



Airlock Qualification

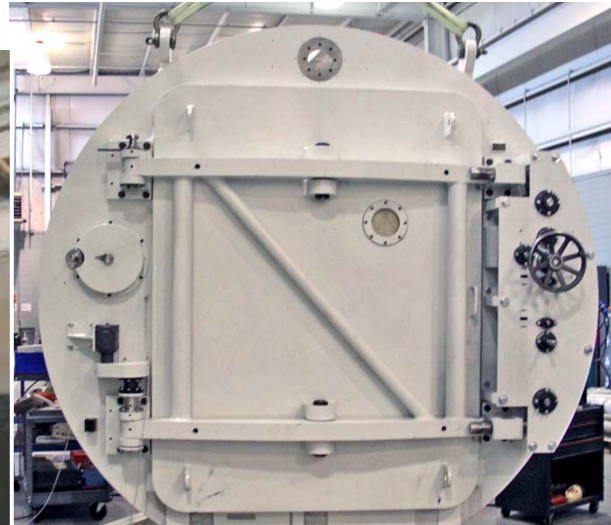
Presentation to IEEE SC-2

*Marie Nemier
June 4, 2013*

BENSHAW **CWFC Korea** **EES Engineering & Services** **EMD** **ENERTECH** **EST Group** **Farris Engineering** **Farris Engineering Services** **NETCO**
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Airlock Qualification

Containment Airlocks



Airlock Qualification

Containment Airlock

- The safety function of an airlock is to maintain pressure boundary
- Due to the size and complexity of the airlock, the environmental and seismic qualification is performed by evaluating the safety function of various sub-assemblies
- Different qualification methods & requirements are used for the various sub-assemblies

Airlock Qualification

Containment Airlock Subcomponents

- Electrical Control System
- Pressure Transmitters
- Drive Mechanism
- Compression Seals
- Pneumatic Pressure Controls
- Site Glass

Airlock Qualification

Containment Airlock – Electrical Control System

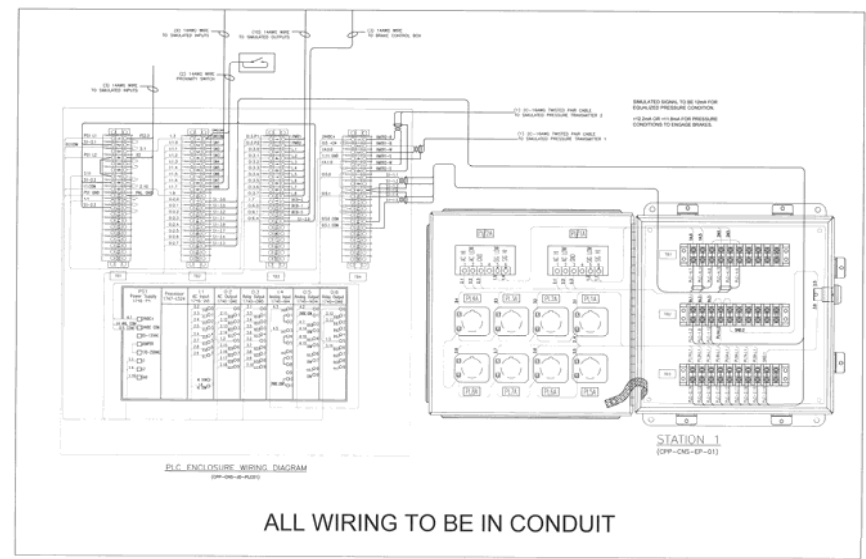
- The electrical control system is non-safety however it a concern was raised that the a control panel sub-component may spuriously operate due to EMI/RFI
- If the assembly received a spurious signal engage/disengage the brakes, the airlock may malfunction. EMI/RFI testing was performed and the test sample assembly was monitored as a system for spurious change of state of the brakes.



Airlock Qualification

Containment Airlock – Electrical Control System

- Electrical control system contains the following components:
 - PLC Panel
 - Junction Boxes
 - Indicating and Display Station
 - Door Brakes
 - Door Brake Control Box
 - Limit (proximity) Switch
 - Pressure Transmitter
 - Various Wiring in Conduit



