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SAFETY INSTRUCTIONS FOR AAC KICKER SYSTEMS

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1. INTRODUCTION

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

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

The AA Injection system consists of four individual injection kickers (modules 1 to 4) used in section 4 of the AA ring.

The AA Ejection system consists of two pulse generators connected in parallel to one magnet in section 22 of the AA ring. These are named 'Normal ejection generator' (Module 16) and 'Spare ejection generator', (Module 15).

The AC Injection system consists of six individual injection kickers (modules 5 to 10) used in sections 55 and 56 of the AC ring.

The AC Ejection system consists of four individual ejection kickers (Modules 11 to 14) used in sections 35 and 50 of the AC 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 Fig. 1.

The oil cooling system with controls is positioned centrally to the kicker high voltage switchgear.

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 AA INJECTION KICKERS

The injection kicker magnets are contained within a vacuum tank in section 4 of the AA machine. Each magnet input is connected to its high voltage pulse generator with pairs of high voltage coaxial transmission cables. The magnet outputs are connected to high power, oil cooled terminating resistors by the same type of cable. Fig. 2 shows the connection of the pulse generators to the magnets and terminating resistors. On the resistor array frame there are two passive spare terminating resistors. The power for each complete module (pulse generator, low voltage control racks, magnet and resistor) is obtained from an individual 3 phase 25 Amp circuit in the auxiliary distribution cupboard BT1. This cupboard is found on the inside of the ring, 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 labelling of the Castell switches in the distribution cupboard BT1 are shown in Table 1. The incoming power feed for BT1 is derived from departure point 5-3-1 of the sub station, zone K (next to ACR). The electrical schematic of BT1 is shown in Fig. 3.

### 3. DESCRIPTION OF AA EJECTION KICKER AND MAGNET MOVING SYSTEM

The ejection magnet and its terminator form an integral assembly and are located in section 22 of the AA ring. The ejection pulse generators are connected to the terminator and magnet by high voltage coaxial transmission cables. The magnet is moved horizontally inside the vacuum chamber via a servo motor driving a worm gear. Both of the ejection pulse generator modules are powered from fused 3-phase circuits operated by Castell key switches in distribution cupboard BTL. Detailed information of the connections is found in Fig. 3 and Table 1. The AA ejection magnet can be pulsed from one of two modules 16 or 15 named Ejection kicker normal or Ejection kicker spare. These two modules are connected in parallel on the kicker platform.

### 4. DESCRIPTION OF AC INJECTION KICKERS

The injection kicker magnets are contained within two vacuum tanks in sections 55 and 56 of the AC 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 circuit Lemo plugs. Power for each complete module (pulse generator, low voltage control racks and magnet) is obtained from an individual 3 phase 20 Amp circuit in the auxiliary distribution cupboard BTL. Each of the fused 3-phase outputs are switched by Castell key operated switches. The labelling of the Castell switches is shown in Table 1.

### 5. DESCRIPTION OF AC EJECTION KICKERS

The ejection kicker magnets are contained within two vacuum tanks in sections 35 and 50 of the AC 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 circuit lemo plugs. Power for each complete module is obtained again from an individual 3-phase 20 Amp circuit from cupboard BTL with Castell key switches, see Table 1.

## 6. DESCRIPTION OF THE OIL SYSTEM

All high voltage switch-gear in the kicker modules as well as the terminating resistors for the AA kickers are cooled by pumping Diala C 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 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 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 BT2 'circuit 1' fused at 25 A operated by Castell key K17.

## 7. 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 BT2, circuit K18 and K22 (see table II).

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.

Cupboard BT2 and BT3 are connected in parallel from circuit N° 5:3:2 in sub-station zone K next to ACR.

