Laboratory Environment Safety and Health Committee
Cryogenic Safety Subcommittee

MINUTES OF MEETING 04-07

August 17, 2004

Final

Committee Members Present	**Committee Members Absent**
W. Glenn	R. Alforque
P. Kroon	S. Kane
E. Lessard (Chairperson)	M. Rehak
P. Mortazavi	
A. Sidi Yekhlef	
R. Travis* (Secretary)	
K. C. Wu	

(* non-voting)

Visitors
A. Ackerman
C. Bade
N. Gmür
R. Kiss
M. Lowry

Agenda:

1. **LEGS Transfer Cryostat**

Minutes of Meeting: Appended on pages 2 through 3.

Signature on File			
E. Lessard	**Date**	**J. Tarpinian**	**Date**
LESHC Chairperson		**ESH&Q ALD**	

DM2120.

Chairperson E. Lessard called the seventh meeting in 2004 of the Laboratory Environmental Safety and Health Committee (LESHC) to order on August 17, 2004 at 10:04 a.m.

1. **Review of the LEGS Transfer Cryostat:** E. Lessard invited M. Lowry of the Physics Department (PO) to present the new Laser Electron Gamma Source (LEGS) Transfer Cryostat to the Committee [1].
   1.1. Mr. Lowry and other attendees made the following points during the course of the presentation and in response to specific Committee questions:

      1.1.1. The LEGS Transfer Cryostat is used to transport the solid hydrogen target between the dilution refrigerator and the LEGS In-Beam Cryostat. (The In-Beam Cryostat was reviewed on April 8, 2004 via LESHC 04-03.)
      1.1.2. The new (Jüelich) Cryostat is an upgrade of the existing unit that was built in Orsay France.
      1.1.3. The Jüelich Cryostat has a number of improvements. The polarization holding field is 120 mT and is produced by a permanent magnet array (versus the 15 mT from a high-Tc superconducting solenoid for the Orsay unit). The mechanical design has also been improved so the vacuum load is carried on axis and a single, high quality, linear track guides the motion of both the liquid nitrogen jacket and the liquid helium center tube.
      1.1.4. The permanent magnet array creates a transverse field with virtually no external field. (The 5 gauss line is largely within the bellows.) The magnet undergoes a phase change at cryogenic temperatures and the field increases slightly. At the Committee's request, Physics committed to perform confirmatory hot and cold magnetic field surveys.
      1.1.5. The unit contains 1.1 liters of liquid helium at 4.5 ^{o}K, which is sufficient for the transfer duration of approximately 2 hours. The 1.8 liter liquid nitrogen jacket requires one refilling during the transfer process.
      1.1.6. The target transfer is done vertically at the dilution refrigerator to avoid transfer tube deflection. A lifting arm and motorized hoist are used to reposition the transfer cryostat to a 30^{o} angle to the horizontal for placement on the transfer cart and subsequent transfer to the In-beam cryostat.
      1.1.7. There was some discussion about which electrical components were approved by a certification agency. The hoist motor is UL approved; the pendant and limit switches are not. The Committee requested a documented electrical safety inspection of the transfer cryostat and associated equipment by a third party, such as a member of the NSLS Electrical Safety Committee.
      1.1.8. The transfer cryostat lifts are considered pre-engineered production lifts. The total weight of the new unit is the same as the old (~300 lbs.) and the same lifting fixture will be used for the Jüelich Cryostat. The Committee requested an independent review of the lifting procedure, and user checkout.

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[1] Mr. Lowry's presentation, the review material provided to the Committee and these Minutes are posted on the LESHC website: http://www.rhichome.bnl.gov/AGS/Accel/SND/laboratory_environemnt,_safety_and_health_committee.htm.)

The original configuration preceded the Lifting Safety Subject Area, and Physics agreed to submit the required documentation to the Lifting Safety Committee.

1.1.9. If cooling is lost, the target will vaporize within the insulating vacuum and the adjacent expansion tube. The resulting pressure increase will not cause the 4 psig relief valve to lift. The LEGS group has had warm-ups in the past using the Orsay cryostat. The target gas was subsequently recovered from the vacuum space and reused.

1.1.10. The transfer procedure is largely unchanged from the original cryostat, except where necessary to reflect the physical upgrades of the new cryostat. The Physics department plans to exercise the procedure at room temperature and with a non-polarized hydrogen target.

1.2. The following motions were crafted and unanimously approved by the Committee:

1.2.1. Motion No. 1 - Prior to performing LEGS Jüelich Transfer Cryostat commissioning activities, the Physics Department must:

1.2.1.1. Complete the Static Magnetic Field Exposure Form and submit it to the Subject Area SME (Nicole Bernholc) for review - **Complete**[2].

1.2.1.2. Conduct a static magnetic field survey and affix any postings that are required by the Subject Area - **Complete**[2].

1.2.2. Motion No. 2 – At the end of the commissioning process, but prior to the start of the Jüelich Transfer Cryostat operations, the Physics Department must:

1.2.2.1. Perform conditions 1.2.1.1 and 1.2.1.2 for the cooled cryostat.

1.2.2.2. Perform a documented, independent electrical safety inspection of the transfer cryostat and associated equipment - **Complete**[2].

1.2.2.3. Arrange for an independent review of the transfer cryostat lifting process including a review of the lifting procedure, and user checkout.

1.2.2.4. Complete the appropriate "Lifting Safety" Subject Area forms and submit them to the Lifting Safety Committee.

1.2.2.5. Perform dry runs of the transfer cryostat procedures at room temperature and at cryogenic temperatures. (See 1.1.10.)

2. The Meeting was adjourned at 11:21 a.m.

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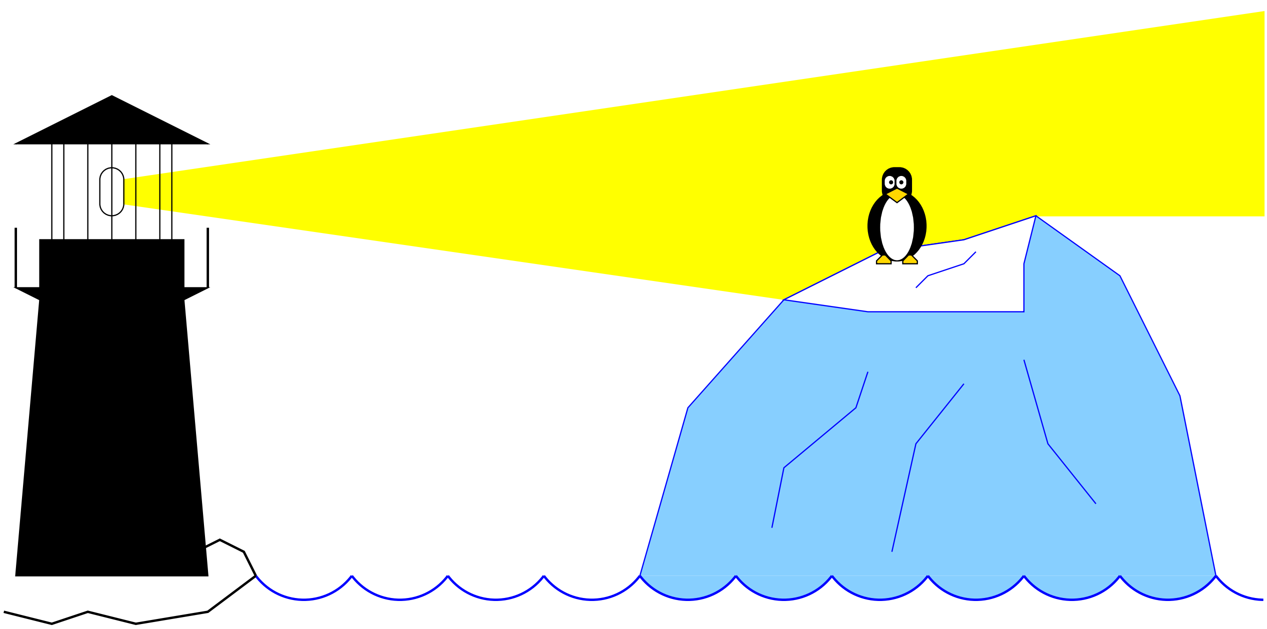
[2] This action was completed prior to the issuance of these minutes.

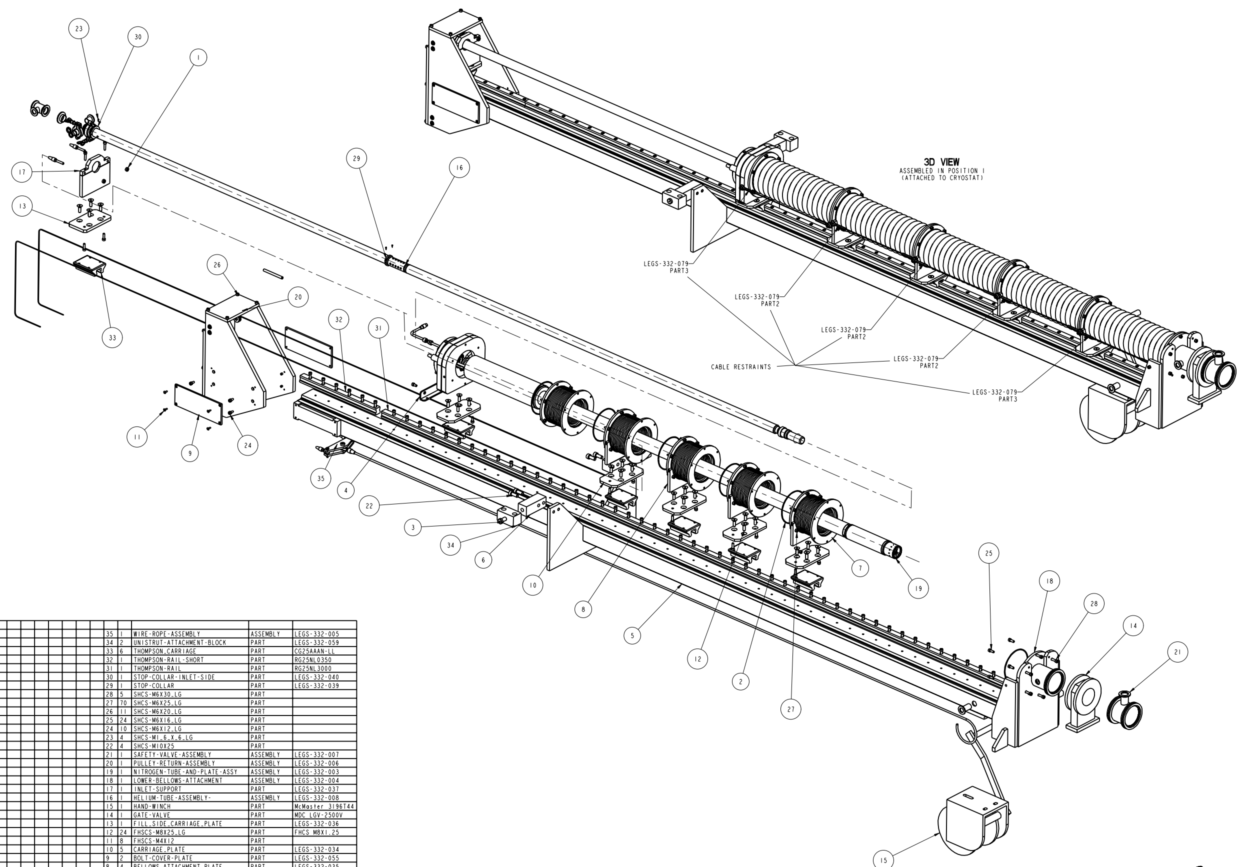
BNL *LEGS*

Jülich Transfer Cryostat



REVISIONS							
REV	ZONE	ECN NO.	DESCRIPTION	BY	DATE	CKR	APP
A			ADDED WIRE ROPE RESTRAINTS	RR			

NOTES:



								35	1	WIRE-ROPE-ASSEMBLY	ASSEMBLY	LEGS-332-005
								34	2	UNISTRUT-ATTACHMENT-BLOCK	PART	LEGS-332-059
								33	6	THOMPSON_CARRIAGE	PART	CG25AAAN-LL
								32	1	THOMPSON-RAIL-SHORT	PART	RG25NL0350
								31	1	THOMPSON-RAIL	PART	RG25NL3000
								30	1	STOP-COLLAR-INLET-SIDE	PART	LEGS-332-040
								29	1	STOP-COLLAR	PART	LEGS-332-039
								28	5	SHCS-M6X30_LG	PART	
								27	70	SHCS-M6X25_LG	PART	
								26	11	SHCS-M6X20_LG	PART	
								25	24	SHCS-M6X16_LG	PART	
								24	10	SHCS-M6X12_LG	PART	
								23	4	SHCS-M1_6_X_6_LG	PART	
								22	4	SHCS-M10X25	PART	
								21	1	SAFETY-VALVE-ASSEMBLY	ASSEMBLY	LEGS-332-007
								20	1	PULLEY-RETURN-ASSEMBLY	ASSEMBLY	LEGS-332-006
								19	1	NITROGEN-TUBE-AND-PLATE-ASSY	ASSEMBLY	LEGS-332-003
								18	1	LOWER-BELLOWS-ATTACHMENT	ASSEMBLY	LEGS-332-004
								17	1	INLET-SUPPORT	PART	LEGS-332-037
								16	1	HELIUM-TUBE-ASSEMBLY-	ASSEMBLY	LEGS-332-008
								15	1	HAND-WINCH	PART	McMaster 3196T44
								14	1	GATE-VALVE	PART	MDC LGV-2500V
								13	1	FILL_SIDE_CARRIAGE_PLATE	PART	LEGS-332-036
								12	24	FHSCS-M8X25_LG	PART	FHCS M8X1.25
								11	8	FHSCS-M4X12	PART	
								10	5	CARRIAGE_PLATE	PART	LEGS-332-034
								9	2	BOLT-COVER-PLATE	PART	LEGS-332-055
								8	4	BELLOWS_ATTACHMENT_PLATE	PART	LEGS-332-035
								7	5	BELLOWS-ASSEMBLY	ASSEMBLY	LEGS-332-010
								6	2	BACKBONE-PIVOT-BLOCK	PART	LEGS-332-058
								5	1	BACKBONE-ASSEMBLY-WELDMENT	ASSEMBLY	LEGS-332-011
								4	1	ANGLE	PART	LEGS-332-075
								3	2	12MM_DIA_SHOULDER-BOLT	PART	
								2	6	114MM_ID-ORING	PART	VITON AS568A-157
								1	2	0250-20_NUT	PART	
QTY PER ASSEMBLY								DET	QTY	DESCRIPTION	TYPE	PART NUMBER

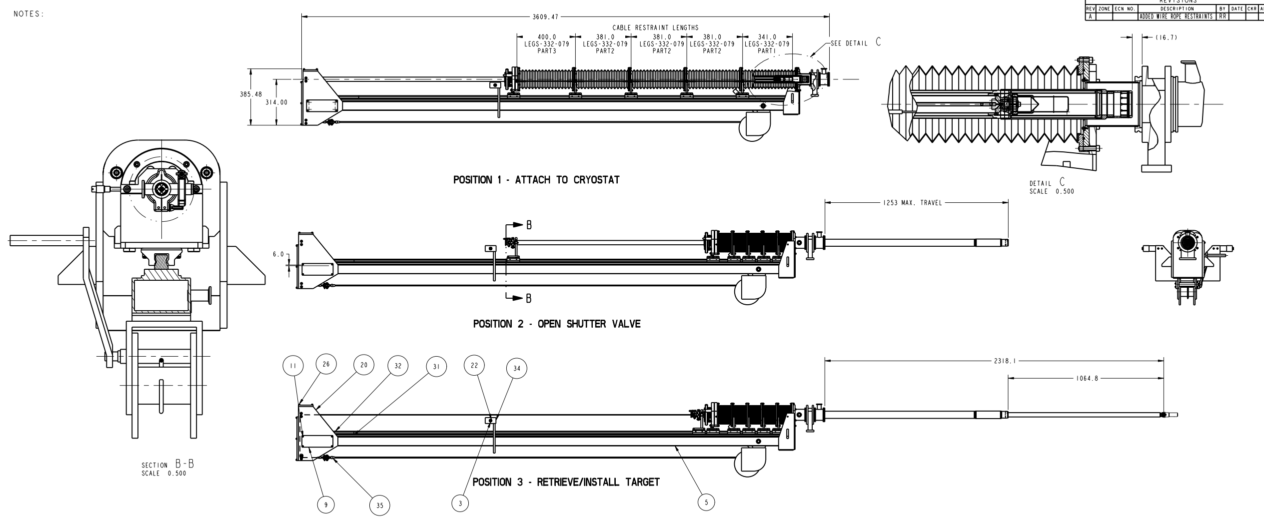
THIRD ANGLE PROJECTION

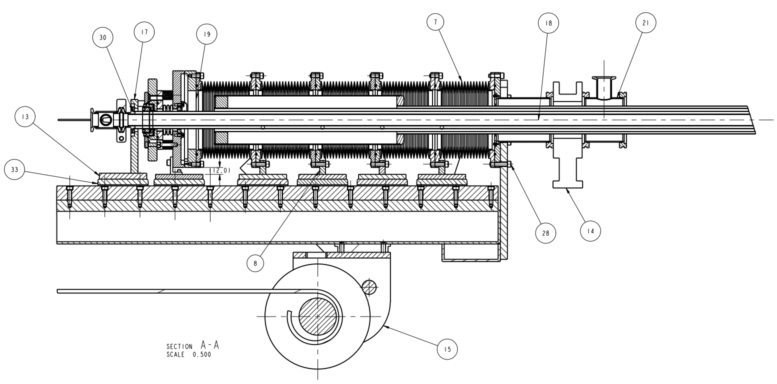
OUTSTANDING ECN NUMBERS	INTERPRET IN GENERAL ACCORDANCE WITH ASME Y14.24M-1989			BROOKHAVEN NATIONAL LABORATORY	
	UNLESS OTHERWISE SPECIFIED	DRAWN BY	RUGGIERO	12-Jul-01	TITLE: LEGS TRANSFER CRYOSTAT ASSEMBLY
	DIMENSIONS ARE IN mm DECIMAL TOLERANCES .X ± .4 .XX ± .13 .XXX ± .025 ANGULAR TOLERANCE ± 1°	DESIGN APPROVAL	M. LOWRY	12-Jul-01	
		CHECKED BY	M. LOWRY	12-Jul-01	
		ENGINEER APPROVAL	M. LOWRY	12-Jul-01	SIZE E DRAWING NUMBER: LEGS-332-000 REV. A
	NA FINISH / BREAK SHARP EDGES MAX MIN NA NA	SUPERVISOR APPROVAL	A. SANDORFI	12-Jul-01	
		Q.A. APPROVAL	M. LOWRY	12-Jul-01	Q.A. CATEGORY: A-3 SCALE: 0.125 WEIGHT: SHEET 1 OF 2

