ANNEXURE F1
1

F O S K O R L I M I T E D

GENERAL ENGINEERING SPECIFICATIONS

DESIGN CRITERIA FOR

ELECTRICAL INSTALLATIONS

GE - 1

REV - 8

REVISION 9

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ELECTRICAL ENGINEER

F O S K O R L I M I T E D

CONTROL SHEET

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DESIGN CRITERIA FOR ELECTRICAL INSTALLATIONS

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GENERAL ELECTRICAL SPECIFICATIONS

DESIGN CRITERIA FOR ELECTRICAL INSTALLATIONS

1. BASIC DESIGN AND DATA:

1.1 THE BASIC ENGINEERING DESIGN CONSISTS OF THE FOLLOWING

1.1.1 Single line diagrams will show all power and control cable sizes and numbers, equipment ratings, metering, relaying, symbols, notes and any other information necessary to make it complete. The single line diagrams will be used in the preparation of final construction drawings.

1.1.2 Typical schematic diagrams will be prepared for all similar drives. All components and devices will be identified and arranged in such a way as to give a clear picture of the electrical operation intended.

Schematic diagrams will include control, alarm, interlocking and indication features and be co-ordinated with equipment manufacturer's diagrams and requirements as they become available.

Block sequence interlocking diagrams for easy reference shall also be supplied on the schematic drawings where applicable.

1.1.3 Electrical control and instrument panel layouts will be prepared to shown the arrangement and type of the various components.

1.1.4 Motor lists will be prepared to show the requirements for each motor.

1.1.5 Arrangement drawings will be prepared for electrical equipment rooms, control rooms, and any other areas where the size, location and arrangement of the building may be affected.

Drawings will also be prepared showing the general location of underground cables in the plant area.

1.1.6 Equipment specifications for all major electrical equipment for use in procurement and delivery to the plant will be supplied by FOSKOR and consist of the following:

Description	Equipment Specification No
525 Volt Motor Control Centres and Switchgear	EE-1
Squirrel Cage Induction and Wound Rotor Motors	EE-2
3,3 kV Motor Controllers (Not Available)	***EE-4***
11 kV - Switchgear (Not Available)	***EE-5***
11 kV - Power Transformers	EE-6
11000 and 660 Volt Cables (Not Available)	***EE-8***
3,3 kV Cables	***EE-9***
11 kV Cables	***EE-10***
Power Factor Correction Equipment	EE-11
Lighting and Small Power Distribution Boards	EE-12

1.1.7 The installation, testing and commissioning of electrical equipment will be in accordance with the Electrical Construction Specification No. EC-1 covering all technical aspects of work to be performed by the electrical contractor.

1.2 PLANT LOCATION AND AMBIENT TEMPERATURES:

The installation described in this design criteria is located in the Northern Province, Republic of South Africa. It shall be designed for operation at an altitude of approximately 440 metres above level and at ambient temperature as follows:

50 C (122 F) Maximum
2 C (36 F) Minimum

2. DETAILED ENGINEERING:

2.1 The detailed engineering design shall consist of drawings and additional specifications to complete in detail the entire electrical system in accordance with the basic engineering and this design criteria. These documents shall enable a qualified electrical contractor to submit tenders for the installation of the electrical system and complete the work with minimum additional engineering in the field.

2.2 The detailed engineering shall include the following:

2.2.1 Combined wiring/schematic and interconnection diagrams shall show all wiring, cabling and connections between equipment in the same format as drawings E50/2/14,3, E50/2/14,4 and E50/2/14,8 internal connections of shop wired equipment shall indicated two types of reference drawings:

A reference drawing or drawings on which the load centre, control panel or other equipment is shown physically.

A reference drawing of drawings of all drives or circuits with which interlocking is established.

A combined wiring/schematic and interconnection diagram shall be prepared for each and every drive or circuit and in such a format that every drawing can be divided in four A4 drawings still indicating all the relevant information. No A0 drawings shall be used.

The primary purpose of wiring/schematic and interconnection diagrams is to provide an accurate and easily understood picture of the cables and conductors which the electrical contractor must install to complete the connections between equipment.

2.2.2 Cable schedules shall list all power and control cables showing the origin, termination. Length and cable description. Cable schedules shall be used to purchase cable and also to assist the electrical contractor with the installation.

2.2.3 The position of all major and minor electrical equipment such as control stations, control devices, switchgear, motor control centres, lighting panels, lighting switches, trays, racks, conduits, etc., shall be shown on General Arrangement drawings. Cables shall be clearly identified so that the electrical contractor will be able to place them in their predetermined route.

2.2.4 Material list containing detail description of all the electrical equipment and material shall complement all the layout drawings. Material lists shall be used for the purchase of electrical material and electrical

equipment not covered by specifications as listed in Paragraph 1.1.6.

2.2.5 Electrical construction specifications shall accompany the finished drawings for the electrical contractor's bidding and construction. The construction specifications shall consist of the Electrical Construction Specification No. EC-1 as well as a project specification in which the following shall be detailed:

2.2.5.1 Exact scope of work applicable to the specific project.

2.2.5.2 Work included.

2.2.5.3 Work not included.

2.2.5.4 Equipment supplied by owner.

2.2.5.5 Equipment supplied by electrical contractor.

2.2.5.6 Drawings and equipment specifications.

2.3 Where complicated interlocking exists between equipment in a plant or part thereof, a programmable logic controller shall be used. The decision to install as well as the type thereof, shall rest with FOSKOR and shall be discussed well in advance.

2.4 **All design drawings, equipment list, specification and documents shall be submitted to FOSKOR for approval prior to any work being carried out. A period of at least 2 (two) weeks shall be allowed for approval and discussion. All drawings shall be submitted in triplicate.**

3. CODES AND STANDARDS:

3.1 Conformance with the latest amendments of the following codes and standards shall be considered a minimum requirement. In the event of differing requirements between codes and standards, the most stringent code or standards shall apply.