## 8. GENERAL SAFETY PRINCIPLES FOR WORKING ON AAC KICKER SYSTEMS

The systems comprise a variety of low and high voltage equipment as well as magnet movement system on K22. 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.

a) Work ON Tank Equipment

No work may be performed on any ring installed tank equipment unless all the pulse generators driving that tank or movement 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.

b) Work ON Individual Pulse Generators

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 (see paragraph 12 c)). The Castell key for the generator must be with the person doing the work.

c) Work ON Total System

No work may be performed on the complete AAC kicker system until total isolation has been made at the incoming power distribution boards BT1 and BT2 and all Castell keys removed from these boards. These keys will be placed in the Castell key press on the side of BT3 board and the master key (KM) removed. The person responsible for the work being executed will keep this key (see Fig. 4).

d) Incomplete Isolation Precautions

In the absence of a complete isolation according to C, above, certain electronic chassis, not specifically associated with individual pulse generators or movement system 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. Care should also be exercised in certain racks housing certain shutter drive chassis.

e) 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.

f) Other Ring Equipment

Safe working conditions as defined in this note relate only to the isolation of kicker systems, the K22 movement system and the oil cooling system. Any other equipment of the ring magnet tanks, such as vacuum pumps and shutters, must be considered energised until isolated by procedures appropriate to that equipment.

9. SAFE WORKING WHEN CHANGING POLARITY

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

- i) AA injection kickers (K4), isolate all pulse generators by removing Castell keys K01, K02, K03 and K04. Place keys in Castell key press on side of BT3 board then remove 'Key B'.
- ii) AC 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 BT3 board and remove 'Key A'.
- iii) AC Ejection kickers (K35 and K50), isolate all pulse generators by removing Castell keys K11, K12, K13 and K14. Place keys in Castell key press on side of BT3 board and remove key C.
- iv) The keys A, B and C 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, B and C 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, B and C.

10. SAFE WORKING ON THE AA EJECTION KICKER OR MOVEMENT SYSTEM TANK 22

To obtain safe working conditions on tank 22, the following isolation procedure is to be used:

- a) Remove Castell keys K15 and K16 from distribution cupboard BT1.
- b) Place these keys in Castell key press on side of BT3 cupboard and remove key 'D'.
- c) This key is to be held in the possession of the person working on K22 tank equipment and must only be replaced when the work is terminated and the equipment safe to re-energise. Tank 22 is equipped with a standard CERN "Danger High Voltage" sign which is normally illuminated and therefore indicates that key D has not been removed. However, extinction of this sign should not be taken to indicate that the equipment has been made safe and is not a substitute for possession of key D.

Key D also isolates the ejection magnet movement system to permit work on the drive motor or mechanics plus drive rack.

(The ejection magnet movement system is powered from rear of Rack A033 with 3 phase 16A plug.)

11. SAFE WORKING ON THE OIL SYSTEM

Removal of Castell key K17 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 BT2 when the work is terminated and the system safe to re-energise. When K17 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.

12. SAFE WORKING WITH THE KICKER SYSTEM PARTLY ENERGISED

Since all the kicker hardware is in the AAC hall (Bldg. 193) there is no possibility of making repairs to parts of the equipment whilst the machine functions normally (Injection, Ejection, Stacking). 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 this case a risk of low voltage contact exists and the work must be executed by a licenced operative in the presence of at least a licensed assistant. 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.

- a) 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.
- b) Verify by inspection that the supply racks pertaining to the modules to be worked on are de-energised and that the capacitor banks in these racks are discharged.
- c) 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".
- d) 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 earthed 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 concerned in c), allowed to pulse.
- e) 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.



14. 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 BT1. All keys removed will be put in Castell key press on side of BT3 and 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.

15. TOTAL ISOLATION OF KICKERS

Total isolation in this context means that both power distribution cupboards BT1 and BT2 are de-energised. This can only be achieved in the sub-station zone K next to the AAC control room (ACR).

The outgoing three phase circuits for both BT1 and BT2 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 put back into the substation 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.

16. PERSONS AUTHORIZED TO ISOLATE ANY PART OF THE AAC KICKER SYSTEM

The following is a list of persons authorized to isolate in whole or in part the AAC kicker system.

F. Blas  
B. Bleus  
T. Fowler  
K.D. Metzmacher  
H.S. Simpson  
D. Rosset

- a) They must have adequate knowledge of the system to allow them to isolate it without danger and bring it to a state for safe working.

- b) They must read , fully understand and be in possession of a copy of these instructions.

If work has to be carried out on part or the whole of the AAC kicker system by any person other than those listed above the following procedure will apply.

