OPERATING MANUAL

Cooling Unit-Field Power Supply CU-FPS

Manual 847331

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LDS

HBK

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CONTENTS OF THIS MANUAL

Figures and tables

Drawings included with this manual **No**

Associated publication **No**

LDS MANUALS

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The content of this manual was correct at the date of publication but does not form part of any contract. Changes to the equipment without prior approval from HBK may invalidate any guarantee or warranty.

LDS manuals are continually updated to suit different configurations and applications. For certain products and systems some information in this manual may not be relevant; where it does not apply it should be ignored.

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ISSUE HISTORY

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Amendments

Date	*Issue*	*Pages Affected*	*Brief Details*	*ECO*
(For prior amendments refer to Issue 14 or earlier)				
15.6.23	15	Preface etc, 1.13, 2.7, A1ff	Business name; labelling; field setup; ES&C appendix	–

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DEFINITIONS

For the purposes of this manual:

Danger Zone means a zone extending 2 m (6 ft) from the periphery of the vibrator and cabling.

Note: Outside this zone noise may still be a risk to health and safety.

Exposed Person means any person either wholly or partially in the danger zone.

Operator means any person transporting, installing, adjusting, operating, cleaning, maintaining or repairing the vibration system.

Main Control Position is next to the vibration control unit.

Payload means the test piece, part or assembly under test including any jigs, fixtures, accelerometers and fastenings used to mount it to the vibrator moving element.

SELV means Safe Extra Low Voltage

RISKS & HAZARDS

When planning, installing, operating or maintaining a vibration test system, careful consideration must be given to the potential hazards inherent in the use of such equipment. The information contained in these notices and elsewhere in HBK technical publications should be considered as part of provision and use of work equipment (PUWER or equivalent) assessments. Where risks and hazards are identified, appropriate warning signs should be displayed and exclusion zones defined.

Noise

Exposure of the human body to high noise levels can damage health. Electrodynamic vibration test equipment can generate significant noise levels and ideally should be sited within a soundproof cell. The operator control position, together with signal generation, control and monitoring equipment should be located outside the soundproof cell. Power amplifiers, cooling units and other ancillary equipment can also generate significant noise levels and should be located away from the operator control position. If the ideal situation is impractical, all personnel at risk must be made aware of the hazards involved and a directive issued that ear defenders should be worn.

Mechanical

It must be remembered that vibrators can be used to test equipment to destruction and that the forces available can be considerably amplified by local resonances. Precautions must be taken to ensure that any parts of the payload which may become detached cannot cause injury to personnel.

Payloads must be designed and mounted such that they cannot overturn the vibrator either statically or under test. Further, they must not exceed the rated load of the vibrator bearings.

In so far as their purpose allows, payloads should have no sharp edges, no sharp angles and no rough surfaces likely to cause injury. Payloads should also have no trapping points e.g. where fingers or hands might be trapped during test.

It is recommended that all persons entering the danger zone, whether the vibrator is energised or not, are aware of the risks and that appropriate protective clothing is worn. Other risks specific to siting and operation of the vibrator are identified in the relevant sections of this manual.

Electrical

All equipment constituting a vibration test system contains voltages above SELV and is potentially lethal. During normal operation it is not necessary for an operator to access areas containing voltages above SELV. Access to high voltage areas can only be gained by removing panels or covers, or by opening doors with the use of a tool (including a key).

It is the policy of HBK to supply two keys for each lock position. To ensure that access to the interior of equipment is restricted to designated personnel, it is strongly recommended that all keys are held by a responsible person, authorised to issue keys for service/maintenance purposes.

With the exception of calibration or fault diagnosis by qualified personnel, equipment should be completely isolated from the supply before gaining access. Residual hazardous voltages may be present immediately after isolation.

Pneumatic

Some vibrators rely on a compressed air supply for armature and body support. Due care and attention must be given when fixing loads to the armature and subsequently setting armature and body positions.

It is recommended that the air supply has a shut-off valve adjacent to the vibrator for use in emergencies or when the vibration system is not being used e.g. overnight. In such cases the payload should be supported by other means e.g. armature lock-out plates or overhead crane.

Hydraulic

Some vibrators and all combos use Shell Tellus oil or equivalent. Whilst this oil does not pose a direct health and safety hazard, care should be taken to clean up any spillages which may occur during filling, draining or operating the system. It is also recommended that any oil making skin contact is removed as soon as possible.

Water

Some vibrators are water-cooled with the cooling system self-contained within the vibrator, hoses and cooling unit. Although water can only be released (leak) due to a failure in the system, operators should be made aware of the temperatures attained during normal operation (see below).

Temperature

The heat generated by all equipment in the vibration test system should be considered before siting. Measures should be taken to ensure that the temperature of the working environment for the system and operating personnel is within allowable limits. Operators should also be made aware that some equipment, particularly water cooled vibrators, can attain high surface temperature during normal operation.

Blower Outlet (Air-cooled vibrators)

The air outlet port from the cooling blower in air-cooled vibrator systems should be positioned such that an operator cannot stand directly in line with the airflow. This precaution will prevent injury in the event of small objects, e.g. nuts or screws becoming detached in the vibrator and ejected at high velocity from the blower.

Cables and Hoses

Where practical, all cables and hoses used in the vibration test system should be sited in ducts or trunking to give clear unimpeded access to the vibrator, power amplifier, cooling unit and other ancillary equipment.

Chemicals

The hazards of chemicals/cleaning agents are dependent not only upon the toxicity of materials but also upon the degree and nature of exposure. Users should adopt procedures conforming to the requirements of the European Directive 90/394/EEC, Protection Of Workers From The Risks Related To Exposure To Carcinogenic Substances At Work, which is implemented in the UK by the COSHH regulations.

IMPORTANT NOTE: In special cases where vibrator rolling seals are required to have resistance to fuel oil, the standard white SILICON vibrator seal may be replaced by a black VITON seal. In the event of a fire, anyone handling residues of VITON must wear Neoprene protective gloves to avoid skin contact with possibly highly corrosive residues which are likely to include hydrogen fluoride. DISCARD GLOVES AFTER USE.

Magnetic Fields

Electromagnetic vibrators and associated power products produce DC and low-frequency magnetic fields. In the light of medical research on the effect of electromagnetic fields on the human body, HBK recommend that wearers of electromedical implants take especial care not to enter the danger zone while the vibrator is operational.

HBK cannot accept responsibility for any effects on health of electromagnetic fields but strongly advise that all precautions as defined in this notice and product manuals are followed.

INSTALLATION

Line of Sight

From the main control position it must be possible to ensure that there are no exposed persons in the danger zone. For vibration systems in which there is no direct line of sight or video link between the control position and the vibrator, it is recommended that an audible warning device is fitted at the vibrator location to give notice of impending operation. This will give personnel in the danger zone opportunity to vacate the area, or actuate the emergency stop to prevent vibrator operation.

Emergency Stop

For most vibration test systems, the vibrator is fitted with a minimum of one locking emergency stop pushbutton, and includes the facility for additional emergency stop pushbuttons at other locations. It is recommended that on large systems (with the vibrator in the horizontal mode) or with combos, the additional emergency stop(s) are located adjacent to the payload position, in easy reach of an operator working in that area.

Additional emergency stop switches must comply with BS EN418-1992

OPERATION

LDS systems are designed to provide a controlled vibration testing environment for quality and reliability testing of components and assemblies, within the limits stated in the specifications. Any other use, e.g. in an explosive or corrosive environment, unusual loading, etc, may invalidate contractual agreements. Any doubts regarding the fitness for purpose of the equipment should be referred to HBK Technical Department before the equipment is used.

Before-use Checks

Before operating any vibration system, check that:

- the vibration test area is clear of unnecessary obstructions.
- all terminal covers are correctly fitted.
- all equipment doors are correctly closed and secure.
- the supply of cooling medium (if applicable) is sufficient.
- the hydraulic oil supply (if applicable) is correctly topped-up.
- the item under test is correctly secured to the vibrator or slip table.
- all personnel are clear of the danger zone

Emergency Stop

If an emergency arises, the emergency stop should be activated immediately.

Remote Control Operation

For systems including a remote control panel (RCP), operation is only permitted from one control position (amplifier or RCP). This protection is provided either by software selection or by keyswitch operation, the key being common for both positions. Although HBK provide more than one key, it is strongly recommended that only one is issued and its use restricted to the authorised operator. This will provide added protection against system mal-operation or misuse.

TRAINING

Vibration test systems encompass a wide variety of technological disciplines and it is essential that personnel are properly qualified and trained before being authorized to work on such a system. Access to areas where vibration test systems are located should be restricted to authorised personnel. HBK offers short training courses providing a practical introduction for technicians/engineers new to vibration testing.

MAINTENANCE

A programme of planned maintenance, carried out by fully trained and qualified personnel, is essential to maintain the safety of the equipment. Safety interlocks must be frequently checked for correct operation. Under no circumstances should protective earth conductors be left disconnected; these should be frequently checked to ensure good earth bonding of all equipment. Frequent checks on armature and field coil insulation should be carried out in accordance with the detailed vibrator maintenance section of this manual.

