MNI3 JRA Sample Environment Meeting
Rome, Italy

High Pressure Task (STFC)

08.11.2011

Science & Technology Facilities Council

Work out a joint approach to the **Health & Safety** aspects based on the **Pressure Equipment Regulations (PED)** *Work in progress*

Inert Gas Cells *(ISIS, STFC)*

Tasks:

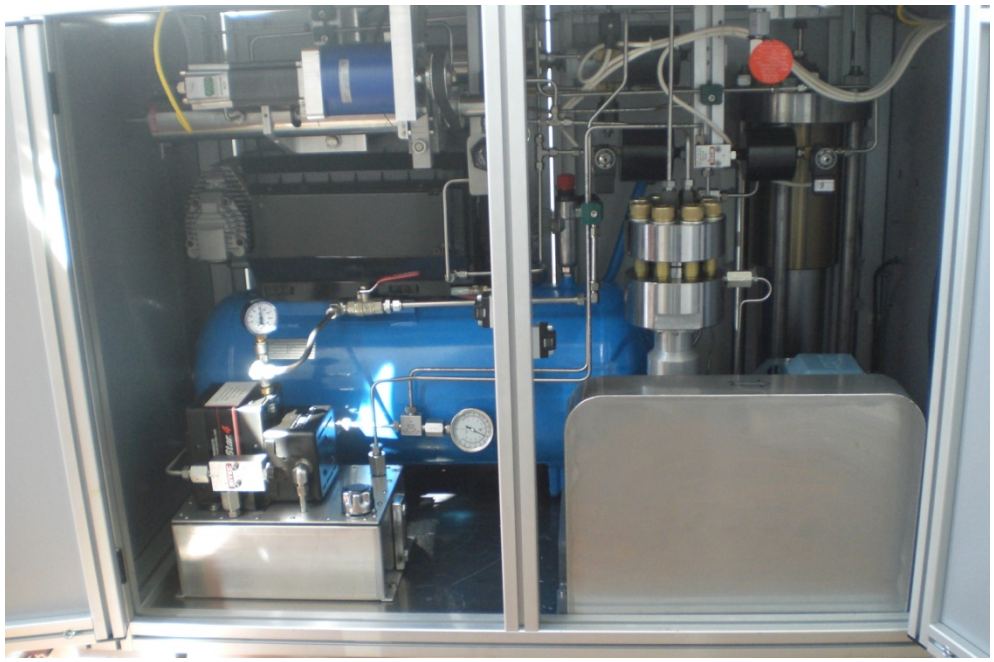
- ***D21.15*** Procurement **10 kbar** automated gas handling system *Completed*

Hydrogen Cells *(ISIS, STFC)*

Tasks:

- ***D21.15*** Sourcing, assembly and commissioning of **10 kbar** H_2 intensifier and gas handling system. *Work in progress*
- ***M21.2.2.1*** Cell material and seal design review *Completed*
- ***D21.16*** Report on material research: H_2 and neutron compatibility . *Completed*
- ***M21.2.2.2*** Design plan review for H_2 gas pressure cell for 8 kbar at 4-300K *Completed*

D21.15 Procurement 10 kbar automated gas handling system



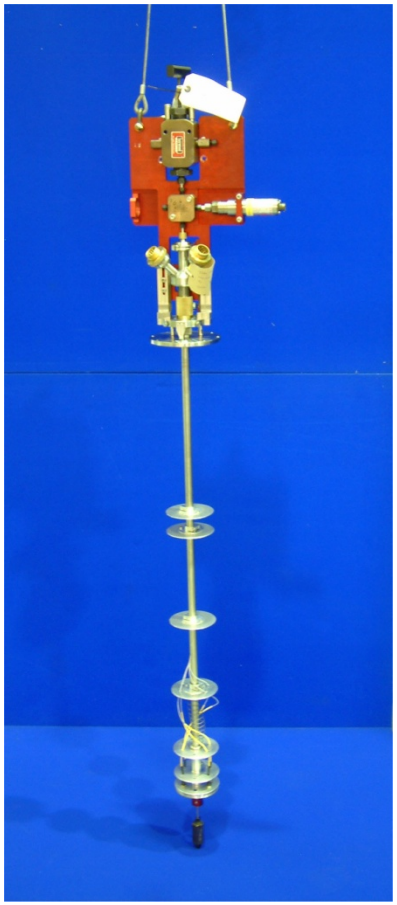
The automated inert gas handling system specification:

- Operating from 0 to 10,000bar
- Transducer accuracy of 0.3%
- Full scale and pressure changes in steps of 40 bar
- This system is able to be controlled by instrument computer

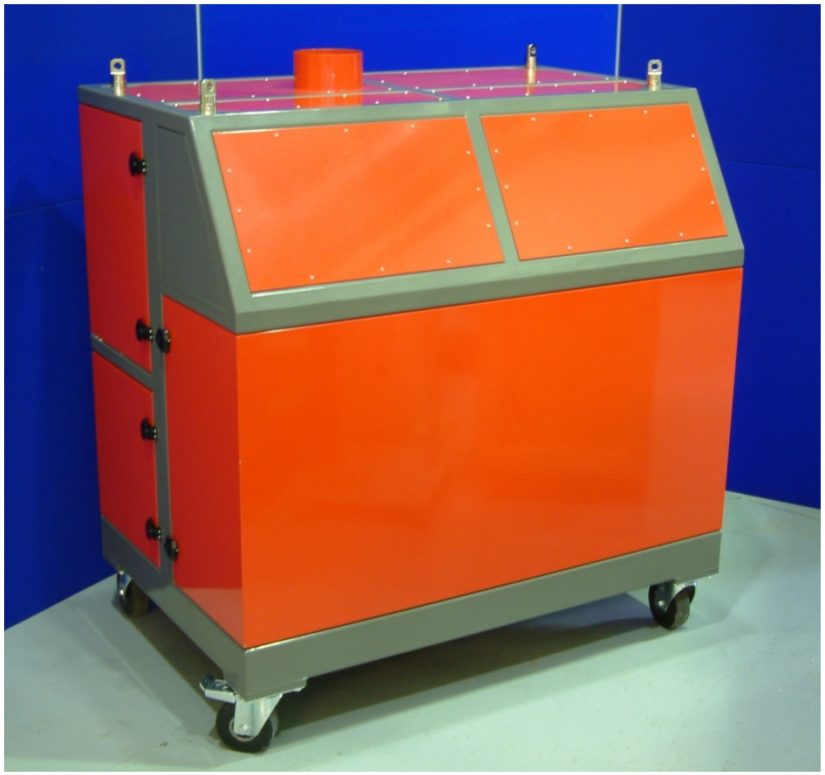
The system is released to ISIS User Program

D21.15 Sourcing, assembly and commissioning of 10 kbar H_2 Intensifier and gas handling system

Due to financial restraints the 10Kbar Hydrogen Intensifier is to be assembled and tested at ISIS by the Pressure & Furnace department. Components have been purchased and assembly work is in progress .



