UT-BATTELLE

nToF11 Hg System Update

Van Graves

Phil Spampinato

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Muon Collaboration Friday Meeting

22 Jul 2005

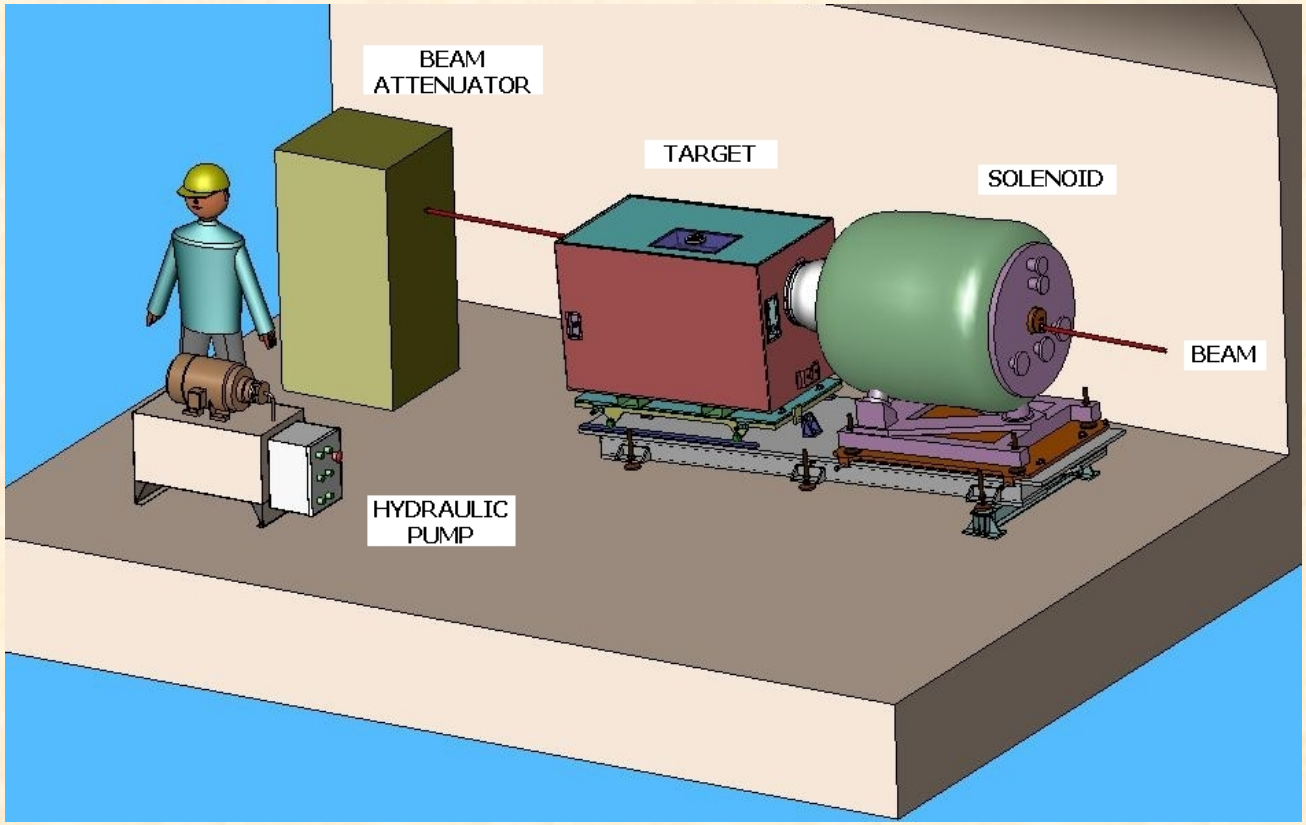
OAK RIDGE NATIONAL LABORATORY
U. S. DEPARTMENT OF ENERGY

Hg System Requirements

- **Produce a steady, 1-cm dia, 20 m/s free Hg jet inside a 15T magnetic field to interact with proton beam pulse**
- **Duration of jet to overlap magnet high-field flat-top of approximately 1 sec**
- **Total of up to 100 beam pulses at 30 minute intervals**