Airlock Qualification

Containment Airlock – Electrical Control System

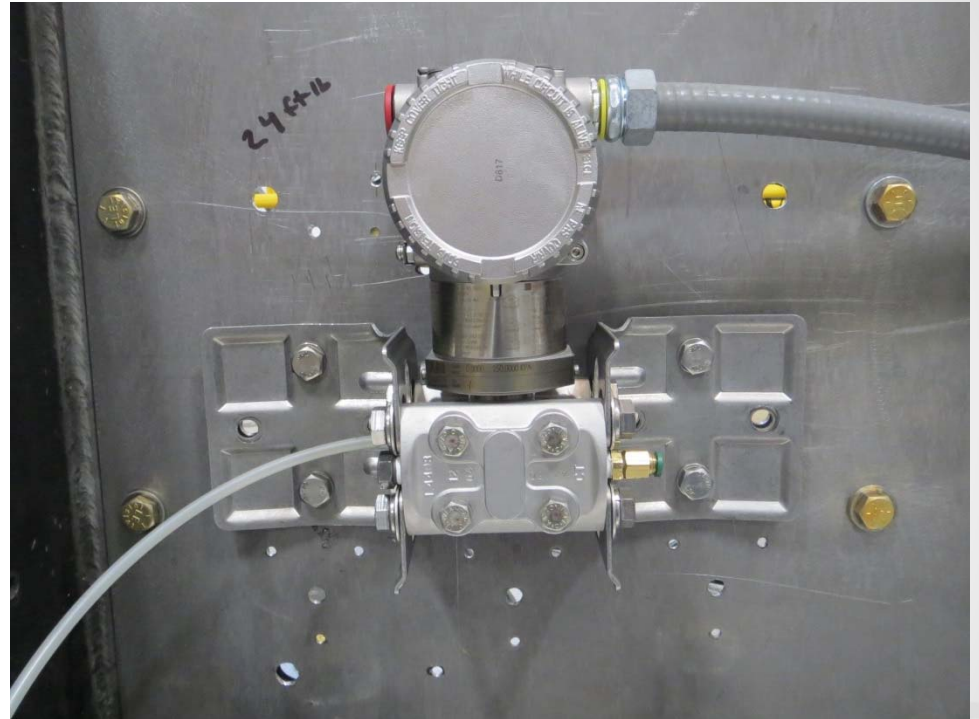
- Components were evaluated to determine susceptibility to EMI/RFI
- Individual components were not monitored. Faulty indications were not considered a failure however; they were noted in the report.
- EMI/RFI tests performed in accordance with APP-GW-G1-002 Revision 2 & Regulatory Guide 1.180



Airlock Qualification

Containment Airlock – Pressure Transmitter

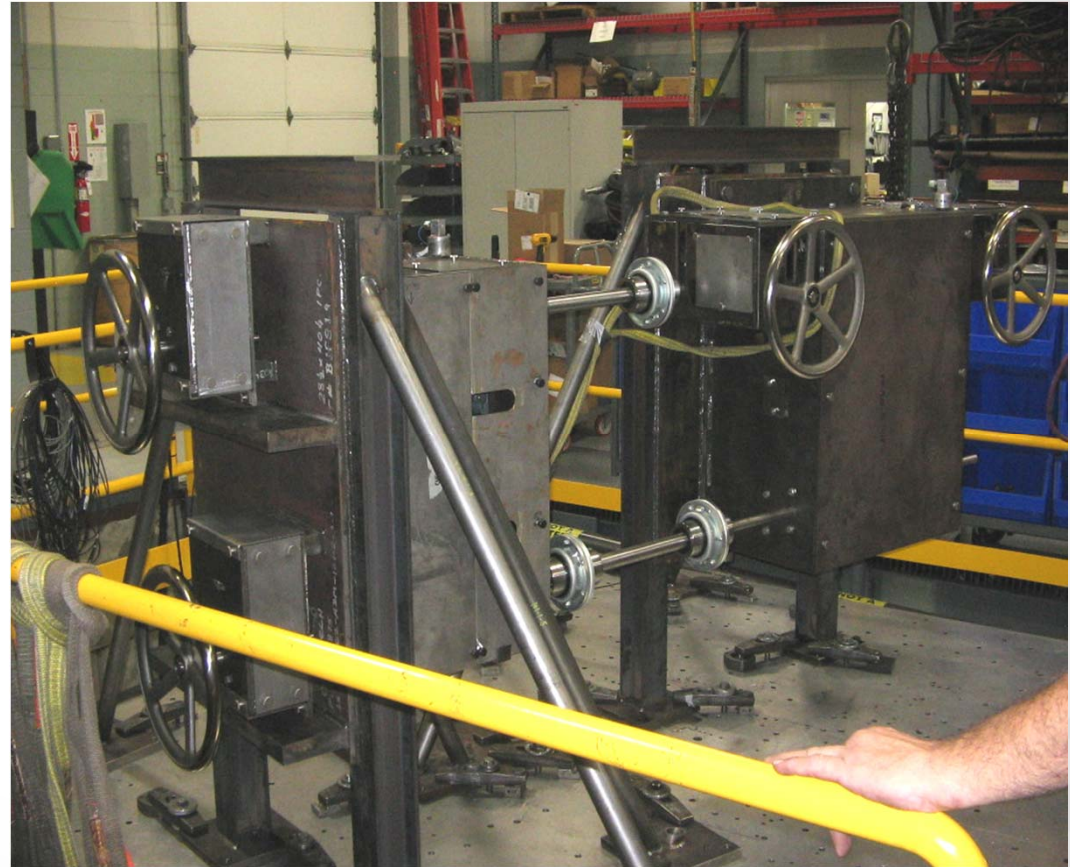
- Safety Function:
Pressure boundary only
- A transmitter was selected with a graphite seal so that environmental qualification was performed by analysis
- Seismic qualification was performed by test to the specification RRS



Airlock Qualification

Containment Airlock – Drive Mechanism

- Safety Function: Structural integrity and post-seismic operability
- Mechanical cycle aging was performed by analysis
- Seismic qualification was performed by test to the specification RRS