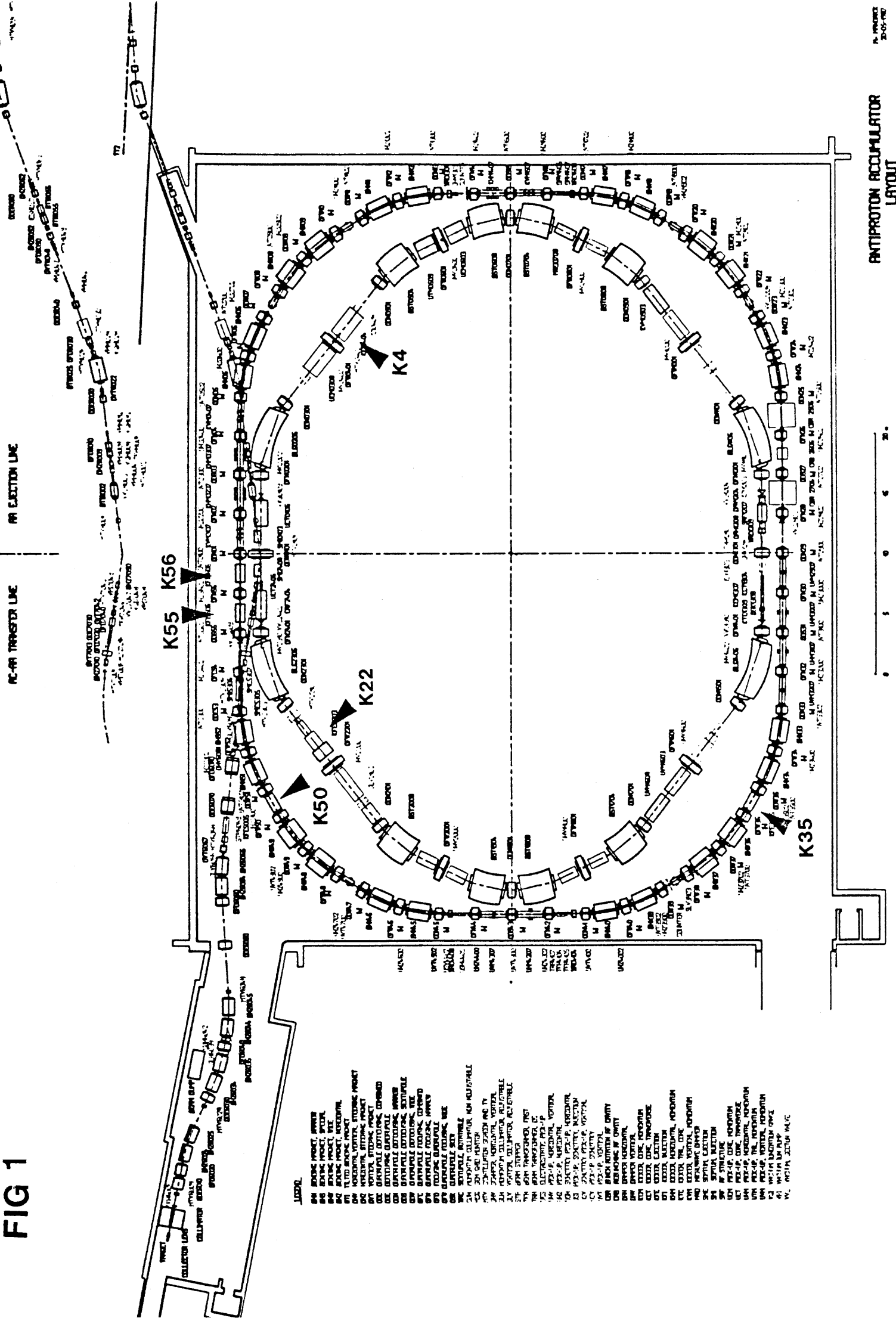
- i) Isolation and necessary earthing must be carried out by one of the above named persons.
- ii) This person will assume personal responsibility for all other persons working on the equipment.
- iii) If the responsible person does not remain full time at the scene of the work he will hand over the key(s) which guarantee the continued isolation of the equipment to the person working on the equipment. This latter will return the key(s) only to the person from whom he received them.

