

# ACCOUNTABLE KEY SYSTEMS SUGGESTED DESIGN GUIDE

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## 1. Introduction

Accountable key systems (Key Interlock) which are to be used for personnel safety must meet ES&H Standard 1.5.1 and 1.5.2. The intent of such a system is to replace the standard Lockout and Tagout (LOTO) schemes but provide the same level of protection as a normal LOTO applied by an individual using a lock and tag .

In the standard system as defined in 1.5.1 **each individual working on the equipment must apply their own lock .**

In some instances this is accomplished by means of a lock box where the keys whose locks have been applied by a "responsible person" reside. Every worker then locks the lock box for their protection.

At the AGS there are two areas for which LOTO is required, namely the equipment processing the energy( e.g. power supply) , and the load where the energy is utilized( e.g. magnet). The LOTO scheme shall take both areas into account unless the load is "barriered" to prevent personnel from coming into contact with the energy.

For load isolation and MCR operational LOTO, a DC disconnect switch and a load grounding switch is preferred for many loads which are a considerable distance from their energy source . This is especially true for loads in the AGS / Booster Rings and the Beam Caves.

This guide is presented to afford a consistent approach to layout and selection of a key interlock arrangement so that personnel will use the system safely and with minimum loss of time to perform their work.

An accountable key system, generally called a Kirk Key system ( the major manufacturer of such locks), allows non-reproducible keys matched to locks permanently installed on equipment to replace the normal padlock arrangement.

It should be noted that these systems are also used for equipment protection by requiring workers to follow a predetermined route when starting up or shutting down a system.

## 2. QA Requirements

For a key system used as a LOTO device to protect personnel, a QA 1 review is required. This will involve a Department safety committee design review as well as Departmental approvals on drawings and purchase orders. See the AGS QA Manual for details.

For electrical systems the Chief Electrical Engineer will have to approve the design and for Mechanical systems the Chief Mechanical Engineer will have to approve the design.

Purchase orders for accountable keys and locks shall be initialed by the AGS Safety Officer and the order delivered to the AGS Safety Officer who shall record the key and lock numbers before installation is started.

### 3. Preliminary Design

Review the main hazards to be LOTO. Arrange equipment so the energy control devices are easy to operate and can accommodate the locks and any transfer key exchanges required. Remember that these locks can be provided with auxiliary contacts that can be used for signaling, status, and equipment protection.

**However, the contacts cannot be used to protect personnel in lieu of safety switches that remove all energy sources from the equipment to be worked on.**

**Minimize the sources of energy for the system.** High electrical power requirements are generally supplied from the 480 volt distribution system and in some cases from the 13.8 Kv distribution system. A fused disconnect switch should deenergize the entire system except where it is necessary to maintain control power with the normal power shut down. In this case it is preferable to have the controls at an inherently safe voltage level such as 24v DC.

For electrical systems a one line diagram showing the power inputs (including control power) must be clearly identified and labeled. This drawing is to be classified as QA 1 since it involves personnel safety. The original and all changes to the drawing must be signed off by the Chief EE and distributed as required by the AGS OPM and QA Manual.

A separate drawing showing the Key diagram superimposed on the one line must also go through a QA 1 review. It is on this drawing that each lock is given a unique ID and should become part of the purchase requisition and PO. The individual key numbers are assigned by the manufacturer who shall be instructed not to duplicate any other keys/locks already purchased by the AGS.

The only exceptions are locks to be integrated into an existing design.

To maintain the concept of "locking and unlocking" a key exchange with more than one key in the unit, should have the key that releases or locks the remaining keys be the one that turns the exchange. Kirk calls this key the "E" key and is the one closest to the bolt ( or where the bolt would be if there was a bolt).

### 4. Detailed design

A flow diagram is a good design tool when it shows each switch, lock and door that will be impacted. Separate "locking" and "unlocking" paths will help to visualize any unsafe possibilities.

equipment interlocking BUT cannot be used to protect personnel **in place of locks on energy control devices**. If you use a contact to trip control power when a key is turned the workers will still have to lockout the control power CB to assure their safety.