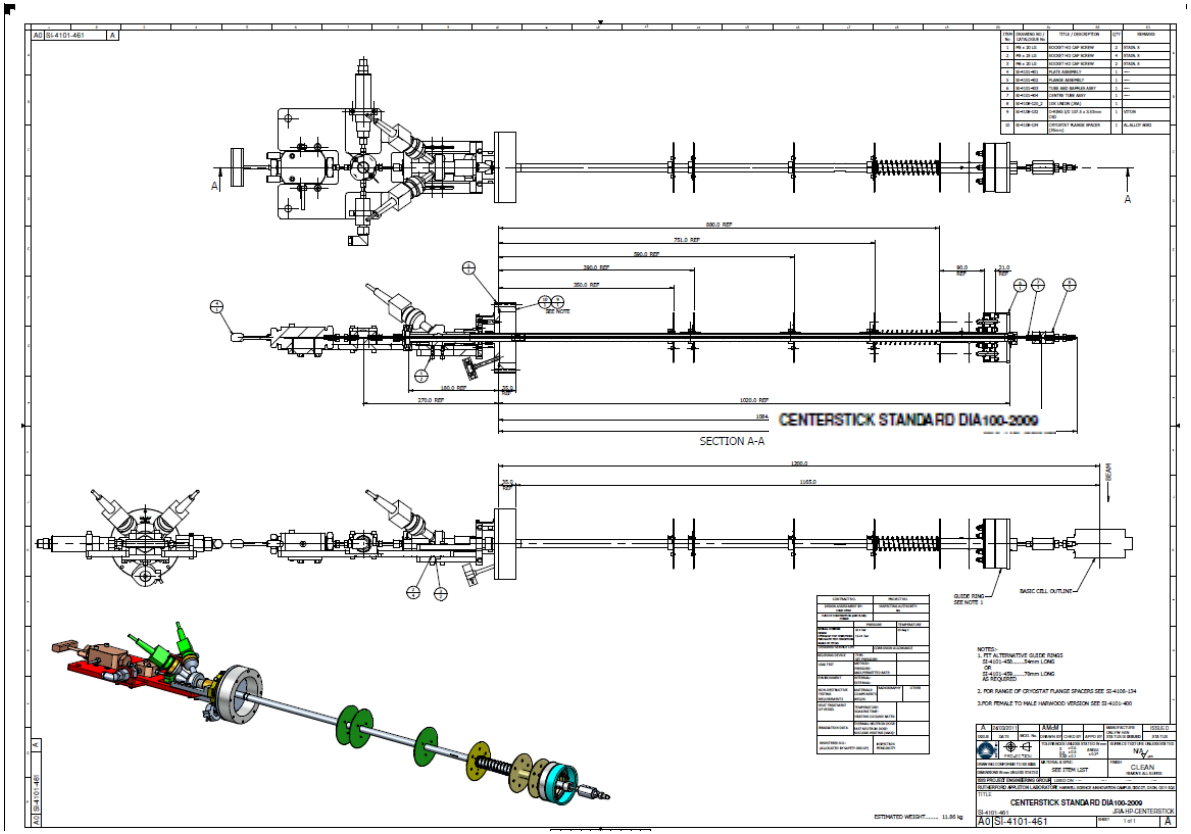
High pressure hydrogen stick



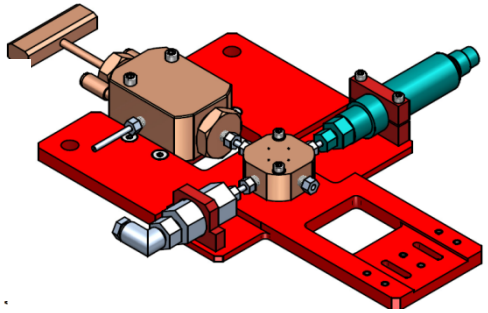
High pressure hydrogen “red“ panel

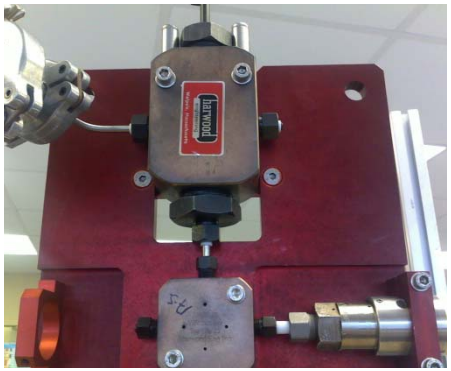
D21.15 Sourcing, assembly and commissioning of 10 kbar H_2 Intensifier and gas handling system

JRA 10Kbar Centre-Stick & H2 Valve



JRA 10Kbar Centre-Stick Drawing





Harwood C-4133 H2 10Kbar valve assembly on Centre-Stick

M21.2.2.1 **Cell material and seal design review**

D21.16 **Report on material research: H_2 and neutron compatibility**

M21.2.2.2 **Design plan review for H_2 gas pressure cell for 8 kbar at 4-300K**

Specification

- To investigate the sample chamber seal design and material compatibility of a pressure vessel intended to operate up to ***8000 bar*** with hydrogen gas on the ISIS neutron instruments.

