

Memorandum

date: October 23, 2003
to: E. Lessard; Chair, LESHC
from: Congwu Du, Micro-MRI Facility
subject: Summary of Responses to Safety Committee Comments

We thank the Committee for walking through the animal MRI facility on Sept 16, 2003, and giving us several valuable suggestions. We have carefully reviewed the questions the Committee raised during the walk-through, and our response is summarized below. We have also provided a summary of the actions and responses to recommendations made by the Committee as documented in the minutes of the August 25, 2003 meeting.

- 1. A cool-down, energize, shim and LOTO plan and schedule shall be written to cover the activities of J. Briske and any staff member he trains during his work time at BNL.***
The procedure for magnet installation includes pre-cooling the magnet using liquid nitrogen (LN₂), flushing the helium reservoir, cooling the magnet using liquid helium (LHe), energizing and superconducting shimming. Each procedure has been provided to the Committee and approved individually.
- 2. ODH calculations shall be documented and submitted to the LESHC. The calculations shall be applicable to LN and LHe in the magnet room, and shall be relevant to filling and topping operations. The calculations need to address the magnet room and the hallway location where dewars are temporarily stored.*** BNL Safety and Health staff has conducted the ODH analysis for the nitrogen filling operation. Based on their recommendation, the room will be considered an ODH 2 level during the fill operation. An ODH analysis for normal operation has also been submitted to the committee. This analysis which assumes proper operation of the ventilation system classifies the magnet room as an ODH 0 space. This item will be independently reviewed and discussed further with the Committee.
- 3. Written procedures shall be written to assure that required ODH controls for normal and emergency conditions are in place. Procedures shall address access to the magnet room and adjacent rooms during the filling, energizing and topping tasks. Procedures shall address the keypad access for entrants into the magnet room, and key access into the magnet room. Procedures shall address ventilation requirements during filling, and when the magnet is cold. Procedures shall address response by the Animal MRI staff if the ventilation or ODH alarm system fails while the magnet is cold. Procedures shall address J. Briske's actions and staff actions should the magnet quench when the magnet is energized during acceptance testing. Procedures shall address required ODH controls and posting during filling operations, topping operations and whenever the magnet is cold. If the ODH calculations warrant, then a safety watch, escape packs***

and other pertinent ODH controls shall be addressed in the procedures. The written procedures for magnet installation have been provided by the Life Sciences Associate Laboratory Director, and approved by the Committee and Laboratory Management on September 17-26, 2003. All safety concerns regarding the installation, training, postings, access control, ventilation and protective equipment to be used during these procedures have been addressed in these written procedures. The emergency response has been included in these procedures as well.

Regarding the quench issue, if a quench occurs, all personnel who are working in the facility (including the Installation Engineer, Jim Briske) shall vacate the space immediately either to the hallway or by exiting the building. The exit door to the building 490 loading dock will be opened from outside to facilitate venting of the helium exhaust in the console room, where the O2 monitoring equipment (Bacarach Sentinal 44 O2, LEL Toxic) sensing O2 level in the magnet room (9-430C) is located. This allows authorized personnel to judge the safety for re-entering the magnet room according to the measurement. The procedure also requires a Health and Safety person to verify the oxygen levels prior to reentry by the research staff.

4. ***The fire run card for the Animal MRI suite shall be updated.*** This has been completed.
5. ***The fire alarm systems in the magnet room and power supply room shall be operable when the magnet is energized.*** They were operable when the magnet was energized.
6. ***ODH monitoring equipment in the magnet room must be tested and maintained operable while the magnet is cold.*** ODH monitoring equipment in the magnet room (Bacarach Sentinal 44 O2, LEL Toxic) has been calibrated and tested on Sept. 17, 2003. It has been working since then.
7. ***The electrical system used to energize the magnet must be reviewed and approved by T. Monahan.*** The electronic system used to energize the magnet is a Xantrex product. It has been tested and calibrated by the manufacturer on March 31, 2001. Magnex Scientific also has checked it before shipping it to the site. Both the certification of calibration and quality from Xantrex and the test sheet from Magnex Scientific are attached in Appendix 1. In addition, the Magnex Installation Engineer, Jim Briske double checked and calibrated the system according to the operating manual (attached in Appendix 2). T. Monahan inspected the electrical system before it was used to energize the magnet.
8. ***A procedure shall be written to perform a sweep of the magnet room for loose ferrous objects prior to energizing the magnet. The procedure shall address how the Animal MRI staff prevents entrants from bringing ferrous objects into the room when a magnetic field is present. The procedure shall include a requirement to perform magnetic field measurements during the time the magnet is energized. The procedure shall address control of whole-body and extremity magnetic field exposures of J. Briske and any trainees when the magnet is powered.*** The sweep of the magnet room for loose

ferrous objects has been performed before energizing the magnet. Also, postings have been used since energizing the magnet to warn persons with pacemakers, medical implants and loose ferrous metal objects.

