HV INDUCTION MOTOR

BCC CONTRACT NO. S.20/95/963

VOLUME 5

weir

WEIR ENGINEERING

A.C.N. 000 373 339

EnviroTech

SCSQ

BRISBANE CITY COUNCIL
DEPARTMENT OF WATER SUPPLY AND SEWERAGE

PUMPWELL No 1
EAGLE FARM PUMP STATION

HIGH VOLTAGE ELECTRIC MOTOR

OPERATION AND MAINTENANCE MANUAL

Volume 5

WEIR ENGINEERING PTY LTD
JOB No 15140
BCC CONTRACT No S20/95/96

REVISIONS/AMENDMENT CERTIFICATE

It is certified that the amendments promulgated in the undermentioned Amendment List have been incorporated in this copy of the Publication.

Amendment List		Topic/Set	*Amendment Effect	Amended By	Date
No.	Date of Issue	Affected			
1	11-Nov-98		Fresh Issue	N R Krishnan	11-Nov-98
2					
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11					
12					
13					
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15					
16					
17					
18					
19					
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***Note: Insert brief details of page(s) amended, inserted or cancelled.**

Table of Contents

SECTION 1 INTRODUCTION

The Crompton Greaves Electric Motor and ancillary equipment for driving Weir SRA 900/1000 Double Volute Vertical Sewage pump is designed, manufactured and supplied by Crompton Greaves, Large Machines Division, Mumbai, India.

The contents of this volume should be read carefully prior to installation, operation, disassembly or reassembly of the induction motors.

The induction motors should be operated and maintained in compliance with the various recommendations, limits and conditions as specified in this manual. Regular checks and maintenance should be carried out in accordance with the instructions and procedures outlined.

If any serious problem occurs and it becomes impossible to operate the induction motor, the supplier should be contacted and the following information provided:

- Nameplate details and serial number of the induction motor.
- Details of the problem including the state of operation and conditions before and after the time when the problem occurred.
- Photograph of the damaged part, if any.

The contact details for Crompton Greaves are as follows:

Marketing Department
Crompton Greaves Limited
Large Machines Division
Kanjur Marg (East) , Mumbai 400042
India.

Phone: 091-022-5783469
Fax: 091-022-5783845
Email: mktgservice@lmd.cgl.co.in
Contact Person: Mr S B Kulkarni

Section 2 Description of Equipment

2.1 Equipment Supplied

Three 6.6kV induction motors along with accessories as detailed in Section 2.4 below.

2.2 Rating Details

Type of Motor:	Squirrel cage
Power Rating:	2000 kW
Supply Voltage:	6.6 kV
No of Poles:	10 pole
Supply Frequency:	50 Hz
Cooling:	CACW (Closed Air Circuit, Water-cooled)
Mounting:	Vertical flange mounted motor.
Class of Insulation:	Class F
Ambient Temperature:	40°C max., 5°C min.
Cooling Water Temperature:	32°C (max.)
Direction of Rotation:	Counter-clockwise looking from drive end

2.3 Application Details

Driven Equipment:	Sewage Pump
Make / Size:	WEIR - pump size 900/1000
Load GD^2:	672 kgm^2
Speed / Torque Characteristics:	As per WEIR Drg. No.15140
Method of starting:	Through VVVF drive
Type of coupling:	Flexible.
Operating speed range:	280-593 RPM

2.4 Accessories Fitted on Motor

Temperature detector for winding:	9 RTD (Resistance Temp Detector)
Type of RTD:	3 wire simplex PT100 (Make- MINCO -USA, type S11016 PD 100 T 315 Z 120)
Temperature detector for bearing:	2 RTD (refer Volume 6)
Type of RTD:	3 wire simplex PT100
Temperature detector for internal air:	4 RTD (refer Volume 6)
Type of RTD:	3 wire simplex PT100
Anti Condensation Heaters:	4x250 watts, 240VAC, 1 phase.
Moisture detector:	2.in H.E.+ 1 in motor enclosure
Make/ Type of Moisture detector:	Schmersal / IFC 15-30-10yTPD
Provision for mounting Pulse generator:	Drg. M485 on Non-Drive end
Provision for mounting vibration sensor:	Bently Nevada - 330525 Velometer

2.5 Special Requirements

The following special provisions have been made for this project:

Shaft extension:	Refer Dwg WD 4314 and 4J 36 001
Square motor flange:	Refer Dwg 3J45189R2
Bearing Insulation:	Bearing at NDE insulated

The motor suitable for 180% over speed in reverse rotation in the **De-Energised** state under abnormal shutdown condition.

Air to water heat exchangers are provided having Cupro-Nickel tubes suitable for a water pressure of 1000 kPa. Maximum cooling water pressure drop across the Heat Exchanger is 30 kPa.

Terminal Box is suitable for ELASTIMOLD bushing connections. The terminal box also includes an Explosion vent.

Section 3 Design Criteria and Process Description

3.1 Specified Design Criteria

Design criteria as laid down in the Specification are as follows:

Motor rating:	2,000 kW , 6.6 KV, 10 Pole
Cooling:	CACW
Type:	Squirrel-cage induction motor
Enclosure:	IP 55 to AS 1939
Mounting:	Vertical Flange
Application:	Sewage water pump
Operating speed range:	280 - 593 RPM
Motor Vibration Limit:	8 mm/s rms – Alarm 11mm/s rms - Shutdown
Direction of rotation:	Counter-clockwise when viewed from DE
Location:	Indoor in a pump well
Ambient Air Temperature:	Normal Maximum 40^0C, Minimum 5^0C
Relative Humidity:	Maximum 90%, Minimum 15%
Cooling Water Inlet Temperature:	32^0c maximum
Heat exchanger Pressure:	Maximum Pressure 700kPa
Cooling water:	Town water quality with additives to minimise fouling
Operating altitude:	Sea Level
Hazardous area Classification:	Non-Hazardous
Standards referred:	AS 1359, AS 1939

3.2 Motor Performance Commitments

The basic performance characteristics of the motors are as follows:

No Load Current:	80 Amp
Starting Torque (% FLT):	70%
Starting Current (% FLC):	550%
Pull out Torque (% FLT):	175%
Full load RPM:	593
Power factor:	0.8
Full Load Current:	227 Amp
Efficiency:	1 FL - 96.2 %
	¾ FL - 96.0 %
	½ FL - 95.8 %
Winding Temperature Rise:	Restricted to Class B i.e. 88°C over 32°C (Water inlet temp.) by resistance method .
Insulation /type of Winding:	Conforming to AS1359 Part 31 (Pre-formed diamond type coils and insulation system shall permit stator to be rewound with pre-formed coils) .
Number of starts:	3 starts per hour with 2 starts in quick succession in hot condition.
Tolerance on performance:	In accordance with Australian Standard AS1359 part 69

3.3 Motor Construction Features

Motor weight:	15,500 kg
Rotor weight:	3,300 kg
Weight of each Heat Exchanger unit:	630 kg
Cooling water flow ratio:	250 l / min. for each Heat Exchanger
Type of Bearing used:	DE - NU240 EMC3 (FAG - GERMANY)
	NDE - 2 x 7334 BCB (SKF- GERMANY)
Insulation:	NDE Bearing Housing - Insulated.
Stator Lamination (S 14 grade):	OD - 1270 mm, ID - 990 mm, 90 slots
Rotor Lamination (S 14 grade):	OD - 985 mm, ID - 810 mm, 112 slots
Air gap:	2.5 mm
Stator Copper:	2 / / 6.3 x 2.6 mm (bare size) - 880 kg
Rotor Copper:	12.05 x 8 mm (bare size) - 315 kg
Short circuiting ring:	50 x 50mm (bare size) - forged Copper- 270kg
Stator resistance / phase (at 20°C):	0.12625 ohm
Rotor Shaft:	Forged ϕ 250 x 3300 long (Grade 080M40 as per BS 970)

3.4 Motor Performance Curves

1. Torque speed characteristics — TN - 70 - 175.550 / 96042.
2. Thermal withstand characteristics — TWT - 15/18 - 550 / 96042.
3. Negative sequence characteristics — NEG - 96042.
4. Performance characteristics — PERF - 96042.

Section 4 Installation and Pre-Commissioning

4.1 Site Connections

The following

- 3 Phase 6.6kV supply through Variable Voltage Variable Frequency (VVVF) motor drive.
- Single Phase 240 Volts 50 Hz supply for space heater.
- Cooling water 500 Litre per minute.

4.2 Cooling Water Requirements

Cooling water for the motor should comply with the standard requirements as listed below:

Quality standard of fresh water

Item	**Normal value**	**Maximum value**	**Remark**
PH	5.8 ~ 8.6	-	Maximum value must not exceed normal value
Chromaticity.	50^0 max	100^0 max.	Maximum value is allowable only in summer
Turbidity.	100 ppm max. when converted into SiO_2	-	Maximum value must not exceed normal value
Biochemical oxygen demand (B.O.D)	5 ppm max. at 20^0 C for 5 days	-	Use normal value as maximum value
Dissolved oxygen	5 ppm max.	-	Use normal value as maximum value
Coliform group	250 /1 cc max.	-	Use normal value as maximum value
Hardness	German hardness : 10^0 dH max. (1785 ppm max. when converted into $CaCO_2$)	German hardness : 15^0 dH max. (270 ppm max. when converted into CaC_3)	Maximum value is applied only in winter, December, January, and February and in summer, August

4.4 Handling Precautions

While handling the motor, the following precautions must be observed for the safety of personnel and equipment:

- The lifting shackle being used has adequate lifting capacity.
- The motor should be lifted by using all the lifting hooks provided on the motor frame.
- Before lifting, any loose parts should be either removed or properly secured to avoid damage during transportation of motor.
- **Lifting eyes on the heat exchanger are meant for lifting heat exchanger only and should NOT be used for lifting the complete motor heat exchanger assembly.**
- While lifting, ensure that the chain / rope is suspended vertically to avoid damage to heat exchanger or accessories mounted on motor.
- Lifting / lowering operation must be carried out slowly and smoothly.

4.5 Storage

During longer periods of storage, prior to installation, the motor may be exposed to many hazards if proper care is not taken. Rain and condensation may rust steel parts, cause pitting on the bearing and reduce the insulation resistance. Dust, dirt and debris encountered especially in a plant under construction, can be severe enough to clog motor ventilating passages.

Atmospheric contaminants and fungal growth may attack and damage paint, insulation, sliprings, brushes etc. Vermin and rodents getting into the machine interiors are likely to eat away the insulation. All this makes it essential to store the motors properly and to carry out regular checks during the storage of the motor. The following precautions should be observed during storage:

- The motor should be stored indoors in a clean and dry place.
- The motor should not be subjected to vibration, which can damage the bearings, or to variations in temperature which can causes condensation inside the motor.
- The motor should be kept warm. Space heaters provided in the motor should be energised and periodically checked during the storage, to prevent moisture condensation.
- Ensure that protective anti-rust paint on the shaft extension is undamaged. Reapply when necessary, after carefully removing any rust or moisture.

NH_4^+	0.5 ppm max.	10 ppm max.	Length of the time in which measured value exceeds normal value must not exceed 20 hours/ month.
H_2S	0.3 ppm max.	10 ppm max.	Length of the time in which measured value exceed but keep below maximum value must not exceed 20 hours/ month.
SO_4^{--}	100 ppm max.	-	maximum value must not exceed normal value
CL^-	50 ppm max.	2000 ppm max.	Application time of maximum value is limited to 4 hours / day.

4.3 Inspection on Receipt

Immediately after receipt of the motor, the wooden crate and/ or motor should be carefully inspected to ensure that all parts are intact. A packing case, which shows damage, should be immediately reported to the carrier and opened in the presence of an Insurance Surveyor.

The following should be checked during inspection:

- Motor nameplate details such as output, Voltage, speed, enclosure, class of insulation, frame size etc. conforms to the requirement.
- No damage to the motor components has incurred during transit. Damage, if any, should be noted.
- The rotor shaft rotates freely by hand and no abnormal sound is present.
- The damage in transit, if any, should be recorded in the form of **Joint Observation Report** with the carrier and Insurance Surveyor. A copy of this report should be immediately sent to concerned Crompton Greaves office.

4.6.3 Minimum Insulation Resistance for Motor Energisation

It is not possible to specify a fixed minimum value for a winding insulation resistance, but the following formula can act as guide:

Ris = (V / 1000 + 1) Mohms

Where: Ris = insulation resistance in Mohms with the machine under cold condition at a room temperature.

V = Rated supply voltage of motor in volts.

In the event of the measured value being lower than that given by the above formula, there is every reason to suspect insulation deterioration due to presence of moisture, contamination or damage. As a first step, the terminal insulator, clamping arrangement for terminal components, should be cleaned and dried. Thereafter a new measurement should be carried out to check whether the step taken has improved the insulation resistance. In case no improvement is seen, then it is most likely that the complete winding is affected by dampness and should therefore be dried.

4.6.4 Drying the Winding

Extreme dampness will cause a reduction of insulation resistance. New machines which have been standing idle for few weeks or more, may need drying out, particularly if they have been subjected to wide and rapid temperature changes or have been in wet or humid surroundings. For example, setting concrete quite often results in extreme humidity. The time required for drying out depends upon the initial degree of dampness and may extend from one day to several days. Whichever drying out process is selected, it is essential that the heating is continuous and that the temperature is maintained constant at a value sufficiently high to ensure the evaporation of moisture, but not so high that the insulation is damaged. A suitable temperature for drying out is 60^0 C to 70^0 C measured by using the built-in slot resistance temperature detector.

The temperature of the winding must not be raised faster than a few degrees per hour (say max. 10^0 C) in order to prevent damage from differential thermal expansion. It will generally be found that at first, as the temperature of the winding increases, the insulation resistance decreases until a minimum value is reached. This is firstly due to

- The rotor shaft should be rotated periodically (at least twice a week) to prevent the grease in bearings from setting down and thereby exposing the bearings to moisture or other contaminants.
- Sensitive and delicate parts such as the pulse generator, vibration sensor etc. should be protected by suitable wrappings.
- During prolonged storage the oil in the grease can ooze out. Hence regreasing should be done every 3 months.

Motors stored outdoors require better care and more frequent checking.

4.6 Installation

4.6.1 Location

The area where the motor is placed should be adequately protected to avoid any risk of injury to persons or damage to equipment resulting from the moving parts. The area should also facilitate adequate ventilation for dissipation of heat generated in more during operation. At the same time, the installation area should have sufficient space all around the motor to facilitate movement of the operating personnel and also for carrying out maintenance.

4.6.2 Measurement of Insulation Resistance

Before the electric motor is put into service for the first time, or after a long period of non-operation, the winding insulation should be checked to ensure that the risk of insulation failure does not exist. The condition of insulation can be detected by carrying out measurement of insulation resistance and polarisation index of the winding. The following value should be measured:

- Insulation Resistance of each phase to the earthed frame and to the other earthed phases.
- Insulation Resistance of all winding phases to the earthed frame.
- The Insulation Resistance is measured with the help of a megger. Whilst a 500 volt megger should be used for measurement of the low voltage winding, the high voltage winding insulation resistance should be checked by a 5000 volt megger.

monitored by repeated measurement of insulation resistance and observing the winding temperature.

If DC welding sets are used for drying machine windings, certain precautions must be taken before connecting them. Since there is no ventilation, adjust the maximum permissible current for winding phase to 0.5 times the rated current. Connect the individual phases unsymmetrically (e.g. plus to U1, U2 to V1, V2 to W2, W1 to minus) in order to keep axial magnetic flux in the shaft low.

Change the connection order about every hour so that the winding is evenly heated. Measure the insulation resistance hourly. Before switching off a direct current, the current should be gradually reduced to ensure winding inductance will not cause arcing. Since the temperature distribution of the machine at standstill is different from that in a running condition, a winding temperature of 60^0 C should not be exceeded and the rotor turned through 90 degree every hour.

If the methods 1 & 2 cannot be applied, the machine must be dried with hot air obtained from an external source. The heaters can be arranged so that by means of suitable covers, the windings being heated are in the hot air stream without permitting excessive temperatures. This requires that continuous circulation and replacement of air takes place.

4.6.5 Lubricant Condition and Relubrication

Grease lubricated ball and roller bearings are originally charged with the right quality and quantity of grease at the time of dispatch of the motor. However, if the motor has been **stored for a long time,** it is advisable to check the condition of grease by opening the bearing covers for both DE and NDE bearings. If the grease appears to have deteriorated, or any signs of grease 'caking' are observed, then the **old grease must be removed and replaced with fresh grease**. The bearing should be washed by petrol and thoroughly cleaned after removal of all old grease.

The bearing should then be carefully checked and if found in good condition should be filled with the recommended grade of grease. The above cleaning and relubrication operation must be carried out in a clean, dust free and dry atmosphere.

4.6.6 Foundation below Motor Stool

The essential qualities of any foundation are rigidity, freedom from transmitted vibrations and maintaining alignment between the motor and driven equipment. A solid concrete foundation is therefore recommended though in unavoidable cases a redistribution of the moisture in the winding and secondly due to the drooping temperature resistance characteristics of the insulation. It is for these reasons that it is essential to maintain a constant temperature during the plotting of drying out curves since even a few degrees fall in temperature may given a misleading rise in the value of insulation resistance.

If the temperature is allowed to fall considerably, re-absorption of moisture will take place. After a lengthy period during which the insulation resistance will remain practically constant at the minimum value, it will begin to rise steadily until a maximum value is reached indicating that the machine is practically dry and ready for service.

A curve showing variation of insulation resistance, with respect to temperature and time, (when drying out) clearly shows how the insulation resistance first decreases after initial heating, then remains steady for a long time till it further increases to a maximum value.

During operation, the insulation resistance of the winding may decrease as a result of environmental and operating conditions. The critical value of the insulation resistance at a winding temperature of 25^0 C can be calculated depending on the rated voltage as mentioned earlier in this Section.

If the measured insulation resistance value is more than the calculated critical figure during operation, the machine can still operate. However, the winding must be dried out if the IR value falls below the specified values. For the machine in operation, the IR value should be checked on a regular basis.

For the purpose of drying out the windings, heat can be applied in three ways:

- By producing heat losses in the machine itself i.e. by operating the machine on short circuit.
- By feeding current from external energy sources to produce heat losses in the windings e.g. with the aid of welding sets or controllable high current rectifiers.
- By providing a flow of hot air after suitably covering with tarpaulins.

With all these methods, some air circulation must naturally be provided to allow the moisture to escape. The magnitude of the current in the winding or the quantity of heat applied should be controlled so as to fulfil the requirements. i.e. Starting with the low values and regulated according to temperature rise. Winding cable leads in terminal boxes should be cleaned with dry rags before drying.

During short circuit drying, the rotor is blocked to avoid rotation. Apply a balanced three phase very low voltage (about 10 % of normal stator voltage) supply across stator terminals. In the first 6 to 8 hours, depending on the size of the machine, increase the stator current from about 0.5 times the rated current such that the winding temperature does not exceed 60^0 C. The progress of drying process should be operation. This type of coupling also permits a limited degree of misalignment of the coupled shafts without excessive stresses due to slight misalignment.

Rotation of the both couplings simultaneously is essential for correct alignment. Alignment done with rotation of only one coupling half will not have the desired accuracy level. Allowable tolerances for this motor for angular misalignment is 0.050 mm and for offset misalignment is 0.060 mm. Alignment will depend on the accuracy of concentricity between the motor stool and pump shaft.

4.7 Electrical Connections

The electrical connection should be made in accordance with the Wiring Rules – AS 3000 after the erection of motor and the all the mechanical assembly works have been completed. The cable manufacturers recommendations should be followed while terminating the cable on motor terminals.

The electrical connections should be made by trained personnel in accordance with the wiring and termination diagrams supplied with equipment.

4.7.1 Connection to Stator

The terminal box is constructed of fabricated steel. The blanking plate fitted to the terminal box is drilled and tapped to receive the incoming cable gland or adaptor. For terminating the incoming supply cable, the core ends of the cable are to be fitted with an elbow connector.

The supply cable lugs are terminated on stator / terminal insulator / bars and should be held in position by using the plain washer, spring washer, and locking screw of correct size. Tightening should be carried out using a tubular box spanner, particularly with pillar type terminal insulators, to avoid the possibility of the stud being subjected to bending force and its subsequent breakage. Before terminating the supply cable, ensure that the correct phase sequence is present to achieve the desired direction of rotation of the motor. The plate showing direction of rotation is fitted on the motor end shield.

Before closing the terminal box covers, check that all the connections are tight. During replacement of terminal box covers, ensure that all the gaskets between mating parts are firmly secured in the respectively positions.

structural steel work may be used, provided it is rigid and free from vibrations. Concrete foundation should be of sufficient depth to rest on solid ground and of the area appropriate to the type of soil. Normally, a mixture of one part of cement, two part of sand and four part of broken stones by volume is suitable provided it is correctly mixed and laid. The foundation should be allowed to set for at least ten days before the machine is placed on it. It is a good engineering practice to ascertain for any foundation that its natural frequency of vibration differs in value from the operating speed of the machine by a minimum of 20%.

Before commencing foundation work, the certified General Arrangement Drawing of the machine which is supplied in advance, should be studied as this drawing indicates not only the fixing and shaft dimensions but also the positions of terminal boxes, dial type thermometers etc. This will facilitate the design of correct foundations and will help in smooth installation of machine.

The machine with its baseplate should be placed on the foundation with its shaft approximately aligned with the driven equipment. The space between machine and the foundation should be packed with steel packing about 25 mm thick placed closely and on each side of every foundation bolt. The foundation bolts should be firmly grouted with mortar consisting of two parts of sand and one part of cement by volume.

The motor should be placed on the machined and spigotted flange plate of the driven equipment after checking its levelling by spirit level. The motor flange should be then firmly clamped to the flange plate of driven equipment by adequate size nuts and bolts. The stool on which on the motor flange is bolted should be rigid on its foundation. A healthy / rigid foundation should not vibrate beyond 5 microns. The machined mating surface of motor flange and stool should be free from dents and burrs etc. to ensure proper contact surface area.

4.6.7 Drive Coupling

The rotational power of motor is transmitted to the driven equipment through flexible coupling. In order to achieve power transmission, respective half couplings are fitted on the motor and driven equipment shaft. The half coupling should be warmed up to around 100^0C uniformly in an oil bath before the fitting over the shaft extension.

This warmed up coupling should be fitted on the shaft by screwing motion or by using a mallet to drive it on the shaft. Undue excessive force or hard blows should be avoided during the fitment so as to prevent damage to the bearings, Whenever possible coupling should be mounted on shaft after initial No load trial run of the motor.

A flexible coupling is recommended for all direct coupled drives and is a must where the driven machine has no endplate to take up the thermal expansion of shafts during

4.8 Factory Test Reports

The following factory tests were carried out in the factory prior to shipment of the motors. Test sheets are enclosed in the following pages.

Number	Description of Test	Remarks
1	Routine Test Results for Machine No. NVUW796042/01	7 Sheets
2	JEC Calculation for Machine No. NVUW796042/01	7 Sheets
3	Type Test Certificate for Machine No.NVUW796042/01	2 Sheets
4	Routine Test Certificate for Machine No. NVUW796042/01	1 Sheet
5	Performance Curve for Machine No. NVUW796042/01	1 Sheet
6	No Load Current Curve for Machine No. NVUW796042/01	1 Sheet
7	No Load Input Curve for Machine No. NVUW796042/01	1 Sheet
8	Friction and Windage Loss Curve for Machine No. NVUW796042/01	1 Sheet
9	Routine Test Results for Machine No. NVUW796042/02	6 Sheets
10	Routine Test Certificate for Machine No. NVUW796042/02	1 Sheet
11	No Load Current Curve for Machine No. NVUW796042/02	1 Sheet
12	No Load Input Curve for Machine No. NVUW796042/02	1 Sheet
13	Polarisation Index Curve for Machine No. NVUW796042/02	1 Sheet
14	Routine Test Results for Machine No. NVUW796042/03	7 Sheet
15	Moment of Inertia Test for Machine No. NVUW796042/03	2 Sheet
16	Polarisation Index Curve for Machine No. NVUW796042/03	1 Sheet
17	No Load Current Curve for Machine No. NVUW796042/03	1 Sheet
18	No Load Input Curve for Machine No. NVUW796042/03	1 Sheet

4.7.2 Earthing

The motors are provided with two earthing pads on the stator frame at two different places. Ensure that:

- The earthing conductor is firmly connected to the earthing points.
- The size and rating of the earthing conductor is adequate.

4.7.3 Space Heaters

Motors are provided with four space heaters, rated at 250 watts, 240 volt, single phase, 50 Hz. Connection is via a separate auxiliary terminal box mounted on the stator frame. The supply to the heater should be interlocked to operate only when the motor is switched off. Under no circumstances, should the space heaters be energised when motor is in operation. This will cause overheating of the machine.

4.7.4 Temperature Detectors

Temperature Detectors for measurement of stator windings, core, bearing and hot air temperature are provided in the motor.

a) Resistance Temperature Detectors for the Stator Windings

The temperature detectors for the stator windings are embedded between two coil sides of the winding and their leads are brought out for termination in separate terminal box on the stator frame.

b) Resistance Temperature Detector for Bearings and Hot Air

The temperature detector is of platinum resistance type. Refer to Volume 6 of the Operation and Maintenance Manual for details.

CROMPTON GREAVES LIMITED
MACHINE 2 DIVISION

INDUCTION MOTOR
ROUTINE TEST
(As Per IS 325 : 1978)

M/C NO. : NVUWT96042/2
FRAME NVUW710

CUSTOMER M/S WEIR ENGG VOLTS : 6600±10% AMPS : 227.0 HP/KW : 2680/2000 R.P.M. 593 INS CLASS F/B

ROTATION FROM DE: ANTI CLOCKWISE / ~~CLOCKWISE~~ / ~~BI-DIRECTIONAL~~

MOTOR RUNS AT FULL SPEED AT REDUCED VOLTAGE : V = 1200 RPM = 592 Hz 49.4

VOLTS M F = 60			AMPS M F = 40			WATTS M F = 60x40x½		
V1	V2	V3	I1	I2	I3	W1	W2	W1-W2
110.0	110.0	110.0	1.68	1.66	1.70	200-	165 =	35

	DESIGN	TESTED
NL LOSS		
NL AMPS		
	COMMITTED	TESTED
% STC	550%	387.6%
% STGT.	70%	74.85%
R V		

OPEN CIRCUIT TEST
STATOR VOLTS : ____
ROTOR VOLTS ____
R.V. @ ____ V = ____ V

BLOCKED ROTOR TEST (As per JEC 37 : 1979) SHAFT VOLTAGE : ____

VOLTS M F = 60			AMPS M F = 80			WATTS M F = 60x80x½		
V1	V2	V3	$I_{sc}1$	$I_{sc}2$	$I_{sc}3$	W1	W2	W_s = W1-W2
29.0	29.0	29.0	2.9	2.9	2.9	110-	55 =	55

$I_s = \frac{\text{RATED V}}{\text{TESTED V}} \times I_{sc}$

I_s = 660.0 Amp.

$STC\%FLC = \frac{I_s}{FLC} \times 100$

$STGT\%FLT = \frac{(1\text{-}s)\ [Ws\text{-}Cu\ LOSS]\ [I_s/I_{sc}]^2}{\text{OUTPUT IN WATTS}} \times 100$

WHERE : S=pu. slip I_s -STC at rated volts. Cu. LOSSES = $3(I_{sc})^2$ x Rph : FOR STAR CONN. $(I_{sc})2$ x Rph : FOR DELTA CONN.

I_s = SHORT CIRCUIT CURRENT
FLC = FULL LOAD CURRENT

VOLTMETER Sr. No. 1/7/3990
AMMETER Sr. No. 1/7/3995
WATTMETER Sr No. BB71634
WATTMETER Sr. No. BB71635

TESTED BY : NDV/SGP/RAS
DATE : 29.03.97
SHIFT : II

WITNESSED BY : Mr. PD. DESAI (From: M/s. LKIS) 29-3-1997

PAGE 01 OF 06

WI/QI/133/01/M01 (01S

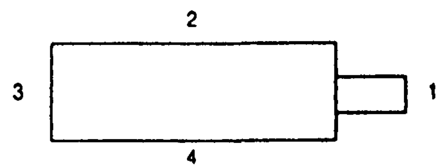
CROMPTON GREAVES LIMITED.
MACHINE 2 DIVISION

INDUCTION MOTOR
NOISE LEVEL, VIBRATION
I.R.-H.V.-I.R.P.I

M/C NO. : NVUW 796042/2
FRAME : NVUW 710

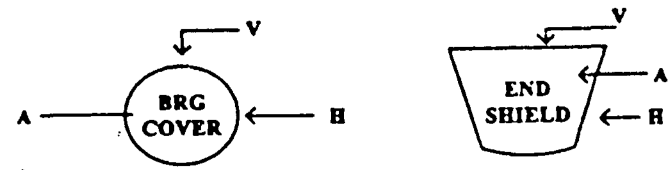
CUSTOMER : M/S WEIR ENGG VOLTS : 6600±10% AMPS : 227.0 HP/KW : 2680/2000 R.P.M. : 593 INS. CLASS : F/B

NOISE LEVEL MEASUREMENT : dB(A)
(AT 1.0/1.5 M DISTANCE) METERS Sr. No. D03791



POSITION	1	2	3	4
BACKGROUND	70	70	70	70
MEASURED	78.0	78.0	79.0	79.0
AVERAGE		dB(A)	COMM 90.0	dB(A)

VIBRATIONS ON NO-LOAD (P-P IN MICRONS)
METERS Sr. No. 2121



FIGURES IN BRACKET INDICATE VEL. IN MM/SEC.