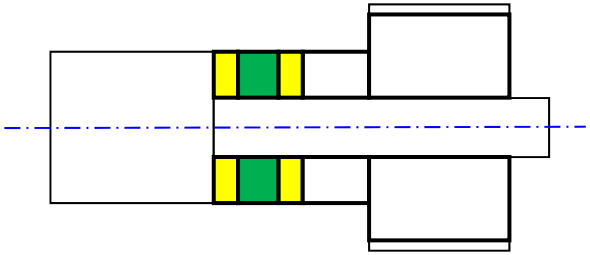
- The working temperature will be from ***300 K*** down to ***4 K***.

- The material of construction should be ***neutron compatible*** and able to retain the ***necessary strength*** to endure the enormous stresses likely to occur at the intended high pressures. Certain materials become brittle following exposure to hydrogen

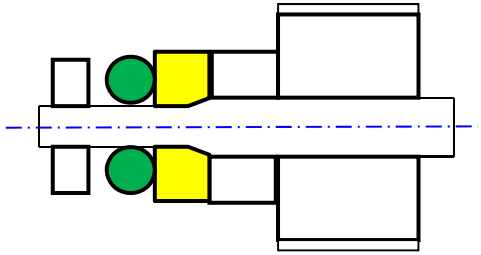
M21.2.2.1 Cell material and seal design review

JRA seal options

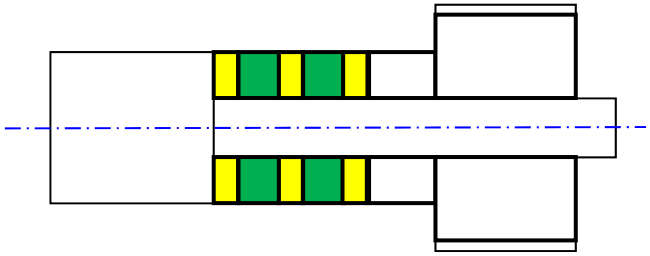
Standard Bridgman seal



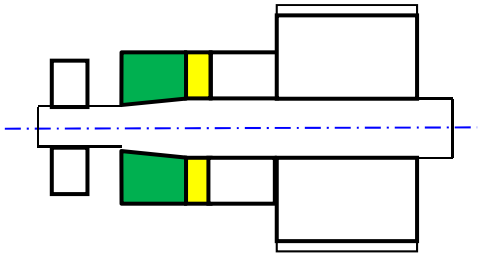
MSE version



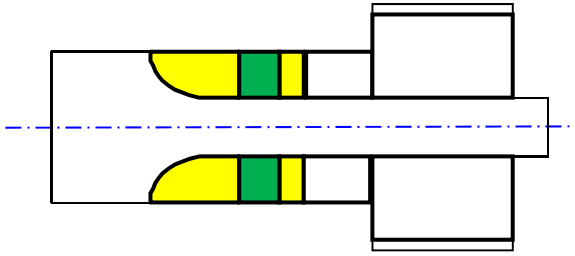
Double Bridgman seal



Tapered version



LLB version



M21.2.2.1 Cell material and seal design review

JRA seal options

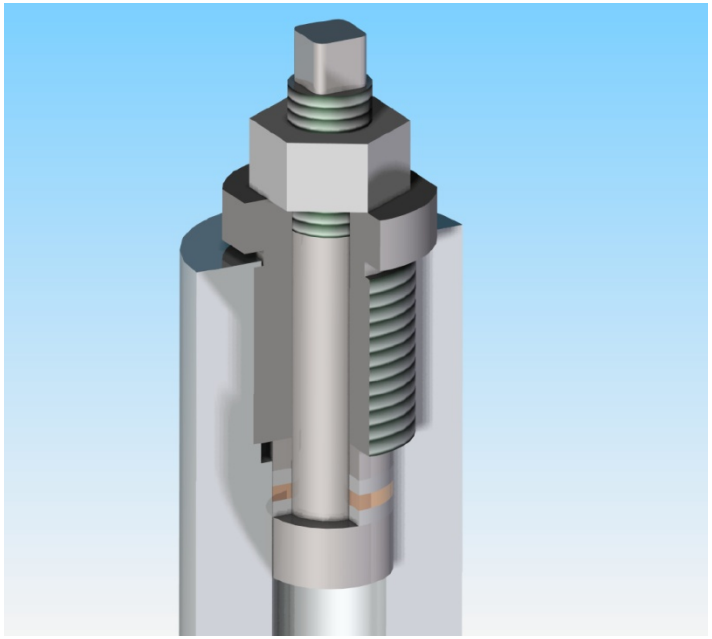
Double Bridgman seal prior to pressurisation.

