TEMPORARY CHANGE REQUEST

TCR NO. TCR-ESHD 5008-2.9 R6-001

The Temporary Change Request (TCR) Form is to be used to process urgent or minor changes for PPPL Policies, Organization/Mission Statements and Procedures. The TCR should be used when changes are:

1) urgent, and can not wait the 2-4 week period for Department Head review/comment, or
2) minor, and do not warrant Department Head review.

Person Requesting Change: Jerry Levine

Department Name: ES&H **Phone Ext:** 3439

Document Number: ESHD 5008-2.9 **Revision No.:** 6

Document Title: ELECTRICAL SAFETY – INDUCTORS AND ELECTROMAGNETS

Reason for change:

Minor changes to make this chapter consistent with recently revised Section 4 of ESHD 5008. This is in response to Finding #1 of Audit 10709 (Non-Ionizing Radiation USR).

Change description: (Summarize and attach changed pages, with changes clearly indicated)

9.2J will be revised to refer to Section 4 and delete references to specific exposure limits already in Section 4. 9.2 K, L & M will be deleted. 9.4 B will be revised to remove Section 4 reference to static magnetic fields only, since Section 4 now includes information on time varying fields, as well. Also, the title of Section 4 has changed slightly, and this change has been incorporated.

1. Does this TCR significantly alter the intent or scope of the document? **YES:**___ **NO:** X

2. Does this TCR significantly impact **ES&H**? **YES:**___ **NO:** X

If 1 or 2 is **YES**, Explain why the changes should not be routed for Department Head review:

_____

Jerry Levine **10/13/08**
Department/Division Head Approval **Date**

Jerry Levine **10/13/08**
Associate Director, Best Practices and External Affairs **Date**

Release/Effective date of this TCR: **10/13/08**

Incorporate this TCR into next revision of this document? **Yes** X **No**

CHAPTER 9 INDUCTORS AND ELECTROMAGNETS

9.1 DESCRIPTION

This section covers inductors and electromagnets with stored energies of 10 J and above. These are used in the following applications:

A. Energy storage, where power is provided by a dc source or low-frequency ac power supply and then switched to a load or test device.

B. Inductors used as impedance devices in a pulsed system with capacitors to provide oscillatory or resonant conditions.

C. Electromagnet coils that produce magnetic fields to guide or confine charged particles.

D. Inductors used in dc power supplies.

9.2 TYPES OF HAZARDS

A. Overheating due to overloads, insufficient cooling, or failure of the cooling system could cause damage to the inductor and possible rupture of the cooling system.

B. Large electromagnets may produce external force fields that can affect the calibration and proper operation of protective instrumentation and controls. These can cause nearby equipment such as motors and transformers to overheat or overload. Such external fields could also attract nearby loose magnetic material and cause injury or damage by impact.

C. Whenever a magnet is suddenly de-energized, production of large eddy currents in adjacent conductive material can cause excessive heating. A fast rate of change of field strength, producing high turn-to-turn and terminal voltages, can also induce hazardous voltages in adjacent conductors.

D. An inductor is also capable of producing large electromagnetic forces.

E. When one inductor is used with a second, improper conductor polarity can result in abnormal forces and field strengths.

F. Loose and/or broken inductor or electromagnet connections can produce excessive heat and arcing.

G. The large amount of energy stored in the field of an energized inductor can damage equipment and injure personnel if not discharged in an appropriate manner.

H. Large amounts of stored energy can be released in the event of a "quench" in a superconducting magnet.

I. The relatively long time constants in highly inductive circuits can cause the prolonged release of energy into a fault, producing severe equipment damage and possible fire.

J. Exposure to static or time-varying magnetic fields can have effects on the human body, medical implants and pacemakers. Exposure guidelines can be found in ESHD-5008, Section 4, "RF, Microwave, Magnetic Field and Other Non-Ionizing Radiation".

9.3 DESIGN AND CONSTRUCTION CRITERIA

The following shall be provided:

A. Sensing devices (such as temperature and coolant flow) interlocked with the power source for safe shutdown of water-cooled or air-cooled inductors and electromagnet coils in the event of excessive temperatures or cooling-system failure.

B. Protective enclosures fabricated from material not adversely affected by external electromagnetic fields produced by the equipment. See NEC article 470 for further details on fabrication of enclosures.

C. Equipment supports and bracing adequate to withstand forces produced during normal operation and fault conditions.

D. Grounding for electrical-supply circuits and electromagnetic cores wherever feasible and for adequate fault protection.

E. Ground-fault detection for grounded or ungrounded (floating) systems and electrical circuits for alarm purpose, or equipment shutdown.

F. Means for safely dissipating stored energy when excitation is interrupted or a fault occurs.

9.4 OPERATING CRITERIA

A. Provide safety signs and/or warning lights to indicate equipment hazards.

B. Advise personnel of the hazards of stray magnetic fields by posted instructions or by other means. There should be no magnetic material in the clothing or on the bodies of personnel who are in the immediate area of large energized inductors or electromagnets. See Section 4.0, "RF, Microwave, Magnetic Field and Other Non-Ionizing Radiation," of ES&H Manual 5008.

C. Before disconnecting the leads of any high-energy inductor (50 J or more), follow the safe-accessing procedure of Chapter 11, paragraph 11.4.

D. Exercise extreme caution when checking continuity or measuring resistance of large inductors or electromagnet coils with a common ohmmeter. Severe shocks can result if both hands are in contact with the terminals when the test probes are removed. A second person acting as the safety watch is required, and PPE shall be worn as specified in the Job Hazard Analysis or procedure.

E. Avoid high dc magnetic fields (100 gauss and above) when carrying security or credit cards. Security cards and credit cards use barium ferrite as their permanent magnetic material. Security cards after magnetization have a flux retentivity of between 120-180 gauss and when degraded to 75 gauss are considered a bad card. If exposed to a dc magnetic field, the magnetization degrades approximately 20 percent in a 100 gauss field and completely demagnetizes in a 300 gauss field, assuming the magnetic field is perpendicular to the credit card.