Regarding the issue of the magnetic field exposures to the personnel after the magnet is energized. Jim Briske will be the only person exposed to the high field (about 8T in the back of the magnet) when he shims the system. The total cumulative exposure time is expected to be less than 20 hours. No trainees will be involved in this installation procedure. Following acceptance testing, the tenets of the Static Magnetic Field subject area will be followed for personnel safety and monitoring, including any periodic medical surveillance.

9. ***All procedures shall be reviewed and approved by the Medical Department. All personnel affected by the procedures shall be trained and their training records shall be maintained ready for audit.*** Presently the trained authorized personnel have been limited to Drs Du, Benveniste and Rooney, Bob Colichio, and Chris Harris who have been instructed to perform the top off cryogenic procedures. The procedure for cryogenic maintenance has been approved by the Medical Department and the Safety Committee.
10. ***Personnel who top off the magnet with LN and LHe after J. Briske leaves must be trained by J. Briske. Training documentation must define clearly what the trainee is allowed to do during the training. A procedure shall be written and it shall delineate precautions, PPE and the many steps necessary to perform the topping tasks. This procedure shall be reviewed and signed by T. Monahan in addition to being reviewed and approved by the Medical Department Chair.*** J. Briske has instructed the staff members, Drs. Congwu Du, William Rooney and Helene Benveniste in the correct procedure for topping off the cryogenes. The maintenance refill or “top off” procedure has been documented and approved.
11. ***J. Briske shall have all required BNL training, or acceptable equivalent, for the work he will perform at BNL.*** He passed the safety courses such as Cryogen web course.
12. ***W. Gunther shall explore and report on venting LN and LHe boil off into the helium quench pipe rather than the magnet room.*** As the boil-off rates for both of LHe and LN are designed to be very low (80cc/hour and 0.5 liter/hour, respectively) compared to the room ventilation rate, it is not considered a significant safety issue. However, Bruker provides this as a customer option so a work order has been submitted to Plant Engineering to have a fitting installed for this purpose. We expect the work to be completed in November 2003.

Comments and Questions as documented in the minutes of meeting 03-06 on August 25, 2003:

1. ***ODH Calculations need to be documented and submitted.*** ODH analyses are being rechecked by a Safety and Health representative. This will be provided to the Committee for comment.
2. ***Written procedures are needed to assure that required ODH controls are in place.*** Written procedures have been completed and approved by the Medical Department safety and management personnel. Additional procedures are planned to support normal operation of the facility and would include items such as forms for the daily instrument readings and facility specific training requirements, among others.
3. ***ODH Equipment must be tested and maintained.*** The oxygen monitoring and alarm equipment have been placed on a semi-annual calibration cycle. The ES&H Manager for Life Sciences is the owner of this procedure and process.
4. ***More information is needed on the BNL installed portion of the electrical and cryogenic systems.*** As part of the installation process, the supplier of the equipment (Bruker Biospin) will approve the entire installation. Plant Engineering worked very closely with Bruker during the design and construction activities associated with the facility so we do not anticipate any major changes.
5. ***A review of the vent piping needs to be completed.*** Plant Engineering used the specifications provided by Bruker to design and install the quench vent pipe system. As far as the quench vent sizing goes, Bruker's Specification T3N-1562 for the quench vent states in section C.2.c : "For a quench pipe possessing a total length shorter than 12 meters (39.37 feet) a tube with a cross-section of 15 cm (6 inches) is required. With these dimensions three 90 degree bends are possible. Other versions must be examined and approved by Bruker. The outlet construction must make it impossible for animals, birds, insects & snow to enter." What was installed was: 7.1 meters (23'-4"), plus three 90-degree elbows. Pipe has a cross-section of 15 cm (6"). The quench pipe is constructed of Schedule 10 - Type 304 Stainless Steel. All joints are welded. We will install an insect screen at the discharge end of the quench pipe. Prior to installation, John Coccoresse of Plant Engineering spoke with Jim Beier (National Service Manager for Bruker) to verify that our design was acceptable. John received a positive response from Jim.
6. ***A sub-committee will walk down the installation.*** Several members of the cryogenic subcommittee had a briefing and tour from Jim Briske, the Magnex Scientific field representative. Further tours and briefings will be arranged as requested by the Safety Committee.
7. ***The Cryo subcommittee needs more information on the design of the quench piping to ensure that it meets BNL expectations and satisfies manufacturer's recommendations.*** This is similar to item 5 above. Additional information will be solicited from Bruker if needed.