DWG NO LEGS-332-000 SHEET 1 OF 2

NOTES:

REV	ZONE	ECN NO.	DESCRIPTION	BY	DATE	CKR	APP
A			ADDED WIRE ROPE RESTRAINTS	RR			





DET	QTY	DESCRIPTION	TYPE	PART NUMBER
35	1	WIRE-ROPE-ASSEMBLY	ASSEMBLY	LEGS-332-005
34	2	UNISTRUT-ATTACHMENT-BLOCK	PART	LEGS-332-059
33	6	THOMPSON_CARRIAGE	PART	CG25AAAN-LL
32	1	THOMPSON-RAIL-SHORT	PART	RG25NL0350
31	1	THOMPSON-RAIL	PART	RG25NL3000
30	1	STOP-COLLAR-INLET-SIDE	PART	LEGS-332-040
29	1	STOP-COLLAR	PART	LEGS-332-039
28	5	SHCS-M6X30_LG	PART	
27	70	SHCS-M6X25_LG	PART	
26	11	SHCS-M6X20_LG	PART	
25	24	SHCS-M6X16_LG	PART	
24	10	SHCS-M6X12_LG	PART	
23	4	SHCS-M1_6_X_6_LG	PART	
22	4	SHCS-M10X25	PART	
21	1	SAFETY-VALVE-ASSEMBLY	ASSEMBLY	LEGS-332-007
20	1	PULLEY-RETURN-ASSEMBLY	ASSEMBLY	LEGS-332-006
19	1	NITROGEN-TUBE-AND-PLATE-ASSY	ASSEMBLY	LEGS-332-003
18	1	LOWER-BELLOWS-ATTACHMENT	ASSEMBLY	LEGS-332-004
17	1	INLET-SUPPORT	PART	LEGS-332-037
16	1	HELIUM-TUBE-ASSEMBLY-	ASSEMBLY	LEGS-332-008
15	1	HAND-WINCH	PART	McMaster 3196T44
14	1	GATE-VALVE	PART	MDC LGV-2500V
13	1	FILL_SIDE_CARRIAGE_PLATE	PART	LEGS-332-036
12	24	FHSCS-M8X25_LG	PART	FHCS M8X1.25
11	8	FHSCS-M4X12	PART	
10	5	CARRIAGE_PLATE	PART	LEGS-332-034
9	2	BOLT-COVER-PLATE	PART	LEGS-332-055
8	4	BELLOWS_ATTACHMENT_PLATE	PART	LEGS-332-035
7	5	BELLOWS-ASSEMBLY	ASSEMBLY	LEGS-332-010
6	2	BACKBONE-PIVOT-BLOCK	PART	LEGS-332-058
5	1	BACKBONE-ASSEMBLY-WELDMENT	ASSEMBLY	LEGS-332-011
4	1	ANGLE	PART	LEGS-332-075
3	2	12MM_DIA_SHOULDER-BOLT	PART	
2	6	114MM_ID-ORING	PART	VITON AS568A-157
1	2	0250-20_NUT	PART	

QTY PER ASSEMBLY

OUTSTANDING ECN NUMBERS

INTERPRET IN GENERAL ACCORDANCE WITH ASME Y14.24M-1989

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN mm
DECIMAL TOLERANCES
.X ± .4
.XX ± .13
.XXX ± .025
ANGULAR TOLERANCE ± 1°

FINISH NA
BREAK SHARP EDGES MAX NA MIN NA

THIRD ANGLE PROJECTION

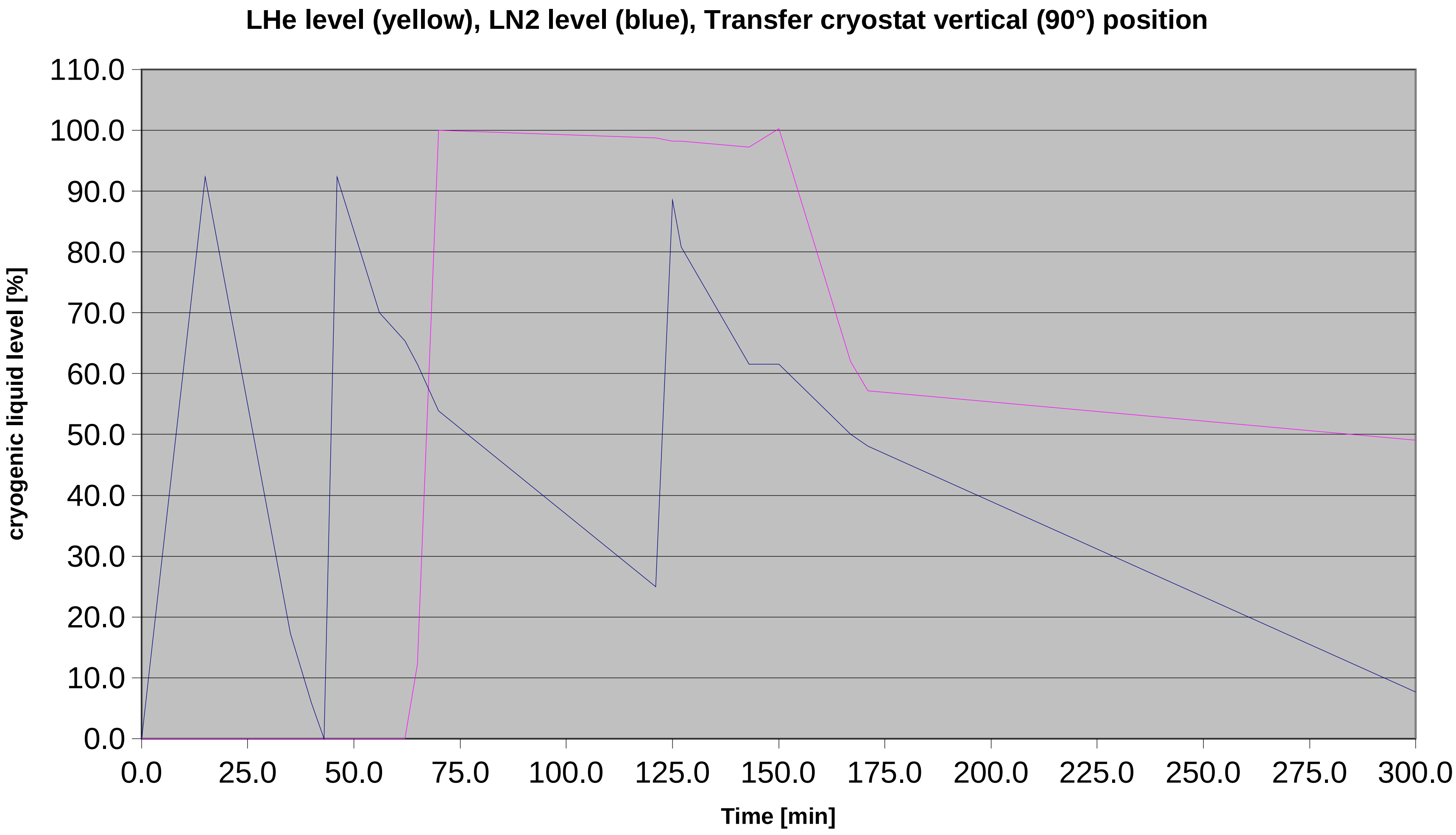
DRAWN BY	RUGGIERO	12-Jul-01
DESIGN APPROVAL	M. LOWRY	12-Jul-01
CHECKED BY	M. LOWRY	12-Jul-01
ENGINEER APPROVAL	M. LOWRY	12-Jul-01
SUPERVISOR APPROVAL	A. SANDORFI	12-Jul-01
Q.A. APPROVAL	M. LOWRY	12-Jul-01

BROOKHAVEN NATIONAL LABORATORY

TITLE: LEGS TRANSFER CRYOSTAT ASSEMBLY

SIZE: E
DRAWING NUMBER: LEGS-332-000
REV. A
Q.A. CATEGORY: A-3
SCALE: 0.125
WEIGHT:
SHEET 2 OF 2

DWG NO LEGS-332-000 SHEET 2 OF 2


LHe level (yellow), LN2 level (blue), Transfer cryostat vertical (90°) position
110.0
100.0
90.0
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0.0
cryogenic liquid level [%]
0.0
25.0
50.0
75.0
100.0
125.0
150.0
175.0
200.0
225.0
250.0
275.0
300.0
Time [min]

Response to BNL Hazard Identification Tool

6b – *Is there any electrical equipment used in the operation with ... OR voltage from 50V to 250V and current greater than 5mA OR... AND stored energy less than 10J?*

There are three commercial electrical devices that operate on 120VAC, the LN2 and LHe level meters and a temperature readout. All are UL certified. In addition, a 120VAC motor for moving the lift point is mounted on the locally built lifting fixture. Its wiring, limit switches and control pendant were inspected as part of the certification for the lifting fixture.

7c – *Does this operation include the use of rigging?*

The lifting fixture is a below the hook device, BNL Ser. No. 326 301-5, which is certified and annually inspected and whose use is detailed in the manual (see sections 2.5.2 and 3.5). It also involves the use of any of three cranes: the one ton monorail crane in the cryolab, 725-CRNE034, the one ton monorail crane in the target room, 725-CRNE005, or the three ton bridge crane in the target room, 725-CRNE004.

8 – *Do you work with any of the following non-ionizing radiation (NIR) sources: ...; or any equipment that would expose personnel to high levels of sub-radiofrequency electric or magnetic fields includingstatic electric and magnetic fields.* (sic)

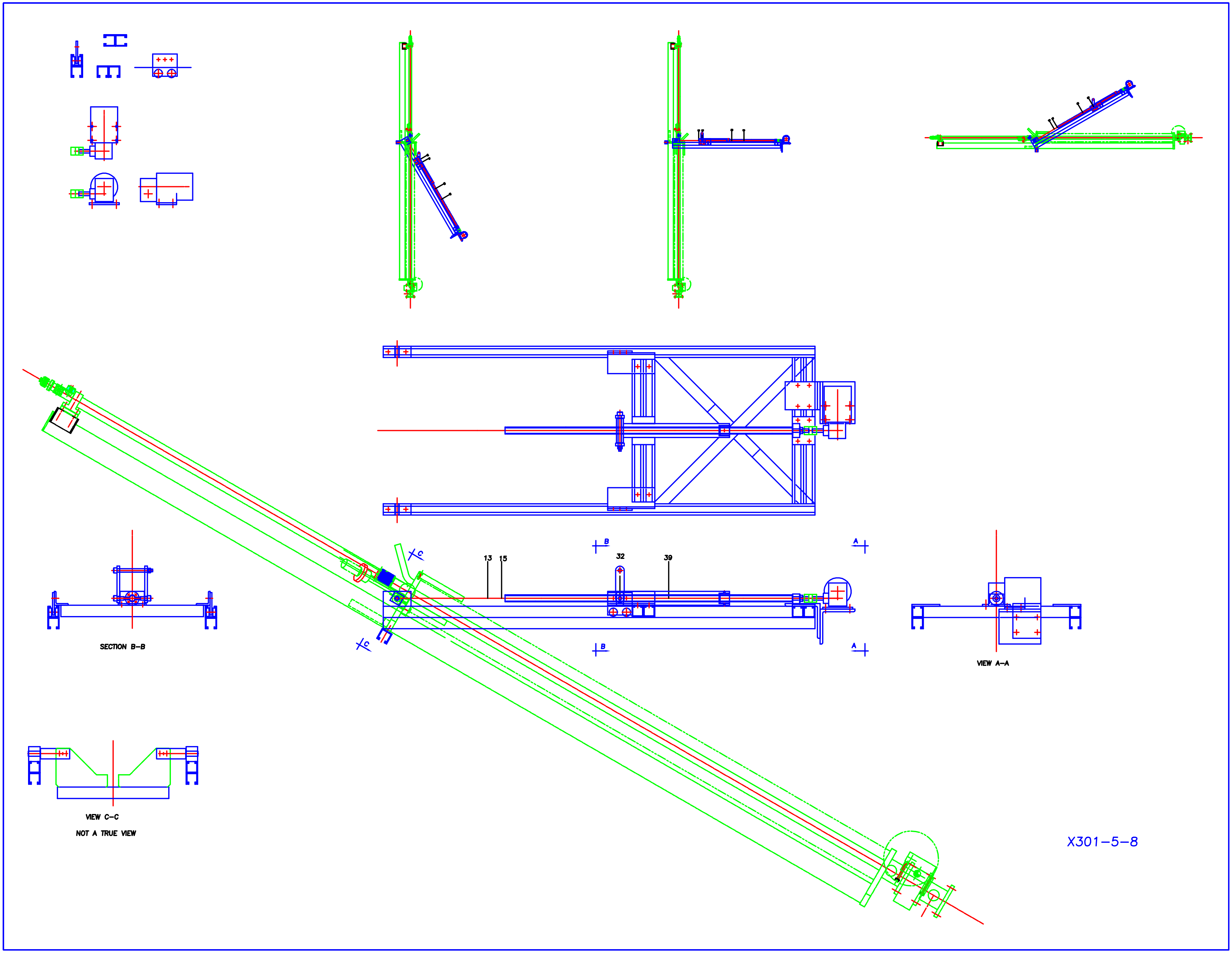
The permanent magnet array generates an external field above the 5 Gauss limit in a limited region near the cryostat (see section 3.4). The cryostat is currently crated so the magnetic survey cannot be done but as soon as the new cart is ready we will uncrate it and arrange with the NSLS for this cryostat to be included in the magnetic assessment of the LEGS cryostats.

13 – *Does this operation involve: the use of equipment, tools, or materials outside of the deisgn* (sic) *spec?*

No, but the operation does involve the use of locally built equipment which also triggers this question. The items are a cart (see section 2.5.1) and the lifting fixture (see sections 2.5.2 and 3.5).

14b – *Will operation require work outside normal working hours?*

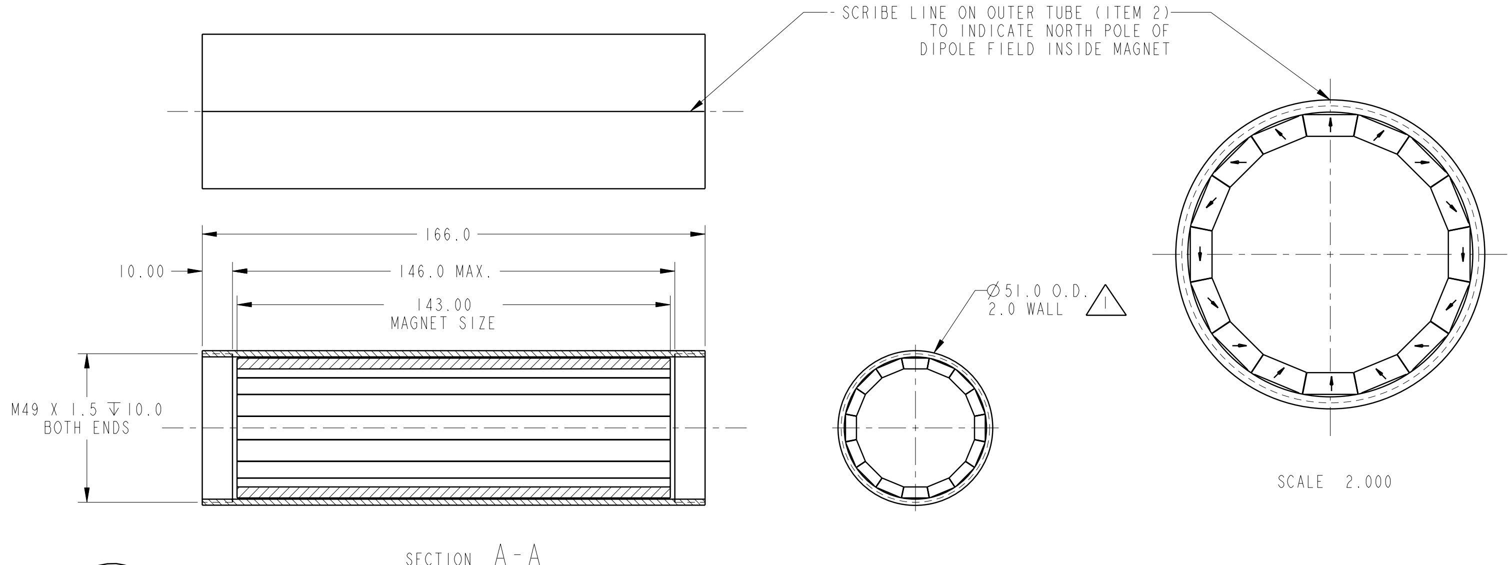
The need to move a polarized target can arise at any time and is not restricted to "normal" working hours.

