
JLAB Pressure Systems Considerations

Ed Daly

Outline

- Introduction
- Federal Law - 10CFR851 Compliance
- JLAB Pressure Systems Program
 - Complies with 10CFR851, but not necessarily ASME construction codes
- Pressure Testing of a Cold CEBAF Cryomodule
- Summary & Discussion

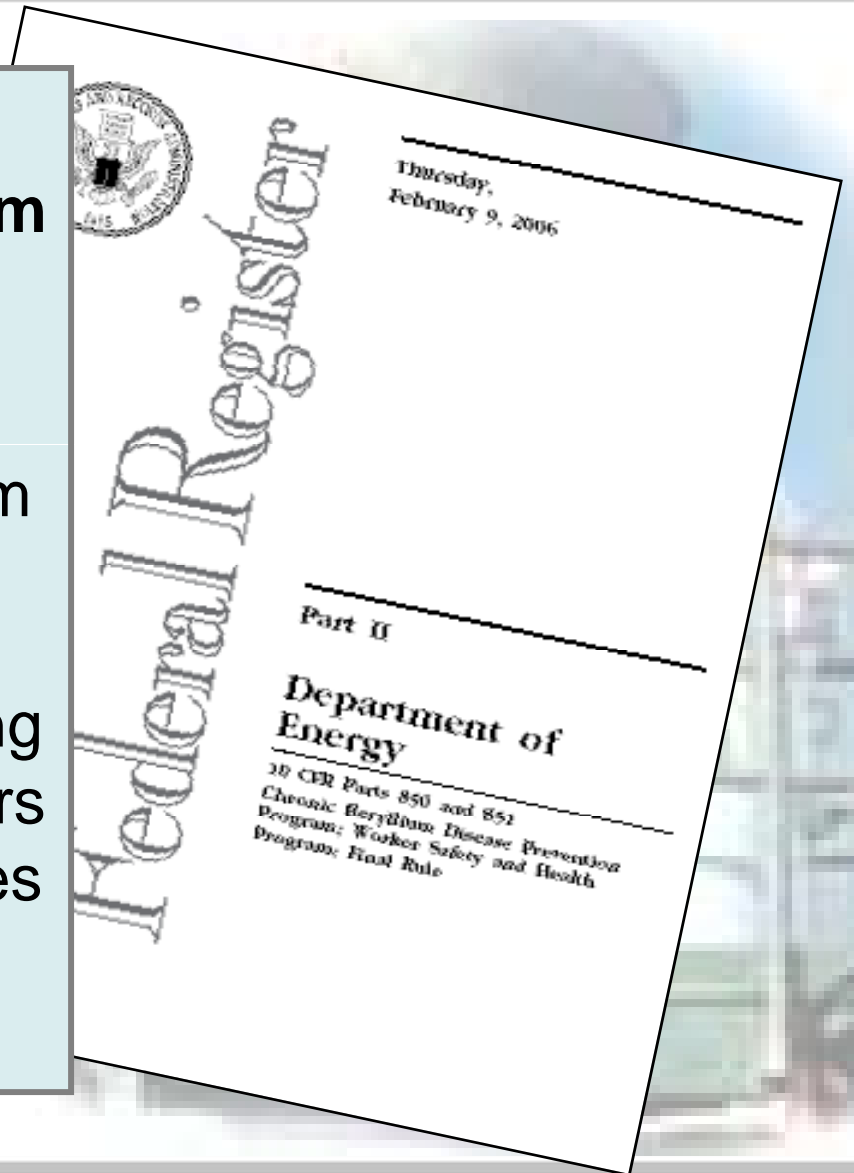
Overview of 10CFR851

DOE 10CFR851

Worker Safety and Health Program

February 7, 2006

Establishes “requirements for a worker safety and health program that reduces or prevents occupational injuries, illnesses, and accidental losses by providing DOE contractors and their workers with safe and healthful workplaces at DOE sites”



More on 10CFR851

DOE 10CFR851

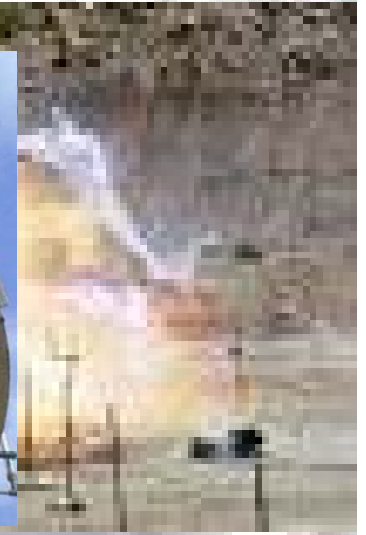
Establishes mandatory requirements for:

- Construction Safety
 - Fire Protection
 - Explosives Safety
 - **Pressure Safety**
 - Firearms Safety
- Industrial Hygiene
- Biological Safety
- Occupational Medicine
- Motor Vehicle Safety
 - Electrical Safety



Why is 10CFR851 concerned with pressure safety?

