# Worldwide Pollution Control Association

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# Precipitator Hazards

**Presented by**
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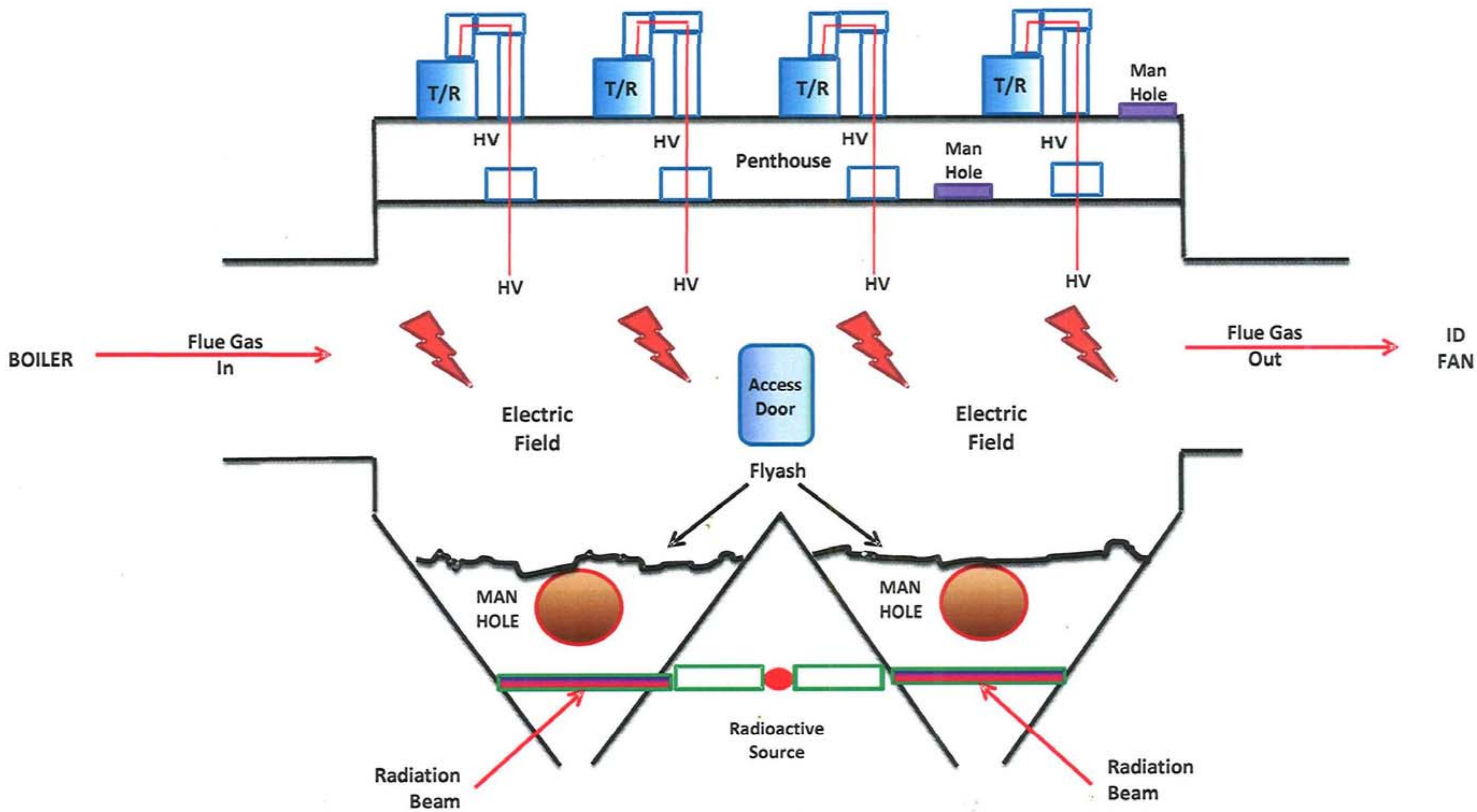
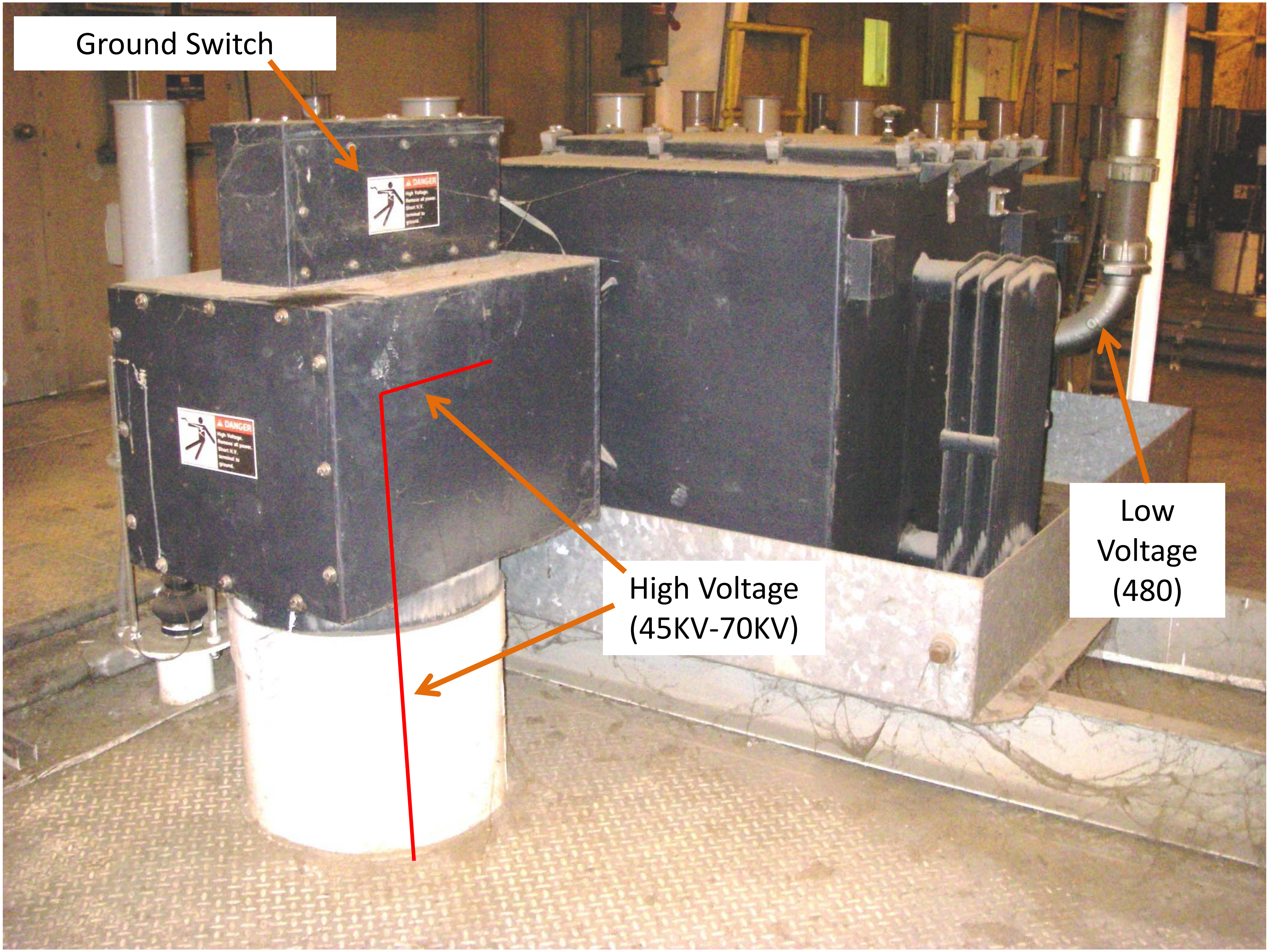
# Hazards

- Electrical-HV and LV
- Nuclear Level Detectors
- Flyash
- Flue Gas
- Other


T/R
T/R
T/R
T/R
Man
Hole
HV
HV
Penthouse
HV
Man
Hole
HV
HV
HV
HV
HV
BOILER
Flue Gas
In
Access
Door
Flue Gas
Out
ID
FAN
Electric
Field
Electric
Field
Flyash
MAN
HOLE
MAN
HOLE
Radioactive
Source
Radiation
Beam
Radiation
Beam


Ground Switch
High Voltage
(45KV-70KV)
Low
Voltage
(480)

# Electrical HV

The voltages on the output of a T/R set are normally between 45KVDC to 70KVDC on the average. Peak voltages can run 85KV or higher. The output current can run as high as 1000mA or more depending on the rating. 1mA can be felt, 100mA can kill.

A concern with high voltage is the ability to arc from high potential (T/R bus or bushing) to low potential (Ground or something grounded). Plate to electrode spacing for a 70KV precipitator is 8 inches (or 16 inch plate spacing).

# Data from T/R Nameplate

- Input 460 V  217 A
- Output 70 kV 1000mA   99.8 KVA
- NWL: 36697     Serial number 92-0996
- Mfg. 7-92     135 gal of R temp liquid

- As you can see from the nameplate, there is a great deal of power available.  99.2 KVA in this example can power a thousand 100W lightbulbs or 82 hair dryers or heat 6 average homes.  That is how much power will flow through you, between your hand, through your body and out your foot or leg, whichever is closest to ground.  Actually the power is probably higher given the precipitator is akin to a large capacitor and it’s also discharging through you too.

- Regardless of the exact amount of power that is available, there is enough to do major damage to human flesh, quite often resulting in death. Even small T/R sets (45KV/300mA) will produce more than enough power to hurt or kill.

**BE Careful**

**Know what you are dealing with and follow procedures**

# Working on the HV Bus

- When possible work on the bus when the entire precipitator is off-line.
- Regardless, the T/R you are working on has to be isolated, confirmed off-line and the HV bus is grounded.
- Initially the grounding is done at the T/R at the HV bushing.
- Ground the HV Bus between the work area and the load/penthouse/electrode.  Work between grounds with grounds on either side of you.

# Working on the HV Bus with an installed HV Capacitor


Isolate the T/R set and ground the HV bus on both sides of the HV Capacitor. Ground the T/R first at the bushing. Uncover the Capacitor and ground it. Expose the bus between the capacitor and Precipitator (load) box and ground the bus.