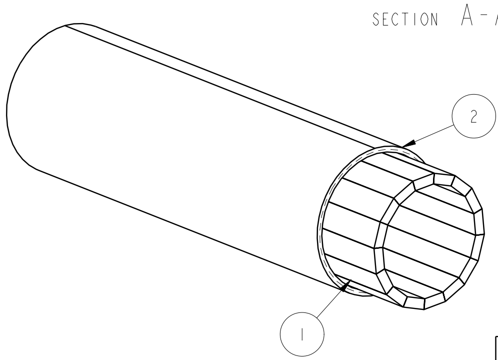

13
15
32
39
B
A
C
SECTION B–B
VIEW A–A
VIEW C–C
NOT A TRUE VIEW
X301–5–8

REVISIONS							
REV	ZONE	ECN NO.	DESCRIPTION	BY	DATE	CKR	APP
A			UPDATED MAGNET SPECS	RR	4/18/03		

NOTES:

1. (△) MATERIAL: OFHC COPPER C10100, ASTM B133
2. HOLBACK ARRAY WITH MINIMUM FIELD OF 0.12 TESLA, 10% UNIFORMITY OVER 26mm DIA. X 52mm LONG CENTRAL CYLINDER.
   SUGGESTED MATERIAL: NdFeB WITH ENERGY PRODUCT ≥ 35 MGOe.
3. ENCAPSULATION AT MANUFACTURE'S DISCRETION. MUST WITHSTAND TEMPERATURE CYCLING TO 70K AND BE VACUUM COMPATIBLE. SUGGEST NICKEL PLATING.
4. LONGITUDINAL AND INNER RADIAL RETENTION AT MANUFACTURER'S DISCRECTION.
   MINIMUM CLEAR BORE IS 38.0mm.





DET	QTY	DESCRIPTION	TYPE	PART NUMBER
2	1	TARGET-OUTER-TUBE	PART	-
1	16	MAGNET SEE NOTES 2,3 & 4	PART	

QTY PER ASSEMBLY

OUTSTANDING ECN NUMBERS

INTERPRET IN GENERAL ACCORDANCE WITH ASME Y14.5M-1994

UNLESS OTHERWISE SPECIFIED

DIMENSIONS ARE IN mm
DECIMAL TOLERANCES
X.X ± .4
X.XX ± .13
ANGLES ± 0.5°

NA FINISH | BREAK SHARP EDGES NA NA MAX. MIN.

THIRD ANGLE PROJECTION

DRAWN BY	RUGGIERO	04-Mar-02
DESIGN APPROVAL	M. LOWRY	04-Mar-02
CHECKED BY	M. LOWRY	04-Mar-02
ENGINEER APPROVAL	M. LOWRY	04-Mar-02
SUPERVISOR APPROVAL	A. SANDORFI	04-Mar-02
Q.A. APPROVAL	M. LOWRY	04-Mar-02

LEGS

BROOKHAVEN NATIONAL LABORATORY

TITLE: LEGS
TRANSFER CRYOSTAT
MAGNET_SPECIFICATION

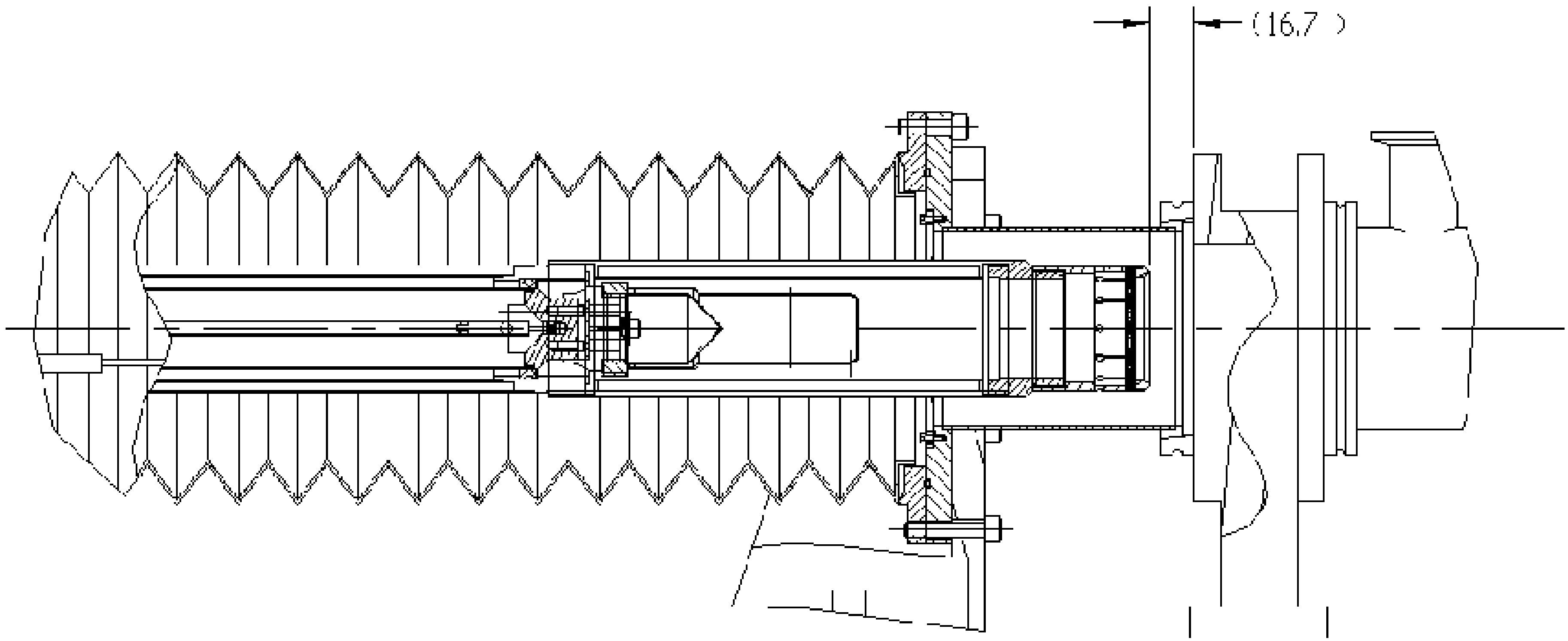
SIZE C | DRAWING NUMBER: LEGS-332-001 | REV. A

Q.A. CATAGORY: A-4 | SCALE: 1.000 | WEIGHT: | SHEET 1 OF 1

MODEL DRAWING NUMBER: LEGS-332-001

DWG NO LEGS-332-001 | SHEET 1 OF 1 | REV

REVISIONS				
REV	ZONE	ECN NO.	DESCRIPTION	BY
A			ADDED WIRE ROPE RESTRAINTS	RR



DETAIL C
SCALE 0.500

LEGS/Juelich Transfer Cryostat Magic Dipole
Magnetic Field Contours
5, 50, and 600 Gauss

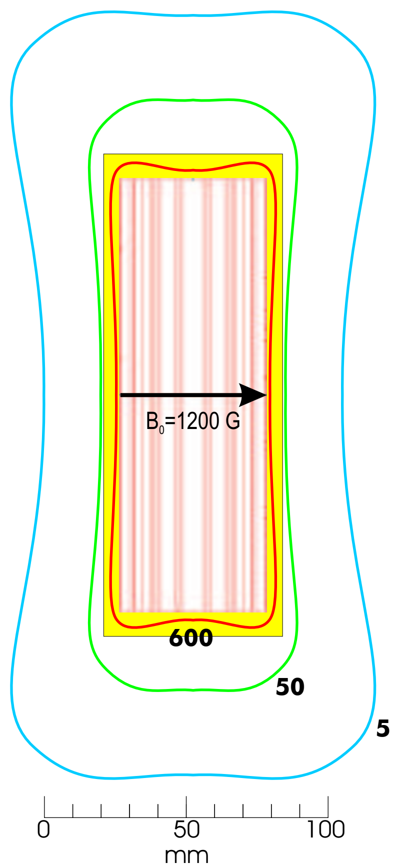
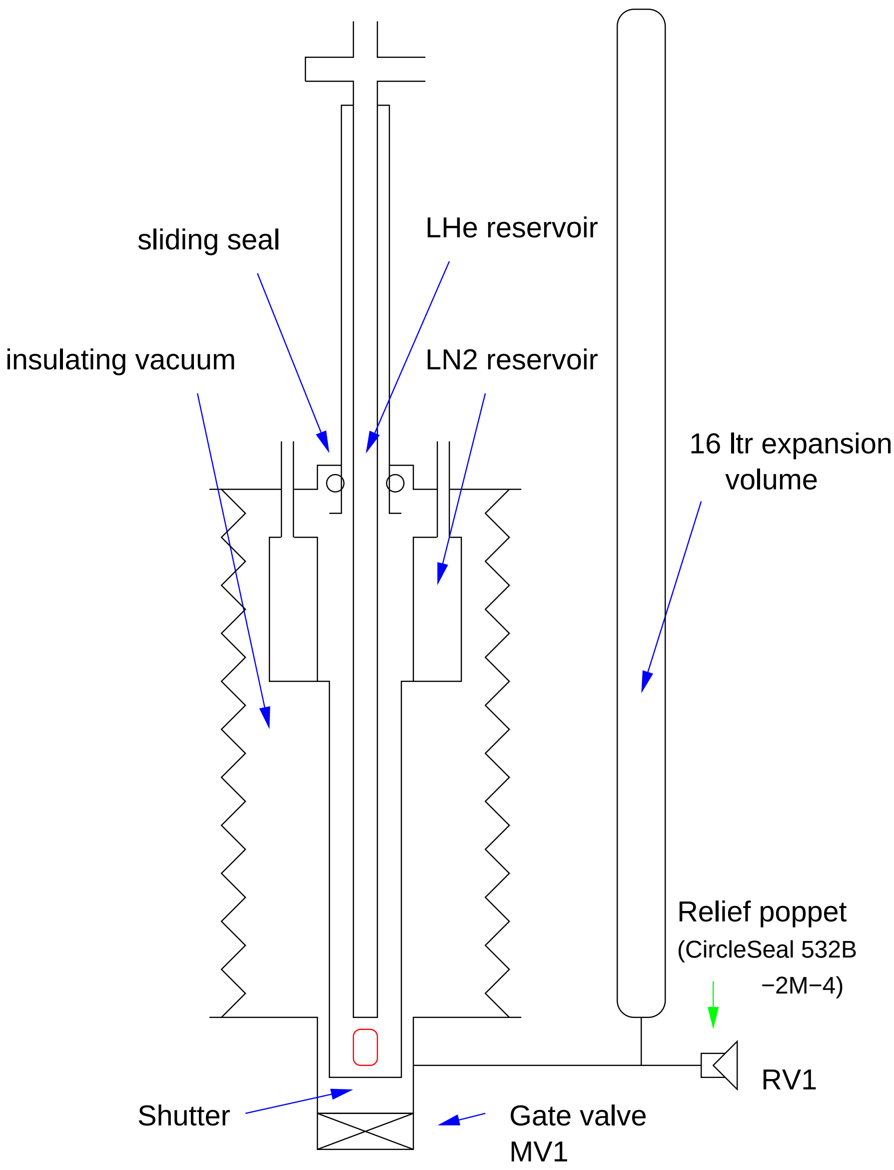


Figure 4: Magnetic field contours in plane containing external field maximum.

Transfer Cryostat Piping and Valves



BNL Static Magnetic Fields Exposure Form

Part A: Source Hazard Assessment Record

USE THIS FORM TO DOCUMENT MAGNETIC FIELD SOURCES THAT ARE AT OR EXCEED 0.5mT (5 GAUSS)
Line Managers or Principal Investigators, and ES&H Coordinators complete a separate form for each Static Magnetic Field source. This assessment applies to occupational exposures only. This assessment does not apply to unmodified consumer products (phones, computer terminals, magnetic stirring devices, refrigerator magnets, etc.) that are used as intended.

I. Source Identification

Department: NSLS (X5 beamline is run by the Physics Dept.)	Building: 725A	Room or Area (location of source): X5 Beamline; Rms. 1-168 and 1-169

Identifier/ Name of Source: X5 beamline solid Hydrogen Deuteride (HD) cryostats

Status of Source Usage **(check all that apply):**
[X] In use on frequent basis [ ] Planned use in the near future [ ] Possible future use [ ] No planned use
[ ] Intermittent use [ ] One-time use [ ] Other:

Check or Describe Use or Process: [X] permanent magnet [ ] medical device [ ] Magnetic Resonance Imaging equipment
[X] Nuclear Magnetic Resonance equipment [X] super-conducting coils [ ] magnetometers [ ] accelerator magnets
[ ] detector magnets [ ] ion pumps [ ] electron microscope [ ] beam transport magnet [ ] electromagnet lifting device
[ ] other (specify):

II. Exposure Summary [Complete Part B: Field Strength Measurement Record *or* attach documentation from manufacturer]

Target Body Area	BNL Exposure Limits (mT)	(G)
Cardiac Pacemaker (Ceiling)	0.5	5
Ferromagnetic Objects (Ceiling)*	60	600
Torso or Head (Whole Body) (8-hour TWA)	60	600
Extremities (Limbs) (8-hour TWA)	600	6,000
Whole Body (Ceiling)	2,000 (2 T)	20,000
Extremities (Limbs) (Ceiling)	5,000 (5 T)	50,000

*Ferromagnetic Objects (Ceiling), including medical implants and prostheses, may be affected by fields. Additional evaluation is required.

Maximum Exposure Potential surveyed applicable to worker exposure:
Maximum fields surveyed were:
Dilution Fridge = 30 gauss in center at floor level (cryostat runs at 15 Tesla; almost entire cryostat is in an 8' deep pit); 5 gauss level is at ~6' distance. Workers cannot access body of cryostat unless unit is turned off, unit is brought up to room temperature and confined space procedure for access to pit is followed.
Storage Cryostat = 870 gauss at contact 24" above floor level (cryostat runs at 10 Tesla max field at the center of the superconducting solenoid; cryostat sits on floor fully exposed); 600 gauss at 19" from surface; 5 gauss at 60" from surface; 18 gauss at Caution tape at 36".
Transfer Cryostat (old) = 175 gauss max at core of magnet (cryomagnet)
Transfer Cryostat (new) = 1200 gauss at core of magnet (permanent magnet)
In-Beam Cryostat = 0.3-1.0 Tesla inside cryostat can; 1 T max field at the center of the superconducting solenoid at end of tube; note that when tube is inserted into detector, personnel cannot make contact with this tube.
NMR equipment. The highest measured RF field strength does not exceed 2.1% of the exposure limits (see ESR for details on RF survey).

III. Exposure Hazard Evaluation [Check all that apply]

1. [ ] **Field Strength does not exceed 0.5mT (5 Gauss). Go to section V.**

BROOKHAVEN NATIONAL LABORATORY

BNL Static Magnetic Fields Exposure Form
Part A: Source Hazard Assessment Record

2a. [ ] **Field strength is at or exceeds 0.5 mT (5 Gauss). No potential for individuals with medical electronic devices to be exposed above exposure limits. Explain in line 4.**

2b. [ ] **Field strength is at or exceeds 0.5 mT (5 Gauss). Individuals with medical electronic devices* may be affected. List users of cardiac pacemakers and other medical electronic devices in Part C: Employee Exposure Record.**

3a. [X] **Field strength is at or exceeds 60 mT (600 Gauss) but for less than 8 hours TWA. No individuals with medical electronic devices* or ferromagnetic implants/prostheses** present.**

3b. [ ] **Field strength is at or exceeds 60 mT (600 Gauss) but for less than 8 hours TWA. Individuals with medical electronic devices* or ferromagnetic implants/prostheses** may be affected. List users of medical electronic devices or ferromagnetic implants/prostheses in Part C: Employee Exposure Record.**

3c. [ ] **Field strength is at or exceeds BNL Exposure Limit (8-hr. TWA or ceiling limit). No potential for individuals to be exposed above BNL Exposure Limit. Explain in line 4.**

3d. [ ] **Field strength is at or exceeds BNL Exposure Limit (8-hr. TWA or ceiling limit). Potential for individuals to be exposed above BNL Exposure Limit. List the names of individuals in Part C: Employee Exposure Record.**

* Medical electronic devices includes cardiac pacemakers, electronic inner ear prostheses, insulin pumps.
** Ferromagnetic implants/ prostheses includes aneurysm clips, replacement hips.

