Transfer IEC Equipment
My role was electric cable connection between each components

Hiroshi Horibe*
*KURITA Manufacturing Corporation (Ujitawara Town Kyoto Japan)
Introduction

• IEC equipment in Kansai University have been moved to Osaka University.
• Its aim is to operate using Tritium gas.
  It was a big job.
• My role was electric connection and wiring between power supply, IEC chamber and distribution panel.
• Not only connecting each component but also improved some of wiring have been done when it have moved to new place.
• I talk detail about these how’s going this transfer and some improvement. ground bar, high voltage cable, corona ring, current limit resistor and so on.
Content

1. High voltage cable
2. Corona ring
3. Current limit resistor
4. Floating potential
5. Ground copper bar
6. Summary
Block diagram of IEC circuit

3 phase AC200V 75A

Glasman HV PS

HV coaxial cable

Support

Corona ring

Insulator

IEC

Ground connecting bar (2 parallel)

Ground based point

A sort earth < 10 ohm

-125kV 30mA

Glassman HV PS

Support
Some pictures before and after transfer

In Kansai University (before)

In Osaka University (after)

Behind:
Radiation Shield room

HV cable support

Moved to shield room

HV cable and ground were leaded
Through 10cm dia hole

Outside of the shield room: HV cable
This time I used 100kV silicon cable (with ground shield). Because Glassman cable was too short to extend to shield room, I connected this cable.

I tried wiring through at high place by supporting insulator bar.

I always think of safety apart distance from HV point to the ground.

In the air: 4kV/cm and surface safety distance is 2.5kV/cm

So 100kV surface: 40cm so I set 50cm this time.

HV insulator surface shapes wave. It gains more surface distance much better than straight.

Only insulating distance is not enough. We have to use HV withstand cable. Otherwise cable itself makes so much corona noise.
Corona ring

1, When we are running with using high voltage corona ring is a must for calming electric field. Without corona ring increasing the voltage bigger and bigger noise. We can’t go forward.

Every terminal and screw like this with high potential corona ring is needed.

2, Over 30kV it is a must. This level small ball shape is enough.

3, Over 50kV, about corona noise is written as follow.

No noise at 100kV
2.8cm section dia
20cm dia

50kV is OK
But not at 100kV
5cm dia

Without ring
Very noisy at 100kV
Current limit resistor

1. We set resistor between HVPS to IEC Chamber.
2. We expect these resistor limit the current when arcing were occurred inside the chamber.
3. How to choice these resistors.
   (our example this time)
   - 100kV Running rated current 60mA
   Let’s calculate resistor drop under rated running.
   100kV - (60mA * 10kohm) = 99.4kV
   No problem this tiny 600V voltage drop.

When arcing were occurred
100kV / 10kohm = 10A so small.
(Without the resistor over 1000A / under us flow the circuit.)
4. Over 10A current can’t be flowed this system whatever happened inside the chamber.
   It is a big help to become system stable.
Floating potential

1, In high voltage potential field electric component without any potential are not allowed. It makes easy to disturb near field, become easy to breakdown. Floating stuff disturb normal running.

2, I tried to fix all component this time. Especially alumite flame and other looks like floating one.

3, This example is 100kV high voltage power tube switch. All black body is high potential when it running. All component have to be fixed to any potential even all screw. Painting stuff is conductive. Also faced ground side also painted with conductive one.
Ground connection

-125kV 30mA
HV cable
Ground return
2pcs together 7cm

-125kV 30mA
HV cable
Based Ground
20cm
2pcs Each 7cm

This time
2pcs together 7cm

Have to use low inductance stuff. Copper bar with wide one is the best.

Can’t through 20cm wide one
10cm dia hole

Reliable A sort Ground point

Ground return
Based Ground

Based Ground

Based Chamber

IEC
20kohm 2parallel

Based Ground

IEC
Chamber

Radiation free
Shield room

G

G
1. While in IEC running we can’t avoid arcing inside the chamber. We want to deal with that one without problem. Low inductance ground connection and limiting the current do work when arcing were occurred.

2. Low inductance means wide surface area and short distance.

3. I usually use 20cm wide copper plate but this time connecting hole to shield room was 10cm dia. So I choice 7cm wide 2pcs parallel.

Let’s calculate sudden voltage increase when arcing occur. This is a little bit extreme example though.

1. Formula \( V = -L \frac{di}{dt} \)
   This mean both terminal between ground return connection, rapid current change makes big voltage difference.

2. Supposed no resistor with poor wire ground connection –5m (1m about 1 uH)
   When arcing occurred: 1000A in 100ns
   \( V = -5uH \times \frac{1000A}{100ns} = 50kV \)
   It looks like extreme but not far from real. Ground wiring increase become 50kV!! That’s why discharge sound inside the cabinet or weak parts have become broken.
3. With 10kohm series. Low inductance copper bar 0.05uH /m inductance (I supposed 5m, shorter the better as you know)
   \[ V = -0.25 \text{ uH} \times 10\text{A}/100\text{ns} = 25\text{V} \]
   Looks perfect.
   Low inductance copper bar and current limit resistor do work well when big arcing have happened.

4. Do you think which is better?
   It is clear.
Summary

1. We have transferred IEC equipment from Kansai University to Osaka University radiation shield room.

2. Running with High Voltage power supply is not easy.
   Can’t do work well only power supply itself.

3. This application we have to deal with “High Voltage cable with safety insulating distance” “Corona ring” “Floating potential” “Current limit resistor” and “Ground Connection with short and wide bar” and so one.

Thank you for attention!