# Confirming the bus is grounded

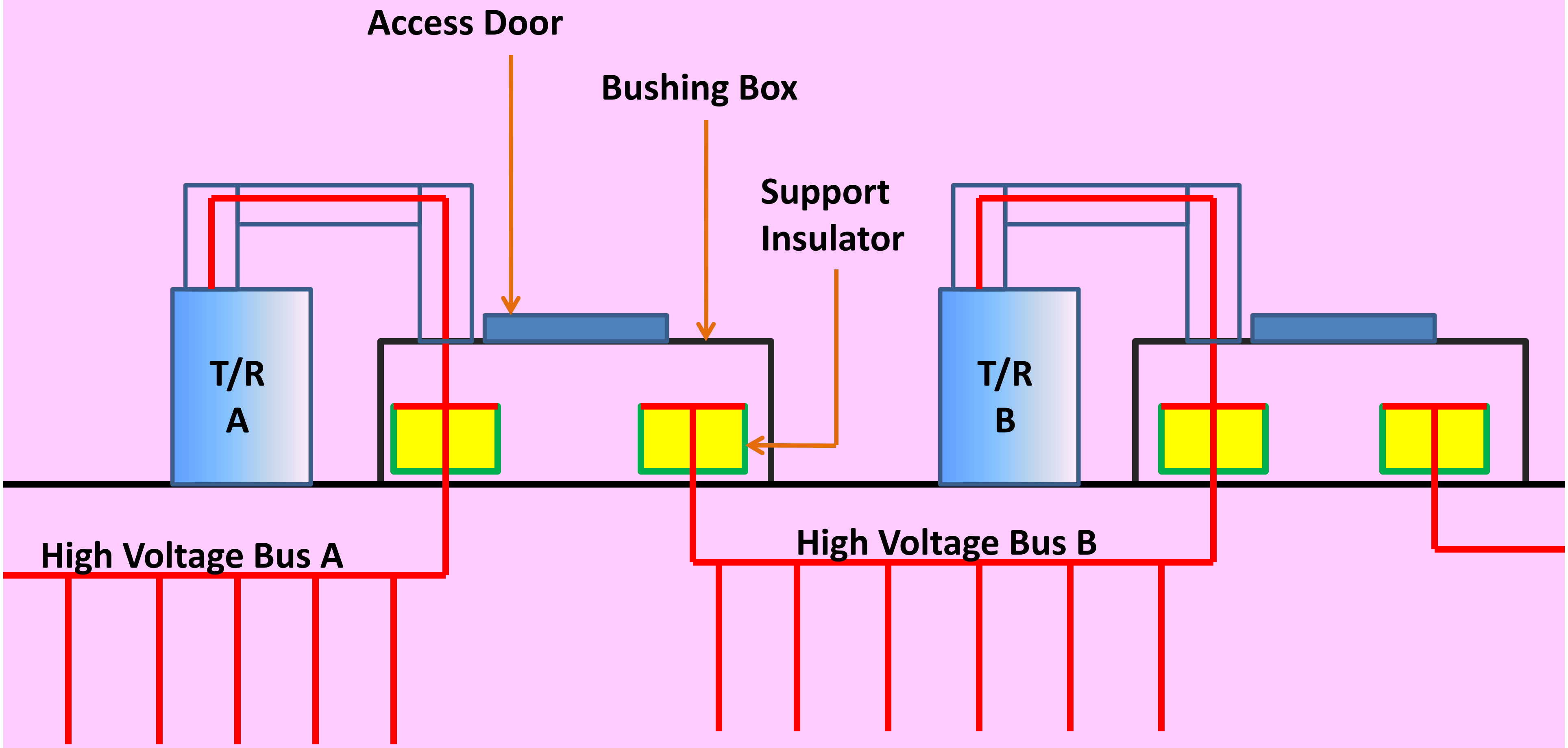
- There isn't too much out there I'm aware of to check the voltage on a HV DC bus. I am in the process of ordering an instrument we will use to check bus that is grounded. It is a Bierer & Associate PD50, which can measure up to 50KV DC. I don't intend to measure DC High Voltage, but only to confirm that there is no HVDC on a bus. (This is not an endorsement.)

# HV DC Tester


PD25/50
METER FUNCTION SELECTOR SWITCH
OFF
Unit Off for Storage & Transit
2KV
Voltage Measurements 0 - 1999 Volts
20KV
Voltage Measurements 0.10 - 19.99 kV
25/50
Voltage Measurements 00.1 - 25.0/50.0kV
TEST
Internal Battery Test
DANGER
METER HOUSING SHALL BE CONSIDERED NON-INSULATING. METER SHOULD NOT BE USED AS AN INSULATING TOOL. SEE OPERATING INSTRUCTIONS BEFORE USE.
PD25/50


20KV
2KV
50KV
OFF
TEST
Patent Number
6,459,252

# Isolating T/R A will not de-energize the inside of a bushing box, if T/R B is still energized



# Low Voltage Side of a T/R

- Don’t let the term *low voltage* make you too complacent.  Typically this is 480V (or 575) and there is plenty of available power to harm.
- Arc Flash is a big concern today and there are new procedures and PPE requirements that have been implemented in most companies.

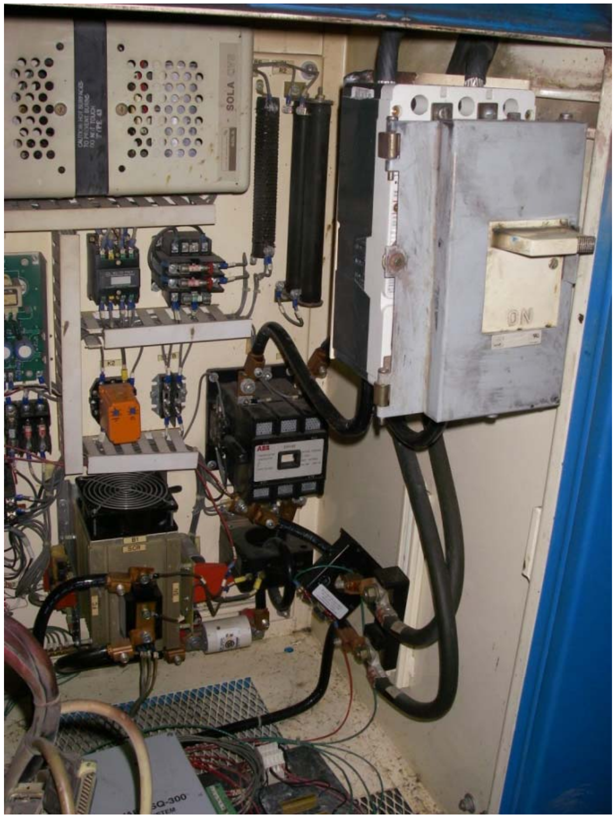
# Be aware of 480 Volt Hazards

- Always check to make sure the circuit is de-energized.
- Some Utilities have moved test points to the door.  KV, mA, Primary Amps and Voltage can be checked at the door without opening the door.

# Heat from 480 Volt Connections

- Heat is a big hazard that doesn’t get enough attention. An electrical connection that is going bad will generate a lot of heat. When it gets hotter, it becomes more resistive and this cycle goes on to failure leading to an arc flash in many cases.

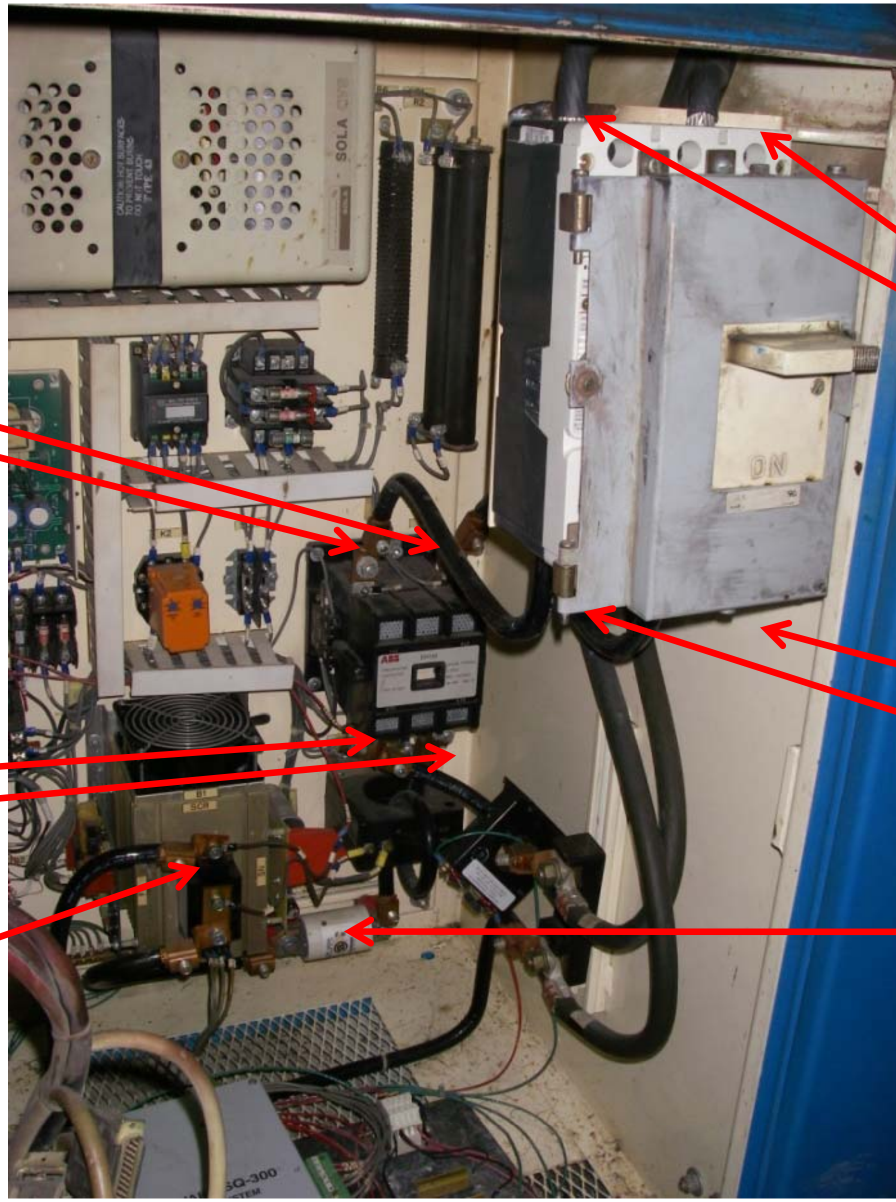
**This cabinet had an arc flash that melted a power cable and required the contactor and breaker to be replaced. You can still see evidence of the heat after repairs**