3.1.1 Code of Practice for the Wiring of Premises SABS 0142-1987.

3.1.2 South African Bureau of Standards - other relevant Codes of Practices.

3.1.3 British Standard Code of Practice.

3.1.4 British Standard Specification of the British Standard Institution.

3.1.5 Mineral Act of South Africa.

3.1.6. Post Office Regulations

4. STANDARD DRAWINGS

4.1 The following attached drawings are electrical standards to be used in the design and the preparation of drawings for the electrical work:

E50/2/6.1	Civil requirements for substations.
E50/2/14.1	Symbols for single line diagrams.
E50/2/14.2	Symbols for schematic and block connection diagrams.
E50/2/14.3	Standard schematic diagram for 525 volt D.O.L motor starter with local-remote switch.
E50/2/13/4	Standard schematic diagram for 525 volt, D.O.L motor starter with test-off-remote switch.
E50/2/14/5	525 V, 3 pH Induction motor requirements (cables, fuses and MCB sizes).
E50/2/14.6	Derating of multicore cables laid in single way ducts.
E50/2/14.7	Typical underground detail of cables.
E50/2/14.8	Standard schematic diagram for 525 volt D.O.L motor starter with no remote control.
E50/2/14.9	Standard cable schedule form.
E50/2/14.10	Standard electric motor schedule form.
E50/3/14.1	Symbols for power and lighting layouts.
E50/4/14.1	Symbols for electric and electronic components.

5. DISTRIBUTION VOLTAGES (EXISTING)

5.1 PRIMARY DISTRIBUTION: **(WEGSTEEK)**

5.1.1 The plant electrical system is fed by two 132 kV, 50 Hertz transmission lines which are designed and installed by ESKOM.

5.1.2 The 132 kV is stepped down to 11 kV through three 40 MVA transformers. The transformers are DELTA-WYE with a YNd1 vector symbol group. The percentage impedance of each transformer is 19,5 % on the lowest voltage tap and at a base MVA of 40. The 11 kV system is impedance grounded through a combination zigzag transformer / DELTA_WYE auxiliary transformer.

5.1.3 The 132 kV switchyard consisting of 5 SF6 circuit breakers, 9 links, 15 current transformers, 6 Voltage Transformers and necessary accessories are Foskor's property and is maintained by FOSKOR.

5.1.4 The 11 kV switchyard transformer consisting of three 11KV, 2400A SF6 Circuit breakers and 12 12000Amp Feeder Circuit breakers.

5.1.5 Power is fed at 11 kV to three main distribution substations from where all secondary 11 kV substations are fed.

5.1.6 11 kV switchyard consists of three 24 MVA capacitor banks each capacitor bank consists of it's own 11KV main circuit breaker with 3 Joslyn circuit breakers for each capacitor stage.

PRIMARY DISTRIBUTION: **(EXTENSION 8)**

5.1.7 The plant electrical system is fed by two 132 kV, 50 Hertz transmission lines (Dual circuit – single tower) which are designed by ABB and installed by LTK.

5.1.8 The 132 kV is stepped down to 11 kV through one 40 MVA transformer. The transformer is DELTA-WYE with a YNd1 vector group. The percentage impedance of the transformer is 18,5 % on the lowest voltage tap and at a base MVA of 40. Automatic Voltage regulation is done by a tap changer on the main transformer. The 11 kV system is impedance grounded through a combination zigzag transformer / DELTA_WYE auxiliary transformer.

5.1.9 The 132 kV switchyard consisting of 3 SF6 circuit breakers, 3 links, 9 current transformers, 6 Voltage Transformers and necessary accessories are Foskor's property and is maintained by FOSKOR.

5.1.10 Power is fed at 11 kV to three main distribution substations from where all secondary 11 kV substations are fed.

5.1.11 11 kV switchboard consists of two 2000A SF6 Circuit Breakers and one 2000A Bus Coupler. Together with this are eight 630A SF6 Feeder Circuit Breakers and four 800A Capacitor Circuit Brakers.

5.2 THERE ARE FOUR SECONDARY DISTRIBUTION VOLTAGES:

5.2.1 6 600 Volt 3-Phase 50 Hertz. Resistance grounded WYE.

5.2.2 3 300 volt, 3 phase, 50 Hertz resistance grounded WYE.

5.2.3 525 volt, 3 phase, 50 Hertz, solidly and resistance grounded WYE.

5.2.4 22 000 volt 3-phase 50 hertz (TTPS/RWPS).

5.3 All lighting and 380/220 V power points and equipment is fed from three phase 380/220V 50 Hertz solidly grounded WYE secondary transformers. The primary voltage is the following:

5.3.1 11 kV, 50 Hertz where the size of the transformer exceeds 250 KVA.

5.3.2 525 V, 50 Hertz where the size of the transformer is to be 250 KVA or less.

5.4 All control voltages are 220 volt, 1 phase, 50 Hertz. 110 volt is used only for instrumentation and special control circuits.

5.5 D.C. distribution are supplied by the following sources:

120 or 30 volt storage batteries with necessary mains charging equipment, protection devices and other accessories.

Individual D.C. rectifiers and/or motor-generator sets feeding various DC. equipment at required voltage.

5.6 Instrumentation control supply shall be fed from a 525/220 constant voltage transformer. Sized for the application. (220 Volt 50 Hz single phase)

6. PRIMARY DISTRIBUTION SWITCHGEAR:

6.1 All H/T switchgear will be the indoor type, metal clad, vacuum or SF6 switches, 1,2 metres clearance shall be provided at rear of switchgear.

6.2 All circuit breakers will be, vacuum or SF6 type, 3 pole, single throw of adequate capacity for operation of a WYE, impedance grounded system, 3 phase, 3 wire, 50 Hertz and to carry continuous load and momentary short circuits. All circuit breakers shall be electrically operated with D.C. control voltage from station batteries.

6.3 All circuit breakers and other switchgear will be furnished with meters and relays as required by FOSKOR.

6.4 The switchgear shall be able to withstand a 3-phase fault current of 18kA for 3 seconds (11kV).

7. DISTRIBUTION POWER TRANSFORMERS:

7.1 All distribution power transformers will be of the oil insulated type, two winding, 3 phase, 50 Hertz. Skid transformers will be of the resin insulated type.

7.1.1 HT/525/380 V transformers will have a delta primary and a solidly grounded WYE secondary (380V) and resistance (31 Ω on 525V) system.

7.1.2 HT/6,6/3,3 kV transformers will have a delta primary and a resistance grounded WYE secondary.

7.2 Each distribution transformer shall have an circuit breaker capable of fault make and load break. The following transformer/circuit protection devices shall be provided on each circuit breaker.