Example 1: A simple Kirk key system is shown in figure 1.

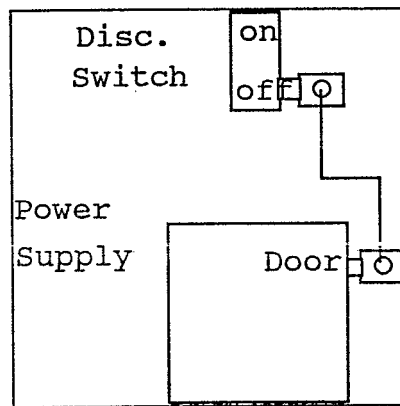


Figure 1

1. When the disconnect switch is "ON" the key is captured in the lock on the switch.
2. The disconnect switch is thrown into the "OFF" position allowing the key to be turned, locking the switch in the off position, because the bolt extends and prevents the switch from being moved to the closed position.
3. The key is removed and is used to open the power supply door. When the key is turned the bolt retracts allowing the door to be opened. In this position the lock captures the key.
4. To re energize the power supply the door is closed and the key turned locking the door and releasing the key.
5. The key is then placed into the switch lock, turned, and captured. The switch can then be thrown into the closed "on" position restoring power.

Note:

If more than one person is going to work on the equipment some means of capturing the door key must be employed, or other means of providing extra keys **to allow each person to maintain the LOTO** is required.

For example, if the disconnect switch is designed to accept safety locks, in addition to the Kirk locks, the switch could be LOTO in the normal manner for those cases where many people work on the equipment.

An alternate is to make the switch exchange with multiple keys which would be released when the switch is locked. Until all the keys are returned the disconnect could not be unlocked.

Example 2:

A sample scheme for a Power Supply with two doors and a control panel is shown in figure 2.