Airlock Qualification

Containment Airlock – Compression Seal

Safety Function: Pressure boundary only

Environmental qualification performed by test

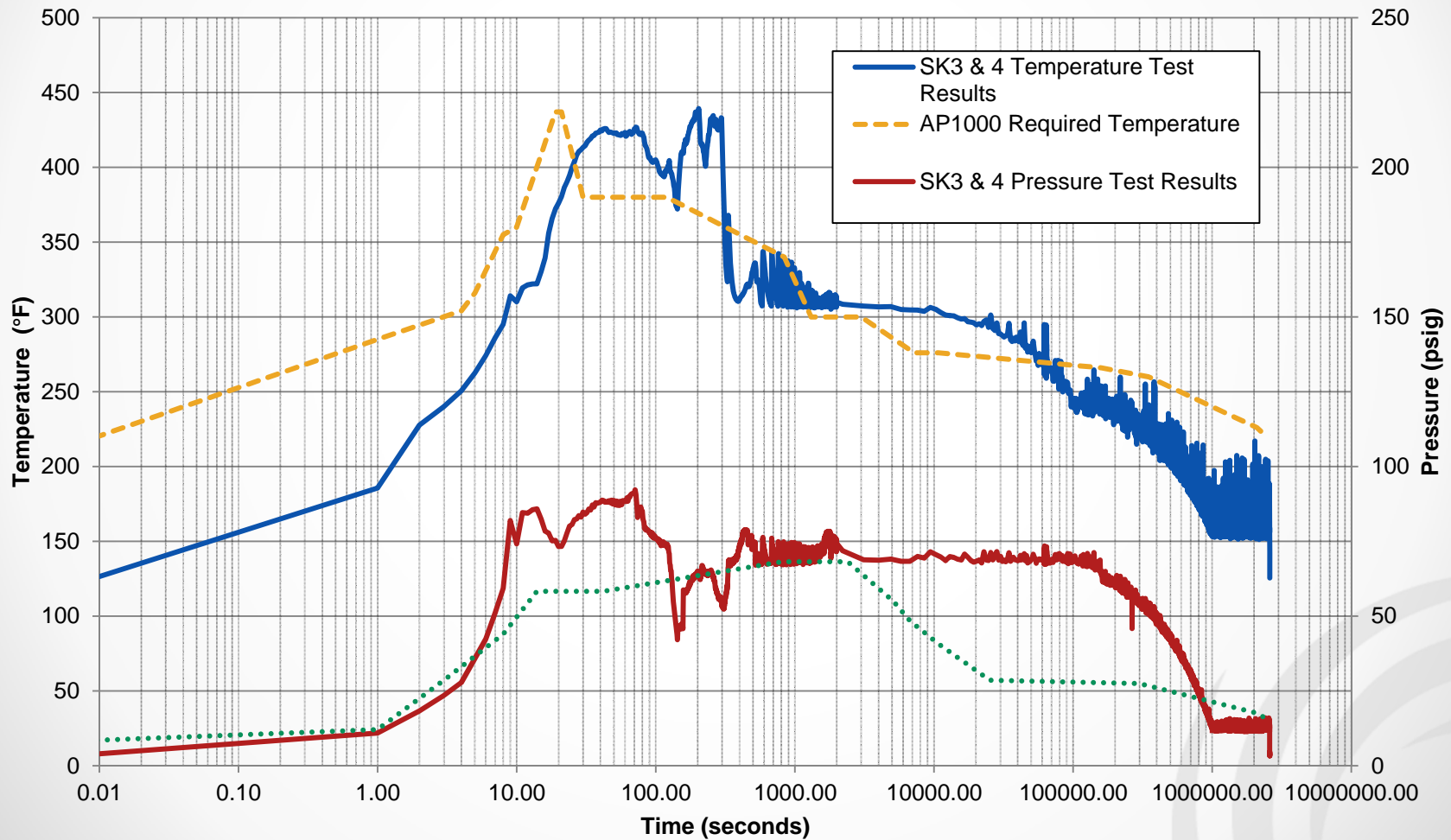
- Test sequence

- Service Life of seals 5 years
- Radiation TID (gamma)* 200 Mrad
- Operational cycles, airlock 20 times/week
- Peak Accident Temperature 360°F
- Peak Accident Pressure 60 psig
- Chemical Spray (boric acid) 4400 ppm
- *1 beta radiation has been directly added to gamma radiation

Airlock Qualification

Containment Airlock – Compression Seal

Trentec Seal Test Fixture LOCA



Airlock Qualification

Containment Airlock – Compression Seal

Safety Function: Pressure boundary only

Environmental qualification performed by test

- Test sequence

- Service Life of seals 5 years @ 120°F
- Radiation TID (gamma)* 46.5 Mrad
- Operational cycles, airlock 12 times/year
- Peak Accident Temperature 360°F
- Peak Accident Pressure 60 psig
- Chemical Spray (boric acid) 4400 ppm
- Chemical Spray (tri-sodium phosphate) 7.53 g/l
- 1 Year Post-Accident Submergence
- *1 beta radiation has been added to gamma radiation