LOCATION	HOR	VER	AXIAL
DE	1.0 (0.35)	3.0 (0.29)	–
ODE	2.5 (0.24)	3.0 (0.33)	–
COMMITTED	2.6 mms⁻¹ (R.M.S)		

INSULATION RESISTANCE (before and after H.V. test)		H.V. TEST (for one minute) K.V.	L.C. (amps)
ST. WDG.	242 M Ohms. (by 2500 V Meggar)	14.2	1.21
RT. WDG.	– M Ohms. (by – V Meggar)	–	–
RTD. (Wdg).	– M Ohms. (by 500 V Meggar)	1.5	0.00
SP. HEATER	– M Ohms. (by 500 V Meggar)	[illegible]	–

POLARIZATION INDEX
I.R. AFTER 10 MIN. 495 M Ohms.
P.I. =
I.R. AFTER 1 MIN. 242 M Ohms.
P.I. = 2.05

TESTED BY : NDV/SGP/RAS DATE : 29.03.97 SHIFT : II WITNESSED BY : [signature] 29.5.97
[signature]
PAGE 02 OF 06
WVQ/133/01/M02(0195)

CROMPTON GREAVES LIMITED
MACHINE 2 DIVISION

INDUCTION MOTOR
NO LOAD [redacted] TEST
[As per IS 325 : 1978; JEC 37 · 1979]

M/C NO : NVUW796042/2
FRAME : NVUW710 INS. CLASS : F/B
CUSTOMER M/S WEIR ENGG VOLTS : 6600 AMPS : 227 HP/KW : 2680/2000 R.P.M. : 593 ROTATION FROM DE. ANCL/CL/BD ✓

[redacted]	VOLTS M.F. = 60			AMPS M.F. = 40			WATTS : M.F. = 60x40x½			Hz	R.P.M [redacted]	AMB	INT. AIR RTD/deg. C			EXT. AIR RTD/deg. C		FRAME RTD. deg. C
	V1	V2	V3	I1	I2	I3	W1	W2	W1+W2				IN	OUT	IN	IN	OUT	
	119	119	119	1.94	1.96	1.98	250–	206	42	50.00	599.6							
	110	110	110	1.66	1.66	1.70	200–	165	35	50.00	599							
	100	100	100	1.50	1.50	1.52	165–	135	30	50.00	599.7							
	90	90	90	1.35	1.34	1.36	135–	106	29	50.00	599							
	80	80	80	1.19	1.19	1.20	109–	85	24	50.00	599.6							
	70	70	70	1.04	1.04	1.04	85–	65	20	50.00	600.0							
	60	60	60	0.84	0.79	0.82	60–	45	15	50.00	599.0							
	50	50	50	0.71	0.70	0.71	44–	30	14	50.00	599.0							
	40	40	40	0.56	0.57	0.58	27–	15	12	50.00	599.0							
	30	30	30	0.42	0.42	0.42	20–	9	11	50.00	599.2							
	20	20	20	0.30	0.30	0.30	9–	2	7	50.00	599.6							
	10	10	10	0.20	0.20	0.20	5–	0	5	50.00	599.7							

VOLTMETER Sr. No. : 1/7/3990
AMMETER Sr. No. : 1/7/3995
WATTMETER Sr. No. : BB71634
WATTMETER Sr. No. : BB71635

TESTED BY : NDV/BGP/RAS
DATE : 29.03.97
SHIFT : II

WITNESSED BY 29-3-97

PAGE 03 OF 06

W/O/133/01/MO5(0195)

CROMPTON GREAVES LIMITED
MACHINE 2 DIVISION

INDUCTION MOTOR
WINDAGE LOSS [redacted] TEST
(As per IS 325 : 1978; JEC 37 : 1979)

M/C NO : NVUH796042/2
FRAME : NVUW 710 INS CLASS : F/B
CUSTOMER : M/S WEIR ENGG VOLTS : 6600 AMPS : 227 HP/KW : 2680/2000 R.P.M. 593 ROTATION FROM DE ANCL/CL/BD

[redacted]	VOLTS. M. F. = 60			AMPS M. F. = 08			WATTS : M. F. = 60x08x½			Hz	R.P.M [redacted]	AMB	INT. AIR RTD/deg. C			EXT. AIR RTD/deg. C		FRAME RTD/ deg. C
	V1	V2	V3	11	12	13	W1	W2	W1+W2				IN	OUT	IN	IN	OUT	
	9.5	9.5	9.5	1.0	1.0	1.0	15+	5 =	20		592							
	8.0	8.0	8.0	0.82	0.81	0.82	10+	2 =	12		480							
	6.2	6.2	6.2	0.70	0.69	0.69	7+	1 =	8		381							
	5.5	5.5	5.5	0.69	0.68	0.69	5+	0 =	5		281							

VOLTMETER Sr. No. : 1/7/3990
AMMETER Sr. No. : 1/7/3995
WATTMETER Sr. No. : BB71634
WATTMETER Sr. No. : BB71635

TESTED BY : NDV/BQP/RAS
DATE : 29.03.97
SHIFT : II

WITNESSED BY (signature) 29.3.97

PAGE 04 OF 06

WI/Q/133/01/MO5(0195)

CROMPTON GREAVES LIMITED
MACHINE 2 DIVISION

INDUCTION MOTOR

TEST LOCKED ROTOR TEST AT VARIOUS VOLTEGES
[As per IS 325 : 1978; JEC 37 : 1979]

M/C NO : NVUW796042/2

CUSTOMER : M/S WEIR ENGG   VOLTS : 6600   AMPS : 227   HP/KW : 2660/2000

FRAME : NVUW710   INS. CLASS : F/B

R.P.M. : 593   ROTATION FROM DE ACW/CW

	VOLTS M.F. = 60			AMPS M.F. = 80			WATTS : M.F. = 60x60x½			Hz	POWER FACTOR	AMB	INT. AIR RTD/deg. C			EXT. AIR RTD/deg. C		FRAME RTD. deg. C
	V1	V2	V3	I1	I2	I3	W1	W2	W1+W2				IN	OUT	IN	IN	OUT	
	13.0	13.0	13.0	1.25	1.25	1.25	22-	11 =	11	50	0.195	31.2						
	15.5	15.5	15.5	1.50	1.50	1.50	29-	13 =	16	50	0.146							
	18.2	18.2	18.2	1.75	1.75	1.75	40-	18 =	22	50	0.199							
	20.5	20.5	20.5	2.00	2.00	2.00	50-	25 =	25	50	0.176		AMB. TEMP : 31.2°C					
	23.0	23.0	23.0	2.25	2.25	2.25	65-	30 =	35	50	0.195	Avg. Wdg. Temp before start - 31.						
	25.5	25.5	25.5	2.50	2.50	2.50	80-	43 =	37	50	0.167	Avg. Wdg. Temp. After Comp. of Test - 37.6						
	29.0	29.0	29.0	2.90	2.90	2.90	110-	55 =	55	50	0.189	Test Conducted without water Circulation.						
	15.5	15.5	15.5	2.90	2.90	2.90	60-	25 =	35	25	0.224							
	6.0	6.0	6.0	2.0	1.95	2.0	18-	5 =	13	12.5	→ MAX POSSIBLE CURRENT AT THIS FREQUENCY.							

Shaft voltage at NL at rated frequency = 0.062 volts

VOLTMETER Sr. No. : 1/7/3990
AMMETER Sr. No. : 1/7/3995
WATTMETER Sr. No. : BB71634
WATTMETER Sr. No. : BB71635

TESTED BY : NDV/GGP/RAS
DATE : 29.03.97
SHIFT : II

WITNESSED BY : [signature] 29-3-97

PAGE 05 OF 06

WO/133/01/MO5(0195)

CROMPTON GREAVES LIMITED
LARGE MACHINES DIVISION

INDUCTION MOTOR
MEASUREMENT OF RESISTANCE
(As Per IS 325 : 1978)

M/C NO. : NVUW 796042/2

FRAME : NVUW 710

CUSTOMER : M/S WEIR ENGG VOLTS : 6600 AMPS : 227 HP/KW : 2680/2000 R.P.M. : 593 INS. CLASS : F/B

COLD RESISTANCE

Amb (t_1) 31.2 degrees C

STATOR

R - Y	0.2859	OHMS
Y - B	0.2842	OHMS
B - R	0.2822	OHMS
DESIGN @ 20 deg C	—	OHMS

ROTOR

1 - 2 :		OHMS
2 - 3 :		OHMS
3 - 1 :		OHMS

— OHMS

THERMISTOR RESISTANCE

1.		OHMS
2		OHMS

SPACE HEATER RESISTANCE 500 OHMS

R.T.D. COLD RESISTANCE (OHMS)

WINDING

1.	112.2 Ω	7.	112.2 Ω
2.	112.0 Ω	8.	112.2 Ω
3.	111.0 Ω	9.	112.1 Ω
4.	112.3 Ω	10	
5.	112.1 Ω	11.	
6.	112.0 Ω	12.	

BEARING R.T.D

DE. 1.		2.	
O.D.E. 1.		2.	

BEARING B.T.D

D.E.		degree C
O.D.E		degree C

HOT RESISTANCE

Amb (t_2) ______ degrees C

STATOR

			TIME
R - Y :		OHMS	
		OHMS	
		OHMS	
		OHMS	
		OHMS	
Y - B		OHMS	
B - R		OHMS	

ROTOR

			TIME	
1 - 2		OHMS		TEMP. RISE (TESTED)
		OHMS		
		OHMS		STATOR :
		OHMS		ROTOR :
		OHMS		
				[ALLOWED]
2 - 3		OHMS		STATOR :
3 - 4		OHMS		ROTOR :

TEMP RISE $T = \left[\frac{R\ hot}{R\ cold} [235 + t_1] \right] - [235 + t_2]$

METER Sr. No. : 10308

TESTED BY : NDV/SGP/RAS

DATE : 29.03.97

SHIFT : II

WITNESSED BY : [signature] 29-3-97

PAGE 06 OF 06

WI/O/133/01/M07 (0195)

MACHINE DIVISION II

INDUCTION MOTOR

J.E.C. TESTS

23/32

CUSTOMER ; M/S. WEIR ENGINEERING

MACHINE NUMBER

HP / POLE : 2880.0/10 VOLTS : 6600 AMPS : 227.0 NVUW796042/1

1 STATOR PARAMETERS :-

RESISTANCE / PHASE at 75C - .16572 Ohm
CONNECTIONS = STAR

2 No Load Test at Rated Volts & Frequency :

TEST PARAMETER	V1	V2	V3	I1	I2	I3	W1	W2	W1-W2	CALCULATED VALUE
	M.F.= 60.00			M.F.= 40.00			M.F.=1200.00			
	110.0	110.0	110.0	1.70	1.72	1.73	200.0	165.0	35.0	Voph= 3810.5 Wo = 42000.0 Ioph= 68.7

3 S.C. Test at :-

TEST PARAMETER	V1	V2	V3	I1	I2	I3	W1	W2	W1-W2	CALCULATED VALUE
	M.F.= 60.00			M.F.= 80.00			M.F.=2400.00			
1)50.00 Hz	29.0	29.0	29.0	2.88	2.88	2.88	109.0	57.0	52.0	VS1ph= 1004.6 WS1 =124800.0 IS1ph= 230.4
2)25.00 Hz	15.3	15.3	15.3	2.86	2.86	2.86	58.0	24.0	34.0	VS2ph= 530.0 WS2 = 81600.0 IS2ph= 228.8

DATE : 13 3 97 SHIFT : 1

Inspected by : Mr. PD DESAI
M/S. L.R.I.S

Tested by : RGG,SUS,

PAGE : 1 / 7

17 3.97

CROMPTON GREAVES LTD.
MACHINE DIVISION II

INDUCTION MOTOR

PERFORMANCE CALCULATION AS PER J.E.C. 37 : 1979

(24/3?)

CUSTOMER ; M/S. WEIR ENGINEERING

MACHINE NUMBER

HP / POLE : 2680.0/10 VOLTS : 6600 AMPS : 227.0 NVUW796042/1

From Blocked Rotor Test ;

	50.00	25.00			
Equivalent impedance / phase, (Zs = Vsph / Isph Ohms)	4.36020 (Zs1)	2.31647 (Zs2)			
Resistive Component of Zs (Rs = Ws / 3IsSQph Ohms)	.78366 (Rs1)	.51959 (Rs2)			
Reactive Component of Zs (Xs = SQRT(ZsSQ RsSQ) Ohms)	4.28920 (Xs1)	2.25744 (Xs2)			
Xs / f	.08578	.09030			

R's & X s are obtained from the graph by using Rsa, Rsb etc. & Xsa , Xsb etc.

In special squirrel cage induction machines or machines with deep bar effect r2 & x2 (Ref. equivalent circuit diagram (2)) vary as a function of slip S. However in a limited range of slip corresponding from NL to breakdown torque, characteristics can be calculated with sufficient accuracy on the assumption that r2 & x2 are constant . (r2 - secondary winding resistance referred to primary & x2 - secondary winding reactance referred to the primary .) Hence for special squirrel cage machines R s is to betaken at frequency 0.5 Hz (This corresponds to a slip of 1% , which is the normal full load slip for large motors .

The locked rotor impedance Z at reference winding temperature is calculated as follows :

R = R's (For Temp. Rise limts corresponding to class A , E & B)
= 1.13 * R's (For Temp. Rise limits corresponding to class F &

X = 5 * X s

Z = SQRT(R**2 + X**2)

R at 0.5 Hz = .31699

Xs at 10 Hz = .93006

Z = 4.66109

PAGE : 2 /

17.3.97

MACHINE DIVISION II

25/32

INDUCTION MOTOR

PERFORMANCE CALCULATION AS PER J.E.C. 37 : 1979

CUSTOMER : M/S. WEIR ENGINEERING

MACHINE NUMBER

HP / POLE : 2880.0/10 VOLTS : 6600 AMPS : 227.0 NVUW796042/1

No.	PARAMETERS	EQUATION	SYMBOL*	VALUE
1	Is ph = Locked rotor current at rated voltage corresponding to impedance Z	Vph(rated) / Z	PscO	817.515
2	Isw - Real part of Is	Is * R / Z	PscD	55.598
3	Isi - Imaginary part of Is	Is * X / Z	OD	815.622
4	Iow = Real part of Noload amps.	Wo / (3 * Voph)	PoA	3.674
5	Ioi = Imaginary part of Noload current	SQRT of (IophSQ - IowSQ)	OA	68.588
6	k = (Stator+Rotor) copper loss under S.C. codition	Isw - Iow	PscK	51.924
7	h	Isi - Ioi	PoK	747.054
8	rho = Radius of the circle	0.5(h + kSQ/h)	PoM	375.332
9	I2s = Output line	SQRT(hSQ + kSQ)	PoPsc	748.856
10	Tan alfa	h / k	PoK/PscK	14.388
11	alfa		Po_Psc_K	86.024
12	Sin alfa		PoK / PoPsc	.998
13	Cos alfa		PscK / PoPsc	.069
14	K1 = Stator copper Loss under S.C. condition	I2sSQ * R1 /Vph	CK	24.388
15	k2 = Rotor Copper Loss under S.C. condition	k - k1	PscC	27.536
16	TAN BETA	h / k1	PoK/CK	30.632
17	BETA		Po_C_K	88.130

SYMBOL* column indicates the circle diagram representation of parameters

UNITS : VOLT , AMP , WATT , Hz , DEGREES

PAGE : 3 / 7

[signature] 17.3.97

CROMPTON GREAVES LTD.
MACHINE DIVISION II

26/32

INDUCTION MOTOR

PERFORMANCE CALCULATION AS PER J.E.C. 37 : 1979

CUSTOMER : M/S. WEIR ENGINEERING

MACHINE NUMBER

HP / POLE : 2880.0/10 VOLTS : 6800 AMPS : 227.0 NVUW798042/1

PERFORMANCE CALCULATION at 100.00 % LOAD :

No.	PARAMETERS	SYMBOL*	VALUE
1	I = Output P / (SQRT(3) * V1)	PR	174.892
2	a = rho * sin alfa - I * cos ALFA	PoP	362.302
3	b = a - SQRT(a**2 - I**2)	PoR	45.008
4	b1 = b * cos ALFA	RQ	3.121
5	b2 = b * sin ALFA	PoQ	44.899
6	C2 = b1 * k2 / k	RS	1.655
7	t = c2 + 1	PS	176.547
8	I1w = Iow + b1 + I (=Real part of FLC / phase)	PI	181.686
9	I1i = Ioi + b2 (=Imaginary part of FLC / phase)	OI	113.468
10	I1 = SQRT(I1w**2 + I1i**2) (=Primary PHASE Amps.)	OP	214.208
11	Efficiency = I * 100 / I1w	PR * 100 /PT	96.260
12	Power Factor = I1w / I1	PT / OP	.848
13	% Slip (s) = C2 * 100 / t	RS * 100 /PS	.937
14	P.O.T. = rho * TAN(0.5*DELTA) * 100 / t		205.769

SYMBOL* column indicates the circle diagram representation of parameters

UNITS : VOLT , AMP , WATT , Hz , DEGREES

PAGE : 4 / /

17.3.92

CROMPTON GREAVES LTD.
MACHINE DIVISION II

INDUCTION MOTOR

PERFORMANCE CALCULATION AS PER J.E.C. 37 : 1979

27/33

CUSTOMER : M/S. WEIR ENGINEERING

MACHINE NUMBER

HP / POLE : 2680.0/10 VOLTS : 6600 AMPS : 227.0

NVUW796042/1

PERFORMANCE CALCULATION at 75.00 % LOAD :

No.	PARAMETERS	SYMBOL*	VALUE
1	I = Output P / (SQRT(3) * V1)	PR	131.169
2	a = rho * sin alfa - I * cos ALFA	PoP	385.333
3	b = a - SQRT(a**2 - I**2)	PoR	24.359
4	b1 = b * cos ALFA	RQ	1.689
5	b2 = b * sin ALFA	PoQ	24.301
6	C2 = b1 * k2 / k	RS	.898
7	t = c2 + 1	PS	132.064
8	I1w = Iow + b1 + I (=Real part of FLC / phase)	PI	136.532
9	I1i = Ioi + b2 (=Imaginary part of FLC / phase)	OI	92.869
10	I1 = SQRT(I1w**2 + I1i**2) (=Primary PHASE Amps.)	OP	165.123
11	Efficiency = I * 100 / I1w	PR * 100 /PI	96.072
12	Power Factor = I1w / I1	PI / OP	.827
13	% Slip (s) = C2 * 100 / t	RS * 100 /PS	.678

SYMBOL* column indicates the circle diagram representation of parameters

UNITS : VOLT , AMP , WATT , Hz , DEGREES

PAGE : 5 / 7

F. Mungekar
17 . 3 . 14

CROMPTON GREAVES LTD.
MACHINE DIVISION II

INDUCTION MOTOR

28/32

PERFORMANCE CALCULATION AS PER J.E.C. 37 : 1979

CUSTOMER : M/S. WEIR ENGINEERING

MACHINE NUMBER

HP / POLE : 2880.0/10 VOLTS : 6600 AMPS : 227.0

NVUW798042/1

PERFORMANCE CALCULATION at 50.00 % LOAD :

No.	PARAMETERS	SYMBOL*	VALUE
1	I = Output P / (SQRT(3) * V1)	PR	87.448
2	a = rho * sin alfa - I * cos ALFA	PoP	368.365
3	b = a - SQRT(a**2 - I**2)	PoR	10.530
4	b1 = b * cos ALFA	RQ	.730
5	b2 = b * sin ALFA	PoQ	10.505
6	C2 = b1 * k2 / k	RS	.387
7	t = c2 + I	PS	87.833
8	I1w = Iow + b1 + I (=Real part of FLC / phase)	PT	91.850
9	I1i = Ioi + b2 (=Imaginary part of FLC / phase)	OT	79.073
10	I1 = SQRT(I1w**2 + I1i**2) (=Primary PHASE Amps.)	OP	121.198
11	Efficiency = I * 100 / I1w	PR * 100 /PT	95.205
12	Power Factor = I1w / I1	PT / OP	.758
13	% Slip (s) = C2 * 100 / t	RS * 100 /PS	.441

SYMBOL* column indicates the circle diagram representation of parameters

UNITS : VOLT , AMP , WATT , Hz , DEGREES

PAGE : 6 / 7

D. Hulgaokar
17.3.97

CROMPTON GREAVES LTD.
MACHINE DIVISION II

29/32

INDUCTION MOTOR

PERFORMANCE CALCULATION AS PER J.E.C. 37 : 1979

CUSTOMER : M/S. WEIR ENGINEERING

MACHINE NUMBER

HP / POLE : 2680.0/10 VOLTS : 6600 AMPS : 227.0

NVU0796042/1

PERFORMANCE CALCULATION at 25.00 % LOAD :

No.	PARAMETERS	SYMBOL*	VALUE
1	I = Output P / (SQRT(3) * V1)	PR	43.723
2	a - rho * sin alfa - I * cos ALFA	PoP	371.397
3	b = a - SQRT(a**2 - I**2)	PoR	2.583
4	b1 = b * cos ALFA	RQ	.179
5	b2 = b * sin ALFA	PoQ	2.578
6	C2 = b1 * k2 / k	RS	.095
7	t = c2 + 1	PS	43.818
8	I1w = Iow + b1 + I (=Real part of FLC / phase)	PT	47.576
9	I11 = Ioi + b2 (=Imaginary part of FLC / phase)	OT	71.145
10	I1 = SQRT(I1w**2 + I11**2) (=Primary PHASE Amps.)	OP	85.587
11	Efficiency - I * 100 / I1w	PR * 100 /PT	91.901
12	Power Factor = I1w / I1	PT / OP	.556
13	% Slip (s) = C2 * 100 / t	RS * 100 /PS	.217

SYMBOL* column indicates the circle diagram representation of parameters

UNITS : VOLT , AMP , WATT , Hz , DEGREES

PAGE : 1 / 1

Dhungekar
17.3.97

CROMPTON GREAVES LIMITED
LARGE MACHINES DIVISION

INDUCTION MOTOR
ROUTINE TEST CERTIFICATE

COMPLIES WITH
IS 325:1978
JEC37:1979

M/C.No. NVUW796042/2 | Customer . M/S. WEIR ENGINEERING.

Mounting VERTICAL FLANGE | Rotation From DE ANTICLOCKWISE

H.P	2680	FLT-Kgm :	3264.99	Enclosure :	CACW
K.W	2000	Syn.RPM :	600	Frame	NVUW710
Voltage	6600	FLRPM	593	Type	SCR
Current	227	Frequency:	50	Insul.Cl	F
RV :	—			Wdg.Conn:	STAR
RA :	—			Rating :	MCR

Motor runs at full speed on no load at 1/3sqrt of rated voltage

NO LOAD TEST:

Voltage	I1 Amps	I2 Amps	I3 Amps	Input KW	Frequency	RPM
6600.0	67.20	67.20	68.00	42.00	49.40	592.0

LOCKED ROTOR TEST (at reduced voltage). Extrapolated values at rated voltage

Voltage	I1 Amps	I2 Amps	I3 Amps	Input KW	STC	Stc % Flc	Stgt % Flt
1740.00	232.0	232.00	232.00	132.00	880.00	387.67	74.85

OPEN CIRCUIT ROTOR VOLTAGE AT RATED STATOR VOLTAGE : ---- Volts

INSULATION RESISTANCE TEST (before and after HV test)

Stator: 242 Megohms | Sp.Heater -- Megohms
Rotor . --- Megohms | Wdg.Rtd --- Megohms

HIGH VOLTAGE TEST (for one minute)

Stator : 14.2 KV | Sp.Heater: -- KV
Rotor : — KV | Wdg.Rtd : 1.5 KV

WINDING RESISTANCE (per phase)

Stator: 0.16542261 Ohms | At 75 Deg C
Rotor : — Ohms

Certified that an identical machine has passed the type tests and complies with the requirements of the governing standard specification.

Tested by : NDV/SGP
On 29/03/97
Date 02/05/97

Approved by [signature] Kulkarni

for CROMPTON GREAVES LIMITED
LARGE MACHINES

CROMPTON GREAVES LIMITED LARGE MACHINES DIVISION	INDUCTION MOTOR ROUTINE TEST CERTIFICATE	COMPLIES WITH IS 325:1978 JEC37:1979

M/C.No. : NVUW796042/1 Customer : M/S. WEIR ENGINEERING.

Mounting : VERTICAL FLANGE Rotation From DE. ANTICLOCKWISE

H.P :	2880	FLT-Kgm :	3284.89	Enclosure :	CACW
K.W :	2000	Syn.RPM :	600	Frame :	NVUW710
Voltage :	6600	Fl.RPM :	593	Type :	SCR
Current :	227	Frequency:	50	Insul.Cl :	F
RV :	—			Wdg.Conn:	STAR
RA :	—			Rating :	MCR

Motor runs at full speed on no load at 1/3sqrt of rated voltage

NO LOAD TEST:

Voltage	I1 Amps	I2 Amps	I3 Amps	Input KW	Frequency	RPM
6600.0	68.00	68.80	69.20	42.00	50.00	598.0

LOCKED ROTOR TEST (at reduced voltage). Extrapolated values at rated voltage

Voltage	I1 Amps	I2 Amps	I3 Amps	Input KW	STC	Stc % Flc	Stgt % Flt
1770.00	239.2	236.80	240.00	132.00	889.94	392.05	69.97

OPEN CIRCUIT ROTOR VOLTAGE AT RATED STATOR VOLTAGE : — Volts

INSULATION RESISTANCE TEST (before and after HV test)

Stator:	6000	Megohms	Sp.Heater:	20000	Megohms
Rotor :	—	Megohms	Wdg.Rtd :	8000	Megohms

HIGH VOLTAGE TEST (for one minute)

Stator :	14.2	KV	Sp.Heater.	1.5	KV
Rotor :	—	KV	Wdg.Rtd	1.5	KV

WINDING RESISTANCE (per phase) At 75 Deg C

Stator: 0.16571562 Ohms

Rotor : — Ohms

Certified that an identical machine has passed the type tests and complies with the requirements of the governing standard specification.

Tested by : RGG/RSS

On : 12/03/97

Date : 15/05/97

Approved by

for CROMPTON GREAVES LIMITED
LARGE MACHINES

Contd......2 TYPE TEST CERTIFICATE M/c. No.: NVUW 796042/1

Temperature rise test by mixed frequency method (at total water flow of 200 LPM)

Voltage	Current	Input KW (losses)	Temperature rise in deg C		
			Stator	Rotor	Core
3240.0	226.9	115.2	75.8	—	—

AIR TEMPERATURES DURING TEMP. RISE TEST (DEG C)

Internal air			External water		
In	Out	Rise	In	Out	Rise
—	—	—	44.0	—	—

OTHER TEMPERATURES (DEG C)

DE Brg	ODE Brg	Slip Ring	Brush	Ambient
43.0	58.0	–	–	28.9

OPEN CIRCUIT ROTOR VOLTAGE AT RATED STATOR VOLTAGE: — Volts

INSULATION RESISTANCE TEST (before & after HV Test) :

Stator : 6140.0 Megohms Sp.Heater: 20000 Megohms
Rotor : — Megohms Wdg.RTD : 8000 Megohms

HIGH VOLTAGE TEST (for one minute):

Stator : 14.2 KV Sp.Heater: 1.5 KV
Rotor : — KV Wdg.RTD : 1.5 KV

WINDING RESISTANCE (per phase) : AT: 75.0 Deg C

Stator : 0.165572 Ohms
Rotor : — Ohms

MOMENTARY OVERLOAD TEST AT 160% FL FOR 15 Sec. SATISFACTORY

VIBRATION TEST :

Displacement (peak to peak in microns) : 45.00 Microns
RMS Velocity (millimeters / sec) 1.10 mm/sec

Allowed limits : 125.0 Microns 2.60 mm/sec

Tested by : RGG/RSS
On : 12/03/97& 13/03/97

Date : 17/03/97

Approved by: [signature]

for CROMPTON GREAVES LIMITED
LARGE MACHINES

30/32

CROMPTON GREAVES LIMITED	INDUCTION MOTOR	COMPLIES WITH
LARGE MACHINES DIVISION	TYPE TEST CERTIFICATE	IS 325 1978
		IEC 37 1979

M/C.No: NVUW 796042/1 Customer: M/S: WEIR ENGINEERING

Mounting: VERTICAL FLANGE Rotation from DE: ANTICLOCKWISE

H.P	2680	FLT-Kgm:	3285.0	Enclosure:	CACW
K.W	2000	Syn. RPM:	600	Frame:	NVUW 710
Voltage	6600	FL. RPM:	593	Type:	SCR
Current	227	Frequency:	50	Insul. Cl:	F
RV	—			Wdg.Conn:	STAR
RA	—			Rating:	MCR

Motor runs at full speed on no load at 1/3sqrt of rated voltage

NO LOAD TEST:

Voltage	I1 Amps	I2 Amps	I3 Amps	Input KW	Frequency	RPM
6600.0	68.0	68.8	69.3	42.0	50.0	598.0

LOCKED ROTOR TEST (at reduced voltage)

Voltage	I1 Amps	I2 Amps	I3 Amps	Input KW
1770.0	239.2	236.8	240.0	132.0

Extrapolated values at rated voltage

STC	STC%FLC	STG%FLT
889.94	392.05	69.97

PERFORMANCE CHARACTERISTICS:

%LOAD	Voltage	Current	KW	RPM	Power Factor		% Efficiency	
					Comm	Tested	Comm	Tested
100	6600	214.21	2077.71	594	0.80	0.848	96.20	96.26
75	6600	165.12	1561.33	596	0.80	0.827	96.00	96.07
50	6600	79.07	1050.37	597	0.78	0.758	95.80	95.21
25	6600	85.59	544.07	599	—	0.56	—	91.90

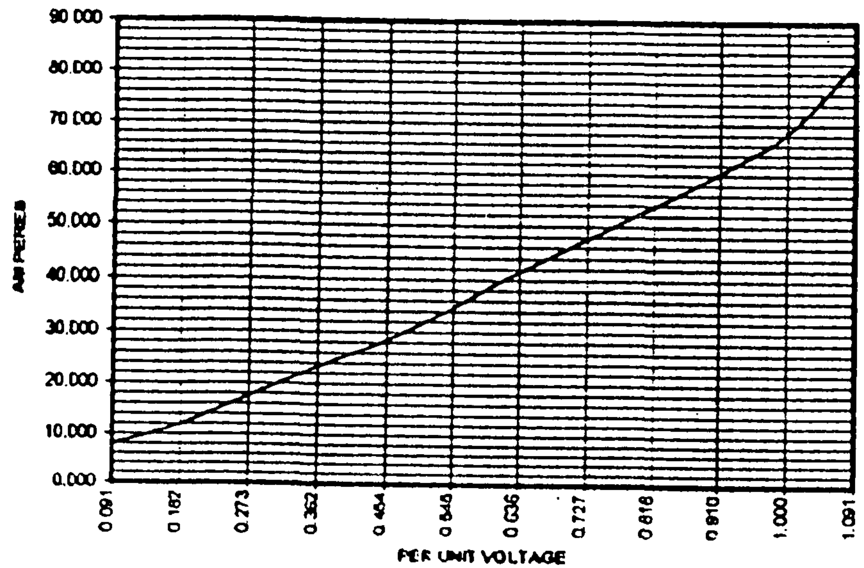
Pull out Torque : 205.77 % of FLT (Comm : 175.0 %FLT)