- Over pressurization, poor construction or maintenance can result in leakage or rupture failures
 - Pose safety risk to personnel
 - May jeopardize other critical components
 - May result in release of hazardous pollution
- Hazards include:
 - Explosion
 - Fires
 - Poisoning
 - Scalding



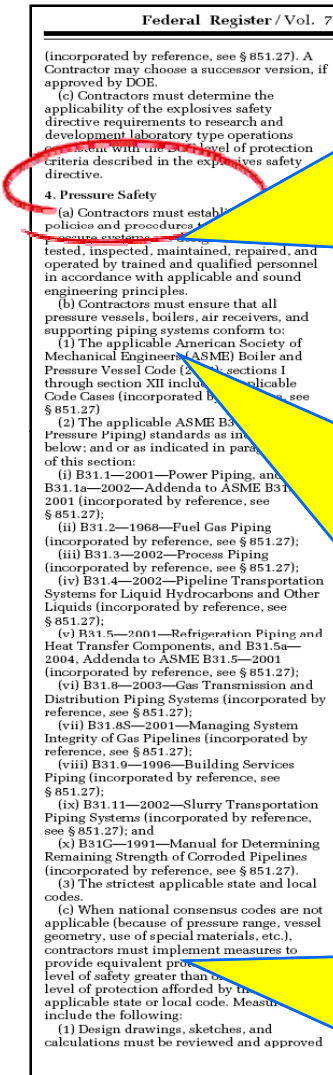
DOE 10CFR851 Pressure Safety

“Contractors must establish safety policies and procedures to ensure that pressure systems are designed, fabricated, tested, inspected, maintained, repaired, and operated by trained and qualified personnel in accordance with applicable and sound engineering principles.”

“Contractors must ensure that all pressure vessels ... and supporting piping systems conform to:

- (1) The applicable ASME Boiler and Pressure Vessel Code
- (2) The applicable ASME B31 Code for Pressure Piping
- (3) The strictest applicable state and local codes”

“When national consensus codes are not applicable (because of pressure range, vessel geometry, use of special material, etc.), contractors must implement measures to provide equivalent protection...”



10CFR851 Definition of a Pressure System

- Pressure systems include all pressure vessels & pressure sources including cryogenics, pneumatic, hydraulic, & vacuum.
- Vacuum systems are considered pressure systems due to their potential for catastrophic failure from backfill pressurization.
- Associated hardware (e.g., gauges and regulators), fittings, piping, pumps, & pressure relief devices are integral parts of a pressure system.



JLab's Response to 10CFR851 Pressure Safety Requirements

- Form a Pressure Systems Committee
- Define pressure systems within JLab.
- Develop policy and procedures to implement 10CFR851 pressure safety requirements

Jefferson Lab
Thomas Jefferson National Accelerator Facility
Exploring the Nature of Matter

ES&H Manual
6151 Pressure and Vacuum Vessels

6151

There is a significant requirement change driving substantial content changes to this document. Individuals needing guidance during this period should consult the Pressure Systems Committee.

Introduction

Click for New Chapter

The hazards associated with pressure vessels and liquefied gas dewars include rupture and explosion. Hazards associated with vacuum vessels such as vacuum chambers in experimental hall equipment include rupture and implosion. Causes of pressure vessel accidents include:

- inadequate design,
- failure to properly maintain the vessel for its rated service,
- exceeding maximum allowable working pressure,
- failure to provide pressure relief devices, and
- unauthorized modifications.

