWGs assertion that the Databook has a somewhat optimistic estimate of launch vehicle reliability

- Highlighted the ability to generate INSRP-specific CCDFs for each of the consequence measures that are tracked

Software Quality Assurance (INSRP) – Carl Mazzola

- Focused on doing a horizontal slice across the entire code suite, along with a deep dive on PEVACI, IAT, and LASEP
- Providing a number of observations on the 3 codes that were looked at more carefully
- Interface issues between codes was looked at, and remains a general concern, in addition to a specific concern regarding the PEVACI/IAT interface
- When invoking the NASA Modeling & Simulation Standard, it should be clear that the Sandia analysis is not required to follow this Standard

“Way Ahead” Discussion (INSRP and Program) – All

- For timing of SER issuance:
 - Need to coordinate with timing of any FEIS Supplement
 - Need to consider whether decisionmaker wants to defer decision until that is the next payload to fly on the Atlas launch vehicle
 - Need to consider the potential that the NSPL changes get delayed
 - Need to allow that the SER would be made public after launch
 - If new policy is issued, it is anticipated that DOE-NE sign-out would be delegated to the Idaho Site Office
- Tentative (new) schedule for SER completion:
 - 8/23 – Final date to submit DRT items to Program
 - 8/30 - WG inputs to RI&U that affect their tabulation of the SER tabular/graphical results; WGs will also provide Lance/Lori the latest version of their STIV
 - 9/6 – Draft final SER with all WG and panel member inputs incorporated, pending no substantive changes to the PrePub FSAR-LA
 - 9/13 or 9/20 (depending on availability for a panel-only in-person meeting) – Panel reviews and finalizes the SER
 - 9/30 – NASA document preparation steps completed, and SER is transmitted to NASA Administrator
 - 10/15 – Publish-ready STIV to Coordinator (through Lori/Lance)
- Bi-weekly call w/ Program:
 - Eliminate the calculational update from Dan Clayton
 - Eliminate the INSRP WG deep dive
 - Get update from Charlie on SAR finalization
 - Retain WG lightning round and DRT item review
- INSRP panel needs to find a date for an in-person meeting sometime during the week of 9/9, or if not, 9/16 (given that Mark may be out-of-the-country the week of 9/9)
 - Also combine this with a meeting with OSTP?
- General agreement that:
 - the SER should be made public (not a unanimous view) after launch (having been reviewed and adjusted as necessary for ITAR or other sensitive information)
 - the STIVs will be marked OOU

Sensitivity Analysis Discussion – INSRP Only Participation (Panel and WGs)

- Everyone should be looking at the NASA Modeling & Simulation guide as a best practice reference

- Candidates:
 - Biases in the Program's treatment of relating contamination concentrations to health effects
 - Role of solid propellant fires, e.g., in RAS 1.6, relative to its significant contribution in MSL
 - Could the MSL results provide an alternative value for this sensitivity?
 - Reasonable computational threshold in MET/BEES area
 - Plans for MET and BEES to generate alternate conditional probabilities for RAS 1.5 that would be fed to RI&U for application to RAS 1.5 or RAS 1.x or all RAS
- Add a standing item to the INSRP-only bi-weekly to discuss sensitivity analyses

SER Discussion – INSRP Only

- General agreement that the existing format remains useful
- When comments are provided, it should include the basis for the comment along with proposed alternate language
- Lance will start distributing the draft SER on a weekly basis (on Monday)