



PRODUCT STANDARD
STEAM TURBINE ENGINEERING

ST 51005

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SHEL EXPERIENCE

**TURBINE SUPERVISORY INSTRUMENTATION SYSTEM
(EXPANSION, POSITION AND VIBRATION) FOR
STEAM TURBINES**

- 1.0 The system shall be used for continuous monitoring of ~~overall~~ thermal expansions of turbine, relative expansion, of turbine rotors and casings, valve positions, axial position of turbine rotor, absolute bearing vibrations and shaft vibrations under all condition of turbine operation.
- 2.0 Scope of supply.
 - 2.1 The system shall consist of various sensors/transducers with suitable leads of heat resistant teflon insulated or higher temperature with-standing cable covered with flexible metallic conduit upto turbine junction boxes, ~~pre-amplifiers~~, complete measuring circuits/ signal conditioners, power supplies/oscillators, limit value monitors etc. housed in a suitable standard 19" rack panel/cabinet as stated in " Instrument Cabinet/Panel" document No. ST 51003
 - 2.1.1 The details of various parameters to be covered in the system shall be as per the schematic diagrams at page No. 5 to 9
 - 2.1.2 The range of measurements and adjustable set points for limit value monitors of various services shall be as stated under " Specification " at page No. 3 & 4
 - 2.1.3 The purpose, scope of supply, accuracies and principle of monitoring for each service shall be as per " additional description" at page No. 10 to 13
 - 2.2 Sensors and mounting brackets.
 - 2.2.1 All the sensors alongwith their respective mounting brackets shall be included in the offer. The sensors/mounting brackets shall be so designed to suit the existing mounting spaces and dimensions for each service(as shown in fig. 1 to 7)in the steam turbines.
 - 2.2.2 All the sensors shall be capable of continuous operation at 180°C invironmental temperature of steam and turbine-oil mist.

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|--------------------|-----------|--------------------|----------|------------|------------|--------------------|------|----------|
| DEPT. | NAME | SIGN | DATE | DRAWN | VERMA | <i>[Signature]</i> | | 31.10.80 |
| TSX | S. KUMAR. | <i>[Signature]</i> | 31/10/80 | WORKED | GHOSH | <i>[Signature]</i> | | ?? |
| | | | | CHECKED | Dr. A.K.B. | <i>[Signature]</i> | | ?? |
| | | | | SUPERVISED | K.P.M. | <i>[Signature]</i> | | ?? |
| Approved : | | | | | | <i>[Signature]</i> | | ST |
| | | | | | | ENGG. DEV. MANAGER | | 8.20 |
| Prepared | | | | Issued | | Date | | |
| <i>[Signature]</i> | | | | STE (TA) | | 31.10.80 | | |
| | | | | HW | | | | |



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- 2.2.3 Each sensor shall be of proven design so that the performance of randomly chosen sensors of same specification shall be identical, i.e. sensors of each type shall be interchangeable.
- 2.2.4 All sensors shall meet the requirements of relevant performance and environmental tests as per IS: 589, IS: 2106 or IEC-68 or equivalent international standards.
- 2.3 Measuring circuits and limit value monitors.
- 2.3.1 All the measuring /processing circuitries shall be compatible to the corresponding sensor alongwith the necessary provisions for built in continuous supervision and annunciations facilities (in terms of flickering lamps to facilitate easy fault finding) in case of internal fault in the circuits or in the power supply or in the sensor.
- 2.3.2 All the measurement services shall have built in self check and complete field calibration facility without disturbing the normal operation of the set.
- 2.3.3 All the measuring units shall be assembled in suitable PCB and housed in standard plug-in type of modules for mounting on standard 19" rack type of panel/cabinet. Incorrect insertion of PCB/module shall be annunciated on the front panel.
- 2.3.4 All the electronic modules/measuring units shall be capable of continuous operation at 0-55°C and relative humidity of 0-95 %.
- 2.3.5 Three independent 4-20 mA d.c. linear analog outputs for each service shall be provided and wired upto the panel's/cabinets terminal stations. Each 4-20 mA d.c. output should be capable of feeding a load resistance of 600 Ohms.
- 2.3.6 Linearity of each output signal of all the measuring units shall be better than $\pm 0.5\%$ and the circuitries shall meet the requirements of performance and environmental tests as per IS: 589, IS: 2106 or IEC:68 or equivalent international standards.
- 2.3.7 For each setting of alarms and annunciations, wherever required (~~as stated in annexure II & III~~), atleast two N.O. and two N.C. contacts, all potential free, suitable for 220V, 0.5 amps d.c. shall be provided on each measuring unit/limit valve monitor.
- 3.0 Power supply arrangement shall be as stated under " Power supply" document No. ST 51002.
- 4.0 Other general requirements, documentation, storage quality etc. shall be as stated under " General Requirement" document No. ST 51004.



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SPECIFICATION.

| Sl. No. | Service | Qty. | Range of measurement | Overall Accuracy Under normal condition | Overall Accuracy Under extreme environmental condition | Analog output requirement | Alarm contact require - ment. (excluding the fault contacts) | Remarks |
|---------|---|------|----------------------|---|--|------------------------------|--|---|
| | | | 3 | 4 | 5 | 6 | 7 | 8 |
| 1 | Axial shift | 1 | -0.5 mm to +0.5 mm | ± 2 % | ± 5 % | Three independent 4-20mA d.c | Two sets of adjustable contacts over 0-100% range to be adjusted independently | |
| 2 | Differential expansion of HPT. | 1 | -5 mm to +16mm | ± 2 % | ± 5 % | -do- | -do- | |
| 3 | Differential expansion of IPT | 1 | -5 mm to +16 mm | ± 2 % | ± 5 % | -do- | -do- | |
| 4 | Differential expansion of LPT | 1 | -10 mm to + 32mm | ± 2 % | ± 5 % | -do- | -do- | |
| 5 | Overall thermal expansion of HPT | 1 | 0-40mm (0-100%) | ± 2 % | ± 3 % | -do- | Nil | |
| 6 | Overall thermal expansion of IPT. | 1 | 0-40mm (0-100%) | ± 2 % | ± 3 % | -do- | Nil | |
| 7 | Bearing shell vibration for HP front, HP rear IP rear & LP rear | 4 | 0-160/μ | ± 5 % | ± 10% | -do- | One set of adjustable contacts over 0-100% range. | Monitoring of shell or pedestal vibration shall |