# Use an IR Camera for heat detection

Fluke IR Camera


# Temperature Checks in a T/R control cabinet



Check Breaker connections

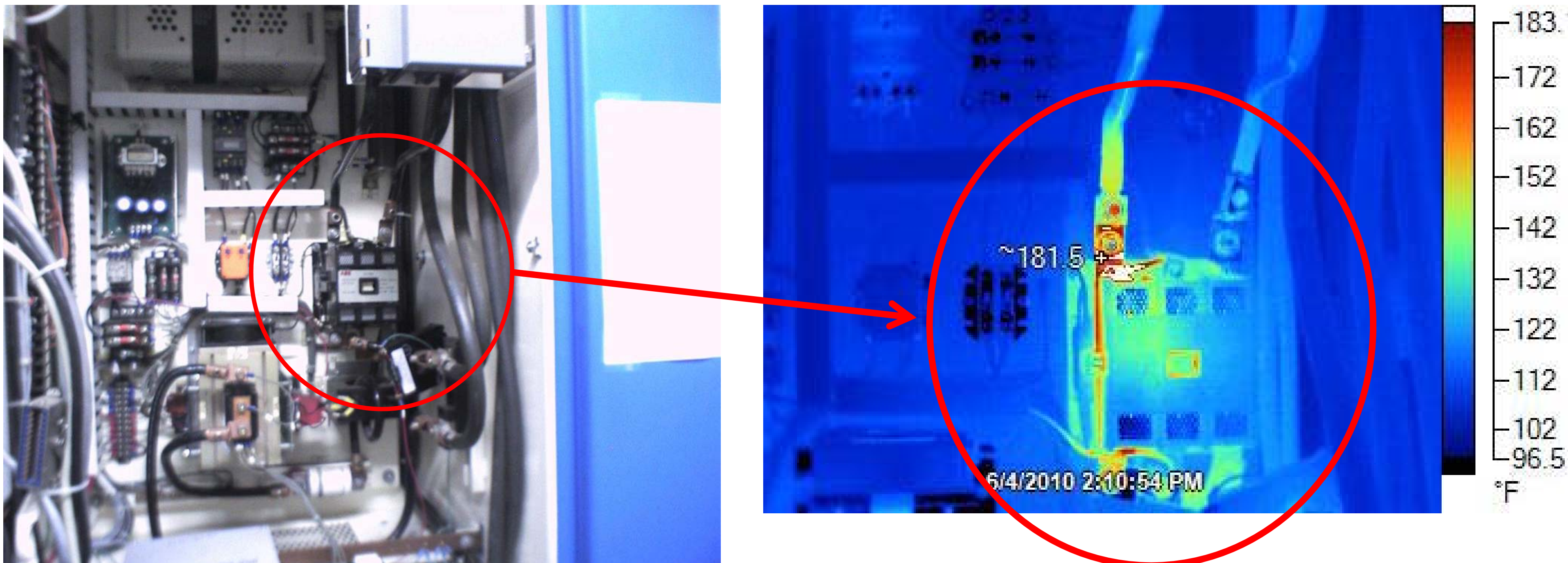
Check Contactor Connections

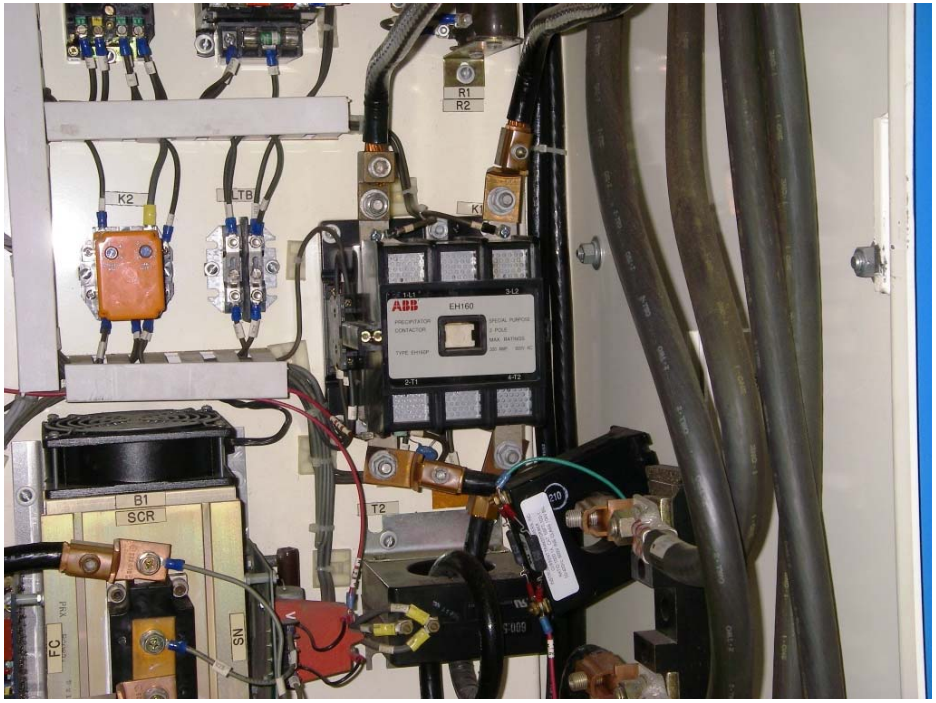
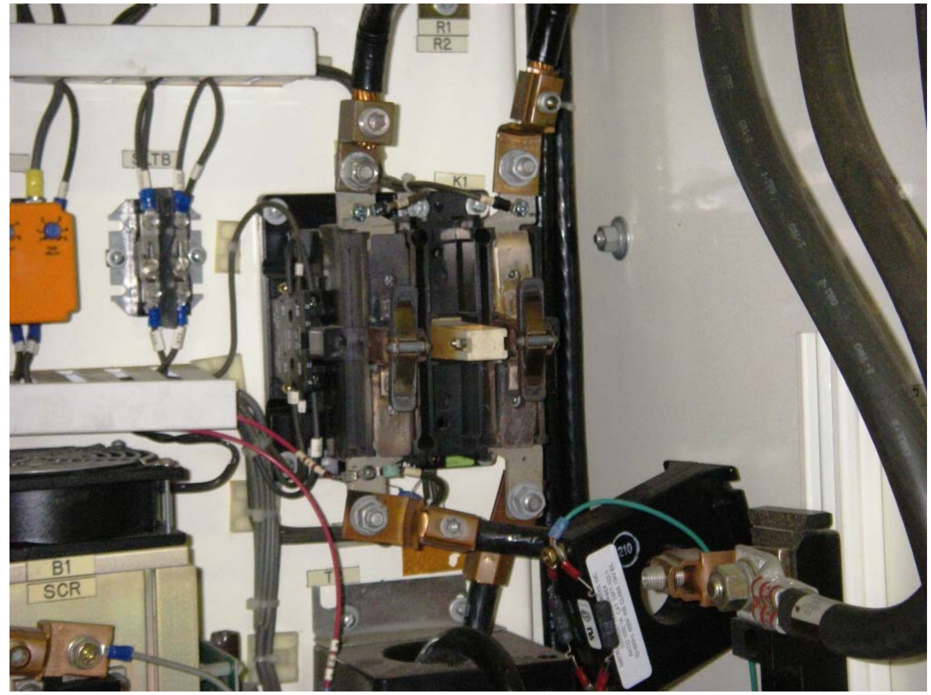
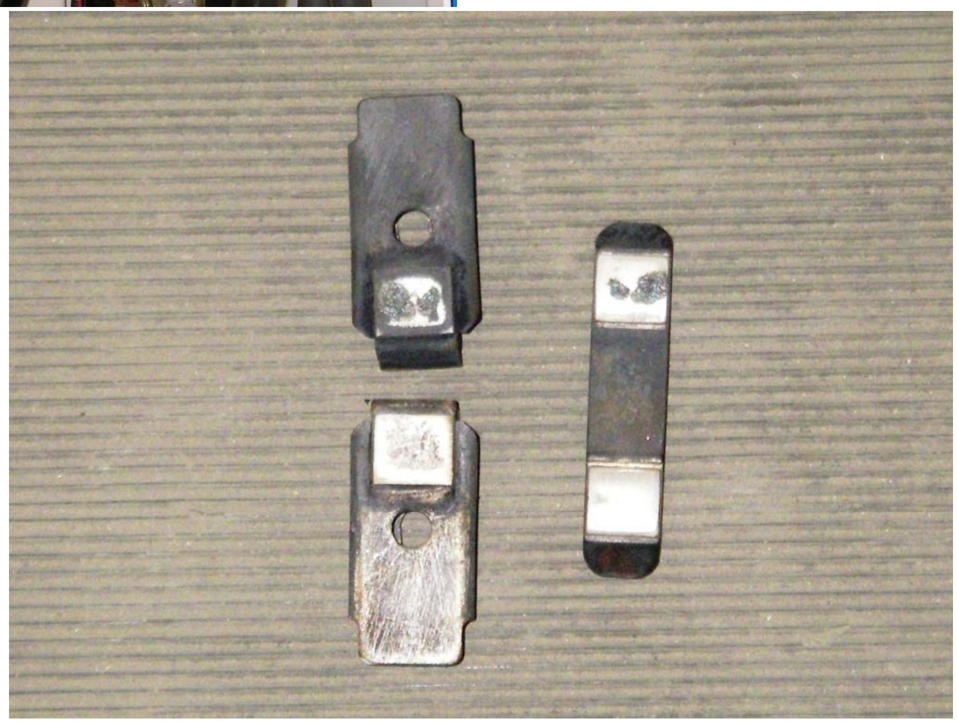
Check Fuse Temperature