Overall System Layout

- **Hg System is self-contained and is inserted into magnet bore**



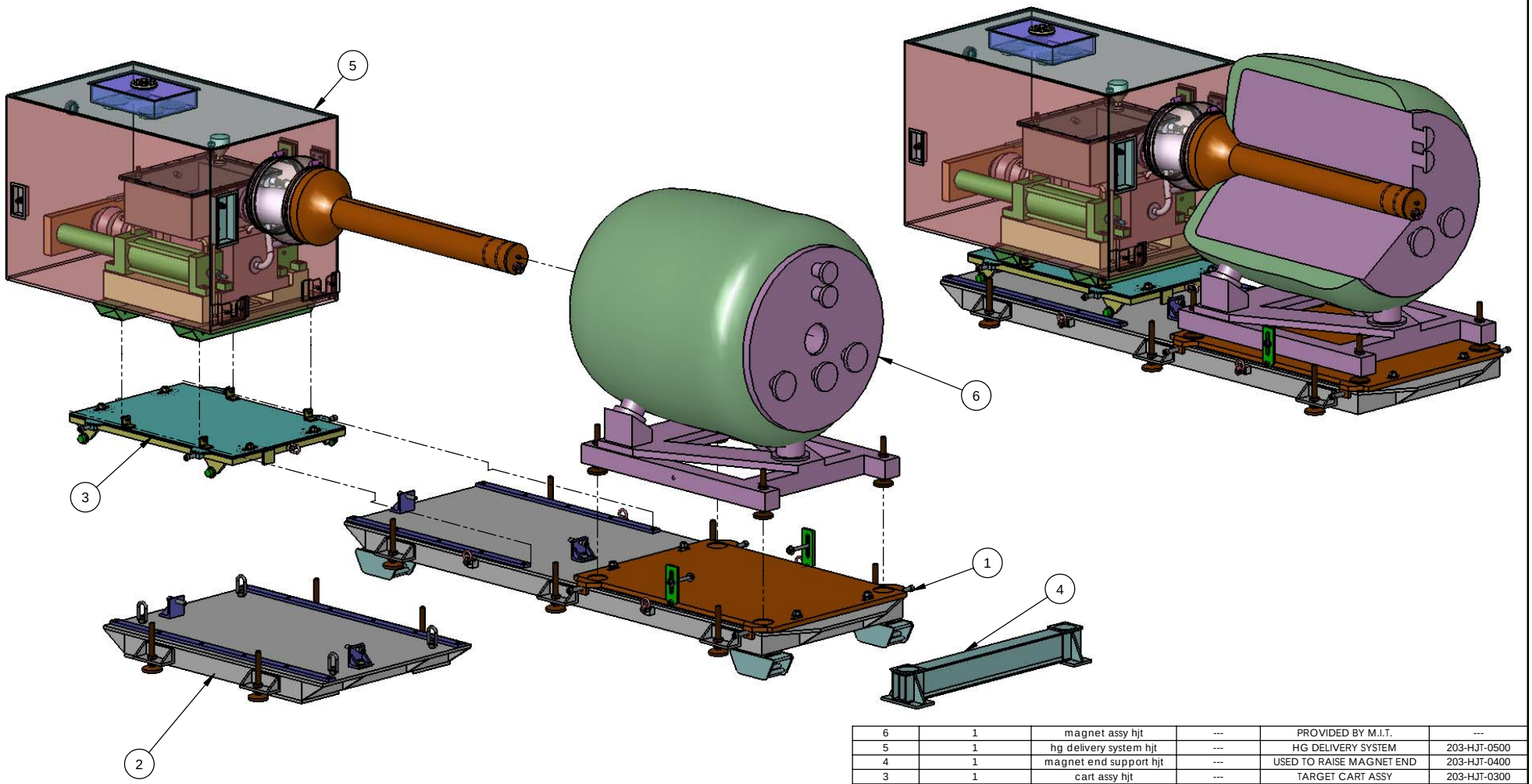
Efforts Since Last Update

- **Design of target baseplates has progressed**
  - **Baseplates provide transport ability and incorporate features for aligning magnet & jet to beam**
- **Installation details better defined**
- **Syringe pump requirements defined, and procurement specification being finalized**

S THIS DRAWING PRODUCED ON SOLIDWORKS

NOTES

1. MATERAL CERTIFICATIONS REQUIRED



ITEM	for dwg with carrier/QTY.	NAME	MATERIAL	DESCRIPTION	DWG
6	1	magnet assy hjt	---	PROVIDED BY M.I.T.	---
5	1	hg delivery system hjt	---	HG DELIVERY SYSTEM	203-HJT-0500
4	1	magnet end support hjt	---	USED TO RAISE MAGNET END	203-HJT-0400
3	1	cart assy hjt	---	TARGET CART ASSY	203-HJT-0300
2	1	target transporter assy hjt	---	TRANSPORTER BASEPLATE ASSY	203-HJT-0200
1	1	common base assy hjt	---	---	203-HJT-0100

THIRD-ANGLE PROJECTION

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   FORMED ANGLES ±1°
6. BREAK SHARP CORNERS AND REMOVE ALL BURRS
7. WHOLE NUMBERS AND FRACTIONS ±1/16
8. X DECIMALS ±.030
9. XX DECIMALS ±.010
10. XXX DECIMALS ±.005

DES	V GRAVES	06/04/2005
DRW	T OQUIN	06/04/2005
CHK		
ENG	V GRAVES	06/04/2005
QA		
-	-	-
DRAWING APPROVALS		DATE

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operated for the U.S. Department of Energy under contract DE-AC05-00OR22725 Oak Ridge, TN

REMOTE SYSTEMS GROUP
NUCLEAR SCIENCE & TECHNOLOGY DIVISION

NUFACT HG JET EXPERIMENT

CAD FILE	PREV ASSY	SCALE	SHEET
COMMON BASE LOADED HJT	---	1:15	1 of 2

SIZE	DWG NO.	REV
C	203-HJT-0001	3

DWG NO. 203-HJT-0001

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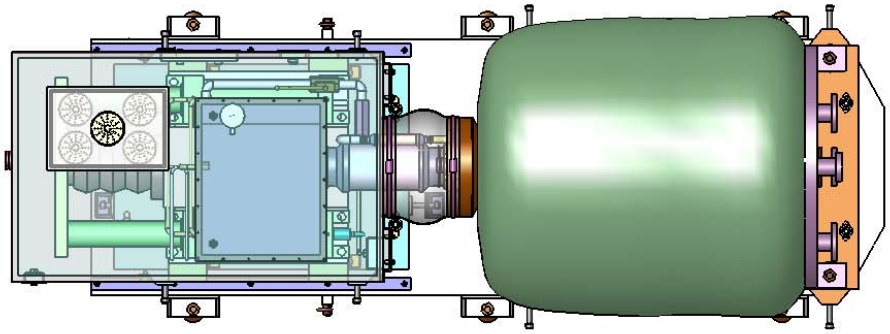