8. ***More information is needed on how the whole-body and extremity magnetic field exposures will be controlled. Procedures should document these requirements.*** A central component of the Small Animal MRI Instrument is a 9.4 T magnet manufactured by Magnex Scientific, Inc. This magnet is actively shielded which eases siting requirements because the spatial extent of the fringe magnetic field is greatly reduced. In fact, at BNL the 5 G field does not extend beyond the room that houses the 9.4 T magnet. Based on field plots supplied by the manufacturer it is expected that standard use of the 9.4 T Small Animal MRI instrument will result in worker whole-body static magnet field exposures of less than 600 G, and limb exposures less than 6000 G. Typically, workers will experience the greatest exposure when they are inserting, or removing an animal from the magnet. This exposure is expected to be brief, likely less than 60 minutes during a full day of experiments. The majority of the time workers will be in locations where magnetic fields are below 5 G. Therefore, it is expected that the time-weighted average will be far below BNL limits tabulated in the Static Magnetic Field Subject Area. It is possible that a worker could experience a limb exposure exceeding 5 T (a BNL ceiling limit for limb exposure); for example, if he or she were to reach a hand into the magnet bore. This is unlikely to be required during standard experimental procedures, but may be required during certain maintenance operations. In accordance with SBMS Static Magnetic Field Subject Area all users will be required to take Web-based Static Magnetic Field training, and high-magnetic field areas will be properly posted. Individuals that experience magnetic field exposures that exceed BNL time-weighted average or ceiling limits will document their exposure in a log book (that includes exposure date, individual's name, duration of exposure, and estimated field strength). This logbook will be maintained at the console of the Small Animal MRI Instrument. Following the activation of the magnet, measurements of the magnetic field will be made to verify the calculations and to mark the floor of the room with the actual distribution.
9. ***Noise measurements need to be conducted by SHSD to assure a proper hearing protection program and postings. A review of the RF system (400MHz, up to 1 Kw) needs to be conducted to assure that RF exposures are within those allowed by BNL SBMS. Procedures need to specify if controls are needed to prevent overexposure to RF.*** These measurements will be taken once the installation is completed.
10. ***Training of Users who conduct "hands on" experiments needs to be documented.*** Facility specific training will be defined and required prior to allowing access to outside users.
11. ***Assurance is required to show that adequate instrumentation is available to allow monitoring of critical parameters of the MRI facility.*** Flow instrumentation to better monitor boil off rates has been ordered and will be installed prior to final commissioning. Safety related instrumentation (oxygen readout unit) has been installed and verified to be operable and in calibration. Training that remains to be conducted by Bruker may identify other instrumentation that would be desirable to monitor and log regularly.

12. ***Written procedures that incorporate manufacturer's generic maintenance and operations instructions into BNL specific procedure steps need to be written.*** The maintenance procedure has been written and approved.
13. ***Specific frequencies for maintenance and testing of all sub-systems need to be established.*** The frequencies for nitrogen and helium fills are dictated by the amount of boil-off that occurs. The calibration of other instrumentation will be as stipulated by the manufacturer or as recommended by Bruker.
14. ***The MRI manufacturer should have all required BNL training, or acceptable equivalent, for the work that will be performed by them at BNL.*** The service representatives that have been provided thus far by Magnex and Bruker have been experienced personnel who have significant training in their areas. This has been supplemented by BNL Training (contractor and/or cryogen safety training). In addition, we have maintained a presence of authorized BNL people while the service personnel are performing any work within the magnet room.

C:

H. Benveniste
W. Gunther



Memo

Date: November 28, 2003
To: W. Gunther
From: R. Karol
Subject: Medical Department Animal MRI ODH Calculations

Purpose

As requested by the LESH, I have completed calculations to determine the proper Oxygen Deficiency Hazard (ODH) Classifications of the Building 490 Animal MRI Room using the guidance from the BNL SBMS Subject Area, [Oxygen Deficiency Hazards, System Classifications and Controls](#).

Conclusions

The following operating states were examined to determine the appropriate ODH classifications:

Normal Operations – small venting of nitrogen and helium occurs into the MRI room, which is well ventilated and monitored for oxygen content. Routine room entries occur (many per hour) to conduct experiments.

Quenching Event – releases large amounts of helium from the magnet via an emergency discharge pipe that is vented directly to the roof of Building 490. Quenches can be initiated automatically to protect the super-conducting magnet or manually to protect personnel.

Powered Cryogenic Magnet-can Failure – this assumes that the magnet-can ruptures, releasing helium or nitrogen into the MRI room.

Routine Top-off Operations – about every week for LN₂ and every month for LHe.

Initial filling operations – this is already completed for the installed magnet but may occur periodically following magnet system repairs.

The calculations documented in the next section show the ODH classifications for each operating mode. The results are summarized in Table 1, Animal MRI ODH Classification Summary.

It is recommended that the facility be posted ODH 0 when it contains LHe and/or LN₂ and ODH 1 when performing initial filling or routine top-offs.

Details of Calculations

A walkthrough of the MRI area was conducted on November 24, 2003 with E. Lessard, R. Colichio and C. Harris. The room has a free volume of ~2835 ft³ (2890 ft³ room minus 54 ft³ magnet). The exhaust flow rate is 1000 CFM (fan EF2), with all intake fresh air. Volumes other than the MRI room are

conservatively ignored, including the opening above the magnet used for rigging the magnet into and out of the room.

