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July 19, 2004

Michael D. Holland
Area Manager
Brookhaven Area Office Group Manager
U.S. Department of Energy
Brookhaven National Laboratory
Upton, New York 11973

Subject: Brookhaven National Laboratory Electrical Safety Action Plan

Reference: Memorandum Johnson to Distribution, dated May 24, 2004 "Department of Energy Electrical Safety Month"

Dear Mr. Holland,

The above referenced memo clearly elucidates the expectations of the Office of Science (SC) pertaining to needed improvement in electrical safety. Brookhaven National Laboratory (BNL) has made electrical safety a top priority, and will continually strive to improve our performance in this area. BNL is committed to meet SC's expectations by demonstrating significant improvements in our electrical program, one year from now as SC has stipulated in their expectations. BNL has formulated a plan of action based on its unique situation and has taken into consideration several specific actions that are outlined below.

First, we will take a critical look at our operations and apply lessons learned to improve performance. Second, we will improve the physical condition by correcting the electrical safety hazards recently identified by OSHA in their recent inspection of BNL facilities. The enclosed Electrical Safety Action Plan (ESAP) and attachments will consist of an analysis of the electrical related incidents, recent infrastructure upgrades, programmatic upgrades, abatement of OSHA electrical findings, and implementation of mechanisms to promote continuous improvement in the ESAP.

We will continue to keep BHSO apprised of any Safety Improvements. If you need further information, please feel free to contact Joe Curtiss, Laboratory Electrical Safety Officer (LSO) at 344-3635.

Sincerely yours,

Praveen Chaudhari
Director

CC2004-2682/SE81SR04/Enc./Att.

cc: Bebon, Michael
Bond, Peter
Level One Managers

BNL Electrical Safety Action Plan

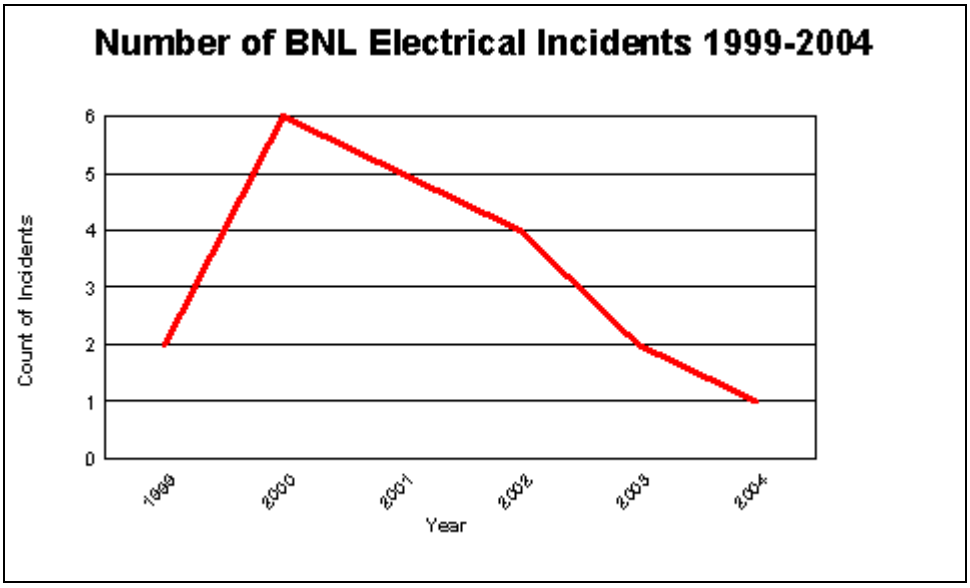
Incident Analysis and Lessons Learned

Causal analysis of BNL electrical safety incidents, and their associated lessons learned provides us with an opportunity for developing an effective ESAP. The referenced memo attributes several recurring types of electrical safety occurrences and recurring causes to SC operations. Typically, these include personal errors, work control problems, configuration management weaknesses, electrical intrusion events, and vehicle incidents.