CUSTOMER : WEIR ENGINEERING

MACHINE No.: NVUW 798042/1

P.U.V	0.091	0.182	0.273	0.362	0.454	0.545	0.636	0.727	0.818	0.910	1.000	1.091
AMPS	8.000	11.970	17.660	23.470	28.530	34.820	41.600	47.600	53.730	60.400	68.670	82.393

NO LOAD CURRENT CURVE

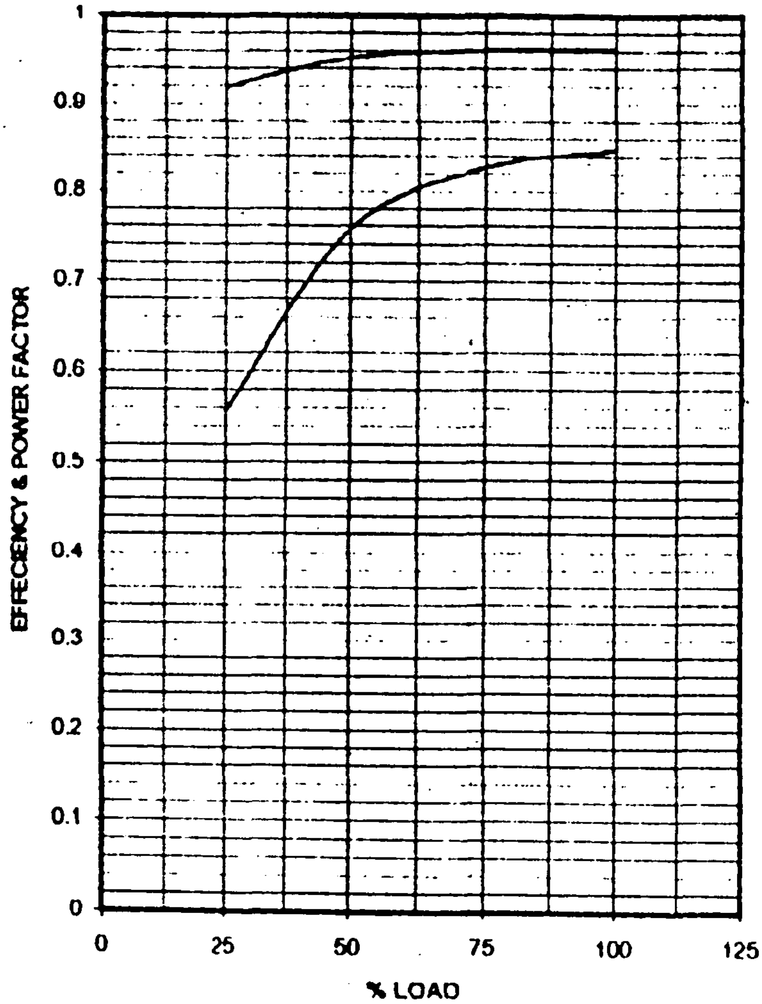


3:/32

Customer : **M/S. WEIR ENGINEERING** **M/c. No. : NVUW 796042/1**

% LOAD	0	25	50	75	100	125
EFF		0.919	0.952	0.961	0.963	
Pf		0.56	0.758	0.827	0.848	

PERFORMANCE CURVES



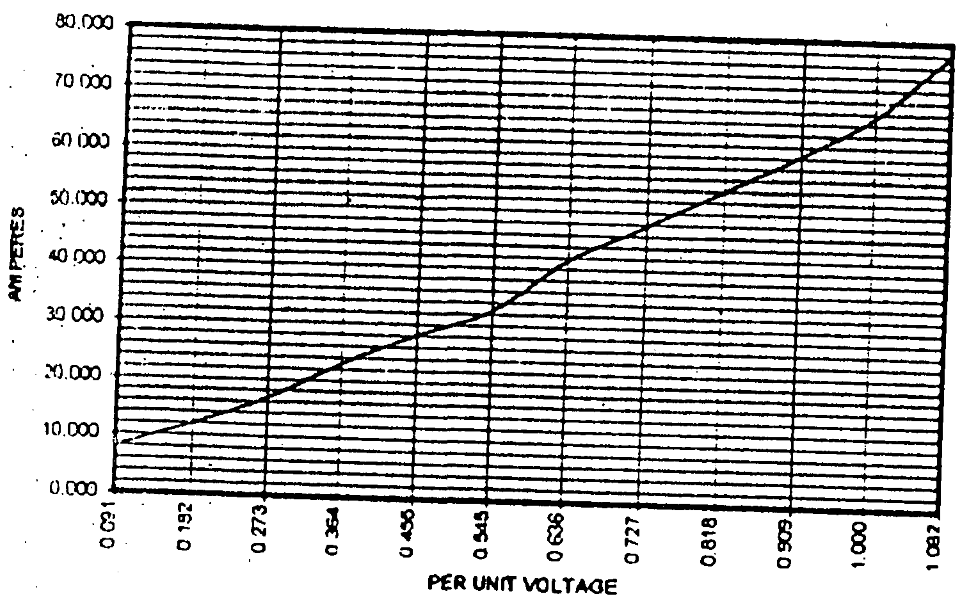
11/3/17

CUSTOMER : WEIR ENGINEERING

MACHINE No.: NVUW 799042/2

PUV	0.091	0.182	0.273	0.364	0.455	0.545	0.636	0.727	0.818	0.909	1.000	1.082
AMPS	8.000	12.000	16.800	23.067	28.270	32.667	41.600	47.733	54.000	60.267	67.467	78.4

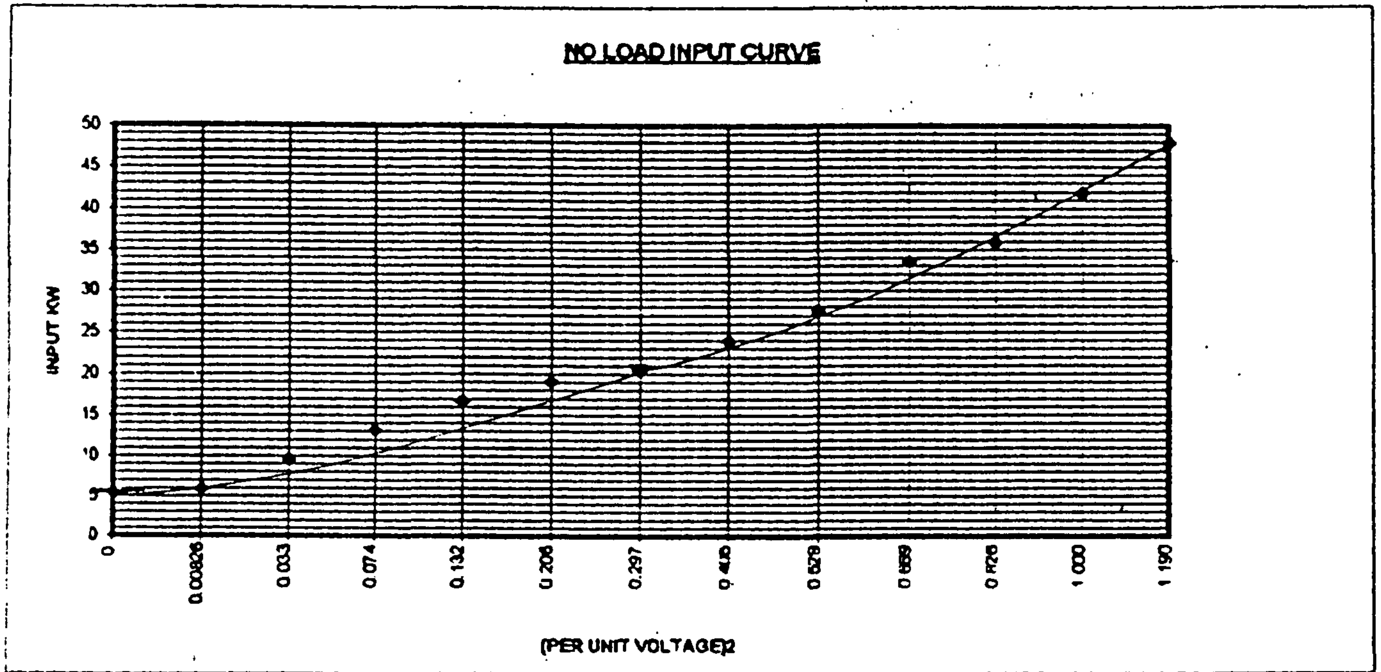
NO LOAD CURRENT CURVE



STATOR RESISTANCE PER PAHSE @ 75 deg C = 0.166 OHMS
NO LOAD CURRENT AT RATED VOLTAGE = 67.47 AMPS
NO LOAD COPPER LOSS = 2.26 KW

CUSTOMER : **WEIR ENGINEERING** **MACHINE No.:** **NVUW 796042/1**

(PUV)2	0	0.00826	0.033	0.074	0.132	0.206	0.297	0.405	0.529	0.659	0.826	1.000	1.190
KW		6.00	9.60	13.20	16.80	19.20	20.40	24.00	27.60	33.60	38.30	42.00	48.00

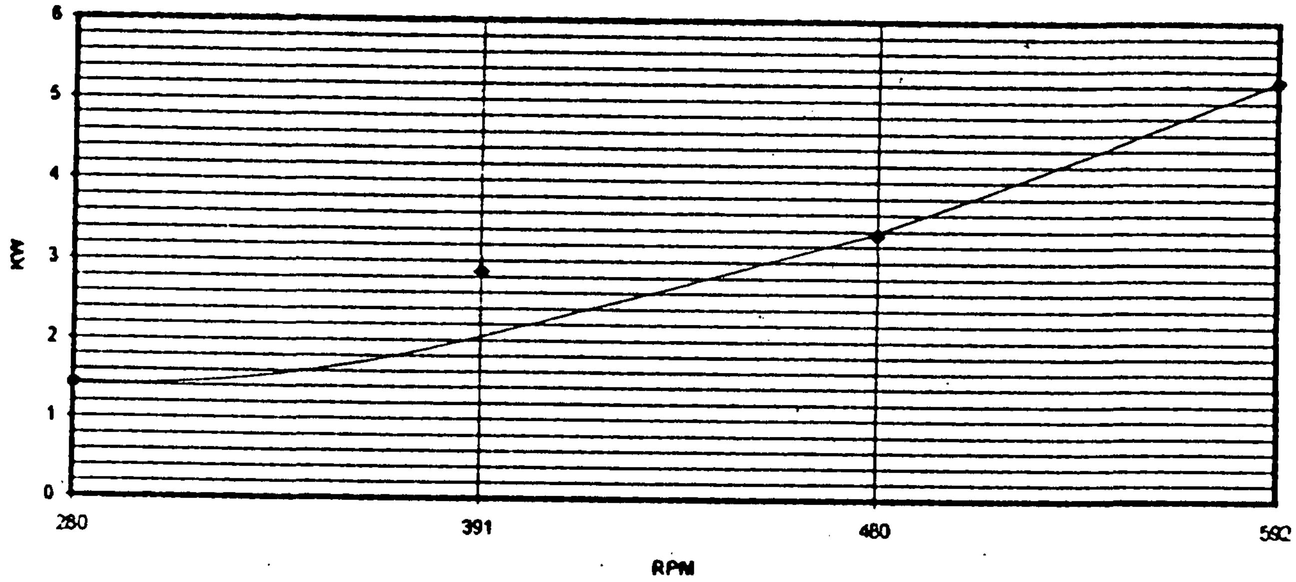


TOTAL NO LOAD INPUT	=	42.00 KW
FRICTION + WINDAGE LOSS	=	5.00 KW
NO LOAD COPPER LOSS	=	2.30 KW
NO LOAD IRON LOSS	=	34.70 KW

CUSTOMER : **WEIR ENGINEERING** **MACHINE No.:** **NVUW 796042/1**

RPM	280	391	480	592
KW	1.44	2.88	3.36	5.28

FRICTION WINDAGE LOSS CURVE



CROMPTON GREAVES LIMITED
MACHINE 2 DIVISION

INDUCTION MOTOR
ROUTINE TEST
(As Per IS 325 : 1978)

M/C NO. : NVUW796042/1
FRAME : NVUW710

CUSTOMER . M/S WEIR ENGG VOLTS : 6600±10% AMPS . 227.0 HP/KW : 2660/2000 R.P.M. : 593 INS. CLASS : F/B

MOTOR RUNS AT FULL SPEED AT REDUCED VOLTAGE : V = 1200 RPM = 575 Hz 47.95

ROTATION FROM DE : ✓ANTI CLOCKWISE / ~~CLOCKWISE~~ / ~~BI-DIRECTIONAL~~

VOLTS M F = 60			AMPS M F = 40			WATTS M F = 60x40x½		
V1	V2	V3	I1	I2	I3	W1	W2	W1-W2
110.0	110.0	110.0	1.70	1.72	1.73	200-	165 •	35

	DESIGN	TESTED
NL. LOSS		
NL AMPS		
	COMMITTED	TESTED
% STC	550%	392.05%
% STGT.	70%	69.97%
R V		

OPEN CIRCUIT TEST
STATOR VOLTS : ____
ROTOR VOLTS : ____
R.V. @ ____ V = ____ V

BLOCKED ROTOR TEST (As per JEC 37 : 1979) SHAFT VOLTAGE : ____

VOLTS M F = 60			AMPS M F = 60			WATTS M F = 60x60x½		
V1	V2	V3	$I_{sc}1$	$I_{sc}2$	$I_{sc}3$	W1	W2	W_s = W1-W2
29.5	29.5	29.5	2.99	2.96	3.00	115-	60 •	55

$I_s = \frac{\text{RATED V}}{\text{TESTED V}} \times I_{sc}$

I_s = 889.94 Amp

$\text{STC\%FLC} = \frac{I_s}{\text{FLC}} \times 100$

I_s = SHORT CIRCUIT CURRENT
FLC = FULL LOAD CURRENT

$\text{STGT\%FLT} = \frac{(1-s)\,[\text{Ws-Cu LOSS}]\,[I_s/I_{sc}]^2}{\text{OUTPUT IN WATTS}} \times 100$

WHERE : S=pu. slip I_s -STC at rated volts, Cu. LOSSES = $3(I_{sc})^2$ x Rph : FOR STAR CONN. $(I_{sc})2$ x Rph : FOR DELTA CONN.

VOLTMETER Sr. No. : 1/7/3990
AMMETER Sr. No. : 1/71399 5
WATTMETER Sr. No. : BE71636
WATTMETER Sr. No. : BE71635

TESTED BY : RGG/RSS
DATE : 12.03.97
SHIFT : I
[signature]

WITNESSED BY : Mr. PD. Desai (From: M/s. LRIS) [signature] 12.3.97

PAGE 01 OF 05

WI/Q/133/01/M01 (0195)

CROMPTON GREAVES LIMITED.
MACHINE 2 DIVISION

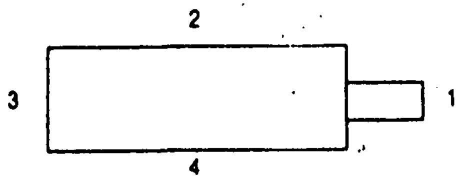
INDUCTION MOTOR
NOISE LEVEL, VIBRATION
I.R.-H.V.-I.R.P.I

M/C NO. : NVUL1796042/1
FRAME : NVUL1710

CUSTOMER : M/S WEIR ENGG VOLTS : 6600±10% AMPS : 227.0 HP/KW : 2680/2000 R.P.M. : 593 INS. CLASS : F

NOISE LEVEL MEASUREMENT : dB(A)

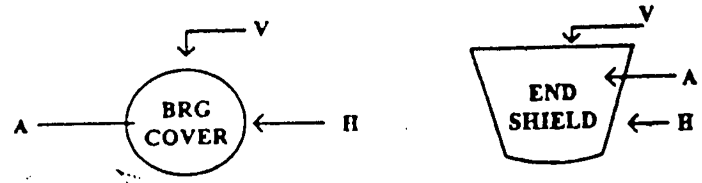
(AT 1.0/1.5 M DISTANCE) METERS Sr. No. D03791



POSITION	1	2	3	4
BACKGROUND	70	70	70	70
MEASURED	77.6	76.4	76.1	76.1
AVERAGE	77.35	dB(A)	COMM 90.0	dB(A)

VIBRATIONS ON NO-LOAD (P-P IN MICRONS)

METERS Sr. No. 3006



FIGURES IN BRACKET INDICATE VEL. IN MM/SEC.

LOCATION	HOR	VER	AXIAL
DE	20 (0.5)	12 (0.35)	–
ODE	45 (1.1)	5.5 (0.25)	–
COMMITTED	2.6 mms⁻¹ (RMS)		

INSULATION RESISTANCE
(before and after H.V. test)

H.V. TEST (for one minute)

POLARIZATION INDEX

			K.V.	L.C. (amps)
ST. WDG.	: 6140	M Ohms. (by 2500 V Meggar)	14.2	1.16
RT. WDG.	: –	M Ohms. (by – V Meggar)	–	–
RTD. (Wdg).	: 8000	M Ohms. (by 500 V Meggar)	1.5	0.00
SP. HEATER	: 20,000	M Ohms. (by 500 V Meggar)	1.5	0.00

I.R. AFTER 10 MIN. 15,800 M Ohms.
P.I. =
I.R. AFTER 1 MIN. 6140 M Ohms.
P.I. = 2.57

TESTED BY : RGG/RSS DATE : 12.03.97 SHIFT : I WITNESSED BY : [signature] 12.3.97

PAGE 02 OF 05

WI/Q/133/01/MK02(0195)

CROMPTON GREAVES LIMITED
MACHINE 2 DIVISION

INDUCTION MOTOR
[redacted] NO LOAD TEST
[As per IS 325 : 1978; JEC 37 : 1979]

M/C NO. : NVUW 796042/1
FRAME : NVUW710 INS. CLASS : F/B
CUSTOMER : M/S WEIR ENGG VOLTS : 6600 AMPS : 227 HP/KW : 2680/2000 R.P.M : 593 ROTATION FROM DE.ANCL/CL/BD

TIME	VOLTS. M. F. = 60 V1	V2	V3	AMPS M. F. = 40 I1	I2	I3	WATTS : M. F. = 60x40x1/2 W1	W2	W1+W2	Hz	R.P.M [redacted]	AMB	INT. AIR RTD/deg. C IN	OUT	IN	EXT. AIR RTD/deg. C IN	OUT	FRAME RTD/ deg. C
	120	120	120	2.05	2.08	2.09	265-	225-	40	50.0	596							
	110	110	110	1.70	1.72	1.73	200-	165-	35	50.0	596							
	100	100	100	1.51	1.51	1.51	165-	135-	30	50.0	600							
	90	90	90	1.34	1.34	1.35	140-	112-	28	50.0	599							
	80	80	80	1.19	1.19	1.19	110-	87-	23	50.0	600							
	70	70	70	1.04	1.04	1.04	85-	65-	20	50.0	599							
	60	60	60	0.872	0.86	0.88	62-	45-	17	50.0	599							
	50	50	50	0.715	0.71	0.715	45-	29-	16	50.0	596							
	40	40	40	0.59	0.58	0.59	30-	16-	14	50.0	599							
	30	30	30	0.442	0.439	0.444	20-	9-	11	50.0	600							
	20	20	20	0.30	0.296	0.30	9-	1-	8	50.0	598							
	10	10	10	0.20	0.20	0.20	5-	0-	5	50.0	597							

VOLTMETER Sr. No. : 1/7/3996
AMMETER Sr. No. : 1/7/3995
WATTMETER Sr. No. : 8871631
WATTMETER Sr. No. : 5871635

TESTED BY : RGG/RSS
DATE : 12.03.97
SHIFT : I

WITNESSED BY 12-3-97

PAGE 03 OF 05

WI/Q/133/01/M05(0195)

CROMPTON GREAVES LIMITED
MACHINE 2 DIVISION

INDUCTION MOTOR
[redacted] WINDAGE LOSS RED.
[As per IS 325 : 1978; JEC 37 : 1979]

M/C NO. : NVUW 796042/1
FRAME : NVULI71C
INS. CLASS : F/B

CUSTOMER : M/S WEIR ENGG
VOLTS : 6600
AMPS : 227
HP/KW : 2660/2000
R.P.M. : 593
ROTATION FROM DE.ANCL/CL/BB

[redacted]	VOLTS. M. F. = 60			AMPS M. F. = 08			WATTS : M. F. = 60x08x½			Hz	R.P.M [redacted]	AMB	INT. AIR RTD/deg. C			EXT. AIR RTD/deg. C		FRAME RTD/ deg. C
	V1	V2	V3	I1	I2	I3	W1	W2	W1+W2				IN	OUT	IN	IN	OUT	
	9.5	9.5	9.5	1.0	0.96	0.98	20.4	2 -	22		592							
	6.0	8.0	8.0	0.86	0.83	0.86	14.4	0 -	14		480							
	6.0	6.0	6.0	0.72	0.68	0.715	12.4	0 -	12		391							
	5.5	5.5	5.5	0.74	0.70	0.72	6.4	0 -	6		281							

VOLTMETER Sr. No. : 1/7/3990
AMMETER Sr. No. : 1/7/3995
WATTMETER Sr. No. : BB71634
WATTMETER Sr. No. : BB71635

TESTED BY : RGG/RSS
DATE : 12.03.97
SHIFT : I

WITNESSED BY ______
12.3.97

PAGE 04 OF 05

5/32

WVO/133/01/MO5(0195)

CROMPTON GREAVES LIMITED
LARGE MACHINES DIVISION

INDUCTION MOTOR
MEASUREMENT OF RESISTANCE
(As Per IS 325 : 1978)

M/C NO. : NVUW796042/1
FRAME : NVUW 710

CUSTOMER : M/S WEIR ENGG VOLTS : 6600± 10% AMPS : 227 HP/KW : 2660/2000 R.P.M. : 593 INS. CLASS : F/B

COLD RESISTANCE Amb (t_1) 32·6 degrees C

STATOR			ROTOR		
R - Y	0·2859	OHMS	1 - 2		OHMS
Y - B	0·2664	OHMS	2 - 3		OHMS
B - R	0·2860	OHMS	3 - 1		OHMS

DESIGN @ 20 deg. C
-- OHMS — OHMS

THERMISTOR RESISTANCE
1 ______ OHMS
2 ______ OHMS

SPACE HEATER RESISTANCE 57·7 OHMS

R.T.D. COLD RESISTANCE (OHMS)

WINDING			
1.	111·7Ω	7.	111·6Ω
2.	111·7Ω	8.	111·7Ω
3	111·8Ω	9.	111·6Ω
4.	111·7Ω	10	
5	111·7Ω	11.	
6	111·8Ω	12.	

BEARING R.T.D.
DE : 1. ______ 2. ______
O.D.E. 1. ______ 2 ______

BEARING B.T.D
D.E. ______ degree C
O.D.E. ______ degree C

HOT RESISTANCE Amb (t_2) ______ degrees C

STATOR			TIME
R - Y :		OHMS	
		OHMS	
		OHMS	
		OHMS	
		OHMS	
Y - B		OHMS	
B - R		OHMS	

ROTOR			TIME	
1 - 2		OHMS		TEMP. RISE (TESTED)
		OHMS		
		OHMS		STATOR :
		OHMS		ROTOR :
		OHMS		(ALLOWED)
2 - 3		OHMS		STATOR :
3 - 4		OHMS		ROTOR :

TEMP RISE $T = \left[\frac{R\ hot}{R\ cold} (235 + t_1) \right] - (235 + t_2)$

METER Sr No. : 10309
TESTED BY : RGG/RSS
DATE : 12·03·97
SHIFT : I
WITNESSED BY : [signature] 12.3.97
PAGE 05 OF 05

W/Q/133/01/M07 (0195)

CROMPTON GREAVES LIMITED
MACHINE 2 DIVISION

INDUCTION MOTOR
~~TEMPERATURE RISE TEST~~ Locked rotor test at various voltages.
[As per IS 325 : 1978; JEC 37 : 1979]

M/C NO. : NVUW 796042/1
FRAME : NVUW 710 INS. CLASS : F/B
CUSTOMER : M/S WEIR ENGG VOLTS : 6600 AMPS : 227 HP/KW : 2680/2000 R.P.M. : 593 ROTATION FROM DE. ANTICLOCKWISE (~~CLOCK~~)

TIME	VOLTS. M. F. = 60			AMPS M. F. = 80			WATTS : M. F. = 60x80x½			Hz	POWER FACTOR	AMB	INT. AIR RTD/deg. C			EXT. AIR RTD/deg. C		FRAME RTD/ deg. C
	V1	V2	V3	I1	I2	I3	W1	W2	W1+W2				IN	OUT	IN	IN	OUT	
	12.5	12.5	12.5	1.25	1.25	1.25	21 -	10 =	11	50	0.203							
	15.5	15.5	15.5	1.50	1.50	1.50	30 -	14 =	16	50	0.198		Amb. Temp. - 35.5°C					
	18.0	18.0	18.0	1.75	1.76	1.76	42 -	20 =	22	50	0.201		Avg. wdg. temp					
	20.2	20.2	20.2	2.00	2.00	2.00	53 -	26 =	27	50	0.193		before start - 35.5°C					
	22.9	22.9	22.9	2.25	2.25	2.25	65 -	34 =	31	50	0.173		Avg. wdg. temp					
	25.2	25.2	25.2	2.50	2.50	2.50	83 -	45 =	38	50	0.174		after completion of test - 42.5°C					
	29.0	29.0	29.0	2.88	2.88	2.88	109 -	57 =	52	50	0.179		Test conducted without					
													water circulation.					
	15.3	15.3	15.3	2.86	2.86	2.86	58 -	24 =	34	25	0.224							
	2.3	2.3	2.3	2.00	2.00	2.00	16 -	3 =	13	12.5	–	→Maximum possible current at						
												this frequency.						
	Shaft voltage at NL at rated voltage & frequency - 50mV.																	

VOLTMETER Sr. No. : 1/7/3990
AMMETER Sr. No. : 1/7/3995
WATTMETER Sr. No. : BB71634
WATTMETER Sr. No. : BB71635

TESTED BY : RGG/SUS
DATE : 13/03/97
SHIFT : I

WITNESSED BY Mr. P.D. Desai - M/s. L.R.I.S.

[signature] 13/3/97 PAGE 01 OF 01 [signature] 13.3.97

WI/O/133/01/MO5(0195)

11/32

TEMPERATURE RISE TEST ON NVUW 796042/1

We have carried out type test (temperature rise test) under following conditions.

1. Temperature rise was carried out at 3.3 KV and full load stator current of 226.93A, for a total loss of 115.2 KW. (as against 77.7 KW based on calculations as per JEC 37.1979).

2. Water flow rate : 200 LPM as against 500 LPM.

3. Water inlet temperature : Initial 33 °C at start of temperature rise test
   : Final 44 °C at conclusion of temperature rise test.
   As against 32 °C for inlet required throughout the test (water was recirculated)

The temperature rise observed at **these extreme conditions** is 75.8 °C at an ambient temperature of 28.9 °C.

Under normal operating conditions, the temperature rise will be well within the acceptable limits of 88 °C for water inlet temperature of 32 °C.

13/3/14

Page 4 of 4

CROMPTON GREAVES LIMITED
MACHINE 2 DIVISION

INDUCTION MOTOR
ROUTINE TEST
(As Per IS 325 : 1978)

M/C NO. : N VUW 79 60(i2/3
FRAME : NVUW 710

CUSTOMER : M/S WEIR Engg VOLTS 6600 AMPS 227 HP/KW 2680/2000 R.P.M. : 593 INS. CLASS F/B

MOTOR RUNS AT FULL SPEED AT REDUCED VOLTAGE : V = 1500 RPM = 599 Hz 50.00

VOLTS M F = 60			AMPS M F = 40			WATTS M F = 60x40x1/2		
V1	V2	V3	I1	I2	I3	W1	W2	W1-W2
110	110	110	1.69	1.71	1.71	205 -	170 =	35

ROTATION FROM DE: ANTI CLOCKWISE ~~CLOCKWISE~~ ~~BIDIRECTIONAL~~

	DESIGN	TESTED
NL. LOSS		
NL. AMPS		
	COMMITTED	TESTED
% STC	550 %	381.53 %
% STGT.	70 %	76.20 %
R V		

OPEN CIRCUIT TEST
STATOR VOLTS : ______
ROTOR VOLTS : ______
R.V. @ ______ V = ______ V

BLOCKED ROTOR TEST (As per JEC 37 : 1979) SHAFT VOLTAGE : 104 mV

VOLTS M F = 60			AMPS M F = 80			WATTS M F = 60x80x1/2		
V1	V2	V3	$I_{sc}1$	$I_{sc}2$	$I_{sc}3$	W1	W2	W_s = W1-W2
29.5	29.5	29.5	2.91	2.90	2.90	117 -	60 =	57

$I_s = \frac{\text{RATED V}}{\text{TESTED V}} \times I_{sc}$

I_s = 866.10

STGT%FLT = $\frac{(1\cdot s)\ [W_s\text{-Cu LOSS}]\ [I_s/I_{sc}]^2}{\text{OUTPUT IN WATTS}} \times 100$

STC%FLC = $\frac{I_s}{FLC} \times 100$

WHERE : S=pu. slip I_s -STC at rated volts; Cu. LOSSES = $3(I_{sc})^2 \times R_{ph}$: FOR STAR CONN. $(I_{sc})2 \times R_{ph}$: FOR DELTA CONN.

I_s = SHORT CIRCUIT CURRENT
FLC = FULL LOAD CURRENT

VOLTMETER Sr. No. 1/7/3990
AMMETER Sr. No 1/7/3995
WATTMETER Sr. No. : BB71634
WATTMETER Sr. No. : BB71635

TESTED BY : RSS/RGG/KMG
DATE : 19/4/97
SHIFT : I

WITNESSED BY : Mr. P. D. Desai - mk. LRIS.

PAGE 1 OF 6

[signature] 19-4-1997

WO/133/01/M01 (0195)

[signature] 19/4/97

CROMPTON GREAVES LIMITED.
MACHINE 2 DIVISION

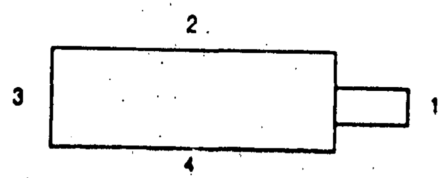
INDUCTION MOTOR
NOISE LEVEL, VIBRATION
LR-H.V.-I.R.P.I

M/C NO. : NVUW 996042/3
FRAME : NVUW 710.