CUSTOMER RESPONSIBILITIES

When specifying, siting, installing and operating a vibration system the customer is responsible for the following:

1. Off-loading, unpacking and siting the equipment at its designated position.
2. Ensuring that the floor surface where the equipment is to be located is suitable for the equipment.
3. Ensuring that access to the equipment is adequate.
4. Providing all service requirements such as water, air lines, electrical power etc. to the point of entry to the equipment and ensuring that such supplies conform to company specifications.
5. Supplying all test equipment necessary to complete acceptance testing.
6. Making available consumable materials such as distilled water, oil, cleaning material etc.
7. Any special tools required for commissioning the system such as lifting equipment etc.
8. Completion of pre-installation check list prior to commencement of installation
9. To validate warranty, return to HBK on completion of all installations or commissioning of the signed commissioning certificate.
10. PAYLOADS AND THEIR EFFECT ON THE VIBRATOR ARE THE RESPONSIBILITY OF THE CUSTOMER.

VISUAL SYMBOLS

The following visual symbols may be used on the equipment:

Symbol	Description
	Alternating current
	Earth (ground) terminal
	Protective conductor terminal
	Caution - risk of electric shock
	Caution - risk of danger

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CONFORMITY

LDS equipment is designed specifically for vibration testing and should not be used for any other purpose except by agreement with HBK.

The equipment complies where applicable with the following European Union (EU) directives and standards:

Machinery Directive	2006/42/EC
Low Voltage Directive	2014/35/EU
EMC Directive	2014/30/EU
RoHS 2 Directive	2011/65/EU

EN 61010-1:2010+A1: 2019
EN 60204-1: 2018
EN IEC 61000-6-2: 2019
EN 61000-6-3: 2007+A1: 2011
CISPR 22 Class A

For installation, use and maintenance of this equipment the responsibilities of employer and employee are specified in Work Equipment Directive 2009/104/EC which refers to suitability of work equipment, maintenance, specific risks, information & instructions and training. The directive is implemented in the United Kingdom by statutory regulations 'Provision and Use of Work Equipment Regulations 1998' and by similar regulations in other EU countries.

LDS product design provides personal protection in accordance with the applicable directives listed above, and care has been taken to minimise the risks associated with all equipment constituting a vibration test system. Since however the vibrator and other equipment contains moving parts and can exert large forces on jigs, fixtures and payloads, the area surrounding such equipment should be declared a Danger Zone (see Definitions) and suitable precautions taken by operators working there.

HBK DOES NOT ACCEPT RESPONSIBILITY FOR RISKS INTRODUCED BY JIGS, FIXTURES AND PAYLOADS.

FOR LDS JIGS AND FIXTURES SEE THE APPROPRIATE MANUAL.

CHAPTER 1 INTRODUCTION

1. GENERAL DESCRIPTION

The information contained in this publication is applicable to all units in the CU/FPS range unless specifically stated otherwise.

The CU/FPS Cooling Unit/Field Power Supply is a multi-purpose assembly providing the following functions required by specific ranges of LDS vibrators:

1. A demineralised water supply, used to cool the vibrator's field coils.

2. A demineralised water supply, used to cool the vibrator's armature coil. This supply is piped directly to the armature.

3. A hydraulic oil supply, with oil cooling, used to operate the vibrator's hydrostatic guide bearing.

4. The power requirements for the air injection equipment *(CU64/84 only)*.

5. The Field Power Supply (FPS) for the vibrator field coils.

Note: If the equipment is used for any other purposes the protection provided to the user is impaired.

For (1) to (3) above, the inlet cooling medium is clean raw town or tower water, with isolation of the demineralised cooling water achieved by dual circuit water-to-water heat exchangers.

For (5) above, the field power supply consists of a 3-phase full wave rectifier circuit employing a half controlled diode bridge for adjustment of field power and setting to fixed economy power levels.

Equipment Range

The range consists of three basic units designated as follows:

CU/FPS64	for operation with the	V964 vibrator
CU/FPS84	for operation with the	V984 vibrator
CU/FPS94	for operation with the	V994 vibrator

Each unit is identical in overall format, the differences being confined to overall Field Power Supply and Cooling Unit dissipation capabilities.

GENERAL DESCRIPTION (cont.)

The units have been designed specifically to interface with, and be controlled by, the LDS DPAK Range 1 amplifier (See Figure 1.1).

Note: The RFI filter is always provided for 'CE' standard amplifiers, i.e. when sold into European countries. For countries outside Europe, the provision of the filter is dependent on customer requirements.

The CU/FPS is housed in a three bay cabinet (refer outline drawing and Figure 1.2). The right-hand bay contains the cooling equipment and control panel, the left-hand and centre bays contain the FPS. For the position of the Input/Output Panel, Contactor Panel, I/O PCB etc. refer to Figure 6.3.

A 3-phase mains supply is required for CU/FPS operation; this supply should be protected by an exclusive 3-phase isolator.

A field isolator switch, fitted at the rear of the left-hand bay, enables (for maintenance purposes) isolation of the FPS section of the unit. Access to the switch requires the rear door to be open. Internal 3-phase 'mains on' indicators are fitted.

A raw water supply is required by the cooling equipment.

The cooling unit can be switched on and off manually from the control panel, located in the right-hand bay, but control of the CU/FPS is normally from the system amplifier. The FPS output cannot be enabled unless the cooling equipment is operating.

Safety interlocks are fitted to all cabinet doors. The interlocks are connected to a system interlock which shuts down the amplifier when a door is opened (refer to Chapter 3 of this publication). Extra contacts are provided in the door interlocks to enable the use of an external trip isolator to remove the 3-phase supply when a door is opened.

A monitoring panel at the rear of the centre bay displays critical temperatures in ºC. The panel consists of four digital displays, each monitoring a temperature within the vibrator or cooling unit. The displays are configured for fail-safe operation: if any thermocouple cable becomes disconnected or fails then the relevant interlock will be tripped. The configuration of each display is factory pre-set and should not be altered. *(14)*

WARNING

LETHAL VOLTAGES ARE PRESENT WITHIN THE EQUIPMENT CABINET. BEFORE ATTEMPTING ANY MAINTENANCE TASK, THE SUPPLY MUST BE SWITCHED OFF AT THE INCOMING ISOLATOR.