1. Normal Operations

The attached figure shows the normal venting flow rates of nitrogen and helium (Venting Arrangement 9.4T210AS, P&I Diagram dated 30-July-2003). Converting routine boil-off to gas volume rates at 300 K room temperature, results in 0.06 CFM helium gas and 0.24 CFM nitrogen gas inputs into the room, which is a total of 0.3 CFM of inert gas. This is obviously so small that the room's oxygen concentration will never fall below 21% with EF2 operating. In fact it would take over 6 days for the room to fall to 19.5% oxygen if the fan were off and it was assumed that no fresh air were to enter the room. Thus for normal operations, no ODH classification is required.

2. Quenching Event

Quenching events can occur to protect the magnet or can be manually initiated to quickly reduce the magnet field for personnel protection. A quench can also be initiated by placing a warm bayonet into the system during top-off operations, which is considered separately in Section 3. The released helium gas passes through a burst disk, a flexible connection held in place with hose clamps and a stainless steel pipe that vents the gas directly to outside the room to the roof. A quench event is safe with respect to ODH unless the quench discharge line pressure boundary fails, allowing helium to enter the MRI room.

The attached figure shows the quench venting flow rate for helium (Venting Arrangement 9.4T210AS, P&I Diagram dated 30-July-2003). The figure shows that 2894 kg/hr of helium are released during a quench event. Converting this to helium gas at 300K results in an enormous spill rate of 10,464 CFM. This far exceeds the exhaust fan flow rate of 1000 CFM. The total volume of LHe in the magnet is 1050 L (37.1 ft³). Using the expansion factor of LHe (4.2K) to GHe (300K room temperature) of 768 results in a total volume of 28,493 ft³ GHe. Thus the room's oxygen concentration would rapidly fall to 0% if the quench vent pipe failed.

The remainder of this calculation thus needs to determine the probability of a quench simultaneously with a quench vent line pressure boundary failure. A quench is judged to occur once every five years (2×10^{-5} /hr). The vent line is 6" diameter stainless steel pipe in four-sections that is connected to the magnet burst disk by a flexible line held on with hose clamps. The failure of the stainless steel line is 4×10^{-10} /hr (four sections of pipe > 3" diameter). The flex line and hose clamps failure rate is determined by using engineering judgment because no value for this configuration is given in the BNL ODH Subject Area. A similar arrangement was used at the HFBR for fuel discharging operations to allow air-cooling of spent fuel elements. This arrangement was used at two locations for over 30 years without failure. There were about 300 refueling operations at the HFBR with the two flex-line vents attached for about 8 hours per discharging operation. Thus a very conservative failure rate would be 2×10^{-4} /hr. Given the fact that a magnet quench would cause a rapid pressurization of the vent pipe, the failure rate of the flexible portion of the vent pipe is increased by a factor of twenty to a rate of 4×10^{-3} /demand. Thus the flex line failure dominates the quench line pressure boundary failure rate.

The probability of a quench (2×10^{-5} /hr) simultaneously with a flex line failure (4×10^{-3} per demand) is 8×10^{-8} /hr. Note that any personnel actions to escape the room when the quench event began were conservatively ignored in this estimate.

Thus a quench event results in a required MRI room posting of ODH 0 because the fatality factor (1) times the frequency of the event (8×10^{-8} /hr) results in a fatality rate that is $<10^{-7}$ /hr.

3. Powered Cryogenic Magnet-Can Failure

This simple scenario assumes that the magnet-can pressure boundary fails, releasing a large volume of LHe in a short interval. The SBMS value for pressure boundary failures of powered cryogenic magnets is

2×10^{-7} /hr. This failure rate applies to a pressurized magnet such as those at RHIC (~4 to 15 atm). Because the MRI magnet has a much lower pressure, the failure rate was reduced by a factor of four, using engineering judgment, to a value of 5×10^{-8} /hr.

Thus a magnet-can failure results in a required MRI room posting of ODH 0 because the fatality factor (1) times the frequency of the event (5×10^{-8} /hr) results in a fatality rate that is $<10^{-7}$ /hr.

4. Routine Top-Off Operations

Routine top-off operations occur by using dewars to top-off the LHe and LN₂ in the magnet can. Two things can cause a helium or nitrogen release: 1) adding a warm bayonet to the system causing release of helium or nitrogen into the room, 2) a quench can occur if too much heat is added by the bayonet.

The SBMS value of 1×10^{-3} per demand is used for a large event caused by improper bayonet operations.

If the quench event were to follow this excessive heating by the bayonet, the probability of a release of helium into the room via a failed quench exhaust line would be $(1 \times 10^{-3} \text{ per demand})(4 \times 10^{-3}/\text{demand})^1$ or $4 \times 10^{-6}/\text{demand}$. The rate of helium release would be so high that the fatality factor would be 1. Conservatively ignoring any emergency actions by the person in the room (i.e., removal of the bayonet or escape from the room), the fatality factor would be equal to $4 \times 10^{-6}/\text{demand}$. This value is between 10^{-5} and 10^{-7} , thus an ODH classification of 1 is needed during routine filling operations.