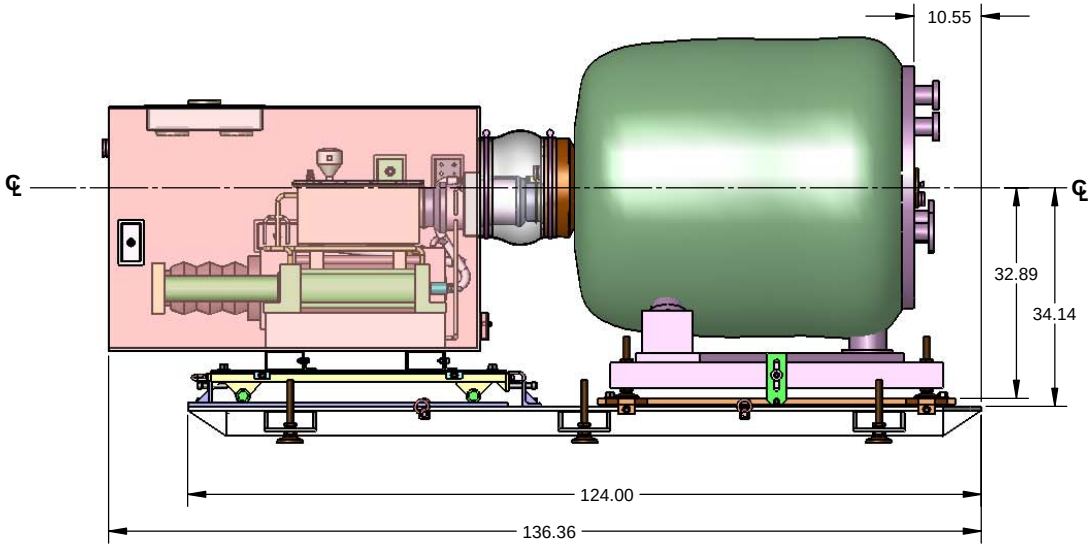

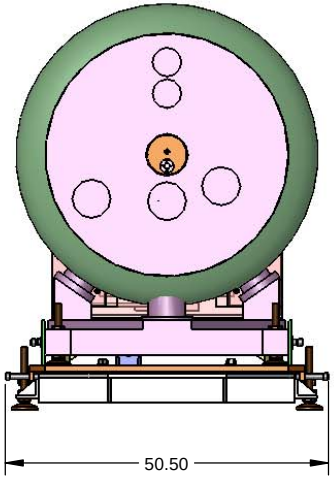

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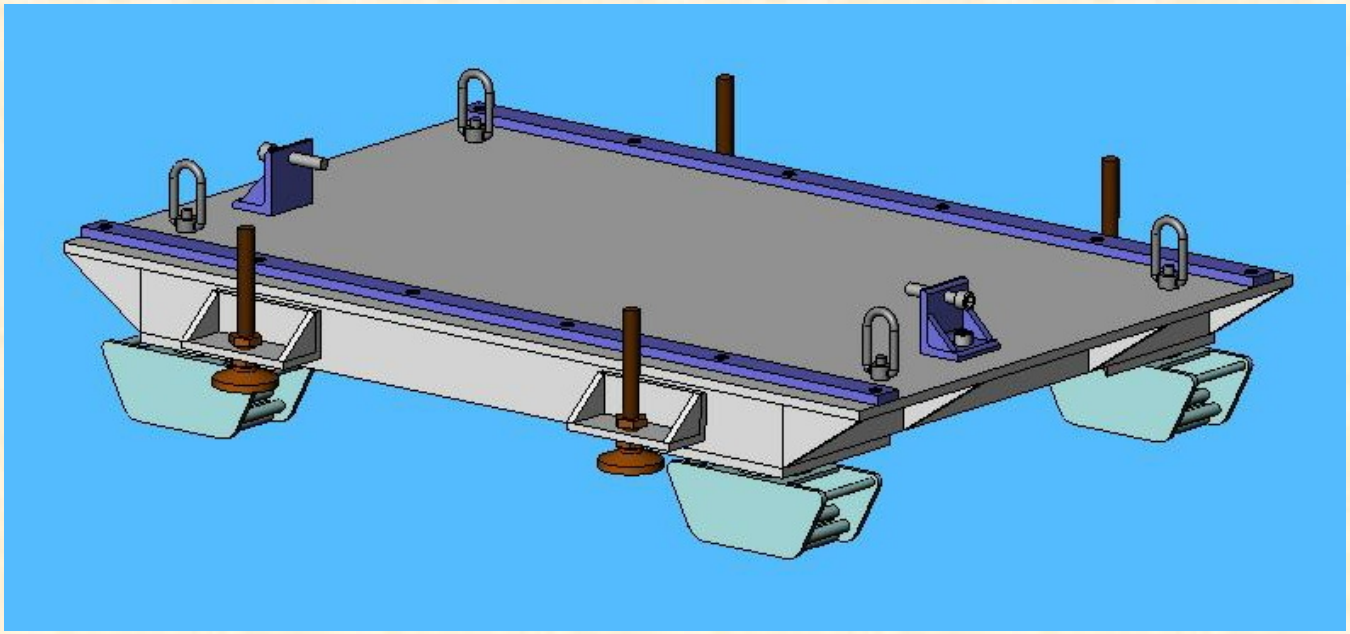
CAD FILE	PREV ASSY	SCALE	SHEET
COMMON BASE LOADED HJT	---	1:15	2 of 2

SIZE	DWG NO.	REV
C	203-HJT-0001	3

DWG NO. 203-HJT-0001

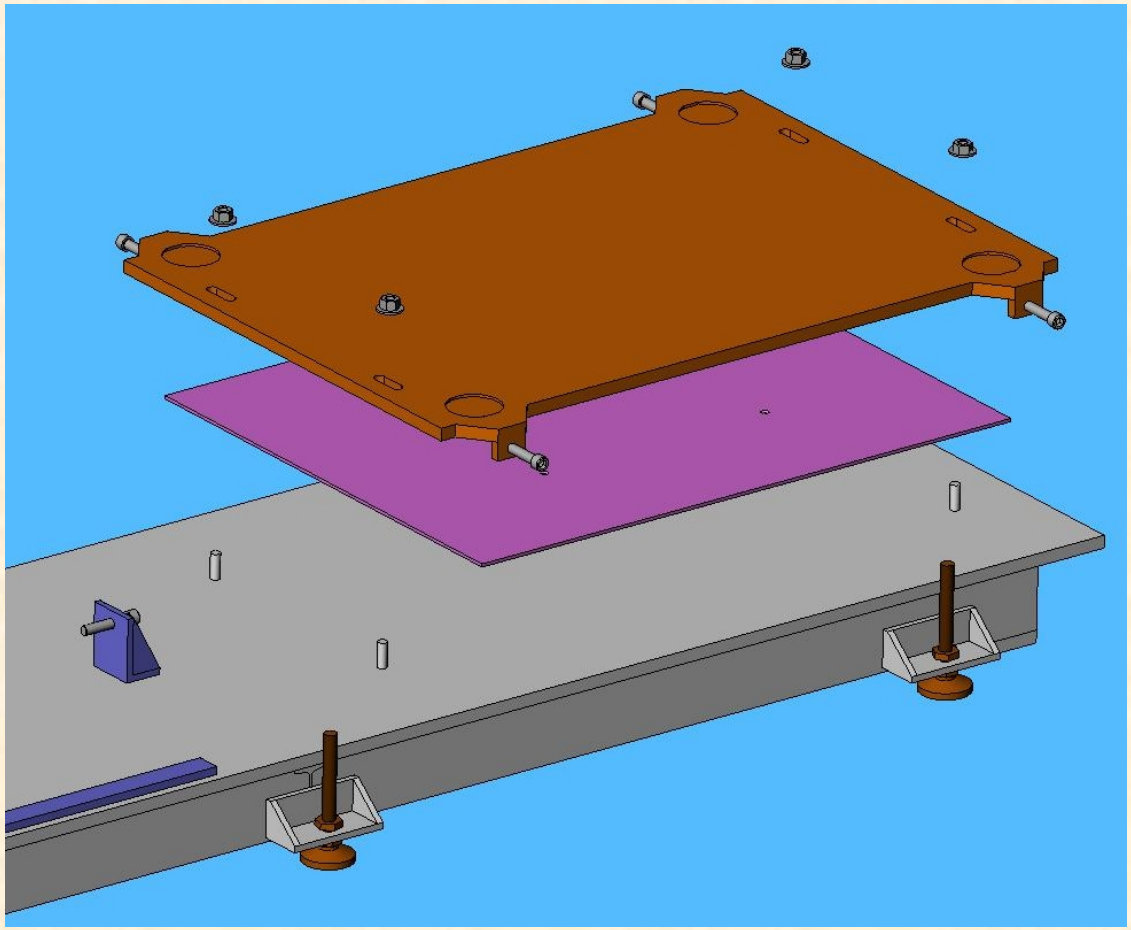
Target Transporter Baseplate

- **Transports Hg system inside tunnel**
- **Rollers removed once in position**
- **Rails for Hg system cart wheels**
- **Jack bolts lock cart in place**



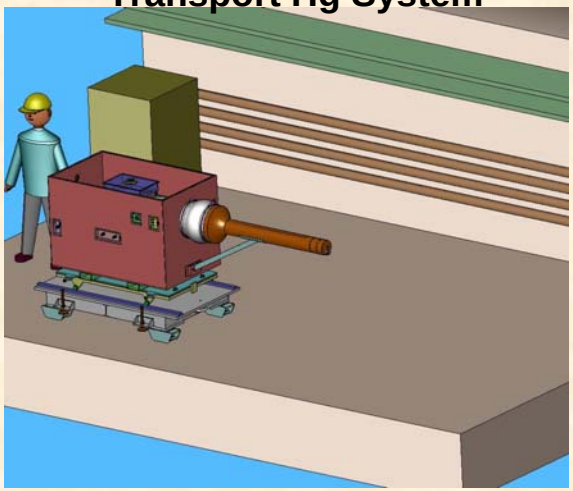
Common Baseplate

- **Same design as transporter baseplate, just longer**
- **Rollers used to grossly align solenoid to beam**
- **Provides lateral movement of solenoid for alignment to beam once rollers removed**