7.2.1 I.D.M.T. Overcurrent and earth fault relays will be an electronic relay with the following type of curves: a) NI b) VI c) EI d) DT .
The relay shall also have communication capabilities with a Modbus protocol.
The relay shall also have a blocking signal facility.
The relays currently used by Foskor is Siemens 7SJ60 and the Multilin SR 750

7.2.2 Transformer differential protection relays with 20%, 30% and 60% load bias selectors. Current transformers to be of such ratio as to avoid the necessity of interposing current transformers as far as possible.

7.2.3 Transformer overtemperature alarm and trip relays operating from temperature sensing devices installed in the transformer.

7.2.4 Transformer Buchholz alarm and trip relays operating from a gas detection apparatus mounted in the transformer oil conservator supply line.

7.3 Each transformer will be equipped with four 2.5% rated kVA full capacity, manually operated taps on the high voltage side. The taps shall be as follows:

Two above and two below primary voltage and shall have the following settings:

+5%, +2.5%, 0, -2.5%, -5%

8. SECONDARY DISTRIBUTION SWITCHGEAR:

8.1 6.6/3.3 kV SWITCHGEAR:

8.1.1 All 6.6/3.3 kV switchgear, will be of the indoor or outdoor metal enclosed SF6 or vacuum break type. 1,2 metres clearance shall be provided at rear of switchgear.

8.1.2 All circuit breakers will be of the SF6 or vacuum break type, 3 pole, single throw of adequate capacity for operation on a WYE, low resistance grounded system rated 6,6/3,3 kV, 3 phase, 3 wire, 50 Hertz and to carry continuous load and momentary short circuits. All circuit breakers shall be electrically operated from a suitable auxiliary source.

8.1.3 All circuit breakers and other switchgear will be furnished with meters and relays as required by FOSKOR.All circuit breakers will withstand 18 kA for 3 sec during fault conditions.

8.2 525 VOLT SWITCHGEAR:

8.2.1 The switchgear will be of the indoor or outdoor metal enclosed air break type.

8.2.2 The switchgear will consist of a main secondary transformer breaker or breakers, bus coupler if required, and circuit breakers. All breakers will be of the thermal magnetic type. Bus couplers and main breakers will be electrically or mechanically operated and interlocked so that parallel operation of more than one incoming supply would not be possible.

9. HIGH VOLTAGE STARTERS:

9.1 All 6.6/3/3 kV motors will be connected to unitised type high voltage starters with high interrupting capacity current limiting fuses as short circuit protection.

9.2 Unitised starters will have metal-clad enclosure suitable for indoor service.

9.3 Each motor starting unit will consist of one 3-pole gang operated isolating switch, one set of current limiting power fuses, one 3-pole vacuum contactor with various accessories and protective devices as follows:

9.3.1 Motor protection relay – Multilin 239 or equipment subject to prior agreement with FOSKOR.

9.3.2 Core balance time delayed earth leakage protection relays operating at an unbalance of 375mA or 500mA.

9.3.3 Striker-pin tripping on main fuses.

9.3.4 Motor overtemperature trip relays operating from thermistors mounted in motor windings and with adjustable alarm and trip points.

9.3.5 Other protective devices and/or interlocks as required by FOSKOR.

9.4 Each starter fuse unit will have an adequate interrupting capacity at rated voltage.

9.5 The back of the enclosure shall be secured by a minimum of 6 (six) bolts so as to be removable. The panel shall be labelled:

"DANGER - ISOLATE BEFORE REMOVING THIS PANEL"

9.6 1,2 metres clearance shall be provided at rear of panel.

10. 525 V MOTOR CONTROL CENTRE

Unless otherwise stated, all 525 volt motors below 400 kW shall be fed from motor control centres. Motor control centres shall be unitised type with H.R.C. (Type DIN fused isolators) or fuses, isolators, magnetic contactors and earth bus. The motor control centres shall be dead front with the following features:

10.1 Enclosure shall be the general purpose type for indoor service.

10.2 Incoming circuit breakers shall be the with-drawable and padlockable Merlin and Gerin type Masterpack with remote close facility and STR28D control relay only. Main bus bars shall have a capacity of at least 600 ampere and shall be rated at 1.6 A/sq.mm minimum.

10.3 Each motor control centre shall have one 525 V /220 V control transformer of adequate capacity and earthed neutral on the secondary side. A 30 mA earth leakage relay shall be provided on the secondary side of the transformer and connected such that a red panel light will light up when an earth leakage is present. **No tripping shall occur**. The light shall be marked. "CONTROL SUPPLY EARTH LEAKAGE".

10.4 Starters units shall be, where possible, of the plug in type (30 kW and smaller starters only) consisting of fused isolator with three H.R.C. (DIN Spec) fuses, earth leakage, a magnetic full voltage contactor and electronic overload. The physical order of installation shall be in the same sequence as above. Other protective devices shall be as follows:

10.4.1 Core balance time delayed earth leakage protection relays operating at unbalance of 375 mA or 500 mA (E.P.C. - EL SEC T only). (If not incorporated in 10.4.3). (Welding plug power outlets shall be protected by 250mA - EL SEC x only). The 1000mA EL SEC T will only be used where VSD's are incorporated.

10.4.2 Motor overtemperature trip relays operating from thermistors mounted in motor windings and with adjustable trip points. This feature is only required for motor starters in excess of 100 kW. (Siemens type 3UN6 or equivalent). (If not incorporated in 10.4.3)

10.4.3 Newelec, equivalent motor protection relays shall be provided for 110KW and above starters. Relays shall have the following features. Overload trip auto/manual reset, short circuit, earth leakage, phase failure, limited motor starts and motor over temperature protection. The relay shall also be an electronic overload relay.

10.4.4 Other protective devices and/or interlocks as required by Foskor.

10.5 H.R.C. fuses shall be of the "English Electric", "Siemens" or similar approved DIN Spec type. The size of the H.R.C. fuses shall be in accordance with standard drawing E50/2/14.5. The main fused isolator for every starter unit shall be mounted on a separate base plate to allow removal of the complete back panel of the starter and equipment without the need to remove fuse-holders or disconnect it from the busbars. **Fuses contactor and overload combination shall assure type 2 co-ordination.**

10.6 Moulded case circuit breakers, isolators and fused isolators shall be rated for not less than 40°C ambient temperature with the nominal ampere rating derated for 50°C ambient operation. The derated ampere rating shall be shown on the drawings. The size and type of isolators for motor circuits shall be in accordance with standard drawing E50/2/14.5.