CUSTOMER : M/S WEIR Engg. VOLTS : 6600 AMPS : 227 HP/KW : 2680/2000 R.P.M. : 593 INS. CLASS : F/B

NOISE LEVEL MEASUREMENT : dB(A)

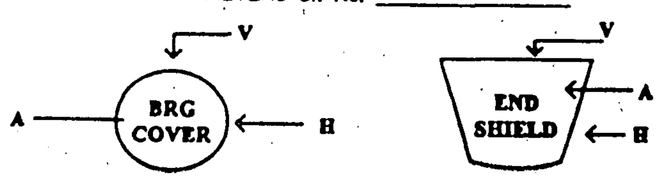
(AT 1.0/1.5 M DISTANCE) METERS Sr. No. D03791



POSITION	1	2	3	4
BACKGROUND	72	72	72	72
MEASURED	80.5	80	84	80.7
AVERAGE		dB(A)	COMM 90	dB(A)

VIBRATIONS ON NO-LOAD (P-P IN MICRONS)

METERS Sr. No. 2121



FIGURES IN BRACKET INDICATE VEL. IN MM/SEC.

LOCATION	HOR	VER	AXIAL
DE	1.5(0.2)	3(0.27)	-
ODE	2(0.43)	7(0.54)	-
COMMITTED	2.6 mm/sec.		

INSULATION RESISTANCE

(before and after H.V. test)

H.V. TEST (for one minute)

			K.V.	L.C. (amps)
ST. WDG. :	4310	M Ohms. (by 2500 V Meggar)	14.2	1.20
RT. WDG. :		M Ohms. (by ~~500~~ V Meggar)	-	-
RTD. (Wdg). :	500	M Ohms. (by 500 V Meggar)	1.5	00
SP. HEATER :	500	M Ohms. (by 500 V Meggar)	1.5	00

POLARIZATION INDEX

I.R. AFTER 10 MIN. 10300 M Ohms.

P.I. =

I.R. AFTER 1 MIN. 4310 M Ohms.

P.I. = 2.39

TESTED BY : RGG/RSS/KMG DATE : 19/4/97 SHIFT : WITNESSED BY : [signature] 19-4-1997

[signature] 19/4/97 PAGE 2 OF 6

WI/Q/133/01/M02(0195)

CROMPTON GREAVES LIMITED
MACHINE 2 DIVISION

INDUCTION MOTOR
NL ~~TEMPERATURE RISE~~ TEST
[As per IS 325 : 1978; IEC 37 : 1979]

M/C NO. : NVUW 796042/3
FRAME : NVUW 710 INS CLASS : F
CUSTOMER : M/S WEIR Engg. VOLTS : 6600 AMPS : 227 HP/KW : 2680/2000 R.P.M. 593 ROTATION FROM DE ANCL/~~CLOCK~~

TIME	VOLTS. M. F. = 60			AMPS M. F. = 40			WATTS : M. F. = 60x40x1/2			Hz	RPM	AMB	INT. AIR RTD/deg. C			EXT. AIR RTD/deg. C		FRAME RTD/ deg. C
	V1	V2	V3	I1	I2	I3	W1	W2	W1+W2				IN	OUT	IN	IN	OUT	
	120	120	120	2.05	2.02	2.02	258 -	217 =	41	50	599							
	110	110	110	1.69	1.79	1.71	205 -	70 =	35	50	599							
	100	100	100	1.50	1.51	1.51	163 -	135 =	28	50	599							
	90	90	90	1.34	1.32	1.32	131 -	107 =	24	50	598							
	80	80	80	1.16	1.15	1.16	108 -	87 =	21	50	599							
	70	70	70	1.02	1.02	1.01	80 -	62 =	18	50	599							
	60	60	60	0.89	0.88	0.89	60 -	45 =	15	50	599							
	50	50	50	0.72	0.71	0.72	42 -	29 =	13	50	598							
	40	40	40	0.58	0.56	0.57	30 -	19 =	11	50	599							
	30	30	30	0.43	0.42	0.42	20 -	10 =	10	50	599							
	20	20	20	0.31	0.30	0.30	10 -	02 =	8	50	599							
	10	10	10	0.20	0.20	0.20	5 -	0 =	5	50	598							

VOLTMETER Sr. No. : 1713990
AMMETER Sr. No. : 1713995
WATTMETER Sr. No. : BB 71634
WATTMETER Sr. No. : BB 71635

TESTED BY : RGG/RSS/Kmr
DATE : 19/4/97
SHIFT : I

WITNESSED BY
19.4.1997

PAGE 3 OF 6

WO/133/01/MO5(0195)

CROMPTON GREAVES LIMITED
MACHINE 2 DIVISION

INDUCTION MOTOR
Windage Loss Test ~~TEMPERATURE RISE TEST~~
[As per IS 325 : 1978; JEC 37 : 1979]

M/C NO. : NVUW 796042/3
FRAME : NVUW 710 INS. CLASS : F
CUSTOMER : M/S WEIR Engg. VOLTS : 6600 AMPS : 227 HP/KW : 2680/2000 R.P.M. 593 ROTATION FROM DE ANCL ✓

TIME	VOLTS M.F. = 60 V1	V2	V3	AMPS M.F. = 8 I1	I2	I3	WATTS M.F. = 60x8x½ W1	W2	W1+W2	Hz	RT. Hz	AMB	INT. AIR RTD/deg. C IN	OUT	IN	EXT. AIR RTD/deg. C IN	OUT	FRAME RTD/ deg. C
	9.0	9.0	9.0	0.99	0.99	1.00	18+	2 =	20									
	8.2	8.2	8.2	0.83	0.81	0.82	10+	3 =	13									
	6.1	6.1	6.1	0.70	0.70	0.70	5+	4 =	9									
	5.5	5.5	5.5	0.68	0.69	0.68	5+	0 =	5									

VOLTMETER Sr. No. : 1/7/8990
AMMETER Sr. No. : 1/7/3995
WATTMETER Sr. No. : BB71634
WATTMETER Sr. No. : BB71635

TESTED BY : RGG/RSS/KDNG
DATE : 19/4/97
SHIFT : I

WITNESSED BY ______ 19-4-1997

PAGE 4 OF 6

WMO/133/01/MO5(0195)

CROMPTON GREAVES LIMITED
MACHINE 2 DIVISION

INDUCTION MOTOR
~~TEMPERATURE RISE TEST~~
[As per IS 325 : 1978; JEC 37 : 1979]

W/C NO. : NVUW 796042/3
FRAME : NVUW 710 INS. CLASS : F/~~B~~ ✓

CUSTOMER : M/S WEIR Engg. VOLTS : 6600 AMPS : 227 HP/KW : 2680/2000 R.P.M. : 593 ROTATION FROM DE. ANCL/~~CLKD~~

TIME	VOLTS. M. F. = 60 V1	V2	V3	AMPS M. F. = 80 I1	I2	I3	WATTS : M. F. = 60x80x½ W1	W2	W1+W2	Hz	P.F.	AMB	INT. AIR RTD/deg. C IN	OUT	IN	EXT. AIR RTD/deg. C IN	OUT	FRAME RTD/ deg. C
	Locked Rotor Test at Various Voltages.																	
	13.1	12.1	13.1	1.25	1.25	1.25	23	11	= 12	50	0.211	Amb temp – 28.5°C						
	15.7	15.7	15.7	1.50	1.50	1.50	33	15	= 18	50	0.221	Ave. Wdg. temp. before						
	18.5	18.5	18.5	1.75	1.75	1.75	44	21	= 23	50	0.205	Start = 34.3°C						
	20.8	20.8	20.8	2.01	2.02	2.02	55	29	= 26	50	0.178	Ave. Wdg. temp. after						
	23.1	23.1	23.1	2.25	2.25	2.27	70	35	= 35	50	0.194	comp. of test = 42.5°C						
	25.9	25.9	25.9	2.50	2.51	2.50	85	47	= 38	50	0.169							
	29.5	29.5	29.5	2.91	2.90	2.90	117	60	= 57	50	0.192	Test conducted without						
												water circulation.						
	15.7	15.7	15.7	2.90	2.90	2.90	62	25	= 37	~~50~~ 25.0	0.234							
	6.5	6.5	6.5	2.05	2.01	2.05	20	6	= 14	~~50~~ 12.53	→ Maximum possible current at							
												this frequency						

VOLTMETER Sr. No. : 178990
AMMETER Sr. No. : 1173995
WATTMETER Sr. No. : BB71634
WATTMETER Sr. No. : BB71635

TESTED BY : RGG/RBS/KMRr
DATE : 19/4/97
SHIFT : I

R. Kamat 19/4/97

WITNESSED BY ____ 19-4-1997

PAGE 5 OF 6

W/Q/133/01/MO5(0195)

CROMPTON GREAVES LIMITED
LARGE MACHINES DIVISION

INDUCTION MOTOR
MEASUREMENT OF RESISTANCE
(As Per IS 325 : 1978)

M/C NO. : NVUW ~~796042~~/3
FRAME : NVUW 710

CUSTOMER : M/S WGJR Eng. VOLTS : 6600 AMPS : 227 HP/KW 2680/2000 R.P.M. : 593 INS. CLASS : F/B

COLD RESISTANCE Amb (t_c) 28.5 degrees C

STATOR
R - Y 0.2720 OHMS
Y - B 0.2722 OHMS
B - R 0.2720 OHMS
DESIGN @ 20 deg. C ______ OHMS

ROTOR
1 - 2 : ______ OHMS
2 - 3 : ______ OHMS
3 - 1 : ______ OHMS

THERMISTOR RESISTANCE
1. ______ OHMS
2. ______ OHMS

SPACE HEATER RESISTANCE ______ OHMS
______ OHMS

R.T.D. COLD RESISTANCE (OHMS)
WINDING

1.	113.3	7.	113.2
2.	113.2	8.	113.3
3.	113.2	9.	113.3
4.	113.2	10	
5	113.1	11.	
6.	113.1	12.	

BEARING R.T.D
DE . 1. ______ 2. ______
O.D.E. 1 ______ 2. ______

BEARING B.T.D
D.E. ______ degree C
O.D.E ______ degree C

HOT RESISTANCE Amb (t_h) ______ degrees C

STATOR TIME
R - Y : ______ OHMS ______
______ OHMS ______
______ OHMS ______
______ OHMS ______
______ OHMS ______
Y - B ______ OHMS ______
B - R ______ OHMS ______

ROTOR TIME
1 - 2 ______ OHMS ______ TEMP. RISE
______ OHMS ______ (TESTED)
______ OHMS ______ STATOR : ______
______ OHMS ______ ROTOR : ______
______ OHMS ______
(ALLOWED)
2 - 3 ______ OHMS ______ STATOR : ______
3 - 4 ______ OHMS ______ ROTOR : ______

TEMP RISE $T = \left[\frac{R\ hot}{R\ cold} (235 + t_c) \right] - (235 + t_h)$

METER Sr. No. : 10308

TESTED BY : RSS/RGG/Kumr
DATE : 19/4/97
SHIFT : I

WITNESSED BY : [signature] 19-4-1997

[signature] 19/4/97

PAGE 6 OF 6

W/Q/133/01/M07 (0195)

CROMPTON GREAVES LIMITED
MACHINE 2 DIVISION

INDUCTION MOTOR
TEMPERATURE RISE TEST
[As per IS 325 : 1978; JEC 37 : 1979]

M/C NO. : 6042/3

CUSTOMER : M/S WEIR Engg VOLTS : 6600 AMPS : 227 HP/KW : 2680/2000 R.P.M. 593

FRAME : NVVW 710 INS. CLASS F/B ROTATION FROM DE ANCL/~~CLKW~~

TIME	VOLTS M.F. = V1	V2	V3	AMPS M.F. = I1	I2	I3	WATTS : M.F. = W1	W2	W1+W2	Hz	RT Hz	AMB	INT. AIR RTD/deg. C IN	OUT	IN	EXT. AIR RTD/deg. C IN	OUT	FRAME RTD/ deg. C
	Time in Sec	RPM		Time in Sec	RPM		Time in Sec	RPM		Time in Sec	RPM		Time in Sec.	RPM		Time in Sec.	RPM	
Start→	0	717		110	488		210	385		310	311		410	259		510	215	
	10	694		120	483		220	378		320	305		420	252		520	213	
	20	664		130	468		230	368		330	301		430	249		530	208	
	30	638		140	462		240	360		340	294		440	245		540	204	
	40	615		150	445		250	354		350	290		450	240		550	204	
	50	593		160	429		260	346		360	280		460	236		560	199	
	60	574		170	422		270	341		370	281		470	232		570	195	
	70	554		180	416		280	330		380	272		480	228		580	194	
	80	539		190	403		290	325		390	270		490	222		590	186	
	90	523		200	394		300	321		400	266		500	216		600	186	
	100	507														610	179	
																620	179	

Retardation Test

VOLTMETER Sr. No. :
AMMETER Sr. No. :
WATTMETER Sr. No. :
WATTMETER Sr. No. :

TESTED BY : NDV/SGP/RAS
DATE : 21/4/97
SHIFT : I

WITNESSED BY

PAGE 1 OF 1

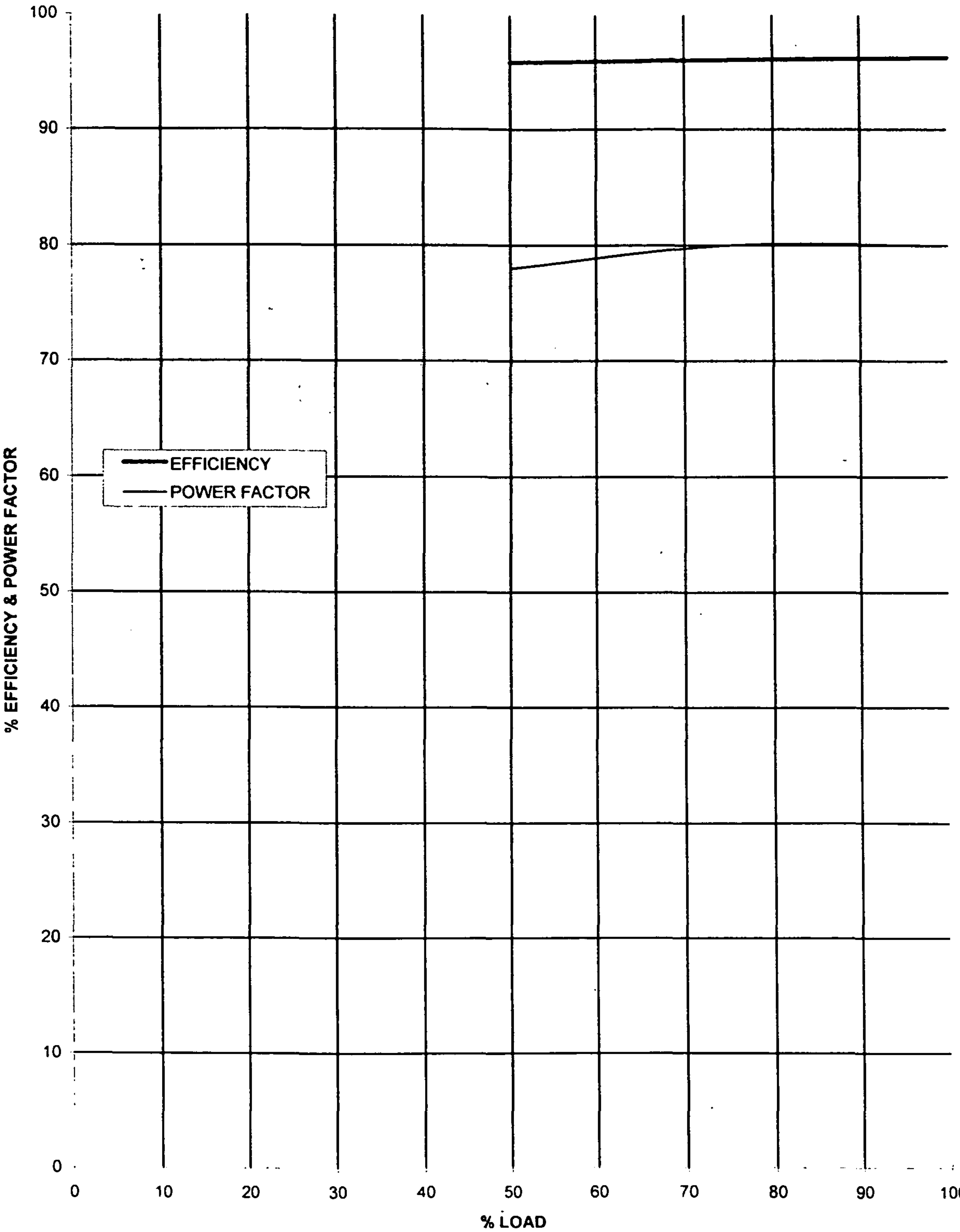
WI/Q/133/01/M05(0195)

DRG. NO.- PERF- 96042

Crompton Greaves
LM DIVISION KANJUR MUMBAI

PERFORMANCE CHARACTERISTICS

CUSTOMER : M/s WEIR ENGINEERING
WORKS ORDER NO. : 96042
kW : 2000 POLES : 10 VOLTS : 6600



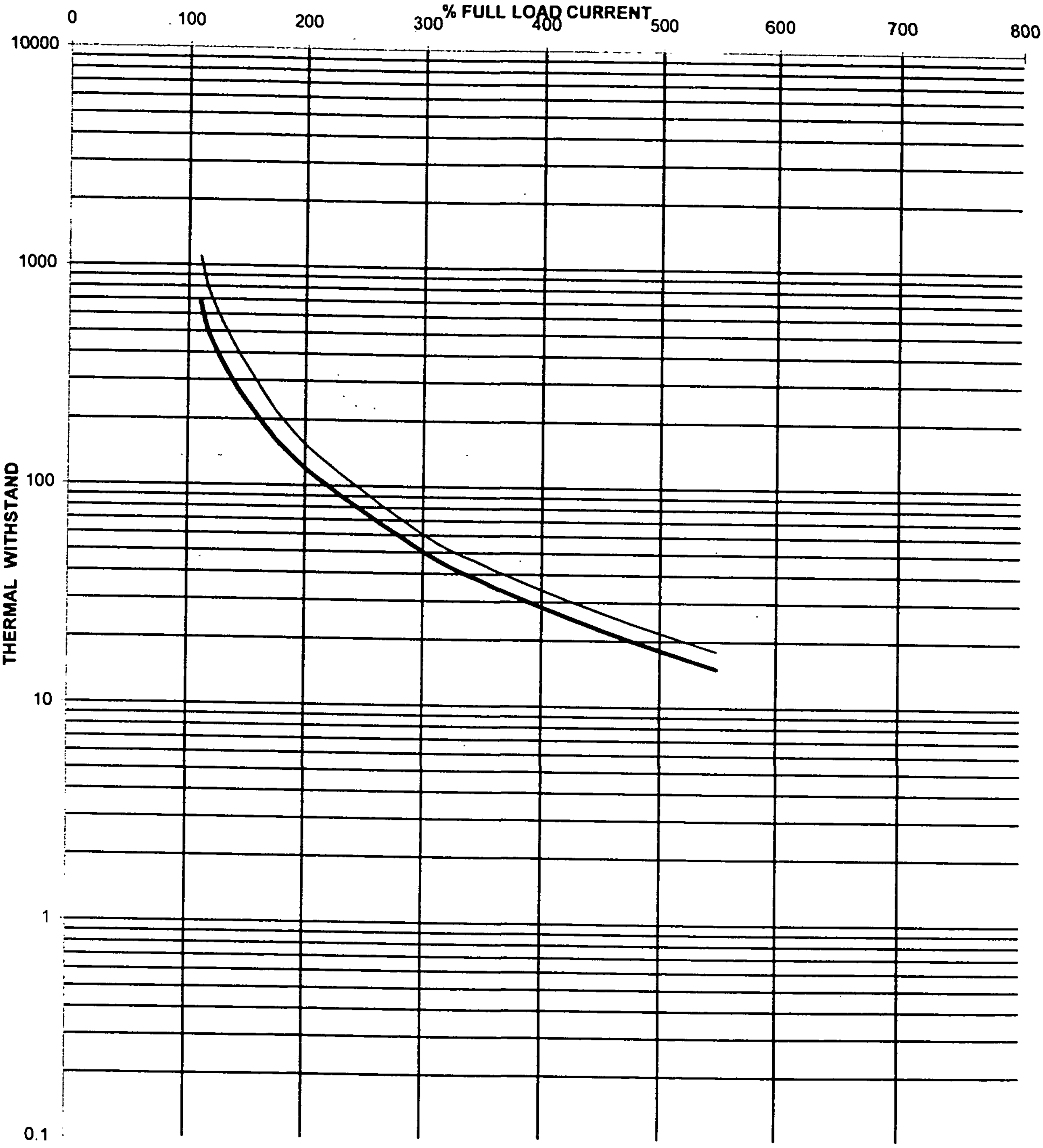
NO	REVISION	SIGN		SIGN	DATE
2			PREP	[signature]	25/9/98
1			APPD		

DRG. NO.- TWT-15/18 - 550 / 96042

Crompton Greaves
LM DIVISION KANJUR MUMBAI

THERMAL WITHSTAND CHARACTERISTICS

CUSTOMER : M/s WEIR ENGINEERING
WORKS ORDER NO. : 96042
kW : 2000 POLES : 10 VOLTS : 6600



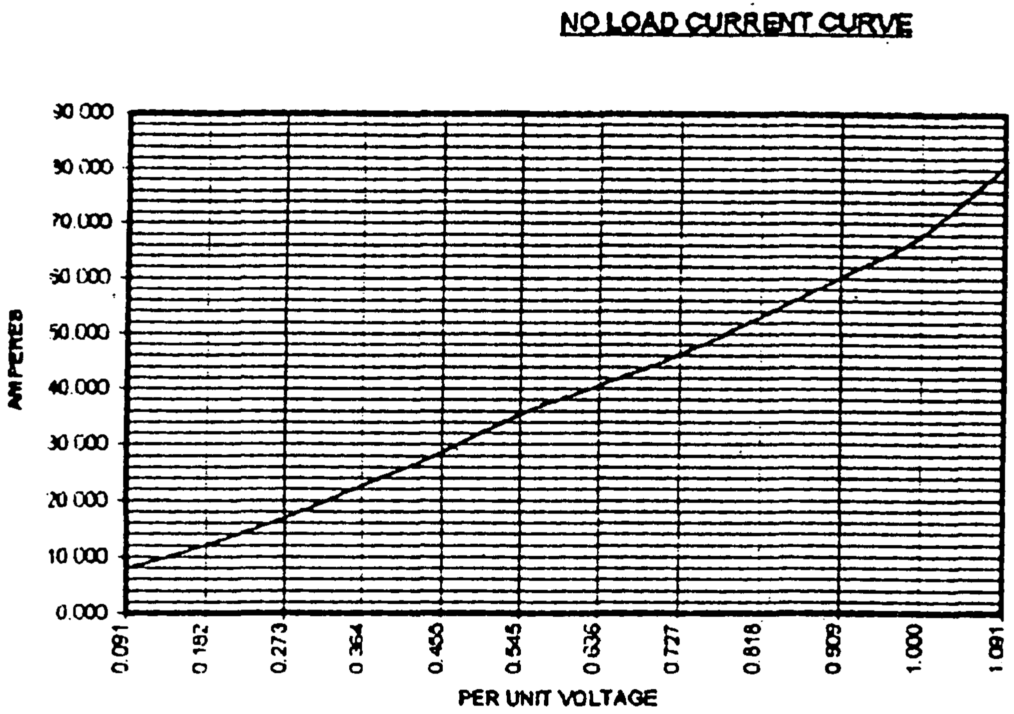
LOCKED ROTOR CURRENT : 550 %FLC

THERMAL WITHSTAND TIME
AT RATED VOLTAGE HOT : 15 SECS
COLD : 18 SECS

NO	REVISION	SIGN		SIGN	DATE
2			PREP	Suruti	25/9/98
1			APPD		

CUSTOMER: WEIR ENGINEERING **MACHINE No.:** NVUW 796042/3

PUV	0.091	0.182	0.273	0.364	0.455	0.545	0.636	0.727	0.818	0.909	1.000	1.091
AMPS	8.000	12.133	16.933	22.800	28.667	35.467	40.867	46.267	53.060	60.267	68.133	81.2



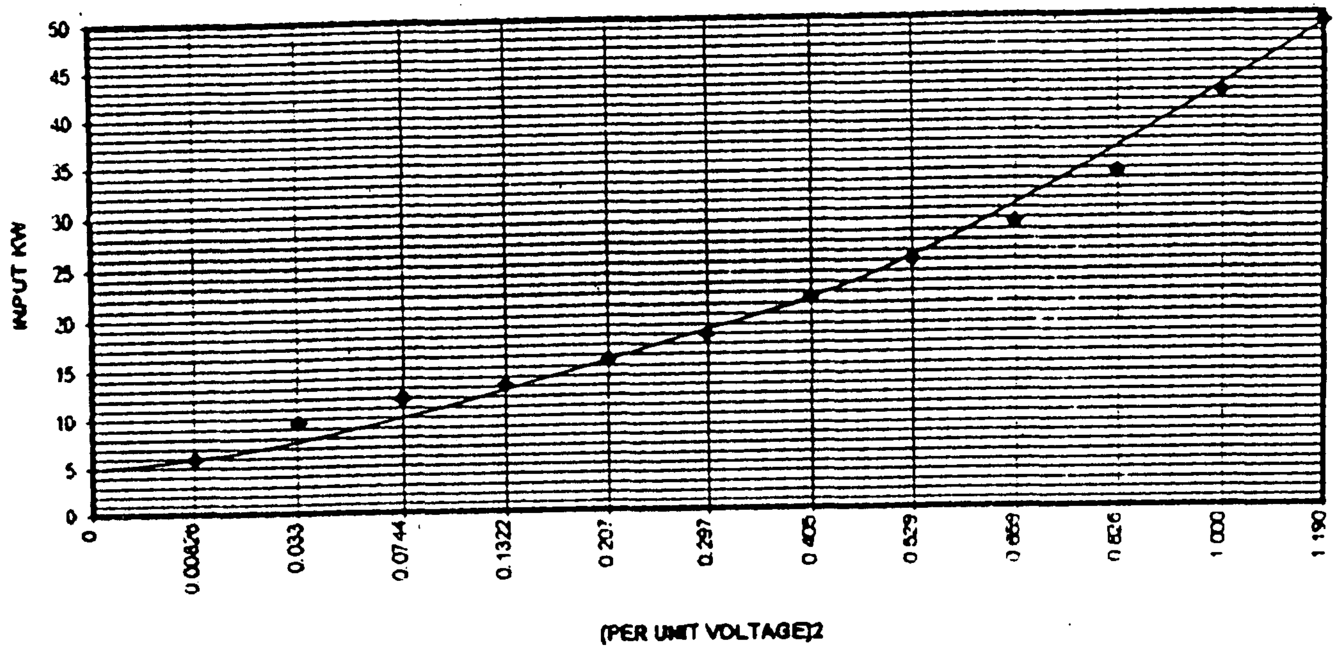
STATOR RESISTANCE PER PAHSE @ 75 deg C = 0.1600 OHMS
NO LOAD CURRENT AT RATED VOLTAGE = 68.13 AMPS
[illegible]

CUSTOMER: WEIR ENGINEERING

MACHINE No.: NVUW 796042/3

(PUV)2	0	0.00826	0.033	0.0744	0.1322	0.207	0.297	0.405	0.529	0.669	0.826	1.000	1.190
KW		6.00	9.60	12.00	13.20	15.60	18.00	21.60	25.20	28.80	33.60	42.00	49.20

NO LOAD INPUT CURVE



TOTAL NO LOAD INPUT = 42.00 KW
FRICTION + WINDAGE LOSS = 5.00 KW
NO LOAD COPPER LOSS = 2.23 KW
NO LOAD IRON LOSS = 34.77 KW