Distribution:

L. Coull  
V. Glaus  
E. Jones  
A. Magnenat  
F. Malthouse  
S. Milner

Group PS/BT  
Group PS/AA  
AAC Operators

FIG 1



- Legend
- 01 BUNCH PROBE, HORIZONTAL
  - 02 BUNCH PROBE, VERTICAL
  - 03 BUNCH PROBE, VERTICAL
  - 04 BUNCH PROBE, VERTICAL
  - 05 HORIZONTAL BUNCH PROBE
  - 06 VERTICAL BUNCH PROBE
  - 07 VERTICAL BUNCH PROBE
  - 08 BUNCH PROBE, HORIZONTAL
  - 09 BUNCH PROBE, HORIZONTAL
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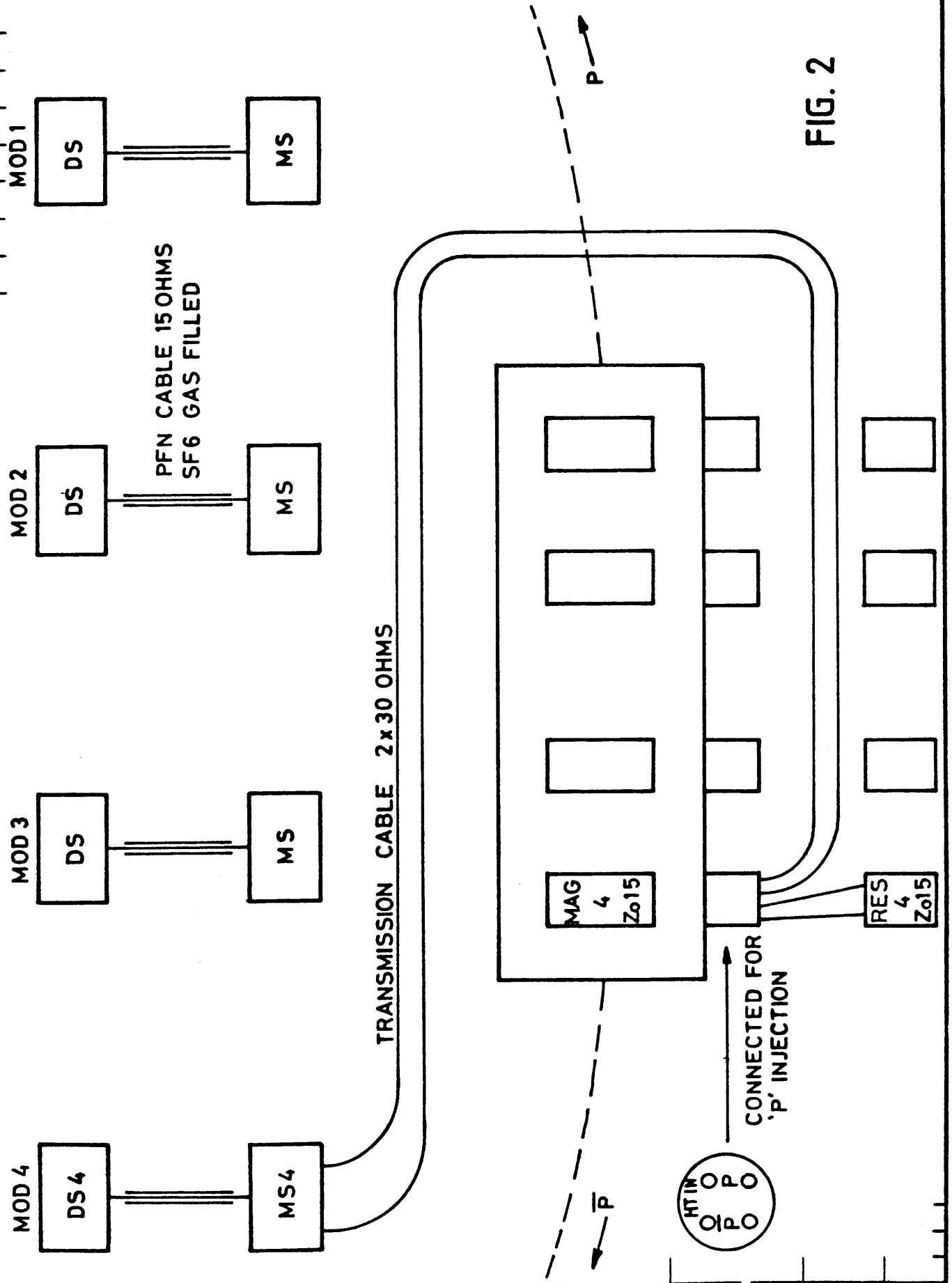


