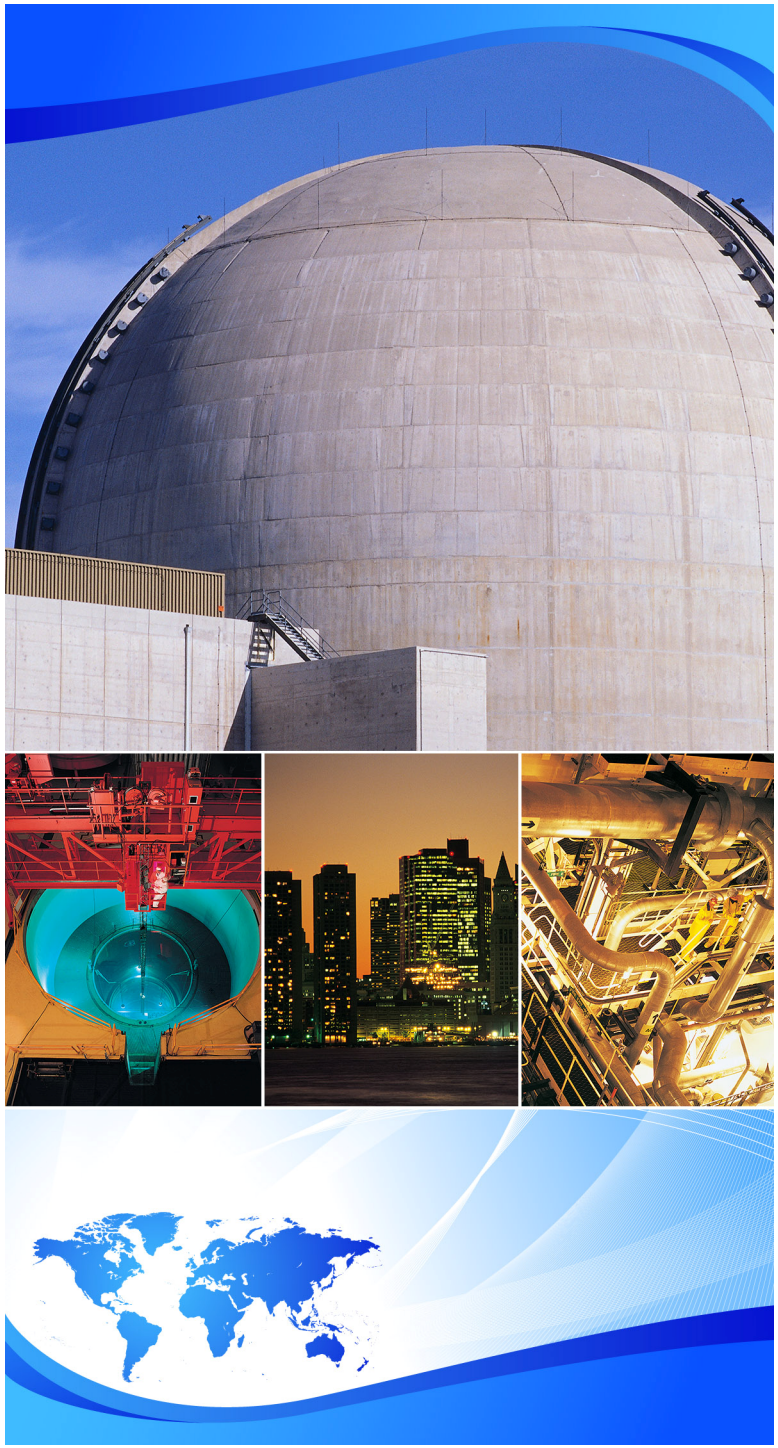

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A Modified Burst Test To Benchmark New Alloy for RIA Performance

Meeting with PNNL & NRC San Diego

Ken Yueh

March 24-25, 2009

Rationale for Test Development

Rationale

- RIA simulation tests in a test reactor are extremely expensive
- NRC has indicated some form of out-reactor mechanical tests may be utilized to qualify new alloys for RIA performance