Airlock Qualification

Containment Airlock – Compression Seal

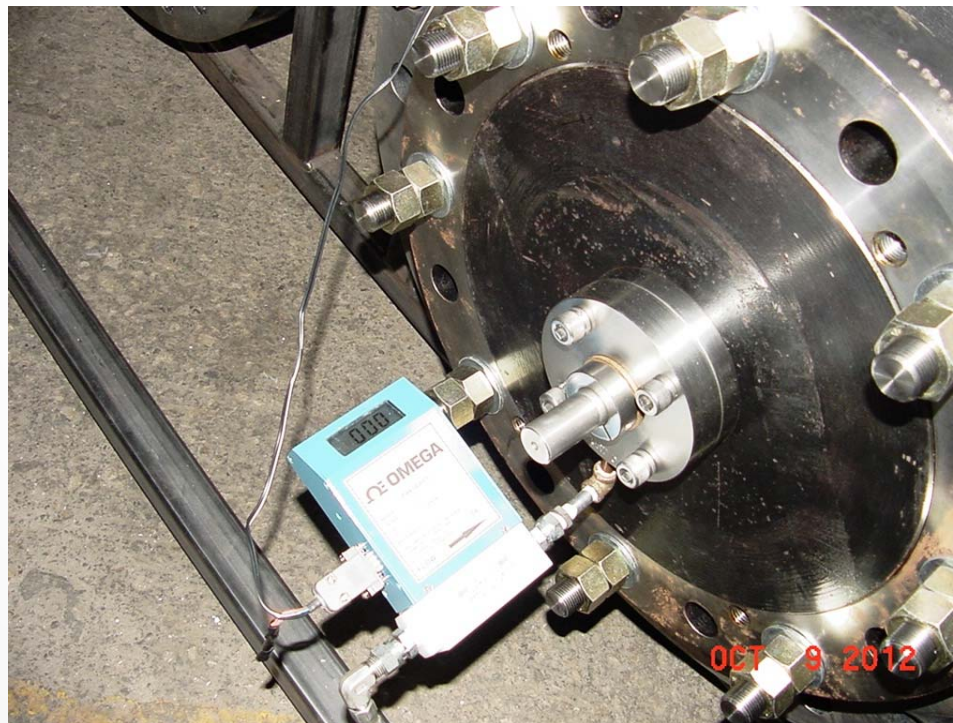
- Each test fixture contains o-rings representative of door o-rings and shaft hub o-rings