The BNL review was conducted by the Safety and Health Services Division, covering incidents from January 1999 through May 2004. We have had 20 electrical safety incidents during that period. The types of electrical safety occurrences and causal relationship at BNL are in line with SC's description of the types of incidents, with the exception of vehicle incidents. There have been none of the latter.

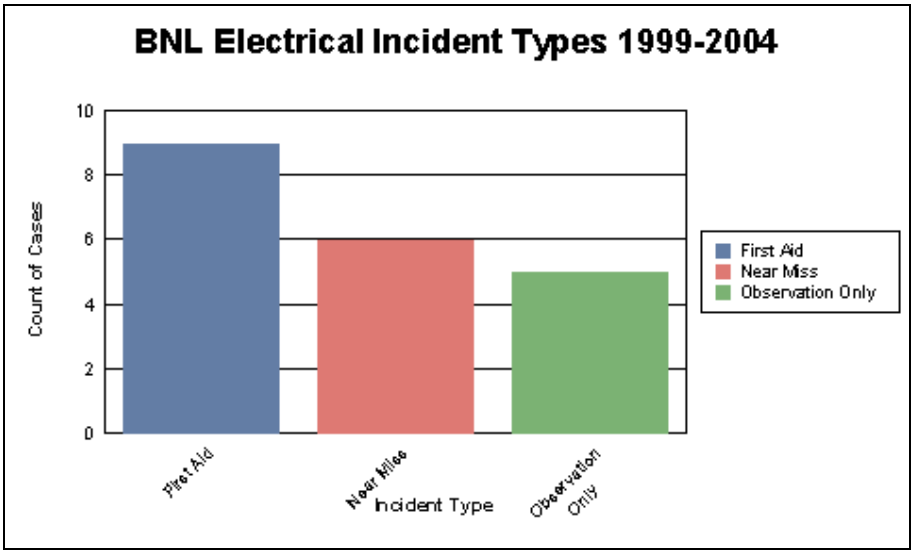
At BNL, it should be noted that vigorous investigations, causal analyses, and the lessons learned system has contributed to the decreased number of these incidents progressively over recent years. See Figure 1.

Figure 1



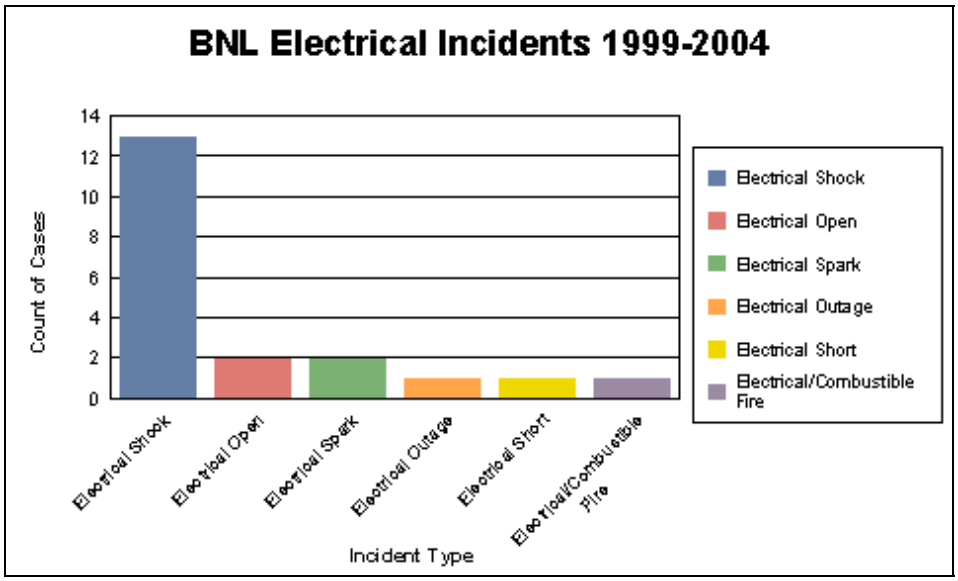
None of these twenty incidents has resulted in an injury, recordable case, or Days Away, Restricted, or Transfer (DART) case. Nine have been first aid cases, 6 near misses, and 5 have been observations of unsafe electrical practices, see Figure 2.