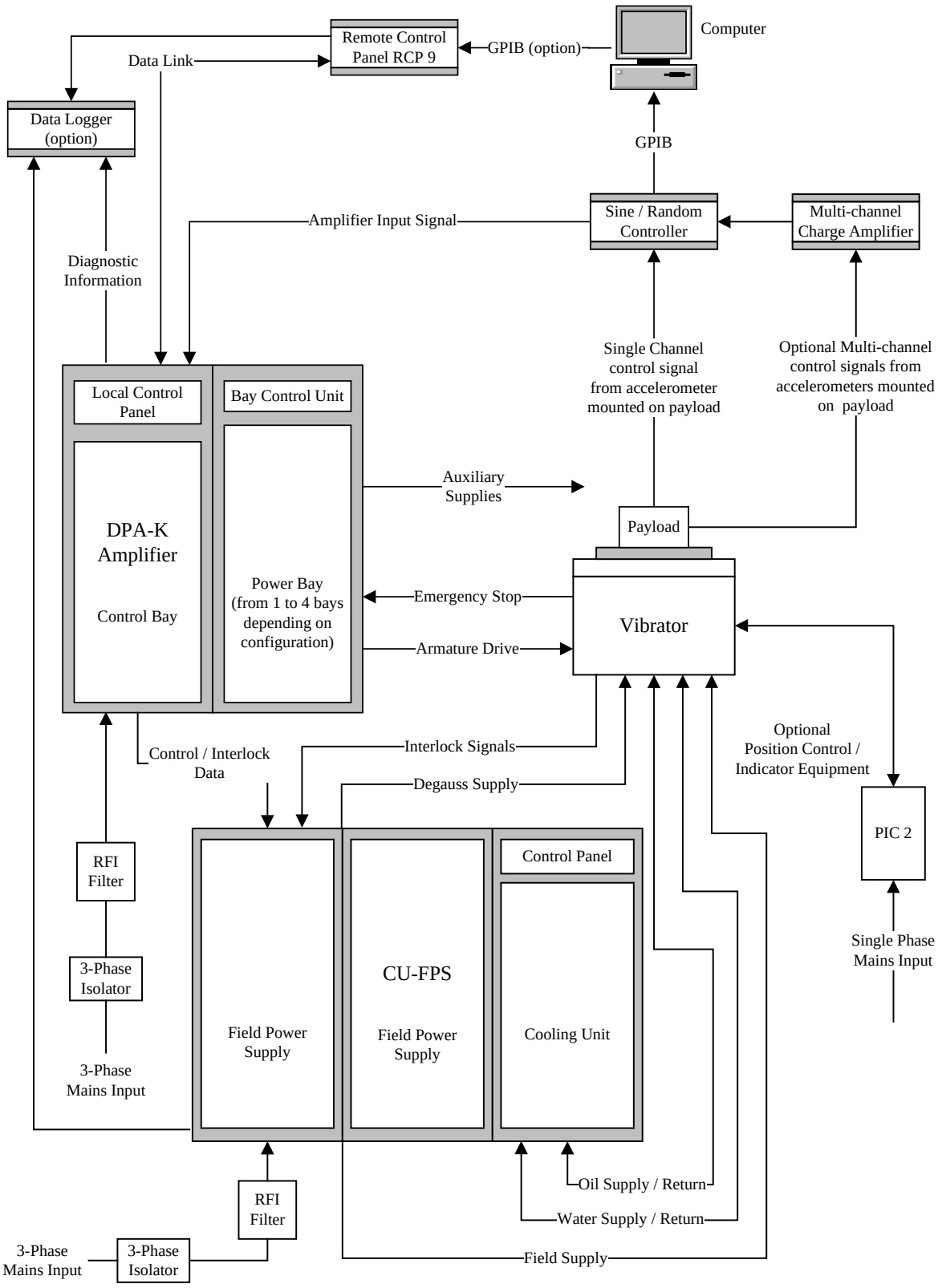
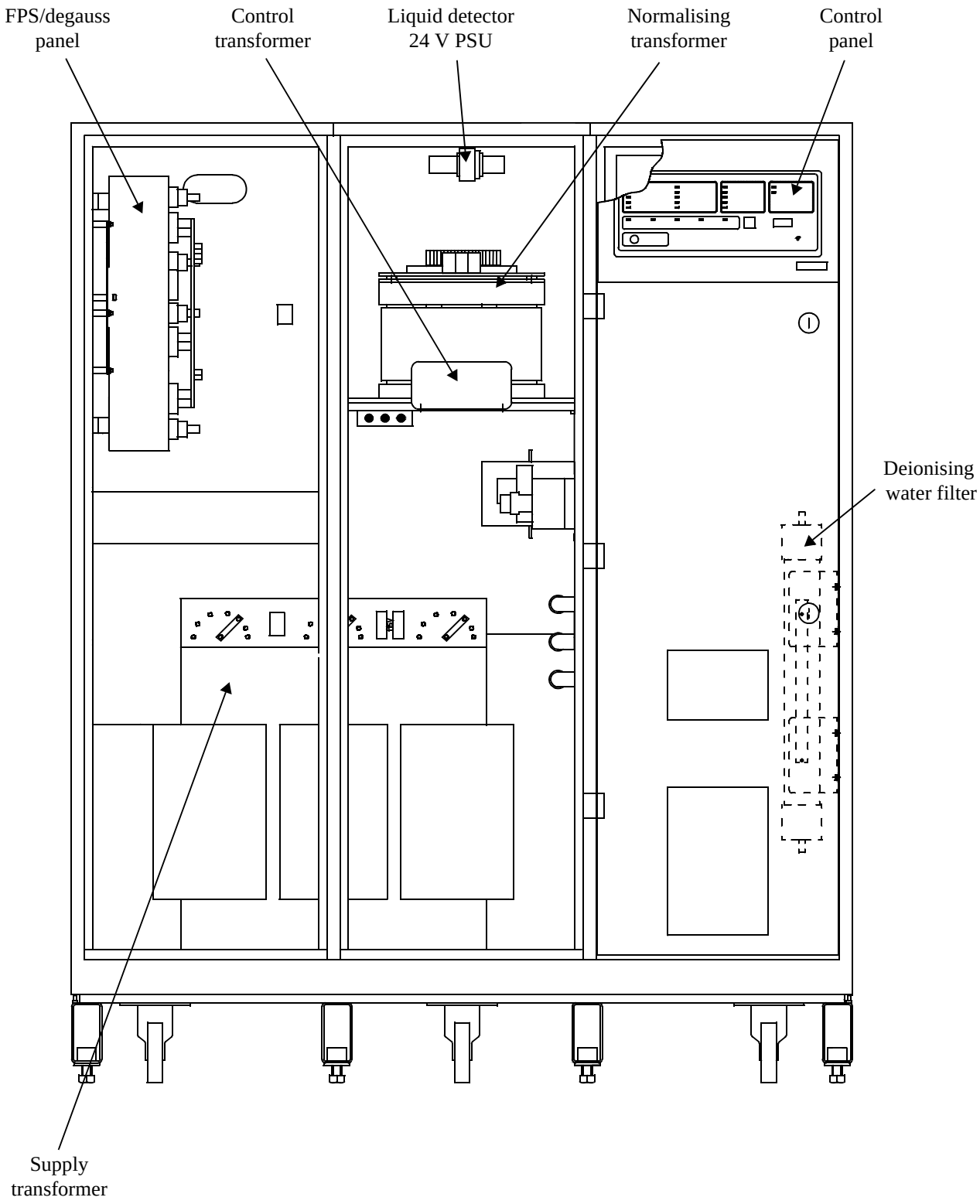
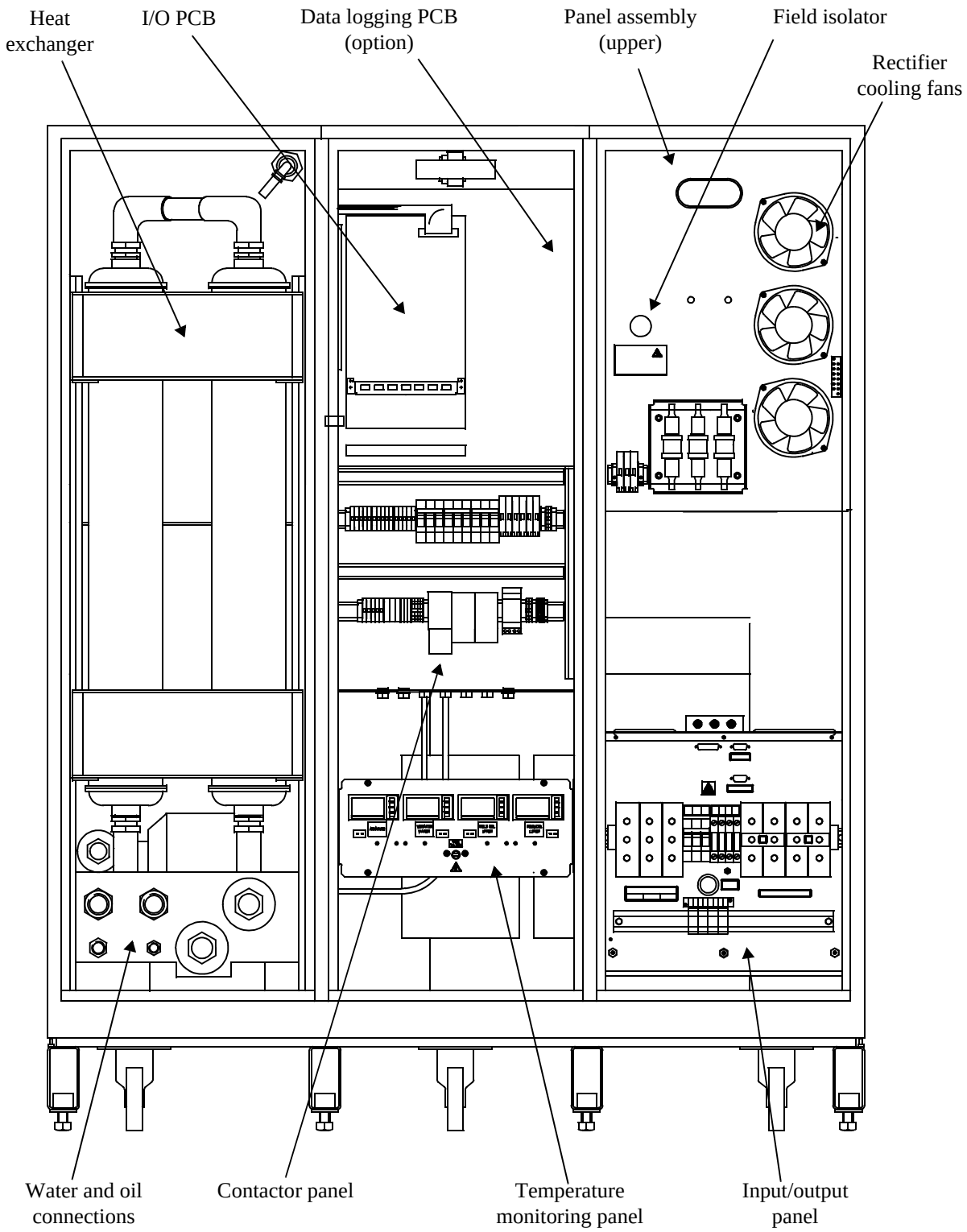


Figure 1.1 Typical V900 vibration test system

GENERAL DESCRIPTION (cont.)