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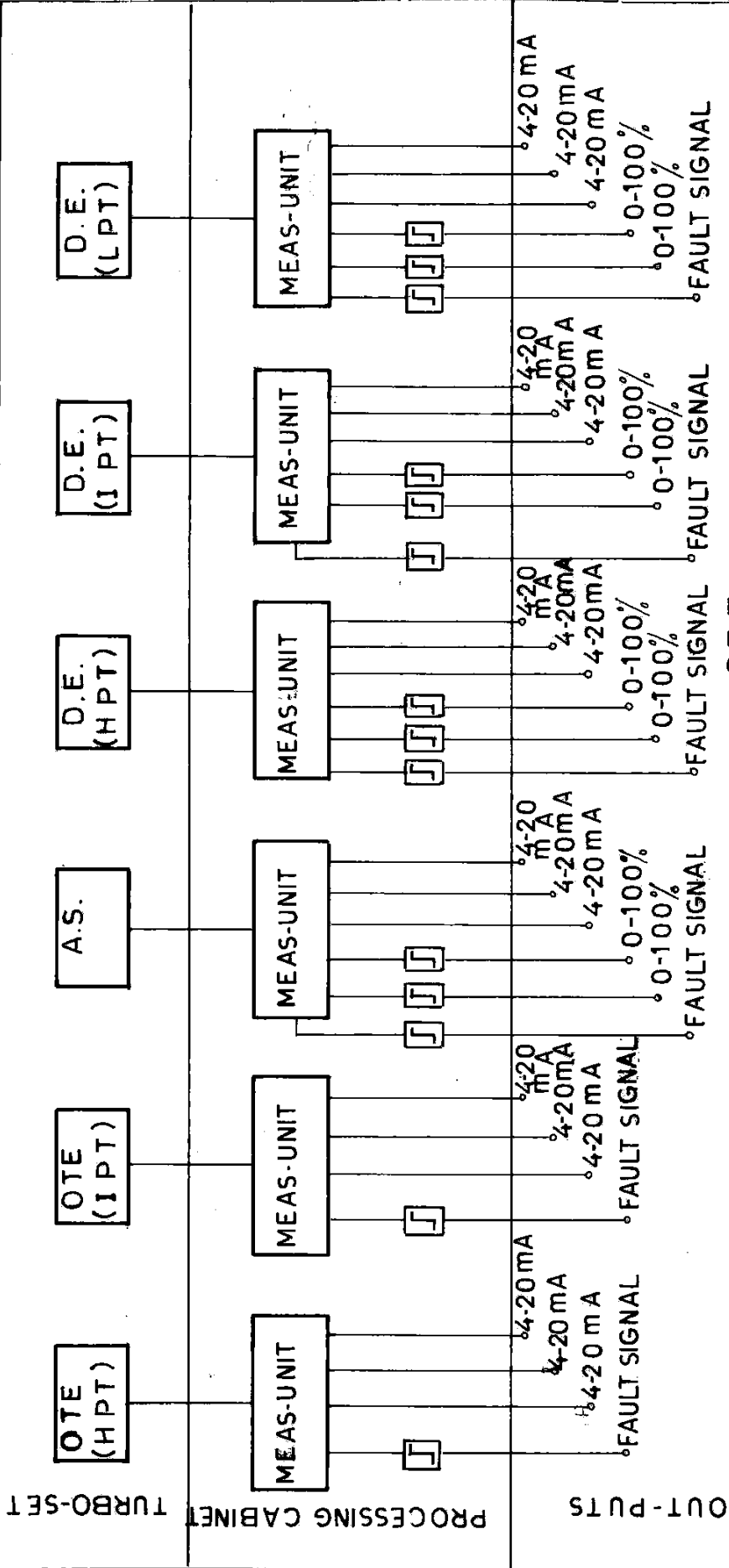
| Sl. No. | Service | Qty. | Range of measurement | Overall Accuracy Under normal condition | Overall Accuracy Under extreme environmental condition | Analog output requirement | Alarm contact requirement (excluding the fault contacts) | Remarks |
|---------|--|------|----------------------|---|--|------------------------------|---|----------------|
| 7 | Bearing pedestal vibration for HP front, HP rear, IP rear & LP rear. | 4 | 0-160 μ | $\pm 5\%$ | $\pm 10\%$ | Three independent 4-20mA d.c | One set of adjustable contacts over 0-100% range | ... |
| 8 | Absolute Shaft vibration for HP front, HP rear, IP Rear and LP rear. | 4 | 0-400 μ | $\pm 5\%$ | $\pm 10\%$ | Three independent 4-20mA d.c | --do-- | |
| 9 | Absolute Bearing pedestal vibration for Gen. front vertical & horizontal, Gen. rear vertical & horizontal. | 4 | 0-160 μ | $\pm 5\%$ | $\pm 10\%$ | --do-- | --do-- | |
| 10 | IP control valve position for CV-1 & CV-2 and for LP By-pass Control Valve position. | 4 | 0-50 mm (0-100%) | $\pm 2\%$ | $\pm 3\%$ | --do-- | Three adjustable contacts over (0-50%), (20-70%) and (50-100%) range. | |
| 11 | HP control valve position for CV-1 & CV-2. | 2 | --do-- | $\pm 2\%$ | $\pm 3\%$ | --do-- | --do-- | |

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NOTE: OVERALL THERMAL EXPANSION
 A S : AXIAL SHIFT
 D E : DIFFERENTIAL EXPANSION
 CONTACTS FOR
 LIMIT VALUE MONITOR (TWO PAIRS AS
 IN CI.2.3.7)

CONT.