4. Describe job/task and potential for employee exposures (e.g., type of work performed around source, method of control, time spent in fields [hours/day] and method of determining exposure):

The cryostats are used for manufacturing solid HD targets, storing the targets, transporting the targets and positioning the targets in the gamma beam for analysis.

The X5 facility as a whole is posted for magnetic fields. Each unit is also posted with specifics. Barriers are placed around the storage cryostat during operation to keep personnel well away from the high fields at contact. The dilution fridge is located in an 8' pit and poses no hazards at the floor surface. The transfer cryostat fields are ~5 gauss at contact for the old cryostat and ~13 gauss at contact for the new cryostat. The highest fields for the in-beam cryostat are at the end of the tube where fields reach 950 gauss at contact (not accessible to personnel when tube is inside detector) but decrease to 60 gauss at 5" and 5 gauss at 15".

Personnel frequently are in the areas around the cryostats working on electronics and other experimental equipment. When the HD targets are exposed to the gamma beam, personnel are interlocked out of this area due to the radiation hazard.

5. Frequency of exposure (e.g., # days per year or month, # tests per year, in continuous use, etc.):

The Dilution Fridge runs almost constantly. Other cryostats operate as needed during experimental runs.

The Transfer Cryostat is used only when a solid HD target is to be moved between dewars. This occurs at a frequency of a few times per year. The old cryostat magnet stays energized for about one hour only when cooled during each target transfer. The new cryostat magnet is a permanent magnet and is exhibits filed all the time.

The In-Beam Cryostat operates only when it is holding a target in the beam. Except for a short time (~1 hr) during target transfer, the In-Beam Cryostat tube is inserted in the middle of a large detector system (SASY) while the magnet is energized. This constitutes a physical barrier that forces personnel to stay meters away from the superconducting magnet. Fields inside the cryostat can are largely contained.

The Storage Dewar is anticipated to run for about six months/year over the next two years. However, personnel need to stay close to the SD, i.e. within the posted magnetic field physical barriers, only for the time necessary (a few minutes) to connect liquid helium and liquid nitrogen transfer lines. This occurs once every 2 days when the SD magnet is energized.

IV. Precautions / Engineering & Administrative Controls

Precautions During Use (check all that apply):

__X_ Signs
___ Lights
__X Barriers
___ Restricted access
___ Rotation of workers
__X_ Working when de-energized
___ Use of nonferromagnetic tools
___ Physical indicator of fringe fields (e.g., use of string with paper clips or equivalent)

Other:
Exhaust fans are available for the hydrogen (HD) targets (these fans are explosion proof) and for ODH conditions. Alarms for these fan systems are local and in the NSLS Control Room. Procedures for reacting to alarms are in place and personnel have been trained.

Written Documentation:

__X_ Experimental Review (Work Planning and Control for Experiments and Operations Subject Area)
___ Work Planning and Control (Work Planning and Control for Experiments and Operations Subject Area)
__X_ Written SOP (describe): All cryostats were originally reviewed by the BNL Cryogen Safety Committee and the NSLS ESH Committee. Recently, a revised In-Beam Cryostat and Transfer Cryostat were reviewed by the BNL Cryogen Safety Committee.

Other workers who may require information/written documentation/training to enter this area:
All personnel listed on the SAF and who work in the X5 experimental areas.

Checklist:

Employee training required: __X__ Static Magnetic Fields Web Course __X__ Dept/Division-Specific Training
Supervisors training required: __X__ Static Magnetic Fields Web Course __X__ Dept/Division-Specific Training
The Dept./Div. training is administered by the X5 staff.
Training required to be linked in Job Training Analysis for affected work groups / job classifications: __X__yes ____no
Staff are linked to JTA #GE-12 – Static magnetic field training.
Medical approval required for individuals with medical electronic devices ____yes ____no
Medical review required for individuals above 8-hour TWA or ceiling ____yes ____no
N.A. for both at this time.

V. Initial Assessment	
Completed by: Nicholas F. Gmür	**Date:**
Reviewed by ES&H Coordinator: Nicholas F. Gmür	**Date:**

Forward the original form to the Static Magnetic Fields Subject Matter Expert, copies to your ES&H Coordinator and Facility Support Representative. Retain a copy in your files. Update and resubmit the assessment when changes occur.

BNL Static Magnetic Fields Exposure Form
Part B: Field Strength Measurement Record

BROOKHAVEN NATIONAL LABORATORY

Field Strength Measurement Record	
DATE: 8/18/2003	**SURVEYOR: R. Zantopp, assisted by Chris Bade of X5 staff.**

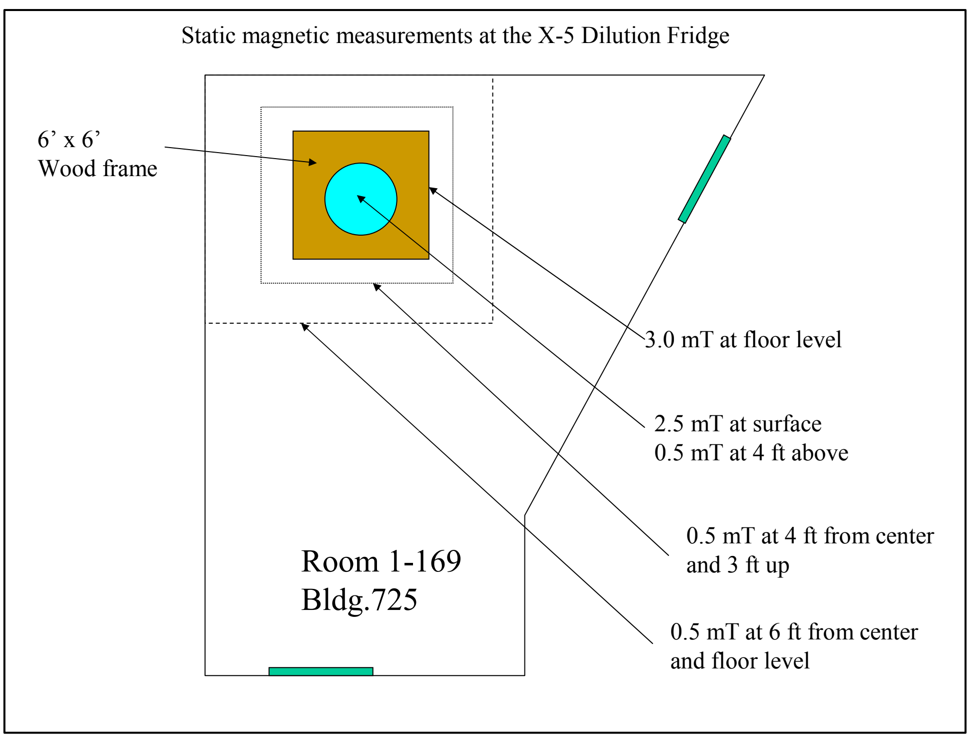
I. AREA INFORMATION		
DEPT.: NSLS	BLDG.: 725A	ROOM: 1-169
SOURCE: X5 Dilution Fridge		
CONTROLS: ___ BARRIERS __X_ SIGNS ___ USE NON-FERROMAGNETIC TOOLS __X_ OTHER: Cryostat held in 8' deep pit in concrete. Signs on surface of apparatus. Confined space procedure required for entry into pit.		

II. SURVEY INSTRUMENT INFORMATION		
INSTRUMENT: THM 7025	MODEL: 7025	SERIAL#: TH-BO 331
FACTORY CALIBRATION DATE: 10/28/2002	FUNCTIONAL CHECK (Test of meter response to known magnetic source) DATE:	

III. SAMPLING INFORMATION & RESULTS	
HAZARD: STATIC MAGNETIC FIELDS	UNITS: ___ mGauss ___ Gauss __X_ mTesla ___ Tesla Amp/meter

INDICATE WHERE READINGS WERE TAKEN IN THE TABLE BELOW AND ON THE SKETCH (GRID) ON NEXT PAGE. EQUIVALENT METHODS OF DOCUMENTATION MAY BE ATTACHED (E.G., PICTURE, PLAN VIEW WITH EXPOSURE LEVELS INDICATED)

DISTANCE FROM SOURCE	LOCATION	READING	COMMENTS
See drawing below	Room 1-169	See below	Magnet operating at 15 Tesla



BNL Static Magnetic Fields Exposure Form

Part B: Field Strength Measurement Record

Continuation of Section III.

Field Strength Measurement Record

DATE: 10/29/2003	**SURVEYOR: Rudy Zantopp**

I. AREA INFORMATION

DEPT.: NSLS	BLDG.: 725A	ROOM: 1-168

SOURCE: X5 storage cryostat with superconducting magnet (Janis Research Corp.)

CONTROLS: __X_ BARRIERS __X_ SIGNS ___ USE NON-FERROMAGNETIC TOOLS ___ OTHER:

II. SURVEY INSTRUMENT INFORMATION

INSTRUMENT: Metrolab	MODEL: THM 7025	SERIAL#: TH-BO 331
FACTORY CALIBRATION DATE: 10/28/2002	FUNCTIONAL CHECK (Test of meter response to known magnetic source) DATE:	

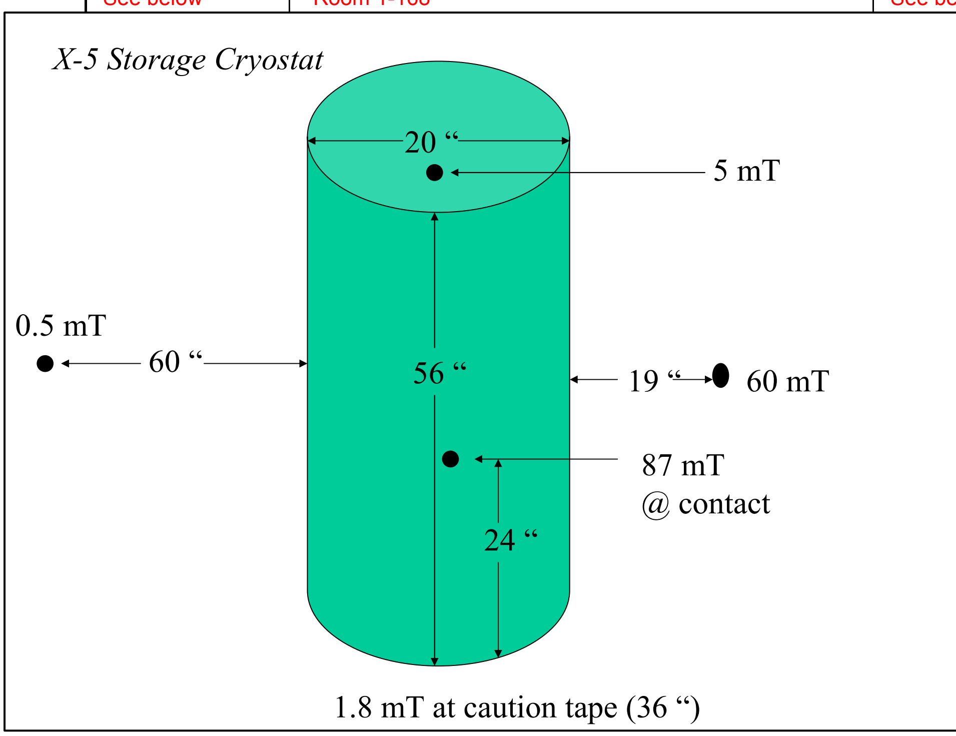
III. SAMPLING INFORMATION & RESULTS

HAZARD: STATIC MAGNETIC FIELDS

UNITS: ___ mGauss ___ Gauss __X_ mTesla ___ Tesla Amp/meter

INDICATE WHERE READINGS WERE TAKEN IN THE TABLE BELOW AND ON THE SKETCH (GRID) ON NEXT PAGE. EQUIVALENT METHODS OF DOCUMENTATION MAY BE ATTACHED (E.G., PICTURE, PLAN VIEW WITH EXPOSURE LEVELS INDICATED)

DISTANCE FROM SOURCE	LOCATION	READING	COMMENTS
See below	Room 1-168	See below	Magnet operating at ~8.7 Tesla



BNL Static Magnetic Fields Exposure Form

Part B: Field Strength Measurement Record

Field Strength Measurement Record	
DATE: 8/18/2003	**SURVEYOR: R. Zantopp, assisted by Chris Bade of X5 staff.**

I. AREA INFORMATION

DEPT.: NSLS	BLDG.: 725A	ROOM: 1-168
SOURCE: X5 Transfer cryostat **(OLD VERSION)**		
CONTROLS: ___ BARRIERS __X_ SIGNS ___ USE NON-FERROMAGNETIC TOOLS ___ OTHER:		

II. SURVEY INSTRUMENT INFORMATION

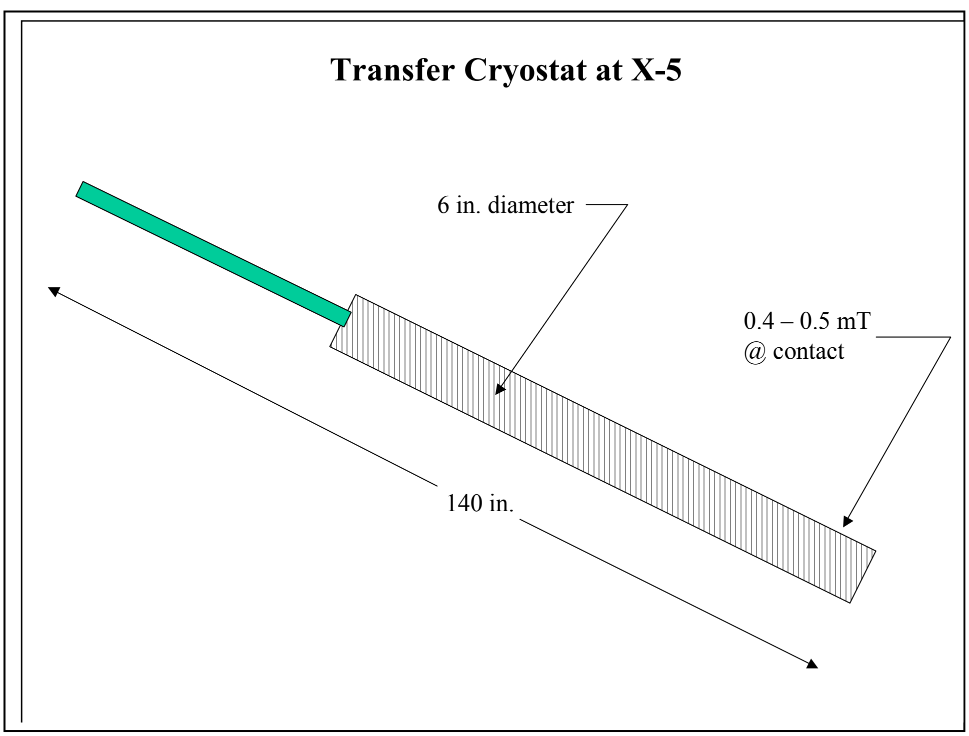
INSTRUMENT: THM 7025	MODEL: 7025	SERIAL#: TH-BO 331
FACTORY CALIBRATION DATE: 01/26/2004	FUNCTIONAL CHECK (Test of meter response to known magnetic source) DATE:	

III. SAMPLING INFORMATION & RESULTS

HAZARD: STATIC MAGNETIC FIELDS	UNITS: ___ mGauss ___ Gauss __X_ mTesla ___ Tesla Amp/meter

INDICATE WHERE READINGS WERE TAKEN IN THE TABLE BELOW AND ON THE SKETCH (GRID) ON NEXT PAGE. EQUIVALENT METHODS OF DOCUMENTATION MAY BE ATTACHED (E.G., PICTURE, PLAN VIEW WITH EXPOSURE LEVELS INDICATED)

DISTANCE FROM SOURCE	LOCATION	READING	COMMENTS
See drawing below	Room 1-168	See below	Magnet operating at 175 gauss



BNL Static Magnetic Fields Exposure Form
Part B: Field Strength Measurement Record

BROOKHAVEN NATIONAL LABORATORY

Field Strength Measurement Record

DATE: 8/26/2004	**SURVEYOR: R. Zantopp**

I. AREA INFORMATION

DEPT.: NSLS	BLDG.: 725A	ROOM: 1-168
SOURCE: X5 Transfer cryostat **(NEW VERSION)**		
CONTROLS: ___ BARRIERS __X_ SIGNS ___ USE NON-FERROMAGNETIC TOOLS ___ OTHER:		