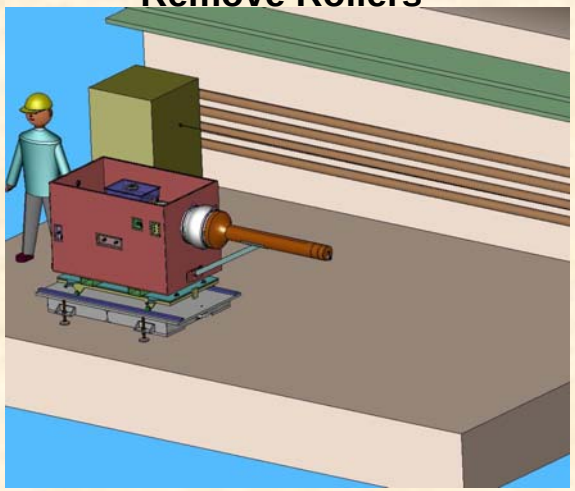


Installation Sequence Part 1 (Out-of-beam)

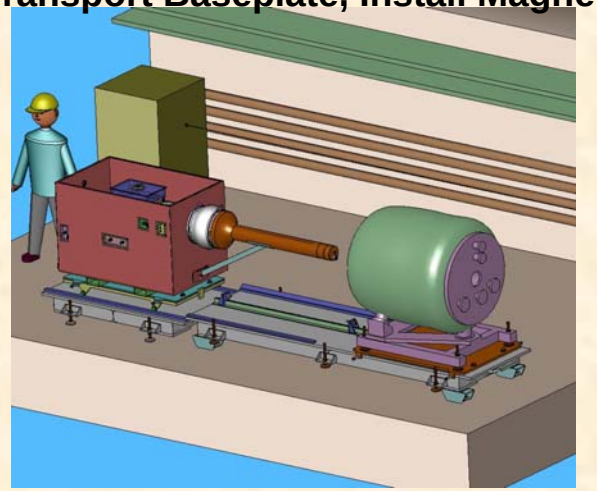
Transport Hg System

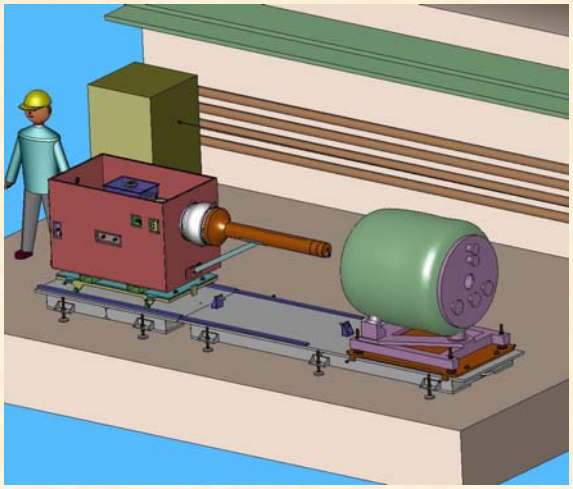


Remove Rollers

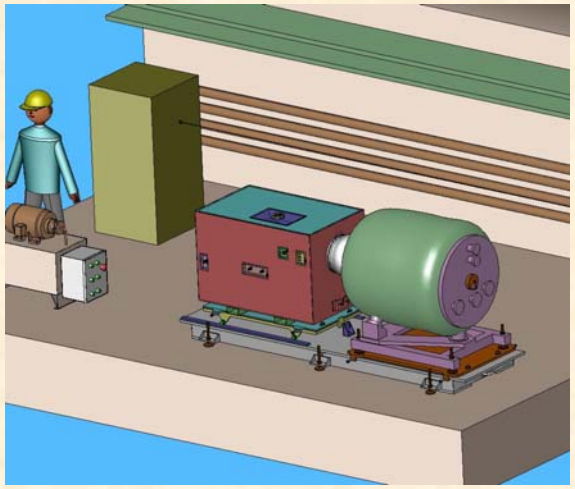


Transport Baseplate, Install Magnet

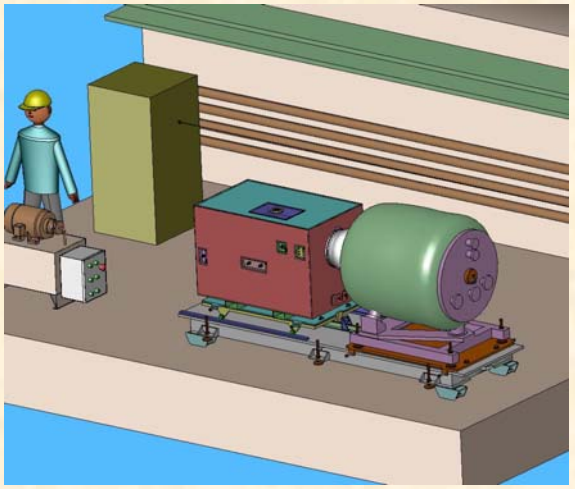




Remove Rollers, Level Magnet



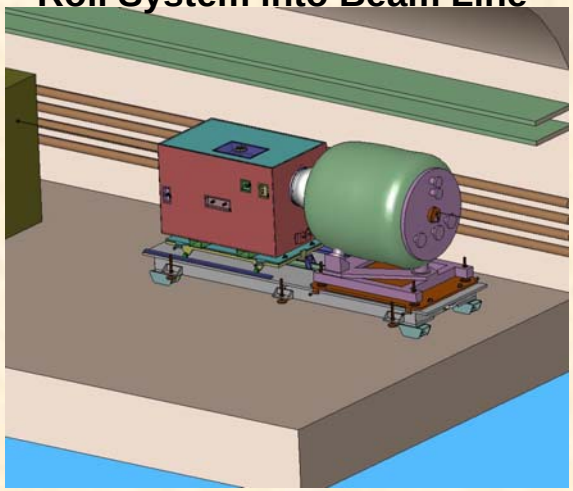
Roll Hg System into Magnet



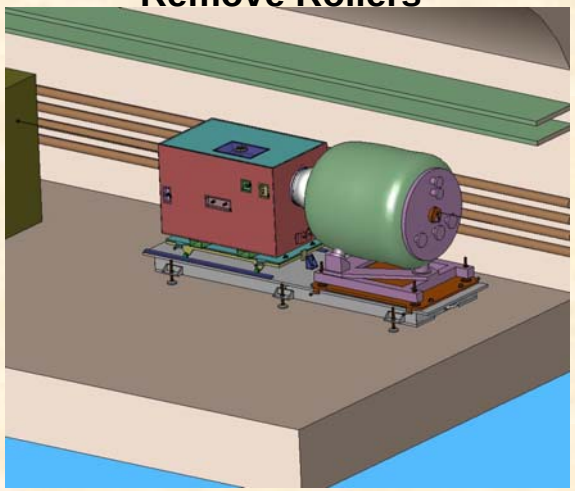
Add Rollers

Installation Sequence Part 2 (In-beam)