Front view



Rear view

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Figure 1.2 CU/FPS Cabinet Configuration

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2. SPECIFICATION

Specification Parameter	CU/FPS64	CU/FPS84	CU/FPS94
Supply Voltage Range	380, 400, 415, 440V 50/60Hz 480, 500, 520V 60Hz		
Overall Dimensions	Height 1905 mm (75 in.) Width 1500 mm (61.4 in.) Depth 825 mm (32.4 in.)		
Audible noise (for all 3 units)	89 dBA		
Ambient Working Temperature	+5^{o}C to +40^{o}C		
Relative Humidity	0 - 95% non-condensing		
Weight (approximate)	718 Kg (1583 lbs)	970 Kg (2139 lbs)	1222 Kg (2695 lbs)
Supply input Power (Full Level FPS) Supply input Power (Economy FPS)	66.15 kW 35.17 kW	107.37 kW 56.83 kW	159.61 kW 84.71 kW
Supply input kVA (Full Level FPS) Supply input kVA (Economy FPS)	70.26 kVA 37.74 kVA	115.03 kVA 61.98 kVA	169.63 kVA 91.01 kVA
Heat Rejected to Air: a. Cooling Unit total b. FPS (Full Level Setting) c. FPS (Economy Level Setting) d. Degauss	 1.684 kW 2.55 kW 1.72 kW 0.072 kW	 2.07 kW 3.30 kW 2.24 kW 0.06 kW	 2.80 kW 4.40 kW 2.93 kW 0.13 kW
Total Unit Heat Rejected * (FPS Full Level) Total Unit Heat Rejected * (FPS Economy Level)	2.76 kW 1.93 kW	3.55 kW 2.49 kW	4.79 kW 3.32 kW

* Figures include losses in the control and normalising transformers

Table 1.1 Specification Parameters of Overall Equipment

2. SPECIFICATION (cont.)

Specification Parameter		CU/FPS64	CU/FPS84	CU/FPS94
FPS Full Level Setting				
Nominal Load	ohms	0.363	0.6	0.495
DC Rated Output	Volts	145	240	265
DC Rated Output	Amps	400	400	535
DC Rated Output	kVA	58	96	141.78
Supply Input Power	kW	60.56	99.7	147.13
Supply Input kVA	kVA	63.6	104.7	154.50
Heat Rejected to Air	kW	2.55	3.30	4.40
Initial Switch on DC overload current (amps) Decaying to rated current within 5 minutes		480	480	642
FPS Economy Level Setting				
Nominal Load	ohms	0.363	0.6	0.495
DC Rated Output	Volts	101.5	168	185.5
DC Rated Output	Amps	280	280	374.8
DC Rated Output	kVA	29	48	69.52
Supply Input Power	kW	29.85	49.03	72.38
Supply Input kVA	kVA	31.34	51.48	76.00
Heat Rejected to Air	kW	1.72	2.24	2.93
Degauss Supply				
Nominal Load	ohms	19.1	57.83	31.55
DC Rated Output (Adjustable Volts)		0 - 145	0 - 240	0 - 265
DC Rated Output (Adjustable Amps)		0 - 7.6	0 - 4.15	0 - 8.4
DC Rated Output	kVA max	1.102	0.996	2.23
Supply Input Power	kW max	1.174	1.056	2.36
Supply Input kVA	kVA max	1.23	1.108	2.48
Heat Rejected to Air	kW max	0.072	0.06	0.13

Table 1.2 Performance Specification of Field Power Supply

2. SPECIFICATION (cont.)

Specification Parameter		CU/FPS64	CU/FPS84	CU/FPS94
Demineralised Water Cooling				
Outlet temperature max*	^{o}C	35	35	35
Inlet temperature max*	^{o}C	77	77	77
Flow Rate	L/min	35	56	74
Pressure Drop	bar	11	11	11
Capacity	Litres	40	50	60
Total Dissipation	kW	100	160	211
Pump Motor Input	kW	4.7	4.7	8.82
Pump Motor Input	kVA	5.47	5.47	10.26
Pump Motor Shaft	kW	4.0	4.0	7.5
Raw Water Cooling				
Inlet temperature max	^{o}C	32	32	32
Outlet temperature max	^{o}C	48	48	47
Flow Rate	L/min	90	147	209
Pressure Drop	bar	0.5	0.41	0.77
Hydraulic Power pack				
Hydraulic Oil type		SHELL TELLUS 68 (or equivalent)		
Oil flow	L/min	2.1	2.1	2.1
Rated Oil pressure	bar	172	172	172
Oil Capacity	Litres	30	30	30
Pump Motor Input	kW	1.28	1.28	1.28
Pump Motor Input	kVA	1.51	1.51	1.51
Pump Motor Shaft	kW	1.1	1.1	1.1
Air Injection Pump				
Pump Motor Input	kW	N/A	0.43	0.43
Pump Motor Input	kVA	N/A	0.51	0.51
Pump Motor Shaft	kW	N/A	0.37	0.37
Overall Heat Rejected	kW	1.684	2.07	2.8

* These temperatures refer to inlet and outlet of the cooling unit. They are reversed for the vibrator.

Table 1.3 Performance Specification of Cooling Unit

2. SPECIFICATION (cont.)

The AC RFI filter is designed for mounting external to the CU/FPS and is provided with flexible conduit, fittings and cable for connection to the CU/FPS. It is the customers responsibility to provide the mains input to the filter via a 3-phase isolator (see Appendix A).

Three electrical ratings are available to match the individual CU/FPS units.

CU/FPS	Filter Current Rating	Filter Size	Filter Weight
64	115 Amps	tba	tba
84	175 Amps	tba	tba
94	275 Amps	tba	tba

3. ENVIRONMENTAL DATA

3.1 Environmental Notes

(For notes applicable to this system, see the Systems Manual and Environmental Data Sht.)

3.1.1 The customer must provide frost protection for cooling water. **Antifreeze must not be added to demineralised water.** Electric heaters are essential.

3.1.2 Equipment positioning is not critical, provided that sufficient clearance is given for cooling airflow and maintenance access (see Chapter 5.1), and may be installed in various configurations to suit laboratory layout.

3.1.3 Customer responsibilities are tabulated on the environmental data sheets and are shown dotted on the schematic cable interconnections diagram.

3.1.4 The determination of sound power levels of noise sources is a varied and complex procedure. (Reference should be made to BS4196: Part 4, or ISO3744) see Figure 1.3.

The noise levels quoted on the environmental data sheets are for general guidance only. Noise levels will vary considerably, depending on equipment type, site installation and test conditions. Electrodynamic vibration systems, and in particular the vibrator, generate very high noise levels and ideally should be sited in a soundproof cell.

3.1.5 The main earth cable should be independent of any electricity supply transformer and taken to a local isolated earth plate adjacent to the vibration system. The earth impedance should not be greater than 0.1 ohm. Earth system loops should be avoided, particularly in the control instrumentation and monitor circuitry.

For good EMC performance, it is recommended that the earth is provided by a ground mesh set in the building foundations, below the CU/FPS position. Connections from the mesh to the CU/FPS protective earth should be via a large copper earth strap (see Chapter 6).

3.1.6 Water quantities quoted are for the cooling unit and vibrator; with standard 6 metre length of interconnecting hose.

3.1.7 Vibration earth connection is via the drive cable.

3.1.8 The system performance quoted is with the standard lengths of vibrator interconnecting cables.

3.1.9 Oil pressure quoted is the maximum available, reduced by internal regulator to the required level.

3.1.10 All cooling units have a standard voltage range 380 - 520 V. An internal normalising system ensures standard pump voltage of 415 V irrespective of input voltage. All cooling units are, however, specific to supply frequency 50 or 60 Hz.

3. ENVIRONMENTAL DATA (cont.)

3.1.11 Amplifier supply voltages over the range are catered for by means of tap changing on the supply transformer.

3.1.12 Oil quantities quoted are for the complete system, i.e. vibrator and oil supply unit with standard lengths of interconnecting hoses (6 metres).

3.1.13 If the amplifier is a derivative of the maximum size, i.e. with power modules removed, then environmental data used should be for the derivative as specified in the appropriate column on the relevant environmental data sheet .

For installations where an amplifier **derivative** is initially specified, with the intention of future expansion to maximum capability, due regard should be made to the environmental requirements of the maximum amplifier size.

3.1.14 Demineralised water flow rates quoted for vibrators are minimum flow requirements. Flow rates may be greater than minimum flow requirement due to nominal manufactured pump sizes.

3.1.15 Transformer dimensions quoted are approximate.

3.1.16 Equipment part numbers shown on environmental data sheets are standard equipment numbers.

3.1.17 Ratings given for heat rejected to system cooling unit and customer cooling tower are dependent on the maximum system thrust rating; and are therefore, quoted with reference to the maximum amplifier size.