10.7 An early break late make auxiliary contact shall be provided on each fused isolator to open the control circuit when the isolator is open. A toggle type switch labelled "NORMAL - TEST" shall be provided on each starter in parallel with the breaker auxiliary contact.

10.8 The internal wiring of all motor control centres shall be colour coded as follows:

10.8.1 Starter or individual panel interwiring grey.

10.8.2 Interlocking wiring between panels in the same board - brown.

10.8.3 Interlocking or control wiring to central panel mounted remotely - white.

10.8.4 Interlocking or control wiring to field equipment or local control stations - black.

10.8.5 Wiring to programmable controller if installed - pink.

10.8.6 Power wiring - phase colours red, white and blue.

Interconnecting cables from motor control centres to field or control room shall be of the multicore black or white type with all cores numbered by the cable manufacturer.

10.9 All control wiring shall be bottom entry and be wired to readily accessible terminal blocks located at each starter unit. Terminal blocks shall be pull-apart type or equal, to enable removing the starter unit with out removing factory or field control wiring from the terminals. All external interlocks shall be wired to the terminal blocks.

10.10 Starter wiring shall be in accordance with standard drawings E50/2/14.3, E50/2/14.4 or E50/2/14.8 unless otherwise required. All symbols used shall be in accordance with standard drawings E50/2/14.1, E50/2/14.2, E50/3/14.1 and E50/4/14.1.

10.11 Every control circuit wiring shall be numbered starting from the number one at the bottom of the top control fuse and proceeding downwards towards the top of the bottom control fuse. Each time using the circuit number as a prefix, e.g. wire no.9 on circuit 12 will read 12/09. Refer to drawings E50/2/14.3, E50/2/14.4 and E50/2/14.8.

10.12 If provided door mounted handles operating the circuit breaker or isolator shall not be interlocked with the opening of the door.

10.13. Provision shall be made on the outside of each panel door for writing down of overload setting, fuse size, kW isolator size. Space shall also be provided to affix the A4 schematic wiring and interconnection diagram.

10.14 A spare set of normally open and normally closed aux. contactor contacts shall be wired to the terminal block.

10.15 Approximately 10% spare starters and circuit breakers of sizes as required by Foskor shall be allowed for and in addition 15% space shall be provided complete with

fuse base and down tails from bus bars for later additional starter circuits.

11. MOTORS:

11.1 In general, motors 400 kW and over shall be 6.6/3.3 kV, 3 phase, 50 Hertz with assisted start if required (refer to 11.6).

11.2 All motors under 0,56 kW shall be 220 volt, 1 phase, 50 Hertz except where it forms part of a production line in which case it shall be 525 volt, 3 phase, 50 Hertz.

11.3 All 525 volt motors shall be totally enclosed, cast iron frame, IP55, fan cooled and shall be rated for 50°C ambient temperature, or alternatively, shall be rated for not less than 40°C ambient temperature with the nominal kilowatt rating derated for 50°C ambient temperature.

6.6/3.3 kV motors shall generally be of the closed air circuit air cooled enclosure while the same temperature considerations as above shall apply. Motors shall be 4 pole foot mounted as far as possible.

11.4 All motors in excess of 100 kW shall be provided with three thermistors mounted in the motor windings and connected to a terminal strip in the motor terminal box. The thermistors shall match the overtemperature trip relay mounted in the motor starter panel. Heaters shall be provided in all motors 300 kW and over and also as required by Foskor. Heaters shall be rated for the motor voltage.

11.5 Motors requiring special characteristics on start or run-up e.g. for crushers or mills, shall be of the slip ring type and provided with a STRATO rotor starter. Motors for loads with very high inertia, e.g. large fans can alternatively be supplied with electronic soft starter controllers. All start-up aids shall be matched with the characteristics required by the load. All soft starters shall have inline contactors to isolate motor from applied voltage on thyristors. **Equipment shall be approved by Foskor.**

11.6 All power supplies to motors shall be provided with padlockable on-load, 3 phase isolators mounted at the motors and connected in the supply to the motors. An early brake late make auxiliary contact shall be provided on each isolator and wired in the control circuit at the local control station. These on-load isolators shall be installed in the same IP55 enclosure as the control buttons and ammeters for drives up to 30 kW. All enclosures to be fabricated from Stainless Steel

304 material. For larger drives, a separate IP55 enclosure adjacent to the control enclosure shall be provided. Enclosure shall have hinged doors with square key lockable latches and shall be SABS 1091 B26 orange colour.

11.7 Full details of all motors shall be provided on a motor schedule form similar to standard drawing E50/2/14.10.

11.8 All motors shall be GEC,Siemens or WEG. Any alternative supplier must be approved by Foskor before ordering.

11.9 Attached is the standard frame sizes. Alternative frames must be approved by Foskor.

11.10 **Special permission must be granted by the electrical engineer before any flange motors will be considered for application on Foskor.**

12. CONTROLS:

12.1 In general, electric motor driven equipment will be supplied by the manufacturers without motor starting equipment, except motor driven equipment which is mobile, such as cranes, conveyor trippers, etc., where the starting and control devices are an integral part of the equipment supplied by the manufacturer.

12.2 All START-STOP push-buttons shall be Cutler Hammer type 10250T with type BN90118 lockout attachment for every stop push-button. Control stations situated at equipment shall generally be of the following three types:

12.2.1 START-STOP-INTERLOCK OVERRIDE push-buttons shall be mounted in a watertight Stainlees steel 304, IP55 enclosure and wired according to drawing E50/2/14.8. This arrangement shall be used where no remote control exists and where equipment is normally started from a local position only.

12.2.2 A TEST-OFF-REMOTE selector switch spring return from TEST to OFF in a IP55 watertight Stainlees steel 304 enclosure and wired according to drawing E50/2/14.4 shall be used where equipment is normally started from a remote control station by means of START-STOP push-buttons. An alternative arrangement using only push-buttons and a desk mounted selector switch is shown on drawing E50/2/14.3 but should only be used if requested.

12.2.3 AN ON-OFF-AUTO selector switch in a IP55 watertight enclosure shall generally be used for liquid level control stations unless otherwise required by FOSKOR.

