- None of the starter or directional contactors are in closed position.
- Emergency corner switches not operated.
- Emergency stop PB not operated.
- Door/gate switches are not actuated.
- Power for lighting circuits will be tapped from the incoming side of the isolator near current collectors.

k) Power supply for CT. motion

Flexible trailing cable systems mounted on retracting support system will be used. The system will consist of insulated multi-conductor or several single conductor cable with permanent termination on the bridge and on the trolley. The flexible trailing cables will have ample length and will be supported by means of properly designed movable clamps. These clamps will be fitted with rollers and will run freely on a guide rail allowing relative movement of bridge and trolley without undue stress or wear on the suspended cable. Provision later stage in case of necessity. The flexible cable will be butyl rubber or EPR insulated CSP sheathed type.

l) Meters

Ammeter & voltmeter will be provided on DC side for electromagnets.

m) Control features

All controls will be fully magnetic, operated through master controllers. All travel motions will be provided with plain rotor resistance control with plugging. For Long travel drives, the electrical controls will be grouped for the individual pair of motor drive & each pair of motors will be able to drive the crane at reduced acceleration & speed.

Hoist motion will have rotor resistance control on all notches during lifting operation & while lowering, counter torque, single phase dynamic braking & super synchronous braking method will be provided on successive master controller notches.

Brakes will not be used for speed control.

Synchronization of separate drives, where required will be done with the use of solid state thyristor controls.

AC thyristor voltage control will be used for hoist motion wherever creep speed is required through electrical means. The creep speed will be provided for both hoisting & lowering directions.

Hoist control circuit will be provided with anti-drop feature i.e, whenever the master controller is brought back to zero position from higher notches in both directions, the motor will automatically be connected to hoisting direction for sometime (time adjustable through a timer) to avoid the downward drift of the load.

Master controller zero position interlock will be provided on control circuit of each motion in under voltage coil circuit.

Brakes will clamp in zero position of the master controller.

n) Thyristor control drives

Thyristor control will be provided for all the cranes operating in areas where ambient temperature is 60 °C. Control will be achieved through master controllers for each direction. Rated and creep speeds are to be provided in each direction i.e., hoisting and lowering. Creep speed will be 10% or lower as per operational requirements of rated speed.

The thyristor regulator will be fully controlled and suitable for four quadrant operation.

Speed control of the slip ring motor will be achieved through regulation of stator voltage with resistance in the rotor circuit, if necessary. The reversal of direction will be through magnetic contactors which will open and close at zero current.

The continuous rating of the thyristor will be at least 2.0 times the motor rated current at the mechanical KW and the converter will be designed and rated for load requirement taking care of peak currents during acceleration, normal operation and regeneration conditions. The dv/dt and di/dt rating of the thyristors will be suitably selected.

The repetitive PIV rating of semi conductor devices will not be less than 2.5 times the peak of normal system voltage. Thyristor bridges will include R.C. snubber circuits across the thyristor, high speed semi-conductor fuses with micro-switches for monitoring of failure. Closed loop regulation suitable for the system with various feedbacks such as speed, current etc. will be provided. Speed feedback will be through tacho-generator of permanent magnet type mounted on the non-driving end of the motor shaft. The regulation will include ramp generators, potentiometers for various setting, various regulators, signal conditioners, logic command module sequence, module, trigger module, zero and over speed monitor, torque less protection module etc. as per the requirements. The control and regulation equipment will be able to maintain their rated performance and control quality even under conditions of variation of +/-10% in voltage and +/-5% in frequency. A zero current sensing device will be incorporated. The reversing of stator contactor will be done at zero current. Braking down to zero speed will be electrical with mechanical brake setting only at zero speed. Protective features like anti-drop etc. will be incorporated to prevent load setting. The circuitry will also provide for the protection against failure of motor torque such that the mechanical brake sets in such cases. All other features of conventional crane controls will also be built into the scheme. The following will also be provided on the A.C. side.

- Surge suppressor
- Over current protection
- Overload protection

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- Single phase protection
- Phase sequence protection
- Ammeter and voltmeter with selector switches
- Isolating switches

Control and auxiliary supply will be provided with separate transformer and under voltage protection.

The test will be performed as per IEC: 146.

Details of the system offered will be furnished along with necessary single line diagrams and block diagrams.