FIG. 2

DEFART 9-3-51  
ZONE K  
SUB-STATION



FIG 3  
BT 1

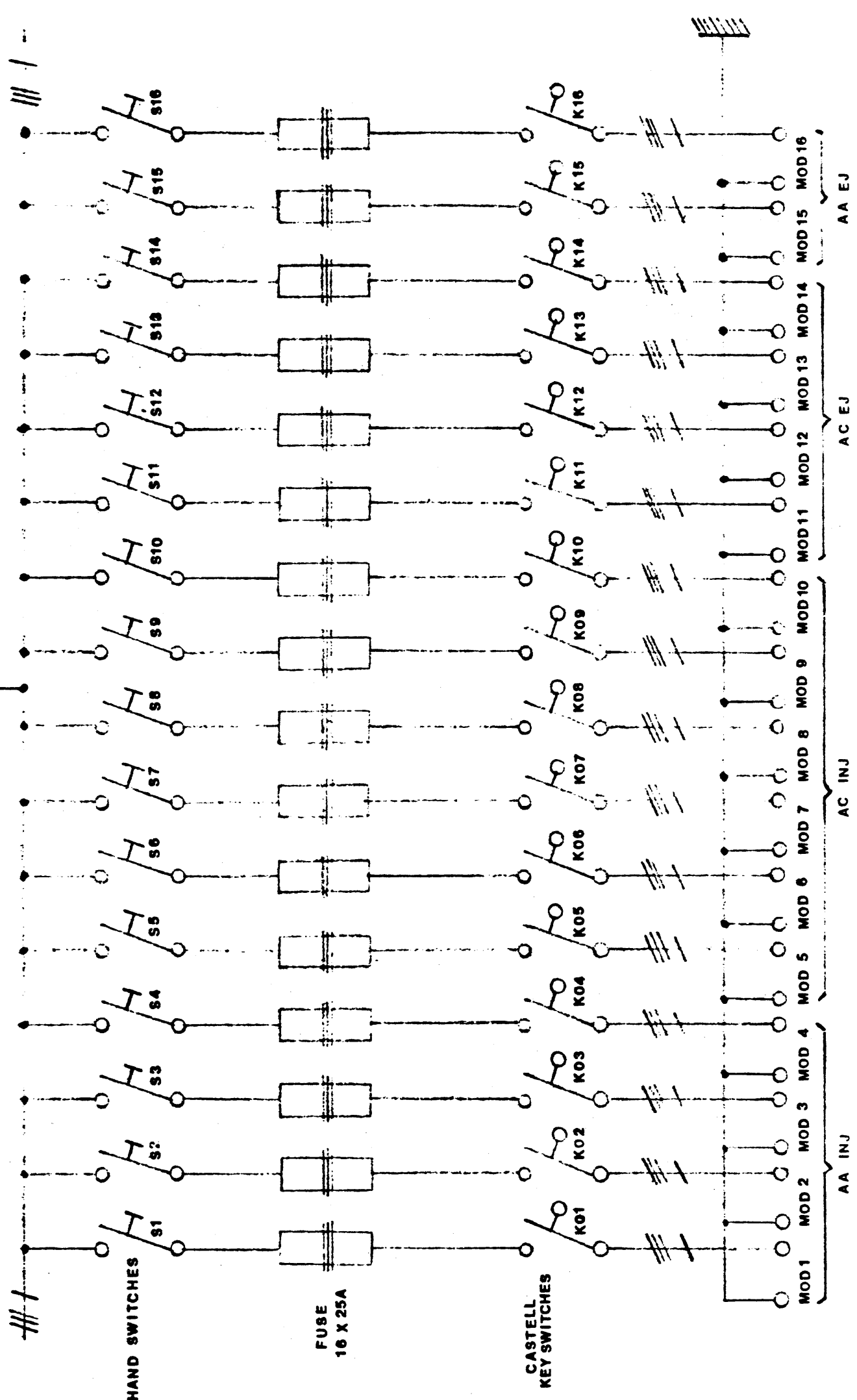
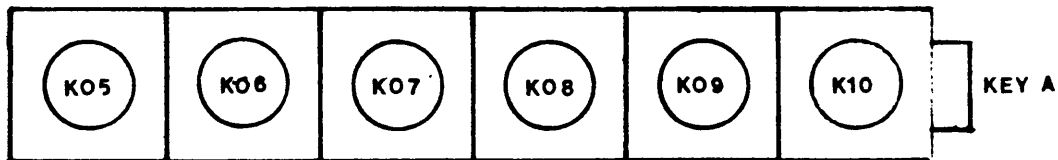
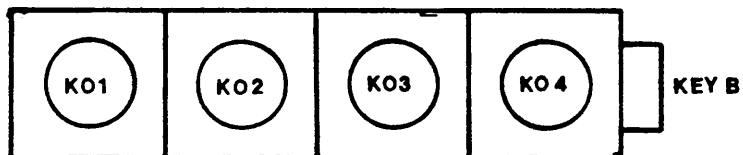