Improper bayonet usage that causes excessive boil-off of LHe or LN₂, short of causing a magnet quench, is bounded by the above scenario.

5. Initial Fill Operations

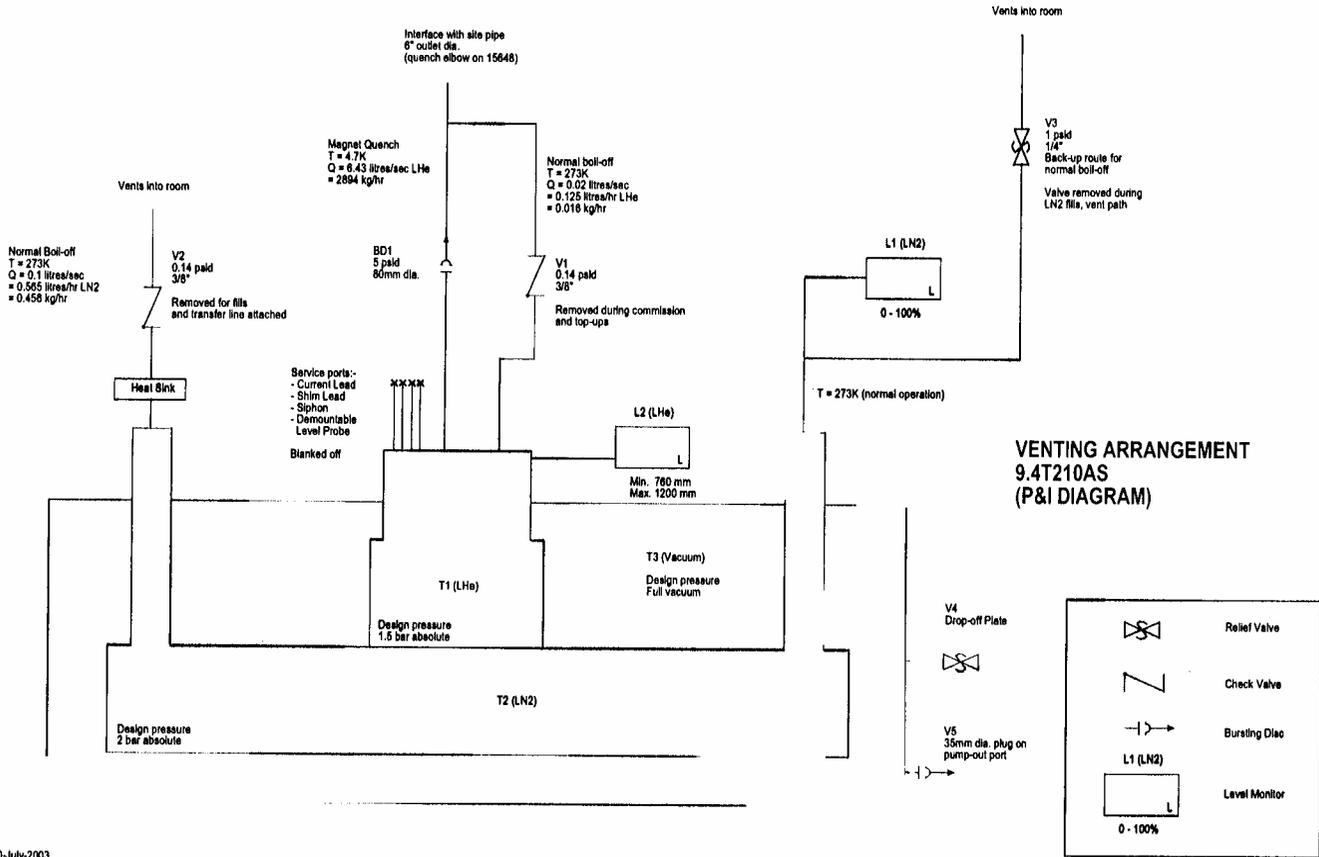
Initial fill operations have already taken place. Based upon review of the procedures and discussion with personnel who operate the facility, initial fill operations are no different than routine top-off operations (Section 4) with the exception that it takes a longer time to complete initial filling. In addition, initial filling cannot cause a magnet quench since the magnet is not energized. Thus, posting the area as ODH 1 during filling is judged to be conservative and provides more than adequate safety of operating personnel.

Cc: E. Lessard C. Du
R. Coilichio

¹ See Section 2, Quenching Event.