Check SCR Temperature

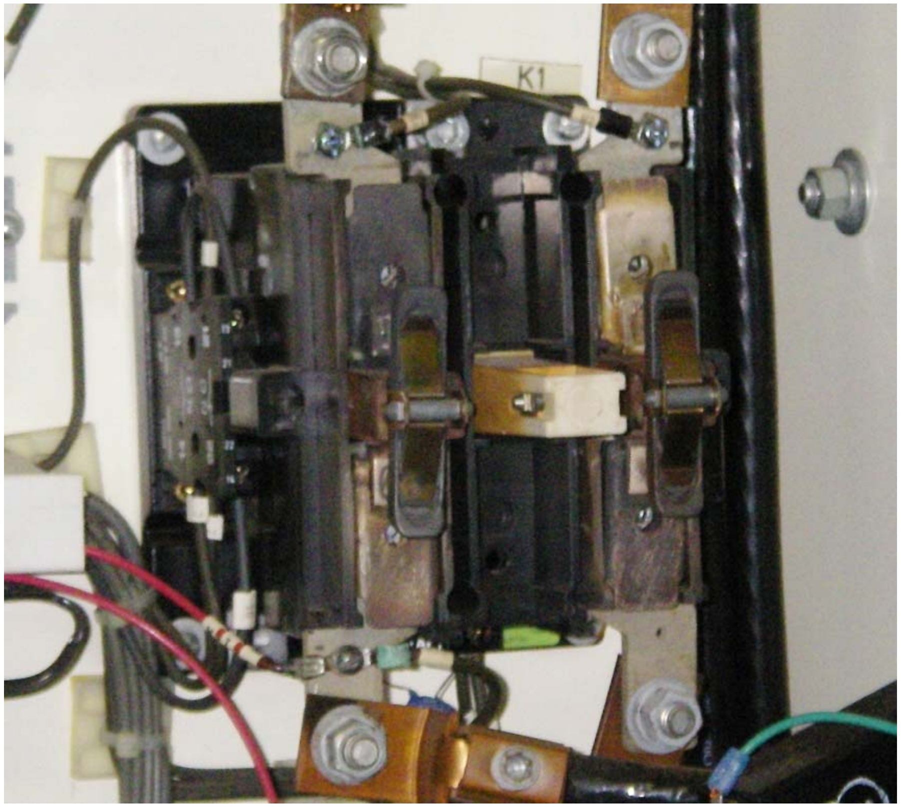
Note: A hot fuse will transfer it's heat to the contactor through the cable.

# Hot Contactor




R1
R2
K2
LTB
K1
ABB
EH160
B1
SCR
T2

R1
R2
LTB
K1
B1
SCR


# Close up of hot contactor




**Sample of a spread sheet tabulating the temperatures for connections and some equipment in a T/R control cabinet.**

•Primary Amps are logged

•Control Limit is noted, i.e. “Spit Spark, Primary Current, Secondary Voltage, SCR Limit, Secondary Current, Primary Voltage, etc.

•Connection temperatures for the breaker and contactor are noted.

•The fuse and SCR temperature are noted.

•The comment is for any performance note.

•The color code denotes “Monitor” or “Action Needed”.

**Unit 6 T/R set cabinet thermography data tabulation**

Date of data:6/14/10

Time of data: 1416

Taken by John Walker and Ray Stasi

All connections were scanned.

| | | | Unit 6 must be off to fix | | Outage Gray Zone | | Unit 6 can be on line | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Top of Breaker | | Bottom of Breaker | | Top of Contactor | | Bottom of Contactor | | Fuse | SCR | |
| T/R | Primary Amps | Control Limit | Left | Right | Left | Right | Left | Right | Left | Right | | | Comment |
| 1A-1 | 20 | PRI | 100 | 101 | 98 | 100 | 102 | 105 | 100 | 104 | 97 | 91 | nternal Close Clearance. This got better when the unit was off-ine for a day. Then it got bad again when it warmed up. |
| 2A-1 | 125 | Pri I | 123 | 128 | 123 | 126 | 130 | 133 | 123 | 128 | 142 | 105 | |
| 3A-1 | 161 | KV | 134 | 133 | 128 | 129 | 137 | 144 | 130 | 138 | 159 | 98 | |
| 4A-1 | 175 | Pri I | 128 | 134 | 134 | 134 | 151 | 145 | 135 | 131 | 147 | 95 | |
| 1A-2 | 163 | Pri I | 138 | 151 | 143 | 143 | 150 | 147 | 128 | 137 | 148 | 111 | |
| 2A-2 | 150 | KV | 140 | 137 | 132 | 134 | 131 | 137 | 121 | 127 | 130 | 113 | |
| 3A-2 | 175 | Pri I | 140 | 140 | 125 | 130 | 130 | 132 | 130 | 119 | 135 | 118 | |
| 4A-2 | 202 | KV | 135 | 127 | 124 | 127 | 127 | 138 | 121 | 126 | 142 | 118 | |
| 1B-1 | 92 | SS | 93 | 93 | 102 | 102 | 105 | 104 | 99 | 104 | 107 | 91 | |
| 2B-1* | 154 | SCR | 130 | 123 | 135 | 152 | 134 | 139 | 133 | 140 | 160 | 134 | |
| 3B-1 | 175 | | 112 | 118 | 126 | 120 | 119 | 123 | 122 | 123 | 150 | 125 | |
| 4B-1* | 175 | | 115 | 113 | 124 | 124 | 128 | 125 | 128 | 135 | 143 | 126 | |
| 1B-2 | 163 | | 123 | 126 | 124 | 124 | 133 | 135 | 122 | 138 | 131 | 115 | |
| 2B-2* | 163 | | 141 | 140 | 140 | 144 | 135 | 148 | 138 | 139 | 148 | 146 | |
| 3B-2* | 175 | | 129 | 128 | 132 | 134 | 142 | 147 | 127 | 134 | 154 | 154 | |
| 4B-2* | 175 | | 141 | 137 | 131 | 135 | 136 | 145 | 133 | 141 | 146 | 158 | |

= Action needed

= Monitor

**12/9/08** All fans fixed. All contactor connections tightened. Bottom Breaker connections tightened. Still need to replace or tighten breaker connections.

**2/27/09** Extensive work done to connections. One SCR replaced. Several contactor contacts cleaned. Cable and breaker replaced on 2B-2. 1B-2 and 2B-2 placed back in service. One hot bus connection needs to be repaired on next outage. This connection is on 2B-1, upper left cable from breaker to bus connection. "A" side ventilation set up for "bottom to top" air movement, while "B" side is left as "top to bottom" air movement.

**6/2/2010** IR scan accomplished. Work orders written for corrections.

**6/7/10** IR scan of connections that were addressed per 6/2/10 scan. These temperatures were due to air load which will produce the highest amp readings, thus temperatures.

**6/14/10** IR scan. All connections were checked, unlike last time when only fixed connections were scanned.

Taken by John Walker and Ray Stasi

All connections were scanned.

| T/R | Primary Amps | Control Limit | Unit 6 must be off to fix: Top of Breaker Left | Top of Breaker Right | Outage Gray Zone: Bottom of Breaker Left | Bottom of Breaker Right | Unit 6 can be on line: Top of Contactor Left | Top of Contactor Right | Bottom of Contactor Left | Bottom of Contactor Right | Fuse | SCR | Comment |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1A-1 | 20 | PRI | 100 | 101 | 98 | 100 | 102 | 105 | 100 | 104 | 97 | 91 | Internal Close Clearance. This got better when the unit was off-line for a day. Then it got bad again when it warmed up. |
| 4B-2* | 175 | | 141 | 137 | 131 | 135 | 136 | **145** | 133 | **141** | **146** | **158** | |

= Action needed

= Monitor

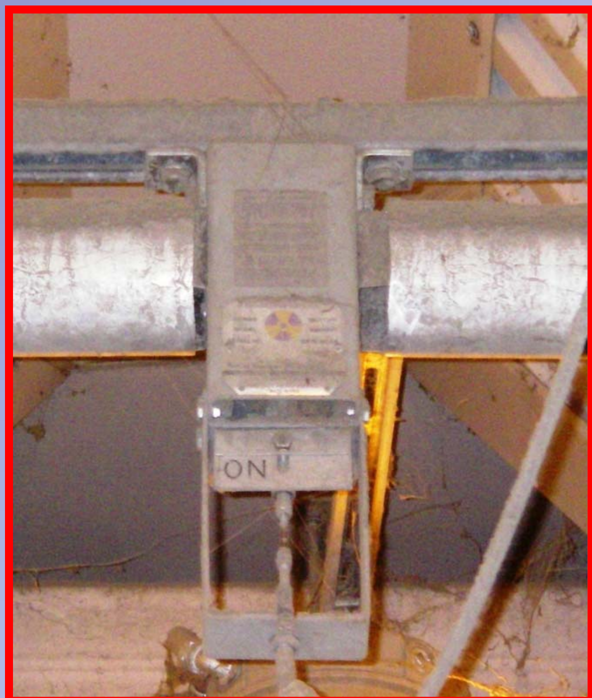
# Legend on Limits

SS =Spit Spark
KV = Sec Volt limit (Peak or Ave)
Pri I = Primary Current Limit
Sec I = Secondary Current Limit
Pri V = Primary Voltage limit
SCR = SCR firing angle limit

Note: Nameplate limit on current is 163 amps for first 2 fields and 217 amps for last 2 fields.