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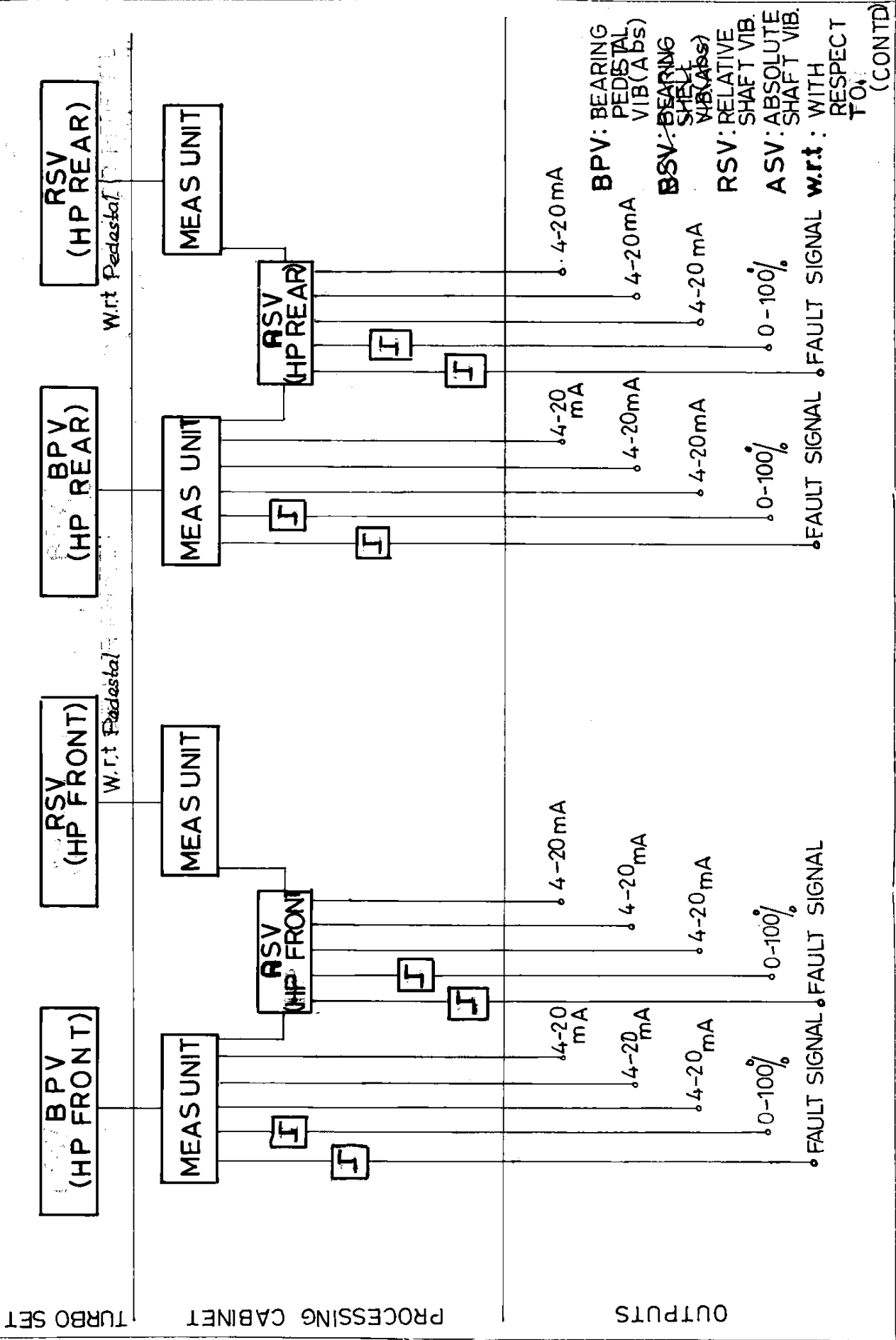
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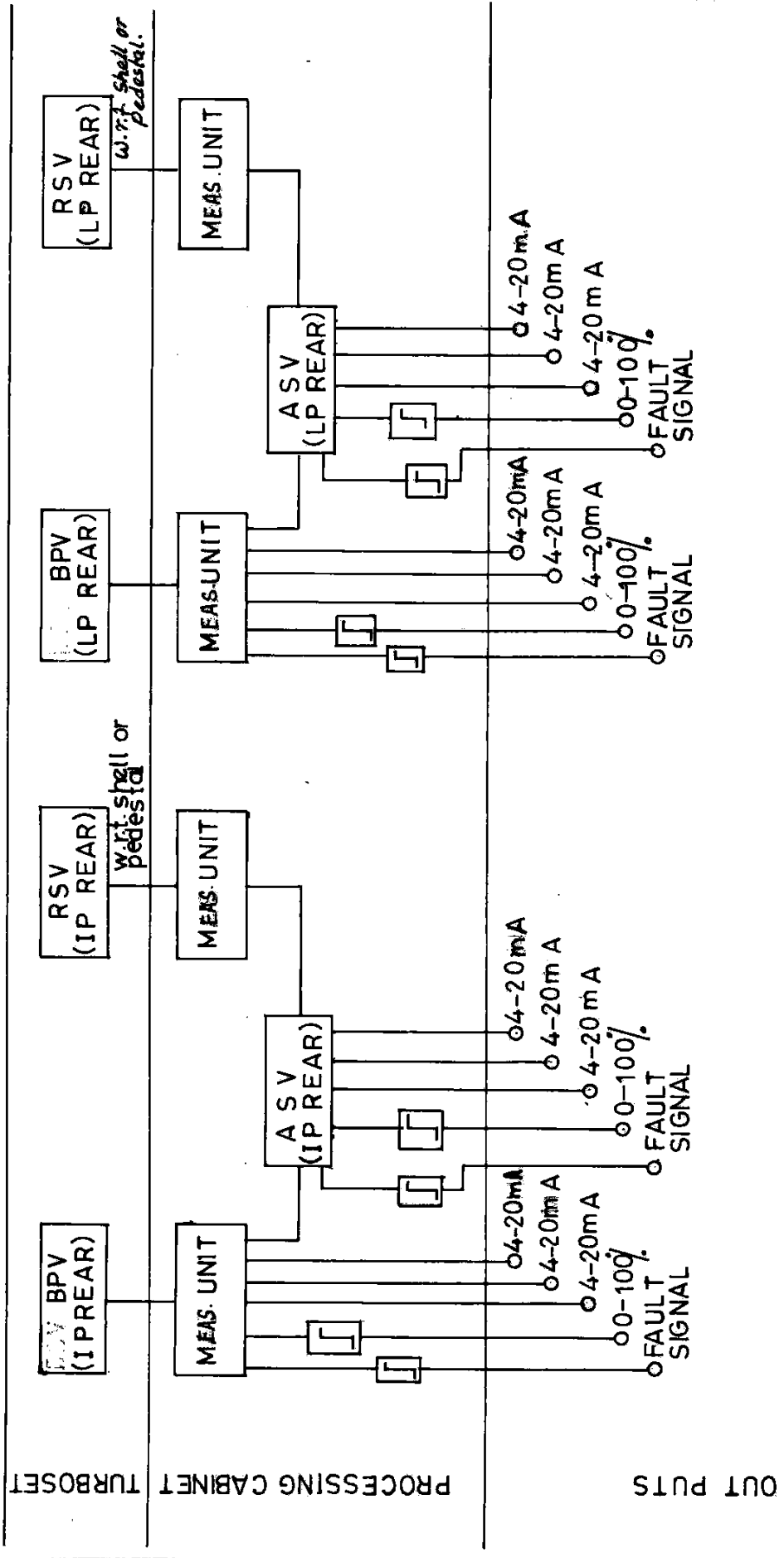
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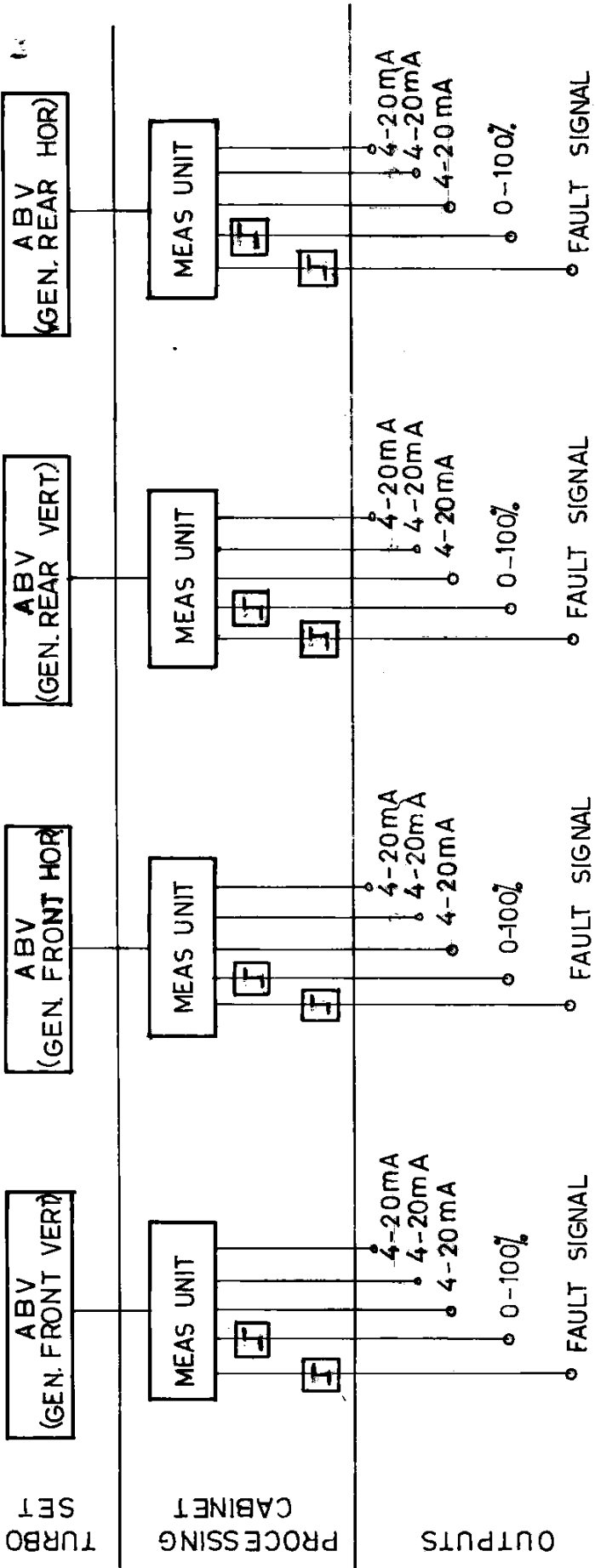
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ABV = ABS. BEARING VIB
VERT = VERTICAL
HOR = HORIZONTAL