II. SURVEY INSTRUMENT INFORMATION

INSTRUMENT: THM 7025	MODEL: 7025	SERIAL#: TH-BO 331
FACTORY CALIBRATION DATE: 01/29/2004	FUNCTIONAL CHECK (Test of meter response to known magnetic source) DATE:	

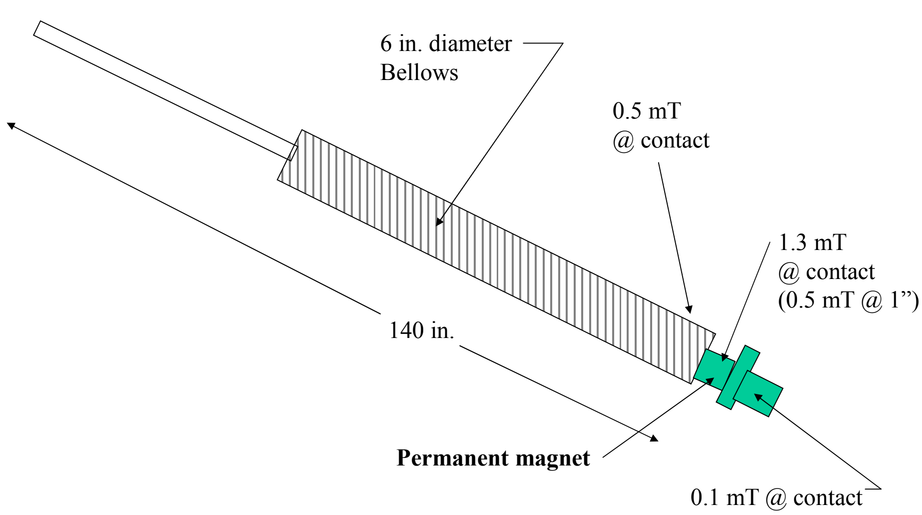
III. SAMPLING INFORMATION & RESULTS

HAZARD: STATIC MAGNETIC FIELDS	UNITS: ___ mGauss ___ Gauss __X_ mTesla ___ Tesla Amp/meter

INDICATE WHERE READINGS WERE TAKEN IN THE TABLE BELOW AND ON THE SKETCH (GRID) ON NEXT PAGE. EQUIVALENT METHODS OF DOCUMENTATION MAY BE ATTACHED (E.G., PICTURE, PLAN VIEW WITH EXPOSURE LEVELS INDICATED)

DISTANCE FROM SOURCE	LOCATION	READING	COMMENTS
See drawing below	Room 1-168	See below	Magnet operating at 1200 gauss

(New)Transfer Cryostat at X-5



BNL Static Magnetic Fields Exposure Form
Part B: Field Strength Measurement Record

DATE: 5/28/2004	**SURVEYOR:** R. Zantopp

I. AREA INFORMATION

DEPT.: NSLS	BLDG.: 725A	ROOM: 1-168
SOURCE: X5 In-Beam Cryostat		
CONTROLS: ___ BARRIERS __X_ SIGNS ___ USE NON-FERROMAGNETIC TOOLS ___ OTHER:		

II. SURVEY INSTRUMENT INFORMATION

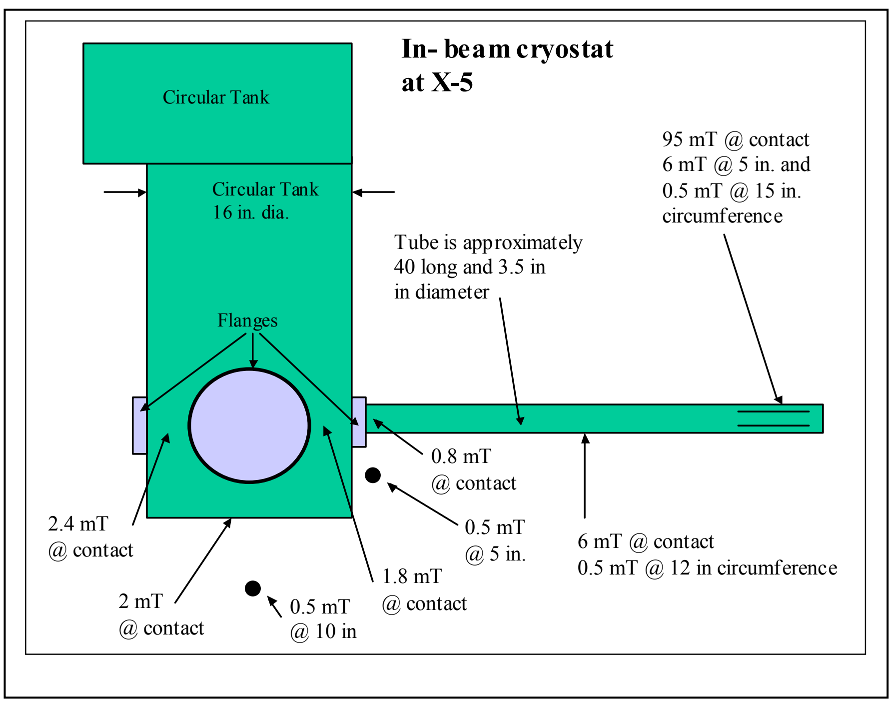
INSTRUMENT: THM 7025	MODEL: 7025	SERIAL#: TH-BO 331
FACTORY CALIBRATION DATE: 01/26/2004	FUNCTIONAL CHECK (Test of meter response to known magnetic source) DATE:	

III. SAMPLING INFORMATION & RESULTS

HAZARD: STATIC MAGNETIC FIELDS	UNITS: ___ mGauss ___ Gauss __X_ mTesla ___ Tesla Amp/meter

INDICATE WHERE READINGS WERE TAKEN IN THE TABLE BELOW AND ON THE SKETCH (GRID) ON NEXT PAGE. EQUIVALENT METHODS OF DOCUMENTATION MAY BE ATTACHED (E.G., PICTURE, PLAN VIEW WITH EXPOSURE LEVELS INDICATED)

DISTANCE FROM SOURCE	LOCATION	READING	COMMENTS
See drawing below	Room 1-168	See below	Magnet operating at 1 Tesla NOTE: when tube is inserted into detector, contact with the tube is not possible.



BNL Static Magnetic Fields Exposure Form
Part C: Employee Exposure Record

Employee Exposure Record

DATE: May 20, 2004	COMPLETED BY: Nicholas F. Gmür – **No medical issues**

I. AREA INFORMATION		
DEPT.: NSLS	BLDG.: 725A	ROOM: 1-168, 169
SOURCE: X5 cryostats		

NOTE: MEASUREMENTS OR CALCULATIONS IDENTIFY THE INDIVIDIUALS BELOW TO HAVE THE POTENTIAL FOR EXCEEDING REGULATORY EXPOSURES LEVELS.

II. EMPLOYEE INFORMATION

FIRST NAME:	LAST NAME:	BNL #:
DEPT:	BLDG:	JOB TITLE:
EXPOSURE DURATION (Hrs):	EXPOSURE (Times per Day):	EXPOSURE (Days per Yr):
JOB/TASKS PERFORMED:		
Check all that apply: __ MEDICAL ELECTRONIC DEVICE USER or	____ FERROMAGNETIC PROSTHESIS &	____ Exposure above BNL Exposure Limit ____ Exposure above 5 Gauss

FIRST NAME:	LAST NAME:	BNL #:
DEPT:	BLDG:	JOB TITLE:
EXPOSURE DURATION (Hrs):	EXPOSURE (Times per Day):	EXPOSURE (Days per Yr):
JOB/TASKS PERFORMED:		
Check all that apply: __ MEDICAL ELECTRONIC DEVICE USER or	____ FERROMAGNETIC PROSTHESIS &	____ Exposure above BNL Exposure Limit ____ Exposure above 5 Gauss

FIRST NAME:	LAST NAME:	BNL #:
DEPT:	BLDG:	JOB TITLE:
EXPOSURE DURATION (Hrs):	EXPOSURE (Times per Day):	EXPOSURE (Days per Yr):
JOB/TASKS PERFORMED:		
Check all that apply: __ MEDICAL ELECTRONIC DEVICE USER or	____ FERROMAGNETIC PROSTHESIS &	____ Exposure above BNL Exposure Limit ____ Exposure above 5 Gauss

Forward the original form to the Static Magnetic Fields Subject Matter Expert, copies to the Occupational Medicine Clinic, your ES&H Coordinator, and Facility Support Representative. Retain a copy in your files. Update and resubmit the assessment when changes occur.

Lessard, Edward T

From: Travis, Richard J
Sent: Friday, September 10, 2004 10:34 AM
To: Ackerman, Andrew; Boerner Jr, Albert; Curtiss, Joseph A
Cc: Sandorfi, Andrew; Lessard, Edward T; Travis, Richard J
Subject: LESHC 04-07, Closure of Electrical Inspection Condition

Follow Up Flag: Follow up
Flag Status: Flagged

Thanks, Gentlemen.
The draft minutes will be issued shortly. This condition will be marked as complete.
Rich

-----Original Message-----
From: Ackerman, Andrew
Sent: Tuesday, September 07, 2004 1:53 PM
To: Sandorfi, Andrew; Travis, Richard J
Subject: FW: TC Motion Control Electronics

The message below is a report of electrical inspection and approval of the LEGS transfer cryostat. Please accept this as confirmation that the device was inspected and found acceptable for use at the NSLS.

Andrew Ackerman
NSLS

From: Boerner Jr, Albert
Sent: Thursday, August 26, 2004 9:19 AM
To: Lowry, Michael; Ackerman, Andrew
Cc: Aloi, John; Zuhoski, Peter B; Chmiel, Robert
Subject: FW: TC Motion Control Electronics

Gentleman,
Joe and I reviewed the material and the E-mail below is Joe's response. Electrically this piece of equipment is acceptable.

Al Boerner PMP
Project Engineer
X5990

-----Original Message-----
From: Curtiss, Joseph A
Sent: Thursday, August 26, 2004 8:36 AM
To: Boerner Jr, Albert
Subject: TC Motion Control Electronics

Al Boerner -

Thank you for the opportunity to review the TC Motion Control Electronics, including the schematic dated 23 Aug. 04 drawn by A. Caracappa.

The device is a motorized hoist intended for raising a large tube during servicing operations, and consists of a 120-volt 60 Hz reversible motor, a relay-based control circuit operating at 12-volts d.c., and limit switches and a hand-held operating control also operating at 12-volts d.c. The 120-volt circuit to the motor is protected by a circuit breaker built into the equipment and is routed through relay contacts to the motor, thus the operator is never exposed to more than the low voltage control circuit. The equipment is connected to 120-volts by a line cord with a plug for insertion into a convenient receptacle, thus providing for simple application of lockout/tagout should servicing be necessary. The enclosure and motor are grounded and the device will be mounted on top of a grounded rack.

Based on my review of this equipment and its intended use, I approve the device for deployment within the NSLS.

- Joseph A. Curtiss, P.E.
- Laboratory Electrical Safety Officer

Brookhaven National Laboratory

Hazard Identification Tool

Operation Title: Juelich Transfer Cryostat
Point Of Contact: Michael Lowry
Hazard Rating: 2 (explanation of rating)

Required Documentation:

Because of the hazards identified, this operation has the potential of being an operation with a **medium initial risk**. Please ensure that you adequately address the magnitude of the hazard (i.e., quantity, duration, frequency, physical state) in your analysis.

The following questions were answered YES and contributed to a hazard rating of 2:

6b. Is there any electrical equipment used in the operation with voltage less than 50V and power greater than 1000W OR voltage from 50V to 250V and current greater than 5mA OR voltage greater than 250V and current less than 500 mA AND stored energy less than 10J?
7c. Does this operation include the use of rigging?
8. Do you work with any of the following non-ionizing radiation (NIR) sources: permanently installed Radio Frequency Micro Wave (RFMW) gear capable of radiating over 1 W into an open area at frequencies between 3 kHz and 300 GHz or of emitting over 100 W if the output is normally completely enclosed by coaxial cables, waveguides, or dummy or real loads; satellite and permanently installed communications transmitters (not receivers); portable walkie-talkie communications sets capable of radiating over 7 W at frequencies between 100 kHz and 450 MHz, and over 7 (450/f) W at frequencies between 450 MHz and 1.0 GHz (f in MHz); induction heaters. (Microwave ovens used as a household appliance, cellular phones, video display terminals, and radar speed Guns are exempt.); or any equipment that would expose personnel to high levels of sub-radiofrequency electric or magnetic fields including static electric and magnetic fields.
13. Does this operation involve: the use of equipment, tools, or materials outside of the deisgn spec?
14b. Will operation require work outside normal working hours?

Notes:

- (6) All energized electrical equipment must be included in the equipment inventory for your group. Contact the Electrical Safety Officer for more information.
- (6) A list of nationally recognized testing laboratories and recognized manufacturers is available from the ESO
- (7c1) There are requirements for cranes to have an annual ANSI electrical and mechanical inspection AND maintenance review. If you would like to add your equipment to the facilities annual request for these services contact Plant Engineering Maintenance Management. Additionally, there are requirements for monthly (Inspection Record for Overhead Bridge and Gantry Cranes AND Monthly Inspection Record for Shop Cranes) and pre-operational (Pre-operational Inspection Record for Overhead Cranes and Hoists) checks for this equipment. In your analysis please enter the crane number and load capacity of the crane. See ESH Std 1.6.0 Material Handling for checklists.
- (7c2) Hoists are required to be load tested before use, have the load capacity listed on them, and to have monthly inspections (Monthly Monorail Overhead Hoist, Monthly Fixed Hoist, Monthly Manual Lever Operated Hoist). In your analysis please list the hoist number and the load capacity of the hoist, if applicable.
- (8) NIR sources must be listed on the BNL NIR inventory and may require measurements to be taken. If your equipment is not part of this inventory, please contact your FSS representative for further guidance. Note in your analysis that sources are included in the inventory.
- (13) Please list the equipment that you are using outside of design specifications or manufacturer recommendations and/or locally built equipment in your analysis along with associated controls.

BNL Requirements:

ESH Standard 1.6.0 Material Handling
ESH Standard 1.5.1 Lockout/Tagout Requirements
ESH Standard 2.3.2 RF and Microwave
Magnetic Fields, Static subject area

BNL Lessons Learned:

BNL Lessons Learned: Electrical/NEC
BNL Lessons Learned: Elevated Work/Falling Objects
BNL Lessons Learned: Ergonomics/Lifting
BNL Lessons Learned: Personal Injury/Exposure, Mechanical Injury
BNL Lessons Learned: Personal Injury/Exposure, Hazardous Materials (General)
BNL Lessons Learned: Personal Injury/Exposure, Other
BNL Lessons Learned: Personal Injury/Exposure, Hazardous Materials (General)
BNL Lessons Learned: Human Factors
BNL Lessons Learned: Human Resources
BNL Lessons Learned: Personal Injury/Exposure, Ambient Temperature Extremes

References:

Department Of Energy
OSHA Code of Federal Regulations
National Fire Protection Agency
American National Standards Institute
Institute of Electrical and Electronics Engineers, Inc.
American conference of Governmental Industrial Hygienists
29 CFR 1910 Subpart S - Electrical Safety (29 CFR 1910.301-308)
29 CFR 1926 Subpart K - Electrical (29 CFR 1926.400-499)
ANSI National Electrical Safety Code (ANSI-C2)
NFPA National Electrical Safety Code (NFPA-70 and 70E)
ESH Standard 1.5.2 Design Criteria for Electrical Equipment
Electrical Safety Implementation Guide
ESH Standard 1.5.1 Lockout/Tagout Requirements
ESH Standard 1.5.0 Electrical Safety
29 CFR 1910 Subpart O Machinery and Machine Guarding
29 CFR 1910.147 Control of Hazardous Energy
29 CFR 1910.179 Overhead and Gantry Cranes
29 CFR 1910.180 Crawler locomotive and truck crane
29 CFR 1910.181 Derricks
29 CFR 1910.183 Helicopter
29 CFR 1910.184 Slings.
29 CFR 1920.97 Non-ionizing Radiation
ACGIH Threshold Limit Values and Biological Exposure Indices
IEEE Std C95.1 Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields

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Jülich Transfer Cryostat Operations

July 15, 2004

Contents

1 Overview

The transfer cryostat is an integral component of the SPHICE target system. The goal of the system is the production and use of frozen-spin polarized deuterium hydride ice targets for nuclear physics experiments. The transfer cryostat moves the HD ice between the other cryostats which make up the system: 1) the dilution refrigerator, where the ice is polarized, 2) the storage cryostat, where the target is stored and shipped between laboratories, 3) the inbeam cryostat, where the target is exposed to the gamma beam while surrounded by the detector array, and 4) the production dewar, where the HD ice is frozen and vaporized. In order to understand how the transfer cryostat accomplishes its mission, a brief review of the target system is required.