12.3 Where motors operate in groups and where the operation of one piece of equipment is dependent upon another, interlocking shall be used and this shall be accomplished by auxiliary contracts in the starters and/or auxiliary relays. Such groups shall be controlled from panels, in addition to START and STOP buttons or TEST-OFF-REMOTE switches located near each motor. Conveyors - Stratford speed sensor.

12.4 Each conveyor shall be provided with hand reset emergency stop switches similar to Cutler Hammer type operated by pull wires along the entire length of the conveyor. The maximum length for pull wire shall be 30 metres.

12.5 Each conveyor system shall be provided with an alarm and shall give 10-20 second warning before the conveyor start up. This requirement applies to TEST, LOCAL and REMOTE operation.

12.6 An ammeter shall be provided for each motor or as otherwise required and shall be mounted on the appropriate locally mounted ammeter as well as a running hour meter shall be provided in the same enclosure as the START-UP push-buttons or TEST-OFF-REMOTE switch. This also applies for drivers with no remote control panel in which case only one ammeter and hourmeter shall be installed in the local control station enclosure.

12.7 Indicating lights shall be provided on the remote control panel (or mimic panel if required) indicating whether the appropriate motor or electrical equipment is running, stationary or tripped. A green light shall be used for running, red for stationary and orange for tripped. The orange light, when activated, shall flicker at a rate of 1 to 2 Hertz until the "alarm cancel" button has been activated. Then it shall remain on until the fault has been cleared.

Additional orange alarm lights shall be provided for conveyor wander, conveyor pull switches, metal detectors, dust fan filter blockages, transformer temperature and Buchholz first alarm and other as required by Foskor. The operation of these lights shall be the same as for motor trip lights. (See also 12.9)

12.8 Alarms shall be provided at each control panel which will sound when one of the alarms, i.e. orange lights, is activated.

12.9 Each alarm shall have an "Alarm Cancel" push-button incorporated in the appropriate control panel.

12.10 Push-buttons and control switches shall be suitable for 600 volt operation.

12.11 The requirements of 12.7, 12.8 and 12.9 only applicable to installations where a centralised control room is required.

12.12 If a programmable logic controller is installed the aforementioned requirements shall apply. Stop Push-buttons, trip circuits as well as emergency stops shall however remain hardwired in the control circuits.

13. POWER FACTOR CORRECTION:

The following methods shall be used to correct the power factor of each substation to 0,95 or better but not exceeding 0,98 lagging.

13.1 By connecting a shunt capacitor or capacitor bank in parallel with each motor 100 kW and upwards.

13.2 By connecting shunt capacitors direct to the M.C.C. bus bars through contactors controlled by an automatic power factor correction relay.

All capacitors shall be indoor/outdoor type with suitable mounting brackets. **No PCB capacitor shall be allowed.**

14. SURGE PROTECTION:

All high voltage rotating machinery above 525 volt shall have surge protection units installed in parallel at the motor or generator terminals. The terminals shall be connected to the rotating machine frame and to the main earthing grid. The equipment shall be housed in waterproof enclosures

15. LIGHTNING PROTECTION:

15.1 All buildings and structures shall be protected from lightning. Protection shall be accomplished in accordance with the "Code for Protection of Buildings from Lightning" of South African Bureau of Standards (SABS 03:1985) or latest revision.

15.2 In general, all chimneys and/or stacks shall be protected from lightning by copper rods, hard or medium-hard drawn 19mm in diameter secured on top of stacks. Lightning rods shall project sufficiently above the top of the stack to include the whole of the stack within its zone of protection. No stranded copper conductor to be used.

15.3 A minimum of two down conductors shall be provided to connect the lightning rods with the earth terminal.

15.4 Down conductors shall be 70 sq.mm minimum soft annealed copper.

15.5 Lightning arresters shall be installed where required.

16. EARTHING

16.1 The earthing system shall be grid or network of bare copper conductors. The cold water main, structural steel, reinforcing steel (only when electrically continuous), electrical and process equipment shall be electrically bonded to the earthing system. The main grid shall be composed of bare stranded soft drawn copper wire surrounding the general outline of the taut-string perimeter of the structure with the down conductors connected to this ring.

There possible, it shall be placed in the backfill of the foundations, a minimum of 460mm from the foundation and a minimum of 460mm below the finished grade except under roads where it shall be buried 1 metre. Where soil conditions are such that corrosion to bare copper earth conductors can prevail, P.V.C. covered copper earth conductors shall be used. Soil conditions are to be discussed with Foskor before designing the earthing system. Structural steel shall be earthed where ever feasible or as indicated on the drawing, but in any case in no less than four (4) positions. The spacing between bonds, shall however not exceed thirty (30) meters.

16.2 All underground earthing shall be so located to avoid interference with underground piping, foundations, or areas likely to be excavated in the future. All buried earthing cables away from buildings shall be surveyed by the contractor and Foskor to be notified to check before backfilling to trenches. Survey drawings shall be submitted to Foskor.

16.3 All earth connections shall be copper welded or solderless pressure type connector ("Crimping lugs") Cadweld only to be used on prior permission by Foskor.

16.4 The earth shall be established by means of driven copper earth rods, 2,4 metres minimum length. Where soil conditions are such that corrosion to the bare copper rods can prevail, stainless steel rods shall be used. The earth grid shall be bonded to the plant water system. Alternatively, copper earth mats may be used but only with prior permission from Foskor and upon submission of detailed drawings.

16.5 The combined plant earthing system resistance shall not exceed 5 ohms during the driest period of the year. The

electrical resistance of the earth continuity conductor, including metal conduits, the metal sheathing of cables and the armouring, together with the resistance of the earth lead, shall not exceed earthing lead to any portion in the complete installation. (See also 16.12)

16.6 A visible upper earth bar of cross sectional area of at least 400 square millimetres shall be installed on suitable insulators at a height of 300mm above floor level in all substations. The plant earth ring shall be connected on the two ends of the copper bar and removable links provided to facilitate decoupling of the earth ring.

16.7 All equipment in and around substations such as transformers, switchgear, motor control centres, control panels, lighting panels, m/g sets, tripping units, etc., shall be connected directly to this earth bar.

All field equipment such as remote control panels, lighting panels, generators, motors, requiring power cables in excess of 35 square millimetres, shall be earthed to the motor control centre strap through an extra bare stranded copper conductor. Low voltage motor requiring power cables of 35mm or less can be earthed through an additional core of the power cable.