Examples of pressure and vacuum vessels used at Jefferson Lab include:

- Cryomodules, which include both a pressure and a vacuum vessel.
- Experimental equipment with voluminous vacuum chambers.
- Small experiment-target vessels sometimes confine as much as 100 atmospheres of pressure.
- In Jefferson Lab's cryogenic plants, oil-removal and gas-storage systems operate at 15 to 20 atmospheres.
- Some pressure compressed-air and reservoirs are pressurized to 85 psi and above,
- Heating and air conditioning systems throughout the site.

This chapter sets Jefferson Lab's general policy on the design, fabrication, testing, and certification of pressure vessels. This policy shall also be applied to vacuum vessels, which under failure conditions could become pressurized. The chapter's pressure vessel requirements are based on the American Society of Mechanical Engineers (ASME) Code. Chapter 6150 *Compressed Gases* and Chapter 6500 *Cryogenic and ODH Safety* are to be referred to for additional requirements for specific uses.

6151PressureVessels.fm rev. October 18, 2005 6151 Page 1 of 11

JLab Definition of Pressure System

Pressure System :

A system containing **pipings, its components and/or pressure vessel(s)** used to either convey or contain a **pressurized fluid** including cryogenic, pneumatic, hydraulic and vacuum. Vacuum systems must be considered pressure systems unless adequate measures have been taken to prevent pressurization above 15 psi. **Includes pressure sources, fittings, pressure relief devices and associated hardware such as gages and regulators.**