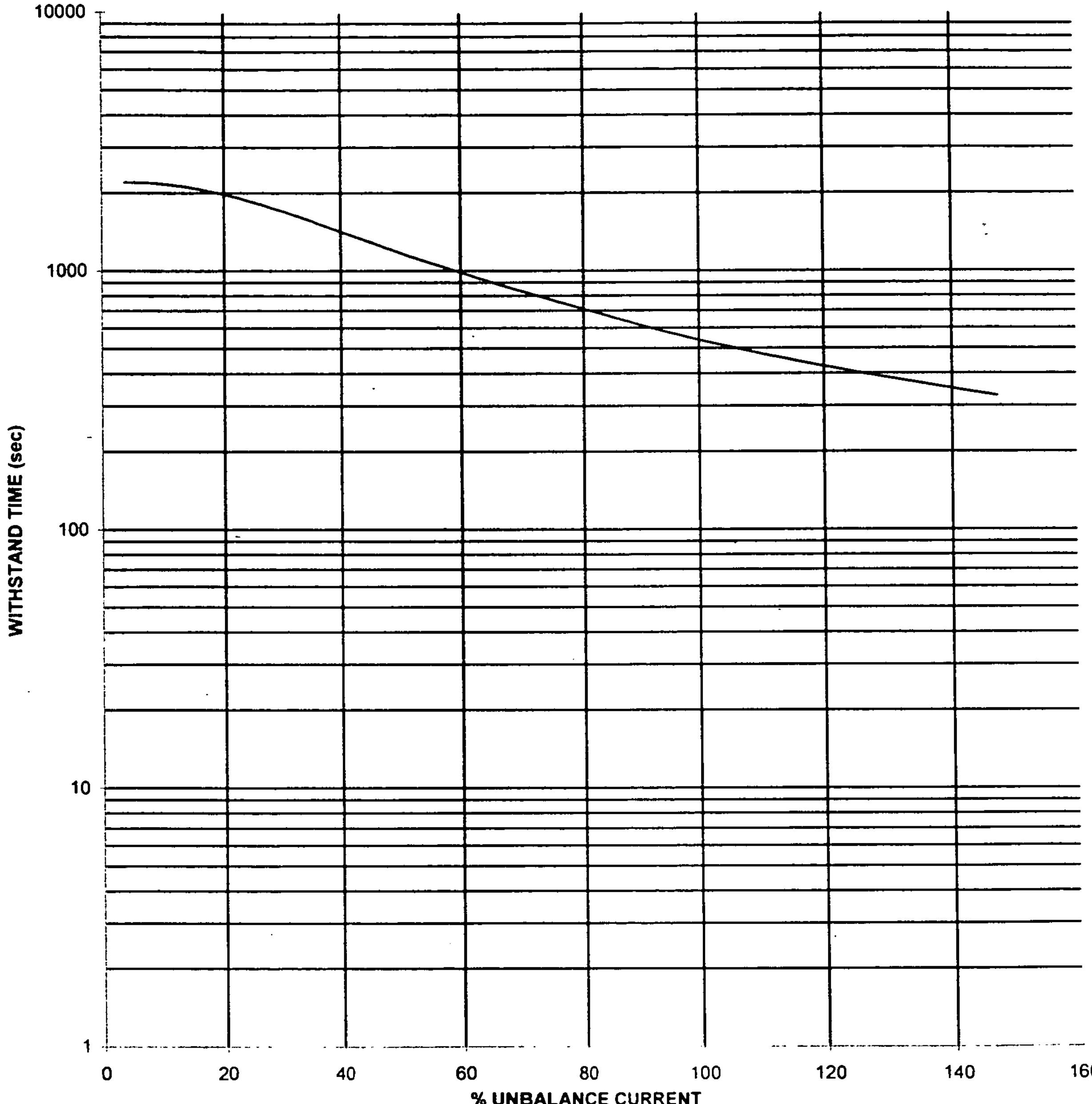
19/4/97

DRG. NO.- NEG -96042

Crompton Greaves

NEGATIVE SEQUENCE CHARACTERISTICS

CUSTOMER : M/s WEIR ENGINEERING
WORKS ORDER NO. : 96042
kW : 2000 POLE : 10 VOLTS : 6600



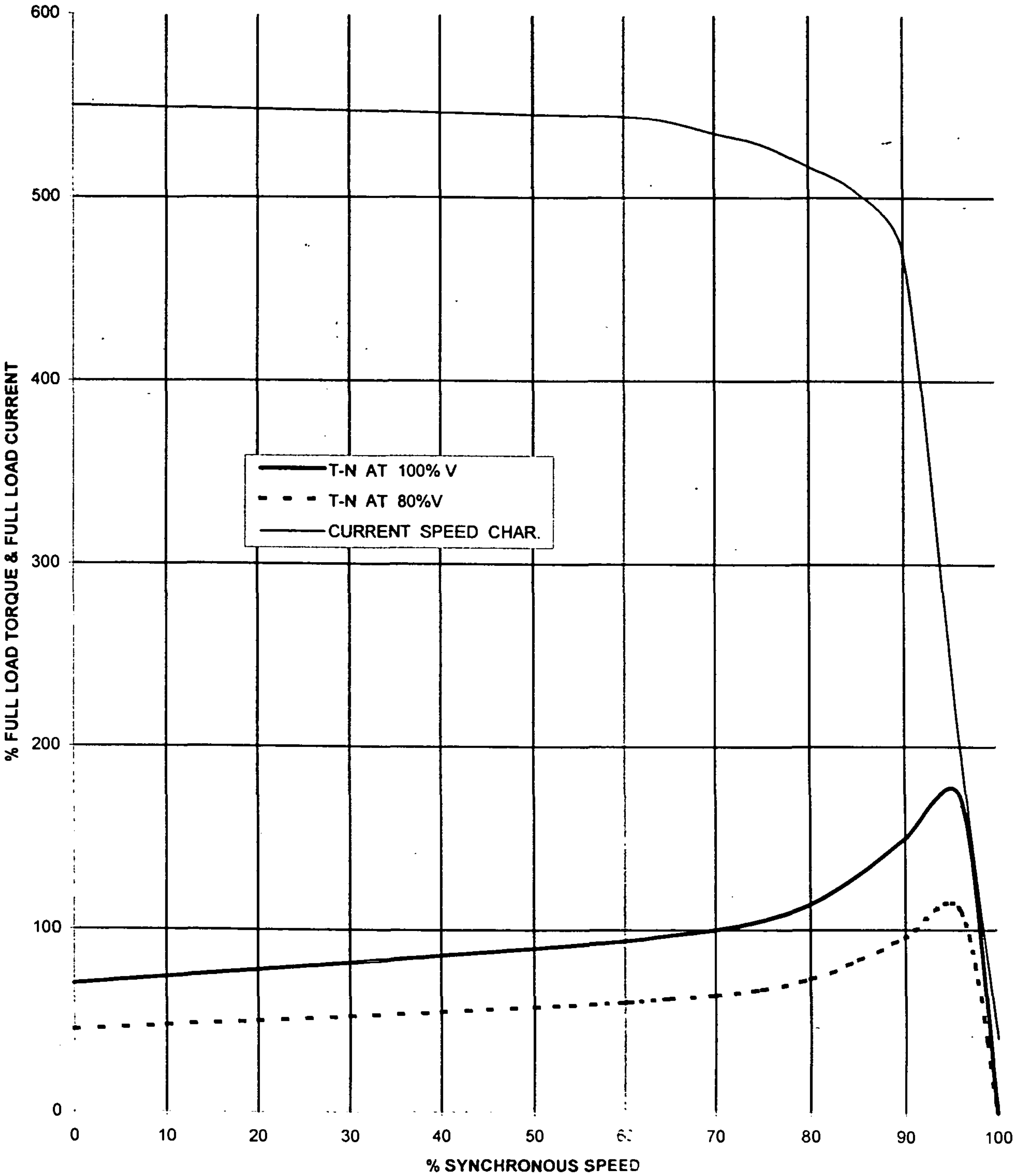
NO	REVISION	SIGN		SIGN	DATE
2			PREP	[signature]	25/9/98
1			APPD		

DRG. NO.- TN-70.175.550 / 96042

Crompton Greaves
LM DIVISION KANJUR MUMBAI

TORQUE SPEED CHARACTERISTICS

CUSTOMER : M/s WEIR ENGINEERING
W.O. NO. : 96042
kW : 2000 POLES : 10 VOLTS : 6600



NO	REVISION	SIGN		SIGN	DATE
2			PREP	[signature]	25/9/98
1			APPD		

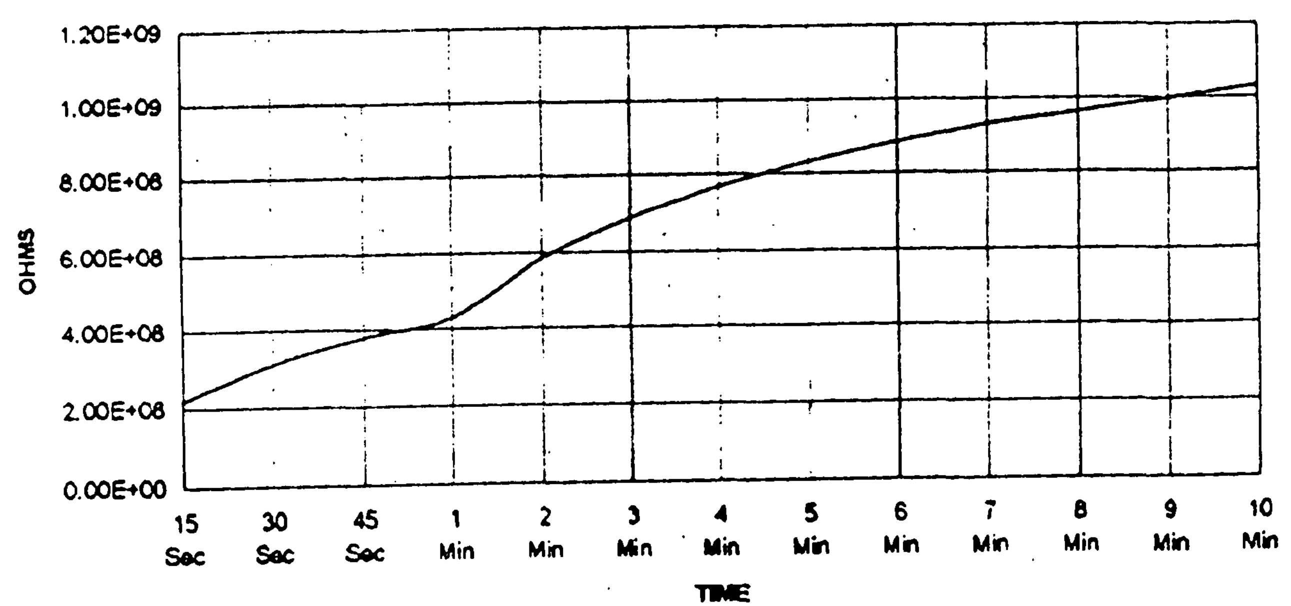
CUSTOMER : WEIR ENGINEERING

MACHINE NUMBER : NVUW798042/3

Type	Date	Start	Volts	15 Sec	30 Sec	45 Sec	1 Min	2 Min	3 Min	4 Min	5 Min	6 Min	7 Min	8 Min	9 Min	10 Min
PI	04/97/21	13:41	2500	2.20E+08	3.13E+08	3.79E+08	4.31E+08	5.84E+08	6.91E+08	7.68E+08	8.32E+08	8.83E+08	9.28E+08	9.64E+08	9.97E+08	1.03E+09

POLARISATION INDEX = 2.39

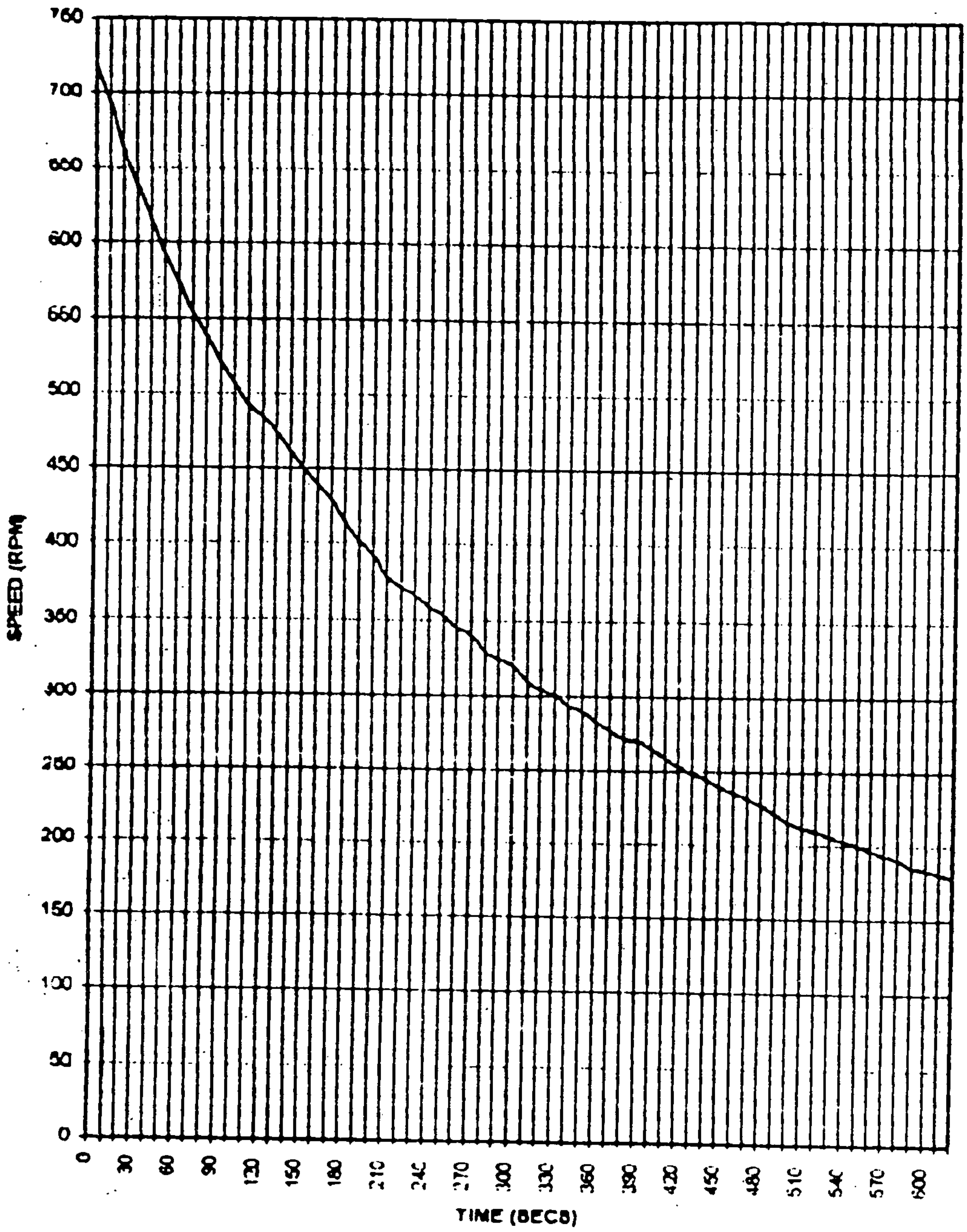
POLARISATION INDEX CURVE



21/4/97

CUSTOMER : **WEIR ENGINEERING** **MACHINE No.:** **NVUW 796042/3**

MOMENT OF INERTIA TEST



MOMENT OF INERTIA TEST

CUSTOMER **WEIR ENGINEERING** MACHINE No. **NVUW 796042/3**

TIME	RPM	TIME	RPM	TIME	RPM	TIME	RPM	TIME	RPM
0	717	130	475	260	346	390	270	520	209
10	694	140	462	270	341	400	266	530	206
20	684	150	451	280	330	410	259	540	203
30	638	160	440	290	325	420	254	550	200
40	615	170	430	300	321	430	249	560	196
50	593	180	416	310	310	440	245	570	193
60	574	190	403	320	305	450	240	580	191
70	554	200	394	330	301	460	236	590	188
80	539	210	380	340	294	470	232	600	184
90	521	220	373	350	290	480	228	610	181
100	507	230	368	360	283	490	222	620	179
110	492	240	360	370	278	500	216		
120	485	250	354	380	272	510	212		

CALCULATION OF MOMENT OF INERTIA

$$GD^2 = \frac{365000\,\Delta P}{N\,(dN/dt)}$$

where

$GD^2/4$ = moment of inertia kg m²

ΔP - Friction and windage loss at rated speed.

N - Rated speed in rev/min.

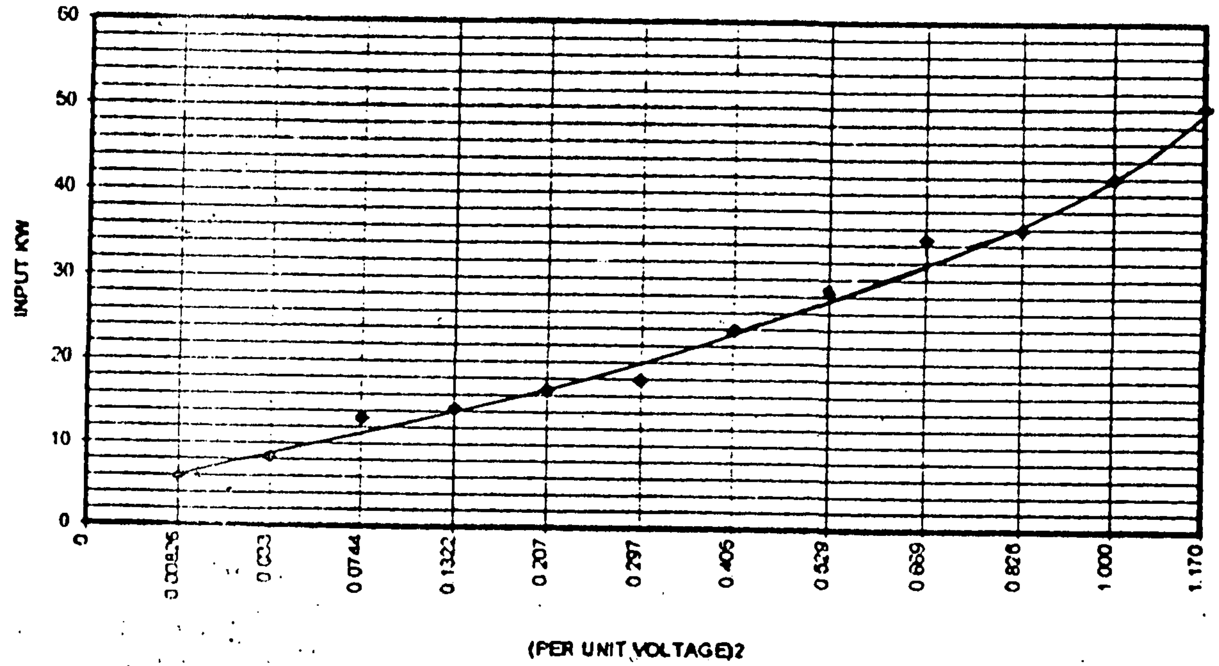
dN/dt Retardation / sec as determined from the slope of the speed - time graph at rated speed.

$$GD^2 = \frac{365000 * 5.0}{600 * 2.5} = 304.16\ \text{kg m}^2$$

CUSTOMER : WEIR ENGINEERING   **MACHINE No.:** NVUW 796042/2

(PUV)2	0	0.0083	0.033	0.0744	0.1322	0.207	0.297	0.405	0.529	0.669	0.826	1.000	1.170
KW		6.00	8.40	13.20	14.40	16.80	18.00	24.00	28.80	34.80	36.00	42.00	50.40

NO LOAD INPUT CURVE



TOTAL NO LOAD INPUT	=	42.00 KW
FRICTION + WINDAGE LOSS	=	5.00 KW
NO LOAD COPPER LOSS	=	2.26 KW
NO LOAD IRON LOSS	=	34.74 KW

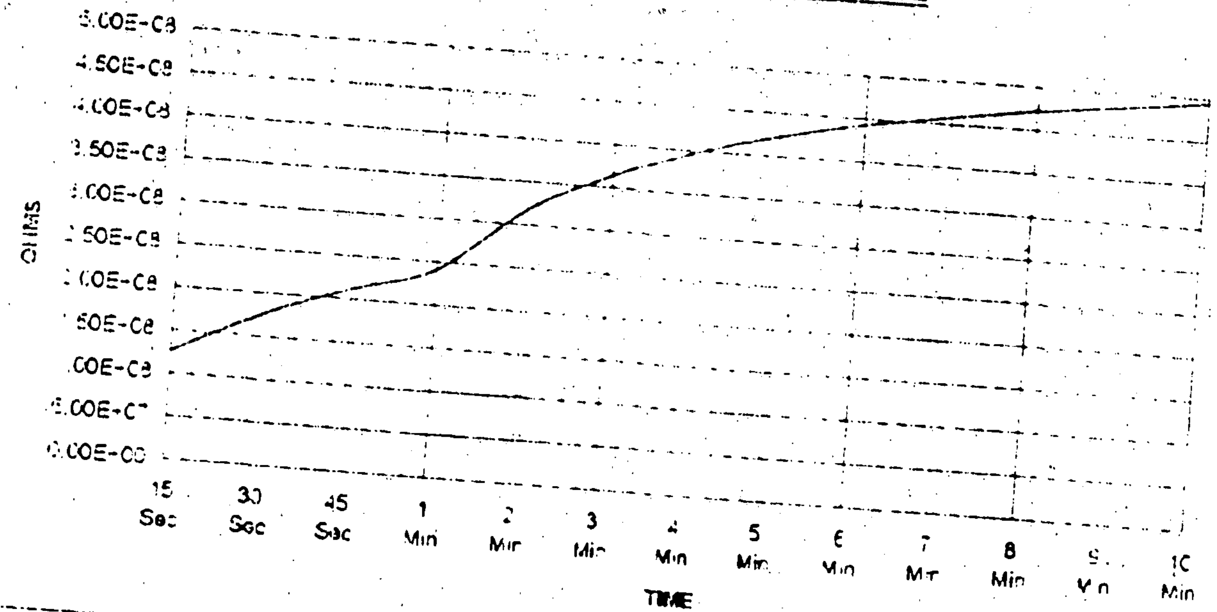
CUSTOMER : WEIR ENGINEERING

MACHINE NUMBER NVUW786042/2

Type	Date	Start	Volts	15 Sec	30 Sec	45 Sec	1 Min	2 Min	3 Min	4 Min	5 Min	[illegible]	7 Min	8 Min	9 Min	10 Min
PI	03/97/29	21 11	2500	1.26E+08	1.76E+08	2.12E+08	2.42E+08	3.18E+08	3.65E+08	3.98E+08	4.25E+08	[illegible]	4.59E+08	4.72E+08	4.84E+08	4.95E+08

POLARISATION INDEX = 2.05

POLARISATION INDEX CURVE



Section 5 Start up and Shutdown Procedures

This Section is not applicable to the High Voltage Induction Motor. The start up and shutdown procedures for the pumping system are included in Volume 2.

Section 6 Commissioning

A detailed Inspection and Test Plan (ITP) has been prepared for the on site pre-commissioning and commissioning of the pump system. The ITP together with all of the relevant testing data has been included in Volume 3.

7.4 Recommended Settings

Following table provides typical setting values for various detectors of motor.

No	Description	Recommended Setting Point ALARM	TRIP
1.	Temperature detector for winding • Class B rise	 130^{0}C	 140^{0}C
2.	Temperature Detector for Bearing • With grease lubricated	 80^{0}C	 90^{0}C
3.	Flow Detector Of cooling water • High point • Low point	 110% 80% (of nominal flow)	 120% 60%
4.	Pressure Detector of cooling water • High point • Low point	 110% 80% (of nominal pressure)	 120% 60%

Section 7 Operations

7.1 Introduction

A well-designed and good quality product is ultimately judged by its performance in the field. It has often been observed that malfunction or failure of equipment occurs due to overlooking of some extraneous factors related to the handling of the equipment. Due attention must be therefore paid to such related factors in order to obtain the desired trouble free performance from the equipment.

7.2 Direction of Rotation and its Reversal

The specified direction of rotation for the motors is marked on a plate fitted to the motor endshields. The motor is designed for unidirectional rotation should not be run in a direction opposite to that indicated on the motor, as they are fitted with curved bladed cooling fans. Rotation in the opposite direction will impair the cooling and is detrimental to the motor.

7.3 Checks During Operation

Regular monitoring of the motor is a prerequisite if potential problems are to be detected in time to avoid damage. It is therefore recommended that following parameters and states of motor are checked regularly during operation.

Stator:	Winding temperature, inlet and outlet air temperature.
Heat Exchanger:	Cooling water inlet and outlet temperature, any leakage of cooling water in the frame.
Bearings:	Bearings temperature, circulating water pressure and flow rate, oil level in housing, grease quantity and condition, bearing assembly tightness, running smoothness.

Section 8 Maintenance

8.1 Introduction

A carefully planned program of inspection and maintenance will result in minimum downtime and lower maintenance costs. The frequency with which maintenance is required depends to a large extent upon the site conditions.

A recommended schedule for periodical checks and maintenance of motor is given below.

- Routine inspection - to inspect for any abnormalities.
- Monthly inspections - to inspect, clean and attend without dismantling.
- Yearly inspections - to inspect, clean and attend by dismantling.

8.2 Mechanical Maintenance

8.2.1 Cleanliness

Both the interior and exterior of the motor should be kept free from dust, oil or grease and moisture by cleaning at intervals of one to three months (depending on the site conditions.) It is recommended to blow out of the dust, dirt, etc. with a jet of dry clean air and to wipe away any deposits of grease and carbon dust with a clean dry cloth.

8.2.2 Bearing and Lubrication

Grease lubricated ball and roller bearings are charged with right quality and quantity of the grease at the time of dispatch and will run for a long period without much attention. Although, the interval between regreasing depends on many factors such as bearing type, size, temperature, condition on the installation, driven equipment etc. This interval generally varies over a wide range from hundreds to thousand of hours. High speed or large size motors require more frequent lubrication than slow speed or smaller motors. The regreasing interval and type of grease is indicated on the motor rating plate.

When the bearings are opened for inspection or to change the caked grease, bearing covers, housing and other surrounding parts should be thoroughly cleaned to prevent entry of dirt into bearings. Hands must be perfectly clean and smeared with a good quality mineral oil before handling the bearing. The bearing housing and covers should be placed on clean table and properly covered as long as these are out. Old grease should be wiped from the bearing, housing and covers. The bearing should be washed out in a bath of clean petrol to which a small amount of lubricating oil has been added.

This motor is provided with a grease relief arrangement. Old grease is pushed out when the bearings are charged with new grease during operation. Excessive grease is also thrown out and these bearings cannot be over greased.

When replacing ball or roller bearings, it is necessary to measure the diameter of the shaft, inside diameter of the bearing housing and bearing to make certain that the fit and perpendicularity are correct. The inner ring of the bearing may now be fitted over the shaft by heating the bearing in a mineral oil to a temperature not exceeding 100^0C to enable easy mounting. The bearing temperature and bearing noise can give a fairly good idea of the condition of the bearing. Grease is suitable for the operation at temperatures below 100^0C. Any bearing with the temperature higher than 90^0C should be examined immediately. The possible causes are insufficient quantity of grease, defective bearing or faulty assembly.

Bearing noise can be checked using a large screw driver held to the ear with its tip resting on bearing cover or housing. Monitoring of bearing condition can be done with the help of a Shock Pulse Meter.

Bearing Housing on NDE Side in insulated type. Whenever the motor is dismantled, the bearing insulation should be checked with 500 V megger.

8.2.3 Vibration

Any excessive noise or vibration should be investigated immediately. The possible causes are change in balance due to wear or dust deposit, possible incipient bearing or rotor failure or change in alignment.

8.2.4 Overhauling – Dismantling and Reassembly

When it is intended to overhaul the motor, the following procedure should be followed. A complete overhaul of the motor is recommended every two to five years depending on the site conditions.

a) Dismantling

Reference should be made to sectional layout drawing No 3J32004.

This procedure is to be followed when the motor is to be taken out of pump well for any major repair. The sequence for dismantling the motor is given below:

- Isolate the motor supply, disconnect cable at the terminal box, remove connection to space heater, vibration pick-ups, moisture detector, pulse generator with its stand.
- Uncouple the motor from the pump
- Stop water supply to heat exchanger. Remove water pipes connected to heat exchanger. Mark heat exchanger position so that heat exchanger is refitted at the original place. Support heat exchanger by an overhead crane. Remove its fixing screws and remove both heat exchangers.
- Unbolt the motor from the foundation. Lift the motor and transfer it to the maintenance workshop / repair shop.
- Remove half coupling fitted on the shaft.
- Motor can be dismantled either in the vertical or horizontal position. This will depend on handling facilities and space constraints.

a) Dismantling procedure (motor in vertical position)

- Fit 2 eyebolts on NDE endshield for which 2 tapped holes are provided.
- Support NDE endshield with the crane at these two eye bolts.
- Remove fixing bolts between NDE endshield and stator at NDE. Jack the NDE endshield out of stator spigot.
- Lift the rotor slowly with NDE endshield till it comes out fully from the stator.
- Make the vertical rotor horizontal with the other crane and rest it on wooden logs/support.

Caution: - Do not try to lift the rotor by fitment of eyebolt on the tapped hole at the shaft centre at NDE of shaft.

8.3 Electrical Maintenance

8.3.1 Connections

All electrical connections must be kept tight and clean. The motor should be stopped and isolated from the supply before opening any terminal boxes. The earthing conductor should be regularly inspected and checked for continuity.

8.3.2 Insulation Resistance

The insulation resistance of the stator winding should be checked regularly preferably at twelve months intervals between respective terminals and the frame.

8.3.3 Polarisation Index

The polarisation index of a winding is defined as the ratio of the insulation resistance after 10 minutes (R 10) to the insulation resistance after one-minute (R1).

i.e. Polarisation Index P.I = R10 / R1

On a clean dry winding the Polarisation Index value should not be less than 1.5. The winding should be checked at regular intervals, preferably when the Insulation Resistance check is carried out.

8.3.4 Drying Out

When the result of the insulation resistance and polarisation index tests indicate that a dry out is necessary, the moisture should be removed as per the methods detailed in Section 4.

8.3.5 Insulation Resistance of Auxiliary Circuits

The insulation resistance of all auxiliary circuits such as the temperature detectors, bearing temperature detectors, space heater etc. must be measured with a 500-volt megger at regular intervals.

a) Dismantling procedure (motor in horizontal position)

- Make the motor horizontal with help of two cranes of 10 Ton capacity each.
- Keep the motor in horizontal condition with one of the heat exchanger fixing side downward.
- Remove grease inlet and outlet pipes.
- Remove DE endshield fixing screws between stator and endshield.
- Then remove screws between endshield and bearing housing and remove endshields.
- Support the shaft with the help of a crane until the endshield comes out of the stator spigot. For jacking of endshield from the spigot, tapped holes are provided on the endshield on respective PCD. Two of the existing fixing screws can be used for jacking.
- Remove end cap fitted over shaft face at NDE.
- Fit eye bolt on the tapped hole at the shaft centre. Support the rotor at NDE by crane hook attached to this eye bolt.
- Unscrew fixing bolts between NDE endshield and stator. Jack the endshield out of stator spigot through tapped jacking holes (2 Nos.) provided on endshield on PCD of fixing holes.
- Insert a minimum 2.5 meter long hollow pipe of 175 mm inside diameter. Over the shaft extension covering its full length to support the rotor while sliding out of stator bore.
- Lift rotor both DE & NDE side by 1 to 1.5 mm. simultaneously.
- Slide out rotor from stator core with NDE endshield by parallel syneronus operation of both the cranes.
- Provide suitable support of thick wooden logs to resting the rotor. Remove hollow pipe.
- Carry out visual inspection of stator & rotor. Static tests such as measurement of insulation resistance, polarisation index etc. can be carried out.

a) Re-Assembly

For re-assembly, the procedure is practically the reverse of that followed for dismantling. Ensure that all the mating surfaces are properly sealed with sealing compound and gaskets provided where required.

8.4.3 Transportation

When the motors are transported for any reason, ensure that the shaft locking arrangement used at the time of shipment from the factory is properly attached to the motor. For the information concerning the method of attachment and the tightening pressure, refer to enclosed drawing No. 4J27018.

Upon receipt of the motors, check if the metal clamps are properly attached. Do not dispense with the shaft-locking device, as it may be required at a later date if the motor is to be moved or it is to be taken out of service and stored for any length of time.