FIG. 4.

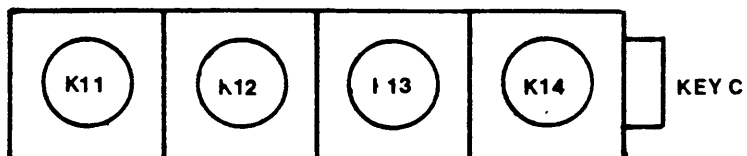
AC.INJ.



AA.INJ.



AC.EJ.



AA.EJ.

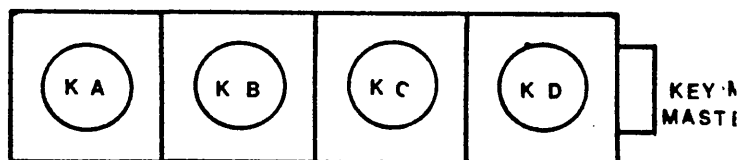
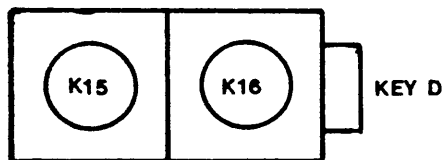


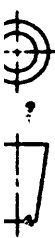
TABLE 1

BT1

CIRCUIT N°	EQUIPMENT IDENTIFICATION	FUSE RATING	CASTELL KEY	CONNECTED TO RACK	SAFETY REMARKS
1	AA INJ. MOD 1	25 A	K 01	B 029	} <u>AA</u> K 4 TANK
2	AA INJ. MOD 2	25 A	K 02	B 027	
3	AA INJ. MOD 3	25 A	K 03	B 001	
4	AA INJ. MOD 4	25 A	K 04	B 003	
5	AC INJ. MOD 5	25 A	K 05	B 005	} <u>AC</u> K 55 TANK
6	AC INJ. MOD 6	25 A	K 06	B 007	
7	AC INJ. MOD 7	25 A	K 07	B 009	
8	AC INJ. MOD 8	25 A	K 08	A 016	} <u>AC</u> K 56 TANK
9	AC INJ. MOD 9	25 A	K 09	A 018	
10	AC INJ. MOD 10	25 A	K 10	A 020	
11	AC E J. MOD 11	25 A	K 11	A 022	} <u>AC</u> K 35 TANK
12	AC E J. MOD 12	25 A	K 12	A 024	
13	AC E J. MOD 13	25 A	K 13	A 037	} <u>AC</u> K 50 TANK
14	AC E J. MOD 14	25 A	K 14	A 035	
15	AA E J. MOD 15	25 A	K 15	A 033	} <u>AA</u> K 22 TANK FEEDS MOVEMENT SYSTEM
16	AA E J. MOD 16	25 A	K 16	A 031	

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TABLE 2

BT 2


CIRCUIT N°	EQUIPMENT IDENTIFICATION	FUSE RATING	CASTELL KEY	CONNECTED TO RACK
1	OIL SYSTEM	20A	K17	A 014
2	CONTROLS MONITORING	20A	K18	A 013
3	SPARE	—	K19	—
4	SPARE	—	K20	—
5	SPARE	—	K21	—
6	VAC PUMP	20A	K22	VAC PUMP

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