

Overview of Keys for the High Intensity Neutrino Source R&D Facility in the Fermilab Meson Detector Building

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4/17/2007

1. Introduction

This note describes the controlled keys used in the High Intensity Neutrino Source (HINS) R&D facility in the Meson Detector Building. This includes keys that are an integral part of the HINS Meson Personnel Safety Interlock System as well as other controlled keys that serve important roles in LOTO procedures for the equipment of this facility.

2. Overview of Facility

Facilities for the HINS R&D program will be installed and operated in the Meson Detector Building. Layout of the HINS program components and five named activity areas are shown in Figure 1.

A 325 MHz, pulsed RF power source, consisting of a 2.5 MW klystron and modulator ultimately capable of operating at a 4.5 millisecond RF pulse length with 1.5% duty cycle, occupies the “325 MHz Klystron and Modulator” area.

A switched RF power distribution system from the klystron feeds the “325 MHz Cavity Test Cave”, “325 MHz RF Cage”, “Ion Source and RFQ”, and “65 MeV Linac” areas. A diagram of the RF power distribution system is shown in Figure 2.

The “325 MHz Cavity Test Cave” will be used for RF testing and conditioning spoke-resonator type accelerating cavities. Copper spoke cavities and three types of superconducting spoke cavities will be individually tested in this cave. The cave will house a large cryostat for superconducting cavity testing. As shown in Figure 2, the cave is fed by two RF power transmission lines; one with 250 kW peak power capability for superconducting cavity tests and one with 25 kW peak power capability for copper cavity tests.

The “325 MHz RF Cage” area is a RF screened cage that will be used for testing various, non-x-ray producing, high power RF power control and distribution components. A waveguide feed supplies the “RF Component Test Facility” cage with RF power up to the full 2.5 MW capability of the klystron.

The “Ion Source and RFQ Area” will contain a 50 keV H⁻ or proton ion source, a Radio Frequency Quadrupole (RFQ) accelerator, and support equipment sufficient to generate a 2.5 MeV beam at currents up to approximately 40 mA at 1% duty cycle. Initial beam operations will be performed to commission the RFQ and to characterize the 2.5 MeV beam that ultimately feeds the Linac.

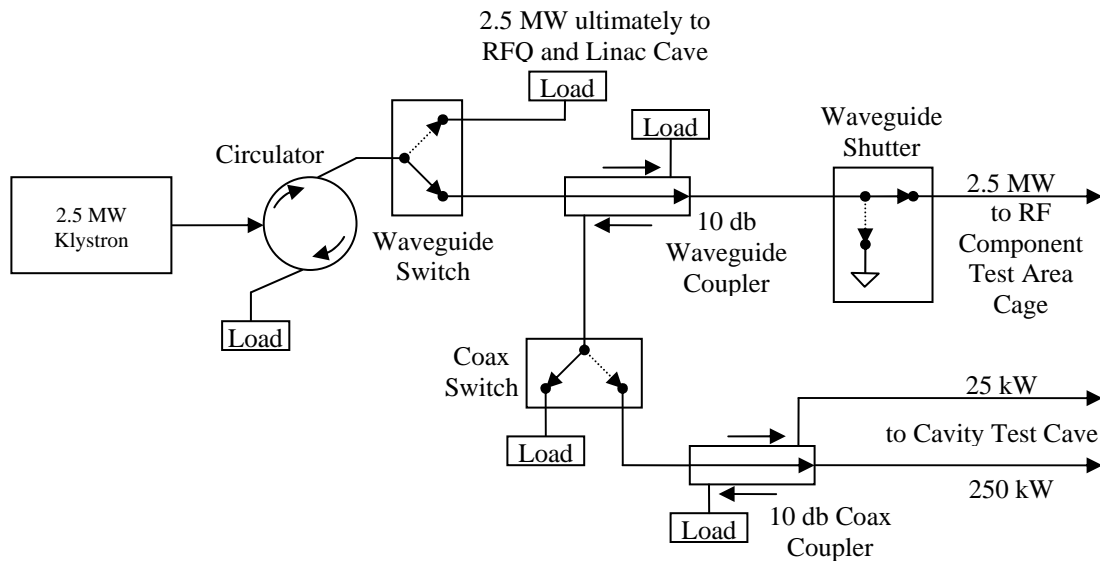


Figure 2. 325 MHz RF Power Distribution System

The “65 MeV Linac” area will house the Linac accelerator downstream of the RFQ. This will include both conventional copper and superconducting accelerating cavities, superconducting solenoids for beam focusing, beam absorbers, and the necessary support equipment that is most appropriately located within the beam enclosure. Ancillary power supplies, controls and diagnostics equipment, and other accelerator support equipment will be located outside the cave.