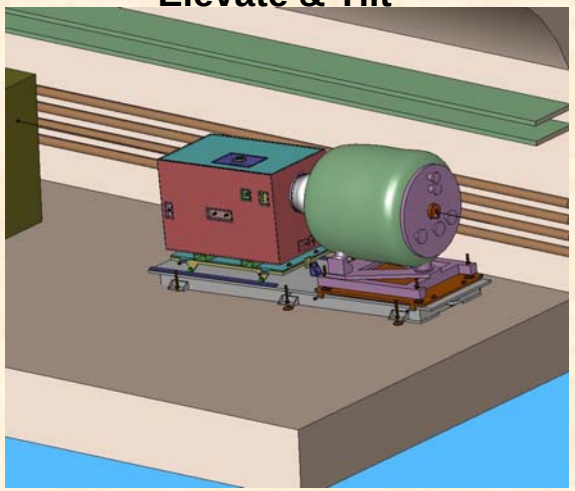
Roll System into Beam Line



Remove Rollers



Elevate & Tilt



- **Baseplate & magnet may go in beam line prior to Hg system**
- **Jacking system needed to remove rollers**
- **Blocks under magnet end to provide adequate tilt**

Procurement of the Hg Target Syringe Pump Equipment

Syringe Pump Procurement Plan

- **Syringe pump equipment is a long lead item requiring 16 weeks for the cylinders**
- **Purchase the pump system in FY05 using available funds from the CERN power supply refurbishment**
- **BNL Procurement Group will issue the RFP**
- **Equipment will be delivered to ORNL**

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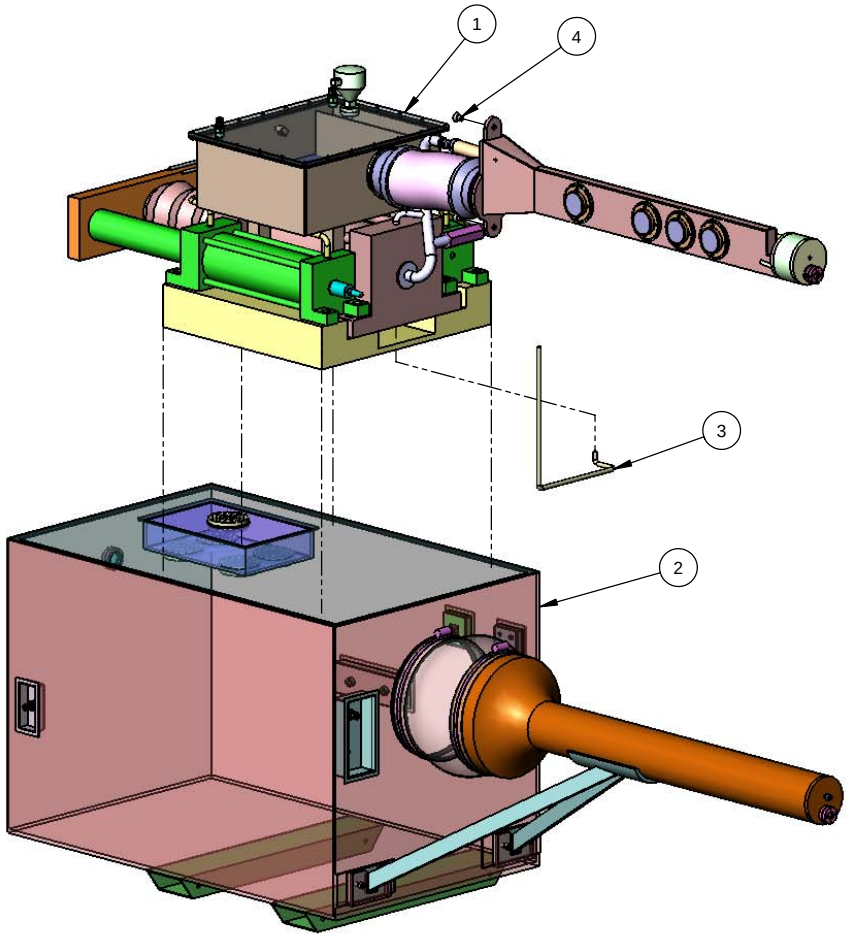

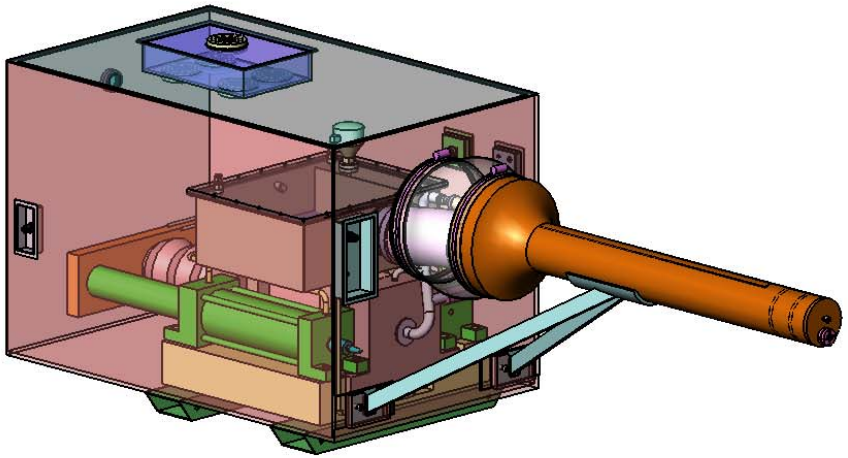

ITEM	for dwg/QTY.	NAME	MATERIAL	DESCRIPTION	DWG
4	2	SCHCSCREW 0.625-11x1x1-HX-N	SS - 18-8	FLAT SHCS - 5/8-11 x 1.00	N/A
3	1	hg cylinder drain tube hjt	SS - 304L, ASTM A-312	1/2 OD, SCH 40 PIPE, FIELD MEASURE	203-HJT-0603
2	1	sec contain assy hjt	---	SECONDARY CONTAINMENT ASSY	203-HJT-0700
1	1	hg syringe hjt	---	PRIMARY CONTAINMENT ASSY	203-HJT-0600

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NUCLEAR SCIENCE & TECHNOLOGY DIVISION