Airlock Qualification

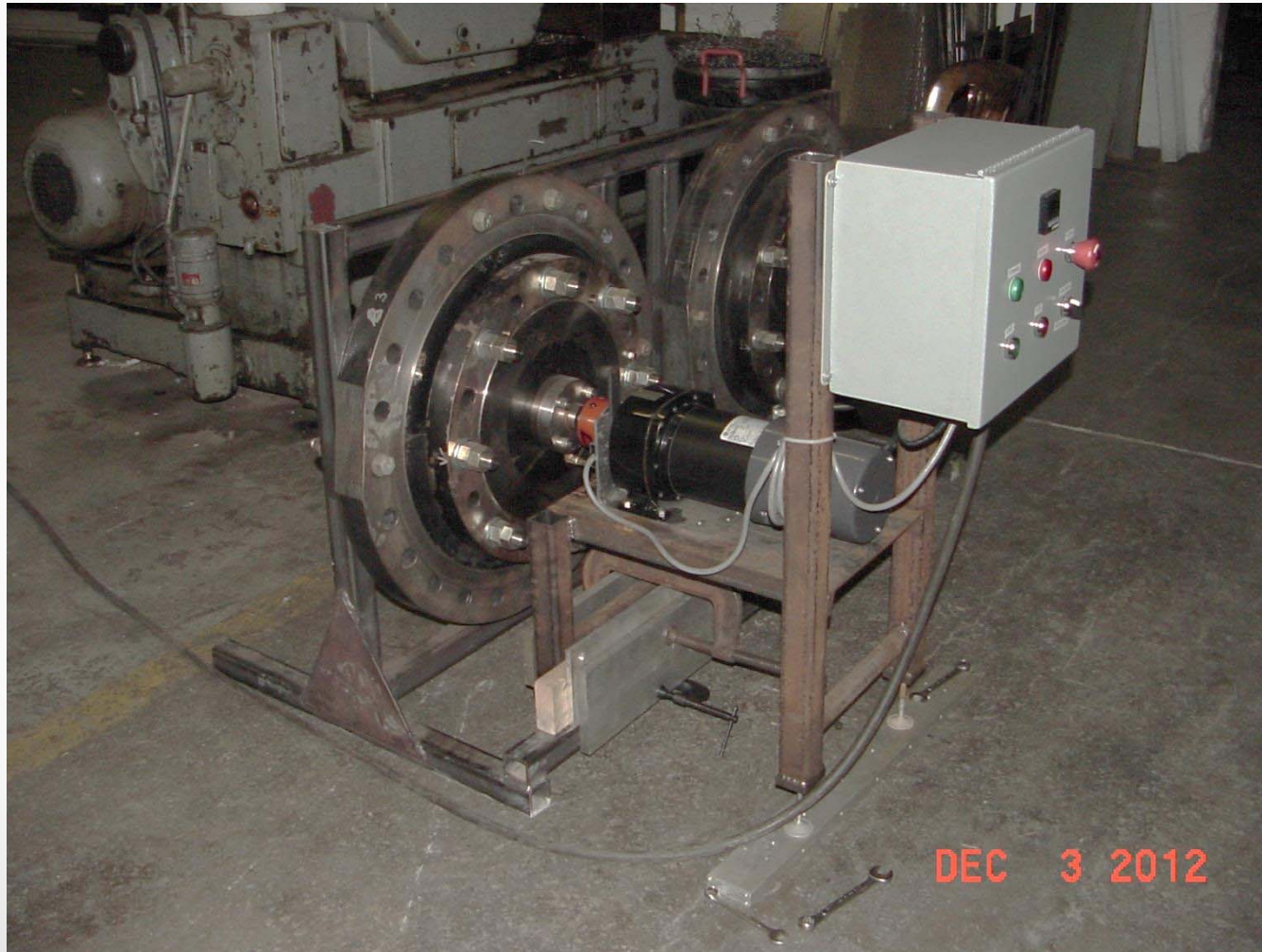
Containment Airlock – Compression Seal

- Leakage criteria: The safety function of the o-ring is to not exceed the total barrel leakage rate of 1.7 slm (1700 sccm) at the design conditions of 59 psig and 300°F. The leakage rate shall not exceed 13 sccm for the the door o-ring and 59 sccm for the shaft o-ring.