8.4.4 Construction

The general arrangement of the bearing assembly are shown in Drawing No 3J27081 for drive end and Drawing No 3J27080 for non-drive end. The construction materials are listed on these drawings.

8.4.5 Mounting and Dismounting of Bearing Assembly

This section deals with the mounting instructions for bearing assembly and should be read in conjunction with the motor assembly procedure.

a) Prior to Mounting

- The mounting site must be clean and dry.
- Carefully clean all mating parts - bearing house, bearing cover, inner and outer collars and liner - the parts must be free of metallic, chips, dirt, dust and any other foreign matters.
- Check seats for the rolling bearings, inner collar and outer collar on the shaft for any damage. Ensure edges are burr-free.
- Unpack bearing only when actual needed. Check whether the designation on the bearing and the packing are identical and correspond to the data indicated on the drawing and motor nameplate. The factory-packed rolling bearings are protected by a corrosion preservative which, as a rule, need not be washed out.

a) Mounting of the rolling bearings on Driving End

Reference should be made to Drawing No 3J27081.

- For this procedure the rotor should be kept in horizontal position without the stator and be well supported.

8.4 Roller Bearings

8.4.1 Drive End Bearing Data

Position:	Bottom (DE Side).
Type:	Cylindrical Roller Bearing.
Designation:	NU 240 ECMP/ C3
Make:	FAG (GERMANY)
Lubrication:	Grease lubricated
Lubricant:	Lithium base grease of NLGI No. 3 consistency and minimum drop point of 180^0 C.
Recommended Lubricants:	Servogem 3 grease of Indian Oil or equivalent.
Initial quantity:	2100 Grams.
Lubrication interval:	5 Months.
Replenishment quantity:	250 Grams.
Cooling method:	Natural cooling.

8.4.2 Non Drive End Bearing Data

Position:	Top (NDE side).
Type:	Angular Contact Bearing
Designation:	2 X 7334 BCB
Make:	SKF
Lubrication:	Grease Lubricated
Lubricant:	Lithium base grease of NLGI No. 3 consistency and minimum drop point of 180^0 C
Recommended lubricant:	Servogem 3 grease of Indian Oil or equivalent
Initial quantity:	5000 gms
Lubrication interval:	5 months
Replenishment:	500 gms
Cooling method:	Natural cooling.

- After tightening the inner lock nut, while the bearings are still hot, immediately after insertion of both the bearings, it is important to fit the lock washer (item no. 15) before tightening the outer nut.
- After fully tightening the outer nut, it is important to fold the tooth of the lock washer into the slot of outer nut.

a) Dismounting

For this procedure the rotor should be taken out along with bottom bearing assembly and kept well supported in horizontal position.

- Remove bearing RTD and vibration monitor.
- Remove grease inlet and outlet pipes.
- Unscrew bearing cover and take it out.
- Take out bearing house along with outer race and rollers.
- Take out outer race and rollers from bearing house, by jacking.
- Unscrew and take out the outer collar.
- Take out inner race and inner collar by a puller. Heat slightly, if necessary.

8.4.1 Putting into Service

Before starting check whether all accessory parts such as grease nipple, seals, etc. are placed and fixed as specified. The running noise of the bearings should carefully be monitored.

Start the motor slowly. During the first operating hours the temperature and the running noise of the bearings should carefully be monitored.

8.4.2 Operation and Inspection

Before operating the machine, the bearings should be greased if:

- The machine has been stored for over three months without operation.
- The machine has been exposed to such abnormal heat which causes the temperature of the bearing to exceed 70^0 C.
- The machine has been stored for over one month at a place where the temperature is abnormally high with a high relative humidity.

- To prevent tribocorrosion apply a very thin coating of Molykote G-n paste or a similar agent to all shaft seats. The bright metallic surfaces should appear dull.
- Heat inner collar on a heating plate or in a hot air furnace to approximately 100^0 C, push it on the shaft until it abuts the shaft shoulder and keep it in positive contact until the tight fit is established.
- Heat inner race of cylindrical roller bearing to approximately 80^0 C push it on the shaft until it abuts mating part keep it in positive contact until the tight fit is established.
- Push on outer collar and fix it in position by grub screw (M 8 x 16). Use Loctite 242 e for screw fixing.
- Screw bearing house flange to the DE endshield.
- Now screw DE endshield with bearing housing to the stator frame. While fixing, ensure grease inlet and outlet openings are positioned towards neutral terminal box side.
- Put recommended grease on top of outer race and rollers and also grease the bearing properly.
- Push outer race and rollers into the bearing housing.
- Put liner in position on bearing cover and push it in position on bearing housing.
- Screw locking bolts into the bearing housing.
- Fix grease inlet and outer pipes in position.
- Fix bearing RTD probe in positions and complete the connections.

a) Mounting of Angular Contact Bearings on NDE Side

Reference should be made to Drawing No.3J27080.

- For this procedure the rotor should be kept in horizontal position without the stator and be well supported.
- Please note that the Bearing Housing is an insulated type
- This assembly uses matched pair of angular contact bearings and therefore both bearings need to be changed together.
- For loosening and tightening of bearing nut, (item no 14) a special hook spanner is required as specified in Section 12 (item 12.2.1)
- Generally, the mounting procedure to be followed is quite similar to the one specified for the drive end bearing.

During operation, attention must be paid not only noises but also to vibration and temperature rise. Even if the noises are somewhat louder than usual, the machine may be kept in use provided the vibration and temperature rise are normal.

The bearing temperature rises gradually with the lapse of time after commencement of operation and reaches a constant state after a certain period (which varies with machines but is usually approximately 2 to 3 hours). If there is abnormal temperature rise or if uncharacteristic noise or vibration occurs, the machine should be stopped and the cause investigated.

The following items should be investigated to locate the cause:

- Poor quality of grease.
- Excessive filling of grease.
- Insufficient filling of grease.
- Dirt mixed in grease.
- Deflection caused during mounting of bearing or assembly of machine.
- Excessively small clearance.
- Flaws in rollers, balls and races.
- Retainer noise.
- Exfoliation and biting.
- Deformation of inner and outer race.
- Improper coupling with driven machine.
- Faulty balancing.
- Elongation of shaft due to temperature rises.
- Deterioration of grease.
- Other causes.

If anything abnormal occurs during operation, it reveals itself as a remarkable temperature rise, abnormal noises or increased vibration. If the operating personnel are familiar with the normal operating condition of the machine and capable of taking appropriate measures at an early stage, serious damage or accidents can be prevented.

8.4.1 Application of Grease

The following guidelines should be followed when applying grease:

- Replenish grease while the machine is running.
- In new machines, approximately one-half to two-third of the capacity inside the bearing cover is filled with grease.
- The amount of grease for the semi pack type bearing construction should be as per the specified amount shown on name plate. Over charged grease will cause overheating of bearing.
- When replenishing grease for the sixth time, take off the bearing cover and remove the old deteriorated grease. Fill approximately one-half to two thirds of the capacity inside the outer bearing cover with new grease. This filling should be regarded as the first filling.

A suitable grease is selected in accordance with the operating condition of bearings. The details of grease recommended is as follows: -

Type:	Lithium base grease
Drop point:	Greater then 180^0 C.
Consistency:	NLGI No. 3
Work Penetration:	265 to 295

Avoid as far as possible, mixing different types of grease. If different types are mixed together, an unexpected chemical reaction may take place, thereby impairing the lubricating performance of the grease. When putting a different type of grease into use, be sure to remove the old grease completely.

8.5 Hardware List

No	Size	Qty.	Location
1.	M12 X 60	92	Heat Exchanger fixing on Stator frame.
2.	M20 X 60	8	DE Endshield fixing.
3.	M12 X 50	7	DE Bearing Housing fixing.
4.	M12 X 100	5	DE Bearing Cover fixing.
5.	M8 X 16	1	Grub Screw DE Bearing outer collar fixing.
6.	M24 X 30	2	Endshield lifting hole closing.
7.	M12 X 30	2	DE Bearing Cover fixing.
8.	M30 X 100	8	NDE Endshield fixing.
9.	M12 X 175	8	NDE Housing fixing.
10.	M12 X 30	12	NDE Housing fixing
11.	M12 X 40	4	NDE Bearing Cover fixing.
12.	M6 X 12	1	Grub Screw for NDE water thrower fixing.
13.	M8 X 20	20	T. B. Lead fixing.
14.	M8 X 20	14	T. B. Facing cover.
15.	M8 X 30	12	T. B. Bush fixing.
16.	M8 X 30	8	T. B. Diaphragm Plate fixing
17.	M8 X 25	12	T. B. Gland plate fixing.
18.	M8 X 25	14	T. B. Box fixing.
19.	M8 X 25	1	T. B. Earthing.
20.	M8 X 105	7	Cable Clamp fixing.
21.	M6 X 15	10	Cheese Head Countersunk Screws - Phase separated fixing.
22.	M6 X 20	4	Aux T. B. - fixing on frame.
23	M6 X 10	4	Aux T. B - Terminal rail fixing.
24	M6 X 16	6	Aux T. B - Lid fixing.
25	M6 X 20	6	Aux T. B - Gland plate fixing.
26	M8 X 20	4	Space Heater Box fixing.
27.	M6 X 10	2	Space Heater Box Terminal Rail fixing.
28.	M6 X 16	4	Space Heater Box - T. B. Lid fixing.
29	M8 X 16	1	Space Heater Box – Earthing pad
30.	M6 X 30	12	Star Point T. B.
31.	M8 X 25	24	Insulator fixing.

All fasteners are ISO Metric with hexagonal head unless otherwise mentioned.

8.6 Recommended Torque Values

BOLT SIZE	TORQUE (N.m.)
M6	5.0
M8	12.2
M12	42.0
M20	200.0
M24	350.0
M30	690.0

Section 9 Fault Protection and Rectification

This section includes instructions for fault analysis and trouble-shooting of large vertical induction motors.

9.1 Faults

Crompton Greaves Large Induction Motors are designed, manufactured and tested with meticulous care to ensure that they give long and trouble-free services.

With a view to facilitate in rapid diagnosis of various faults, a 'Fault Analysis Guide' showing causes and remedies of various symptoms is included in this section. Use of this guide should enable a fault to be detected in the early stages before it leads to major breakdown. Once the faults are detected, remedial measures in the fault analysis guide should be adapted.

9.2 Fault Analysis Guide

Key of Symptoms

1. Motor fails to start.
2. Motor starts but will not take load.
3. Magnetic noise.
4. Mechanical noise.
5. Vibration.
6. Frame overheating.
7. Bearing overheating.
8. Brushes or sliprings overheating,
9. Injurious sparking at brushes and burning of sliprings.
10. Low speed.
11. Rapid wear of brushes or sliprings.
12. Low power factor.
13. Tripping of protection relay at start on overcurrent.
14. Fluctuation in current on steady load

Fault Analysis Guide

SYMPTOMS	CAUSE	TEST	REMEDY
1 2 3 6 13	Wrong connection	Compare connections with wiring diagram.	Reconnect correctly.
1 2 3 6	Reversed phase after rewind	Reverse one stator phase (not the line lead) if trouble persists, restore connections before reversing next phase and so on.	
1 2 3 6	Supply failure (partial or total)	Check voltage at motor terminals.	Repair circuit, renew fuses or adjust overload trips.
1 2 6 8 9 10	Low voltage	Measure voltage at motor terminals and compare with rating plate.	Rectify cause of low supply voltage.
10 11	Low frequency	Measure frequency of supply and compare with rating plate.	Rectify cause of low supply frequency.
1	Load requires greater starting torque than that originally specified.	Measure starting torque required by load.	Reduce starting torque required or install motor with higher starting torque.
2 6 8 9 10	Motor overloaded	Measure line current and compare with rating plate.	Rectify cause of overload or install suitably rated motor.
11	Motor underloaded	Measure line current and compare with rating plate.	Install suitably rated motor.
6	Excessive ambient temperature or altitude.	Check room ambient temperature and altitude and make sure that motor was specified for the correct conditions.	Resite the motor modify the building or provide additional ventilation. Otherwise install suitably rated motor.
6	Recirculation of ventilating air.	Check whether air inlet temperature above room ambient temperature.	Erect baffles, resite motor or modify building.
4 5 7	Misalignment of thrust from drive.	Check alignment and nature of drive, with solid coupling check for end float.	Realign motor or make provision to take thrust.

2 7 10	Incorrect tension of driving belt.	Check tension with belt manufacturer's recommendation.	Adjust belt tension to the correct value.
2 8 9 10 12	Incorrect size or grade of replacement brushes.	Check size and grade of brushes fitted and compare those specified.	Fit correct replacement brushes from motor manufacturer.
1 2 3 5 6 8 9 10 12	Brushes or rings in bad condition.	Examine brushes for signs of sticking in holder, check brush pressure, inspect slipring surfaces and bedding of brushes.	Re-bed brushes, clean holders adjust brush pressure, polish or true up sliprings.
6	Restriction of ventilating paths.	Inspect all cooling-air inlets, outlets and ducts in motor.	Clean out motor.
4	Foreign matter in air gap.	Remove and frame and inspect air gap	Clean out motor.
3 4 5 6 11	Uneven air gap or rotor fouling stator.	Measure air gap at four points, turn rotor through 180^0C.and measure again. Test bearings for wear.	Replace worn bearings centralise and frame or true up rotor.
7	Incorrect grade or quantity of grease.	Remove bearings cover and inspect grade and quantity of grease.	Remove incorrect grade of surplus grease and replenish with correct quantity of recommended grease.
4 5 7	Incorrect reassembly of bearing.	Remove bearing cover and inspect assembly of bearing in housing and on shaft.	Remount bearing squarely in housing and on shaft.
4 5 7	Damaged bearing.	Remove bearing cover and inspect bearing and grease.	Fit new bearings if stationary vibration is occurring, turn rotor ¼ revolution weekly.
4 5 7	Bearing slack in housing.	Remove cover and inspect fit of outer race in housing.	Fit new bearing housing
4 5 7	Bearing rotating on shaft.	Remove bearing cover and inspect fit of inner face on shaft	Build up shaft by electro chemical deposition.
4 7	Incorrect replacement bearing.	Remove bearing cover and inspect type of bearing fitted.	Fit correct replacement bearing from motor manufacturer.
5	Faulty foundations	Check foundations are	Remake or stiffen and level

		rigid and level.	foundations.
4 5	Dynamic unbalances	Uncouple motor and run with and with out pulley to locate source of unbalance.	Balance dynamically the unbalanced component.
1 2 3 6 8 9 10	Faulty rotor winding.	On squirrel cage rotor inspect joints and bars.	Remake joints on squirrel cage rotor.
1 2 3 5 6 8 9 10	Faulty stator winding.	Check whether the line currents and phase resistances are balanced and check insulation resistance of each phase.	Repair fault or rewind stator.
13	Inadequate relay setting.	After checking connections insulation resistance as increase the setting of over current element and try to start.	Set the relay properly taking into account transient starting current, 20% is tolerance on command values and unbalance in supply voltages.

Section 10 Isolation and Restoration Procedures

This Section is not applicable. The Isolation and Restoration procedures for the power supply are not included in the scope of work.

Refer to the Brisbane City Council Isolation procedures for the HV power supply.

Section 11 List of Sub-Contractors and Proprietary Equipment

Sub-Contract suppliers of proprietary equipment include:

Pulse Generator	Emsby Equipment Pty Ltd 27 Rodwell Street Archerfield QLD Ph 07 3274 2566
RTD Temperature Sensors	Temperature Controls Pty Ltd 55 Henry Street Leichhardt NSW 2040 Ph 02 9560 0644
Moisture Sensors	NHP Electrical Engineering Products Pty Ltd 25 Turbo Drive Coorparoo QLD 4151 Ph 07 3891 6008
ELASTIMOLD Brushing	Australmold Pty Ltd 22 King Street Airport West Vic 3042 Ph 03 9338 1600

Section 12 Recommended Spares and Special Tools

12.1 Recommended Spare Parts

Item.	Description	Quantity
1	Roller Bearing NU 240 EM C3	1
2	Angular Contact Bearing 2 x 7334 BCB	1 pair
3.	Insulated Bearing Housing (NDE) to CGL drawing 3J33033	1
4.	Bearing Housing DE to CGL drawing 3J33034	1
5.	Anti - Condensation Heater 250watts / 240 V	2
6.	Bearing RTD for DE and NDE Bearing (WEIR Supply)	2
7.	Moisture Detector (WEIR Supply)	1

12.2 Special Tools

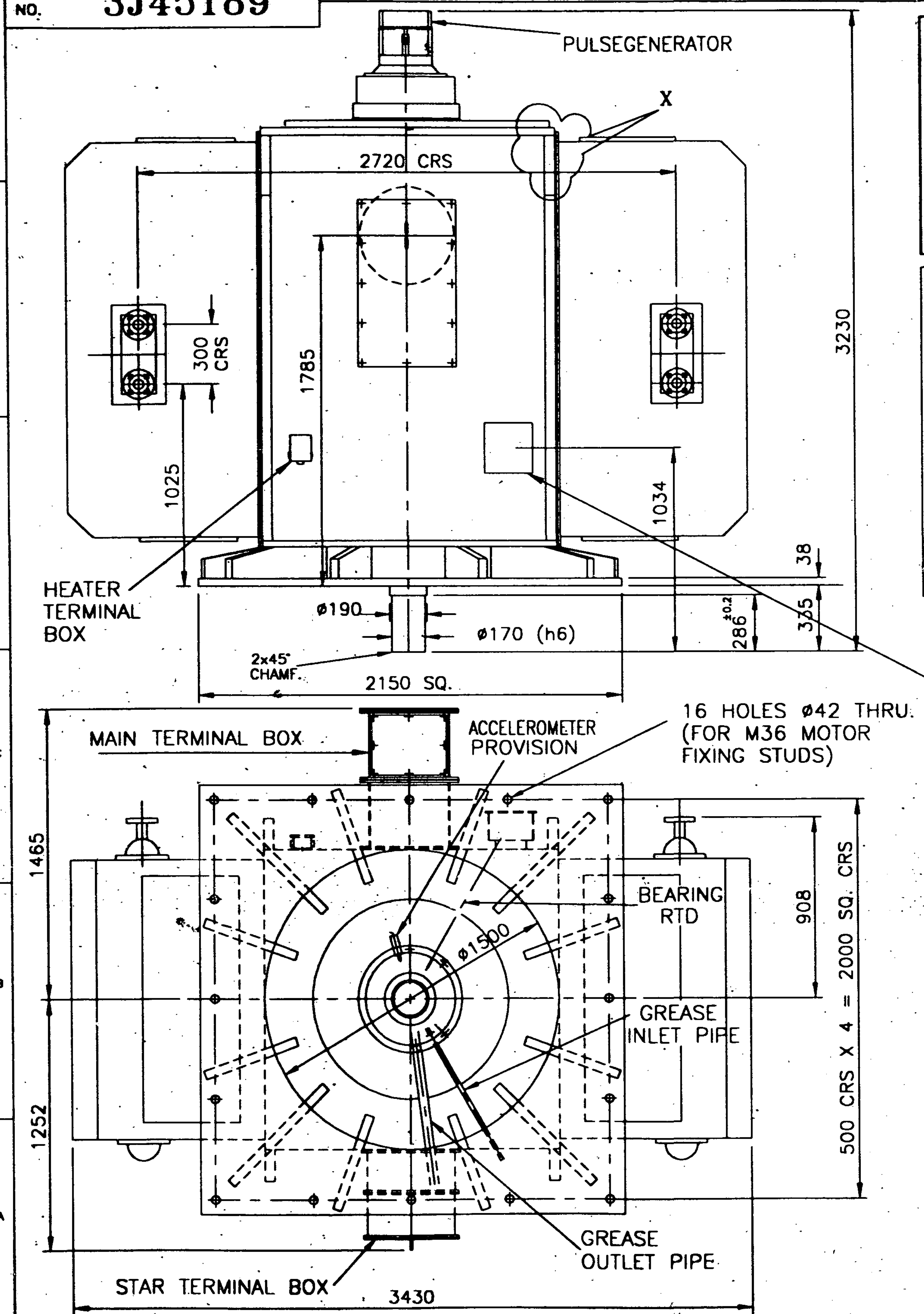
HN - 34 (SKF) Hook spanner for 7334 Bearing Nut - 1 off

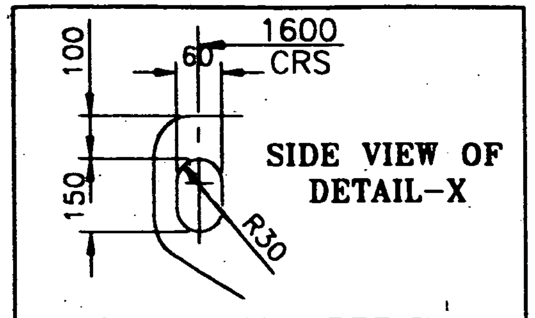
Section 13 List of Engineering Drawings

Number	Document Name	Document No.
1.	G.A. DRAWING	3J 45 189 R4
2.	SECTIONAL LAYOUT	3J 32 004 R0
3.	SHAFT EXTENSION DETAILS	4J 36 001 R0
4.	ROTOR SHAFT	3J 36 191 R1
5.	MAIN TERMINAL BOX ASSEMBLY	41 73 22 R1
6.	AUXILIARY TERMINAL BOX ASSEMBLY	41 73 20 R0
7.	INSULATED BEARING HOUSING (NDE)	3J 33 033 R1
8.	BEARING HOUSING (DE)	3J 33 034 R1
9.	BEARING ASSEMBLY (NDE)	3J 27 080 R1
10.	BEARING ASSEMBLY (DE)	3J 27 081 R1
11.	STATOR COIL ASSEMBLY	96042 STCLA
12.	SHAFT LOCKING ARRANGEMENT	4J27018
13.	PERFORMANCE CHARACTERISTICS	PERF - 96042
14	THERMAL WITHSTAND CHARACTERISTICS	TWT-15/18- 550/96042
15.	TORQUE SPEED CHARACTERISTICS	TN. 70.175.550 / 96042
16.	NEGATIVE SEQUENCE CHARACTERISTICS	NEG - 96042

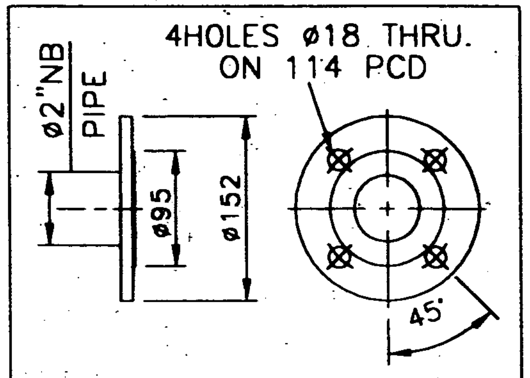
DRG. NO. 3J45189

ALL DIMENSIONS ARE IN MILLIMETRES | DO NOT SCALE | THIRD ANGLE PROJECTION | IF IN DOUBT,ASK





LIFTING LUG DETAIL



WATER INLET/OUTLET FLANGE DETAIL AS PER BS:10(TABLE-E)

TECHNICAL DATA

POWER RATING:	2000 kW
POLE:	10
VOLTAGE,3PH,50Hz:	6600 V
SPEED:	593 RPM
FLC:	227 AMPS
FRAME:	NVUWC710
ENCLOSURE:	C.A.C.W.
WEIGHT OF MOTOR:	15500 Kg.
WEIGHT OF ROTOR:	3300 Kg.
BEARINGS D.E.	NU240 EMC3
BEARINGS O.D.E.	2 X 7334 BCB
LUBRICATING GREASE:	SERVOGEM 2
COOLING WATER:	2 X 250 LPM
APPLICATION:	SEWAGE PUMP
WORKS ORDER NO.	NVUWC796042
CUSTOMER:	M/s WEIR ENGG PVT. LTD. AUSTRALIA

CUSTOMER DATA

STATOR CABLE SIZE: 3X1CX150mm^2, 6.6kV. XLPE
DIRECTION OF ROTATION
LOOKING AT D.E. OF MOTOR: ANTICLOCKWISE

ACCESSORIES

SPACE HEATER: 4X250W, 240V, SINGLE PHASE, 50Hz.
WINDING RTD: 9NOS.
BEARING RTD: 2NOS.
HOT AIR RTD: 2NOS.
COLD AIR RTD: 2NOS.
} 100 OHMS AT 0°C 3WIRE SIMPLEX
MOISTURE DETECTOR: 3 NOS. SCHMERSAL (GERMANY), IDC 15 300-01 YLG.

PROVISION FOR MOUNTING VIBRATION SENSOR ON BRG. HOUSINGS (DE & NDE) : YES (FOR BENTLY NEVADA-330400 ACCELEROMETER WEIR SUPPLY).

PROVISION FOR MOUNTING PULSEGENERATOR ON NDE.: YES (AS PER WEIR DRG.M485)

*MOTOR SHAFT END DETAILS AT D.E. AS PER DRG.4J36001

MATL SPECN | CODE NUMBER

▽ ROUGH FINISH
▽▽ SMOOTH FINISH
▽▽▽ GROUND FINISH

GENERAL TOLERANCE ON DIMENSIONS ± UNLESS OTHERWISE STATED

Crompton Greaves
LM DIVISION, KANJUR, MUMBAI

NO	ZONE	REVISION	DATE
5			
4	—	PULSGENERATOR ADDED AT POSSITION TOTAL HEIGHT OF MOTOR WAS 2976.	12.2.98
3	—	HOT AIR & COLD AIR RTD WERE 1NO. EACH. MOISTURE DETE. & ACCEL.METER SPEC. ADDED.	12.2.98
2	—	** DIM. SHOWN, 3430 WAS 3200.	17.11.97
1	—	* NOTE ADDED, SHAFT EXT.LTH. WAS 282. GP. BRG. RTD POSITION SHOWN	12.12.96

GENERAL ARRANGEMENT DRAWING
C.A.C.W. SQUIRREL CAGE
INDUCTION MOTOR

USED ON WORKS ORDER NO. 96042

DRN		29.10.96	SCALE
CKD			
APPD		2/11/96	

DRAWING NO. 3J45189

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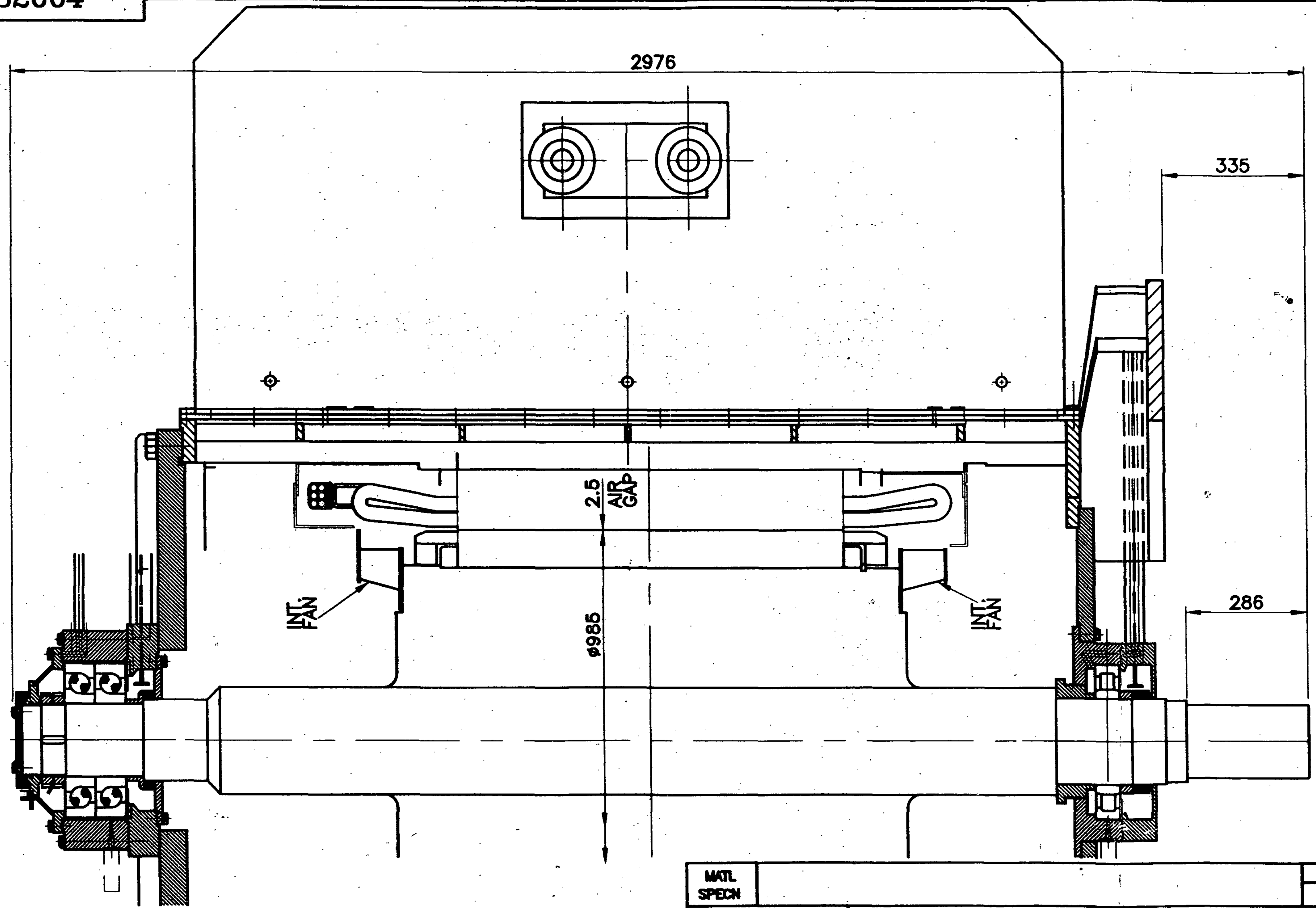
DRG. NO. 3J32004	ALL DIMENSIONS ARE IN MILLIMETRES	DO NOT SCALE	THIRD ANGLE PROJECTION	IF IN DOUBT,ASK



MATL. SPECN		CODE NUMBER
▽ ROUGH FINISH ▽▽ SMOOTH FINISH ▽▽▽ GROUND FINISH	GENERAL TOLERANCE ON DIMENSIONS ± UNLESS OTHERWISE STATED	Crompton Greaves LM DIVISION, KANJUR, MUMBAI