3. Controlled Keys

3.1. Enumeration of Key Types and Names

The HINS Meson Personnel Safety Interlock System includes seven unique key and lock types:

1. 325 MHz RF Cage Reset Key (RF Cage Reset Key)
2. 325 MHz RF Cage Enter Key (RF Cage Enter Key)
3. 325 MHz Cavity Test Cave Reset Key (Cave Reset Key)
4. 325 MHz Cavity Test Cave Enter Key (Cave Enter Key)
5. 325 MHz RF Permit Key
6. 325 MHz Linac Reset Key (Linac Reset Key)
7. 325 MHz Linac Enter Key (Linac Enter Key)

In addition, two unique captured Kirk™ key types are part of equipment interlock and/or LOTO procedure systems; the 325 MHz modulator charging supply disconnect and door key and the 325 MHz waveguide shutter key.

All other key types and/or locks shall be only for administrative configuration control or personal LOTO purposes. An incomplete list of applications for such locks includes the control power disconnect for the 325 MHz waveguide shutter upstream of the RF Cage, the control power disconnect for the 325 MHz waveguide switch at the output of the klystron, the control power disconnect for the 325 MHz coaxial RF switch for feeding RF power into the 325 MHz Cavity Test Cave, etc.

3.2. Description of Purpose and Operational Use of Each Key Type

3.2.1. 325 MHz RF Cage Enter Key

There is one key of the 325 MHz RF Cage Enter Key type. This key is used to control access to the RF Cage, to control the Interlock System permit to the RF power equipment, and to provide the Main Control Room the possibility to monitor and control operational activities in the HINS facility.

The RF Cage Enter Key is required to unlock the interlocked RF Cage entry door. Note: Execution of the 325 MHz RF Power Distribution System LOTO Procedure, ADDP-RF-7902, Beams-doc #2701 is a prerequisite for RF Cage access. The RF Cage must be secured and interlocked to obtain an RF permit regardless of the RF power destination. To obtain a permit to generate any RF power from the klystron, this key must be engaged in the 325 MHz RF Cage RMSS chassis. Otherwise, this key shall reside in the MCRMKT or in the possession of trained and authorized person. This key is to remain in the Meson Detector Building at all times.

3.2.2. 325 MHz RF Cage Reset Key

There is one key of the 325 MHz RF Cage Reset Key type. This key is used to reset the RF Cage interlocks following an access to the RF Cage and to provide the Main Control Room the possibility to monitor and control operational activities in the HINS facility.

The RF Cage Reset Key is required to reset the RF Cage interlocks. When not in active use, this key shall reside in the MCRMKT or in the possession of trained and authorized person. This key is to remain in the Meson Detector Building at all times.

3.2.3. 325 MHz Cavity Test Cave Enter Key

There is one key of the 325 MHz Cavity Test Cave Enter Key type. This key is used to control access to the Cave, to control the Interlock System permit to the RF power equipment, and to provide the Main Control Room the possibility to monitor and control operational activities in the HINS facility.

The 325 MHz Cavity Test Cave Enter Key is required to unlock the interlocked Cave entry door. To obtain a permit to transmit RF power from the klystron into the Cave this key must be engaged in the 325 MHz Cavity Test Cave RMSS chassis. Otherwise, this key shall reside in the MCRMKT or in the possession of trained and authorized person. This key is to remain in the Meson Detector Building at all times.

3.2.4. 325 MHz Cavity Test Cave Reset Key

There is one key of the 325 MHz Cavity Test Cave Reset Key type. This key is used to reset the Cave interlocks following an access to the Cave and to provide the Main Control Room the possibility to monitor and control operational activities in the HINS facility.

The 325 MHz Cavity Test Cave Reset Key is required to reset the Cave interlocks. When not in active use, this key shall reside in the MCRMKT or in the possession of trained and authorized person. This key is to remain in the Meson Detector Building at all times.

3.2.5. 325 MHz RF Permit Key

There is one key of the 325 MHz RF Permit Key type. This key is used to switch the positions of the high power RF switching devices (waveguide switch, shutter, and coaxial switch), to control the Interlock System permit to the RF power equipment, and to provide the Main Control Room the possibility to monitor and control operational activities in the HINS facility.

The 325 MHz RF Permit Key is required to change the position of any of the high power RF switching devices via control locks in the 325 MHz RF Permit/Switch Control chassis. To obtain a permit to generate any RF power from the klystron, the 325 MHz RF Permit Key must be engaged in the appropriate lock in the 325 MHz RF Permit/Switch Control chassis. Otherwise, this key shall reside in the MCRMKT or in the possession of trained and authorized person. This key is to remain in the Meson Detector Building at all times.

3.2.6. 325 MHz Linac Enter Key

There are TBD keys of the 325 MHz Linac Enter Key type. These keys are used to control access to the Linac beam enclosure, to control the Interlock System permit to the RF power equipment, and to provide the Main Control Room the possibility to monitor and control operational activities in the HINS facility.

The 325 MHz Linac Enter Key is required to unlock an interlocked Linac entry door. To obtain a permit to transmit RF power from the klystron into the Linac enclosure, this key must be engaged in the Linac Safety System Key Tree. Otherwise, these keys shall reside in the Linac Safety System Key Tree or possession of trained and authorized personnel. These keys are to remain in the Meson Detector Building at all times.

3.2.7. 325 MHz Linac Reset Key

There is one key of the 325 MHz Linac Reset Key type. This key is used to reset the Linac enclosure interlocks following an access to the enclosure and to provide the Main Control Room the possibility to monitor and control operational activities in the HINS facility.