Figure 2



Thirteen of the incidents had potential, or resulted in, minor electric shock. It is notable that, in the last four and a half years, none of the incidents summarized in Figure 3 below were related to Lockout/Tagout (LOTO) violations. Of these 13 incidents, 6 were directly attributed to research lab work, 5 to construction or site maintenance related activities (1 was excavation related), and 2 were attributed to janitorial or building maintenance where equipment defects were the cause. The electrical shock category includes the potential for (observation), near miss, and first aid (minor shock) cases. The electrical open category describes events that may have resulted in an open circuit and loss of power to a circuit. The electrical spark category describes events that resulted in a spark while drilling into live wires or water damage to circuits. The electrical outage category describes the Northeast Blackout event (August 14, 2003) and is included because moderate damage was done to electrical components on site. Electrical shorts resulted from water leaking into panels and power feed failures, where a short circuit was determined to be the cause. Electrical/Combustible fires were a result of overloaded motor controls. See Figure 3.

Figure 3



Lessons Learned

BNL's Lessons Learned documents have been an integral part of the Laboratory's program to disseminate information about electrical safety incidents throughout the Lab and the DOE community. They are included in safety briefings with workers, and are well published through a variety of media to promote awareness. BNL has generated eleven electrical related "Lessons Learned" documents for dissemination throughout the BNL work force. Four of the lessons learned were based on BNL events; the remaining seven originated within the DOE complex and were determined to be applicable for work at BNL.

Recent Infrastructure Upgrades

Brookhaven National Laboratory is an aging facility. Many of the buildings on site are left over from the original Camp Upton. BNL facilities are well maintained, despite the availability of limited funding for upgrades, new facilities and maintenance.

Within the last few months, BNL completed, a major upgrade to the site-wide 2400-volt buried electrical distribution system. The system has been wired into a ring-type configuration. This allows for convenient segmentation of portions of the system for maintenance, while continuing to maintain service to our facilities.

Most air-break circuit interruption devices have been replaced by remotely operated SF6 switches. This significantly contributes to safety during high-voltage switching operations.

Also completed were upgrades to the Electrical Safety Tray Upgrade. This improved the construction, grounding and cable supports. An Activity Data Sheet (ADS), part of the Project Planning Program and Budget Process (3PBP), enabled BNL to complete upgrades to the Electrical systems in the Apartment Areas. The electrical system was improved to conform with NFPA code. All interior renovations to apartment buildings were completed.

BNL continues to identify infrastructure upgrades to enhance electrical safety and has incorporated those upgrades into the ADS system for prioritization and funding. Presently, BNL is seeking funding for Electrical Distribution Panel Labeling (AA3D0029), Cable Tray Upgrade at the Collider Accelerator (X92D0144) and retrofit of 480V Breakers with solid-state trip devices (P95D004).

Programmatic Upgrades

BNL has made many programmatic upgrades to its electrical safety program over the years, and uses an expert-based approach to implement the program. The Laboratory established an Electrical Safety Committee (ESC) and designated the committee as our "Authority Having Jurisdiction" (AHJ) for judgments pertaining to electrical safety matters. The ESC's primary mission is to advise Laboratory management on matters relative to electrical systems, equipment and components; and to develop and maintain up-to-date electrical related standards. The Laboratory also has an Electrical Safety Officer (ESO), a Licensed Professional Engineer (PE) in Electrical Engineering and a member of the ESC, who acts as the AHJ in the field, and returns significant issues to the committee (ESC) for discussion and resolution.

The ESO and ESC are responsible for development and continual review of the Laboratory's electrical safety program, and for content of training programs for electrical safety. This responsibility includes

preparing institutional-level documentation that includes our four electrical safety standards: Electrical Safety; Lockout/Tagout; Interlocks for Protection of Personnel; and Guidance on the Design and Deployment of Electrical Equipment.