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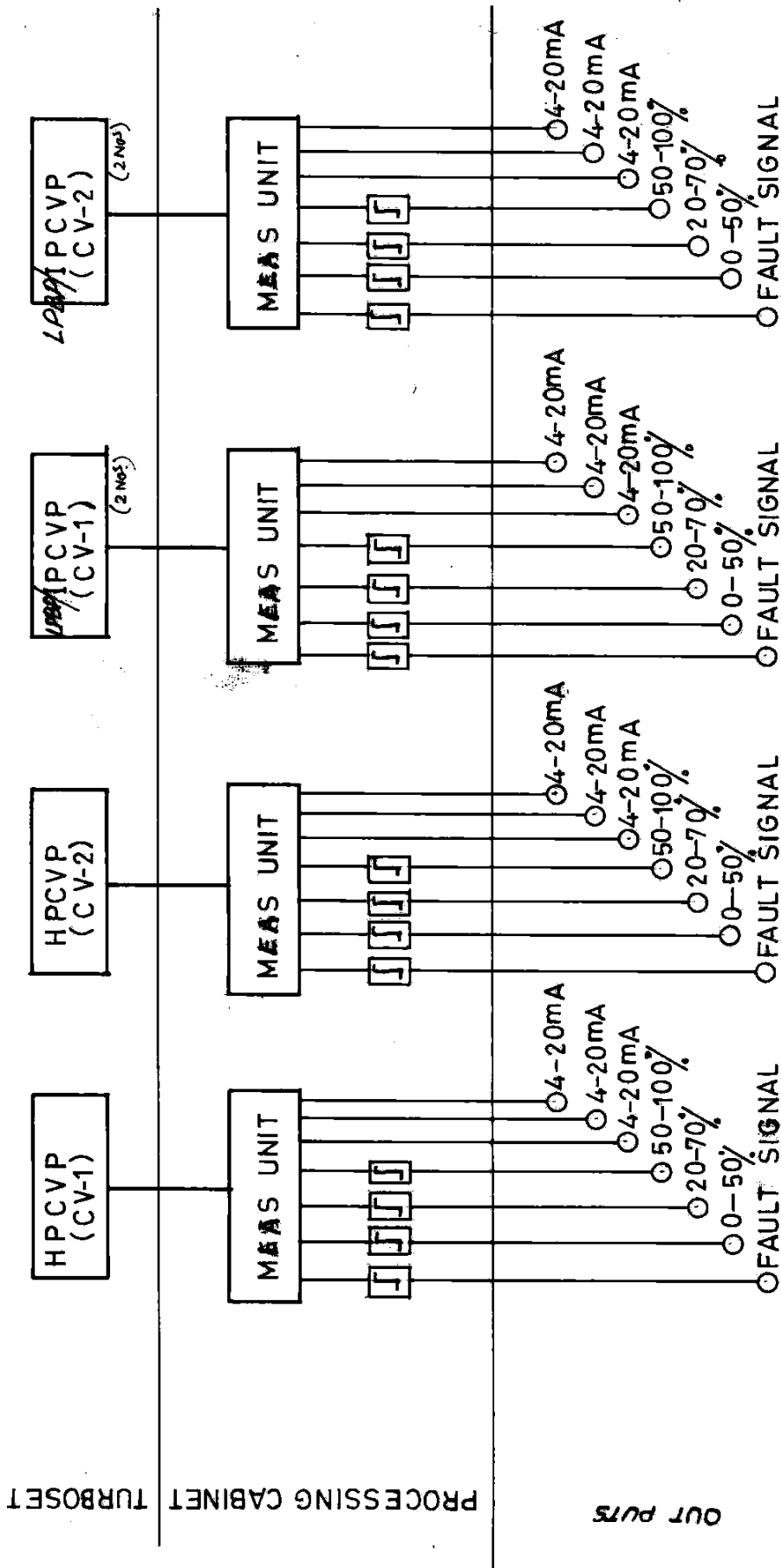
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HPCVP : HP CONTROL VALVE POSITION
~~LPBP~~/IP/PCVP : IP CONTROL VALVE POSITION
 LP By-pass "