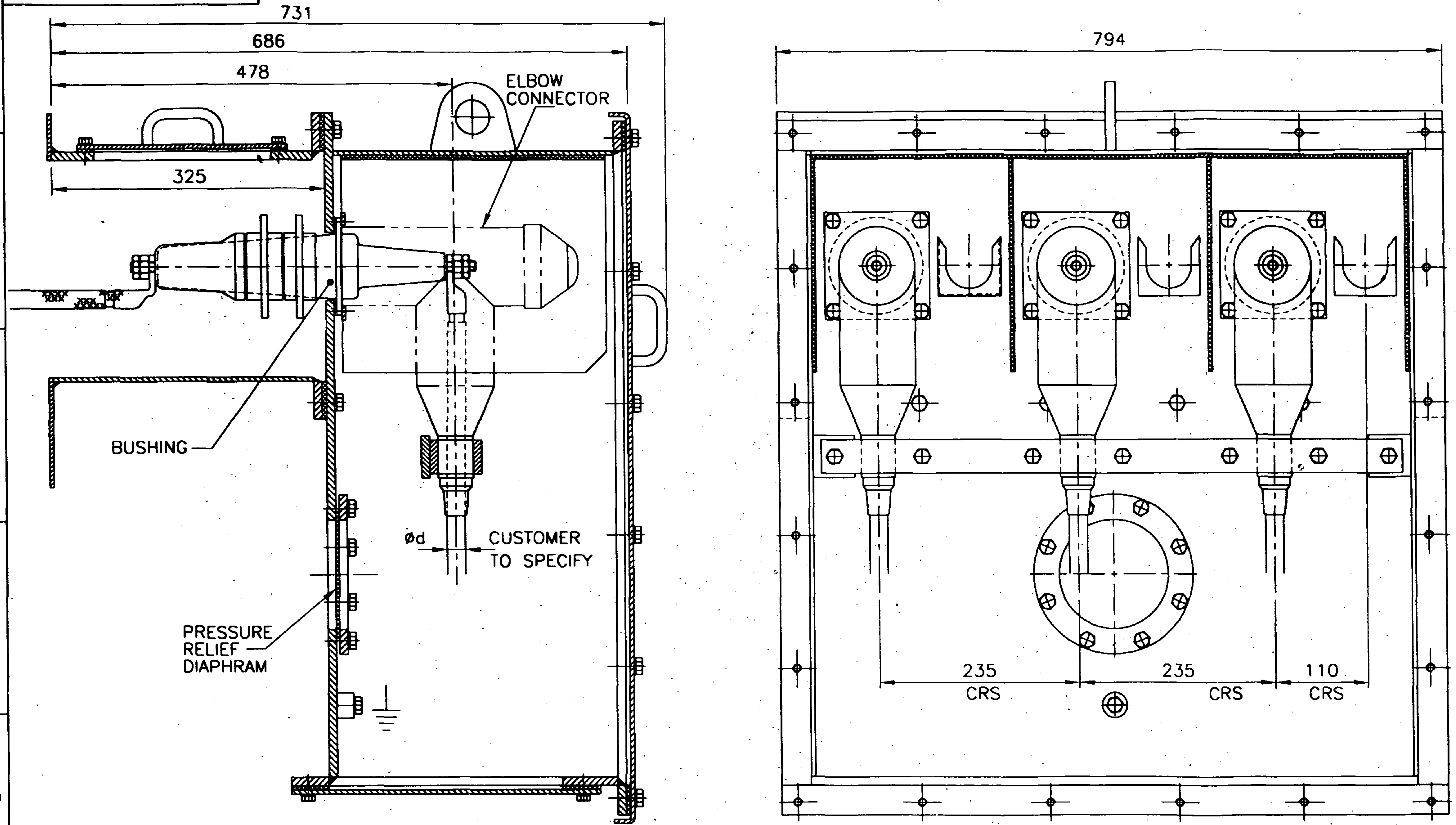
NO	ZONE	REVISION	DATE
5			
4			
3			
2			
1			

SECTIONAL LAYOUT
FOR W.O.96042

USED ON

DRN		9.1.98	SCALE	DRAWING NO.
CKD			NTS	3J32004
APPD				

DRG. NO. 417322	ALL DIMENSIONS ARE IN MILLIMETRES	DO NOT SCALE	THIRD ANGLE PROJECTION	IF IN DOUBT ASK



BUSHING TYPE	ELBOW CONNECTOR TYPE	VOLTAGE kV	CURRENT A
600 TBC (AI ①)	650 LR (AI ①)	MAX.6.6	MAX.600

1) USE BIMETALIC CONNECTORS
2) MINIMUM DIMENSIONS NECESSARY TO DISCONNECT

MATL SPECN		CODE NUMBER
▽ ROUGH FINISH ▽▽ SMOOTH FINISH ▽▽▽ GROUND FINISH	GENERAL TOLERANCE ON DIMENSIONS ± UNLESS OTHERWISE STATED	Crompton Greaves LM DIVISION, KANJUR, MUMBAI

NO	ZONE	REVISION	DATE
5			
4			
3			
2			
1	—	PARKING STAND ADDED, DIM:794 WAS 540, 235CRS WAS 150CRS.	

MAIN TERMINAL BOX ASSEMBLY DRAWING

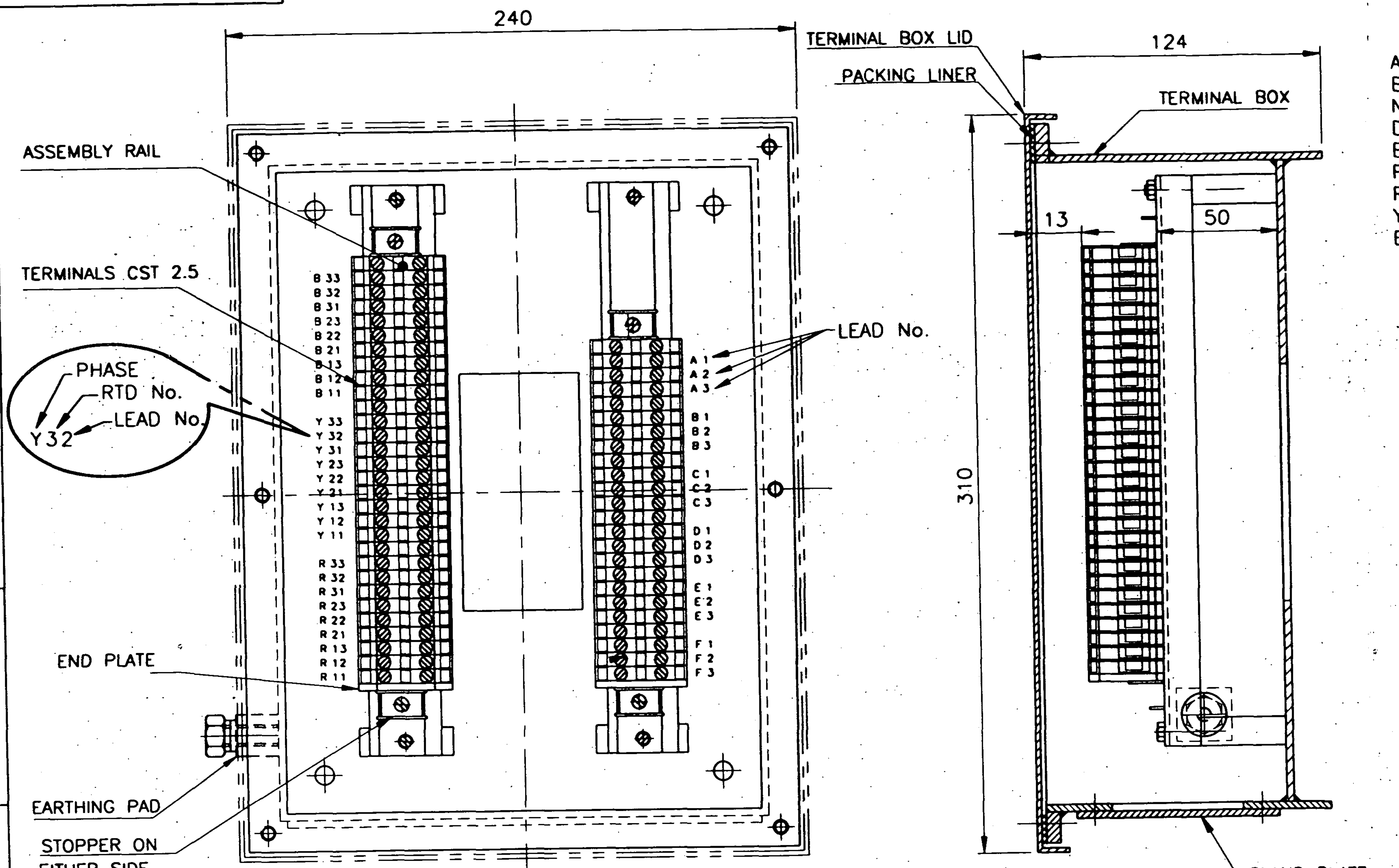
USED ON W.O. 96042

DRN 19.11.96 | CKD | APPD 23/11/96

SCALE 1:5 | DRAWING NO. 417322

DRG. NO. 417320

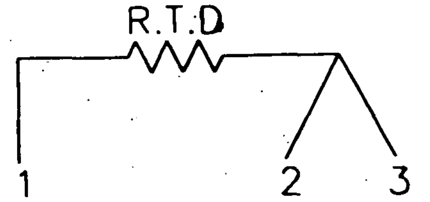
ALL DIMENSIONS ARE IN MILLIMETRES | DO NOT SCALE | THIRD ANGLE PROJECTION | IF IN DOUBT,ASK



VIEW WITHOUT TERMINAL BOX LID

FERRULE CODE

A = RTD FOR COLD AIR LH SIDE
B = RTD FOR HOT AIR LH SIDE
N = RTD FOR O.D.E. BEARING
D = RTD FOR D.E. BEARING
E = RTD FOR COLD AIR RH SIDE
F = RTD FOR HOT AIR RH SIDE
R, Y, B } PHASEWISE WINDING RTD



ENCLOSURE :IP55

MATL SPECN

CODE NUMBER

▽ ROUGH FINISH
▽▽ SMOOTH FINISH
▽▽▽ GROUND FINISH

GENERAL TOLERANCE ON DIMENSIONS ± UNLESS OTHERWISE STATED

Crompton Greaves
LM DIVISION, KANJUR, MUMBAI

NO	ZONE	REVISION	DATE
5			
4			
3			
2			
1			

RTD TERMINAL BOX ASSEMBLY(SIMPLEX TYPE)

USED ON 6WDG+2BRG+2HOT AIR+2COLD AIR RTD

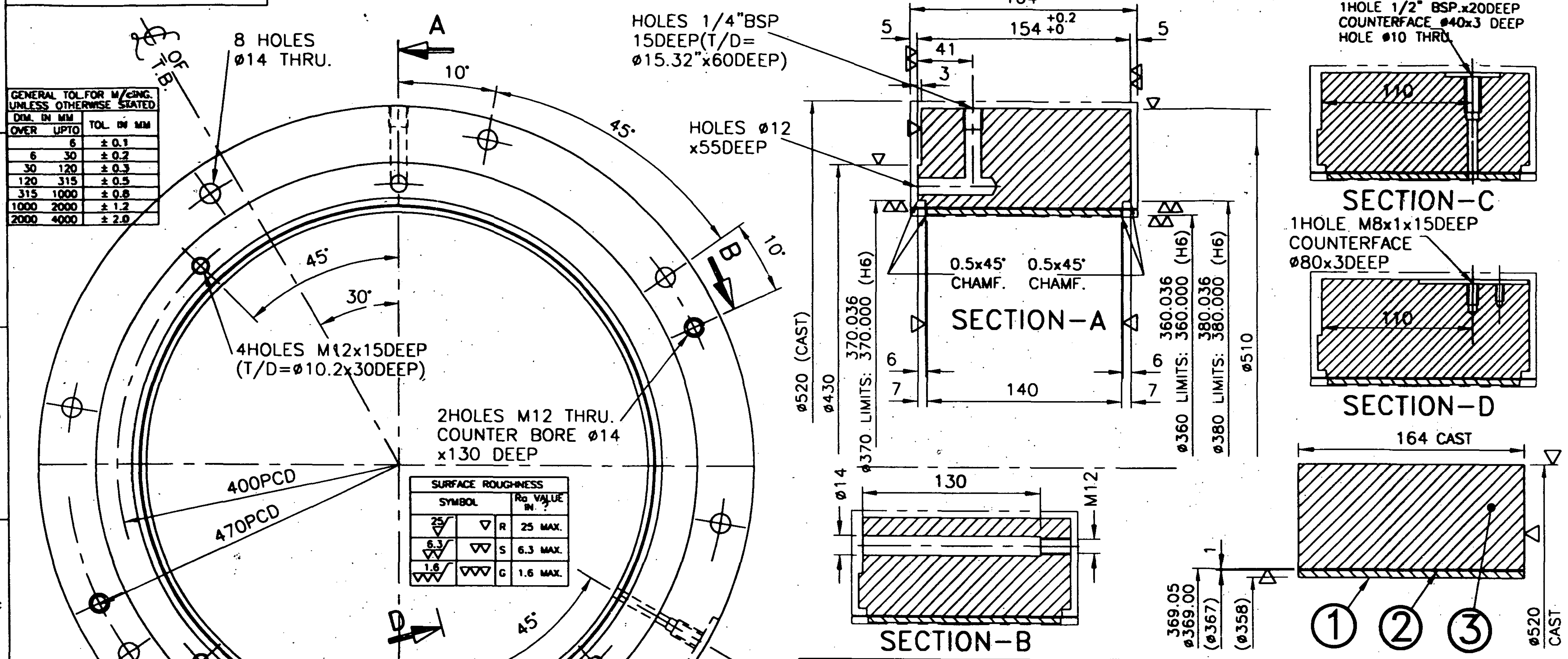
DRN 8.10.98
CKD
APPD 22/11/98

SCALE N.T.S

DRAWING NO. 417320

DRG. NO.	3J33033	ALL DIMENSIONS ARE IN MILLIMETRES	DO NOT SCALE	THIRD ANGLE PROJECTION	IF IN DOUBT,ASK

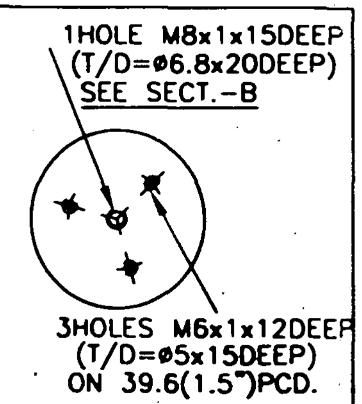
GENERAL TOL.FOR M/cING. UNLESS OTHERWISE STATED		
DIM. IN MM		TOL. IN MM
OVER	UPTO	
	6	± 0.1
6	30	± 0.2
30	120	± 0.3
120	315	± 0.5
315	1000	± 0.8
1000	2000	± 1.2
2000	4000	± 2.0



SURFACE ROUGHNESS			
SYMBOL			Ra VALUE IN. ?
25 ∇	∇	R	25 MAX.
6.3 ∇∇	∇∇	S	6.3 MAX.
1.6 ∇∇∇	∇∇∇	G	1.6 MAX.

NOTE:
1. BORE AND SPIGOT MUST BE CONCENTRIC WITHIN 0.02mm AND PERPENDICULAR TO SMOOTH MACHINED SURFACE WITHIN 0.02mm. SMOOTH MACHINED SURFACE MUST BE FLAT WITHIN0.1mm
2. REMOVE ALL SHARP CORNERS.
3. TOOL MARKS ON MACHINED SURFACES ARE NOT ACCEPTABLE.

PROCESS NOTE:
1. ITEM1,2 & 3 TO BE ORDERED SEPERATELY.
2. ITEM1 TO BE ORDERED AS PER DRG. 4J33002/4.
3. ITEM3 TO BE ORDERED AS PER DRG. A3-01009/1 AND TO BE MACHINED AS PER FIG.1
4. POLISH SURFACES OF ITEM 2 WITH EMERY PAPER BEFORE STICKING.
5. STICK ITEM 2 TO ITEM 3 WITH ITEM4 AND ITEM5 AS IN FIG.2
6. STICK ITEM 1 TO ITEM 2 WITH ITEM4 AND ITEM5 AS IN FIG.2
7. CURE AT 130°C FOR 12HRS. AFTER STICKING AND THEN PROCEED WITH FINAL MACHINING.



DETAIL 'X'

ITEM	DESCRIPTION	MATL. SPECN.	QTY.	DRG. NO.	REMARKS
5	HARDNER XY 73		0.032KG.		CODE No. 601183040
4	RESIN XY 67		0.800KG.		CODE No. 605183034
3	HOUSING	OD.520, ID.360, 164THK. CAST IRON Gr.FG200, IS:210	1NO	4J00006/1	CODE No. 749021008
2	INSULATING RING	1165x164x0.5THK.SHEET GLASS EPOXY Gr.G11	2NO		CODE No. 602081013
1	COLLAR	1145x 164 x 12THK.PLATE	1NO	4J33002/15	CODE No. 747052844

MATL SPECN — CODE NUMBER 7 4 8 0 4 1 3 9 9

∇ ROUGH FINISH
∇∇ SMOOTH FINISH
∇∇∇ GROUND FINISH

GENERAL TOLERANCE ON DIMENSIONS ± SEE TABLE UNLESS OTHERWISE STATED

Crompton Greaves
LM DIVISION, KANJUR, MUMBAI

NO	ZONE	REVISION	DATE
5			
4			
3			
2			
1		SECT.C 1/2"BSP. WAS1/2"NPT &ø10 WAS ø7 SECT.D DETAIL-'X' ADDED FOR SECT.D	

INS.BEARING HOUSING

USED ON INS.BRG:2x7334

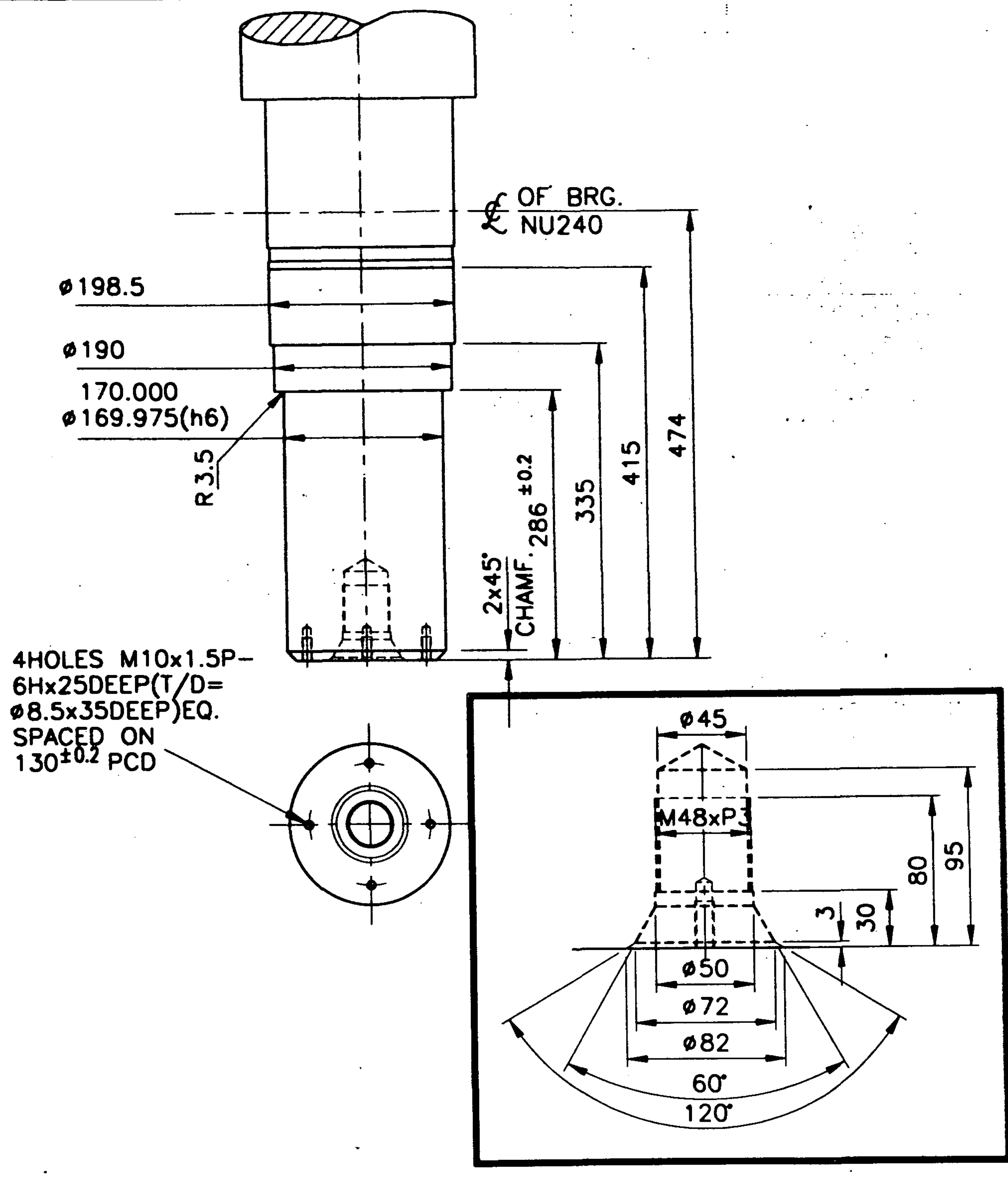
DRN — CKD — 13.12.96 — APPD

SCALE NTS — DRAWING NO. 3J33033

DRG. NO. 4J36001

ALL DIMENSIONS ARE IN MILLIMETRES

IF IN DOUBT,ASK | THIRD ANGLE PROJECTION



MATL. SPECN.

CODE NUMBER

▽ ROUGH FINISH
▽▽ SMOOTH FINISH
▽▽▽ GROUND FINISH

GENERAL TOLERANCE ON DIMENSIONS ± UNLESS OTHERWISE STATED

Crompton Greaves
LM DIVISION, KANJUR, MUMBAI

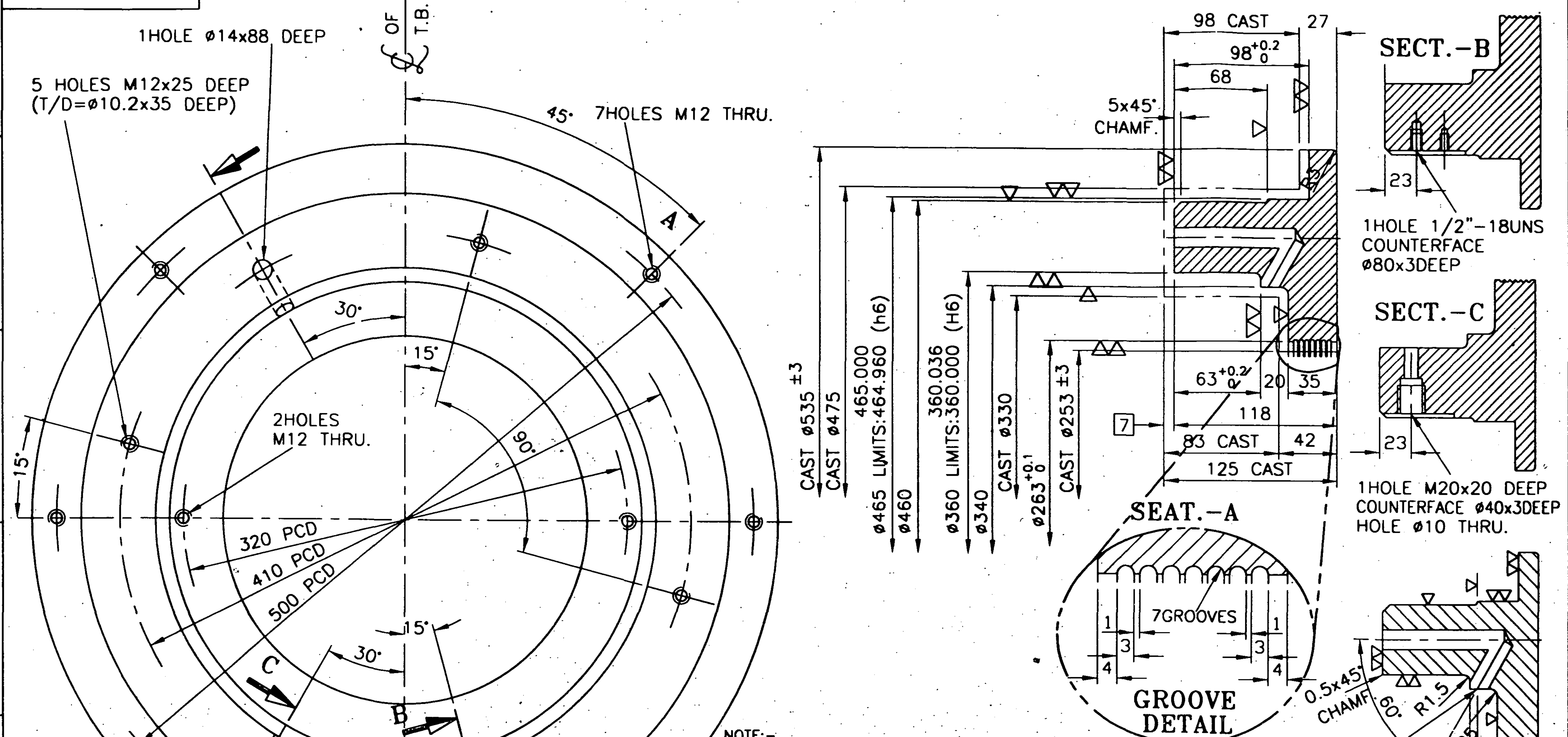
SHAFT EXTENSION DETAIL

NO	ZONE	REVISION	DATE
5			
4			
3			
2			
1			

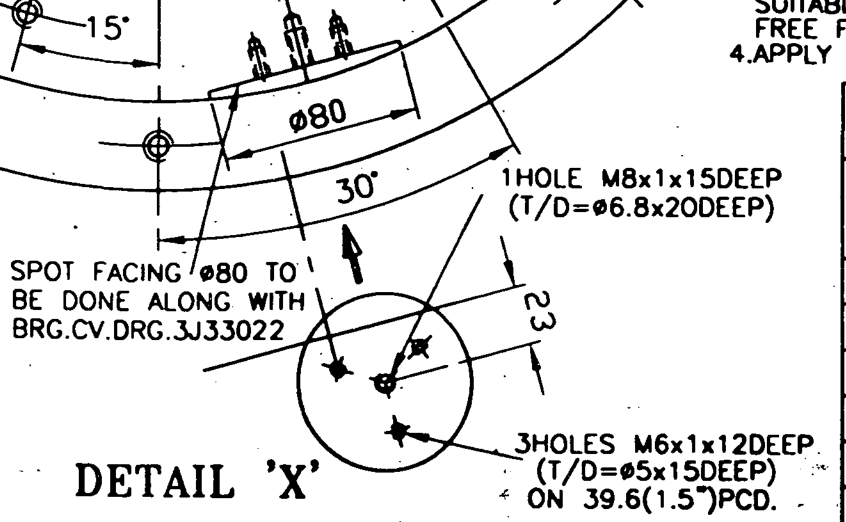
USED ON W.0.96042

			SCALE	DRAWING NO.
DRN	[signature]	3.1.97	—∕\/—	4J36001
CKD				
APPD	[signature]	11/1/97		

DRG. NO. 3J33034 | ALL DIMENSIONS ARE IN MILLIMETRES | DO NOT SCALE | THIRD ANGLE PROJECTION | IF IN DOUBT ASK



NOTE:-
1. CASTING SHALL BE PROPERLY FITTED & DRESSED.
2. ALL SURFACES SHALL BE THOROUGHLY CLEANED.
3. DEGREASE & DERUST ALL SURFACES BY SUITABLE TREATMENT. ENSURE SURFACES ARE FREE FROM MOISTURE & LOOSE MATTERS.
4. APPLY RED OXIDE.



DETAIL 'X'

GENERAL TOL. FOR CASTING UNLESS OTHERWISE STATED

DIM. IN MM OVER	UPTO	TOL. IN MM
—	25	± 3
25	100	± 4
100	400	± 6
400	1600	± 8
1600	4000	± 10

GENERAL TOL. FOR M/cING. UNLESS OTHERWISE STATED

DIM. IN MM OVER	UPTO	TOL. IN MM
	6	± 0.1
6	30	± 0.2
30	120	± 0.3
120	315	± 0.5
315	1000	± 0.8
1000	2000	± 1.2
2000	4000	± 2.0

SURFACE ROUGHNESS

SYMBOL			Ra VALUE IN μ
25 ▽	▽	R	25MAX.
6.3 ▽▽	▽▽	S	6.3MAX.
1.6 ▽▽▽	▽▽▽	G	1.6MAX.