1.1 HD Target

The current target design is for a 50 mm long by 25.2 mm diameter cylinder of HD ice. That cylinder is contained between two, 0.5 mm thick pCTFE cups, one inside the other. The outer one is 86.2 mm long and the inner one is 36.4 mm long. The inner, shorter cup is 26.2 mm OD and ends in a 45 degree cone with a 3 mm hole at its vertex. The 2.92 grams of HD liquid enters the target via this hole. The outer cup is enlarged to 29.7 mm ID in the region of the inner one to create a 1.75 mm gap.The gap is sealed at the top of the cups by the copper target support ring to which both cups are attached. Roughly 2000 aluminum cooling wires, 51 microns in diameter are soldered to the support ring and extend through the gap down into the HD ice cylinder. The target support ring has a central clearance of 24.5 mm in order for the gamma ray beam to traverse the length of the target. The outer surface of the ring has a right-handed M35x1.0 thread for attachment of the ring into each of the four cryostats mentioned above. The inner surface of the ring has a left-handed M26x1.0 thread. This allows the transfer cryostat to attach to the ring with the left-handed inside thread and then unscrew the right-handed outside thread to release the target when the attachment screw of the transfer cryostat rotates counter-clockwise (as seen

Table 1: HD vapor pressure and sublimation rate vs. temperature

Temperature	Vapor Pressure	Sublimation Rate
7 K	7.8×10^{-4}torr	181 milli-gm/day
5 K	4.4×10^{-7}torr	123 micro-gm/day
4.216 K	3.9×10^{-9}torr	1.16 micro-gm/day

from above) or to attach the ring inside the appropriate cryostat and then detach from the transfer cryostat with clockwise rotation.

In order for the unsealed target not to sublime appreciably, its temperature must be maintained below 5 Kelvin, although brief excursions up to 7 Kelvin are tolerable. Table 1 gives the vapor pressure inside and sublimation rate from our HD target with its 3 mm hole.

It is even more important to maintain the target at cold temperatures in order to reduce the rate of polarization loss as we shall see in the next section.

1.2 Target Cycle

The target is filled with HD by condensing HD vapor at just above the triple point of HD, 16.6 K. This temperature regime is reached with a specialized cryostat called the production cryostat or IceMaker, or by utilizing the vertical temperature gradient in a dilution refrigerator with its inner vacuum filled with exchange gas. After filling, the target is transferred to a He3-He4 dilution refrigerator with a 10 mK base temperature and a 17 Tesla superconducting solenoid. With the aid of a 10^{-4} doping of metastable ortho-H2, the H reaches equilibrium polarization of up to 80% within a few days. This polarization can be transferred to the D with an adiabatic fast passage technique and the H repolarized. Repeating the fast passage transfer allows D polarizations of up to 50% to be reached. After 6 to 9 weeks of aging the ortho-H2 and para-D2 have decayed to such an extent that the polarization approach to equilibrium is extremely slow. This allows the target to be removed from such extremes of temperature and magnetic field. The target can be transferred to a storage cryostat, where the target can be stored and shipped between laboratories, and then to the inbeam cryostat, where the target is exposed to the gamma beam surrounded by the detector array. After the target polarization has decayed too low to be useful, it is transferred to the production cryostat for vaporization of the HD and re-generation of the ortho-H2 at room temperature. The HD gas is then ready to begin a new cycle. Table 2 gives the polarization lifetime goals for a fully aged target as a function of temperature for both H and D at the nominal fields of the three relevant cryostats : storage, inbeam and transfer.

Table 2: H and D polarization lifetimes vs temperature

Field	10 Tesla (storage)		1 Tesla (inbeam)		0.12 Tesla (transfer)	
Temperature	H	D	H	D	H	D
4.2 K	27 days	80 days			1 day	3 days
1.5 K	80 days	240 days	14 days	42 days	3 days	9 days
0.4 K			35 days	100 days		

2 Transfer Cryostat

Thus we see that in order for the transfer cryostat to perform its job it must extend a 4 K left-handed screw thread into each of the cryostats and rotate that thread multiple times. To keep the radiant thermal load on the 4 K section at a manageable level, it must be surrounded by a 77 K liquid nitrogen shield. Further, when the target is withdrawn from any of the cryostats, it must at all times see a magnetic holding field of at least 0.12 Tesla. In the following subsections, each of the components of the transfer cryostat will be examined in detail (see Figures 1, 2, and 3).

2.1 LHe Reservoir

The transfer cryostat is a series of concentric cylindrical or toroidal volumes, of which the center most is the liquid helium (LHe) reservoir. This volume extends some 3.3 meters, from the cross at the top of the cryostat to the target attachment screw on the reservoir's bottom. It is filled with LHe through the opening at the top of the cross. It has a capacity of 1.1 liters of LHe. Helium boiloff vents through one of the side arms of the cross. The other arm carries the electrical feedthroughs for a temperature sensor at the bottom of the helium reservoir and for a liquid level sensor.

2.2 LN2 Reservoir

A toroidal reservoir for liquid nitrogen (LN2) is contained in the vacuum space. It is supported by a rod from the reservoir to the top of the bellows and by three tubes extending out the top of the vacuum space. Two of the tubes serve as the fill and vent lines. The third carries the capacitive level sensor for the top, larger-diameter section of the reservoir. The reservoir has a 1.8 liter capacity. The top 0.29 meters are larger diameter than the rest, roughly corresponding to the compressed length of the bellows. The bottom of the reservoir is a smaller outer diameter radiation shield which covers the LHe reservoir for an additional 1.6 meters. Attached to the bottom of the shield is a permanent magnet array in an Holbach configuration which provides the holding field for the polarized target while it is in the transfer cryostat,

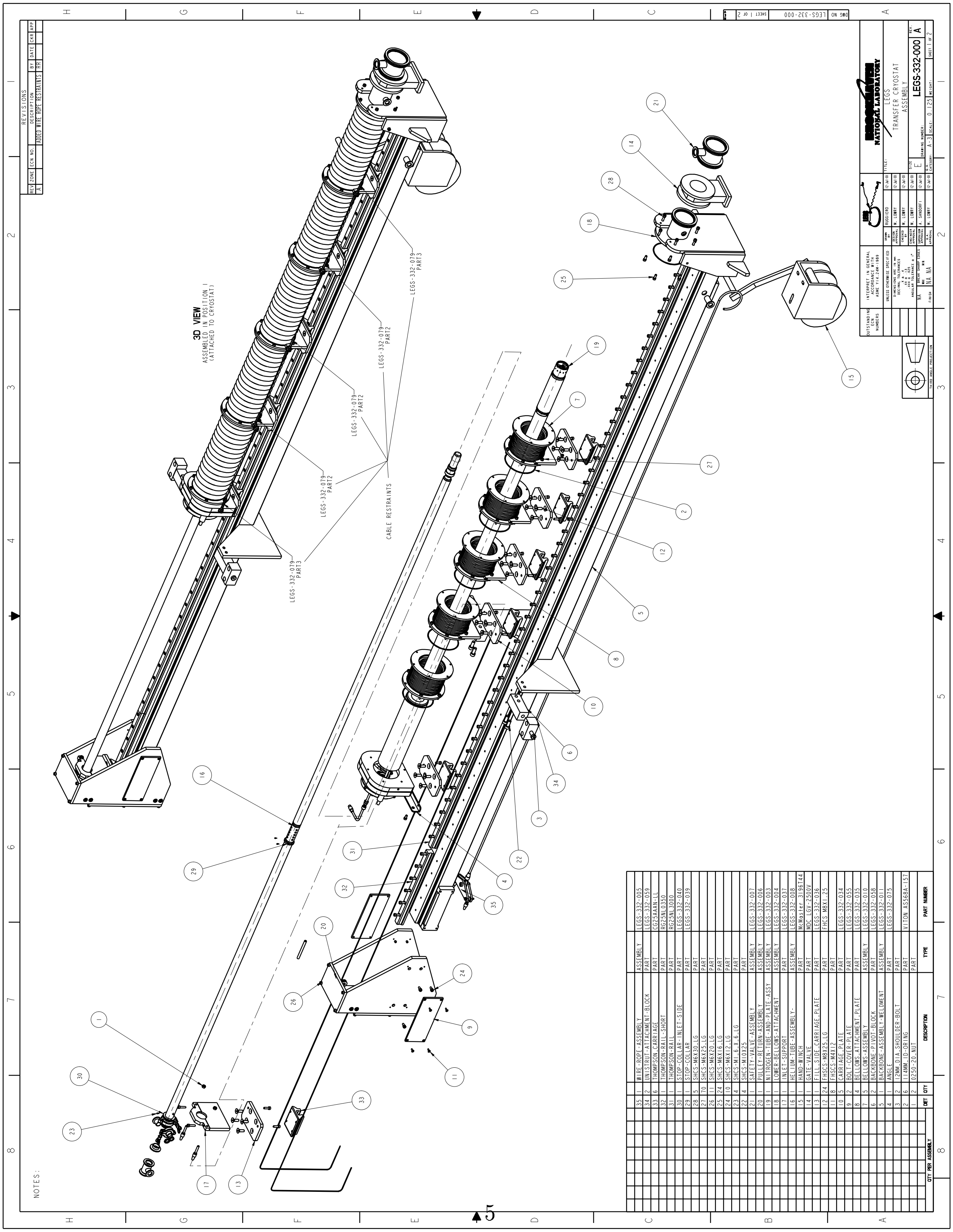


Figure 1: Transfer Cryostat Drawing

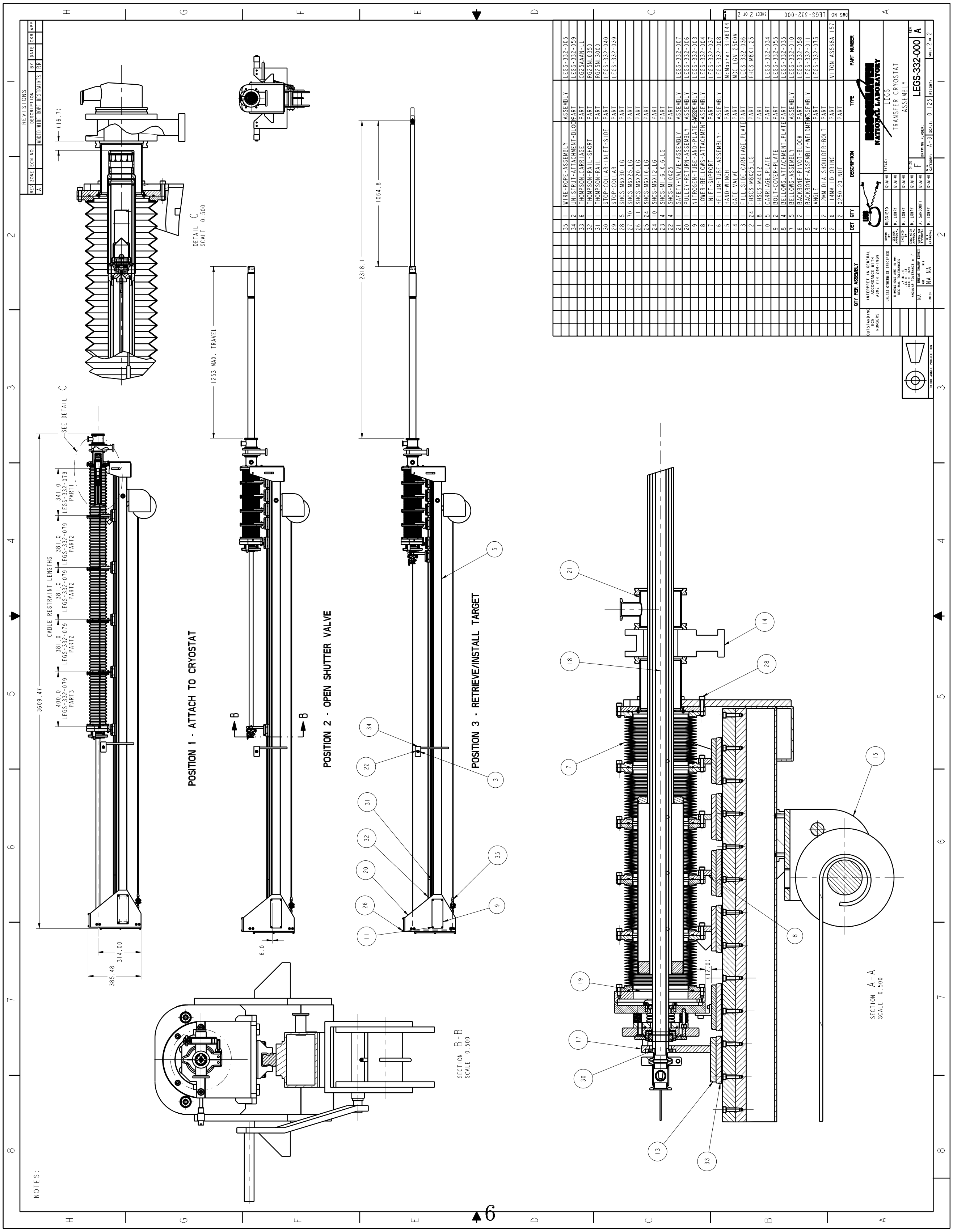


Figure 2: Transfer Cryostat Drawing

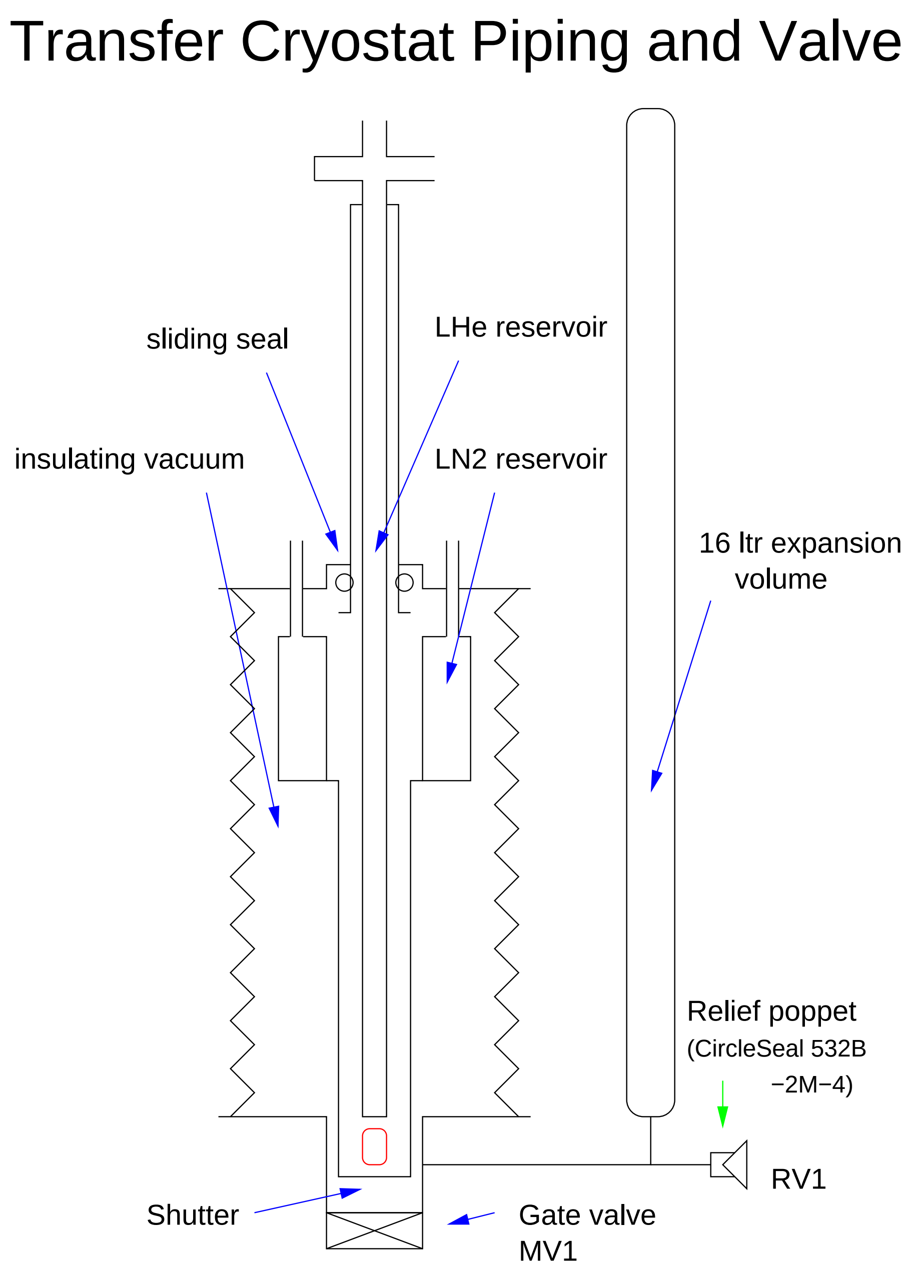


Figure 3: Transfer Cryostat Piping and Valves Schematic

0.12 Tesla transverse. A calculation of the external magnetic field contours is given in Figure 4. Below the magnet is a multi-leaf, spring-operated shutter that seals the bottom from room temperature radiation. Note that lowering the top of the bellows causes extrusion of the lower portion of the LN2 reservoir and the shutter through the gate valve at the bottom of the bellows.