During 2001, the ESC arranged for a comprehensive training session on the provisions of NFPE 70E, Standard for Electrical Safety Requirements for Employee Workplaces to be given by an electrical safety expert from the Princeton Plasma Physics Laboratory (PPPL). This Electric Utilization Course trained approximately 200 electrical engineers, technicians and electricians.

In early 2003, the Laboratory issued a revision to our electrical safety standard, which was updated to conform to NFPA 70E. At the same time, the Laboratory issued a revision to our standard on lockout/tagout. The standard was revised to more closely follow OSHA lockout/tagout provisions, and also to clarify and simplify lockout/tagout for mechanical servicing. The safety standard revisions were based on NFPA 70E - 2000.

In September 2003, BNL developed a comprehensive plan for the content of electrical safety training courses, introducing the course "Electrical Safety for Electrical Workers" which replaced a more general electrical safety course. These training materials all conform with BNL's updated electrical safety standards. It is noteworthy that BNL just completed a "wall-to-wall" OSHA inspection, and there were no comments regarding our standards for electrical safety, lockout/tagout, or pertaining to our training program.

Abatement of OSHA Electrical Findings

The Occupational Safety and Health Administration (OSHA) conducted an on-site assessment of Brookhaven National Laboratory from October 21 through November 19, 2003. This assessment was completed at the direction of Congress in order to determine the cost of having DOE Science Laboratories transition to OSHA external regulation. This assessment resulted in 5503 instances of non-conformance with OSHA regulations.

The scope of the OSHA assessment included a "wall to wall" review of all 472 buildings at BNL, including those funded under the Environmental Managements Superfund cleanup. OSHA conducted a closeout with the BNL in November 2003, and provided a detailed punch list of items in March 2004. The findings were consistent with the referenced memo, which cited typical DOE SC labs having 50% of OSHA findings relating to the electrical standards. BNL had approximately 57% of all OSHA findings attributed to electrical findings. The distribution of OSHA findings, by 29 Code of Federal Regulations (CFR) 1910 Subpart S, is provided in Attachment 1.

An integral part of BNL's ESAP is to establish a multi-phase corrective action strategy to address the OSHA findings. This strategy includes:

- Documenting OSHA Citations and Related Abatements in a Database managed by the Safety and Health Services Division;
- Developing a Cost Estimate for addressing all OSHA findings and recommendations;
- Tracking all abatements to closure;
- Correcting all imminent danger findings immediately;
- Evaluating hazards by Safety Professionals as to their hazard severity and frequency;
- Prioritizing abatement based on severity and frequency;

- Identifying "Quick Fix" Items and abating them quickly;
- Prioritizing abatements that require significant funding by risk and severity, and prioritizing procurement efforts to obtain necessary funding for abatement;
- Submitting capital improvement items to the Laboratory's Project Prioritization system to obtain funding within the existing ESH Project Planning System;
- Invoking existing DOE exemptions that do not increase hazards to workers while developing plans to move to full compliance with OSHA (e.g. frequency of fire extinguisher inspections);
- Contending apparent non-violations that may have been misinterpreted by OSHA for exclusion from the abatement process; and
- Establishing additional initiatives to improve the overall safety culture at BNL.

To date, the Laboratory has spent one million dollars in Office of Science Funding and an additional $70k in Laboratory funding to correct over 25% of the OSHA findings. See Table 1. The Laboratory hired four temporary electricians specifically for the electrical-related items, and dedicated their work to remediation of OSHA findings. This OSHA remediation team has completed 23% or 734 of the electrically related findings. Monies made available to BNL for infrastructure improvement of OSHA findings have been fully utilized and any additional abatement will need to be funded through other resources. Requests have been made and submitted through the ADS as part of the Project Planning Program and Budget Process (3PBP) process to request funding to abate the remainder of the OSHA findings.