Airlock Qualification

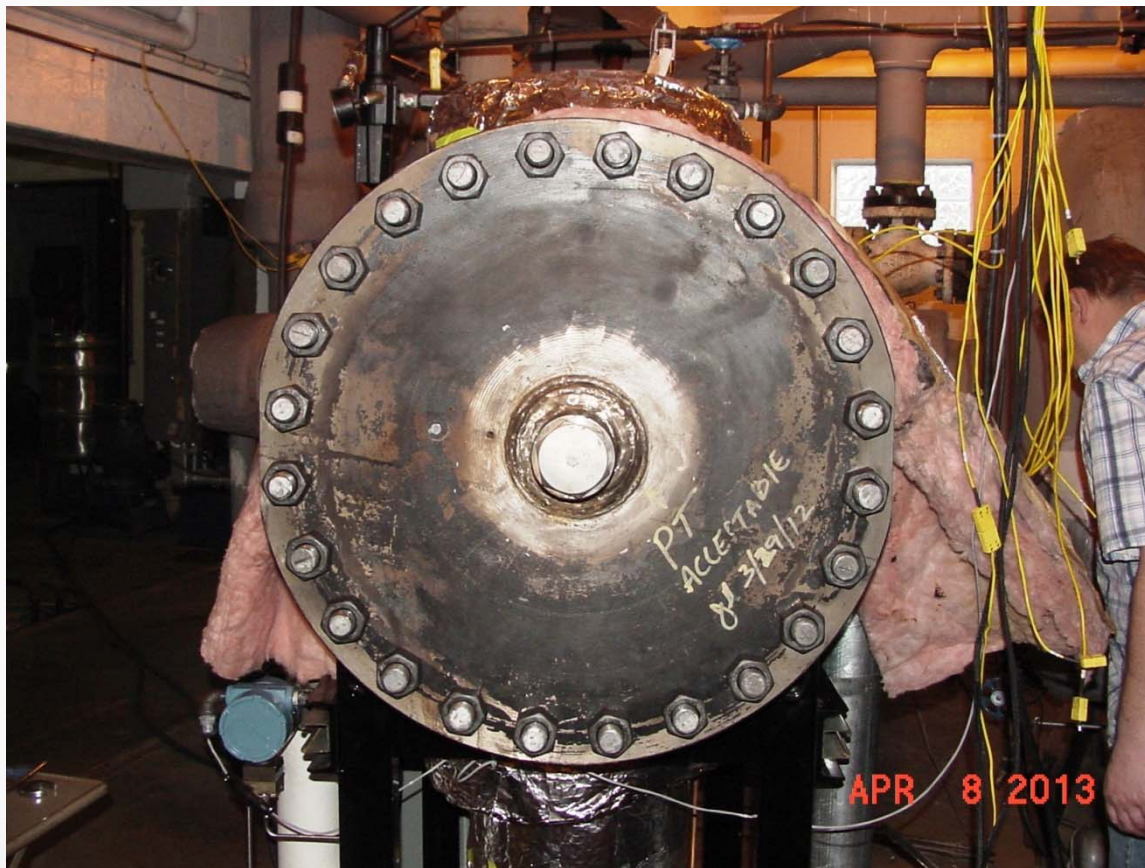
- Mechanical cycling



Airlock Qualification

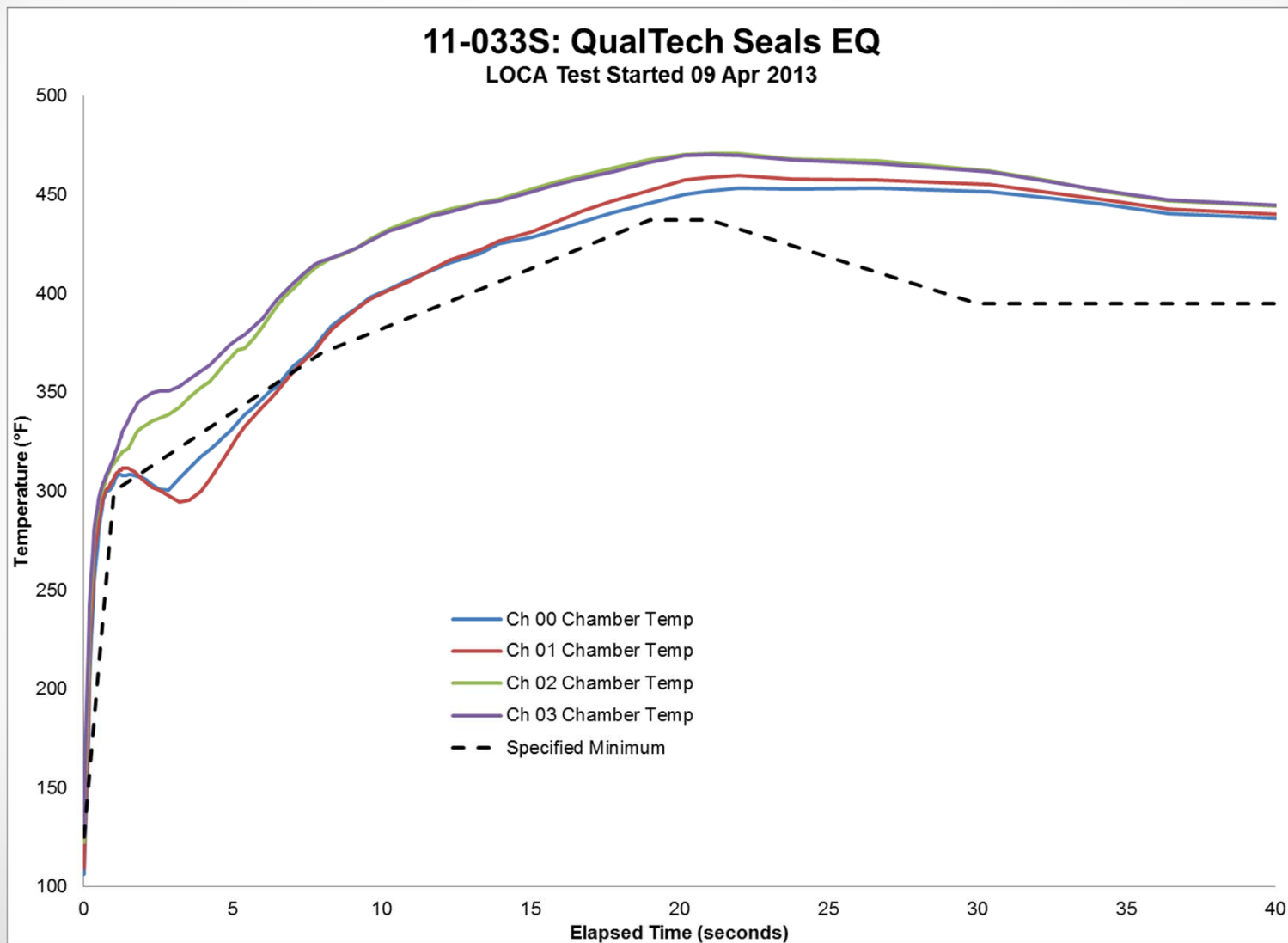
Containment Airlock – Compression Seal

- Seals in test fixture on LOCA Chamber



Airlock Qualification

Containment Airlock – Compression Seal

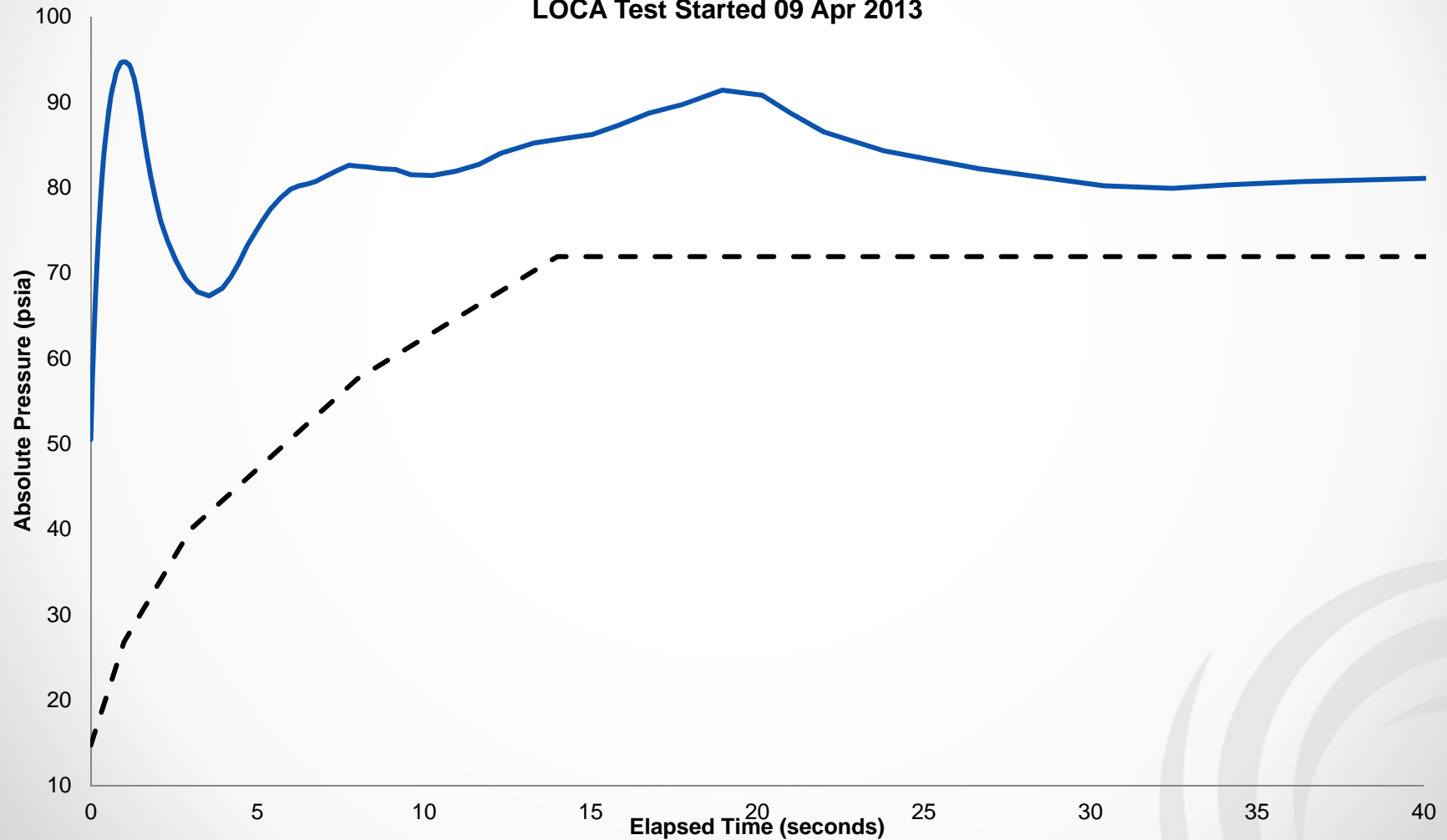


Airlock Qualification

Containment Airlock – Compression Seal

11-033S: QualTech Seals EQ

LOCA Test Started 09 Apr 2013



Airlock Qualification

Containment Airlock – Compression Seal

- Seals in test fixture moving from LOCA Chamber to submergence chamber



Airlock Qualification

Containment Airlock – Pneumatic Pressure Controls

- Airlock pressure controls for pneumatic systems with inflatable seals
- Components include manual valves and pressure switches
- Safety Function: Maintain pressure boundary
- Seismic qualification performed by test



Airlock Qualification

Containment Airlock – Site Glass

- Safety Function: Maintain pressure boundary
- Environmental qualification performed by test