Table 1
Animal MRI ODH Classification Summary

Operating Mode	Maximum Spill Rate (SCFM)	Frequency	Fatality Factor	Fatality Rate	ODH Classification
Normal Operations	0.3	1	0	0	NA
Magnet Quenching Events	10,464 CFM	$8 \times 10^{-8}/\text{hr}$	1	$8 \times 10^{-8}/\text{hr}$	0
Powered Magnet Can Rupture	Very High	$5 \times 10^{-8}/\text{hr}$	1	$5 \times 10^{-8}/\text{hr}$	0
Routine Top-Off Operations	10,464 CFM	4×10^{-6}	1	4×10^{-6}	1
Initial Fill Operations	Low to High	$< 4 \times 10^{-6}$	1	$< 4 \times 10^{-6}$	1





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9.4 Tesla MRI, De-energizing and Warming-up Procedure

1. Purpose: This procedure includes the processes of de-energizing and warming-up of the super-conducting Animal MRI magnet to enable repair work to be performed on the magnet bore.
2. Prerequisites for de-energizing the magnet and subsequent boiling-off cryogens:
 - Postings
 - i. 9-430C shall be posted with the appropriate signage for Static Magnetic Fields and additional postings advising that the "Magnet is Always On" until the magnet is verified as completely de-energized.
 - ii. 9-430C shall be posted "Authorized personnel only".
 - Access control
 - i. The door to the Animal MRI Suite will be locked when unattended.
 - ii. During de-energizing and boiling-off work, the assigned Safety Watch will prevent access to the Animal MRI Suite by unauthorized personnel and will remain in the control room while people are in the magnet room in case of accidental quenching of the magnet.
 - iii. The roof hatch will be opened during the whole procedure.
 - Safety related equipment
 - i. The installed O2 Monitor shall be operational during the de-energizing/warming-up procedure.
 - ii. The Bacarach Sentinal 44 Monitor shall be used in the event of installed O2 system failure and only from remote location indication (outside room 9-430C).
 - iii. During the process of de-energizing any authorized personnel entering the Animal MRI Magnet Room (9-430-C), will utilize the EIA PD-140 Hand-Held Metal Detector to ensure that no metals are on their person.
 - iv. If metals are detected, the individual will utilize the 15lb. pull, 1000 Gauss Test Magnet to ensure the items they are carrying are non-magnetic.
 - Personal protective equipment (PPE)
 - i. As an additional precaution, the Installation Engineer will wear a personal (lapel), O2 monitor during the power supply set up and removal.

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- Electrical Safety Requirements
 - i. The magnet power supply will be connected to the magnet via cables and remain exterior to the room.
- Approvals
 - i. The Medical Department ESH Coordinator and the Principal Investigator/ Life Sciences ALD shall approve this procedure.

3. Initial De-energizing and warming-up Procedures:

- i. De-energizing the magnet. The procedure will follow the guideline of the de-energizing procedure, which has been previously approved.
- ii. Flushing the helium chambers with helium gas.
- iii. Pumping N₂ gas into the vacuum chamber through the N₂ chambers to speed up the process of evaporation.
- iv. Naturally boiling-off rest of the cryogen overnight.
- v. Repeating steps ii and iii if it is necessary.
- vi. Ensure that the magnet is sealed properly from atmosphere.

4. Emergency Response

- i. In the event of an accidental quench or O₂ alarm, all personnel shall remain outside the magnet room. Re-entry shall only be authorized by Facility Support and the Installation Engineer.
- ii. Safety Watch will be on hand during the initial hookup of the power supply to the magnet and subsequent removal of the power supply after de-energization.
- iii. All emergencies shall be reported by calling extension 2222 or 911.

5. Equipment required for de-energizing the magnet:

Bruker provides power supply and other instrument and tools.



Brookhaven National Laboratory
Medical Department
9.4 Tesla MRI, De-energizing and Warming-up Procedure

Prepared by:

Congwu Du, MO

Reviewed by:

Robert L. Colichio(ESH Manager, DJ)

Michel Corbeil, Installation Engineer

Approved by:

Acting Chairman of
Medical Department

William E Gunther,

LS-ALD,

Helene Benveniste

Memo

date: April 9, 2004

to: R. Colichio

from: R. Travis, *ORE* Chairman

subject: **Operational Readiness Evaluation (ORE) Report – Building 490, Micro MRI Facility, Full Operation**

As requested by the Medical Department (MO), an Operational Readiness Evaluation (ORE) of the Micro MRI Facility (Rooms 9-430A, B and C) was performed on Thursday, March 25, 2004. This facility was formerly called the Animal MRI. A Beneficial Operational Readiness Evaluation took place in the April 2003 timeframe. That evaluation focused on the renovations that were required to house the new machine and supporting activities. The BORE Report also provided a list of items to support the follow-on ORE. The Facility was also the subject of several LESHC Cryogenic Subcommittee Reviews (LESHC 03-06, 07 and 09). In addition to the final walk through of the operational configuration of the facility, the purpose of this ORE is to confirm the implementation of the issues cited in the BORE and LESHC reports with emphasis on the training and procedural requirements for the facility.

The ORE Committee consisted of: N. Bernholz, R. Colichio, L. Stiegler, S. Ferrone, J.W. Glenn and myself. In addition, J. Curtiss, A. Dilmanian, C. Du, J. Durnan, W. Gunther, C. Harris, P. Hayde and J. Searing also participated in the evaluation.