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ADDITIONAL DESCRIPTION

- A.1.0 Axial Shift:** This is for monitoring the axial displacement of the turbine rotor. The service shall consist of;
- A.1.1 Sensor:** Contactless variable reluctance or eddy current sensor to suit the available ferromagnetic measuring collar (of the turbine); the mounting bracket shall be compatible to the mounting dimension as shown in Figure-1. The sensor coils shall be housed in oil tight metallic housing with cables in flexible metal conduit. The sensor/mounting bracket shall be mounted on slide guide for simulation of the entire measuring range while the turbine is at stand still.
- A.1.2 Measuring Unit:** To process the sensor signal for the following linear outputs corresponding to the range of -0.5 mm to + 0.5 mm
- i) Three independent 4-20 mA d.c. for a load resistance of 600ohm each.
 - ii) Two sets alarm contacts adjustable over 0-100% of the range with each set being capable of being adjusted independently.
- A.2.0 Differential Expansion of IPT.** Except the mounting arrangements and the size of the sensor, (shown in figure-2) the other details shall be identical to those of A-1-0.
- A-3.0 Differential Expansion of HPT.** This is for monitoring the relative expansion of the rotating and stationary parts of the turbine. Other details shall be identical to those of A-1-0 to A-1-2 except that the outputs of the measuring unit shall be linear corresponding to the range of - 5 mm to + 16 mm.
- A.4.0 Differential Expansion of LPT.** The mounting bracket and the sensor shall be compatible to the mounting dimensions shown in Figure-3 and the outputs of the measuring unit shall be linear corresponding to the range of - 10 mm to + 32 mm. Other details shall be identical to those of A-2-0.
- A.5.0 OVERALL Thermal Expansion of HPT.** For monitoring the overall thermal expansion of the turbine, the service shall consist of;

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- A.5.1 **SENSOR:** LVDT or variable inductance type of sensor to sense the linear movement (expansion). The sensor shall be mounted on the turbine foundation and mechanically connected to the casing (as shown in Figure -4). The sensor shall be provided with a local indication device also.
- A.5.2 **MEASURING: UNIT.** Consisting of processing circuits to process the sensor's output signal for deriving three independent linear analog outputs of 4-20 mA D.C. corresponding to the range of 0-40 mm.
- A.6.0 **OVERALL : THERMAL EXPANSION OF IPT.** All details shall be identical to those of A.5.0 to A.5.2,
- A.7.0 **BEARING PEDESTAL VIBRATION (4 Nos). FOR HP FRONT, HP REAR, IP REAR AND LP REAR.** For monitoring the absolute mechanical vibration of bearing pedestal with a frequency range of 3 Hz to 1 KHz, the service shall consist of :



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A.7.1 (Alternative)

Sensor:

Semimass sensor for mounting on the bearing pedestal (mounting shown in fig.6) shall be supplied with 5 mts. long connecting cable alongwith both male and female connectors for further hooking-up.

A.7.2 (Alternative)

Measuring Unit:

To process the sensor's signal for the following linear outputs a corresponding to the range of 0-160 μ (displacement).

- 1) Three independent 4-20 mA d.c. for a load resistance of 600 Ω each.
- 2) Compatible output for the measuring unit in co. "A.8.2" (alternative) to compute the absolute shaft vibration.
- 3) One set of alarm contacts adjustable over 0-100 % of the range.

A.8.0 Shaft vibration (4 Nos.) for HP Front, HP Rear, IP Rear and LP Rear.

For monitoring the absolute shaft vibration the service shall consist of:

A.8.1 Sensor :

Contactless eddy current type of sensor to detect the relative shaft vibration/any periodic radial displacement of the shaft made of ferrous metal. With respect to bearing pedestal (mounting arrangement is shown in Figure-7. Sensor shall be supplied with 5 mts. long connecting cable alongwith both male & female connectors for further hooking up with the pre-amplifier (cl. A.8.3)

A.8.2 Measuring Unit:

The absolute shaft vibration shall be computed in this unit with the help of suitable processing circuits to process the sensor's signal (in Co. A.8.1), and the compatible output signal of the measuring unit in Col. A.7.2 . The measuring unit shall have three independent linear 4-20mA d.c. analog outputs for a load resistance of 600 Ω each and one set of alarm contacts adjustable over the range of 0-400 μ (displacement) of absolute shaft vibration.