Development Goals

- Develop a test that more closely simulates pellet/clad mechanical interactions during a RIA event
- Potential to be utilized as a go/no-go type of test to bench mark new alloys

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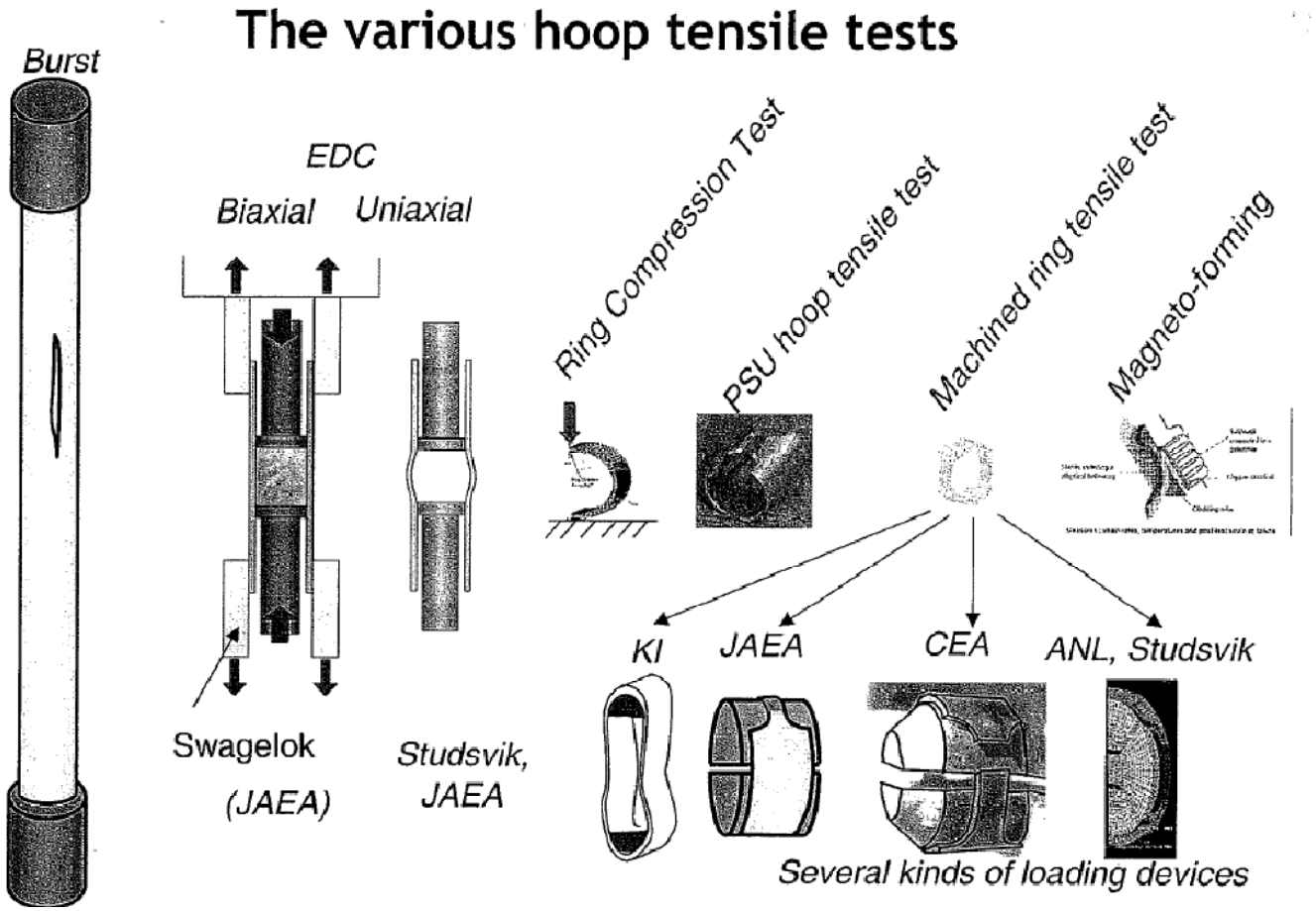
Example of Some Existing Tests