NUFACT HG JET EXPERIMENT
HG TARGET SYSTEM ASSY
HG DELIVERY SYSTEM ASSY

CAD FILE	PREV ASSY	SCALE	SHEET
HG DELIVERY SYSTEM HJT	203-HJT-0001	1:12	1 of 2

SIZE	DWG NO.	REV
C	203-HJT-0500	4

DWG NO. 203-HJT-0500

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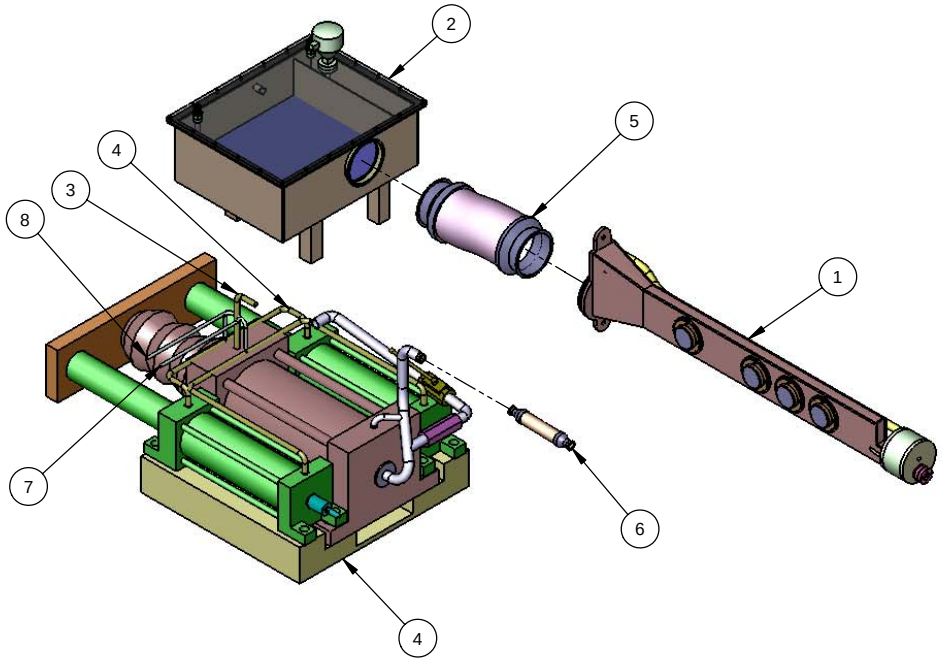

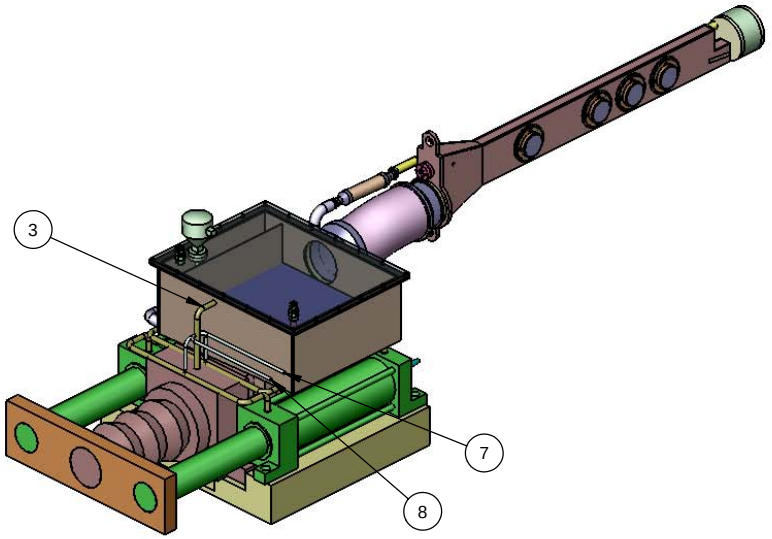

ITEM	Default/QTY.	NAME	MATERIAL	DESCRIPTION	DWG
8	1	hyd supply line2 hjt	SS - 304L, ASTM A-312	3/8 OD, SCH 40 PIPE, FIELD MEASURE	N/A
7	1	hyd supply line1 hjt	SS - 304L, ASTM A-312	3/8 OD, SCH 40 PIPE, FIELD MEASURE	N/A
6	1	flex supply line assy hjt	---	---	N/A
5	1	flex discharge line	---	---	N/A
4	1	syringe cylinder assy hjt	---	---	203-HJT-0650
3	1	hg cylinder vent tube	SS - 304L, ASTM A-312	5/8 OD, SCH 40 PIPE, FIELD MEASURE	203-HJT-0602
2	1	sump tank assy hjt	---	---	203-HJT-0450
1	1	pri tube assy hjt	---	---	203-HJT-0610