The attached table lists findings that need to be addressed. The issues from this evaluation have been categorized as: pre-start findings, post-start findings or committee recommendations. The pre-start findings shall be corrected or resolved by other mitigating action prior to receiving approval to operate. The post-start findings and committee recommendations should be corrected in a timely manner. Where appropriate, an action plan should be developed to assist in resolution of the findings. The Medical Department shall track all findings until completion.

RT/lq/SE53SR04

Attachment

cc: ORE Com., Attendees, D. Adika, M. Bebon, M. Beckman, H. Benveniste, J. Bond (BAO), N. Contos, A. Costantini, J. DiNicola, J. Ellerkamp, J. Eng (BAO), A. Epple, P. Eterno, D. Hensley, L. Hinchliffe (BAO), S. Hoey, F. Horn, C. Johnson, C. Jung, H. Kahnhauser, R. Lee, E. Lessard, J. Levesque, J. Peters, R. Petricek, J. Remien, D. Robertson, B. Royce, D. Ryan, J. Searing, J. Selva, R. Selvey, T. Sperry, G. Shepherd, J. Tarpinian, S. Waski, J. Williams, A. Wessen, P. Yerry

OPERATIONAL READINESS EVALUATION

(BUILDING 490, MICRO MRI FACILITY, FULL OPERATION)

(March 25, 2004)

The following Pre-Start Findings need to be corrected or resolved by the responsible party in a timely manner. All findings shall be tracked by the Medical Department until completion.

No.	Pre-Start Findings	Responsible Party
1.	Review the Facility Authorization Basis Program Description (https://sbms.bnl.gov/program/pd08/pd08d011.htm) and contact the Facility Hazard Categorization SME (Gerry Shepherd) for assistance in implementing the Program Requirements. (A hazard category review is required to complete the ORE Approval Document.)	Medical Department (MO) – Complete ¹
2.	Thirty-five action items were generated during the course of two Laboratory Environmental, Safety and Health Committee meetings (LESHC 03-06 and 07) that were held to review this facility. In response to a request at a subsequent meeting (LESHC 03-09), MO provided the status of these actions (Reference 1). Although the majority of the findings have been addressed, several items, including finalizing the normal and emergency procedures and personnel training, are in process. Please provide a current status of the 35 action items to the LESHC Chairman and Secretary (Ed Lessard and Rich Travis, respectively). Kindly include supporting documentation such as training records and approved procedures for LESHC review. Note: this ORE finding is complete when the LESHC accepts the responses to their action items.	MO
3.	The National Electric Code (392.2, .3) does not permit the use of a cable tray for both electrical and non-electrical applications. Any systems that are not carrying current, i.e. gas or water lines, must be removed from the tray (These systems may be placed in the remaining tray of the two-tray installation.) Further, all wiring bundled together must be rated at the maximum voltage carried by any of the conductors in the bundle. Accordingly, signal cables are likely to require separation from power cables. (They can be tied at opposite sides of the same tray.) Please contact the Laboratory Electrical Safety Officer (Joe Curtiss) for additional guidance.	MO

4.	<p>With the recent OSHA inspection, there is a heightened awareness of the requirement (OSHA 1910.303(g), NEC 110.26(A)) to maintain unobstructed access to electrical equipment. Please ensure the required clear areas are provided for any electrical equipment <u>likely to require examination, adjustment, servicing, or maintenance while energized (exposing the worker to more than 50 volts ac or dc)</u>, i.e., 36 inches in front and the width of the equipment (or 30 inches minimum for panels, disconnect switches and rack doors). This footprint must be kept clear from grade to 6-1/2 feet above grade. The Committee noted the following violations of this requirement:</p> <ul style="list-style-type: none"> • The main disconnect switch for the MRI equipment does not have the required clearance. • A gas cylinder is being stored within the clearance space of a circuit breaker panel and must be relocated. <p>In addition, depending on the potential worker exposure (See the underlined text immediately above.), the following potential violations require review and possibly correction:</p> <ul style="list-style-type: none"> • Boxes are stored on the floor within the clearance space of the doors of the center rack. This material must be removed, to allow the doors of the equipment racks to be fully opened. • The front and rear doors of the racks in the center of the equipment room do not have the required clearance. <p>As a recommendation, consider marking the required area on the floor to help ensure that this clearance is maintained.</p>	MO
5.	When the compressed gas cylinder is relocated (See Finding 4 above.), please ensure it is properly secured.	MO -Complete ¹
6.	Industrial Hygiene performed a survey of the magnetic field strength of the Micro MRI on 3/25/04 Please permanently mark the 5 gauss line on the floor of the MRI room and where it extends (slightly) into Room 9-436. (See also Prestart 7.)	MO – Complete ¹
7.	Please complete the remaining requirements of the Static Magnetic Fields Subject Area, https://sbms.bnl.gov/standard/1u/1u00t011.htm including the submittal of the completed Static Magnetic Fields Exposure Form to the SME (Nicole Bernholz) and the posting in Room 9-436. (See also Prestart 6.)	MO
8.	The missing ceiling tiles (removed during MRI equipment installation) must be reinstalled to permit proper operation of the fire protection system.	MO – Complete ¹
9.	The moveable microscope stand in the Prep Room is a recognized tripping hazard. In the near term, Medical intends to highlight the edges of the stand. (See also Post Start 2 below.)	MO – Complete ¹

¹ Based on input received during the review cycle, this finding is closed.