A.8.3 Pre-amplifier :

For transmitting the sensor's signal to the measuring unit (cl. A.8.2) at the control room, the pre-amplifier shall be mounted near the sensing point on the turbine floor. The pre-amplifier shall be required to operate at an environment of max. 100°e and 0-95% relative humidity and shall be housed in dust proof & water-proof encapsulation.

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The absolute pedestal vibration shall be measured by means of "Absolute" and the output of the measuring unit in Col. A.7.2 (displacement). Other details shall be identical to those of Col. A.7.1.

- A.9.0 Absolute Bearing**
Pedestal vibration (4 Nos) for Gen. front (horizontal), Gen. Rear (Vertical), Gen. Rear (Horizontal).
For monitoring the absolute mechanical vibration of the generator bearing pedestal, the service shall consist of:
- A.9.1 Sensor:** Same as in Col. "A.7.1"
Necessary mounting arrangements shall be provided to detect absolute pedestal vibration in both horizontal and vertical axes on Gen. Front and Gen. Rear bearings - pedestals.
- A.9.2 Measuring Unit:** The measuring unit shall have three independent linear 4-20 mA d.c. analog outputs for load resistance of 600Ω each and one set of alarm contacts adjustable over the range of 0-160μ (displacement) of absolute pedestal vibration.
- A.10.0 HP Control valve position (2 Nos.)** For monitoring of the valve / position, the service shall consist of:
- A.10.1 Sensor:** LVDT or variable inductance type of sensor to monitor the valve movement (valve lift). The sensor shall be mounted on the valve body and mechanically connected to the valve spindle through a flexible cord (as shown in Figure-4).
- A.10.2 Measuring Unit:** Consisting of processing circuits to process the sensor's signal for three independent 4-20 mA d.c. linear analog outputs corresponding to the range of 0-50 mm and three sets of alarm contacts adjustable over (0-50%), (20-70%) & (50-100%) of the range.
- A.11.0 IP Control valve Position (2 Nos). and LP By-pass control Valve position (2Nos).** The outputs of the measuring unit shall corresponds to the range of 0-95 mm; all other details shall be identical to those of A.10.0 to A.10.2.

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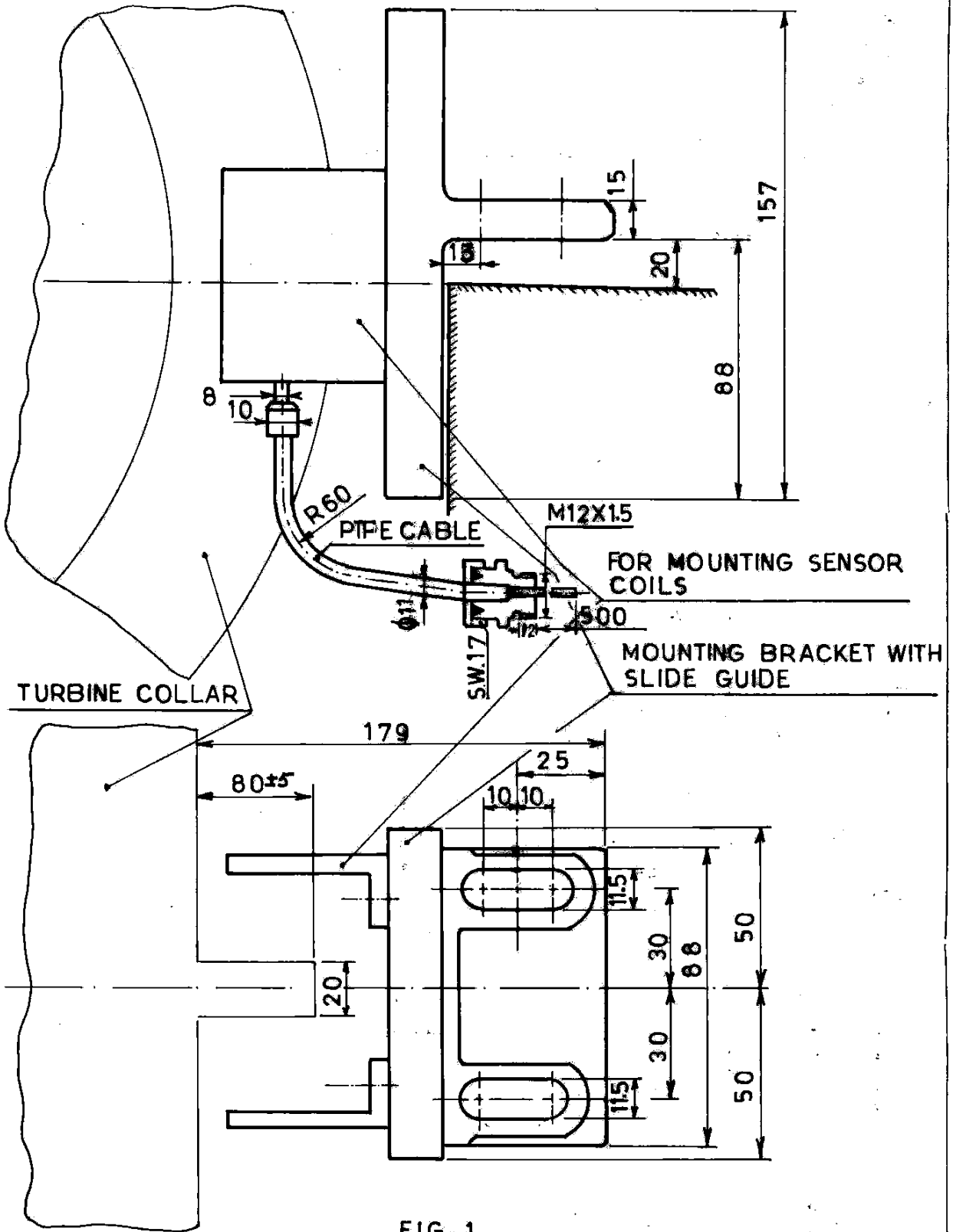


