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SAFETY INSTRUCTIONS FOR AD KICKER SYSTEMS

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1 INTRODUCTION

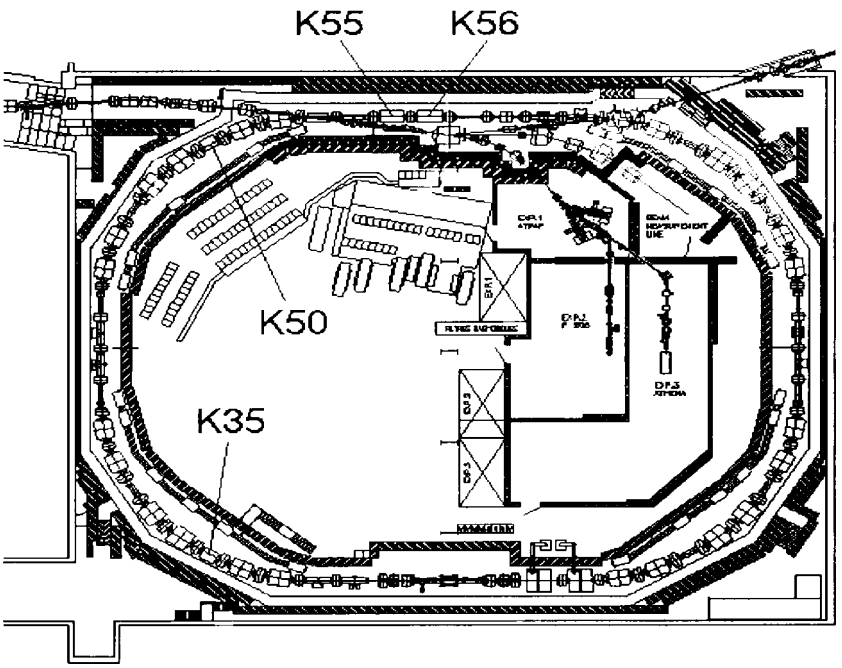
The AD machine in building 193 has installed, at various positions around its rings, two kicker systems, and an oil cooling plant used with the kickers. This equipment is used during the anti-proton injection and ejection phases of the machine. These systems are referred to in the text as:

- AD Injection system
- AD Ejection system
- Auxiliary equipment (oil, gas, air, water, etc.)

The AD Injection system consists of six individual injection kickers (modules 1, 2, 3, 4, 5 and 6) used in sections 55 and 56 of the AD ring.

The AD Ejection system consists of four individual ejection kickers (modules 7, 8, 9, and 10) used in sections 35 and 50 of the AD ring.

The pulse generators of both the injection and ejection kickers are equipped with resonant charging high voltage power supplies capable of charging the individual, SF6 gas filled, coaxial pulse forming cables to 80 kV in a few milliseconds. Each pulse generator can be completely isolated from its incoming 3 phase supply by means of a Castell key at the central distribution cupboards. The position of the kickers in building 193 is shown in the figure below.



Kicker position in AD

The oil cooling system with controls is positioned centrally to the high voltage switch gear.

This note describes the necessary precautions to be taken to obtain safe working conditions on any or all of the above mentioned equipment.

2 DESCRIPTION OF THE AD INJECTION KICKERS

The injection kicker magnets are contained within two vacuum tanks in section 55 and 56 of the ring. Each magnet input is connected to its high voltage pulse generator with pairs of high voltage coaxial transmission cable.
The magnet outputs are connected directly to ground (earth) using short-circuited Lemo plugs. Power for each complete module (pulse generator, low voltage control racks and magnet) is obtained from an individual 3 phase 25 Amp circuit in the auxiliary distribution cupboard ERD51*49.
This cupboard is found inside the AD Hall, on the kicker platform and between the drums of PFN cable.
Each of the fused 3 phase outputs are switched by Castell key operated switches. The incoming power feed for ERD51*49 is derived from departure point 5-3-3 of the sub station, zone K (next to the ACR).
The labeling of the Castell switches is shown in the appendix *table 1*.

3 DESCRIPTION OF THE AD EJECTION KICKERS

The ejection kicker magnets are contained within two vacuum tanks in section 35 and 50 of the ring. Each magnet input is connected to its high voltage pulse generator with pairs of high voltage coaxial transmission cable.
The magnet outputs are connected directly to ground (earth) using short-circuited Lemo plugs, except for module 10.
Module 10's magnet outputs are connected to high power, oil cooled terminating resistors by the same type of cable. There is an option to terminate module 9 as well if required.
Power for each complete module is obtained again from an individual 3-phase 25 Amp circuit from cupboard ERD51*49 with Castell key switches.