Double Bridgman seal after pressurisation

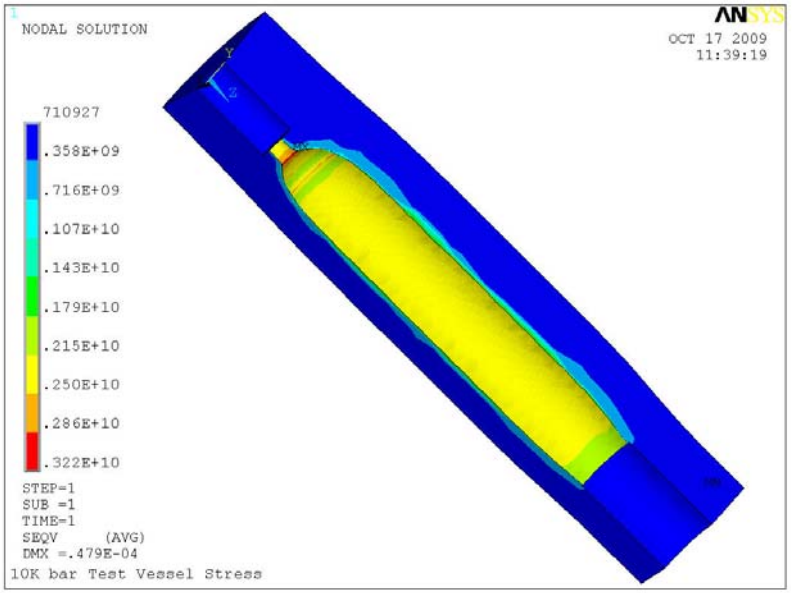
Typical Bridgman seal arrangement showing a three part seal assembly and the supporting backing nut.

M21.2.2.1 Cell material and seal design review

10 kbar seal-test containment vessel



Typical Bridgman seal arrangement showing a three part seal assembly and the supporting backing nut.



Axial FEA results of the seal-test containment vessel.

M21.2.2.1 Cell material and seal design review

JRA Bridgman seal test results

Seal Configuration	Room Temp Leak Tight at 2Kbar	Room Temp Leak Tight at 10Kbar	Liquid Nitrogen Leak Tight at 2Kbar	Liquid Nitrogen Leak Test at 10Kbar
Pb\Cu\Pb\Cu\Pb (Copper seals lead plated)	10 mins hold time ✓	3hrs hold time ✓	10mins RT hold time then immersed in N_2 10mins hold time ✓	Pressurised to 10Kbar in N_2 3hrs hold time ✓
Al\Cu\Al\Cu\Al (Copper seals lead plated)	10 mins hold time ✓	Left over night hold time ✓	10mins RT hold time then immersed in N_2 10mins hold time (slight leak observed) ✓	Pressurised to 10Kbar in N_2 (leak sealed) 3hrs hold time ✓
Al\Cu\Al\Cu\Al (Copper seals *not* lead plated)	Seals struggled to seal but finally sealed at 2Kbar ✓	Seal remained leak tight until 7.6Kbar then failed and never resealed during attempt to obtain 10Kbar ✗	Test not performed ✗	Test not performed ✗

M21.2.2.1 Cell material and seal design review

D21.16 Report on material research: H_2 and neutron compatibility

Hydrogen compatible material tests

Joint project with Imperial College, the University of London

Hydrogen embritlement is a process where certain materials become brittle following exposure to hydrogen. High-strength steels, titanium alloys and aluminium alloys seem particularly vulnerable to this.

17-4PH tensile test sample

17-4PH tensile test sample

D21.16 Report on material research: H_2 and neutron compatibility

Fatigue results of various vessel materials