**Head off problems by checking connection temperatures. Reduce temperatures by limiting current through the control. Keep in mind $W=I^2R$. A linear current change results in a non-linear heating affect. Repairing the problem is best, but not always possible. Running a de-rated T/R is better than not at all or keeping it on at full rating and creating a failure and a potential health hazard.**

# Nuclear Hopper Level Detectors




**This photo shows the source and the mechanical indicator shows "ON". A mechanical lever located via cable at the ground level actuates this radiation shutter.**

**The source in this case is a Cesium 137 Isotope with an activity of 100 mCi. This particular design can hold as much as 200 mCi, but normally holds 20, 50 or 100 mCi.**

# Nuclear Hopper Level Detectors

- Normally the source is located between two hoppers and the radiation beam is trained to go through the hoppers on either side of it. There is a Geiger-Mueller tube on the other side of the hopper that produces a signal count. The count is relative to the beam path obstruction. When there is dust in the beam path, the count drops to a certain level and triggers the alarm that the hopper is "Full".
- The aluminum tubes on either side of the source are there to keep people from getting into the beam path outside of the hopper. These tubes do not "train" the beam or block radiation.

# Nuclear Hopper Level Concerns

- The radiation source should be shut off when working in the beam path, typically when inside the Precipitator hopper or trouble shooting and repairing the Geiger Mueller tube.
- The source is easily blocked with the lever activated shutter. This lever can be locked or part of a Castell (or Kirk) Lock system.
- The absence of the radiation beam can be confirmed with a Geiger Counter.

# Additional Information

- Any work on the shutter, actuator, cable or housing for the nuclear source must be done by a certified technician.  Normally there is no one at the plant or even in your company that can do this.  Therefore this is work that must be outsourced and quite often accomplished by the OEM.

# Fly Ash Concerns

- The reason for Precipitators is to collect fly ash created from burning some kind of carbon based fuel, usually coal.
- Fly ash temperatures in the hopper can range from around 300 F on a cold side Precipitator to +700 F on a hot side Precipitator.
- Be sure the fly ash is cool enough to be around. Experience and monitoring gas temperatures will give you an idea when the time is right. If in doubt, confirm the temperature with an IR gun.

# Fly Ash Concerns

- Not all coal (fuel) burns and there can sometimes be a substantial amount of unburned carbon (LOI=Loss On Ignition) in the fly ash.  Be aware of this as it can lead to a precipitator fire and/or clinkers.  These clinkers can smolder and be the source of ignition or gases.  Pulling the dust out of a hopper of course is needed to get the dust out.  It doesn't hurt to ask operations to pull it one more time, if they aren't sure it hadn't been done prior to/or on their shift.

# MSDS for Flyash

- ** PERCENTAGES **

| | HIGH % | LOW % |
|---|---|---|
| AMMONIA | LESS THAN 0.02% | |
| ALUMINUM OXIDE | 28 | 24 |
| IRON OXIDE | 15 | 8 |
| SILICA, AMORPHOUS | 65 | 50 |
| SILICA, CRYSTALLINE | 10 | 1 |
| CALCIUM OXIDE | 3 | 1 |
| MAGNESIUM OXIDE | 1.0 | 0.7 |
| POTASSIUM OXIDE | 6 | 1 |
| TITANIUM DIOXIDE | 1.0 | 0.5 |
| SODIUM OXIDE | 0.8 | 0.4 |
| METALS (NOTE 5) | < 0.1% | |

# MSDS for Flyash

Note 5 - FIVE METALS (AND/OR THEIR COMPOUNDS) THAT ARE LISTED BY NTP, IARC, OR OSHA AS CARCINOGENS ARE SOMETIMES FOUND IN ASH IN TRACE CONCENTRATIONS. THESE INCLUDE: ARSENIC,BERYLLIUM, CADMIUM, CHROMIUM, AND NICKEL.

# Inorganic Arsenic

- Use respirators, coveralls, gloves and other personal protective equipment as specified by supervision or health and safety for work in inorganic arsenic regulated areas.
- Vacuum coveralls (and shoes) with a HEPA vacuum before breaks and lunch and at the end of the work shift if wearing coveralls out of the regulated area. Note: Leave the respirator on while removing contaminated coveralls.
- Wash face and hands prior to break. Shower at the end of the work shift.

# Inorganic Arsenic

- Never shovel or sweep flyash and dust particulate (slag) unless vacuuming or other relevant methods (wet wash down) have been tried and found ineffective.
- Where protective clothing and equipment is required for inorganic arsenic protection, use change rooms, with separate contamination-free storage facilities for street clothes.
- Do not take contaminated clothing home.
- Do not wear dusty or contaminated clothing into break rooms, lunch rooms or other areas where food and drink are stored or consumed.

# Inorganic Arsenic

- Ensure that inorganic arsenic-contaminated protective clothing is:
  - Removed at end of the task or end of the shift (whichever comes first); and
  - Placed in closed container and labeled as follows:

  CAUTION-Clothing contaminated with inorganic arsenic.
- Do not remove dust by blowing or shaking. Dispose of inorganic arsenic contaminated wash water in accordance with applicable local, state or federal regulations.

# Inorganic Arsenic

- Remove contamination from coveralls (or other clothing), using a method that does not put dust into the air (e.g. vacuum dust from work clothing with a HEPA vacuum).
- Where used, empty or change HEPA vacuums/filters in accordance with department or site work practice to minimize exposure and to ensure appropriate waste disposal.
- Never blow off, shake off, or do anything else to contaminated materials that could send dust or particulate debris into the air.
- Never carry coveralls, protective equipment, or other contaminated materials home.
- Certain activities, such as eating, drinking, smoking, chewing gum or tobacco, or applying cosmetics, are prohibited in regulated areas.

- Reference-OSHA 1910.1018

# Inorganic Ash Safe Work Practices

- **<u>Washed/vacuumed precipitator</u>.** A precipitator is considered to be suitably cleaned once it has been thoroughly washed down inside from top to bottom in order to remove accumulated scale and fly ash on the plates, wires and walls. Minimal residual fly ash (as identified by the equipment owner) shall remain inside of the precipitator. Note: Special attention must be paid to horizontal surfaces and "pockets" where ash may accumulate. This wash down includes washing all plates and wires and the removal of any residual fly ash in the baffle plates and ash hoppers. Dead air spaces shall be vacuumed as needed to facilitate work and to meet this definition of a "washed precipitator".

# Safely Inspecting Precipitators

- Inspections are required because:
  - The Environmental Operating permit requires it.
  - Performance indicators are bad:
    - Opacity
    - Power
    - Sparking
  - T/R Open Circuit Test indicates the problem is inside the Precipitator
  - An electric field operates poorly when it heats up

# Safely Inspecting Precipitators

There are primarily 4 processes/procedures that most plants implement to keep the inspection team safe:

- Lock Out Tag Out (LOTO)
- Key Interlock
- Confined Space
- PPE

# Lock Out Tag Out

Different Plants have different names for this procedure, such as “Hold Card” or “Red Card”. Some even use actual locks. The idea is to isolate and secure all forms of energy and other harmful elements from someone working in an area not normally accessible when the unit is operating.

# Lock Out Tag Out

The procedure for one plant looks like this:

- Isolate FD Fans (Pushbuttons and breakers)
- Close Ignition Oil Supply Handwheel
- Close Ignition Oil Vent Handwheel
- Open and rack out 2400V breaker for the precipitator
- Check (2) Dampers are closed for stack duct and drive breakers are opened.
- Check Damper Seal Air fan is on between the 2 dampers.

# Lock Out Tag Out

Three fundamental areas are addressed:

- The Boiler cannot be started because the FD fans are not available and the fuel oil is shut off.
- The electrical power to the T/R sets is off and isolated.
- Gas from other units cannot back feed into the precipitator because the stack/duct dampers are closed and the seal air is on.

# Lock Out Tag Out

Notes:

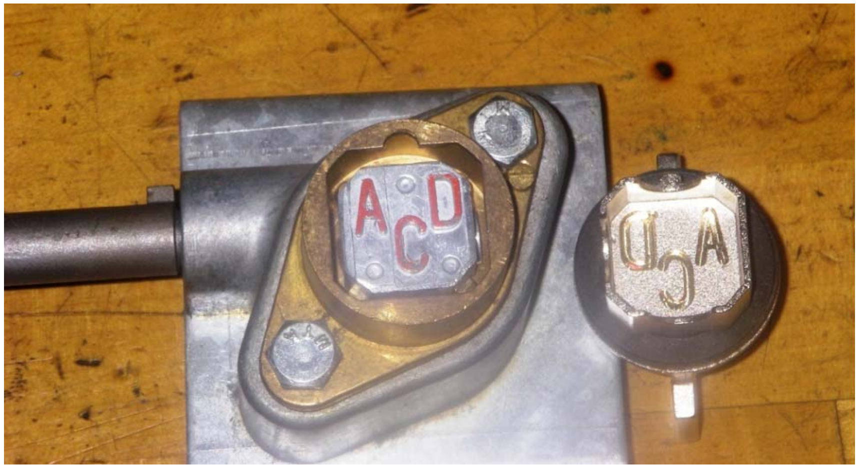
- The ID fan(s) are left on to keep fresh air flowing into the boiler and precipitator. A duct door between the precipitator and the dampers is opened to allow the air to exit.
- The procedure in this case does not address purge air heaters for the penthouse. These have local controls.

# Key Interlock

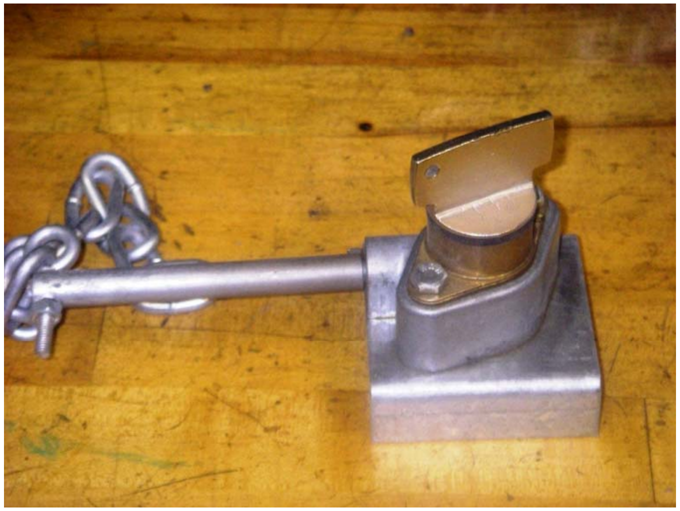
The key interlock procedure is known popularly as the Castell Key or Kirk Key interlock.  My plant uses the Castell system so that is what will be illustrated.  Both systems are similar in operation.