16.8 All major electrical equipment, e.g. transformers, generators, etc., shall be earthed in such a manner as to provide a minimum of two paths to earth.

16.9 The size of earth conductors shall be according to the fault level available in the specific area. Typical size of the main earthing conductors are as follows.

	Square Millimetres
Main earth grid	150
Building steel	70
Steel fence (where required)	70
Main large high voltage transformers	150
Main high voltage switchgear	150
Low voltage switchgear	150
Motor control centres	150
Distribution panels	70
High voltage motors	70
Lighting transformers - Not less than	16
Lighting panels - Not less than	16
Control panels - Not less than	16
Welding outlets - Not less than	16

16.10 Every earthing conductor liable to mechanical damage shall be protected by an adequate length of galvanised pipe flared at both ends.

16.11 All connections of the earthing lead to the installation shall be readily accessible.

16.12 When the armour of a cable is earthed, the clamp used shall be of special design so that it will grip firmly and permanently without damage to the insulation or to the metal sheath of the cable. The armouring or metal sheath of any cable shall not be used for earth continuity.

16.13 Cranes and mobile machinery shall be earthed through a separate collector rail. In addition the rails shall be electrically bonded to the earthing grid.

17. OVERHEAD LINES, MATERIALS, METHODS OF CONSTRUCTION AND MINIMUM REQUIREMENTS (22/11 kV AND LOWER VOLTAGES)

17.1 The overhead distribution system shall consist of aluminium line wire with steel reinforcing or hard drawn copper open line wire on wood or steel poles. Minimum length of poles, projecting above the ground, shall be 6 metres. For H/T lines the sag shall be calculated for a temperature of 50°C.

17.2 All conductors shall be supported on pin type insulators using galvanised steel pins, or by strain insulators at dead end and angle poles. Galvanised surfaces shall have a continuous coating of pure zinc of uniform thickness applied by hot dip sherardizing or electro-disposition, so as to produce a coating adhering firmly to the surface of the metal.

17.3 All conductors shall be large enough to limit voltage drop to 6% at full load. All conductors shall be stranded minimum size 30 sq.. mm.

17.4 A static earth wire is required for all overhead lines. Static wire shall be 8 mm diameter, minimum 7 strand galvanised steel wire, attached to the tops of the poles. Every pole shall have a stranded galvanised wire running from the earth wire at the pole top, down the side of the pole with 6 m of slack, wound around bottom of the pole and stapled in position.

17.5 The value of the lighting ground flash density for this area would be in the order of 1-2 flashes/km/yr. However good lighting protection is required. Lightning arresters shall be located where an overhead system changes to an underground system and at all angle poles. H/frames, dead ends,, boxes, links, bays, etc.,

17.6 Station type lightning arresters shall be used at all substations and at high voltage switchgear.

For distribution lightning arresters, pellet type shall be used on overhead lines and where overhead system changes to an underground system.

17.7 Angle and dead end poles shall be stayed by galvanised steel guys with straining insulators and properly anchored.

17.8 Pole mounted transformers shall be oil filled and weatherproof. They shall be protected by pole mounted fused links.

17.9 Anti-climb devices to be installed on all poles, switchgear and cable.

18. UNDERGROUND CABLES:

18.1 As far as possible, only power distribution cables shall be installed underground. Equipment supply, control and instrumentation cables shall only be installed where it is impractical to construct concrete trenches or overhead cable trays and only with prior permission from Foskor.

18.2 All buried cables shall be surveyed by the contractor. Survey drawings shall be submitted and Foskor to be notified to check trenches before backfilling.

18.3 Underground installations shall be accomplished by direct burial of cables type pilcswac, (Paper insulated lead covered steel wire armoured cable) PVC PVC SWA PV, (polyvinylchloride, steel wire armoured with polyvinychloride sheating) PEX PVC SWA PVC, (crosslinked polyethylene steel wire armoured with polyvinylchloride sheating or other acceptable cable.

18.4 Direct burial cables shall be installed at 600mm below grade in the case of L/T cable and 1000mm for H/T and standard plastic danger tape shall be installed 300mm below G/L for the entire length of the cable. See drawings E50/2/14.7 Where power cables cross communication cables, the depth of burial should be increased to 1000mm (this also applies to road crossings).

18.5 Direct burial cables, if possible, shall be installed in whole lengths. Where jointing is necessary, it shall be performed in accordance with the cable manufacturer's recommendations. H/T cable joints shall be surveyed and the drawings submitted to Foskor.

19. WIRE AND CABLE:

19.1 All cable shall be suitable for the application and in accordance with S.A.B.S. 97/1959 : 150/1957 and BS 3346:1961 or other acceptable cable.

19.2 All cables for 220, 380 and 525 volt motors shall be multiple core polyvinylchloride steel wire armoured medium voltage (660-1100 volt) cables as per S.A.B.S. 150:1957.

19.3 All control cables shall be multi core polyvinylchloride steel wire armoured cable as per S.A.B.S. 150:1957 where applicable.

19.4 All underground cables when put in groups shall be derated in accordance with standard drawing E50/2/14.6.

19.5 Only approved end terminations shall be used both indoors and outdoors.

19.6 Only approved mechanical glands to be used on all PVC PVC SWA PVC cable ends.

19.7 All cable operating in areas near equipment which generates excessive heat and in which the temperature is consistently more than 43°C (110°F) shall be pyrotenax MICC type or approved equivalent.

19.8 Cable sizes for 525 volt motor feeders shall be as shown on standard drawing E50/2/14.5. Cable sizes for feeders to other equipment shall be designed such that the maximum overall volt drop at full load shall not be more than 5 % of the supply voltage.

19.9 Full details of all wire and cable installed shall be provided on a cable schedule form similar to standard drawings E50/2/14.9.

20. CONDUIT AND TRAY:

20.1 All power and control cabling inside buildings and as far as possible, outside, shall be installed into open trays, racks, or on supports. In come cases cables may be installed in conduit, for mechanical protection, but trays and racks are preferred wherever possible.

20.2 Trays and racks shall be the ladder or perforated type and constructed so that they will have sufficient strength for the load imposed and will adequately support the cables. Where water or material spillage is likely, trays and racks shall be installed edge-on to minimise material build-up. Trays and racks shall be hot dip galvanised except in corrosive areas where PVC or fibreglass type shall be used. Classification of corrosive areas shall be obtained from Foskor.