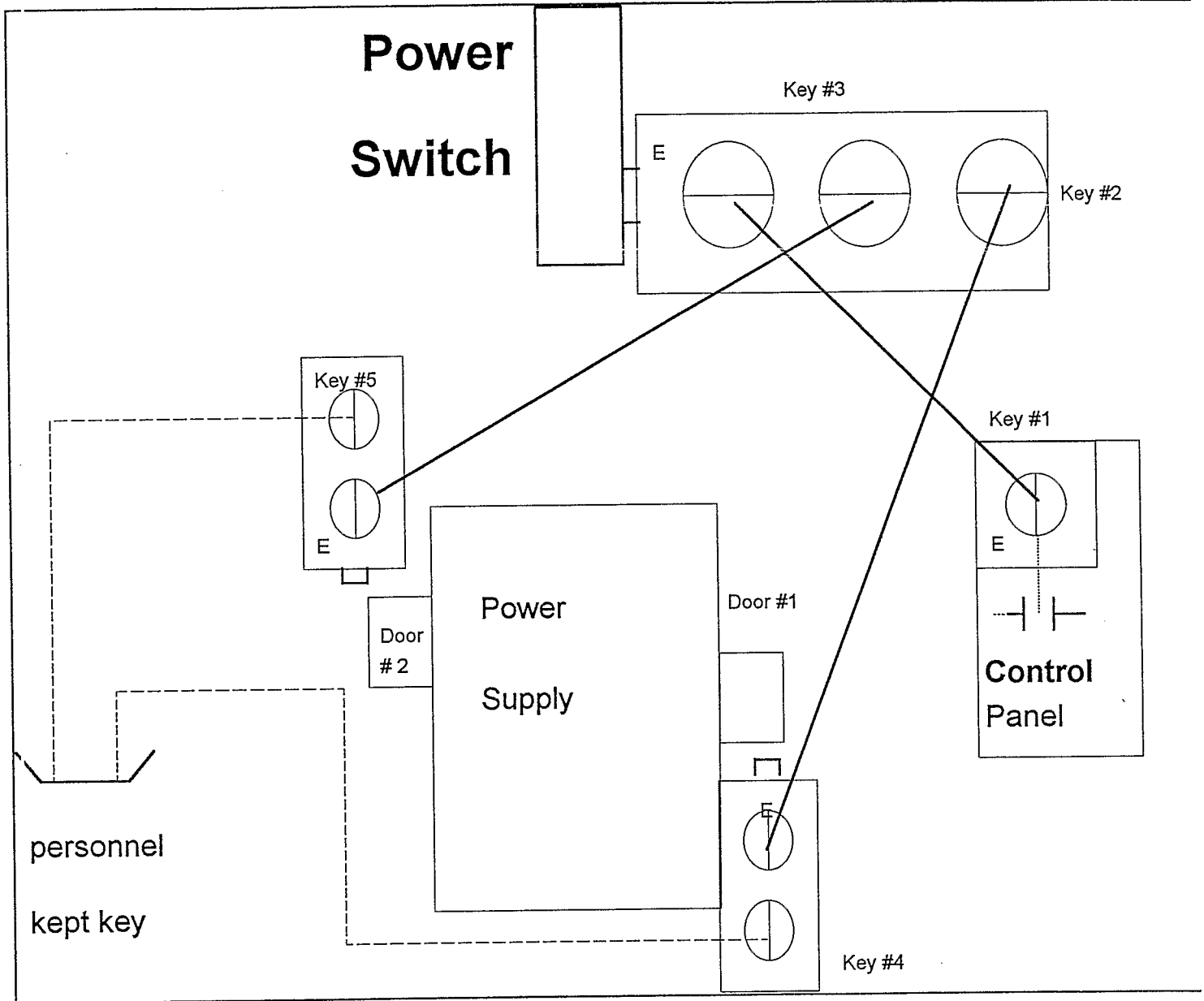


Figure #2

1. With the power switch in the "ON" position Keys # 2 & 3 are captured in the lock and Key #1 is released.
2. Key # 1 Is then placed in the Control Panel lock, turned and captured. The interlock mechanically tied to the lock bolt then permits control power to be energized.
3. To gain entry to the Power Suplly key #1 is turned de-energizing the control power and releasing the key.

4. When the Power Switch is placed in the "OFF" position the key exchange is turned releasing Keys #2&3.
5. Door #1 is opened with Key #2 and Door #2 by Key # 3 capturing these keys and releasing keys #4 and / or #5 for personnel safety. Note that the door cannot be locked without the return of the Personnel key and that the power switch exchange cannot be operated without both doors locked and both keys returned to the exchange.
6. Returning the keys and closing the doors allows the bottom "E" key(#2 & 3) to be turned and then placed in the power switch exchange.
7. The bottom "E" key #1 for the power switch can be turned UNLOCKING THE POWER SWITCH and permitting the operator to close the power switch. This "E" key #1 is then placed in the control panel exchange, turned and with an interlock switch built into the exchange, the control power logic is satisfied to permit operations.

Note:

This scheme is based upon having the control power isolation controlled by the power switch. If a separate source of control power is used and it is the range requiring LOTO then a separate switch and key would be required.

If this system was to be LOTO by the MCR to permit Ring or Cave Access, then an additional key would have been added to Key Exchange #3 permitting the MCR to prevent energizing the system by not returning their key until the Ring was safe.

There are many variations of this scheme depending on the complexity of the system to be locked.



### Example 3:

If the Power supply arrangement had a capacitor bank to be discharged before entry was permitted, a separate grounding switch should be added to the equipment. Most designs have an automatic shorting switch such as a vacuum contactor which drops out when interlocks detect loss of AC power( off button or loss of input AC or door interlock).

**OSHA does not allow credit for this as a safety lock.**

The scheme shown can be arranged to accommodate a manual shorting switch as shown in figure 3.