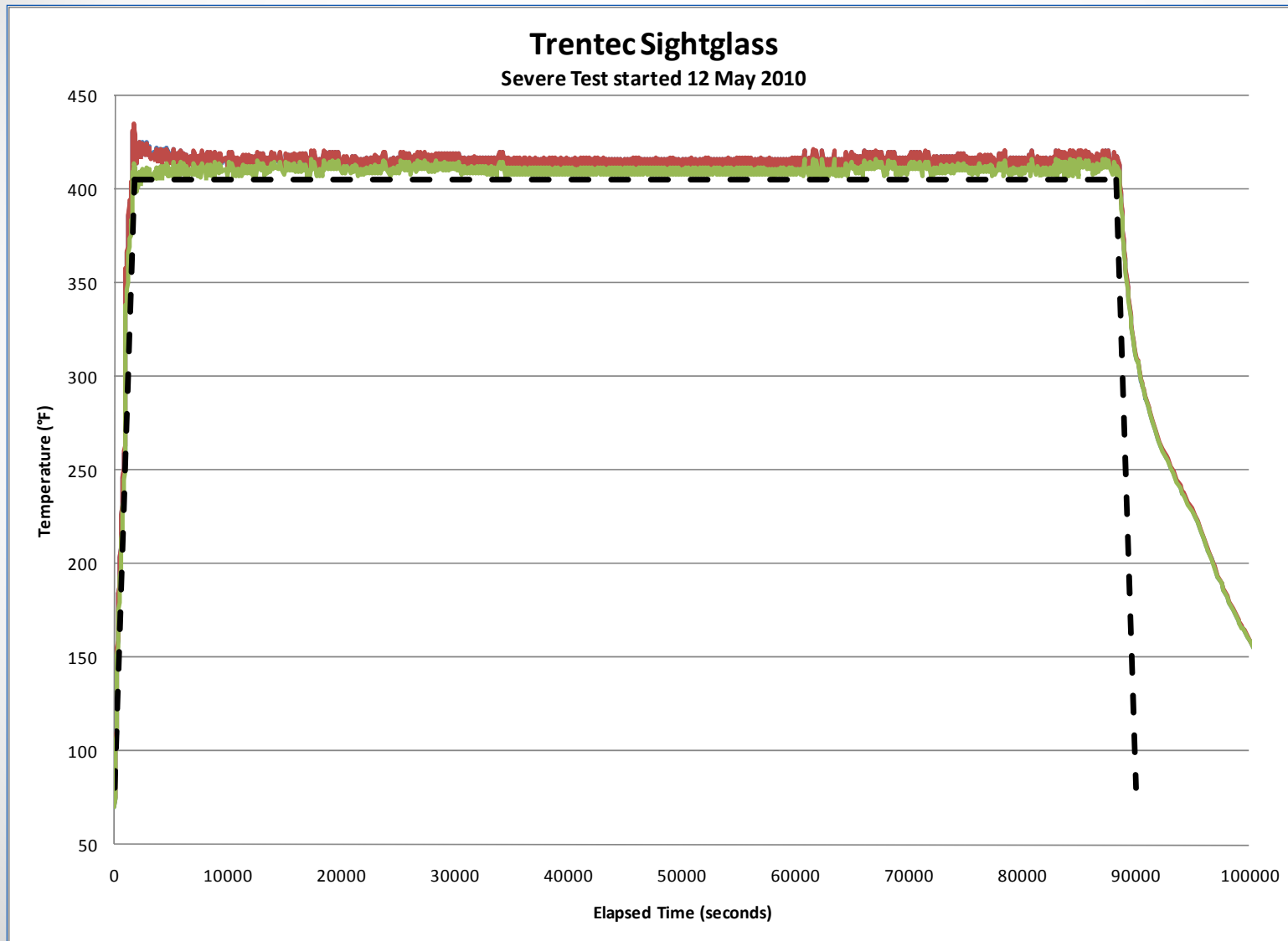
Airlock Qualification

Containment Airlock – Site Glass

- Test sequence
 - Radiation aging to 234 Mrads
 - Thermal aging to simulate 40 year life, 103 hours at 240°F
 - Mechanical cycle aging for 700 compression cycles – one side of the site glass was pressurized at 0 to 70 to 0 psig
 - Severe Accident Test: 24 hours at 405°F at 105psig

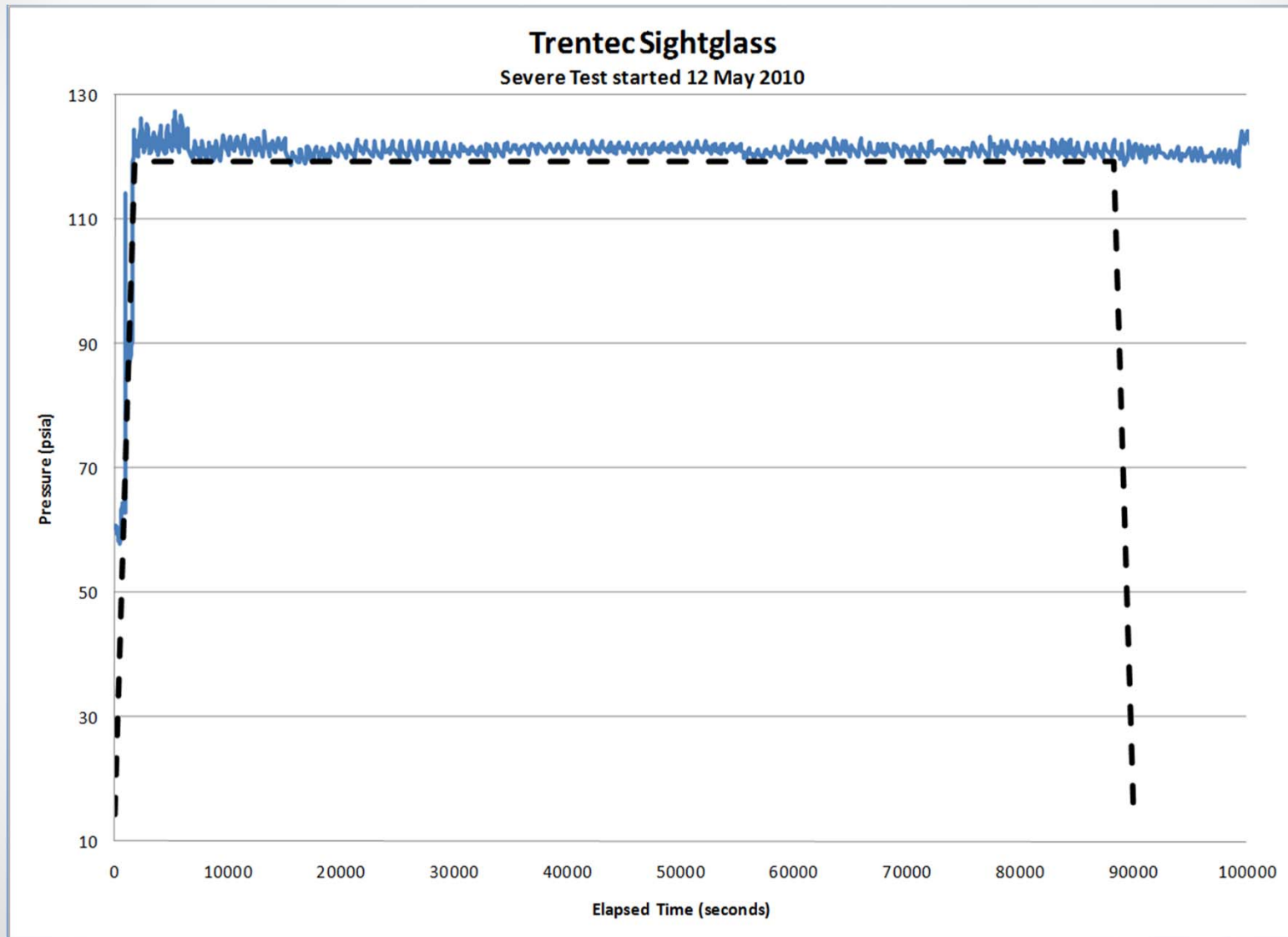
Airlock Qualification

Containment Airlock – Site Glass



Airlock Qualification

Containment Airlock – Site Glass





Questions

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