JLab Definition of Pressure System

ASME B31 exclusions include:

- piping systems between 0 and 15 psi with nonflammable nontoxic and not damaging fluids between -20 °F to 366 °F.
- tubes, tube heaters, crossovers, and manifolds of fired heaters.

ASME BPV Code exclusions include:

- pressure vessels which are parts of rotating devices.
- water vessels with design pressure < 300 psi and design temperature < 210 °F.
- hot water tanks with indirect heat source < 200,000 Btu/hr where temperature < 210 °F and capacity < 120 gallons.
- vessels with internal or external operating pressure < 15 psi.
- vessels with inside diameter, width, height or cross section diagonal < 6 inches.

Exclusion under one does not provide exclusion under the other.

Pressure Systems Policy

JLab has policies and procedures that ensure all pressure systems are designed, fabricated, tested, inspected, maintained, repaired, and operated by trained and qualified personnel in accordance with applicable and sound engineering principles.

JLab verifies that all pressure systems conform to applicable

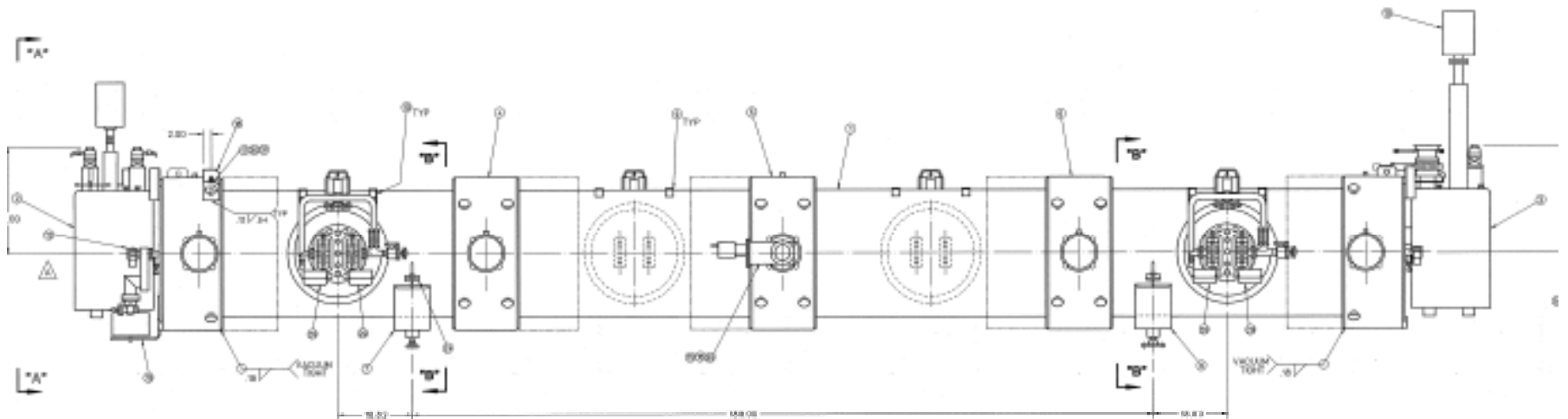
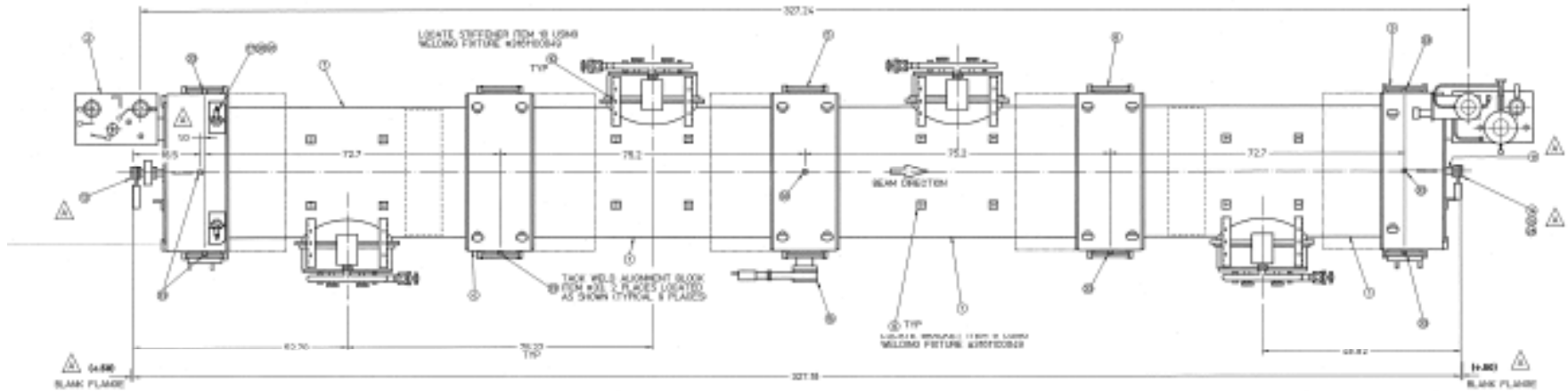
- ASME BPV Code
- ASME B31 Code
- State and Local Codes