2.3 Insulating Vacuum Space

The liquid cryogen reservoirs are isolated from room temperature by an enclosing vacuum space, termed the insulating vacuum. This volume includes the double wall of the LHe reservoir tube from the cross at the top of the cryostat down approximately half of the length of the LHe reservoir. It contains the LN2 reservoir and the HD target itself. This vacuum space can be evacuated through the gate valve, MV1, at the bottom of the cryostat. Just above that gate valve is a connection to an NW16 tee that carries a relief poppet valve, RV1 (4 psi), and provides connection to the 10 cm x 5 cm x 3.3 meter long backbone tube. This tube adds 16 liters of expansion volume to the 15 liters of insulating vacuum and thus guarantees that the cryostat will remain below atmospheric pressure should cooling be lost and a target vaporize (21.6 liters).

The outside wall of the double wall section makes contact with the sliding seal at the top of the bellows. This seal allows translation and rotation of the target attachment screw thread. Care must be taken to ensure that the wall in contact with the sliding seal remains at room temperature to prevent freezing of the O-ring and loss of vacuum integrity.

The outside wall of the lower section is a 1.9 meter long, highly compressible bellows. This allows vertical motion of the bellows top along with the attached LN2 reservoir and the LHe reservoir captured by the sliding seal located on the bellows top.

2.4 Support Frame

The cryostat weight and motions are supported and guided by an aluminum backbone, which spans nearly the full, 3.6 meter length of the cryostat. At the bottom of the backbone is a winch whose cable supports the vacuum force and controls the motion of the LHe tube and the bellows. On top of the backbone is a linear track. Four small carts ride the track to guide the bellows sections and one cart rides it to guide and support the top of the bellows. The cross at the top of the LHe reservoir is also guided by a cart riding on the backbone track. The interior of the backbone serves as an additional 16 ltr expansion volume for the cryostat.

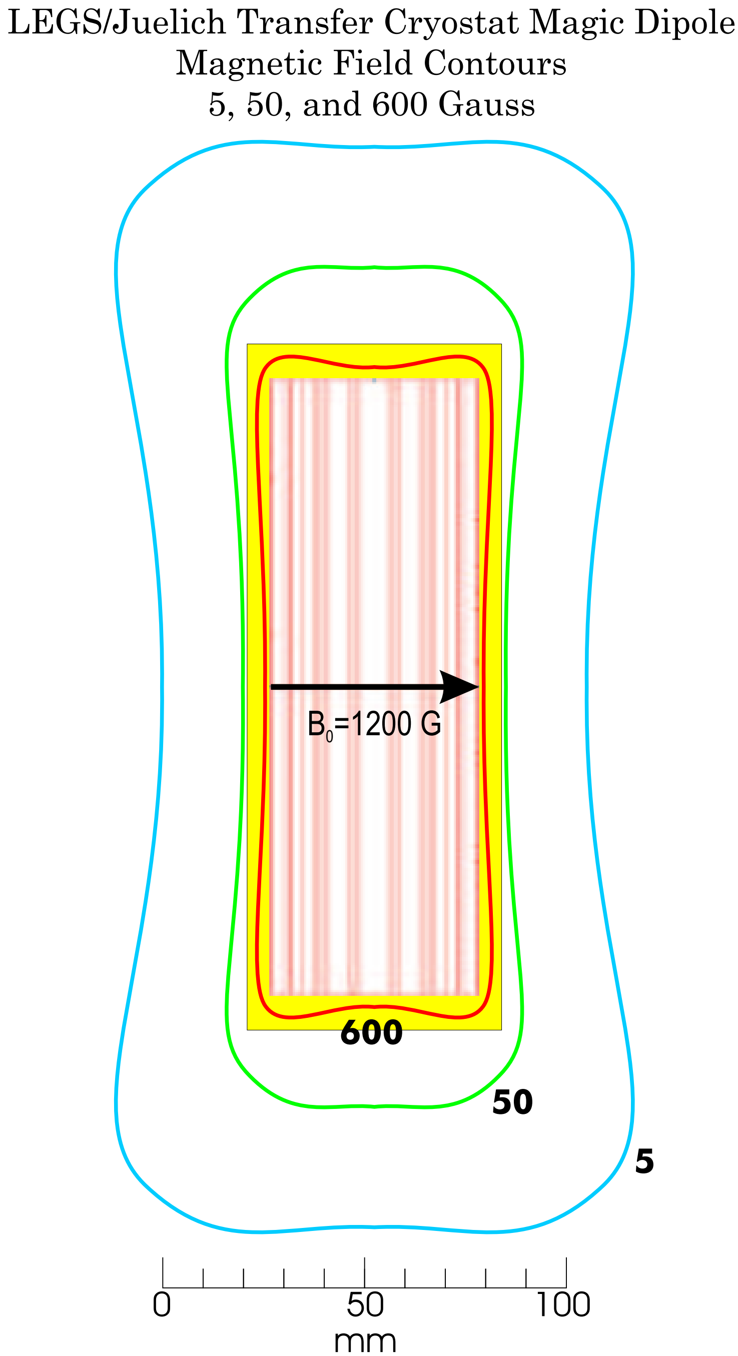


Figure 4: Magnetic field contours in plane containing external field maximum.

2.5 Ancillary Equipment

Two additional pieces of equipment have been constructed to aid in safely moving and storing the cryostat.

2.5.1 Cryostat Cart

A cart has been provided with a cradle to hold the cryostat at a 30° angle as well as space to hold the liquid cryogen level and temperature readouts.

2.5.2 Lifting Arm

A specially made arm has been constructed to lift and hold the cryostat off-center from the hoist. The cryostat may be held at any angle between 0° and 90° to horizontal. At 90°, the cryostat is held at the top of the LN2 space and balanced by a counter weight hung on the other end of the arm. A 3:1 mechanical advantage allows gentle placement of the transfer cryostat on top of the storage cryostat, production cryostat and dilution refrigerator. By attaching the other end of the arm to the bottom of the cryostat, and moving the lift point, the cryostat may be held at a 30° angle for placement either on the supports for transfers in and out of the inbeam cryostat or on the cryostat cart.

3 Safety

3.1 Liquid Cryogens

The total volumes of liquid cryogens are quite small, 1.8 liters of liquid nitrogen and 1.1 liters of liquid helium. The liquid nitrogen is at atmospheric pressure and vents through a 3/8" tube. The liquid helium vents through a 3/4" tube.

3.2 Solid Hydrogen

The cryostat can transport one solid hydrogen target which corresponds to 21.6 liters STP. The internal volume into which the target would expand is 31 liters. So if cooling were lost, the internal pressure would rise to 0.7 Bar absolute, still less than the external 1.0 Bar. In the event of a slow leak of air or nitrogen, significant quantities could acumulate on the LHe tube prior to loss of cooling. In this case, the air or nitrogen plus hydrogen mixture could exceed the 31 liter internal volume and a 4 psi relief valve will vent the excess to the room. Note that, considering only the latent heats, 1.1 liters of LHe can at most condense 18 mL of LN2 which corresponds to only 14 liters of gas. This, plus the hydrogen, would result in a pressure of 2.2 psig, insufficient to trigger the 4 psi relief. There is no ignition source in the vacuum space.

3.3 Pressure Vessel

There is only one vacuum space so the maximum differential occurs with 14.7 psia external and zero internal. The maximum differential in the other direction is governed by the 4 psi relief valve, 14.7 psia external, 18.7 psia internal. These values fall outside the scope of ESH Standard 1.4.1. The bellows, gate valve and reservoirs are stainless steel type 304L except for the bottoms of the reservoirs which are copper type C10100. The backbone is aluminum type 6061-T6. There are no glass or plastic windows.

3.4 Magnetic Field

The Holbach array configuration for a permanent magnet results in a high central field, 1200 Gauss in this case, but small external fields. The accessible external field is quite similar in magnitude to that of the previous transfer cryostat which has only a 150 Gauss central field. The 600 Gauss contour line of this magnet falls entirely within the vacuum envelope and is normally inaccessible. The 5 Gauss contour extends outside the 76 mm diameter of the spool pieces (see Figures 2 and 4) so that a low exposure is possible. The cryostat is only used in areas already posted for static magnetic fields and will be surveyed, assessed and will have the appropriate controls implemented by the NSLS.

3.5 Lifting Fixture

The lifting arm utilized by this device is the same one used on the previous generation cryostat, supplied by Orsay group. The design has been checked by plant engineering, and the device has been inspected, tested and certified for this application by the plant engineering crane inspector. It undergoes annual inspection by the plant engineering crane inspector.

4 Procedures

Before attempting any of the procedures detailed in the following sections, all personnel should acquaint themselves with standard laboratory safety procedures, including vacuum pumping, liquid cryogen handling, magnetic field safety and proper hoist operation. All personnel must have read this manual fully and be certified by the head of the SPHICE target group at BNL. This equipment is for experimental use only and requires handling by trained personnel only. If the cryostat performance deviates from the performance expected in this manual, consult with the head of the SPHICE target group or other expert immediately.

4.1 Cooling to LN2

This procedure cools the cryostat from room temperature to that of liquid nitrogen, 77 Kelvin. It is recommended that the transfer cryostat be on its cart to start.

1. Check the LN2 and LHe level readouts to make sure both are connected and working properly. The sensor fail lights should not be lit and both should read at ot below zero.

2. Check the LHe temperature sensor readout, which should be 300 Kelvin.

3. Record the time and readings in the cryostat logbook.

4. Attach a turbo pumping station to the gate valve MV1 at the bottom of the cryostat. Evacuate the insulating vacuum space to better than 8×10^{-6}torr.

5. Attach a roughing pump to one vent port of the LN2 reservoir and plug the other one with a rubber stopper. Pump the reservoir to below 50 microns and then back fill with He gas. If the reservoir fails to pump down, it may indicate the presence of water from the previous cold cycle. Continue pumping and flushing until the water has been removed.

6. Repeat previous step for the LHe reservoir, attaching the pump to the vent and putting the stopper in the fill.

7. Add LN2 to the LN2 reservoir. Because of the large surface to volume ratio of the LN2 reservoir, this should be done somewhat slowly, allowing approximately 15 minutes for the filling operation. When the LN2 boiloff from the LN2 reservoir has slowed and the level meter indicates full, the cryostat has been pre-cooled to LN2 temperature.

8. Record the time and LN2 level reading in the logbook.

4.2 Cooling to LHe

This procedure cools the cryostat from that of liquid nitrogen to that of liquid helium, 77 to 4.2 Kelvin. It is recommended that the transfer cryostat be on its cart for this operation. This procedure requires that pre-cooling, Procedure 4.1, has been completed immediately prior to this one.

1. Remove the plug from the LHe fill port. Insert the fill lance into the LHe reservoir. Make sure the lance is firmly seated in the initial transfer cone. Direct the helium exhaust gas away from the cryostat with temporary tubing.

2. Place the withdrawl lance in a LHe supply dewar and begin the transfer. Adjust the pressure in the supply dewar, by adding heat or venting, as necessary, to maintain a steady light breeze of helium exhaust from the cryostat. The filling should take about 40-60 minutes.

3. Monitor progress with the LHe temperature meter and note time and readings in the logbook.

4. Re-fill the LN2 reservoir when necessary as indicated by the LN2 level meter.

5. After blowoff from the LHe reservoir has reached a steady state and the LHe level meter indicates 140 cm or more, the cryostat is considered cooled to LHe temperature.

6. Record the time , LN2 and LHe level, and LHe temperature readings in the logbook.

7. Remove the fill lance from the LHe reservoir and remove the fill lance from the LHe supply dewar. Insert the plug in the LHe fill port.

4.3 Warming up the Cryostat

This procedure warms the cryostat to room temperature from that of liquid helium, 4.2 Kelvin. It is recommended that the transfer cryostat be on its cart for this operation.

1. Cease to replenish the LHe and LN2 reservoirs. The cryostat will warm up on its own in 12 to 24 hours.

WARNING: Do not attempt to speed up this process by adding exchange gas to the vacuum space. This may freeze the sliding O-ring, causing a vacuum failure and excessively rapid venting of the liquid cryogen boiloffs.

WARNING: Do not attempt to pour out the liquid cryogens by tilting the cryostat on the lifting arm. The LN2 reservoir cannot be drained in this way because of the position of the vents. Sudden contact of the LHe with the upper, warmer part of the LHe reservoir may result in flash boiling and excessively rapid venting.

4.4 Lifting the Cryostat

This procedure details hoisting the cryostat from its cart. This operation is considered a pre-engineered, production lift and requires Incidental Overhead Crane Operator certification on the crane to be used.

1. Obtain the crane key from the NSLS control room. Inspect the crane and the lifting arm for damage or wear.
2. Inspect the transfer cryostat and its cart to make sure the cryostat is properly positioned on the cart and that the cart casters are in working order.
3. Check the clearances and remove any obstructions that could interfere with the motion of the cart or the swing of the lifting arm during the lift. Reposition the cart if necessary.
4. Secure the area for lifting operations.
5. If the lifting arm is not already in place, position the arm over the cryostat and attach it to the cryostat at the lifting pins near the top of the side rails. Attach the cable between the counterweight end of the lifting arm and the bottom of the transfer cryostat.
6. Adjust the movable lifting point to the marked position for 30°support.
7. Position the crane over the movable lifting point. Attach the hook and make sure it is properly moused.
8. Slowly hoist. The lifting arm will rise to a horizontal position. Care must be exercised to avoid swinging the arm too rapidly. Use the tether to help minimize swinging. Continue lifting an additional 5 to 10 cm so that one end of the cryostat has lifted off the the cart.
9. Re-adjust the lifting point if necessary so that both ends are free of the cart, the cryostat is hanging parallel to its cradle on the cart and the lifting arm is level.

4.5 Rotating to 90°

This procedure details rotating the cryostat from the lift position 30° from the horizontal to the 90° vertical position preparatory to attaching to the storage cryostat. This operation is considered a pre-engineered, production lift and requires Incidental Overhead Crane Operator certification on the crane to be used. It requires that Procedure 4.4 has been performed.

1. Check the overhead clearance. The cryostat is approximately 4 meters long. There is insufficient headroom to perform this procedure on the small crane located above the beamline upstream from the inbeam cryostat. Reposition the crane and or rotate the arm horizontally if necessary.

2. Hoist the cryostat so that the lift point is at least 2.1 meters (7 feet!) off the floor. Use the tether to control any swing. Secure the crane.

3. Adjust the lift point towards the cryostat so that the counterweighted end and the cryostat swing downward. Continue adjusting until the cable connecting the bottom of the cryostat to the arm goes slack and the cryostat hangs vertically (the position is marked).

4. Detach the connecting cable from the lifting arm by opening the shackle. Store the cable by looping it around the body of the gate valve and shackling it to itself.

5. Adjust the lifting point back towards the counterweighted end of the arm so that that end swings up. Use the tether to prevent undesirable rocking or swinging. Continue adjusting until the arm is horizontal (the position is marked). The cryostat will pivot on its lifting pins to remain vertical but will swing out and down.

4.6 Rotating to 30°

This procedure details rotating the cryostat to 30° from a vertical position on the crane such as from mounting atop the production cryostat. This operation is considered a pre-engineered, production lift and requires Incidental Overhead Crane Operator certification on the crane to be used. It assumes that Procedures 4.4 and 4.5 have been performed.

1. Check the clearances and remove any obstructions that could interfere with the motion of the cryostat or of the lifting arm during the procedure. Reposition the cryostat if necessary.

2. Lower the cryostat to within about 30 cm of the floor. Secure the crane.

3. Adjust the lift point towards the cryostat so that the counterweighted end swings downward. Use the tether to eliminate rocking and swinging. Continue adjusting until the cable connecting the bottom of the cryostat to the arm can be attached (the position is marked).

4. Attach the cable between the bottom of the cryostat and the arm. Un-shackle the cable from itself, unwrap from the gate valve and re-shackle it to the eye on the lifting arm.

5. Adjust the lifting point back towards the counterweighted end of the arm so that that end and the cryostat swing upward. Continue adjusting until the arm is horizontal (the position is marked) and the cryostat hangs beneath it at 30° from horizontal.

4.7 Lowering the Cryostat

This procedure details lowering the cryostat to its cart. This operation is considered a pre-engineered, production lift and requires Incidental Overhead Crane Operator certification on the crane to be used. It assumes the cryostat is hanging beneath the lifting arm at 30° from horizontal as at the end of Procedure 4.4 or Procedure 4.6.

1. Inspect the transfer cryostat cart to make sure the cradle is clear and the cart casters are in working order.

2. Check the clearances and remove any obstructions that could interfere with the motion of the cart or the swing of the lifting arm during the procedure. Reposition the cart if necessary.

3. Slowly lower the cryostat to within 2 to 6 cm of the cart. Adjust the lifting point so that the bottom end of the cryostat rests against its stop on the cart.

4. Slowly lower the top end of the cryostat onto the cart. Continue lowering until the lifting arm rests on its support.

5. Unhook the crane and secure it from hoisting operations.

6. Return the key to the NSLS control room.

4.8 Attaching to the Production Cryostat

This procedure describes positioning the transfer cryostat on the production cryostat or other vertical cryostat in preparation for inserting or removing a target. This operation is considered a pre-engineered, production lift and requires Incidental Overhead Crane Operator certification on the crane to be used. It assumes the transfer cryostat is cold and on its cart ready to be lifted (see Procedure 4.2).