10.	Please provide signage at the entrance to the Facility to inform personnel of the ODH hazard if the strobe light is activated.	MO
11.	Provide permanent continuous grounding for all cable trays in the facility.	Plant Engineering, Engineering and Construction Services (EP ECS)
12.	Ensure that the Post Start Findings (listed below) have been entered into the Department/Division tracking system. (Required to complete the ORE Approval Document.)	MO
13.	Complete the ORE Approval Document. (Section 4 of the ORE Subject Area provides a template for your use.) Forward copies of the completed document to Mike Bebon (as Deputy Director for Operations) and Rich Travis (ORE Chairman).	MO

The following Post-Start Findings need to be corrected or resolved by the responsible party in a timely manner. All findings shall be tracked by the Medical Department until completion.

No.	Post-Start Findings	Responsible Party
1.	Review the Chemical Management System Reports to assure that chemicals that were introduced into this area are entered into the system correctly.	Medical Department (MO) – Complete ¹
2.	The moveable microscope stand is not suitable for the tight confines of the Prep Room. (See Prestart 9 above.) It should be replaced with a wall or table mounted model. Please confer with the Researcher and request funding for a suitable replacement.	MO
3.	The wall between the MRI Room and the Control Room has several penetrations (e.g., the cable tray) that should be sealed.	MO
4.	The Committee understands that the steady state cryogenic boil off from the magnet may be vented into the exhaust ductwork. Please evaluate the exhaust capacity and integrity to ensure the ductwork continues to function as designed.	MO
5.	As per MO's suggestion, please document the intrusion of the 5 gauss line into Room 9-436 in the next FUA revision for Building 490	Building 490 Building Manager
6.	Please label the main disconnect switch for the MRI in accordance with OSHA (1910.303(f)) and National Electric Code (110.22) requirements, (e.g., component number and function). Kindly also indicate the source of the feed.	MO
7.	In accordance with BNL practice, please identify the source of the power for the two circuit breaker panels in the facility.	Plant Engineering, Engineering and Construction Services (EP ECS)
8.	Please provide the architectural plans for this project to the Maintenance Management Center (Don Hensley) so that the Building 490 Key Plans can be updated.	EP ECS

9.	A Contractors Material and Test Certificate (CMTC) is required for the sprinkler system alterations. Please route the CMTC through the required signoff distribution list, obtain the necessary approvals, and forward a copy of the completed document to the Maintenance Management Center (Keith Radich) for input into the Sprinkler Head Database. Kindly also send a copy to Fire Protection Engineering (Joe Levesque) and the ORE Chairman (Rich Travis).	EP ECS
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The Committee recommendations listed below should be addressed by the responsible party in a timely manner.

No.	Recommendations and Observations	Responsible Party
1.	Rekeying of locks needs to be coordinated with the Fire Rescue Group. Please interface with John Searing, chief@bnl.gov , as necessary.	Medical Department (MO)
2.	The Committee observed the "Calibrated On (date)" tag for the oxygen sensor. However, the calibration interval must be known to verify that the sensor is still in calibration As a recommendation, please consider putting a "Calibration Due" date on the oxygen sensor.	MO
3.	The April 17, 2003 BORE Report (Reference 2) documented 18 findings in preparation for facility operation. The findings included: <ul style="list-style-type: none"> • FUA and Fire/Rescue Runcard updates. • Oxygen Deficiency Calculation. • Oxygen sensor calibration and operability. • UPS evaluation for the oxygen sensor. As part of this ORE, the BORE findings were reviewed and all were verified as complete.	Not Applicable (NA)
4.	As part of the resolution of the BORE findings, Plant Engineering Operations and Maintenance had previously determined that a Transfer for Maintenance Accountability (TFMA) was not required.	NA
5.	The Committee would like to thank Bob Colichio for his innovative solution for Prestart Finding 3. The proposed use of raceway to separate the control, power and non-electrical lines will avoid rerouting lines into the second tray. Since the cabling is already tight this will save significant time and cost.	NA

Reference:

1. BNL memo, C. Du to E. Lessard, "Summary of Responses to Safety Committee Comments", dated October 23, 2003.
2. BNL Memo, R. Travis to R. Colichio, "Beneficial Operational Readiness Evaluation (BORE) Report – Building 490, Animal MRI Facility", dated April 30, 2003.

ORE COMMITTEE CONCURRENCE

BUILDING 490, MICRO MRI FACILITY, FULL OPERATION
(March 25, 2004)

Name

Date

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