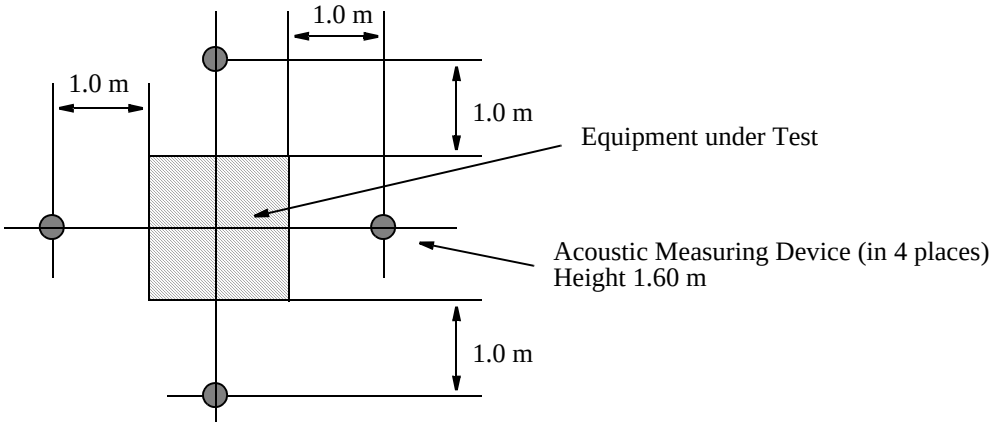

Figure 1.3 Noise Level Measurement (distances taken in a large open area)

4. LABELLING

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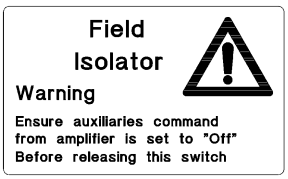
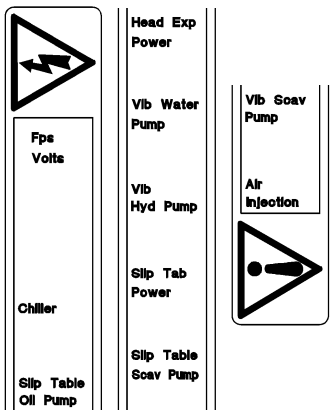
The following textual labels are affixed to the CU-FPS:

a) "Warning – isolate equipment before removing this cover"

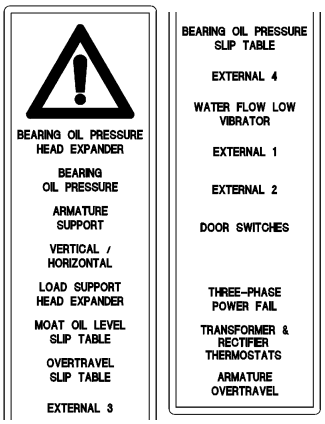
a) "Protective conductor terminal"



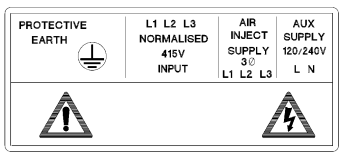
b) "Field Isolator: Warning – Ensure auxiliaries command from amplifier is set to 'Off' before releasing this switch."



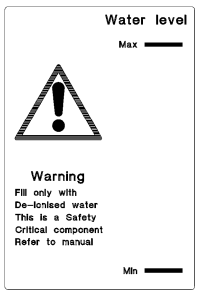
c) "FPS volts; Chiller; Slip table oil pump; Head exp[ander] power; Vib[rator] water pump; Vib[rator] hyd[raulic] pump; Slip tab[le] power; Slip table scav[enge] pump; Vib[rator] scav[enge] pump; Air injection."



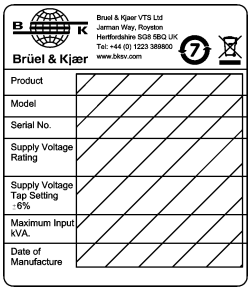
d) "Bearing oil pressure – head expander; Bearing oil pressure; Armature support; Vertical/ horizontal; Load support – head expander; Moat oil level – slip table; Overtravel – slip table; External 3; Bearing oil pressure – slip table; External 4; Water flow low – vibrator; External 1; External 2; Door switches; Three-phase power fail[ure]; Transformer and rectifier thermostats; Armature overtravel. "



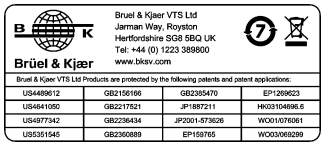
e) "Protective earth; Normalised input; Air inject[ion] supply; Auxiliary] supply."



f) “Warning – Fill only with de-ionised water. This is a safety critical component. Refer to manual; Water level Max–Min;”



b) “Product; model; serial no; supply voltage rating; supply voltage tap setting; maximum input kVA; date of manufacture”



c) “Bruel & Kjaer VTS products are protected by the following patents and patent applications.”

CHAPTER 2 DESCRIPTION

1. CLOSED WATER CIRCUIT

NOTE

DEMINERALISED WATER IS A SAFETY CRITICAL COMPONENT. UNDER NO CIRCUMSTANCES USE TAP OR CONTAMINATED WATER. ENSURE THAT THE CONDUCTIVITY OF DEMINERALISED WATER, USED TO FILL THE SYSTEM, IS NO GREATER THAN 10 μS.cm. *(12)*

IN SERVICE, THE CONDUCTIVITY SHOULD BE MAINTAINED AT A LEVEL NO GREATER THAN 5 μS.cm BY THE INTERNAL WATER FILTER.

General

The closed water circuit which provides cooling water for the vibrator, contains the following items (refer to Figure 2.2):

- Heat exchanger
- demineralised water expansion tank
- demineralised water circulating pump
- Flow switch
- Thermocouple
- De-ionising water filter *(12)*

Heat Exchanger

A shell and tube heat exchanger is used; the raw water flows through the tubes, and the demineralised water through the shell. The exchanger is hinged to improve access for servicing. Approximately 1.5 m space is required at the rear of the cabinet to swing the exchanger into the servicing position.

Expansion Tank

The expansion tank, fitted at the top of the cabinet, allows the demineralised water circuit to be topped-up as required. Losses can be caused by leakage or evaporation. A sight glass indicates the level of water in the tank; the maximum and minimum levels are shown on the side of the tank. A filter is fitted to the expansion tank output circuit. Refer to Table 1.3 for tank capacity.

Demineralised Water Pump

This pump circulates the demineralised water directly through the vibrator field coils, and to the armature coil. The pump's motor is driven from an internally normalised 415 V, 3-phase supply.

1. CLOSED WATER CIRCUIT (cont.)

Flow Switch

A flow switch is fitted in the return line. In the event of hose failure, kinking of a pipe, blockage or failure of the circulating pump, the flow rate falls below a safe working level and activates an interlock.

Thermocouple

A thermocouple monitors the demineralised water temperature and activates an interlock if the temperature rises above a set limit (refer to Chapter 5.1 - Installation Notes).

De-ionising Water Filter

A de-ionising water filter is incorporated to maintain low levels of conductivity (less than 5 μS.cm). This helps to protect the system from internal corrosion. *(12)*

Overrun Adjustment *(14)*

The cooling unit is designed to provide an overrun of the demineralised water circuit in order to dissipate residual heat from the vibrator after shut down of the system.

The pump overrun times are determined by the setting of SW2 on the main control pcb, situated behind the front door of the cooling unit. SW2 is factory set to provide a run-on time of 12 minutes.

Note: This run-on circuit is inoperative if the cooling unit is switched on directly at the cooling unit front panel.

Pump overrun times are changed by the setting of SW2 as shown below:

Switch Setting	Overrun Time
SW2-8	3 secs
SW2-2	23 secs
SW2-6	45 secs
SW2-4	1 min 30 secs
SW2-5	3 mins
SW2-3	6 mins
SW2-7	12 mins
SW2-1	24 mins

2. HYDRAULIC SUPPLY

2.1 GENERAL

The hydraulic supply provides cooled oil at high pressure to the vibrator's bearing. The assembly contains the following items (refer to Figure 2.1):

- Oil tank
- Pressure regulator and gauge
- Pump
- Filter and blockage indicator
- Heat exchanger.

Oil Tank

The oil tank contains the supply of hydraulic oil required by the system The capacity and oil type is detailed in Chapter 1, Table 1.3. The tank is fitted with a sight gauge.

Pressure Regulator And Gauge

The gauge indicates the pressure on the discharge side of the pump. The regulator allows the supply pressure to be adjusted.

Pump

The rotary pump is driven by a totally enclosed induction motor. The motor is driven from an internally normalised 415 V, 3-phase supply.

Filter And Blockage Indicator

The hydraulic supply line is fitted with a filter and blockage indicator. The filter must be renewed at regular intervals. If the filter becomes blocked, a bypass circuit is activated to allow unfiltered oil to flow to the vibrator. blockage of the filter is indicated by the indicator window (located on top of the hydraulic unit) changing from green to red when a blockage is sensed. It should be noted that a blockage is only indicated when the hydraulic unit is switched on.

Heat Exchanger

The oil is cooled by pumping it through the oil-to-water heat exchanger. The heat exchanger raw water is tapped off from the closed water circuit raw water supply. Refer to the Oil and Water Schematic Diagram.

3. AIR INJECTION

3.1 GENERAL

The purpose of the air injection system fitted to water cooled vibrators is to reduce sine wave distortion levels.