Table 1

Number of Electrical Instances Identified	Number of Electrical Instances Fixed	Number Remaining	Percent Completed	Total Estimated Cost of Electrical Instances	Total Dollars spent on electrical to date (FY04)
3129	734	2395	23%	$2,257,328	$339,315

Some findings noted on the OSHA final report are either currently exempted by DOE under an equivalency agreement or, due to the type of application, exempted by code and the finding would not be applicable to BNL. BNL's approach is to re-validate those equivalency exemptions and/or continue to comply with the existing exemptions.

For certain electrical related deficiencies, the Lab will be requesting exemptions through DOE. This is especially for, either low risk issues, or those that were cited in error. It is anticipated that successful exemptions will reduce the overall number of electrical deficiencies by roughly 15%. A copy of the Laboratory's basis for these exemptions is provided as Attachment 2.

Implementation of Mechanisms to Promote Continuous Improvement in the ESAP

The Laboratory will continue to aggressively make systematic improvements to the infrastructure and the electrical safety programs. Our approach will be to build on our past trend of improvement and to enhance our programs and implement infrastructure upgrades as appropriate. This approach includes:

1. Continue to perform credible and critical self-assessments of the electrical safety program.

BNL periodically performs Lab-wide electrical safety assessments of considerable scope and depth. These assessments may result in changes to Laboratory electrical safety standards and to training. The most recent assessments were the following:

- Dec. 2000, *Critical Systems* (Those systems which remain energized during testing and maintenance), 122 pp.;
- April 2003, *Implementation of NFPA 70E,* 126 pp.;
- July 2003, *Interlock Safety*, 135pp.

In addition, the Brookhaven Group Site Office with the assistance of Chicago Operations and contractor experts will be conducting an ISM assessment of BNL on August 9-13, 2004. One of the principal focus areas of this assessment will be on electrical safety.

2. Continually update electrical safety documentation to include the latest regulatory changes and best management practices; and disseminate that information to the staff.

   The 2004 edition of NFPA 70E was just released, and the ESC will review the Laboratory's safety documents and training programs to determine any necessary changes to our electrical safety standards and training.

3. Continually monitor the DOE lessons learned system for any that are applicable to work performed at BNL; and disseminate that information to the staff.

4. Identify and prioritize infrastructure upgrades using the Project Planning Program and Budget Process (3PBP) process to secure funding for electrical related upgrades.

5. Provide ongoing training for staff in electrical safety issues as well as in the identification of electrical related hazards. In view of the large number of electrically related OSHA citations, the Laboratory recognized the need to improve the way we identify electrical hazards and deficiencies. As an outreach effort, the Laboratory added a number of OSHA 30-hour and 10-hour training courses. Additionally, the Laboratory initiated development of an Environment, Safety, Health and Quality Inspection Subject Area to be added to our web-based Standards-Based Management System. This Subject Area will include checklists to facilitate the identification of OSHA deficiencies, as well as provide a method for tracking and trending.

6. Continue to aggressively correct OSHA identified electrical issues including submitting requests for funding through the Project Planning Program and Budget Process (3PBP) process.

7. Implementation of Laboratory wide Safety Improvement Plan

   BNL is using this Safety Improvement Plan to implement several specific and decisive actions in order to establish and sustain a culture committed to safety excellence. Specifically identified were the needs to: cultivate safety leadership throughout the Laboratory; improve communications of expectations and goals; reinforce responsibility and accountability; and develop a culture that is committed to continuous learning and improvement.

This plan is currently under review by the BHSO. It includes five imperatives that serve as the Laboratory's core strategy to drive overall safety improvement. These five imperatives include:

- Pursue, Achieve and Sustain OHSAS 18001
- Develop Safety Leadership Skills and Behaviors
- Raise and Sustain Safety Consciousness
- Develop Mature Aspects of Event and Condition Management Processes
- Develop Mature Self-Assessment Processes and Behaviors

Implementation of this plan will have a significant positive impact on the electrical safety program at the Laboratory.