- Various mechanical tests schematics



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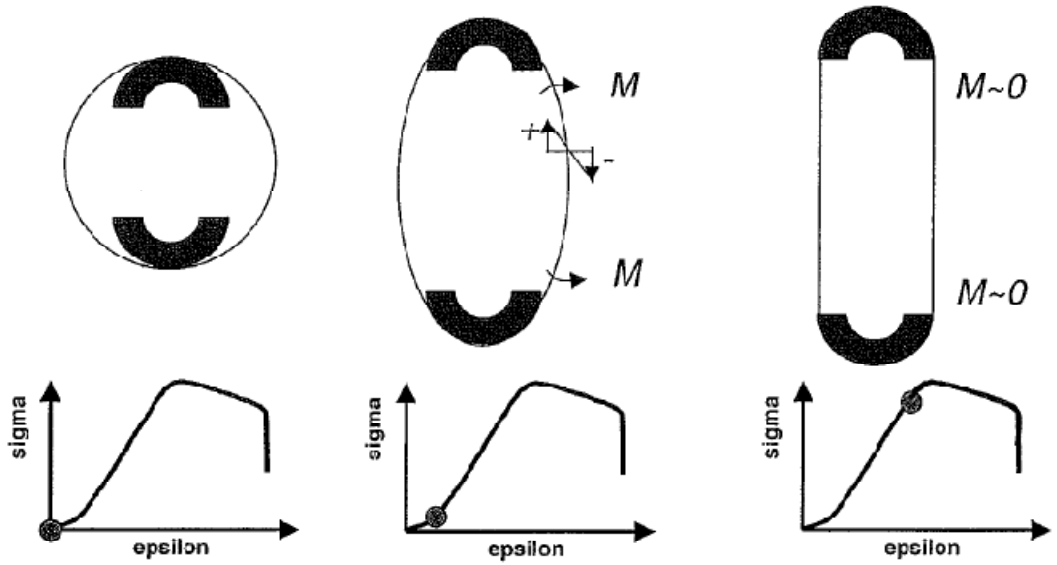
New Alloy Safety Licensing Requirements

- Issues with ring hoop tensile tests

Induced bending during hoop tensile tests



- *Limited to the beginning of the load-displacement curve,*
- *Slightly delays the hydride rim failure with a compression component at the OD*
- *The bending moment is reduced when adjusting the mandrel diameter to the cladding inner diameter,*
- *The bending moment is also reduced by introducing a dog-bone.*

Taken from an IRSN presentation

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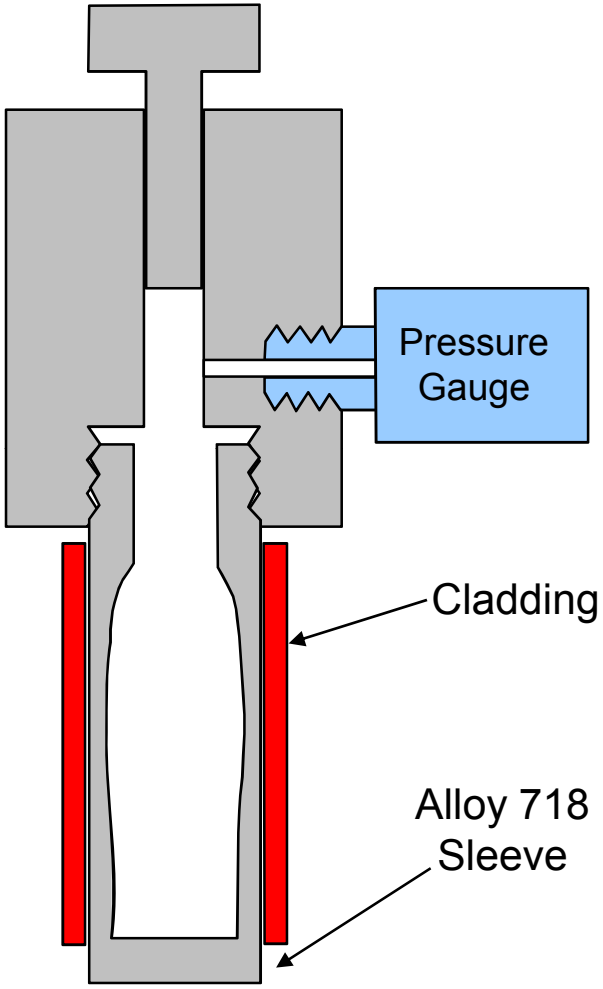
Modified Burst Test