This distortion is only apparent during operation at high acceleration levels (typically greater than 30 g) and takes the form of a high frequency waveform superimposed on the sinusoidal waveform. The high frequency waveform has a frequency typically greater than 20 kHz and is the result of cavitation within the armature cooling water.

Air injection is achieved by introducing a small quantity of air into the cooling water circuit. In order to achieve satisfactory operation it is necessary that the air is evenly dispersed within the water such that the cooling water displays a 'milky' appearance.

Correct adjustment of the system is essential:

* Too much air injection will lead to overheating and premature failure of the armature and field coils.

* Too little air injection will fail to reduce distortion to acceptable levels.

Note: Air injection is only required at high acceleration levels. If the majority of testing is with heavy payloads or with acceleration levels lower than 30 g it is important that the air injection system is turned off in order to provide optimum cooling conditions for the armature and field coils, and to minimise corrosion within the distilled water circuit.

Two methods of air injection are available, depending on the system configuration:

Type 1. Under normal operating conditions, air injection is achieved on V964 and V984 installations by the use of an air inlet pipe situated within the demineralised (distilled) water make-up tank. Depression caused by the water circulating pump sucks air into the distilled water circuit, which is then evenly dispersed into minute bubbles by the action of the centrifugal water circulating pump. An air flow adjustment valve is fitted at the outer end of the air inlet pipe.

Type 2. To ensure consistant aeration with V994 installations, V984 installations utilizing a chiller unit, or V964 and V984 installations using long hoses within the armature cooling water circuit, air is injected directly into the armature inlet connection on the vibrator. Air is provided by an air compressor controlled by a contactor energised when the cooling unit water pump is running.

For setting instructions relating to a particular system configuration, refer to the vibrator Installation and Operating Manual.

Type 2 (only) air injection is selected or inhibited from SW4 on the I/O pcb (See Figure 5.2).

4. FIELD POWER SUPPLY

4.1 GENERAL

The Field Power Supply (FPS) is designed specifically to provide the field and degauss requirements of the V964LS/V984/V994 vibrators. The FPS output is controlled from the DPAK amplifier, and by link settings on the Degauss Control PCB (located at the end of the left-hand bay).

FPS Circuit

From the input/output panel, the 3-phase supply is connected via a contactor circuit to the primary winding tap selection terminals of the supply transformer; and via three fuses, FS19, FS20 and FS21 (see Table 4.1) to the primary winding tap selection terminals of the normalising transformer. On both transformers the voltage taps accommodate supply voltages in the range 380V, 400V, 415V, 440V, 480V, 500V and 520V.

Two 3-phase visual indicators, located within the left-hand and centre bays, are connected one to each of the transformer primary windings; these indicators are intended to warn service personnel that dangerous voltages are present.

The supply transformer secondary voltage is rectified by a 3-phase rectification circuit to produce the vibrator field voltage.

The 3-phase rectification circuit contains a combination of diodes and thyristors forming a half-controlled bridge. The rectified output is dependent on the phase of the thyristors' gate drive signals which are received from the Degauss Control PCB. Variation of thyristor gate drive signal provides adjustment of field voltage below maximum value (approx. 50% - 100%).

A non-intrusive field current transducer monitors the field current to provide a low voltage signal (proportional to the field current) suitable for the interlock and metering circuitry.

The degauss circuit comprises a switch mode regulator to provide adjustable degauss current. Metering and adjustment of degauss current is provided on the front panel.

WARNING

LETHAL VOLTAGES ARE PRESENT WITHIN THE EQUIPMENT CABINET. BEFORE ATTEMPTING TO ALTER ANY LINKS, THE SUPPLY MUST BE SWITCHED OFF AT THE INCOMING ISOLATOR.

4. FIELD POWER SUPPLY (cont.)

Field Power Settings

On the Degauss Control PCB (Figure 2.2), the user can adjust:

1. Economy Field Voltage
2. Maximum Field Voltage

} In accordance with modes shown below.

3. Degauss Current

1. Mode Selection

The user can, by manual link selection, choose to operate the vibrator field in one of four different modes:

MODE 1. 100% field power - no maximum current adjustment.

Field voltage is **permanently** set to maximum with no adjustment. Field current is directly proportional to the field coil resistance.

MODE 2. Economy field power - adjustable

Field voltage is permanently set by means of potentiometer RV1 on the Degauss Control PCB. Field current is directly proportional to the set field voltage and field coil resistence.

MODE 3. Auto Economy - Economy and maximum adjustable

Field voltage is automatically set to a value adjusted by RV1 on the Degauss Control PCB, when the amplifier MASTER GAIN control is set to the fully counter-clockwise position (detent position). When the MASTER GAIN control is rotated off the fully counter-clockwise position, the field is automatically set to a value adjusted by RV2 on the Degauss Control PCB.

MODE 4. 100% field power - maximum field current adjustable

Field voltage is permanently set to a value adjusted by RV2 on the Degauss Control PCB **irrespective** of the setting of the amplifier MASTER GAIN control.

4. FIELD POWER SUPPLY (cont.)

To select any of the field power setting modes, set the degauss Control PCB links as follows: *(15)*

(Open = link removed, Short = link made, xx = link setting immaterial):

	Link 1	Link 2	Link 3	Link 4
MODE 1	xx	xx	*100*%	100%
MODE 2	xx	Open	50%	50%
MODE 3	Short	Short	50%	50%
MODE 4	*Short*	*Open*	50%	50%

2. Field Voltage Adjustment

To ensure long life of water cooled field coils, prevention of excessively high operating temperatures is essential.

To ensure that water cooled field coils operate at the correct working temperature, it is advisable to adjust the supply voltage in order to provide the optimum operating current. This adjustment should be made (or checked) on site when the vibrator and cooling circuit have reached normal operating temperature; this ensures the temperature rise of the cooling water across the coils is restricted to approximately 40^0C.

4. FIELD POWER SUPPLY (cont.)

WARNING

THE FOLLOWING PROCEDURE NECESSITATES ACCESSING AREAS OF THE CU/FPS WHICH CONTAIN LETHAL VOLTAGES. BECAUSE THE PROCEDURE CAN ONLY BE PERFORMED WITH THE CU/FPS 'LIVE' IT IS ESSENTIAL ADJUSTMENTS ARE PERFORMED ONLY BY QUALIFIED ENGINEERS/PERSONNEL.

The LDS CU/FPS units feature a thyristor drive circuit for the field power supply; voltage adjustment is therefore very simple and achieved as follows:

a. With all power removed from the CU/FPS, access the Degauss Control PCB assembly behind the left hand front panel (located on the mounting plate assembly).

Disable the door switch by pulling the operating rod fully out.

Ensure links are set for MODE 3 or MODE 4.

b. Apply power to the CU/FPS and to the DPA'K' amplifier.

Press the amplifier AUXILIARIES push-button such that the cooling unit (and integral power supply) are switched ON.

If MODE 3 has been link selected, set amplifier MASTER GAIN control clockwise of the detent position.

c. Select 'Adc Field' (field current) metering on the CU/FPS control panel.

d. Allow a period of time for the field current to stabilise (i.e. the time it takes for the vibrator's temperature to stabilise).

Adjust SET FIELD MAXIMUM on the Degauss Control PCB to give the appropriate current reading (see Table)