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REMOTE SYSTEMS GROUP
NUCLEAR SCIENCE & TECHNOLOGY DIVISION

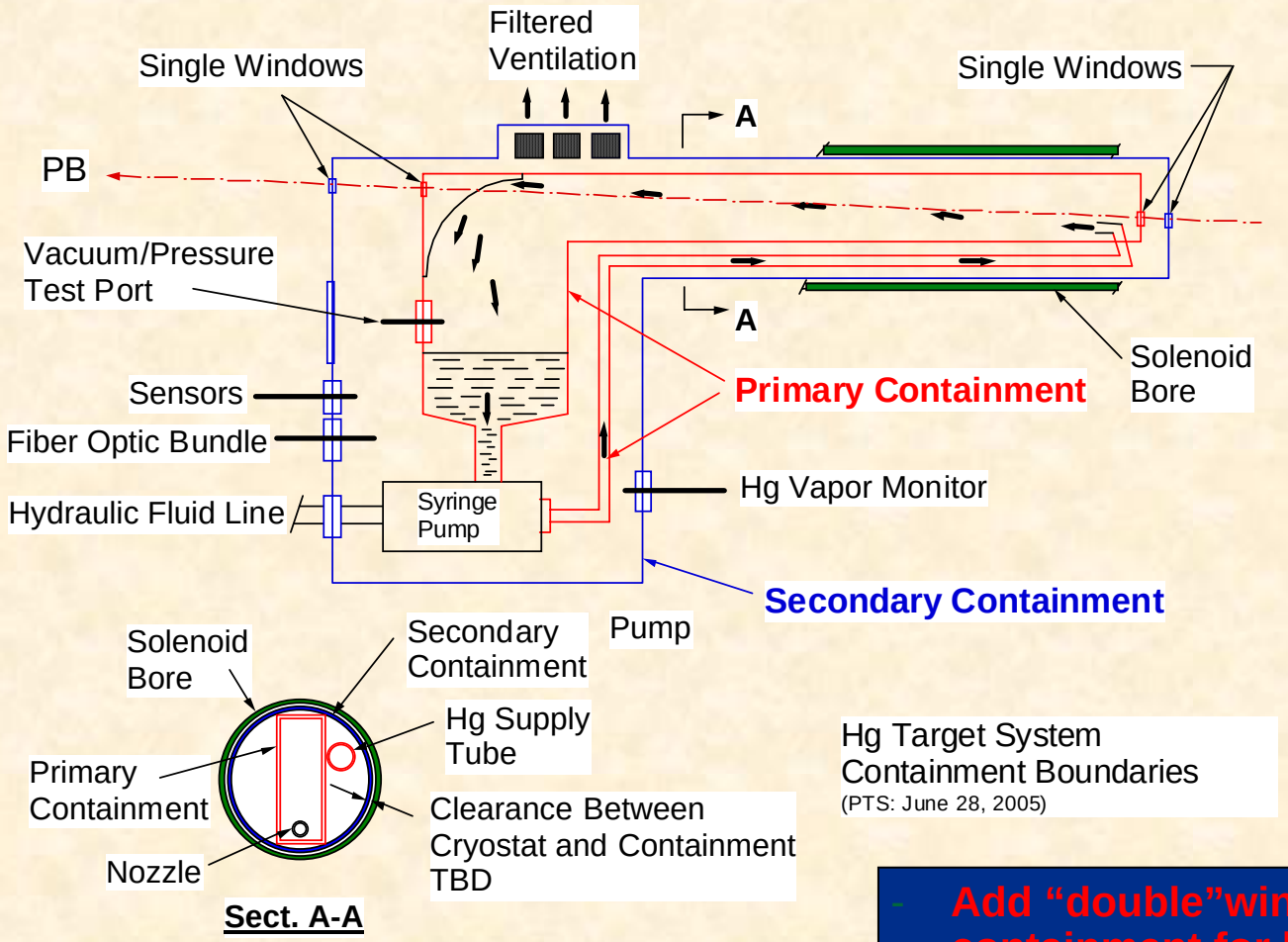
NUFACT HG JET EXPERIMENT
HG DELIVERY SYSTEM
PRIMARY CONTAINMENT ASSY

CAD FILE	PREV ASSY	SCALE	SHEET
HG SYRINGE HJT	203-HJT-0500	1:12	1 of 2

SIZE	DWG NO.	REV
C	203-HJT-0600	4

DWG NO. 203-HJT-0600

Schematic Diagram



Hg Target System
Containment Boundaries
(PTS: June 28, 2005)

- Add "double"windows at secondary containment for leak monitoring
- Add second Hg vapor monitor

Milestones

- **Design concept drawings for the syringe pump are nearly complete**
  - **Procurement specification is at 90% completion**
  - **Internal design review is scheduled for July 26**
  - **Send specification, drawings, and list of vendors to BNL in early August**
  - **BNL procurement cycle Aug-Sept ’05**
  - **Bid & award Sept-Oct ’05**
  - **Deliver equipment to ORNL Feb-Mar ’06**
  - **Integrate with Hg delivery system Apr ‘06**

Pump Procurement (cont.)

- **Scope – There are two subsystems**
  - **Design, fabrication, and assembly of syringe pump system (SPS) and hydraulic pump system (HPS)**
  - **Fabricate system from commercially available equipment**
  - **Fabricate base support structure that fits into the secondary containment box**
  - **Test and deliver to ORNL**

Terminology

1.1 Terminology

1.1.1 Hydraulic Pump System – The HPS consists of a hydraulic pump and electric motor, hydraulic lines connected to the drive cylinders (see below), proportional directional valve, the fluid reservoir, and fire resistant hydraulic fluid.

1.1.2 Syringe Pump System – The SPS consists of three hydraulic cylinders (see below) and the associated tubing, connectors, sensors, the tie beam, and a base support structure.

1.1.3 Drive Cylinders – The drive cylinders are two matched, double-acting hydraulic cylinders (and pistons) used to drive the pump cylinder.

1.1.4 Pump Cylinder – The pump cylinder is a double-acting cylinder (and piston) that contains only mercury.

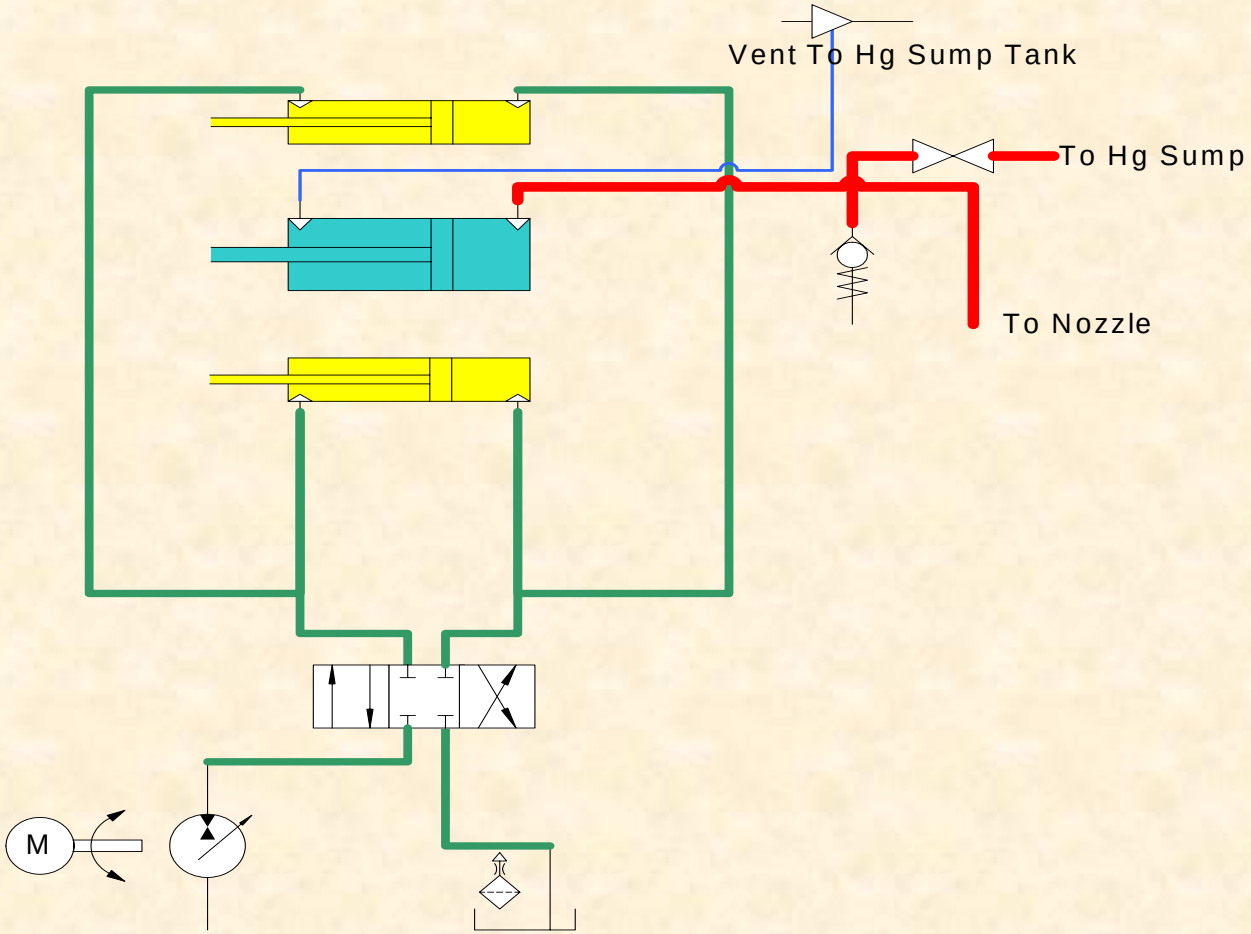
1.1.5 Base Support – The base support is a common support structure for mounting the drive cylinders and the pump cylinder on a horizontal plane.

1.1.6 Tie Beam – The tie beam is a rigid structure that connects the drive cylinder and the pump cylinder piston rods together for unified motion.