Where ASME Codes cannot be directly applied, JLab shall implement equivalent measures that ensure a level of safety greater than or equal to the level provided by the ASME Codes.

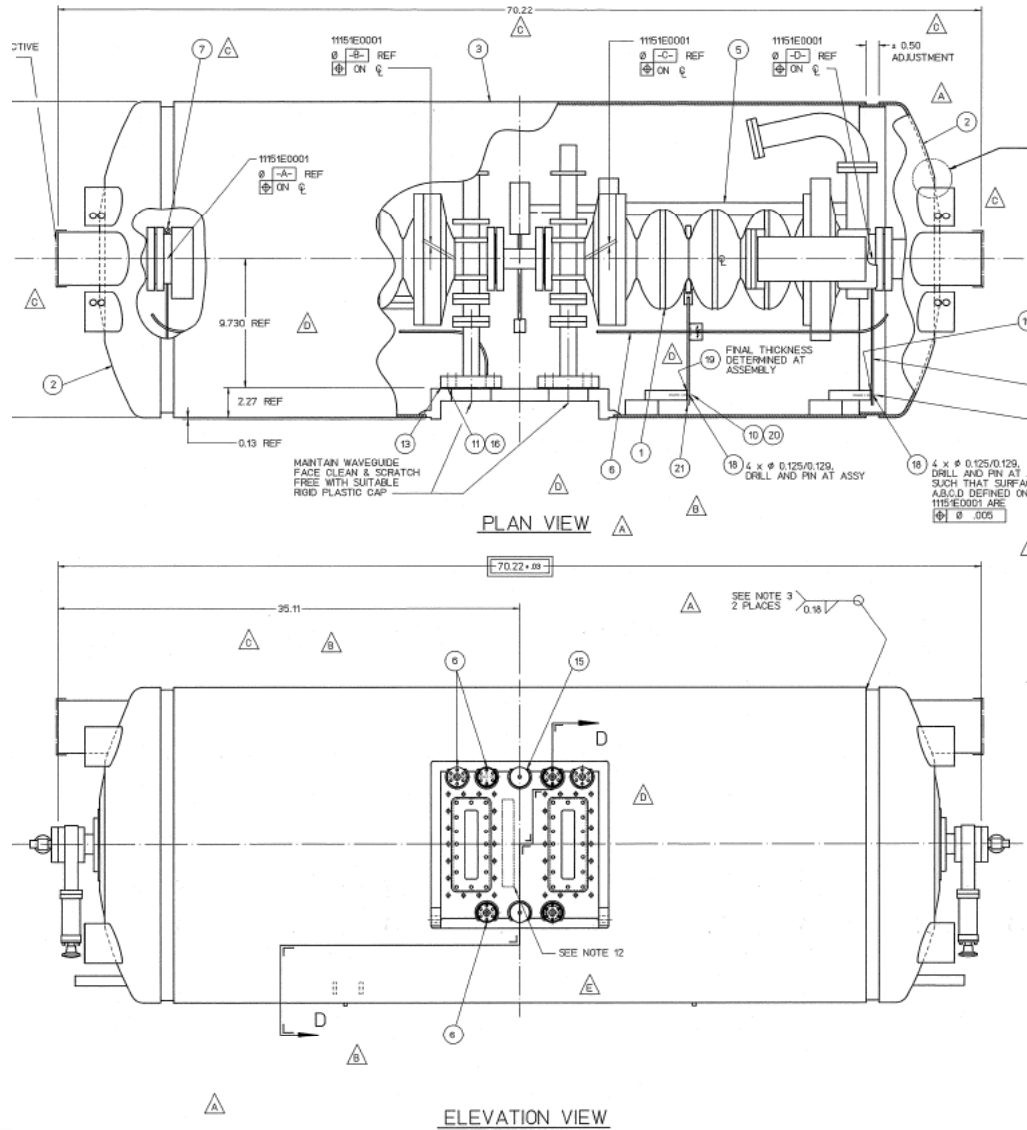
Cold Pressure Test of CM

- C50 Program at JLAB – refurbish 10 cryomodules to improve voltage from ~20 MV to 50 MV
 - Also improve tuner performance and reduce arc trip rate
- During decommissioning tests, “old” cryomodules can be challenged or evaluated at low risk
 - These will be disassembled anyway
- Pressure Testing
 - Measure Qext and passbands before pressure test
 - Pressurize to 4.4 atm
 - Re-measure Qext and passbands, bead pulls if necessary
 - Final helium leak check