All the control modules will be grouped in a sheet steel enclosure. The control module cards will be made of epoxy glaze and suitable for plugging into the racks. The cards will be locked into the rack, which carries a sealing bar and assists locking of the cards thereby cutting down on the wear of the printed circuit connector contacts which can be subjected to high rate or vibration and further avoid the disconnection of cards from the connector. The thyristor panel will be suitably mounted so that little vibrations are reflected to the components and connection.

The cables for the thyristor controller and associated equipment will be laid and clamped separately on the crane.

o) **VFD control drives**

VFD control will be provided for cranes operating in areas where operating temperature is 50°C. Control will be achieved through master controllers for each direction. Rated and creep speeds are to be provided in each direction i.e., hoisting and lowering. Creep speed will be 10% or lower as per operational requirements of rated speed.

The VFD will be fully controlled and suitable for four quadrant operation (active front end type).

p) **Panels**

All panels will be of free -standing floor - mounting dust and vermin proof construction suitable to withstand vibrations encountered on crane.

Hinged doors will be provided for closed type panels and will have locking and latching arrangement.

Front wired with bottom most equipment mounted at least 350 mm above the bottom cover of the panel.

Panel will be fabricated from 2.0 mm thick steel sheet. The height of panel will be accessible.

Power & control terminals will be segregated. 10% spare control terminals will be provided in each panel.

Equipment in the panel will be so mounted that removal or replacement from the front is easy.

Power and control connections strips should be laid at the bottom end horizontally and at the side end vertically respectively.

Panel will be mounted at least 150 mm above floor.

Panels will be closed type when mounted on bridge platform. Sufficient clearances will be provided between the panels. A minimum clearance of 500 mm will be provided in front of panels for walkway & approach.

Open type panels will be used for installation inside the box girders. In this case, adequate lighting & ventilation will be provided for the room.

q) **Switch gears**

Each mechanism motor will be provided with SFU/MCCB, contactors on stator & rotor sides, overload relays & suitably rated rotor resistance.

In case of thyristor-controlled drive, each mechanism motor will be provided with breaker / switches, transformers, thyristors, rotor resistances, contactors on rotor & stator side, etc. Each motor will be fitted with a tacho-generator for speed feedback. The overload capacity of thyristor will be 200% for 2 minutes. The speed range will be 0 to 100% of the rated speed.

MCB will be provided in the control circuit of each motion.

Each brake circuit will be provided with a suitable contactor.

Rating of contactor selected for any mechanism will be at least 50% higher than respective motor full load current at mechanism duty cycle.

r) **Motors**

For heavy duty reversible crane motors, TEFC wound rotor motor will be used for various drives. The motors will have tapered shafts.

Pull-out torque to be not less than 275% of the full load torque corresponding to 40% CDF.

The class of insulation will be 'B' and for slip ring motor, class of rotor insulation will be class F but temperature rise will be limited to class B.

All motors will have terminal box at top.

Frame sizes will conform to IEC Standards.

Horizontal foot mounted & tapered shaft extension.

While selecting the motor rating, following will also be taken into consideration:

- Duty.
- Cyclic duty factor.
- Type of control used.
- Inertia of the motor & mechanism.
- Ambient correction factor.
- Service factor.

- Max. permissible operating speed will be 250% of the synchronous speed or 2000 rpm whichever is less.
- Crane hoist motors and other drives will have minimum 60 starts/hr.
- Overload capacity: 150% of full load current for 2 minutes without damage or permanent deformation.

s) **Brakes**

- Brakes will be DC electromagnetic type with copper coil.
- Brakes will be designed to fail safe whenever the current is interrupted either intentionally or by failure of the mains supply.
- Field forcing relay will be provided for DC brakes. DC brake circuit will be switched-off on DC circuit for quick operation of the brake.

t) **Limit switches**

Roller lever operated, self-resetting limit switches will be provided for all travel motions.

For each hoist motion, a rotary type over hoist & over lower self-resetting limit switch will be provided. An indication panel will be provided to the operator whenever this limit switch has been operated.

u) **Anti- Collision Devices**

In cranes where two or more cranes are operating in the same bay(at same or different level) all cranes will be provided with suitable Anti-collision system. Anti-collision device will be electronic type.

Anti-collision will also be provided on trolley for twin trolley cranes along with suitable by pass arrangement.

v) **Resistances**

Air cooled, robust, heavy duty, corrosion resistant punched stainless steel grid type.

Resistances will have vibration proof assembly & mounting. Resistance will be rated for 10 minutes.