1.1.7 Electrical System – The electrical system, including safety interlocks, control the hydraulic pump and the flow valves of the cylinders.

Hydraulic Schematic

Under development



Requirements

1.1 System Operation

The syringe pump system shall be capable of operating in the following environmnents:

- temperature range of 20°C to 80°C,
- magnetic field that varies from 6500 Gauss at the mercury delivery port to 600 Gauss at the tie beam; the magnetic field ramps from zero to 6500 Gauss in 9 seconds, and from maximum field to zero in 6 seconds (after the piston motion has stopped),
- average gamma radiation field of 20 millirad/hr, and a peak field of ????; the total dose will be 1.5 x 10^4 rads.

The hydraulic pump system shall be capable of operating in the following environments:

- temperature range of 20°C to 40°C,
- … 60 Hz for operation in the U.S., and 50 Hz for operation in Switzerland
- ??

1.2 Flow Rate

The pump cylinder shall be capable of pumping mercury at room temperature over a range of flow rates from 1 gal/min to 20 gal/min (4 – 95 liters/min).

Requirements (cont.)

1.1 Capacity

The pump cylinder shall have a capacity of 5.0 gal (18.9 liters).

1.2 Lifetime

The pump system shall be capable of operating for 10,000 cycles.

1.3 Materials

1.3.1 The three (3) pump cylinders shall be fabricated from carbon steel, the typical material listed in hydraulic equipment vendor catalogs.

1.3.2 The three (3) pump pistons and rods shall be fabricated from 300 Series austenitic stainless steel (non-magnetic).

The base support structure shall be fabricated from 300 Series austenitic stainless steel.

Requirements (cont.)

Materials (cont.)

1.1.1 Materials for the pump cylinder assembly shall be compatible with mercury; therefore, the use of bronze, brass, copper, aluminum, and similar metals, for bearings, bushings, and other miscellaneous hardware is prohibited.

1.1.2 The hydraulic fluid shall be fire resistant, Quintolubric® 888, or equivalent fluid.

1.1.3 The seals in the drive cylinders shall be at least double-wipe seals fabricated from material(s) that are compatible with the chosen hydraulic fluid.

1.1.4 The seals in the pump cylinder shall be at least double-wipe seals fabricated from PTFE Teflon® or other materials compatible with elemental mercury.

1.1.5 All materials must be identified on the Seller's drawings by specification number, by generic name, and by grade or type. Company approval of the drawings and documents wherein materials are so identified, constitutes approval of the materials.

Specific Requirments

1.1.1 **Reservoir**

1.1.1.1 Cart - The reservoir shall be mounted on a cart with four lockable wheels; one pair shall be swivel wheels, one pair fixed wheels. Provisions for a handle shall be mounted on the cart in front of the swivel wheels. The cart may be fabricated from structural shapes of aluminum, painted steel, or stainless steel, and the cart shall have a drip pan under the reservoir.

1.1.1.2 Standard Maintenance Features – The reservoir shall have the following features normally found in catalogue-purchased equipment: internal baffling, level sight gauge, cleanout port, and drain and fill ports.

1.1.1.3 Capacity - The capacity of the reservoir shall be at least 40 gallons.

1.1.1.4 Proportional Directional Control Valve – The flow shall be controlled by … XXX or equivalent.

1.1.1.5 Hoses – One pair of hoses shall connect to the reservoir to form the supply and return lines; these shall be split into two pairs inside the secondary containment of the mercury delivery system (see figure 4), with each pair connecting to one of the drive cylinders. The supply and return hoses shall be XXX …, and a minimum of 50 ft. in length.

1.1.1.6 Contamination Control – add wording for appropriate filter … The fluid shall be maintained at 18/16/13 per ISO 4406:1999 – "Hydraulic Fluid Power -- Fluids -- Method For Coding The Level Of Contamination By Solid Particles," or equivalent.

A filter meeting the contamination control requirements above shall be installed in the return line close to the reservoir. The HPS shall be delivered to the ORNL with two spare filters.

Specific Requirements (cont.)

1.1.1 **Drive Cylinders**

1.1.1.1 Materials – The drive cylinders shall be fabricated of conventional carbon steel as that used by manufacturers of hydraulic cylinders; the pistons and rods shall be fabricated from 300 Series austenitic stainless steel.

1.1.1.2 Capacity – The drive cylinders shall be rated at 3000 psi, with a 15-inch stroke and a 6-inch bore.

1.1.1.3 Fittings – The drive cylinders shall terminate with male/female bulkhead "quick disconnect" fittings.

1.1.2 **Pump Cylinder**

1.1.2.1 Materials - The pump cylinder shall be fabricated from conventional carbon steel as that used by manufacturers of hydraulic cylinders; the piston and rod shall be fabricated from 300 Series austenitic stainless steel.

1.1.2.2 Capacity – The pump cylinder shall be rated at 3000 psi, with a 15-inch stroke and a 10-inch bore.

1.1.2.3 Ports – port configuration … vent, drain, center. (TBA)

1.1.2.4 Containment - A boot cover (soft bellows) shall be provided to cover the extracted piston rod of the pump cylinder to contain mercury vapors that may escape the cylinder. The boot material and its connecting hardware must be compatible with mercury. A vent port shall be provided to allow routed-venting of the boot cover into the mercury sump tank.

Specific Requirements (cont.)

1.1.1 **Base Support**

1.1.1.1 Material – The base support shall be fabricated from 300 Series stainless steel.

1.1.1.2 Sump Tank Access – the base support must be configured to permit access for installation/removal of the leg supports of the mercury sump tank; the leg supports will be 2-inch square tubing. See figure XX for interface dimensions. (Should they make the tank support legs … welded to the base support??)

1.1.1.3 Hoisting - Four swivel hoist rings shall be provided on the base support structure. The location of each shall be coordinated with the Company prior to drilling and tapping holes in the structure.

1.1.1.4 Transport - The base support shall be designed to permit local transport by means of forklift equipment.

1.1.2 **Tie Beam**

1.1.2.1 Material – The tie beam shall be fabricated from 300 Series austenitic stainless steel.

1.1.2.2 Attachment – The tie beam shall provide a rigid attachment between the drive cylinders and the pump cylinder so that all three move simultaneously, and be demountable from the piston rods.

Specific Requirements (cont.)

1.1 ***Instruments***

1.1.1.1 Reservoir Pressure Gauge – A pressure gauge shall be located at the discharge (high pressure) port .

1.1.1.2 Position Sensor – Drive cylinder No. 1 shall be fitted with a XXX position sensor, or equivalent, with 50 ft. (15 meters) of instrument wire. (See figure 4.)

1.1.1.3 Drive Cylinder Pressure Gauges – Each drive cylinder shall have a remotely readable pressure sensor, with 50 ft. (15 meters) of instrument wire. (See figure 4.)

1.1.1.4 Position Sensor – Drive cylinder No. 1 shall be fitted with a XXX position sensor, or equivalent, with 50 ft. (15 meters) of instrument wire. (See figure 4.)