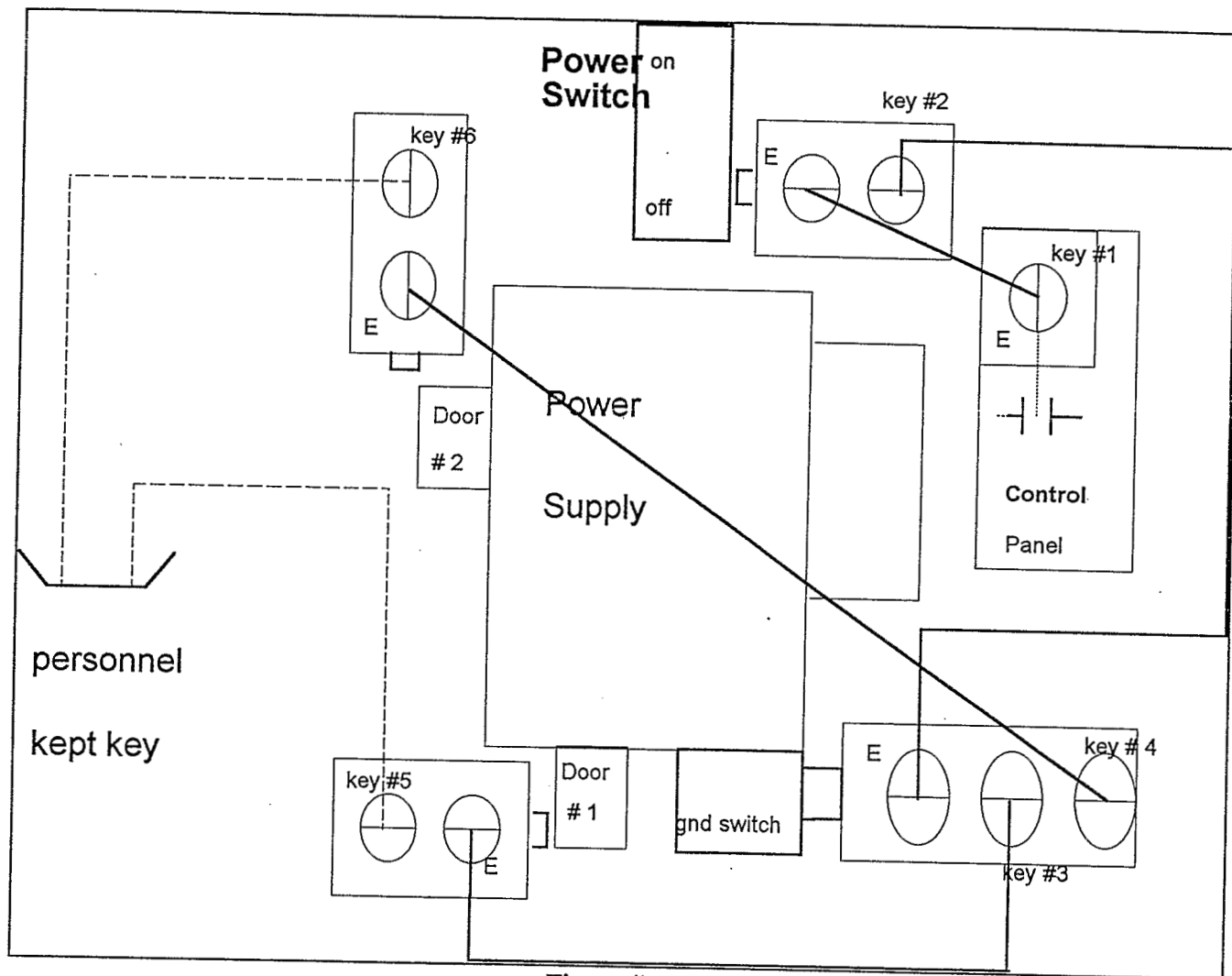


Figure #3

In this configuration the sequence of unlocking to enter the power supply is:

1. Turn off power supply with controls
2. Turn control panel key to release key #1. Place in power switch exchange.

3. Turn off AC Power switch and lock in open position. This will capture Key # 1 and release Key #2
4. Place key #2 in ground switch exchange.
5. Throw Ground switch and lock in Ground position by turning key #2. This will capture Key # 2 and release Keys # 3 & # 4.
6. Remove keys # 3 and #4 to open doors.
7. Open door by placing key # 3 or # 4 in the door exchange. Turn exchange This will capture Key # 3(4) and release key ( #5 or 6) to maintain LOTO.
8. To operate the power supply, reverse the steps.