20.3 Cables shall be fixed to trays or racks with suitable clips or stainless steel straps at 400mm intervals when

run edge-on or in a sloping or vertical plane (this interval shall be reduced to 400mm with cables of 185mm and above) on cables above 50mm^2 stainless steel straps shall be installed on 2 metre intervals in conjunction with PVC straps. When the tray is flat it should only be necessary to clip or strap the cable sufficiently to prevent "Walking". Colson type or similar straps may only be used if the tray or rack is flat.

20.4 Trays for power or lighting shall be filled up to 60% capacity maximum, with space between cables to permit air flow. Trays for control cables may be filled to 90 % capacity.

20.5 Separate cables shall be used for power and control.

20.6 Power, control, lighting and small power cables may be run in a common tray, providing the cable insulation voltage rating is identical. Separate trays will be used however for cables of different insulation voltage rating.

Separation shall also be provided for communication cables and special instrumentation circuits.

20.7 Conduits when used shall be rigid iron, heavy-wall, hot-dipped galvanised 20 mm minimum and shall comply with British Standard Specification BSS no. 31, Type B, screwed heavy gauge.

20.8 All cable rising from a trench to motors or other equipment shall have a steel protection (not pipe) of sufficient size, running from just below ground or floor level to a height of no less than 450mm. This protection shall, where circumstances dictate also contain the earth wire and shall not be welded to the equipment but bolted in a proper manner.

21. SUBSTATIONS AND TRENCHES (INSIDE BUILDINGS)

21.1 The size of substations shall be adequate to allow for free movement in front of motor control centres and other panels. A minimum clearance of 1m shall be allowed behind every L/T panel or motor control centre (see 8.1.1 & 9.6 for clearance on H/T switchgear) Provision shall be made in every substation for a 20% extension of the motor control centres.

21.2 Substation shall be provided with at least two stainless entrances, one of which shall be used as an emergency exit double steel door and only be opened from the inside of the substation by means of a panic bar. This door shall not be lockable from the outside. The other shall be a single steel door with padlockable latches on outside.

21.3 Emergency lighting shall be provided in every substation in accordance with paragraph 23.7.Only Beka emergency lights will be supplied as they control the charging process.

21.4 Substations shall be provided with split unit air-conditioners of adequate size to keep temperature in sub-stations at 26° C under maximum load conditions.

21.5 Trenches, if used, shall have a width of 300 to 600mm and depths as required. In substations, wider trenches may be necessary so as to permit easy tracing or removal of any cable. Cables shall be installed on racks in cable trenches.

21.6 Trenches shall have walls and bottoms of concrete or bricks, and covers of removable steel chequered plate in substations and removable concrete slabs in places other than substations. Chequered plate covers shall be of such a size and weight to allow easy handling by one person. (Refer EC-1 item 4.3.21.2 for Concrete Slabs).

Trenches in buildings, however, shall be avoided as far as possible and should only be used where cable racks or trays are impractical.

21.7 Trenches shall slope towards drainage points at a rate of 1%. Cable racks shall be firmly supported to the bottom or sides of trench. Entrance of cables into the trench from the sides shall be through a galv. pipe of adequate size.

21.8 The general civil requirements for all substations and transformer bays shall be as indicated on drawing E50/2/6.1.

21.9 The following safety notices in both official languages shall be installed:

21.9.1 <u>Inside substations at entrance door</u>

a) Prohibiting unauthorised persons from handling or interfering with electrical apparatus.
b) First aid treatment from the effects of electrical shock.

c) Emergency exit notice above emergency exit door.
d) Directions as to procedures in case of fire.

21.9.2 <u>Outside substation on both doors</u>

a) Flash danger/gevaar notice.
b) Directions as to procedures in case of fire.
c) Unauthorised entrance notice.

21.9.3 Transformer bay gates

a) Flash danger/gevaar notice.
b) First aid treatment from the effects of electrical shock.
c) Unauthorised entrance notice.

22. WELDING AND POWER OUTLETS

22.1 Three phase 4 pin, 525 volt, 50 Hertz, welding and power outlets shall be installed at appropriate locations in the plant areas for supplying power to portable welders and similar loads. Similar 380 volt outlets shall be provided in workshops or workshop areas. Sufficient circuit and number of outlets shall be provided in order that all areas of the building can be reached with a 20 metre extension cord.

22.2 Outlets shall be connected to earth grid by means of not less than 16 mm bare copper conductor.

22.3 All welding and power outlets shall be protected by shunt trip moulded case circuit breakers operated by earth leakage relays as specified in paragraph 10.4.1.

22.4 63A 3 Phase 4 pin power outlets shall be used for welding only, unless otherwise stated. (Ampco DIN type)

23. LIGHTING AND SMALL POWER DISTRIBUTION:

23.1 LIGHTING TRANSFORMERS, PANELS AND CONTROL

23.1.1 All lighting and 380/220 volt power points and equipment shall be fed from 3 phase, 380/220 volt, 50 Hertz solidly grounded WYE secondary transformers without taps. Primary voltage shall be in accordance with section 5.3. All lighting transformers shall be oil filled, placed outside, or in a chamber provided with adequate ventilation and protected from any spillage of water or material.

23.1.2 All industrial area lighting and yard area floodlighting shall be fed from centrally located lighting panels with moulded case type circuit breakers. Control of these lights shall by by light sensitive photo cells controlling a contactor if necessary. Rating of breakers for general lighting shall be loaded to a maximum of 2 500 watts.

Breakers for single phase socket outlet circuits shall be 220 volt, 1 pole, 20 ampere. (Unless protected)

All socket outlet circuit shall be protected by current operated earth leakage units. No more than eight 15 ampere socket outlets shall be connected on these

circuits, with due regard to heating and cooling equipment. Radial rather than ring connections shall be used. Minimum size of wire to be used shall be 1,5 sg.mm for light circuits and 4 sg.mm for socket outlet circuits.

23.1.2.1 Cognizance be taken in the design of socket-outlet circuits exceeding 20A.

23.1.3 Floodlights shall be mounted not more than 9 metres above grade on buildings or an special steel poles with concrete bases. Where poles are required for other purposes, lights can be bracket mounted on these poles. Lights mounted higher than 9 metres, shall be provided with a cat ladder, platform or walkway in order to replace lamps safely.