# Key Interlock

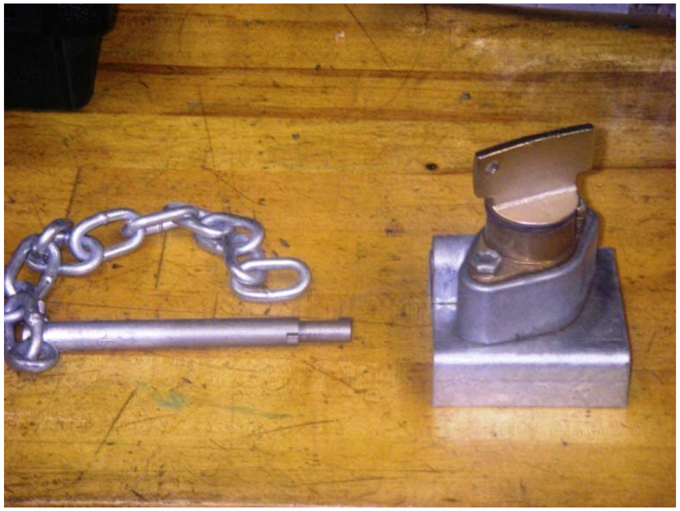
**1.) Engraving on Key and Lock match. You can't get the wrong key in the lock and make it work.**




**2.) Insert Key and rotate.**



**3.) The door rod can be rotated and removed. The door lock is removed and door can be opened.**



# Keying Procedure Example


**This is 1 of 2 examples of shutting off the electric power to a T/R.**

- Turn off the control by reducing primary amps or KV. Do this over a period of time until the KV is less than 15KV, where corona occurs. This will minimize the release of dust from the plates and spiking when control is off.
- Rotate Castell lock key to off position. This is a contact in the control circuit which blocks the Contactor from closing. Remove the key.
- Shut off Breaker.

# Keying Procedure Example


**Example 2**
**These breakers are closed in.  You can see the Lock mechanism below each breaker.**

# Keying Procedure Example

•Turn off the control per the previous example.
•Place the breaker in the off position
•Rotate the key and it will place a blocker in front of the breaker to keep it from being closed in.
•Remove the key.
•Go to the T/R set next.

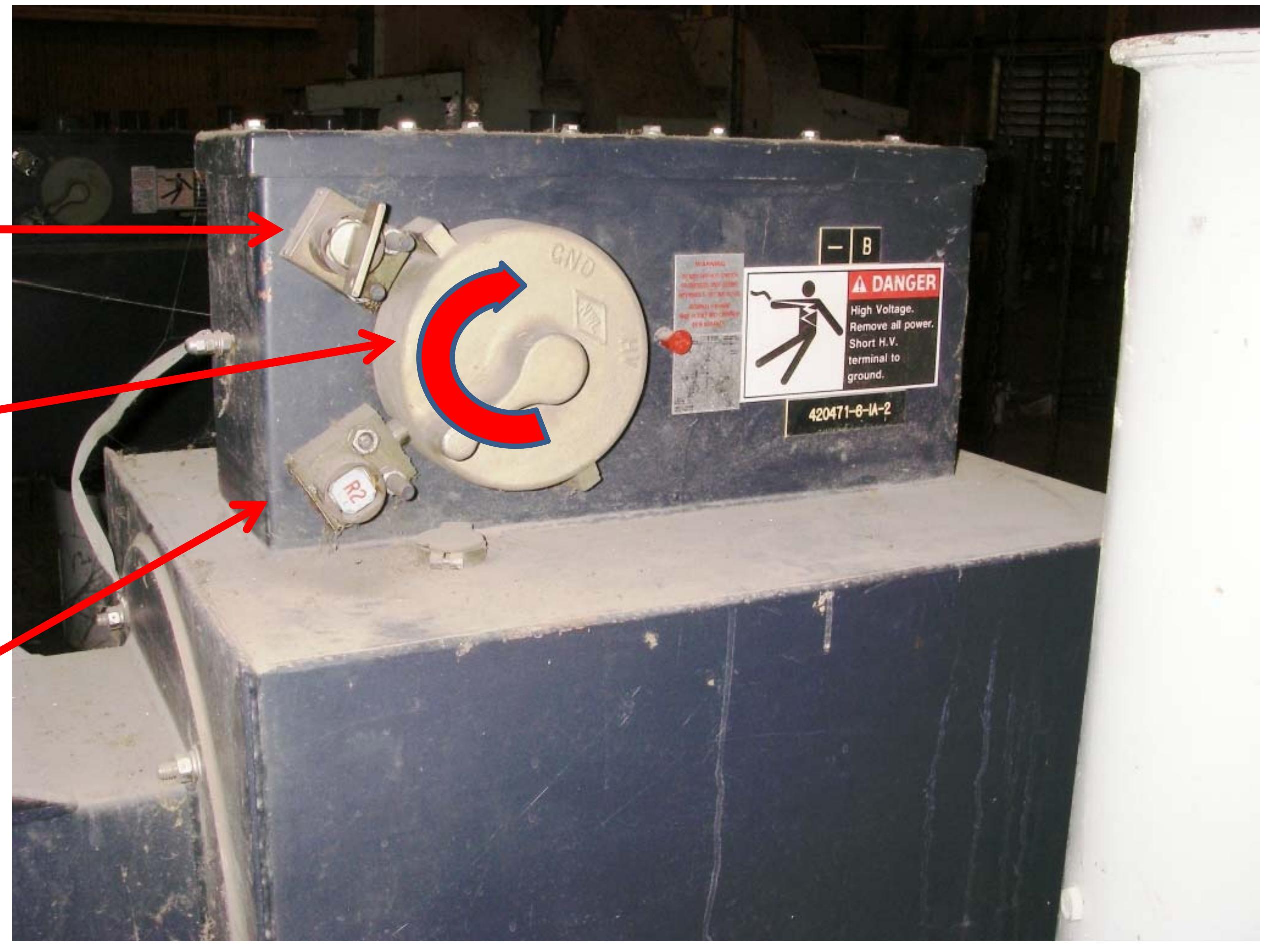
# Keying Procedure Example

**T/R Ground Switch**

**3.)** Rotate (X) key and lock in ground switch to "Grounded" position. Remove the key.

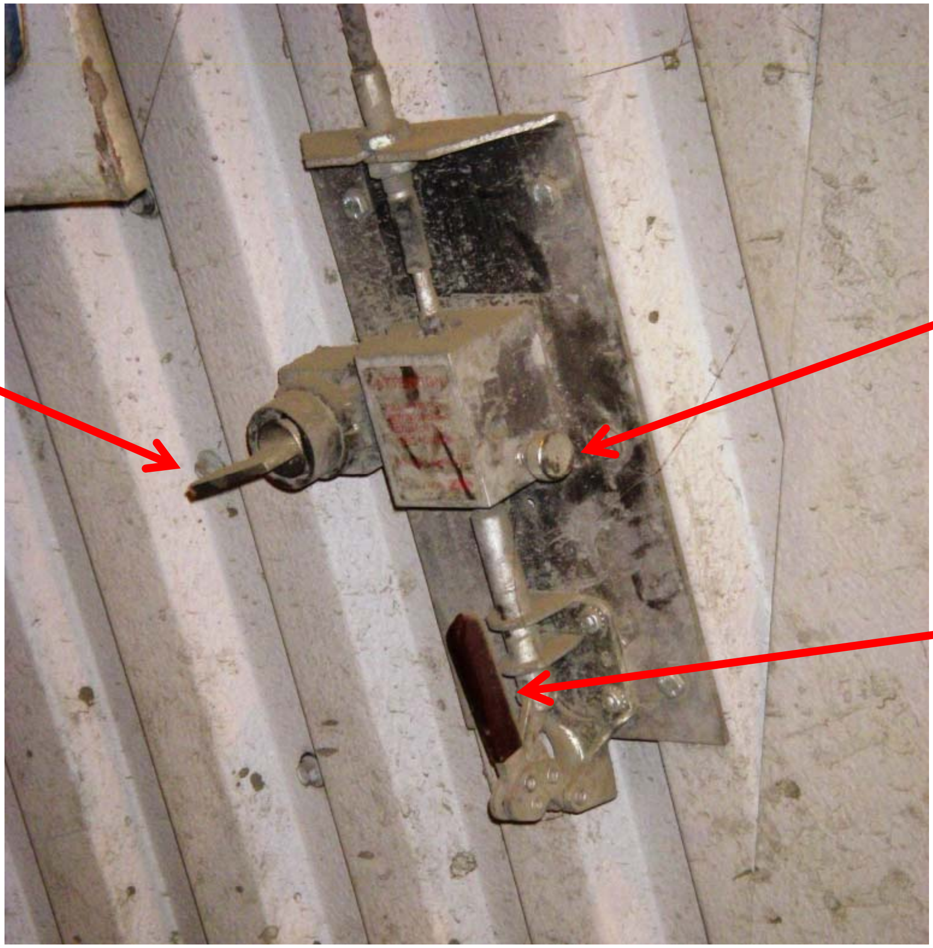
**2.)** Rotate the ground switch and confirm visually the HV bushing is grounded