CODE FOR CASTING 7 4 5 0 2 1 0 0 9

CODE FOR M/cING 7 4 4 0 4 1 4 0 1 (CODE NUMBER)

MATL SPECN: CAST IRON Gr.200 IS:210

▽ ROUGH FINISH
▽▽ SMOOTH FINISH
▽▽▽ GROUND FINISH

GENERAL TOLERANCE ON DIMENSIONS ± SEE TABLE UNLESS OTHERWISE STATED

Crompton Greaves
LM DIVISION, KANJUR, MUMBAI

BEARING HOUSING

NO	ZONE	REVISION	DATE
5			
4			
3			
2			
1	SECT-C SECT-B	DIM.23 WAS 34, M20 HOLE WAS 1/2"NPT & ø10 WAS ø7. DETAIL 'X' ADDED	

USED ON: BRG.NU240
DRN / CKD / APPD: 18.12.96
SCALE: 1:3
DRAWING NO. 3J33034

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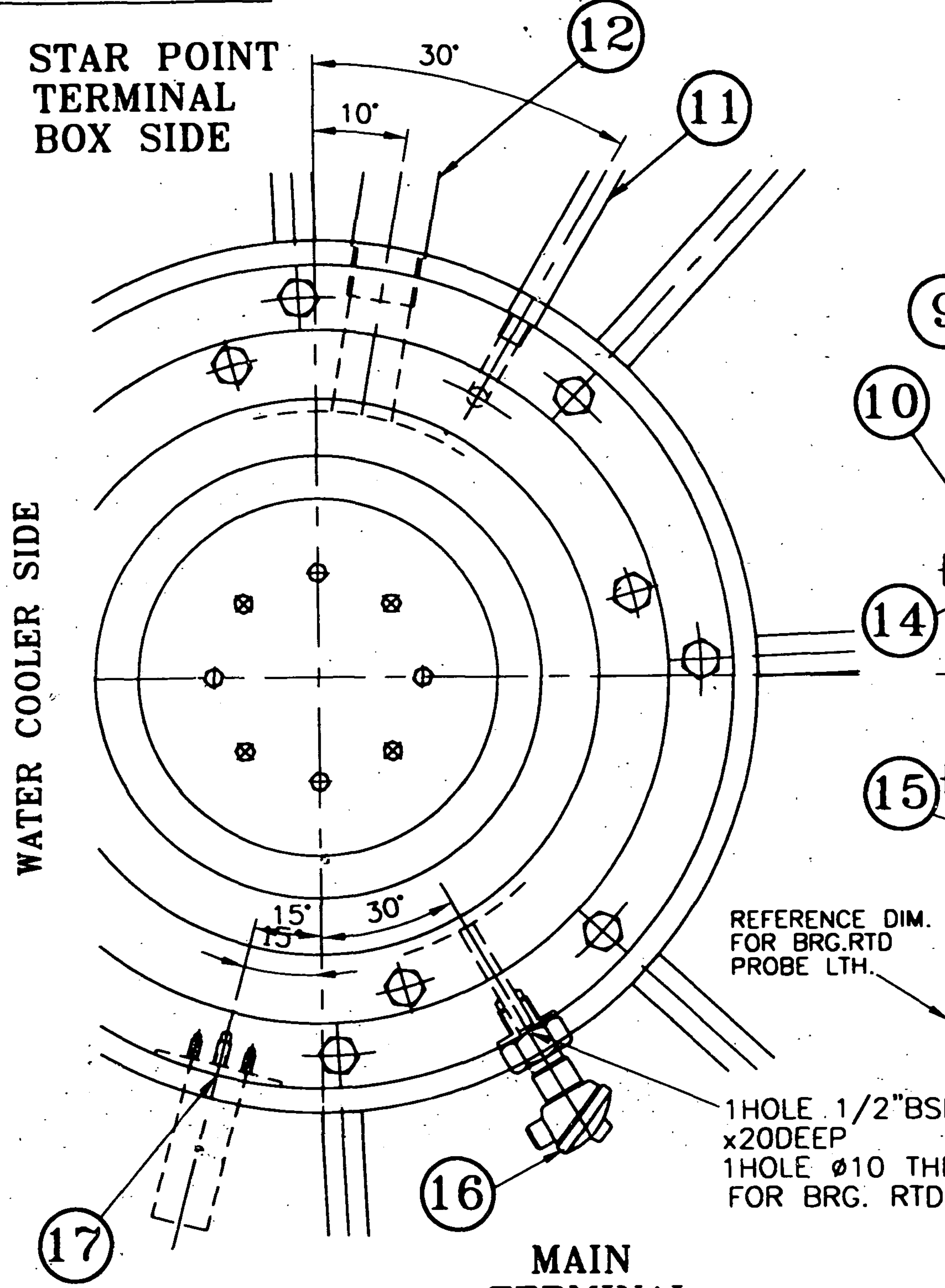
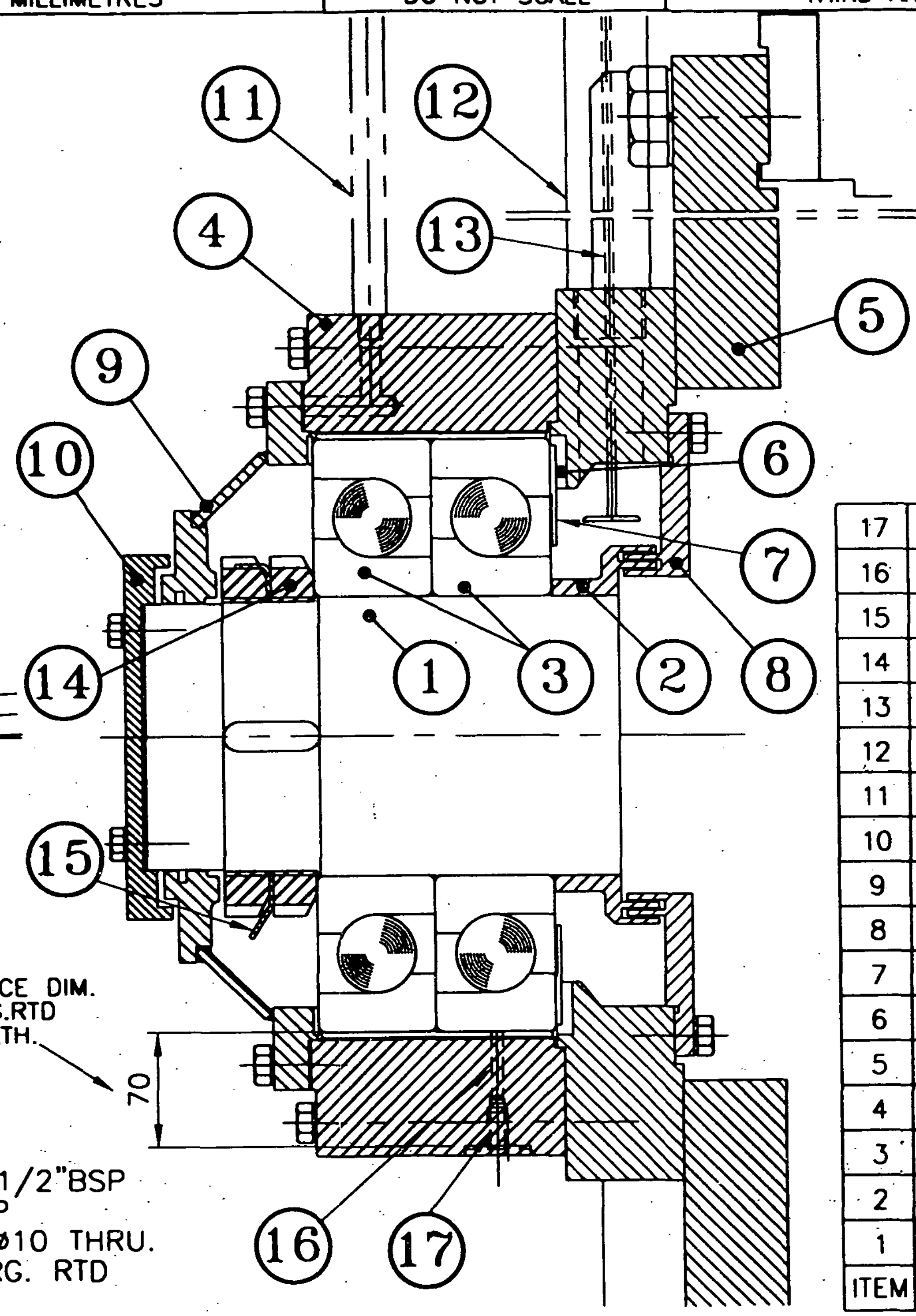
DRG. NO. 3J27080

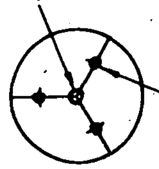
ALL DIMENSIONS ARE IN MILLIMETRES | DO NOT SCALE | THIRD ANGLE PROJECTION | IF IN DOUBT, ASK





ITEM	DESCRIPTION	MATL. SPECN.	QTY.
17	ACCELEROMETER PROVISION		✓
16	BEARING RTD PROVISION		✓
15	LOCK WASHER	STEEL	1
14	BEARING NUT	STEEL	2
13	GREASE SCRAPER	STEEL FAB.	1
12	GREASE OUTLET PIPE	GI PIPE	1
11	GREASE INLET PIPE	GI PIPE	1
10	WATER THROWER	STEEL	1
9	OUTER BEARING COVER	STEEL	1
8	INNER BEARING COVER	STEEL	1
7	GREASE RETAINING CV.	BRASS SHEET	1
6	INSULATING LINER	G11	1
5	ENDSHIELD	STEEL FAB.	1
4	BEARING HOUSING	CAST STEEL	1
3	BEARING	ALLOY STEEL	2
2	INNER COLLAR	STEEL	1
1	SHAFT	CARBON STEEL	1

1HOLE M8x1x15DEEP (T/D=ø6.8x20DEEP)



3HOLES M6x1x12DEEP (T/D=ø5x15DEEP) ON 39.6(1.5")PCD.

ECCELEROMETER MOUNTING KIT DETAILS

MATL SPECN | CODE NUMBER

▽ ROUGH FINISH
▽▽ SMOOTH FINISH
▽▽▽ GROUND FINISH

GENERAL TOLERANCE ON DIMENSIONS ± UNLESS OTHERWISE STATED

Crompton Greaves
LM DIVISION, KANJUR, MUMBAI

NO	ZONE	REVISION	DATE
5			
4			
3			
2			
1	—	ACCELEROMETER FIXING DETAIL & BRG. RTD. PROBE MOUNTING DETAIL ADDED.	[illegible]

BEARING ASSEMBLY
FOR N.D.E.

USED ON BRG.2x7334

DRN: [signature] 8.1.97
CKD: [signature]
APPD: [signature]

SCALE: NTS
DRAWING NO.: 3J27080

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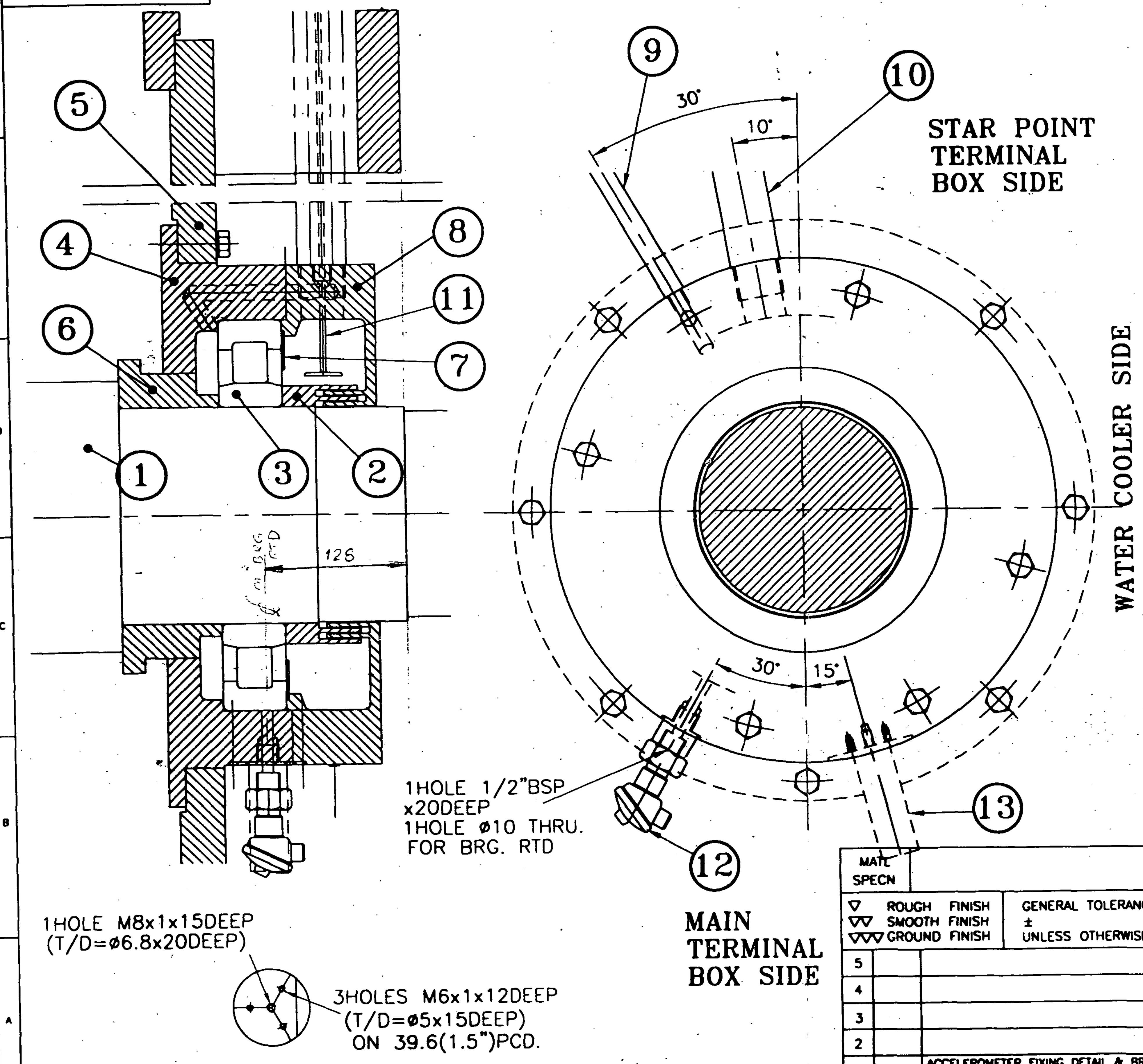
DRG. NO. 3J27081

ALL DIMENSIONS ARE IN MILLIMETRES | DO NOT SCALE | THIRD ANGLE PROJECTION | IF IN DOUBT,ASK



ECCELEROMETER MOUNTING KIT DETAILS

ITEM	DESCRIPTION	MATL. SPECN.	QTY.
15			
14			
13	ACCELEROMETER PROVISION		✓
12	BEARING RTD PROVISION		✓
11	GREASE SCRAPER	STEEL FAB.	1
10	GREASE OUTLET PIPE	GI PIPE	1
9	GREASE INLET PIPE	GI PIPE	1
8	OUTER BEARING COVER	STEEL	1
7	GREASE RETAINING CV.	BRASS SHEET	1
6	INNER COLLER	STEEL	1
5	ENDSHIELD	STEEL FAB.	1
4	BEARING HOUSING	CAST STEEL	1
3	BEARING	ALLOY STEEL	1
2	OUTER COLLAR	STEEL	1
1	SHAFT	CARBON STEEL	1

MATL SPECN | CODE NUMBER

▽ ROUGH FINISH
▽▽ SMOOTH FINISH
▽▽▽ GROUND FINISH

GENERAL TOLERANCE ON DIMENSIONS ± UNLESS OTHERWISE STATED

Crompton Greaves
LM DIVISION, KANJUR, MUMBAI

NO	ZONE	REVISION	DATE
5			
4			
3			
2			
1	—	ACCELEROMETER FIXING DETAIL & BRG. RTD. PROBE MOUNTING DETAIL ADDED.	

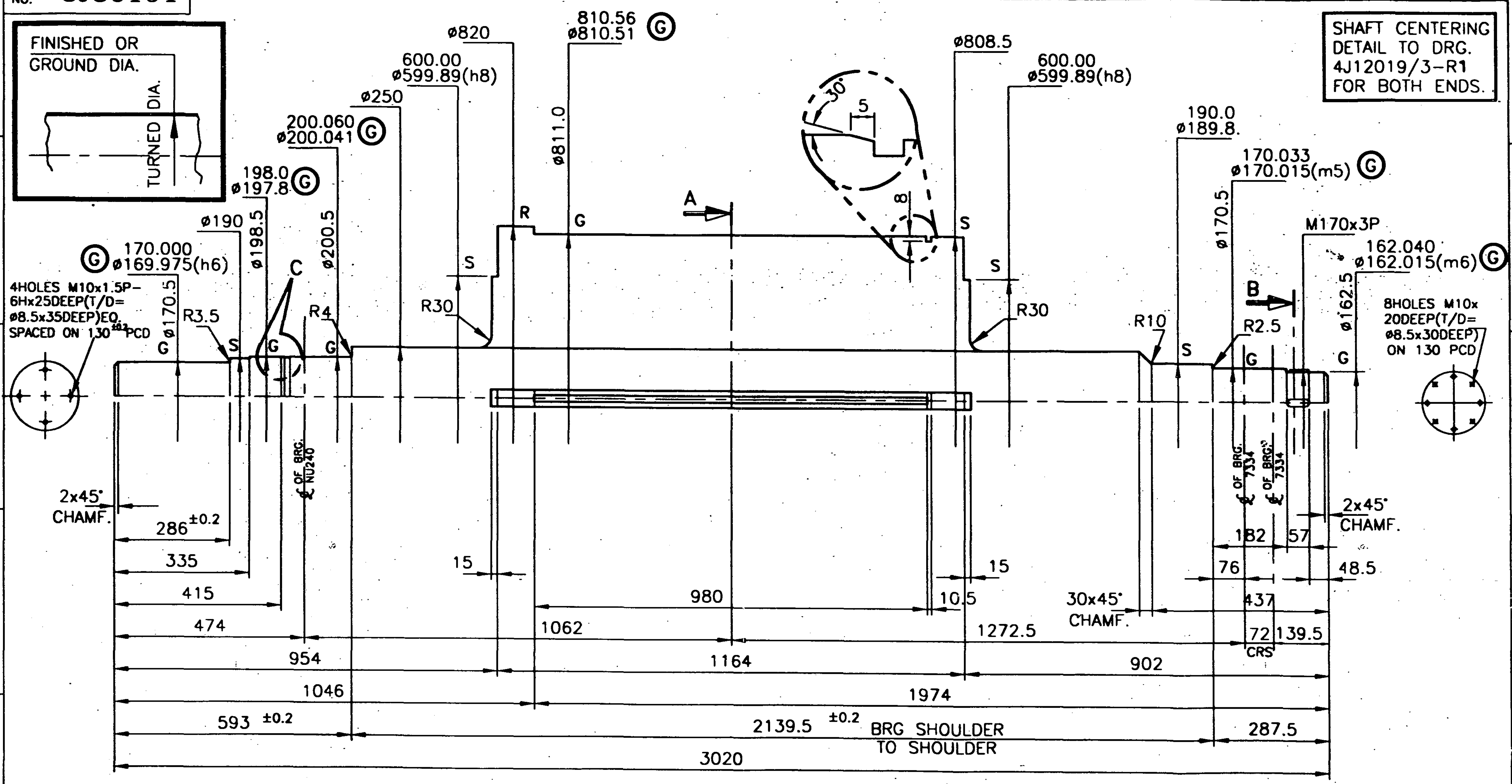
BEARING ASSEMBLY
FOR D.E.

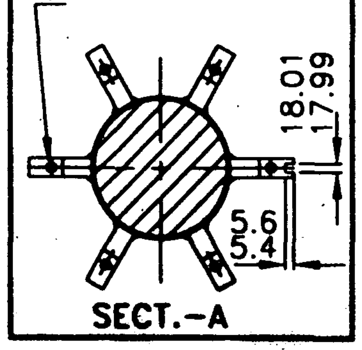
USED ON BRG. NU240

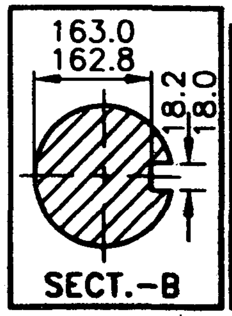
DRN | CKD | APPD — 8.1.97

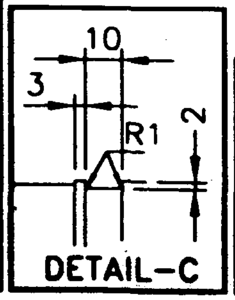
SCALE: NTS | DRAWING NO.: 3J27081

DRG. NO. 3J36191 | ALL DIMENSIONS ARE IN MILLIMETRES | DO NOT SCALE | THIRD ANGLE PROJECTION | IF IN DOUBT, ASK









GENERAL TOL. FOR M/cING. UNLESS OTHERWISE STATED

DIM. IN MM OVER	UPTO	TOL. IN MM
	6	± 0.1
6	30	± 0.2
30	120	± 0.3
120	315	± 0.5
315	1000	± 0.8
1000	2000	± 1.2
2000	4000	± 2.0

SURFACE ROUGHNESS

SYMBOL			Ra VALUE IN ?
25√ ▽	▽	R	25MAX.
6.3√ ▽▽	▽▽	S	6.3MAX.
1.6√ ▽▽▽	▽▽▽	G	1.6MAX.

MATL SPECN: FABRICATED ROTOR AS PER DRG.468283/9B

CODE NUMBER: 7 4 5 0 4 1 3 9 7

▽ ROUGH FINISH
▽▽ SMOOTH FINISH
▽▽▽ GROUND FINISH

GENERAL TOLERANCE ON DIMENSIONS ± SEE TABLE UNLESS OTHERWISE STATED

Crompton Greaves
LM DIVISION, KANJUR, MUMBAI

NO	ZONE	REVISION	DATE
5			
4			
3			
2			
1	Fx1, Ex1 Dx1	SHAFT CENTERING DETAIL DRG. FOR WAS824049/2. M10 HOLES AT NDE WERE 4NOS. ON 125PCD	

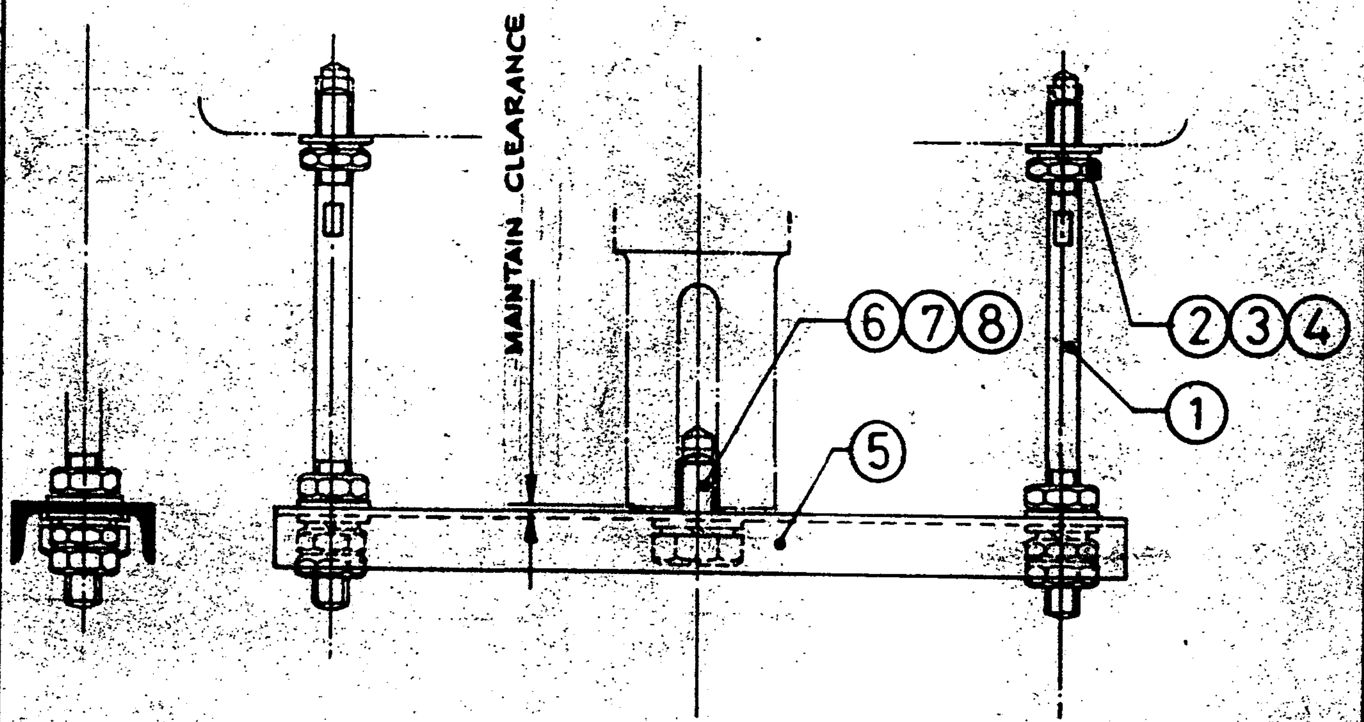
ROTOR SHAFT

2000kW, 10P, 6.6kV, GROSS CR.LTH.900mm

USED ON W.O.96042

DRN		10.12.96	SCALE	DRAWING NO.
CKD			NTS	3J36191
APPD		12.12.96		

DRG. NO. 4J27018 | THIRD ANGLE PROJECTION | IF IN DOUBT, ASK



ITEM	DESCRIPTION	MATL. SPECN.	QTY.	DRG. NO.	REMARK.
8	PLAIN WASHER	M.S.	1		
7	SPRING WASHER	SPRING STEEL	1		
6	HEX. HD. SCREW	M.S.	1		
5	CHANNEL	M.S.	1	4J33074	
4	PLAIN WASHER	M.S.	6		
3	SPRING WASHER	SPRING STEEL	4		
2	HEX. HD. NUT	M.S.	8		
1	STUD	M.S. ROD.	2	4J33073	

MATL. SPECN.

CODE NUMBER

▽ ROUGH FINISH
▽▽ SMOOTH FINISH
▽▽▽ GROUND FINISH

GENERAL TOLERANCE ON DIMENSIONS
±
UNLESS OTHERWISE STATED

Crompton Greaves LIMITED
KANJUR BOMBAY

SHAFT LOCKING ARRGT.

USED ON

NO	ZONE	REVISION	DATE
5			
4			
3			
2			
1			

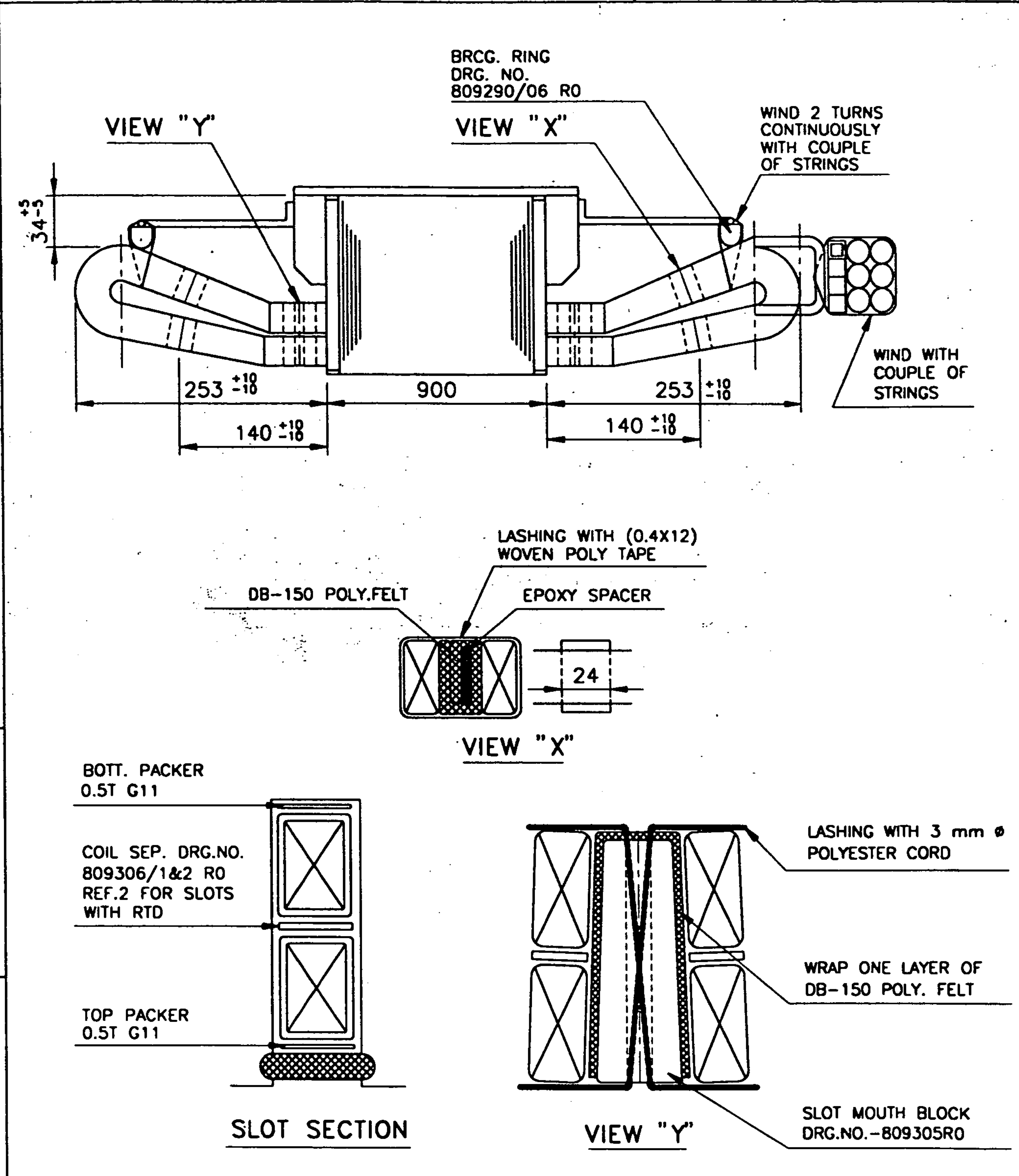
DRN.		11.8.86	SCALE	DRAWING NO.
CKD.			N.T.S	4J27018
APPD.		7.1.87		

MASTER LISTED SIGN DATE 21.10.92

DRG. NO. 96042 STCLA

ALL DIMENSIONS ARE IN MILLIMETRES

IF IN DOUBT, ASK | THIRD ANGLE PROJECTION



MATL. SPECN.	
CODE NUMBER	

▽ ROUGH FINISH
▽▽ SMOOTH FINISH
▽▽▽ GROUND FINISH

GENERAL TOLERANCE ON DIMENSIONS ± UNLESS OTHERWISE STATED

Crompton Greaves
LM DIVISION, KANJUR, MUMBAI

NO	ZONE	REVISION	DATE
5			
4			
3			
2			
1			

STATOR COIL ASSEMBLY

USED ON 2000 Kw, 10 PLOE, 6.6 KV, FR.-NVUWC 1400

			SCALE	DRAWING NO.
DRN	[illegible]	24/01/97	N.T.S.	96042 STCLA
CKD	[illegible]	24/01/97		
APPD				

Section 14 Training

Please consult Weir Engineering for Operator and Staff training on 02 4349 2999.

Section 15 List of Contract Variations and Plant Modifications

The following plant modifications were made:

Section 16 Commissioning and Test Reports

A detailed Inspection and Test Plan (ITP) has been prepared for the on site pre-commissioning and commissioning of the pump system. The ITP together with all of the relevant testing data has been included in Volume 3.