Vibrator	Field Coil Current
V964LS	400 Amp
V984	400 Amp
V994	475 Amp

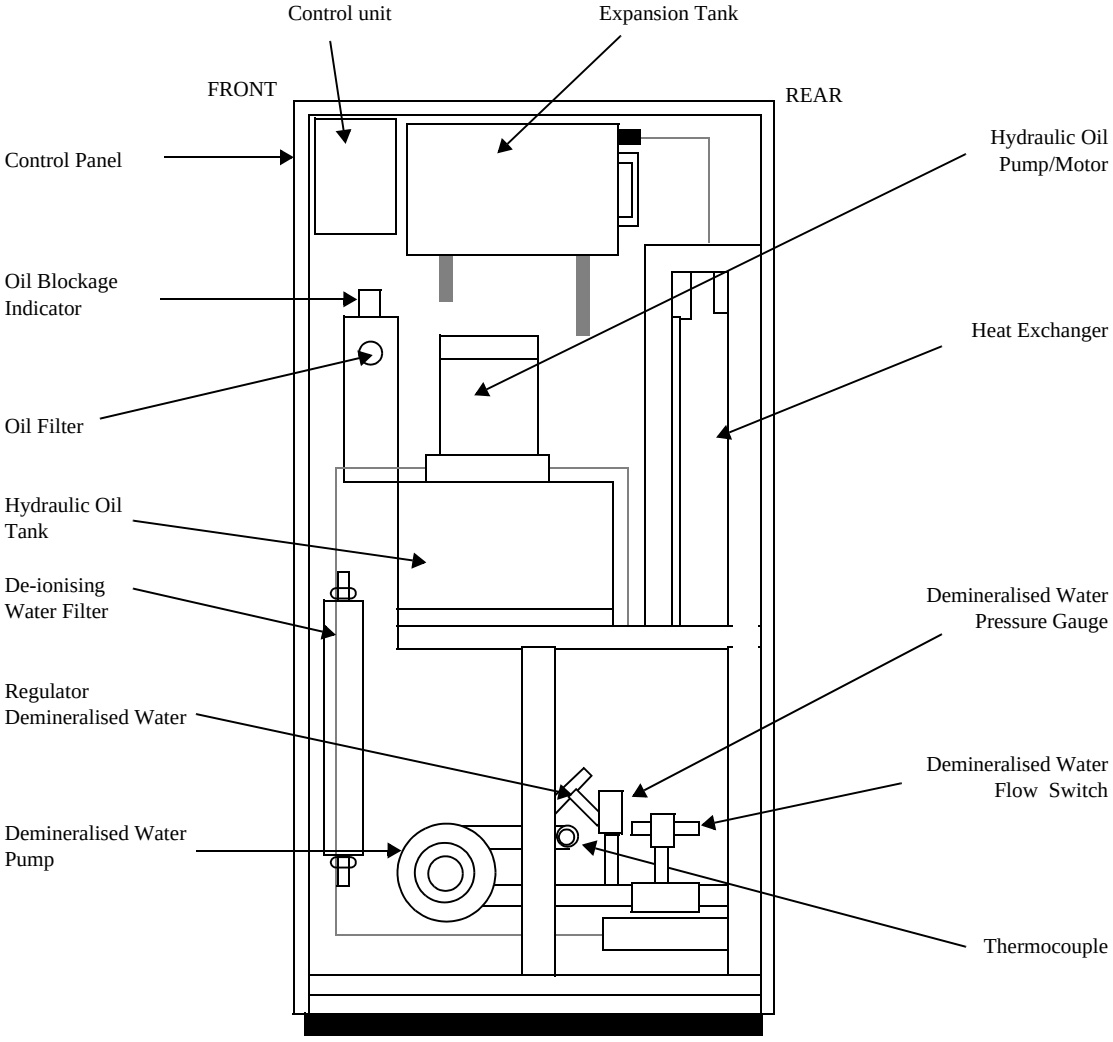
4. FIELD POWER SUPPLY (cont.)

e. Allow a further period of time for the field current to stabilise again; re-adjust SET FIELD MAXIMUM if necessary.

f. Switch off the amplifier; remove power from the CU/FPS.

3. Degauss Current Adjustment

Maximum degauss current is permanently set by means of potentiometer RV3 on the Degauss Control PCB (see Figure 2.2).



(12)

Figure 2.1 View of Cooling Unit (Right-Hand End)

4. FIELD POWER SUPPLY (cont.)

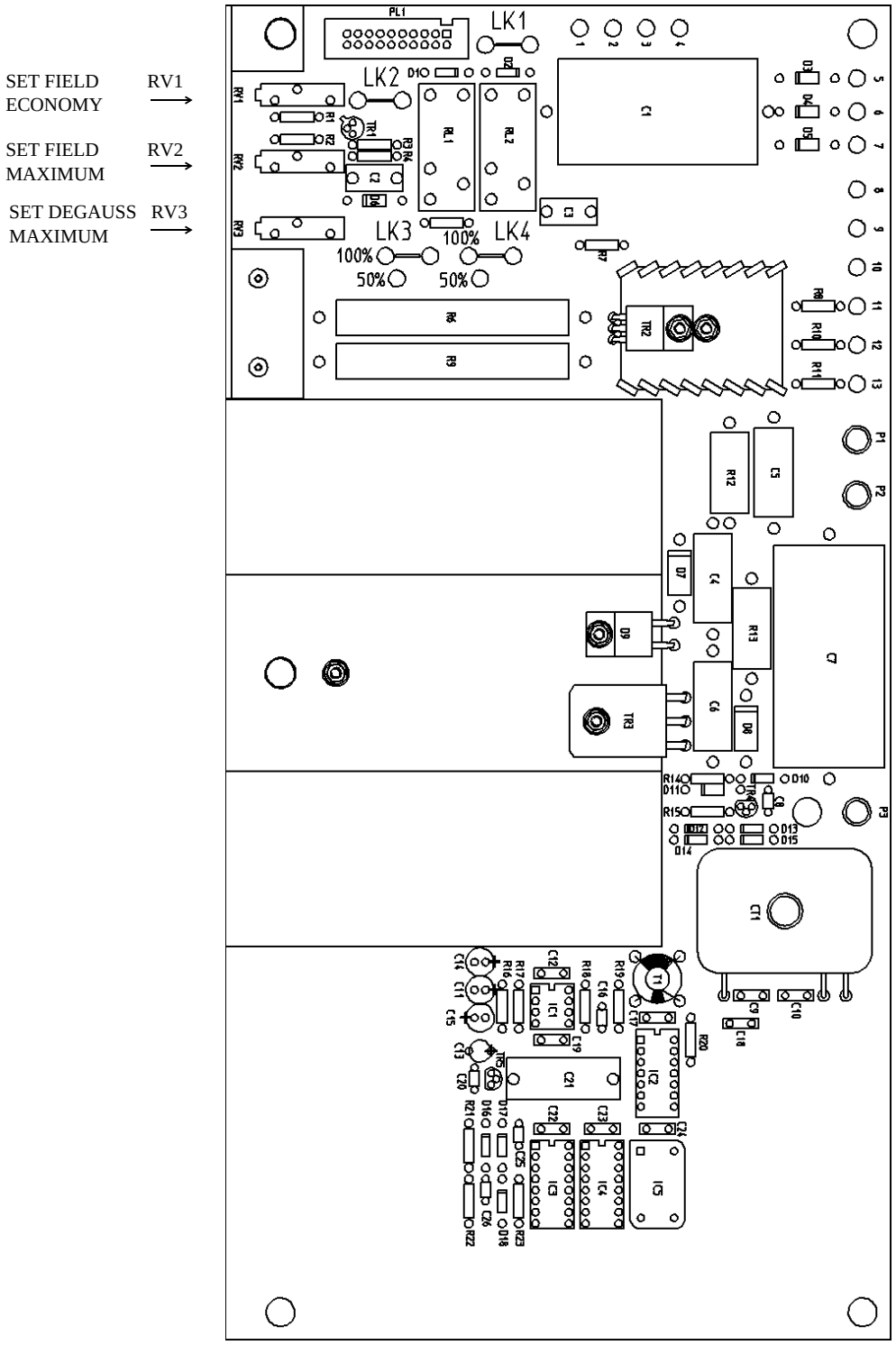


Figure 2.2 Degauss Control PCB

CHAPTER 3 OPERATION

GENERAL

This chapter describes the CU/FPS control panel and interlock indicators and, for any particular system configuration, should be read in the context of those interlocks and indicators which are actually present.

**** IMPORTANT ****

The CU/FPS is normally turned ON and OFF from the system amplifier by means of the AUXILIARIES pushbutton. When the AUXILIARIES pushbutton is pressed, the ON command signals are sent to the CU/FPS to turn on the cooling section and the field. However, the field will not energise until all cooling interlocks are correct. During this period (and before the AMPLIFIER ON pushbutton is pressed) the field ON/OFF status is dependent directly on the cooling interlock status, which may constantly change until correct cooling is established.

When the AMPLIFIER ON pushbutton is pressed, any tripped cooling interlock will shut the amplifier down and switch off the field. The field can then only be energised by pressing the AMPLIFIER ON pushbutton to re-set the interlock circuit.

It is important that, when tracing a persistant interlock fault in the cooling circuit (either at the CU/FPS or at the vibrator) the amplifier AUXILIARIES pushbutton is pressed for AUXILIARIES OFF and that the FIELD ISOLATOR within the CU/FPS, see Figure A1, is set to OFF, i.e. pushed in.

To re-energise the field, the FIELD ISOLATOR must be turned clockwise to release. The field will then be energised by the AUXILIARIES ON command from the amplifier.

Local control of the CU/FPS (cooling section only) can be achieved by using the front panel control of the CU/FPS, see Chapter 3 Section 3.

Note: Phase sequence detection comes into operation when the AMPLIFIER ON push-button is pressed. If, after initial installation or maintenance, the amplifier switches on and then immediately off, and no other fault is evident, it will be necessary to reverse any two phases of the incoming 3-phase supply, see Chapter 5.2.

1. CONTROLS

CONTROLS AND INTERLOCKS

The CU/FPS control panel, illustrated in Figure 3.1, allows the cooling unit (CU section only) to be switched on and off locally (control of the cooling unit and field power supply is normally from the system amplifier); and provides a number of interlock indicators.

When the CU/FPS is powered-up, all indicators are illuminated (lit), and remain so until the cooling unit is switched on. This facility provides an indicator serviceability check.

When a 'turn off ' command is received from the system amplifier there is a delay period before the demineralised water and hydraulic oil pumps shut down. The air injection pump (if fitted) shuts down immediately on receipt of the command.

In operation, the interlock indicators are normally quiescent, i.e. not indicating a fault. They are lit or unlit, depending on the configuration of the control PCB; and when an interlock is activated, the relevant indicator flashes approximately twice per second.