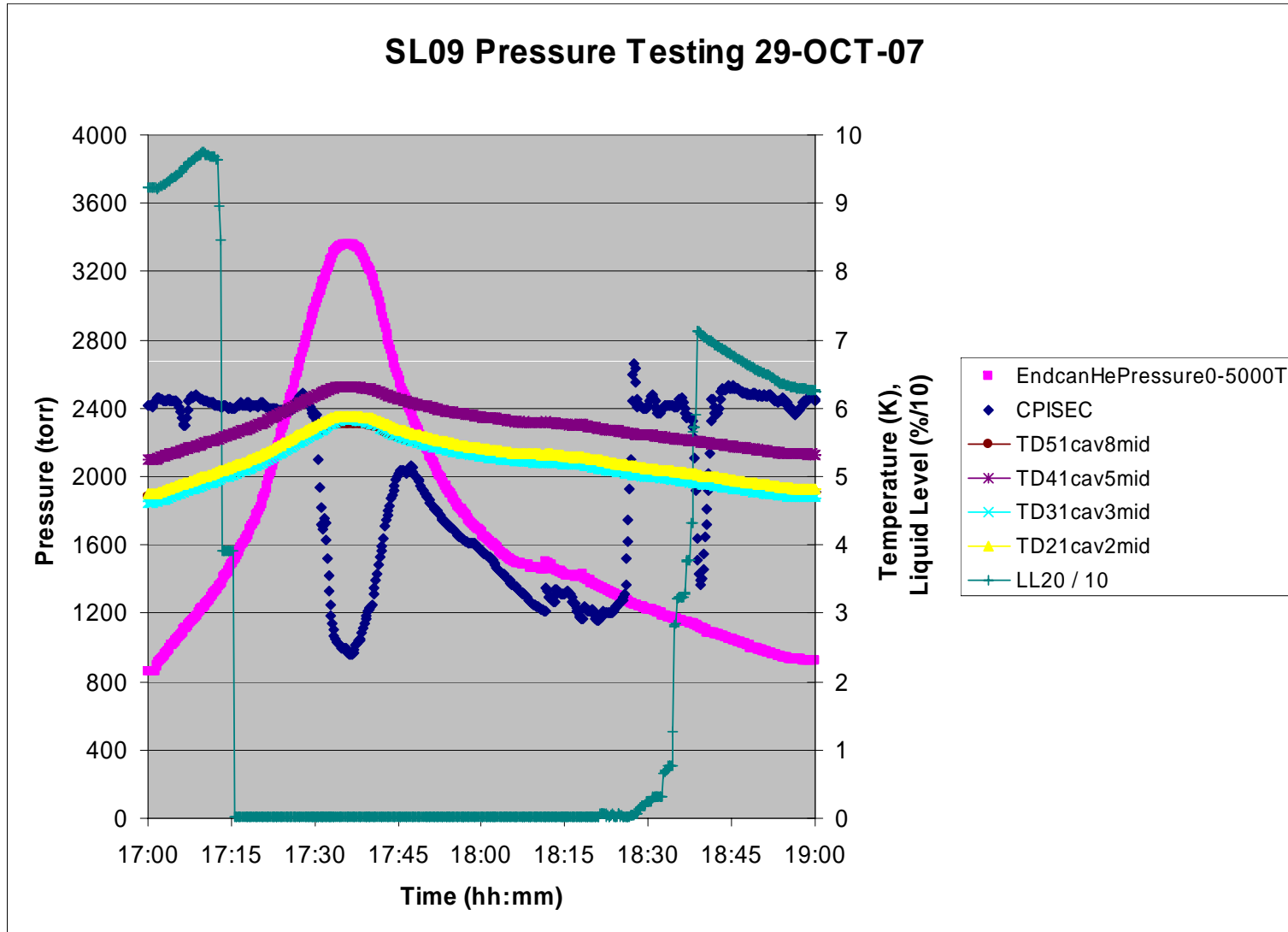
Original CEBAF Cryomodule



Cavity Pair Installed in Cryo-Unit



Time-History of Pressure Test

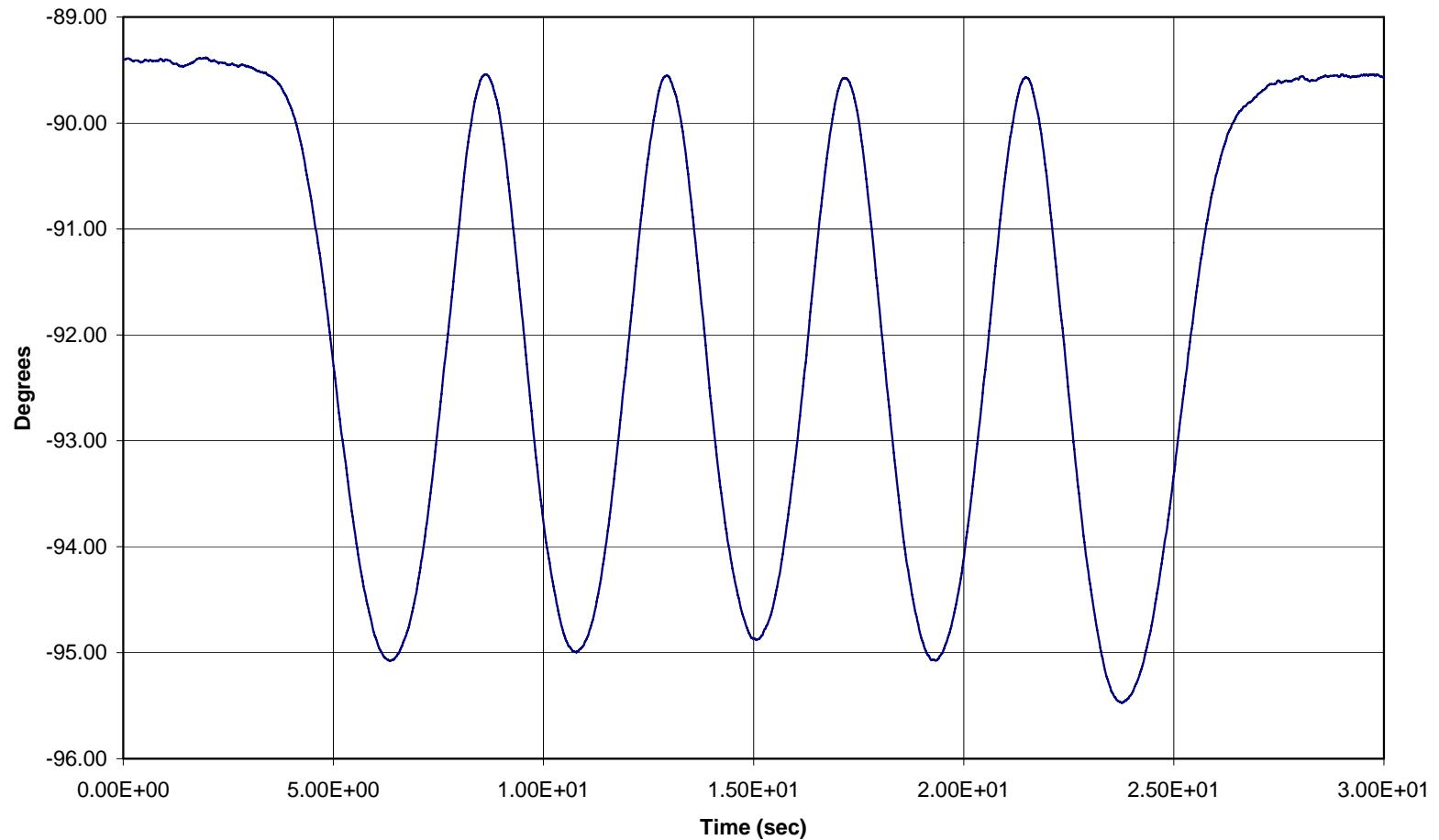


Cavity Field Flatness = 4.6% after Test

C50 IA-260 Pre Disassembly Check
Pull Dir = FPC to FP

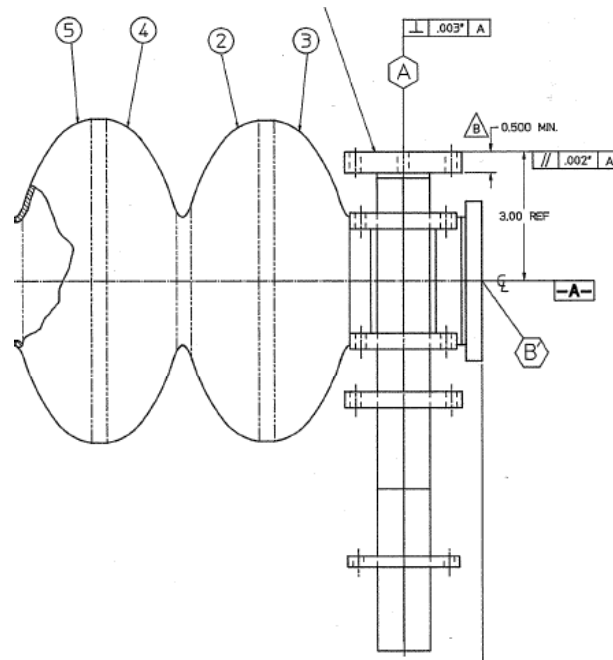
CW Freq = 1494.266 MHz
12/12/07

Field Flatness = 4.64 %



Change in Qext due to Pressure Test

Cavity #	SN	Before 1st Test	After Second Test	% Change
1	IA-180	7.74E+06	7.51E+06	-3.0%
2	IA-222	7.65E+06	7.84E+06	2.5%
3	IA-345	6.39E+06	6.25E+06	-2.2%
4	IA-299	5.61E+06	5.72E+06	2.0%
5	IA-260	5.33E+06	5.99E+06	12.4%
6	IA-38	7.28E+06	7.31E+06	0.4%
7	IA-218	5.83E+06	5.82E+06	-0.2%
8	IA-280	6.82E+06	6.82E+06	0.0%



Results of Pressure Test

- Two pressure tests conducted successfully
- Primary circuit was helium leak-tight.
- Bead pull on two cavities showed acceptable field flatness
- Relative spacing between pass bands change within acceptable limits
- Qexternals for all cavities were within specification
- A second test was conducted last week – more results to come!

Summary & Discussion

- JLAB has a policy in place that will make us compliant with 10CFR851 primarily for pressure systems.
- JLAB's policy allows for construction of vessels that are not compliant with ASME or other construction codes.
- JLAB's approach may differ from approaches at other laboratories.
 - For example : SNS – New cryomodules may have stamped vacuum vessels
 - Others?
- Pressure testing of cold cryomodules is being conducted to increase SRF community understanding of pressure system construction issues