

DARHT

The Evolution of Beryllium Controls at the
Dual-Axis Radiographic Hydrotest Facility

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- A series of several parallel white diagonal lines of varying lengths, located in the bottom right corner of the slide, extending from the right edge towards the center.

THE WORLDS' LARGEST CAMERA?

- ▶ Underground test ban treaty 1996
 - ▶ Two electron accelerators at a 90 degree angle
 - ▶ The electron beam passes through a metal target and generates a burst of X-rays
 - ▶ One accelerator produces a single pulse
 - ▶ The second accelerator produces 4 discrete pulses
 - ▶ Time-lapsed images of a component or assembly are possible at the moment of hydrodynamic implosion
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[HTTPS://_{www}.YOUTUBE.COM/WATCH?V
=EFZZYLXVQ30&FEATURE=YOUTU.BE](https://www.youtube.com/watch?v=EFZZYLXVQ30&feature=youtu.be)

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PLANNING AND CONSTRUCTION

- ▶ Planning began in early 1980s as an improvement on PHERMEX
- ▶ Construction of the first axis began in 1992 and the 2nd axis in 199
- ▶ Construction was halted between 1995 and 1996 due to lawsuits by 2 anti-nuclear weapons groups.
- ▶ An environmental Impact Statement had to be prepared
- ▶ When completed in 1999, axis 1 could produce 1 short electron pulse lasting 60 ns with a current of 2 KA and an energy of 20 MeV
- ▶ The beam could be focused to a 1.5 mm spot on the target

A MINOR SETBACK....

- ▶ Axis 2 was a more complicated design
- ▶ When completed in 2003 it was found to be unusable
- ▶ A design error led to faulty equipment used to calibrate voltages
- ▶ Axis 2 was redesigned and completed in 2008
- ▶ Projected cost: \$30M Actual cost: \$350M
- ▶ And.....it didn't fit through the door!
- ▶ An access opening was cut in the roof and the accelerator cells were installed with a crane – inside the beryllium area.

FIRST SHOTS

- ▶ The initial plan was to use an existing vessel to contain shots while a prototype vessel was built and tested
- ▶ Initial shots were open air
- ▶ 10 CFR 850 implemented in 1999
- ▶ Prior to 2001 controls were only for depleted uranium
- ▶ DARHT was constructed without any provisions for change facilities
- ▶ Trailers were used for PPE change-out and removed prior to shots
- ▶ Graded approach to PPE requirements

BERYLLIUM EXPENDITURE

- ▶ Initial shots contained minor amounts of beryllium
 - ▶ A 2001 shot contained over 15 billion micrograms ! of beryllium
 - ▶ The shot was thermally controlled with an enclosure lined with Styrofoam insulation
 - ▶ Failure to clean up shot debris resulted in contamination of parking areas and the building interior
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THE CABLE PORT INCIDENT

- ▶ A 2002 shot sent a blast of beryllium and DU contamination into the detection chamber via uncovered cable ports
 - ▶ Several rounds of decontamination were required
 - ▶ An enclosing building was constructed over the cable ports
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MATERIALS AND EQUIPMENT RELEASE

- ▶ Frequent movement of cranes, forklifts, vehicles, tools, etc.
 - ▶ Large numbers of swipe samples collected and analyzed
 - ▶ Delays while waiting for sample results
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IMPLEMENTATION OF FOAM CONTAINMENT

- ▶ Open-air shots were becoming increasingly unacceptable
 - ▶ Fire fighting foam was used to eliminate the airborne plume
 - ▶ Effective but costly:
 - ▶ Construction of large concrete pad with collection gutters
 - ▶ Construction of foam collection, storage, and treatment system
 - ▶ Monitoring and treatment by a team of chemists
 - ▶ Disposal costs for liquid waste
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FINALLY – VESSEL CONTAINMENT

- ▶ Foam was determined to be too expensive and labor intensive
 - ▶ The original plan for vessel containment had to be implemented
 - ▶ A secondary vessel was constructed as a precautionary measure in case the primary vessel failed
 - ▶ The Vessel Prep Facility was constructed for vessel clean-out
 - ▶ A robotic auger system allowed for removal of large debris without entry
 - ▶ Decon is performed in a Permacon under negative pressure
 - ▶ An on-site analytical lab monitors effectiveness of decontamination
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CURRENT-DAY STATUS

- ▶ The DARHT firing point is no longer a beryllium area
 - ▶ Experiment assembly and adjustment is simpler
 - ▶ All potential exposures have been moved to the Vessel Prep Facility
 - ▶ The number of exposed workers has been reduced.
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