1. Ensure the production cryostat is positioned so that a clear path to the ISO-NW 63 flange on the gate valve exists and requires motion of the crane in only one direction (either trolley or bridge).

2. Perform Transfer Cryostat Procedures 4.4 and 4.5 to lift the cryostat and rotate it to vertical.

3. Position the crane so that the two cryostats are near each other and on the line of the clear path.

4. Raise the transfer cryostat to a height such that the ISO-NW 63 flange on the vacuum lock on the bottom of the transfer cryostat is 2 to 4 cm higher than the top flange of the gate valve atop the storage cryostat. Note that the controls on the crane are too crude to allow vertical adjustments while the transfer cryostat is over the production cryostat.

5. Move the transfer cryostat into position over the production cryostat with the crane. De-energize (Lock-Out) the crane.

6. Insert an ISO-NW 63 centering ring and O-ring between the two flanges then gently (approximately 0.4 kilogram/cm or 2 lbs/in is required) pull down on the transfer cryostat to shift the balance of the lifting arm and close the gap. Secure the flange with 4 half-claw clamps and screws.

7. Attach a pumping station to the vacuum lock. Evacuate the vacuum lock to better than 8×10^{-6} torr. Valve off the pumping station.

8. Open the gate valves on both cryostats.

The cryostats are now ready for Procedure 4.12 or 4.13.

4.9 Detaching from the Production Cryostat

This procedure describes separating the transfer cryostat from the production dewar or other vertical cryostat. This operation is considered a pre-engineered, production lift and requires Incidental Overhead Crane Operator certification on the crane to be used. It assumes the transfer cryostat is cold and is hanging vertically on the crane attached to the production cryostat (see Procedure 4.8).

1. Check that the winch controling the LHe reservoir and the LN2 reservoir is in its fully withdrawn position.

2. Close the gate valves on the both cryostats.

3. Vent the vacuum lock. Remove the 4 half-claw clamps closing the ISO-NW63 flange and guide the transfer cryostat as it rises to its balance position. Remove the centering ring and O-ring.

4. Re-energize the crane.

5. Trolley or bridge the crane so that the transfer cryostat is no longer over the storage cryostat. Lower the transfer cryostat to within 30 cm of the floor.

6. Return the transfer cryostat to its cart with Procedure 4.7.

4.10 Attaching to the InBeam Cryostat

This procedure describes positioning the transfer cryostat on its supports upstream of the inbeam cryostat in preparation for inserting or removing a target. This operation is considered a pre-engineered, production lift and requires Incidental Overhead Crane Operator certification on the crane to be used. It assumes the transfer cryostat is cold and is ready to be lifted from its cart (see Procedure 4.2).

1. Prepare the supports for receipt of the transfer cryostat by clamping the stop on the downstream support in the retract position.

2. Consult the inbeam cryostat manual for the procedures for readying and positioning the inbeam cryostat for target insertion or removal. If it is necessary to preserve target polarization, activate the inbeam main solenoid.

3. Perform Procedure 4.4 on the beam line crane. Position the transfer cryostat to be several centimeters above its cart and at 30° as viewed from the side. Slowly raise the cryostat so that the bottom end of the LN2 section is 10 cm higher than the lower, downstream support and the top end is more than 10 cm higher than the upstream support.

4. Rotate the cryostat in a horizontal plane to place the top above the upstream support and the bottom over the downstream one.

5. Trolley the crane as necessary to position the bottom end so that it will engage the stop on the downstream support when lowered.

6. Slowly lower the transfer cryostat onto the downstream support, making sure the stop on the downstream support properly engages the bottom of the cryostat.

7. Move the lifting point away from the upstream support, reducing the side angle, and lowering the upper end onto the upstream support. Insure the plate attaching the transfer cryostat to the lifting arm lies between the guides on the upstream support so as to properly align the cryostat on the supports.

8. De-energize (Lock-Out) the crane.

9. Insert an ISO-NW 63 centering ring and O-ring between the two flanges. Unclamp and then, using the lever mechanism, gently lower the stop on the downstream support to slide the transfer cryostat down and close the gap. Secure the flange with 4 half-claw clamps and screws.
10. Attach a pumping station to the vacuum lock. Evacuate the vacuum lock to better than 8×10^{-6} torr. Valve off the pumping station.
11. Open the gate valves on both cryostats.

The cryostats are now ready for Procedure 4.12 or 4.13.

4.11 Detaching from the InBeam Cryostat

This procedure describes separating the transfer cryostat from the inbeam cryostat and lifting it off the supports upstream of the inbeam cryostat. This operation is considered a pre-engineered, production lift and requires Incidental Overhead Crane Operator certification on the crane to be used. It assumes the transfer cryostat is cold, attached to the beamline crane in the 30° attitude, resting on the supports upstream from the inbeam cryostat and attached to that cryostat (see Procedure 4.10).

1. Check that the winch controling the LHe reservoir and the LN2 reservoir is in its fully withdrawn position.
2. Close the gate valves on both cryostats.
3. Vent the vacuum lock. Remove the 4 half-claw clamps closing the ISO-NW63 flange. Move the stop on the lower support to the retract position to slide the transfer cryostat up and separate the two cryostats. Clamp the stop. Remove the centering ring and O-ring.
4. Re-energize the crane.
5. Hoist the transfer cryostat off the supports.
6. Rotate the lifting arm and cryostat counterclockwise in the horizontal plane.
7. Lower the cryostat to within 30 cm of the floor.
8. Return the transfer cryostat to its cart with Procedure 4.7.

4.12 Retrieving a Target

This procedure describes transferring a target from an external cryostat into the transfer cryostat. Although this procedure does not require any hoisting itself, it does require that a crane be in operation and as such this operation is considered a pre-engineered, production lift and requires Incidental Overhead Crane Operator certification on the crane in use. This procedure requires that the transfer cryostat be attached to either the production cryostat (or similar vertical cryostat, see Procedure 4.8) or the inbeam cryostat (see Procedure 4.10) and not contain a target.

1. Check the cryogen levels in the transfer cryostat and confirm that the gate valves on both cryostats are fully open.

2. If attached to the dilution refrigerator, open its radiation baffle.

3. Slowly un-wind the winch, compressing the bellows and extending the LN2 reservoir into the other cryostat. Look for the touch of the shutter on the shutter opener (the position is marked on the side rail). The tension on the cable will be drastically reduced as the majority of the vacuum force is taken up by the shutter opener. It is essential that the position be positively identified in order to confirm that the shutter is fully open and no damage will result from passing the LHe reservoir through it.

4. If attached to the inbeam cryostat, open its radiation baffle.

5. Loosen but do not remove the locking clamp on the LHe reservoir. Start the pump on the intermediate volume between the double O-rings of the sliding seal.

6. Continue to unwind the winch and slowly insert the LHe reservoir into the vacuum space. (The operation is more controlling the sucking in of the tube by the vacuum.) Feel for the touch of the left-handed threads on the target (the position is marked on the backbone rail).

7. Slowly rotate the LHe reservoir clockwise. Feel for the slight drop (1 mm) of the reservoir when the threads align. It is essential that this be positively identified so as to avoid crossthreading the delicate copper threads.

8. Rotate the reservoir counterclockwise to screw the left-handed thread of the transfer cryostat into the target base. The reservoir should continue to descend 1 mm per turn. After 4 turns, the reservoir should be felt to bottom out.

9. A significantly stronger torque must now be applied to release the target from its old home and firmly attach it to its new one.

10. Continue unscrewing the target and the reservoir will rise 1 mm per turn for 8 turns (the pitch of the left and right threads are identical, 1 mm per turn).

11. Continue turning and feel for the drop of the LHe reservoir when the threads re-align. Turn an additional half turn to insure the threads are free.

12. The LHe reservoir must now be slowly pulled from the vacuum with the winch. Note that the portion of the tube inside the vacuum will have been radiatively cooled by the LN2 reservoir. It is therefore essential to wear protective gloves and to direct a stream of warm air from a heat gun on the emerging tube.

13. After the LHe reservoir has been pulled out to its maximum, tighten the locking clamp and turn off the pump on the sliding seal.

14. If attached to the inbeam cryostat, close its radiation baffle.

15. Continue to wind up the winch to pull the LN2 reservoir back inside the transfer cryostat.

16. If attached to the dilution refrigerator, close its radiation baffle.

17. Continue pulling the LN2 reservoir out until the marked home position is reached.

4.13 Placing a Target

This procedure describes transferring a target into an external cryostat from the transfer cryostat. Although this procedure does not require any hoisting itself, it does require that a crane be in operation and as such this operation is considered a pre-engineered, production lift and requires Incidental Overhead Crane Operator certification on the crane in use. This procedure requires that the transfer cryostat be attached to either the production cryostat (or similar vertical cryostat, see Procedure 4.8) or the inbeam cryostat (see Procedure 4.10) and contain a target as a result of Procedure 4.12.

1. Check the cryogen levels in the transfer cryostat and confirm that the gate valves on both cryostats are fully open.

2. If attached to the dilution refrigerator, open its radiation baffle.

3. Slowly un-wind the winch, compressing the bellows and extending the LN2 reservoir into the other cryostat. Look for the touch of the shutter on the shutter opener (the position is marked on the side rail). The tension on the

cable will be drastically reduced as the majority of the vacuum force is taken up by the shutter opener. It is essential that the position be positively identified in order to confirm that the shutter is fully open and no damage will result from passing the LHe reservoir through it.

4. If attached to the inbeam cryostat, open its radiation baffle.

5. Loosen but do not remove the locking clamp on the LHe reservoir. Start the pump on the intermediate volume between the double O-rings of the sliding seal.

6. Continue to unwind the winch and slowly insert the LHe reservoir into the vacuum space. (The operation is more controlling the sucking in of the tube by the vacuum.) Feel for the touch of the right-handed outer threads of the target on the target holder (the position is marked on the backbone rail).

7. Slowly rotate the LHe reservoir counterclockwise. Feel for the slight drop (1 mm) of the tube when the threads align. It is essential that this be positively identified so as to avoid crossthreading the delicate copper threads.

8. Rotate the LHe reservoir clockwise to screw the right handed outer thread of the target into the target holder. The reservoir should continue to descend, 1 mm per turn. After 8 turns, the tube should be felt to bottom out.

9. A significantly stronger torque must now be applied to release the target from its old home and firmly attach it to its new one.

10. Continue screwing in the target (actually unscrewing the left handed thread on the LHe reservoir) and the reservoir will rise for 4 turns, 1 mm per turn).

11. Continue turning and feel for the drop of the reservoir when the threads re-align. Turn an additional half turn to insure the threads are free.

12. The LHe reservoir must now be slowly pulled from the vacuum. Note that the portion of the reservoir inside the vacuum will have been radiatively cooled by the LN2 reservoir. It is therefore essential to wear protective gloves and to direct a stream of warm air from a heat gun on the emerging tube.

13. After the LHe reservoir has been pulled out to its maximum, tighten the locking clamp and turn off the pump on the sliding seal.

14. If attached to the inbeam cryostat, close its radiation baffle.

15. Continue to wind up the winch to pull the LN2 reservoir back inside the transfer cryostat.
16. If attached to the dilution refrigerator, close its radiation baffle.
17. Continue pulling the LN2 reservoir out until the marked home position is reached.

Lessard, Edward T

From: Sandorfi, Andrew
Sent: Thursday, October 21, 2004 5:09 PM
To: Travis, Richard J; Lessard, Edward T
Cc: Muller, Thomas R; Mike Lowry (E-mail)
Subject: Re: Sections 1.1.4, 1.2.2.4 and 1.2.2.5 of TC review

LS-MAG-Aug04-1.xls (43 KB)

Dear Rich and Ed,
I would like to tie up a few loose ends, regarding sections 1.1.4, 1.2.2.4 and 1.2.2.5 of the TC LES&H review document (minutes of meeting 04-07, Aug
17'04):
1.1.4: The magnetic field survey was done and is attached. I think this was forwarded to the committee some time ago. This was done warm. We have made measurements comparing the on-axis field warm and cold. These values change by less than 10% when cold. The exterior fields will scale with the field on axis and so we can say with confidence that they are less than 10% more than the warm survey.
1.2.2.4: Mike Lowry and Tom Muller are working on the lifting safety form in preparation for a review by the lifting committee.
1.2.2.5: Dry runs were successfully carried out mating the Transfer Cryostat to both the Production Dewar and to the In-Beam Cryostat. These were carried out first warm and then cold. The entire process was verified by successfully transferring a solid unpolarized H2 target from the Production Dewar to the In-Beam Cryostat where it is now being used to collect calibration data. Andy Sandorfi

BROOKHAVEN NATIONAL LABORATORY
DIRECT READING INSTRUMENT SURVEY FORM

Date: 8/26/2004 Surveyor(s): R. Zantopp

I. AREA INFORMATION

Dept. : NSLS Bldg. : 725 Room: 1-168
Source: Transfer cryostat
Engineering Controls: None

II. EMPLOYEE INFORMATION

Name : N/A BNL / GUEST # : N/A
Dept. : N/A Bldg. : N/A Job Title : N/A
Exposure Duration (Hrs) : N/A Times Per Day : N/A Times Per Year : N/A
Job / Task Performed : N/A
PPE Used : N/A

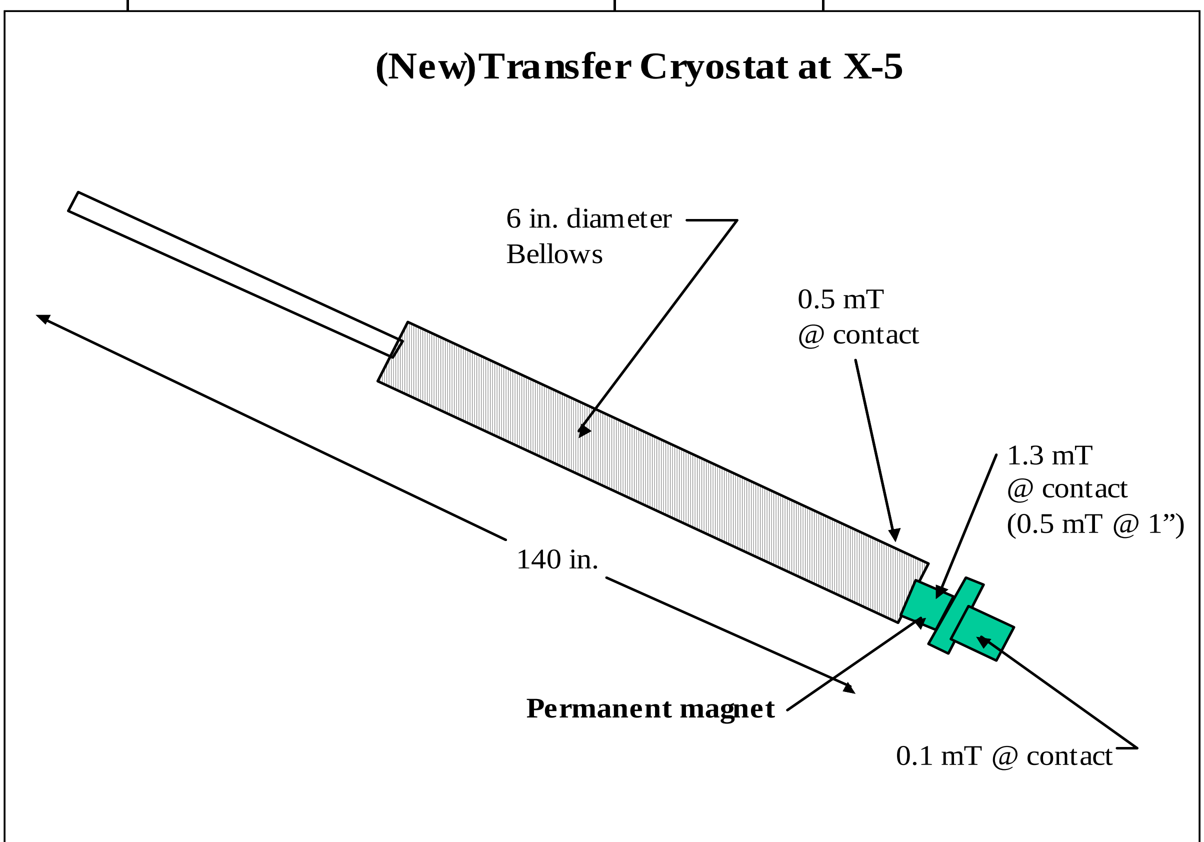
III. SURVEY INSTRUMENT INFORMATION

Instrument: Metrolab Cal Date : 1/29/2004 Calibrator : N/A
Model : THM 7025 ☐ Pre-Cal No Comment :
Serial # : TH-BO 331 ☐ Post-Cal No Comment :

IV. SAMPLING INFORMATION AND RESULTS

Hazard : Magnetic Field Units : mTesla Correction Factor : None

Time	Location	Reading	Comments
9:45	See map below	See map below	



V. Conclusion and Recommendation