4 DESCRIPTION OF THE OIL SYSTEM

All high voltage switch-gear in the kicker modules as well as the terminating resistor(s) are cooled by pumping Diala B transformer oil through their sealed enclosures. The cooled oil is pumped around many closed oil circuits in parallel by a 3-phase motor pump and returns to the main storage tank via a common return pipe.
There is also a second storage tank with permanently connected pipe work, which has two small oil pumps. This system is used for emptying oil modules during maintenance periods only.
Both the controls for the main pumping system and that of the maintenance system are powered from a fused 3-phase circuit operated by a Castell key switch in the distribution cupboard ERD51*49 fused at 25 A operated by Castell key K11.

5 CONTROLS, MONITORING AND GENERAL SERVICES

This equipment is located in racks A012-A015 on the kicker platform, and it is imperative for the kicker operation. This is powered from a fused 3-phase circuit operated by a Castell key switch in the distribution cupboard ERD51*49, circuit K12 and K13.

Controls, monitoring and general services include :

- Timing distribution
- Delays
- Monitoring
- Oil and gas fan-outs
- Data transmitting units
- Interlock fan-outs for vacuum and HT switches

6 GENERAL SAFETY PRINCIPLES FOR WORKING ON AD KICKER SYSTEMS

The systems comprise a variety of low and high voltage equipment.
Because of the complexity and the large number of interconnections which exist between different parts of the systems and the very high voltages (up to 85 kV) which are present, certain principles must be laid down in order to guarantee safe working conditions during repair, modifications or maintenance.
The application of these principles may result in more equipment being isolated than is strictly necessary for access to a particular part of one of the systems, but the principles must nevertheless be rigorously respected.

1. ***Work on tank equipment***
   No work may be performed on any ring installed tank equipment unless all the pulse generators driving that tank have been isolated. The Castell key (s) for that tank must be in the possession of the person executing the work. Any person working in the ring must be accompanied by a second person in case of an accident.

2. ***Work on individual pulse generator modules***
   No work may be performed on any pulse generator module until the module has been isolated from the electrical supply and its transmission cables have been unplugged at the generator and capped-off. Due to risk of flashback through the magnets, the other pulse generators must be prevented from pulsing during this operation. The Castell key for the generators must be with the person doing the work.

3. ***Work on total system***
   No work may be performed on the complete AD kicker system until total isolation has been made at the incoming power distribution boards ERD51*49 and all the Castell keys removed from these boards. These keys will be placed in the Castell key press on the side of ERD55 board and the master key (KM) removed. The person responsible for the work being executed will keep this key.

4. ***Incomplete isolation precautions***
   In the absence of a complete isolation according to *point 3*, certain electronic chassis, not specifically associated with individual pulse generators and which may be supplied with power from remote parts of the system, must be considered live until isolated by removal of all in-going and out-going cable connections.

5. *System security interlocks*

The system contains a certain number of HT and LT interlocks which are intended to prevent damage to equipment in the event of careless or faulty operation. Under no circumstance are these interlocks to be relied upon to provide a safe environment for maintenance or repair work.

6. *Other ring equipment*

Safe working conditions as defined in this note relate only to the isolation of kicker systems and the oil cooling system. Any other equipment of the ring magnet tanks must be considered energised until isolated by procedures appropriate to that equipment.

7 SAFE WORKING WHEN CHANGING POLARITY

To obtain safe working conditions when changing kicker polarity at the ring magnets the following procedure must be used:

- AD injection kickers (K55,K56), isolate all pulse generators by removing Castell keys K05, K06, K07, K08, K09 and K10. Place keys in Castell key press on side of ERD55 board remove 'key A.'

- AD ejection kickers (K35 and K50), isolate all pulse generators by removing Castell keys K01, K02, K03 and K04. Place keys in Castell key press on side of ERD55 board remove 'key B'.

- The keys A and B must remain in the possession of the person doing the polarity changing and must only be replaced in the key press when work is terminated and the equipment safe to re-energise.
  It should be noted that all tanks are equipped with standard CERN 'Danger, High Voltage' signs operated via the Castell key press.
  These signs are normally illuminated and flashing and therefore indicate that keys A and B have not been removed from the key press.
  Extinction of the signs, however, should not be taken to mean that the equipment has been made safe and is under no circumstance a substitute for possession of keys A and B.

8 SAFE WORKING ON THE OIL SYSTEM

Removal of Castell key K11 will completely isolate the main pump controls and maintenance control station. The person working on any part of the oil system must retain this key in his possession. The key must only be replaced in ERD51*49 when the work is terminated and the system safe to re-energise. When K11 key is removed this will stop all kicker modules from working, however, the flashing 'Danger High Voltage" signs on all tanks and the switch-gear platform will continue to flash.

9 SAFE WORKING WITH THE KICKER SYSTEM PARTLY ENERGISED

- Work on Individual Pulse Generator Modules

Since all the kicker hardware is in the AD hall (bld. 193) there is no possibility of making repairs to parts of the equipment whilst the machine functions normally.
However, under certain circumstances, when there is access to the machine, repair work may have to be executed on one or more kicker modules with others working on test.
In order to eliminate the risk of high voltage and to minimise the risk of low voltage contact the following procedures must be strictly adhered to.