The 325 MHz Linac Reset Key is required to reset the Linac interlocks. When not in active use, this key shall reside in the Linac Cave Safety System Key Tree or possession of trained and authorized personnel. This key is to remain in the Meson Detector Building at all times.

3.2.8. Modulator Charging Supply Disconnect and Door Kirk™ Key

There is one key of the Modulator Charging Supply Disconnect and Door Kirk™ Key type. This key is used to control the position of the AC power disconnect switch for the modulator charging supply.

The Charging Supply Disconnect and Door Kirk™ Key is required to switch on AC power to the modulator charging supply and also to unlock charging supply or modulator doors. The key is captured in either situation to ensure that power cannot be applied with unlocked doors and that doors cannot be opened when charging supply may be energized. This key is to remain in the Meson Detector Building at all times.

3.2.9. Waveguide Shutter Kirk™ Key

There is one key of the Waveguide Shutter Kirk™ Key type. This key is used to mechanically lock the position of the waveguide shutter.

The waveguide shutter key is captured in the shutter mechanism unless the shutter is locked in the closed position. To transmit RF power into the RF Cage, the shutter must be opened and the shutter key will be captured in the shutter. The shutter cannot be locked in the open position. Access to the RF Cage requires that the RF power distribution system be locked off and tagged according to the 325 MHz RF Power Distribution System LOTO Procedure ADDP-RF-7902, Beams-doc #2701. As an additional measure to prevent RF power from entering the RF Cage, the shutter may be closed, locked, and the shutter key secured in a designated lock box. This key is to remain in the Meson Detector Building at all times.

3.3. Designated Key Locations

3.3.1. Personnel Safety Interlock Keys

According to Table 1, each Personnel Safety Interlock System key shall be located in one of the following designated locations in the Meson Detector Building at all times.

1. Personal possession of a trained and authorized person
2. Main Control Room Monitored Key Tree located in the Meson Control Room (MCRMKT)
3. 325 MHz RF Cage Rack Mount Safety System (RMSS) chassis located in Relay Rack PD-R6
4. 325 MHz Cavity Test Cave RMSS chassis located in Relay Rack PD-R6
5. 325 MHz RF Permit/Switch Control chassis located in Relay Rack PD-R6
6. 325 MHz Linac Key Tree (location TBD)

3.3.2. Modulator Charging Supply Disconnect and Door Kirk™ Key

Designated modulator charging supply disconnect and door Kirk™ key locations are shown in Table 2.

3.3.3. Waveguide Shutter Kirk™ Key

Designated waveguide shutter Kirk™ key locations are shown in Table 3.

| Key Type | Quantity | Area Enabled | Area Disabled | Area Unattended |
|---|-----------------|--|--|------------------------|
| RF Cage Enter (Safety Interlock System Key) | One | 325 MHz RF Cage RMSS | MCRMKT or authorized person | MCRMKT |
| RF Cage Reset (Safety Interlock System Key) | One | MCRMKT or authorized person | MCRMKT or authorized person | MCRMKT |
| Cave Enter (Safety Interlock System Key) | One | Cavity Test Cave RMSS | MCRMKT or authorized person | MCRMKT |
| Cave Reset (Safety Interlock System Key) | One | MCRMKT or authorized person | MCRMKT or authorized person | MCRMKT |
| 325 MHz RF Permit (Safety Interlock System Key) | One | 325 MHz RF Permit/Switch Control chassis | 325 MHz RF Permit/Switch Control chassis | MCRMKT |
| Linac Enter (Safety Interlock System Key) | Ten? | Linac Key Tree | Linac Key Tree or authorized person | Linac Key Tree |
| Linac Reset (Safety Interlock System Key) | One | Linac Key Tree | Linac Key Tree or authorized person | Linac Key Tree |

Table 1. Designated Locations for Personnel Safety Interlock System Keys for Stated Operational Status'

| Key Type | Quantity | Charging Supply Power Operation | Accessing Charging Supply, Modulator, klystron collector, or RF Power Distribution System | Area Unattended |
|--|-----------------|--|--|--|
| Modulator Charging Supply Disconnect Switch and Door Kirk™ key | One | Modulator charging supply disconnect switch or temporary charging supply Kirk lock | Possession of qualified modulator expert or Modulator door | Modulator charging supply disconnect switch, temporary charging supply Kirk lock, Modulator door, or other designated location |

Table 2. Designated Locations for the Modulator Charging Supply Disconnect Switch and Door Kirk™ Key for Stated Operational Status'

| Key Type | Quantity | 325 MHz RF Cage Area Operational | Accessing 325 MHz RF Cage Area | 325 MHz RF Cage Area Unattended |
|-----------------------------|-----------------|---|--|---|
| Waveguide Shutter Kirk™ key | One | Under control of qualified RF Cage Operator | Captured in Shutter (if shutter open) or in Designated Lock Box (if shutter locked closed) | Captured in Shutter (if shutter open) or in Designated Lock Box (shutter locked closed) |

Table 3. Designated Locations for the Waveguide Shutter Kirk™ Key for Stated Operational Status'