Maximum temperature of resistor elements will be limited to 275 deg.C (when measured by resistance method) at desired duty.

Each step of rotor resistance for hoist mechanism should be for 100% CDR. Resistance will have suitable tapping points.

Complete resistance of one phase should be accommodated in enclosure and not distributed along with other resistance of other phases.

Resistance boxes will be mounted in racks that permit independent removal of any selected box.

Distance between live & earthed part will not be less than 100 mm.

w) **Master controller**

Cam type master controllers with joy stick type lever will be used.

Master for magnetic controls will have five notches in each direction.

Lighting, socket outlet, bell, etc.

Lighting will be provided in driver's cabin, stair cases, platforms & working area.

Selective switching ON/OFF arrangement should be provided from a central post.

400 W high pressure sodium vapour lights equally spaced under crane girders about the crane span will be provided along with shock absorbing & anti-swing suspension arrangements.

Fluorescent lamps with necessary fittings will be used for driver's cabin, stair cases, platforms, etc. One 500 watt HPMV fitting below the cabin will be provided.

Adequate No. of hand lamp socket outlets & power socket outlets will be provided along with switches.

A hand lamp along with sufficient length of cable with a plug will also be provided for each crane.

Festooned cable arrangement will be provided for power supply to crane trolley. This will have cable trolleys, chain etc. with flexible cables.

x) **Intentionally deleted.**

y) **Enclosure Class**

a) For indoor operations

-	Resistance boxes	:	IP : 11
-	Motors	:	IP : 55
-	All other electric equipment	:	IP : 54

b) For outdoor operations

-	Resistance boxes	:	IP : 33 with canopy
-	Motors & panel	:	IP : 55 with canopy
-	All other electrical equipment	:	IP : 65 with canopy

z) **Cables**

Power cable suitable for 3 Phase, 4 wire, AC effectively earthed power supply system.

All cables will have stranded copper conductors. Control wiring will be with 2.5 mm2 copper Fixed wiring on cranes will be carried out with PVC insulated. PVC sheathed armoured cable or EPR insulated CSP sheathed cable or better.

All flexible cables (i.e. cables for magnet, trolley, feed, pendant unit etc.) will have copper conductor, EPR insulation and CSP sheathing or better.

All cable will be suitably de-rated for grouping and higher ambient temperature.

All cables will be of 1100 Volts grade.

All accessories like cable glands, clamps, pipes, wire and terminal marks etc. will also be provided.

Cable laying and terminations will be such that the chances of cables getting damaged is remote.

Cable sizes will be selected considering motor rated current.

In all passages and on trolley the cable will be laid in trays and will be covered by similar trays and properly clamped & fixed.

aa) LT Power Cable

1.1 kV, heavy duty power cable will be used. Specification will conform to the chapter on cables included in Vol-IV (Electrics).

bb) Control Cables

1.1 kV, multicore control cables will be used. Specification will conform to the chapter on cables included in Vol-IV (Electrics).

cc) Flexible Trailing Cable

1.1 kV grade, highly flexible stranded tinned, annealed high conductivity flexible copper conductors, ethylene propylene (EPR) insulated and chlorosulphorated polyethylene (CSP) sheathed conforming to IS: 8130-1984, IS: 6380-1984 and IS: 9968 (Part-I)-1988.

dd) Earthing

A ring earthing system will be provided on the crane. Each & every electrical equipment will be connected to this earthing at at least two points. However, for electronic circuits, insulated earth wire will run in panel & terminate at main earth connection only at one point.

The earthing will be connected to the earth bus of the trolley lines through 2 Nos. of collectors.

An earth-core will be provided in trolley feed cable & the magnet. The cable reeling drum will have separate slip ring for earthing purpose.

It will conform to general specification for earthing.

Rubber mats will be provided in front of the protective & control panel.

All bonds between earth conductors & crane parts will be welded if possible or rivetted & soldered. Where screwed bonds are made, care will be taken that there is satisfactory contact surface & nuts will be locked to prevent their loosening. Earth connections to equipment will be made by means of multi-strand flexible conductor of adequate sections.

The earth ring on the crane/ machine will be connected to the plant earthing system through to gantry rails. Each end of each gantry rail will be bonded to the plant earthing system.

In addition, intermediate earthing bond will also be provided on the rails at every 60 m in case of longer tracks.

Flexible copper bonds will be provided across any gap in the running gantry rail.

For mobile equipment with flexible cables, one separate copper conductor of adequate size will be provided for earthing.