- Test Concept
  - Burst test with a driver tube
    - $\sigma_{axial}/\sigma_{radial} \approx 0.5$, can probably be increased with clad axial restraints
    - Driver tube could elongate in z direction depending on friction coefficient
  - Very fast loading with controlled expansion
    - Hammer drop height determines loading rate
    - Piston elevation determines degree of deformation



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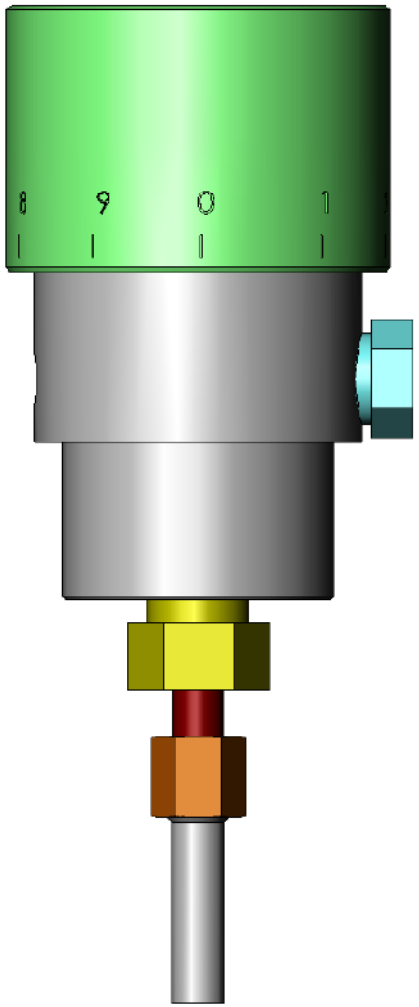
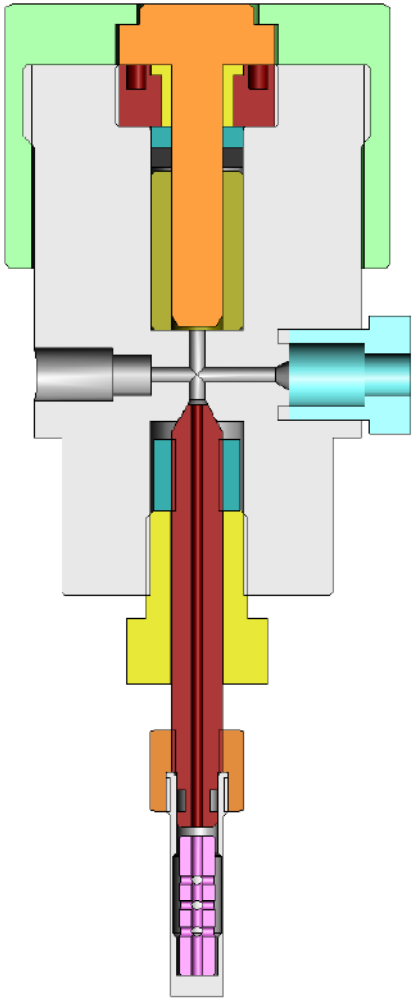
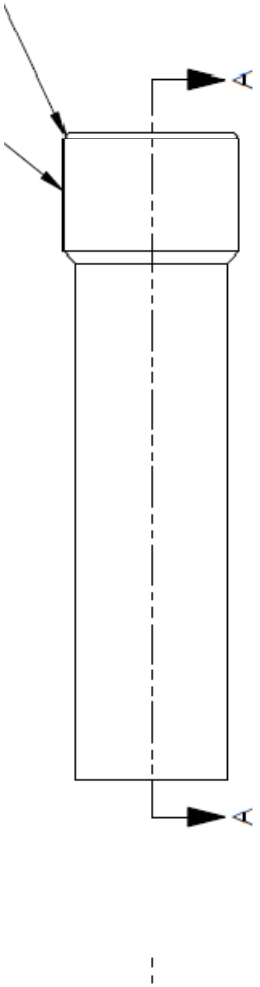
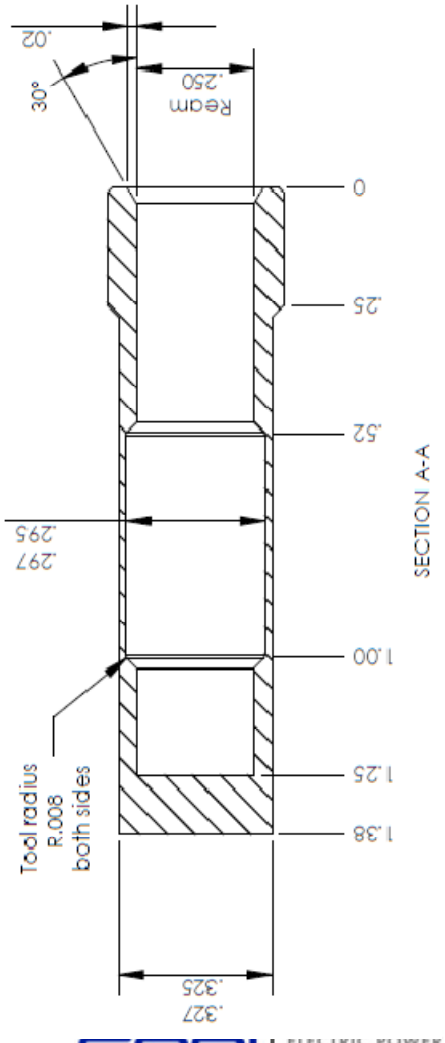
Apparatus Design

