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# Overview of Structural Issues

- Finite Element Analysis benchmarking using LS-DYNA

- HI-STAR 180 Finite Element Analysis using LS-DYNA

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# Finite Element Analysis benchmarking using LS-DYNA

1) Choice of Benchmark
2) Questionable Modeling Techniques and Material Properties
3) Component Benchmarking Not Performed

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# Choice of Benchmark

- Drop tests used were never intended for the purposes of benchmarking an explicit FEA code.
- An off-the-shelf test with limited instrumentation used for benchmark.

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# Questionable Modeling Techniques and Material Properties

- Use of isotropic material properties for aluminum honeycomb.
- Use of direction dependent global material axes.
- Use of mixed tetrahedron-hexahedron mesh for impact limiter material.
- No mesh sensitivity studies presented.
- Use of design values for material properties instead of material certs.

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# Component Benchmarking Not Performed

- No bolt benchmark.
- No aluminum honeycomb benchmark.

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# HI-STAR 180 Finite Element Analysis using LS-DYNA

1) Approach Not Consistent
2) Questionable Modeling Techniques
3) Internal Gaps Not Properly Considered

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# Approach Not Consistent

- Impact limiter modeling – use of all hexahedral elements as opposed to mixed hex/tet meshing used in benchmark.
- Bolt modeling – discretization method changes between the benchmark and the HI-STAR 180 closure bolts.

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# Questionable Modeling Techniques

- Fuel basket uses coarse meshed thick shell elements with two through thickness integration points.
- Deformations in fuel basket show strains exceeding failure strain of Metamic HT.
- Localized regions exceed failure strain of the material.
- Failure strain for Metamic HT not specified in material model.

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# Internal Gaps Not Properly Considered

- The maximum possible gap between internal components for fuel cladding and basket evaluation was not considered.

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# Conclusions

With these deficiencies, the staff cannot determine:

1) The adequacy of the methodology used for the benchmarking of LS-DYNA for this licensing action, and
2) That the HISTAR-180 is sufficiently characterized to perform its safety function from the perspective of structural behavior.