FIG. 1
MOUNTING ARRANGEMENT FOR AXIAL
SHIFT AND DIFF. EXP. OF HPT

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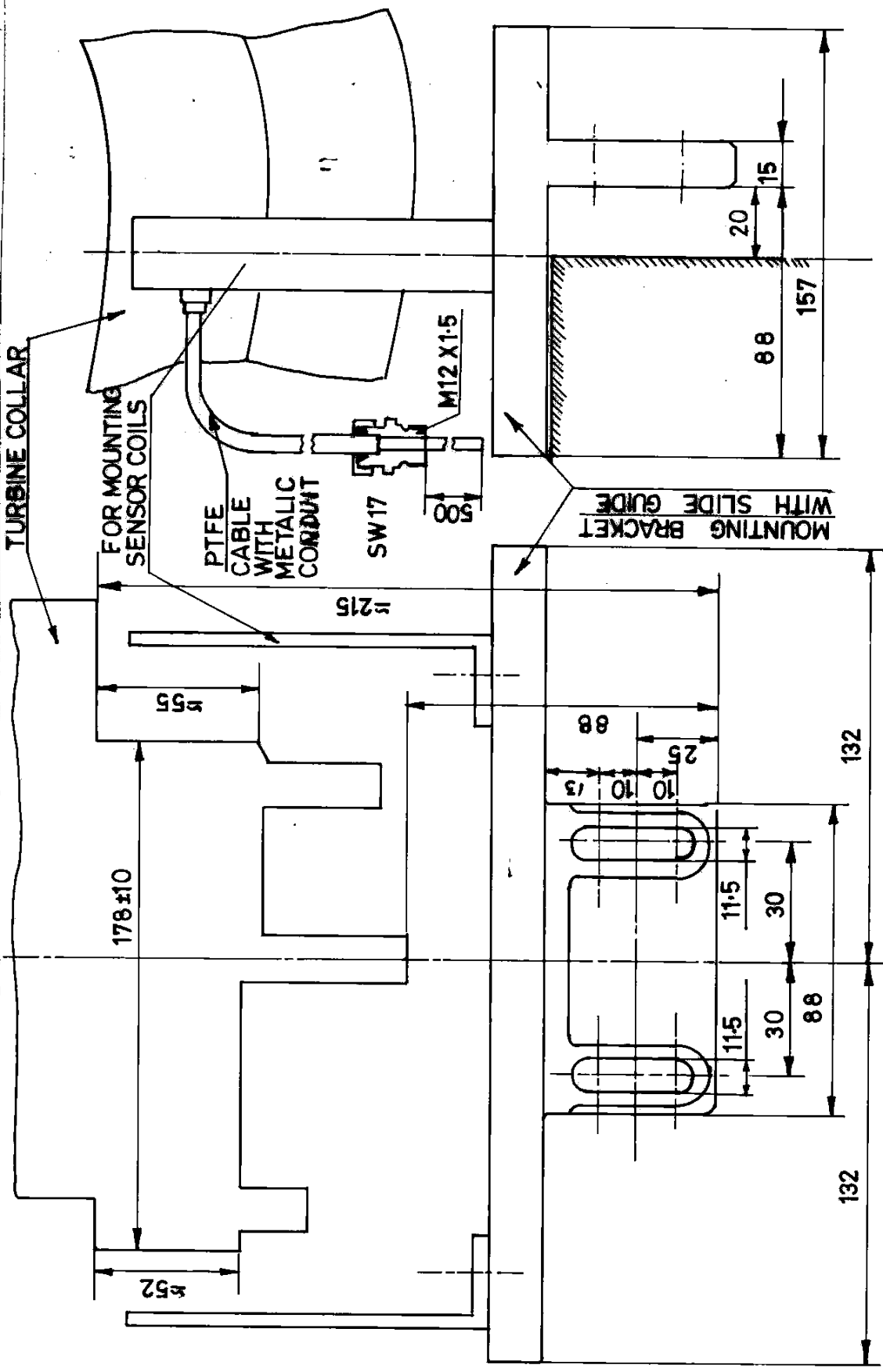


FIG. 2
MOUNTING ARRANGEMENT FOR Diff Exp of IPT

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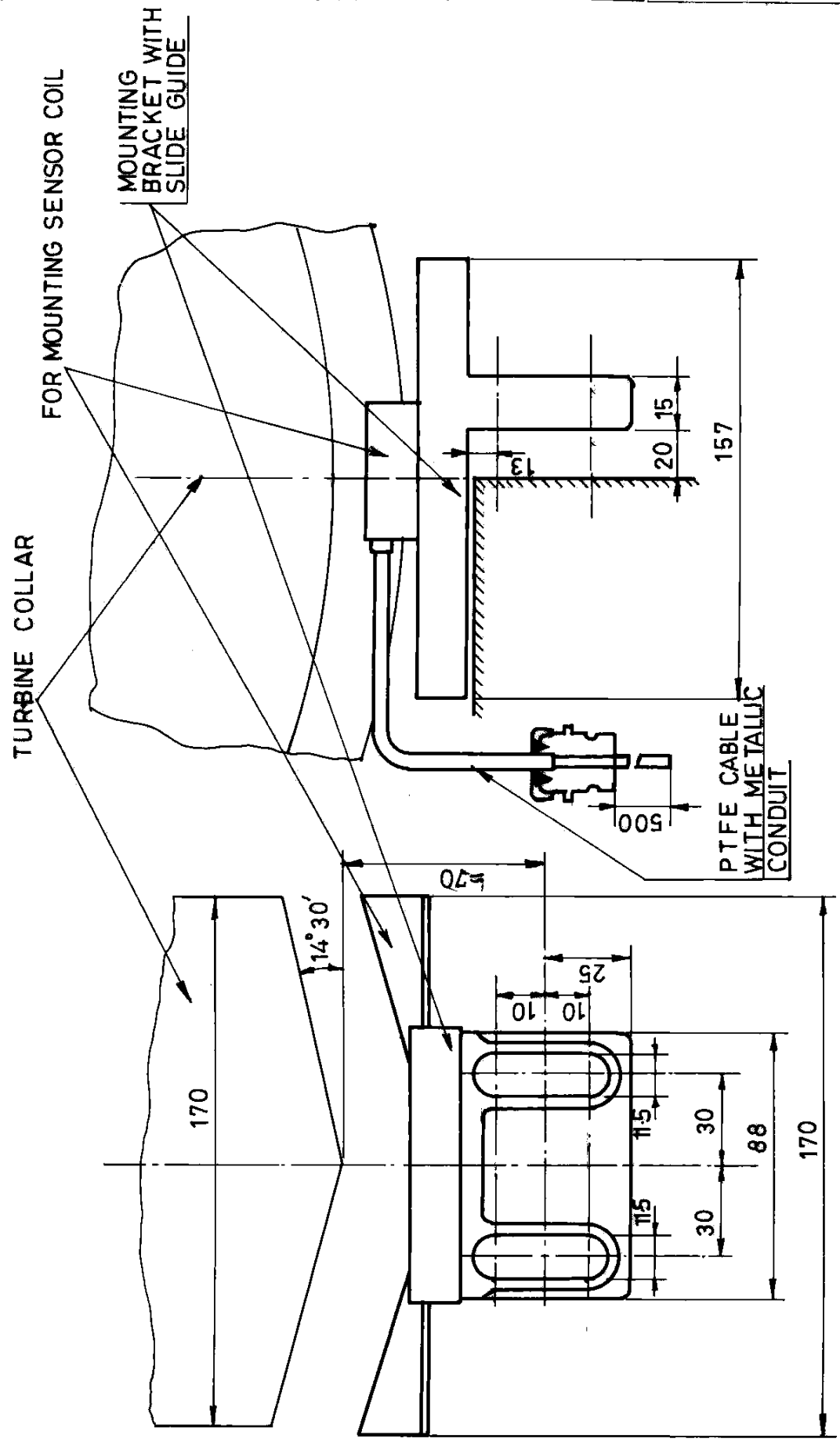