- Isolate the correct kicker module by removal of the Castell key appropriate to the equipment. Personally retain this key until the module is safe to re-energise.

- Verify by inspection that the supply racks pertaining to the module(s) to be worked on are de-energised and that the capacitor banks in these racks are discharged.

- Where work has to be done on a kicker module, temporarily stop all other modules associated with the same magnet tank from pulsing by switching to 'OFF' their 'SORENSEN' power supplies, discharging their capacitor banks and setting the 'LOCAL HT SWITCH' on the interlock unit to 'OFF'.

- Locate the two red flexible coaxial high voltage cables connected to the output of the Main Switch (MS) of the modules to be worked on. Unplug these cables and cap them off with the earth brass caps provided. The HT interlock plug, connected to the cables by a chain has first to be unplugged, ensuring that the HT interlocked chain is broken. Work on the module or modules thus de-energised may now proceed, and the other modules mentioned in the previous point, allowed to pulse.

- If during repair work any parts normally at high tension become exposed, these should be earthed with the earthing rods installed on the kicker platform. After the repair all earth connections must be removed before applying any power to the module.

10 TOTAL ISOLATION IN THE RING

To isolate all the kicker tanks in the ring, the following procedure must be used. Remove all Castell keys from ERD51*49. All keys removed will be put in the Castell press on the side of ERD55 and the keys A, B, C and D removed. These keys put into the master key press allows master key to be removed. The person responsible for this work will keep the master key in his possession and will inspect each zone of the system to ensure that it is safe to re-energise before replacing any Castell key.

11 TOTAL ISOLATION OF THE KICKERS

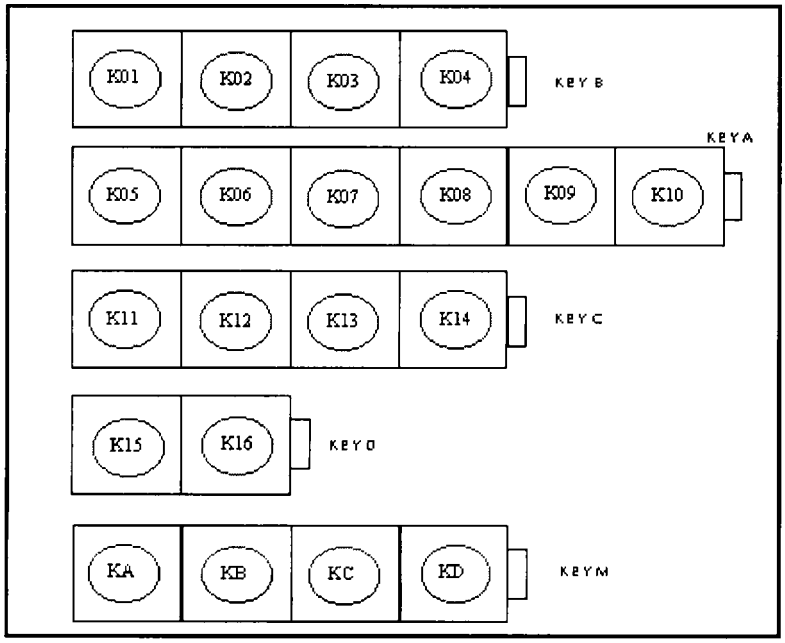
Total isolation in this context means that the power distribution cupboard ERD51*49 is de-energised. This can only be achieved in the sub-station zone K next to the AD control room (ACR).

The outgoing three phase circuit for ERD51*49 must be switched 'OFF' and locked with locks provided in the sub-station for this purpose. A sign must be placed on the disabled circuits indicating that work is in progress.
The keys for the locked circuits must then be put back into the sub-station key press.
This action can only be undertaken with the authority and under the supervision of the EIC of the ACR who keeps in his possession the key giving access to the key press.

Appendix.

Circuit No	*Equipment ID*	*Castell Key*	*Connected to rack*	*Kicker Tank*
1	Module 7	K01	A037	K35.1
2	Module 8	K02	A035	K35.2
3	Module 9	K03	A033	K50.1
4	Module 10	K04	A031	K50.2
5	Module 1	K05	B009	K55.1
6	Module 2	K06	A016	K55.2
7	Module 3	K07	A018	K55.3
8	Module 4	K08	A020	K56.1
9	Module 5	K09	A022	K56.2
10	Module 6	K10	A024	K56.3
11	Oil	K11	A014	
12	Monitoring	K12	A013	
13	Vacuum	K13	Vacuum Pump	

Table1 Layout Fuse rating of all circuits is 25A.



Castell Keyboard layout

12 Distribution List

PS-PO Kicker Magnet Section:
B. Bleus
S. Deman
H. Gaudillet
A. Fowler
J.C Freze
J. Schipper
L. Sermeus

PS-PO Group Leader
K.D. Metzmacher