6. Documentation

(1).Drawings and documents to be submitted by the Contractor during detailed engineering:

The Contractor will submit adequate sets of following technical drawings & technical data/ information during detailed engineering for cranes.

a) General Arrangement drawings of cranes/ hoists / attachments & signed copies of Clearance diagram.

b) Duly filled in questionnaire.

(2).List of Drawing/ Documents to be furnished by the Contractor for approval / reference

a) General Arrangement drawings of cranes/ hoists / attachments & signed copies of Clearance diagram.

b) Quality assurance plan for inspection.

c) Specification of oils and lubricants and other consumables and their quantity and frequency of change.

d) Detailed layout plan and sections for power supply system. (Angle Bus bar/Shrouded Bus Bar/ Festoon Cable etc.)

e) DSL / Trolley line arrangement layout.

(3).List of Drawings/ Documents to be furnished alongwith equipment by the Contractor

a) Requisite no. of sets of all GA drawings, complete assembly and sub assembly drawings of the equipment.

b) Drawing of all equipment/ component received from sub supplier.

c) Engineering and design calculations.

d) Motor data sheets/ characteristic curves

e) Electrical schematic diagram.

f) Test and warranty certificate for each item of equipment.

g) Detailed erection schedule and manuals, assembly/ erection drawings, erection sequence, special precautions to be followed during assembly/ erection (these will be dispatched three months prior to FOT/FOR delivery).

h) Test reports and inspection reports.

i) Instruction manuals for testing and commissioning.

j) Operation, maintenance and safety manuals.

k) Requirement of special tools and tackles, if any, for subsequent maintenance.

l) Detail drawing and specifications of all wearing out parts and parts subject to breakage during normal operating conditions (two sets and one reproducible and/or two sets of catalogues).

m) List of spare parts with drawings, sketches, specifications and manufacturer's catalogue (two sets and one reproducible and/ or two sets of catalogues)

n) All other drawings and documents as stipulated in General Conditions of Contract.

7. Data Sheets For SG EOT & Under slung Crane

a)	Crane No.	:	DDE
b)	Nos. off	:	DDE
c)	Type of crane	:	DDE
d)	Capacity (t)	:	DDE
e)	Span (m)	:	DDE
f)	Duty class	:	DDE
g)	Location	:	DDE
h)	**Hoists:**		
i)	Speed with safe working load, m/min	:	DDE
ii)	No. of rope falls supporting the load	:	DDE
iii)	Elevator of hook above floor, m	:	DDE
iv)	Drop of hook below floor, m	:	DDE
v)	kW of motor at specified rating	:	DDE
vi)	RPM of motor	:	DDE
vii)	Make, type and size of brake	:	DDE
i)	**Cross travel:**		
i)	Speed with working load, m/min	:	DDE
ii)	Wheel base, mm	:	DDE
iii)	No. of wheels	:	DDE
iv)	kW of motor at specified speed	:	DDE
v)	RPM of motor	:	DDE
vi)	Make, type and size of brake	:	DDE
j)	**Bridge:**		
i)	Speed with safe working load, m/min	:	DDE
ii)	Wheel base, mm	:	DDE
iii)	No. of wheel on each end-carriage	:	DDE
iv)	Diameter of wheel, mm	:	DDE
v)	Maximum wheel load, kg	:	DDE

VOLUME- IV
SECTION-2,
MOTOR

TABLE OF CONTENTS

1 GENERAL

This specification is intended to cover the design, Engineering, manufacture, assembly, testing at manufacturer's works, supply in properly packed condition for transport to site and delivery of Electric Motor complete with all accessories for efficient and trouble-free operation of 2 x 500 MW New Thermal Power Plant at Neyveli, Tamilnadu for Neyveli Lignite Corporation Limited.

2 CODES & STANDARDS

All equipment and materials will be designed, manufactured and tested in accordance with the latest applicable Indian Standards (IS) / IEC as given below except where modified and/or supplemented by this specification.