FIG. 3
MOUNTING ARRANGEMENT FOR DIFF EXP OF LPT

श्री लक्ष्मी इन्डिया



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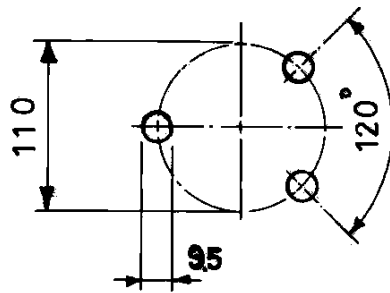
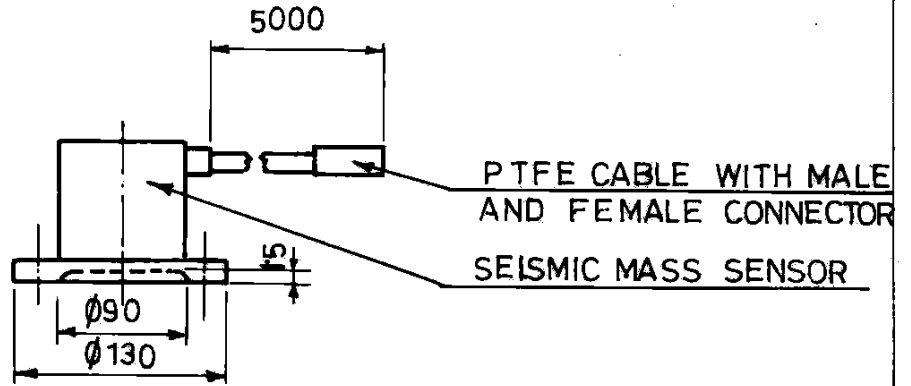
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BEARING PEDESTAL VIBRATION

FIG-5

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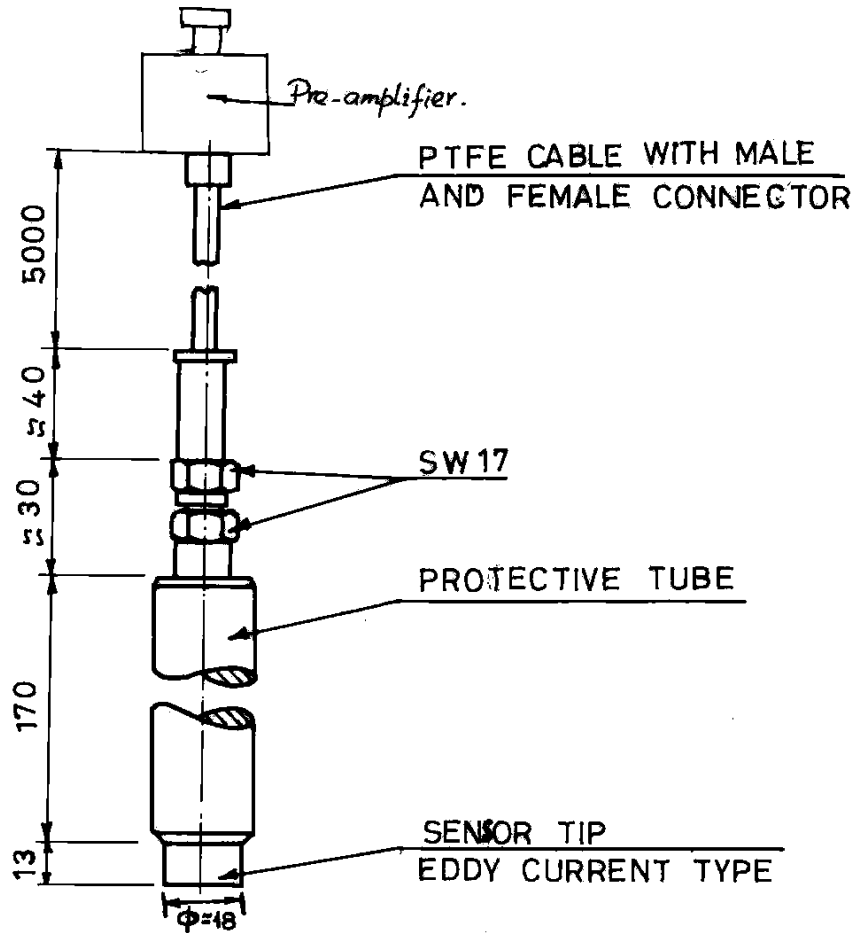
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RELATIVE SHAFT VIBRATION

FIG-6