23.1.4 All lighting in offices and control rooms shall be controlled from wall switches.

23.1.5 All access doors shall be provided with an accessible switch that will turn on walking lights or passage way lights to the nearest area lighting panel. Walking lights shall not be extra or special fixtures but should be part of the area lighting system.

23.1.6 If the current drawn by light fittings exceeds the capacity

23.1.5 All access doors shall be provided with an accessible switch that will turn on walking lights or passage way lights to the nearest area lighting panel. Walking lights shall not be extra or special fixtures but should be part of the area lighting system.

23.1.6 If the current drawn by light fittings exceeds the capacity of a single switch, a contactor shall be installed for control of the lights.

23.1.7 Plug circuits, stoves and geysers shall be protected by earth leakage units. only single phase double pole units with a sensitivity of 30 mA shall be used.

23.1.8 Distribution boards shall be painted electrical orange. Boards shall be completely wired to a common terminal block prior to installation. Approximately 20 % spare capacity shall be allowed for in every board.

23.2 LIGHTING VOLTAGE:

23.2.1 Mercury and sodium vapour lighting shall operate on 220 volt.

23.2.2 Incandescent lighting shall operate on 220 volt.

23.2.3 Inspection lighting such as for boilers rotary driers, crushers and generally any accessible steel enclosure shall operate on 32 volt using locally mounted step-down dry type transformers.

23.2.4 Approved lighting suppliers are Magnitech,Eye Beka.

23.3 LIGHTING LEVELS:

The lighting system shall be designed to provide adequate illuminations as indicated below:

Location	Lux
Offices and Laboratories	500
Switchgear rooms, cntrl rooms & Substations	300-400
Stairways	100
Warehouse	50-100
Outdoor substations	50
Conveyors	20-50
Walkways	20-50
Yard	5-10
Railroad loading area	50-100
Change houses	150
Other working areas	100-150

23.4 SOCKET OUTLETS:

A sufficient number of 220 volts, single phase socket outlets shall be provided throughout the plant and areas adjacent to equipment requiring regular servicing. As a guide, it should be possible to reach all the plant areas with a 20 metre extension cable on the same building level. All socket outlets in the plant areas shall be provided with a spring return dust lid and shall be mounted on type S15 fibre reinforced enclosure. 32 V socket outlets shall be of the flat pin type and marked accordingly.

23.5 LIGHTING FIXTURES:

23.5.1 Lighting fixtures shall be perpendicular level and true with properly fitting canopied appurtenances. Types and sizes to be determined by specific applications. In general the following types of light fittings shall be used:

Type of fitting	Location
Laboratories, switch-gear and control rooms.	1200mm and 2400 single or double tube fluorescent fitting plus special lights if necessary.

Stairways, walkways, conveyors and outdoor substations.	Injection moulded square bulkheads with acrylic diffuser. Lamps to be 150W high pressure sodium.
Warehouses, workshops and process buildings	Reflectorised HPsodium lamps with suitable shield if height is less than 9m. if more, sodium vapour high bay fittings shall be used.
Offices.	1500mm single or double tube switch start fluorescent fittings with special design silent ballasts
Loading area, yard and other open areas	High pressure Sodium floodlights with a maximum of 2x400W lamps/fittings.
Change houses and areas where the humidity is high.	1200mm double tube waterproof fluorescent fittings.

23.5.2 All general lighting to be used throughout the plant shall be HP Sodium vapour type 220 volt.

23.5.3 All floodlighting shall be high pressure sodium type fixture 220 volt.

23.5.4 Ballasts for high pressure sodium and fluorescent fixtures shall be mounted as close as possible to each individual fixture. Ballasts shall output type, self contained in an adequate enclosure. Ballasts shall be rated for ambient temperature of 50°C (120 F0 and shall be filled with high melting point insulation compound or epoxy.

23.5.5 The use of incandescent lighting shall be avoided as far as possible and shall be restricted to special applications only.

23.5.6 Where light fittings are located below open grate floors or likely to be affected by spillage of water or material, protective canopies shall be provided.

23.5.7 All light fittings in workshops, warehouses and in-process buildings shall be provided with a 15 amp switchable plug and socket located at the light fitting to disconnecting the supply cable.

23.6 CABLE FOR LIGHTING AND SOCKET OUTLETS:

23.6.1 All cable for lighting and socket outlets in normal conditions and temperatures shall be polyvinylchloride steel wire armoured cables terminated with mechanical compression type glands.

23.6.2 When conduit tubing is used it shall comply with British Standard Specifications BSS No. 31, Type B, screwed heavy gauge or S.A.B.S. 162:1951. Aluminium sheathed cable is permissible in substations and for surface work in workshops, offices and other suitable locations.

23.6.3 All cable where operating at ambient temperatures more than 50°C (120 F) shall be mineral insulated copper sheathed cable (e.g. Pyrothenax) with suitable accessories.

23.6.4 All cables shall be:

a) Attached directly to the structures by means of clamps or clips.

b) Hung from steel messenger cables where necessary.

c) Run in trays or racks when the number of cable make this procedure advisable.

23.6.5 Where applicable cast metal or heavy duty moulded plastic junction boxes can be used to make all connections, splices and taps and they shall be of the weatherproof dust-tight type.

23.6.6 Voltage drop in lighting circuits shall be limited to 5 volt of the utilisation voltage measured from the lighting panel to the last point of application of the circuit.

23.7 EMERGENCY LIGHTING:

23.7.1 Emergency lighting shall be kept to a minimum and will generally be required to enable operators to evacuate a building or working area safely in the event of a power failure. Stairways and walkways are typical areas for such lighting. Emergency lighting for special purposes shall be as required by Foskor. In addition, one or more emergency lights shall be provided in every substation and shall be adequate for a person to move about safely.

23.7.2 The emergency lighting shall be provided by self charging units furnished complete with automatic transfer relay.

23.7.3. The type of emergency lights shall be approved by Foskor.

23.7.4 Units shall be bracket-mounted at strategic location throughout the buildings and shall where applicable,

form part of a socket outlet circuit. On normal supply failure, units shall automatically turn on and provide emergency light except in the substations where the emergency light shall only turn on when the substation door is opened.

23.8 BALANCE OF CIRCUITS:

All circuits of three phase distribution boards shall be spread over the phases to ensure proper load balancing.

24. AIRCRAFT WARNING LIGHTS:

Smoke and other stacks do not require obstruction lighting but shall be floodlighted from the ground.

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