**1.)** Insert Control/Breaker key (R) and rotate to release ground mechanism.



# Keying Procedure Example

**Nuclear Hopper Level Keys**

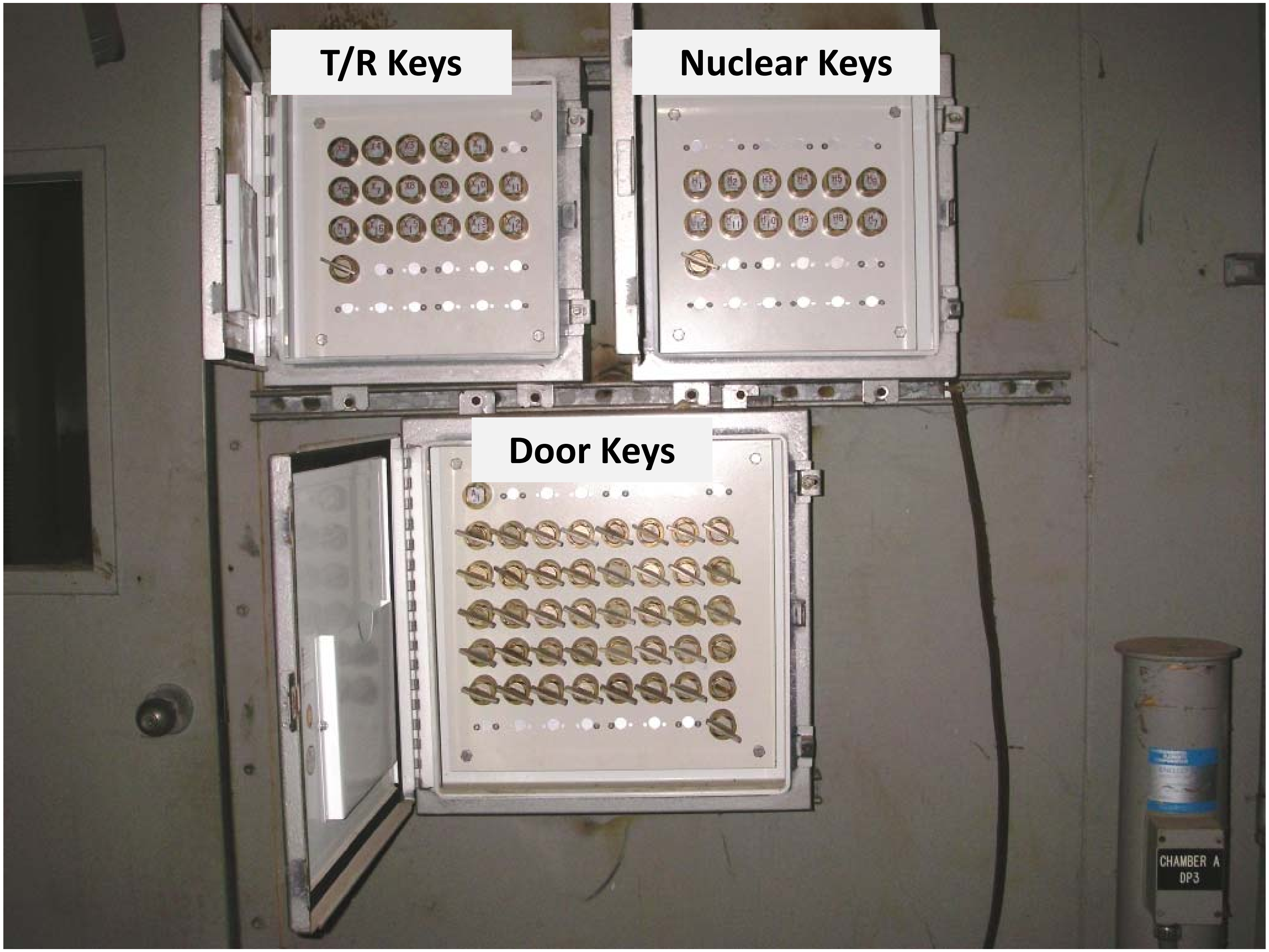


**3.) Rotate Key and remove. Handle is blocked from moving shutter.**

**1.) Pull and hold knob.**

**2.) Pull handle down and confirm shutter goes from "ON" to "Off". Release Knob.**

# Keying Procedure Example

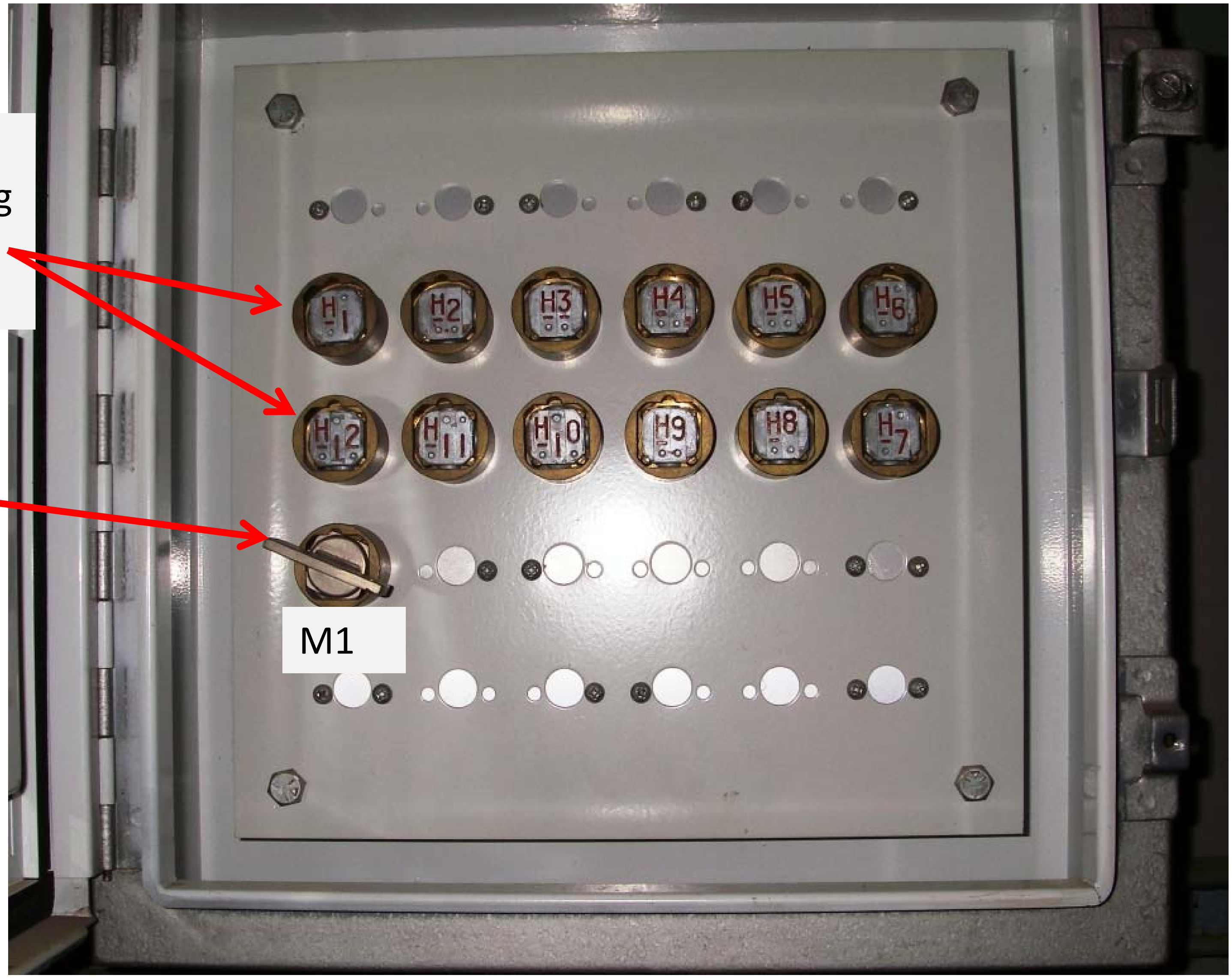


# Keying Procedure Example

**Nuclear Hopper Key Box**

1.) Insert Nuclear Hopper keys  (H) starting with #1 and turn after insert.

2.) After all Keys are inserted and rotated the M1 Key can be rotated and removed. It goes in the T/R key box.



