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Storage and Transportation of Used Fuel: Does Storage/Transport System Hardening Enhance Safety and Security

Blue Ribbon Commission on America's Nuclear Future

September 23, 2010

A SPENT FUEL STORAGE/TRANSPORT SAFETY SUMMARY

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Storage and Transportation of Used Fuel: Does Storage/Transport System Hardening Enhance Safety and Security

Topics

- What is hardening?
  - Design basis (DB) vs beyond-design-basis (BDB) events
- Why do some feel it necessary?
  - Not aware of current system design margins for BDB events?
  - Fear of large radiological risk to public?
- Reasonable, objective standard for hypothetical BDB doses
- Liabilities of over-structure hardening
  - Benefit/cost ratio for hardening
- Conclusions

What Is Hardening?

- First consideration: used fuel storage/transport systems do not fail under DB events; system designs exceed regulatory requirements
- Hardening of used fuel storage/transport systems is usually related to BDB events and typically means methods that
  - increase system resistance to failure (release of radioactivity)
  - reduce likelihood of successful attack or sabotage
- There are various approaches to hardening and the “HOSS concept” is but one
- Appropriate safety and security may be better achieved, not by further hardening, but by effective, tiered deterrence/resistance: effective security systems, national and local; effective security forces; and conservative, robust and resistant technology

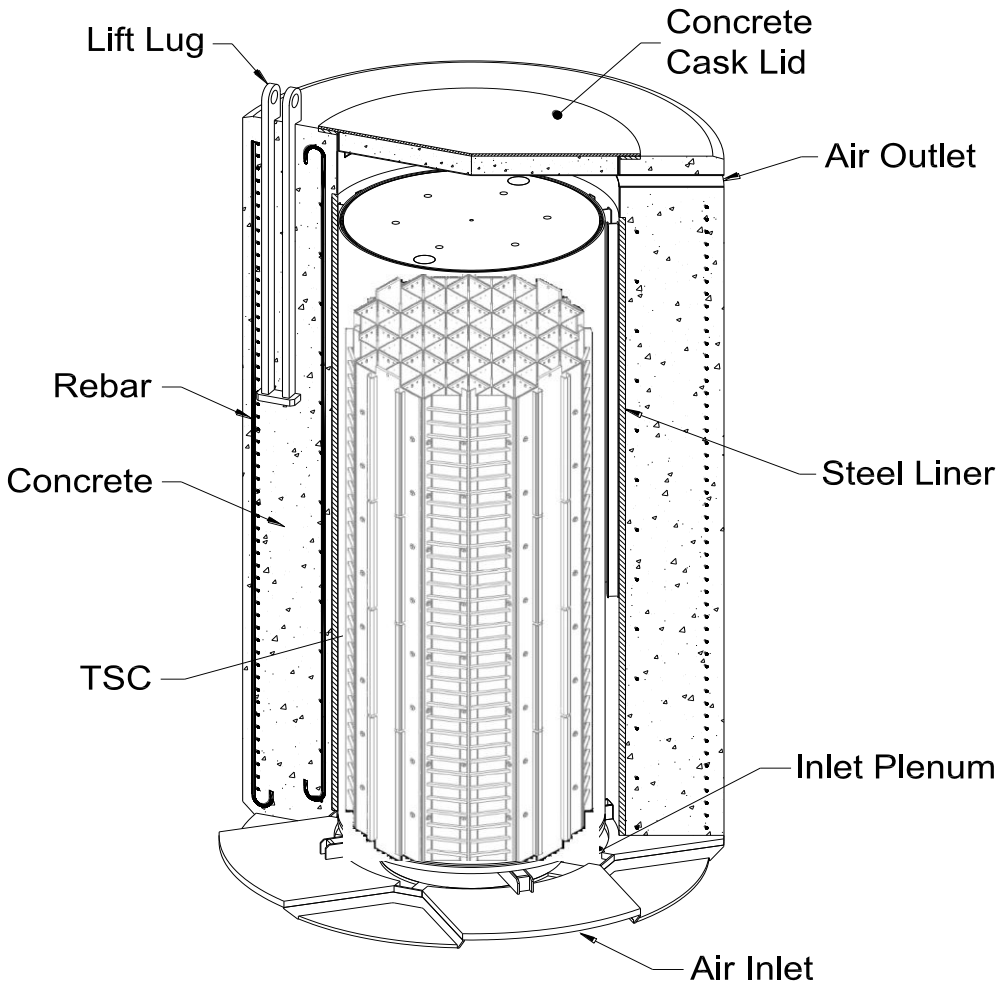
Why Do Some Feel Hardening Necessary?