Code		Name of standard
IEC: 60034-1	:	Rotating electrical machines.
NEMA, MG-1	:	Motors and Generators
ISO : 1940-1	:	Mechanical vibration – Determination of permissible residual unbalance
IS : 325	:	Specification for three phase induction motor.
IS : 900	:	Code of Practice for installation and maintenance of induction motors
IS : 996	:	Single phase AC motors
IS : 1231	:	Dimensions of three-phase foot-mounted induction motors
IS : 1271	:	Thermal evaluation and classification of electrical insulation.
IS : 2223	:	Dimensions of flange mounted ac induction motors.
IS : 2254	:	Dimensions of vertical shaft motors for pumps
IS : 3043	:	Code of practice for earthing.
IS : 3177	:	Crane duty motors

Code		Name of standard
IS : 4029	:	Guide for testing three phase induction motors.
IS : 4691	:	Degree of protection for enclosures of rotating electrical machinery.
IS : 4722	:	Specification for rotating electrical machinery.
IS : 4728	:	Terminal marking and direction of rotation for rotating electrical machinery.
IS : 4889	:	Methods of determination of efficiency of rotating electrical machines.
IS : 5571	:	Guide for selection of electrical equipment for hazardous areas.
IS : 6362	:	Designation of Method of Cooling of Rotating electrical machines.
IS : 8223	:	Dimensions and output ratings for foot mounted rotating electrical machines with frame numbers 355 to 1000.
IS : 8789	:	Values of performance characteristics for three phase induction motors.
IS : 12065	:	Noise level of motors.
IS : 12075	:	Measurement and evaluation of vibration of rotating electrical machines.
IS : 12615	:	Induction motors - Energy efficient, three-phase, squirrel cage - Specification
IS : 12802	:	Temperature rise measurement of rotating electrical machines
IS : 12824	:	Type of duty and classes of rating assigned.

Code		Name of standard
IS : 14222	:	Requirements and method of Impulse withstand test
DIN/IEC/IS	:	RTD
BS 5308 part II	:	RTD triad Cable

Equipment and material conforming to any other standard, which ensures equal or better quality, may be accepted. In such case, copies of the English version of the standard adopted will be furnished during detail engineering.

The electrical installation will meet the requirements of Indian Electricity Rules as amended up to date and relevant IS Code of Practice. In addition, other rules and regulations applicable to the work will be followed.

3 DESIGN CRITERIA

All motors shall be suitable for an ambient temperature of 50 degree C and relative humidity of 85%. The motors shall be suitable for operation in a highly polluted environment.

AC Motors shall be of constant speed, squirrel cage, three/ single phase, induction type. Motors shall be rated for continuous duty. They shall also be suitable for long period of inactivity.

DC motors provided for emergency service shall be shunt / compound wound type. Motor shall be sized for operation with fixed resistance starter for maximum reliability.

Power supply for AC motors shall be as follows:

•	Description		Supply
•	Below 0.22 kW	:	240V, 1 Phase, 50Hz
•	From 0.22 kW up to & including 160 kW	:	415V, 3 Phase, 50Hz
•	Above 160 kW up to & including 750 kW	:	3.3kV, 3 Phase, 50Hz
•	Above 750 kW	:	11KV, 3 Phase, 50Hz

All AC motors shall be suitable for following voltage & frequency variations as follows:

•	Description		Supply variation
•	Voltage Variation	:	(±) 10%
•	Frequency Variation	:	(+) 3% to (-)5%
•	Combined Variation of Voltage & Frequency	:	10% (absolute sum)

The motor characteristics will match the requirements of the driven equipment so that adequate starting, accelerating, pull up, break down and full load torques are available for the intended service.

Moreover, motors will be so designed that maximum inrush currents and locked rotor and pullout torque developed by them at extreme voltage and frequency variations do not endanger the motor and driven equipment.

For 11kV motors, locked rotor current not to exceed 600% of full load including positive tolerance, except for ID fan motor without VFD.

For ID fan motor without VFD, the starting current shall not be more than 450% of FLC.

For 3.3 kV and 415 V motors Locked rotor current not to exceed 600% of full load with IS tolerance.

Maximum continuous motor ratings shall be at least 15% above the maximum load demand of the driven equipment under entire operating range including voltage and frequency variations.

Accelerating torque at any speed with the lowest permissible starting voltage shall be at least 10% motor full load torque.

The motors will be suitable for bus transfer schemes provided on the 11KV, 3.3kV and 415V systems without any injurious effect on its life. If motors are connected to an automatic bus transfer system, they may be subjected to 150% of the nominal voltage during changeover of buses due to the phase difference between the incoming voltage and motor residual voltage. In such cases, Motors will be capable of restarting under full load after momentary loss of voltage.

Motors shall be of energy efficient of type Eff-2 as per IS: 12615/equivalent IEC/ International Standards.

Motor will be designed to keep torsional and rotational natural frequencies of