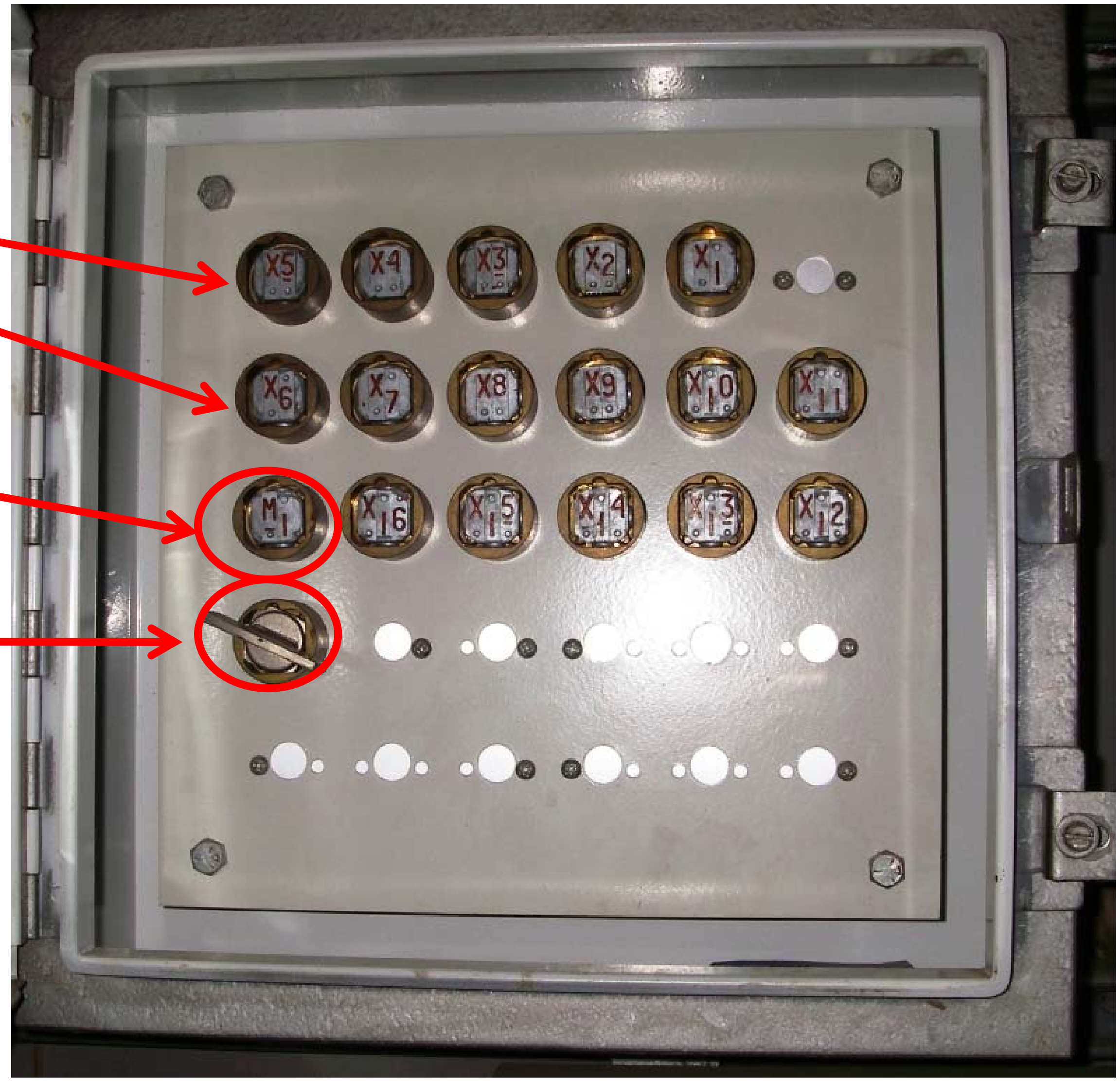
# Keying Procedure Example

**T/R Key Box**

**1.) Insert and rotate all T/R Ground Switch (X) keys, starting with #1.**

**2.) Insert and rotate the M1 key.**

**3.) A1 Key will now rotate and can be removed.**

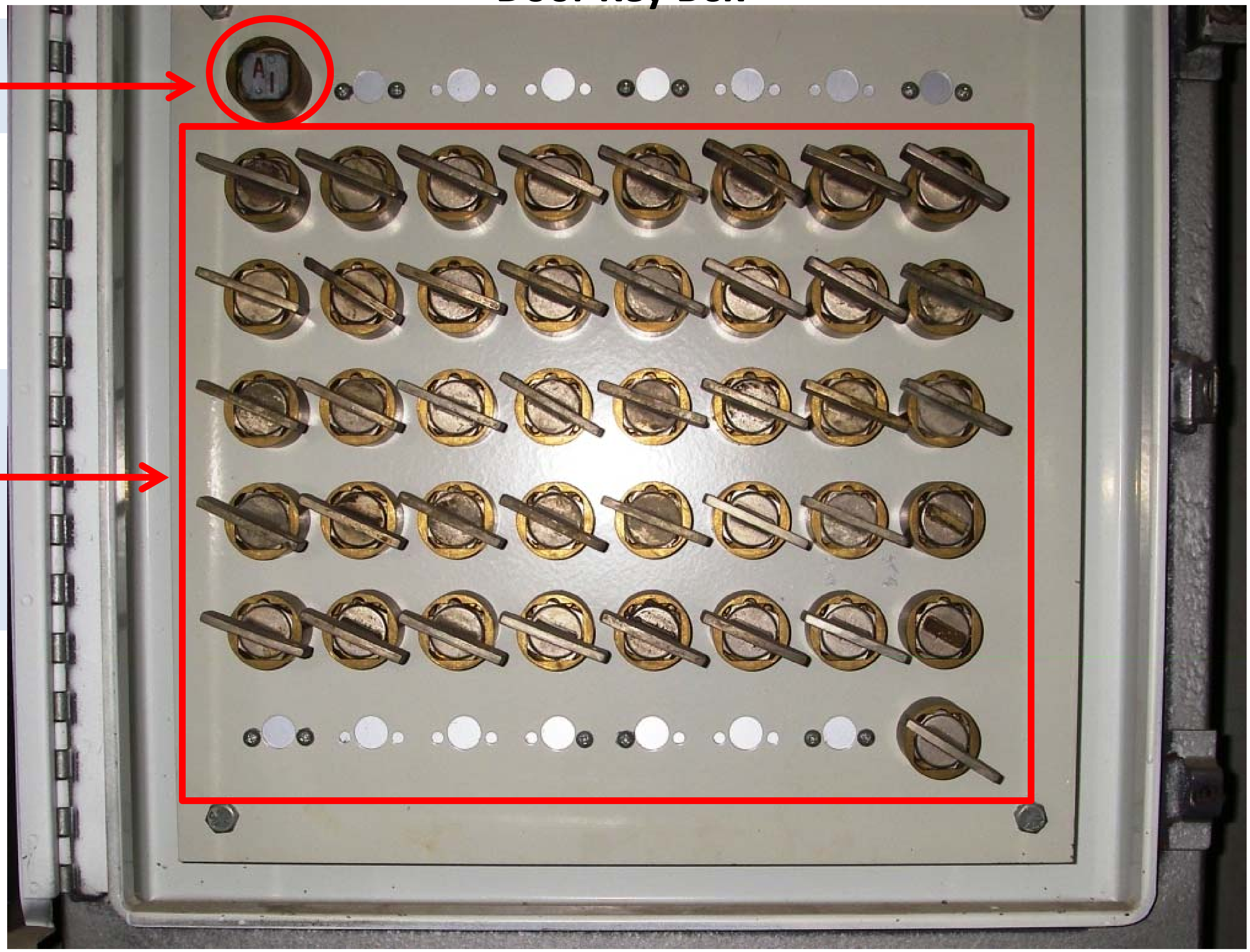


# Keying Procedure Example

**1.) Insert A1 Key and rotate.**

**2.) The door keys can not be rotated and removed as needed.**

**Door Key Box**



# Key Concern

**Normal Key** **Master Key**

**Master keys** are available or can be made. A Master key is useful for targeted and planned testing such as T/R HV Open Circuit testing. Also a Master key can be used in place of a bad or missing key. There are concerns:

- **BE AWARE:** In the previous slide a Master key can be used in place of the A1 key which will free up all the door keys. The door keys will provide access to areas or the precipitator where electrical, dust and flue gas hazards have not been addressed.
- **Master keys should be controlled and accounted for**.

# Key Philosophy

**The Interlock keys portrayed are a specific example from one plant. The labeling at your plant will probably be different, but the idea should be the same.**

1. The control power had to be shut off to allow the T/R ground switches to be used.
2. The T/Rs all had to be grounded to release keys for the T/R box.
3. The Nuclear sources had to be shut off to free the Nuclear keys for the Nuclear Key box.
4. The Nuclear Hopper keys had to be installed in the box before the M1 Key was removed.
5. The M1 key had to be installed in the T/R key box along with all the T/R ground keys before the A1 key was released.
6. At this point all the electrical power and Nuclear radiation is shut off and secured.
7. The A1 key is installed in the Door Key box to free the door keys.

# Key Interlock Final Notes

- Additional concerns can be addressed by the key interlock system such as rapper power, hopper heater power, hopper vibrator power, etc. In this particular case the LOTO procedure de-energized all those items. This may not be true for your installation. Carefully review your configuration before specifying a Key system. Also know the shortcomings of your system to stay safe.

# Confined Space

**I would imagine 99.9999 % of all plants has a Confined Space Procedure. I can't be absolutely sure, but I'm fairly confident you have this procedure at your plant unless you just crawled out from under a rock.**

**The confined space procedure is designed to assure a worker or inspector can function in an environment not normally designed for human occupation. In our case this is the Precipitator.**

**As stated earlier the Precipitator has the following hazards:**

- **Electrical**
- **Flue Gas**
- **Fly Ash**
- **Nuclear (radiation)**

# Confined Space

**The Confined Space Permit procedure is a formal process that requires the permittee to specifically address all hazards in a check off fashion.**

**The confined space form usually requires information filled in on:**

- **The specific equipment being inspected.**
- **Communication procedure (radio/phone or both, including phone numbers)**
- **Entry Supervisor , entry personnel names and ID numbers.**
- **Rescue personnel available listed.**
- **Rescue plan required, i.e. Non-entry, Plant rescue team, Off-Site team.**
- **Rescue Technique needed, i.e. Horizontal, vertical or highline.**
- **Atmospheric testing and data noted.**
- **Forced ventilation needed ? and character of ventilation (continuous, prior to entry)**
- **Fire/Mechanical/Electric/Elevated Work Protection**
- **Pre-entry check-off.**
- **Hot work Check Off.**

# Confined Space

- Confined space normally requires a “Hole Watch”. Be sure to contact your hole watch regularly to assure him you are OK and assure yourself he’s still there.
- Use an air monitor to assure the atmosphere is good. There can be smoldering clinkers in the hoppers that may not have been pulled out. Just because the vacuum system indicates the hopper has pulled clean doesn’t mean it’s not full of dust.

# Confined Space

- Part of the inspection process is checking from above the hoppers to check that the hoppers have been pulled clean.  I found a hopper once that was completely filled and there was a vortex/funnel like space between the top and bottom of the hopper.  Instrumentation indicated it was pulled clean, but it was almost completely packed.

# Confined Space

- Air monitor device
- Be sure it's been calibrated.
- The batteries are fully charged or fresh.

# Confined Space

**Be sure the air monitor works before you get to the precipitator.  It's a long walk back to the office with all your gear on.**

# PPE

**Inspectors and workers in a precipitator need to be properly dressed and equipped for the job. This includes the following:**

- **Full Face Respirator.** The filters should address particulates/dust and multi vapor gases.
- **Hood or paper suit with a hood.** Keep your ears and hair protected. Flyash is hard to wash out of these areas.
- **Hard Hat.** This is important to protect from Flyash falling on you from overhead. Especially if you have workers overhead and if the plates are being cleaned manually.
- **Cloth work suit.** This is good protection to keep your clothes and paper suit from being damaged or dirtied.
- **Hard toed boots.** The higher the better. After you empty out your ankle high boots you'll wear full length boots.
- **Long cuffed gloves.** You'll be surprised how much dust will get into your gloves.
- **Flashlight.** LED lights work great and last a long time. Use a lanyard.
- **Air Monitor.** I wear an air monitor and keep it turned on. Check it frequently.
- **Radio.** This is your link to the outside. Most radios hold up well to the dusty environment, especially compared to a cell phone.

# PPE

**Wear your PPE and you can come out looking this good!!**

- **Dispose or take care of clothing properly.**
- **Take a shower immediately. (Don’t take it home)**
- **Clean all equipment, footwear, hardhat and tools.**