- Not aware of current system design margins for BDB events?
  - Use of conservative codes and standards – materials have greater energy absorption before true failure than codes, standards, regulations allow credit for
  - Systems designed with layered external shells of materials for shielding and protection – external shells not fully challenged structurally for DB events; results from gamma shielding materials
  - NAC evaluation of Boeing 747 impact on storage cask at 500 mph (both aircraft body and turbine rotor, with fire) shows no release
- Look at typical NAC dry storage system design that uses vertical concrete cask (VCC)

NAC Dry Storage System Design

System design features:

- concrete
- aggregate
- rebar
- steel liner (canister armor)
- transportable storage canister (TSC)
- basket



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Why Do Some Feel Hardening Necessary?
(continued)

- Fear of large radiological risk to public?
  - No DB events cause releases
  - Many analyses of BDB events show no, or very limited, releases
  - DOE assessed releases from transport package sabotage in FSEIS for YM – low and high population densities
    - Conservative models and assumptions
    - Used research from a number of tests
    - Results - high densities: 47,000 person-rem; low densities: 92 person-rem
  - Storage results would be similar for low density populations
  - Other conservative, more realistic analyses show < 10,000 person-rem for high density populations
  - Applying credible sabotage probabilities shows very small risk
- What is a reasonable, objective standard for acceptability of BDB hypothetical population dose risk?

Reasonable, Objective Standard for Hypothetical BDB Population Doses

- A reasonable standard arises from non-nuclear industry population doses; these industries are not regulated to control their population dose characteristics
- Industries such as aviation, agriculture, building design/construction, potable water supply, construction material, tobacco supply, medical diagnostics produce *actual,* lognormally distributed, annual and 50 year collective effective dose equivalents (CEDE) to the public well above any hypothetical U.S. nuclear fuel cycle event
- Comparative standard for hypothetical dry storage and transport BDB event population dose outcomes based on actual population doses from non-nuclear industries is an objective method to assess society's true risk from such hypothetical BDB events
- DB events would still meet regulatory standards; hypothetical BDB dose consequences would be evaluated against some fraction of what society accepts today for unregulated population doses from non-nuclear industries

Reasonable, Objective Standard for Hypothetical BDB Population Doses (continued)

This shows a comparative assessment with non-nuclear industries

Industry	Current Annual CEDE (Person-cSv)	Estimated Previous 50 Year CEDE (Person-cSv)	Projected 50 Year CEDE (Person-cSv)
Aviation	>0.6 million	>12 million	>28 million
Building Design/Construction	>15 million	>430 million	>750 million
Potable Water Supply	>1.5 million	>38 million	>75 million
Agriculture	>1.3 million	>52 million	>65 million
Construction Materials	>2 million	>78 million	>100 million
Tobacco Supply	>44 million	>3 billion	>2.2 billion
CT Medical Diagnostics	>44 million	>1 billion	>2.2 billion
Total for 7 Non- Nuclear Industries	>108 million	>4.6 billion	>5.4 billion
Commercial Used Fuel Storage and Transport, supporting growth to 300 reactors over next 50 years	<0.00008 million	<0.002 million	No Breach Events: <0.008 million 10 Breach Events: <0.07 million

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Liabilities of Over-Structure Hardening

- System inspections/maintenance?
- Reduced system capabilities for spent fuel storage?
- Much larger ISFSI?
- Off-site transportation impairment?
- Hardening over-structures need multiple cooling openings – jet fuel or explosive ingress from sabotage may cause furnace or reflected overpressure conditions; over-structure collapse a credible outcome
- Storage technology will not fail from collapse; storage systems may loose cooling or be inaccessible
- Public health and safety not significantly threatened, with or without hardening
- Recovery staff may experience higher doses, delayed access, injury from collapse of unstable or weakened over-structure, etc.: real health and safety concerns
- Over-structure benefit-cost ratio does not appear attractive

Conclusions

- Additional over-structure hardening likely an expensive undertaking
- Little or no discernable public health and safety benefit
- Liabilities for efficient dry storage are likely higher
- Liabilities for recovery staff likely higher for BDB event
- Benefit-cost ratio for over-structure hardening likely approaches zero, perhaps is negative
- Reasonable conclusion is that further hardening of dry storage does not produce clear, discernable enhancement of public or worker health and safety for BDB conditions

Appropriate safety and security best achieved, not by further hardening, but by effective, tiered deterrence/resistance: effective security systems, national and local; effective security forces; and conservative, robust and resistant technology

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QUESTIONS?

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