- Piston/cylinder pressurization and driver tube









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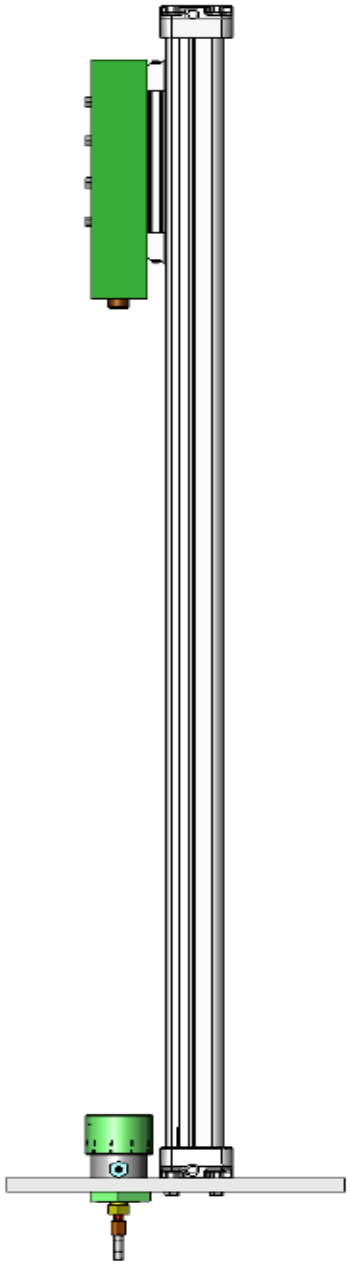
Apparatus Design

- Drop tower
  - Weight raised and force dropped with compressed air



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Development Plan

- Scoping test (2009)
  - Cold worked Zircaloy-4
  - With pressure transducer
- If concept proven (2010)
  - add additional capabilities
    - On-line diameter measurement
    - High temperature testing up to 400°C
  - Irradiated material testing

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Discussion

- EPRI sponsored studsvik tests indicate some difference in material response between isothermal and rapid heating conditions
  - Difference appears to be a bias
    - Instead of conducting RHL type of tests, feasible to conduct tests at adjusted lower isothermal temperatures?
  - Candidate tests for new alloy qualification
    - EDC
    - Studsvik RHL ring test
    - Chi-test
    - Modified burst test

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