Attachment 1

Distribution of OSHA findings

The punch list resulting from the OSHA inspection identified 2630 citations with 5503 instances of findings, distributed as follows:

Subpart	Subpart Description	No. of Instances	% of Total
C	Record keeping 1904.1	1	0.0
D	Walking-Working Surfaces	259	4.7
E	Exit Routes, Emergency Action Plans, and Fire Prevention	297	5.4
F	Powered Platforms, Man lifts, and Vehicle-Mounted Work Platforms	1	0.0
G	Occupational Health and Environmental Control	3	0.1
H	Hazardous Materials	104	1.9
I	Personal Protective Equipment	56	1.0
J	General Environment	207	3.8
K	Medical and First aid	130	2.4
L	Fire Protection	132	2.4
N	Materials Handling and Storage	307	5.6
O	Machinery and Machine Guarding	501	9.1
P	Hand and Portable Powered Tools and Other Hand-Held Equipment	23	0.4
Q	Welding Cutting and Brazing	3	0.1
R	Special Industries	28	0.5
S	**Electrical**	**3130**	**56.9**
Z	Toxic and Hazardous Substances	85	1.5
5 (A1)	General Duty Clause	41	0.7
REC	Recommended	154	2.8
Cons	1926 Construction (D, M, K)	41	0.7
Total		5503	99.255

Attachment 2

OSHA Exemption Requests – Electrical Safety Overview

Panel Labeling

A number of citations were related to improper panel labeling. Panels that are not labeled at all will be corrected by labeling. However, there are a many panels that are labeled for which OSHA felt the label did not meet current standards. BNL does not recognize this as a risk, primarily because facility staff (engineers, electricians and technicians) are familiar with the current markings and their meaning, so that no confusion exists. Any new staff, or contractors would readily recognize the labeling. The costly effort to change all the labels will not improve safety.

As an example, a typical panel labeling at RHIC might be "R5C6". This label, uniform within RHIC, describes the power feed (a Rack, in alcove 5C, the 6th rack). Racks and panels are typically located in the same room or vicinity, and there would be no error in determining which rack is fed by which circuit breaker. Furthermore, authorized personnel trained in the presently existing labeling service the RHIC alcoves.

While OSHA requested a plain English label, and an acceptable label should be "Rack 5C6," future labeling can easily contain the word “Rack”. Complete re-labeling, including removal of old labels, application of new labels, and updating all procedures, documents and drawings, is viewed by RHIC as expensive and unnecessary. There would be no benefit to such an effort.

Temporary Wiring

There are many hundreds of citations in the C-A area, and other areas as well, involving use and protection of temporary wiring in the research areas. The temporary wiring referred to in the citations is generally 535-MCM locomotive cable used to power the experimental beam-line magnets. These are used to guide and focus charged-particle beams on temporary beam transport systems, delivering beams to the various term-limited experiments carried out each year. This is not permanent wiring.

OSHA States the following requirements:

> **1910.305(a)(2)(i)** “Uses permitted, 600 volts, nominal, or less. Temporary electrical power and lighting installations 600 volts, nominal, or less may be used only:”
>
> **1910.305(a)(2)(i)(B)** “For experimental or development work.....”

Since all the citations for temporary wiring relate to the experiments, the very reason that BNL facilities exist, the Laboratory believes that temporary wiring used in experimental areas such as in RHIC, AGS, and NSLS should be permissible.

Guarding of Live Parts

There are a large number of citations relating to cable emanating from electrical equipment and rising to cable trays while not being protected by conduit. OSHA inspectors cited these circumstances under the following:

1910.303(g)(2) *Guarding of live parts*.

1910.303(g)(2)(i) "Except as required or permitted elsewhere in this subpart, live parts of electric equipment operating at 50 volts or more shall be guarded against accidental contact by approved cabinets or other forms of approved enclosures, or by any of the following means:"

1910.303(g)(2)(i)(A) "By location in a room, vault, or similar enclosure that is accessible only to qualified persons."

1910.303(g)(2)(i)(B) "By suitable permanent, substantial partitions or screens so arranged that only qualified persons will have access to the space within reach of the live parts. Any openings in such partitions or screens shall be so sized and located that persons are not likely to come into accidental contact with the live parts or to bring conducting objects into contact with them."

1910.303(g)(2)(i)(C) "By location on a suitable balcony, gallery, or platform so elevated and arranged as to exclude unqualified persons."

1910.303(g)(2)(i)(D) "By elevation of 8 feet or more above the floor or other working surface."

1910.303(g)(2)(ii) "In locations where electric equipment would be exposed to physical damage, enclosures or guards shall be so arranged and of such strength as to prevent such damage."

1910.303(g)(2)(iii) "Entrances to rooms and other guarded locations containing exposed live parts shall be marked with conspicuous warning signs forbidding unqualified persons to enter."

BNL believes these citations are incorrect and that current installations do comply with the National Electrical Code (NEC) and OSHA. The premise of the OSHA citation appears to be that an insulated cable is a "live-part". The NEC Article 100 *Definitions* provides that Live Parts are energized *conductive* components. In the case of a cable, be the cable a power cord to a portable vacuum cleaner, or from equipment to cable tray, the cable conductors are protected by insulation and jacket material that is not conductive and therefore not a live part. Accordingly, BNL believes the citation is fundamentally in error.

Use of RPT's (Power Strips)

Relocatable Power Taps (RPT's), commonly used to power computers and associated devices, were cited a number of times for improper use. These devices are intended to be directly connected to a permanently installed branch circuit receptacle. They are not intended to be series connected (daisy chained) to other RPT's, nor to extension cords. BNL agrees, and such uses were identified and corrected.

There were a number of citations for improper use of RPT's that BNL believes are not consistent with OSHA's Standard Interpretation dated 11/18/02, *Compliance requirements for relocatable power taps or "power strips."* This interpretation essentially states that use consistent with the UL listing was acceptable. While use of RPT's on light-duty workbenches, and in kitchen spaces, were cited as not being used in compliance with manufacturer's recommendations or with the UL listing, commercial

RPT’s from Sears and similar vendors list workbenches as an application, as well as for serving kitchen appliances.

When used on workbenches, RPT’s can reduce clutter and hazards due to multiple runs of power cords, and can provide a neater, more controlled and safer workplace. When questioned by e-mail regarding use on workbenches, UL responded that it is acceptable to use these devices in other locations in addition to the locations identified in UL's *Certification Guide* information for these products. UL noted that Relocatable Power Taps are not intended to be permanently secured to building structures, tables, workbenches or similar structures, nor are they intended to be used as a substitute for fixed wiring. Accordingly, BNL believes that appropriate use of RPT’s on workbenches to be an acceptable practice and that the associated citations are not appropriate.

In addition, in shops or where technicians are located, many workers have set up small areas with refrigerators, coffee pots, and small microwave ovens. When queried, UL responded that RPT’s are capable of handling the small appliance loads typically found in a household kitchen. They note that it is the responsibility of the Authority Having Jurisdiction (AHJ) to determine the requirements for a "kitchen", that the supply cord and jacket construction must be suitable for the environment, and use of the RPT should not defeat the intent of required short-cord lengths on certain small appliances. With these restrictions and documented reviews, BNL believes that appropriate use of RPT’s should be allowed in kitchen spaces, and that the associated citations are not appropriate.

Applicability of OSHA Requirements due to Age of Installation

There are a number of sections in Subpart S that are not applicable, if the installation was done prior to 1972, and no major renovation is performed. While BNL will not request a blanket exemption to apply this clause, BNL will request exemptions for those that apply while mitigating the potential hazard through other means. One example would be where the required clearance in front of electrical panels is not present, and generation of this clearance would be very expensive. The hazard could be mitigated though administrative means by prohibiting working hot on those panels, under any circumstances. Proper posting on the panel would be made and work controlled though our work control procedures.