1. Controls

VIBRATOR COOLING ON/OFF

This press button control, containing an integral lamp, is used to provide a local facility to switch the cooling unit on and off. The button is lit when the cooling unit is off .

The ON and OFF indicators reflect the state of the cooling unit, whether it be under local or DPAK amplifier control.

METERING SELECTION

This push button control scrolls through the digital display to show:

field d.c. voltage,
field d.c. current,
or degauss d.c. current

SET DEGAUSS

This rotary control allows the user to adjust the degauss current within the maximum limit set by the degauss control PCB.

1. CONTROLS (cont.)

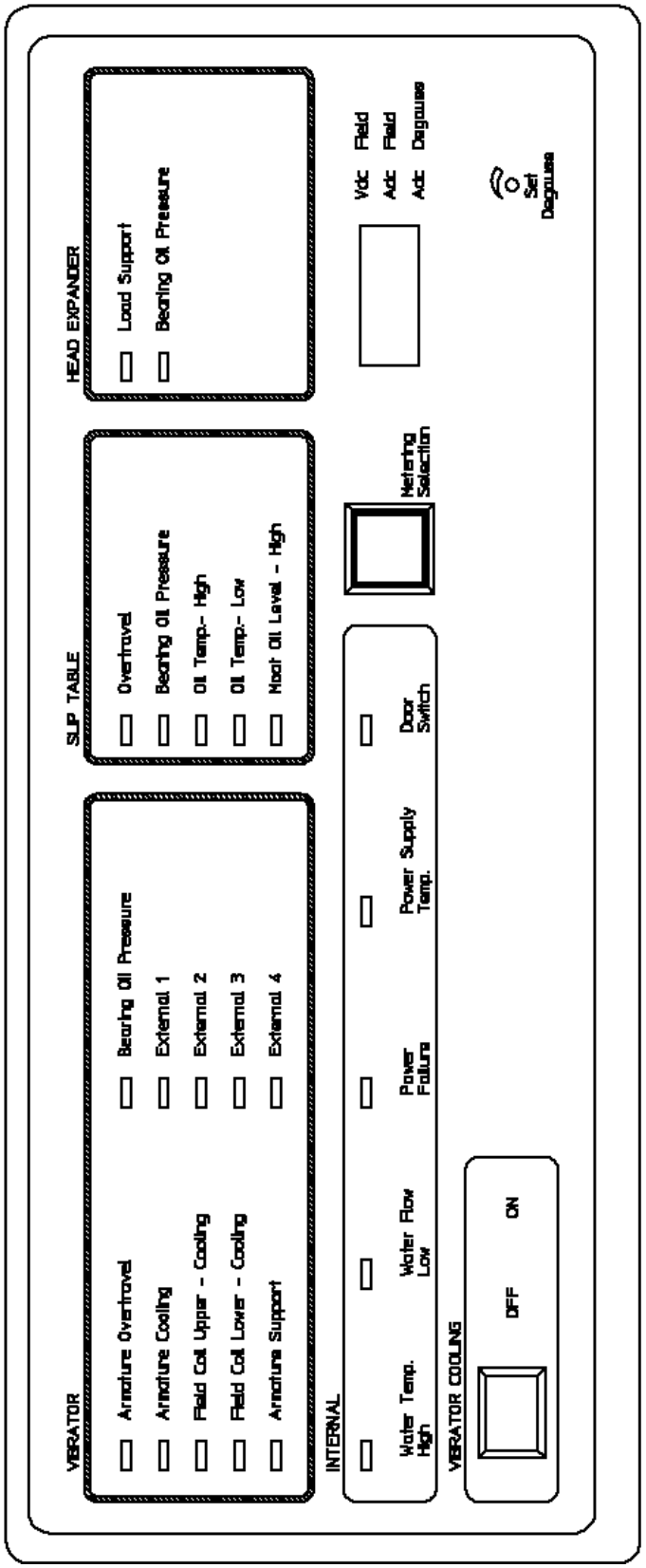


Figure 3.1 Control Panel

2. INTERLOCKS

2. Interlocks

The interlock system provides a visual indication of faults arising in the vibration test system. The faults are indicated on the control panel display area. Which of the interlocks are operative, and have been armed, will depend on the overall system configuration.

In most cases, the indication of a fault condition will also initiate controlled system shut-down. However, for the slip table Oil Temp-High, Oil Temp - Low and Moat Oil Level-High interlocks system shut-down is at user discretion.

The four indicators designated External 1, External 2, External 3 and External 4 are provided for user defined applications.

Vibrator Interlocks

ARMATURE OVERTRAVEL	Indicates excessive travel of the vibrator's armat 2 ure, and initiates system shut-down.
ARMATURE COOLING	Indicates a failure in the armature cooling circuit, and initiates system shut-down.
FIELD COIL UPPER - COOLING	Indicates a failure in the upper field coil cooling circuit, and initiates system shut-down.
FIELD COIL LOWER - COOLING	Indicates a failure in the lower field coil cooling circuit, and initiates system shut-down.
ARMATURE SUPPORT	Indicates that one or more armature lock-out plates are in position. The vibrator will not operate until all lock-out plates have been removed.
BEARING OIL PRESSURE	Indicates that the oil supply to the vibrator's hydrostatic bearing has fallen below the normal minimum operating pressure, and initiates system shut-down.

2. INTERLOCKS (cont.)

EXTERNAL 1
EXTERNAL 2
EXTERNAL 3
EXTERNAL 4

For user defined interlocks. Require normally closed (N/C) potential free contacts, opening to indicate fault condition.

Interlock trips enabled by:

EXT 1	SW1-8	all on the Control PCB
EXT 2	SW1-3	
EXT 3	SW1-4	
EXT 4	SW4-1	

Interlock indicator lamps enabled by:

EXT 1	SW2-4	all on the I/O PCB
EXT 2	SW2-5	
EXT 3	SW3-8	
EXT 4	SW2-2	

Connection details (see Figure 5.2) are:

EXT 1	SK 7	all on the left hand edge of the I/O PCB
EXT 2	SK 6	
EXT 3	SK 11	
EXT 4	SK 9	

Note: To enable the interlock trips, set the relevant DIL switch on the Control PCB to the ON (Right) position.

To enable the interlock indicators, set the relevant DIL switch on the I/O PCB to the OFF (Left) position.

Float Switch Interlock *(Not indicated on front panel)*

Some vibrator systems employ an oil scavenge pump with integral tank. The electrical supply to this pump is separate from, and not controlled by, the CU/FPS. In the event of a power failure or malfunction of the pump, an interlock circuit is included in the CU/FPS to prevent an overfill of the scavenge pump tank. A level switch within the tank is connected to the FLOAT SWITCH interlock in the CU/FPS to de-energise the hydraulic pump control contactor in the event of the oil level reaching the maximum for the tank. For standard systems this interlock is linked out.

2. INTERLOCKS (cont.)

Slip Table Interlocks

OVERTRAVEL	Indicates excessive travel of the slip plate, and initiates system shut-down.
BEARING OIL PRESSURE	Indicates that the oil supply to the slip plate bearings and the slip plate-granite block interface has fallen below the normal minimum operating pressure, and initiates system shut-down.
OIL TEMP - HIGH (Optional) OIL TEMP - LOW (Optional)	Allows maximum and minimum oil temperatures to be set, and used as a safety interlock circuit, by the use of type K thermocouples.
MOAT OIL LEVEL - HIGH (Optional)	Indicates excess oil in the moat. Possible cause: Scavenge pump failure. Allows an infra-red oil level indicator to be fitted in the slip table moat, and linked to the amplifier, in order to provide an interlock safety circuit.

Head Expander Interlocks

LOAD SUPPORT (Optional)	Under normal circumstances, large head expanders are fitted with mechanical load support bars to support the load in the event of air pressure failure. The support bars are fitted with micro-switch interlocks to prevent system operation when they are in place.
BEARING OIL PRESSURE (Optional)	Allows an oil pressure switch to be fitted and indicates that the oil supply to the head expander guidance bearings has fallen below the normal minimum operating pressure. Initiates system shut-down.

2. INTERLOCKS (cont.)

Internal Interlocks

DISTILLED WATER TEMP. HIGH

Indicates a fault in the heat exchanger system, and initiates system shut-down. Possible faults are:

* Raw water supply warm or inadequate.
* The closed water system partially blocked (would also appear as low flow).
* Excessive air injection.
* Heat exchangers require cleaning. (Build up of scale and sediment)

DISTILLED WATER FLOW LOW

Indicates a fault in the closed water system, and initiates system shut-down. Possible faults are:

* Blockage in the closed circuit.
* Pump failure.
* Low water level in the header tank.
* Distortion/flattening of flexible pipework.

POWER FAILURE

Indicates failure or reduction in one or more of the 3-phase supply lines, and initiates system shut-down.

POWER SUPPLY TEMP.

Indicates an overtemperature condition in the field power supply transformer or rectifiers, and initiates system shut-down.

DOOR SWITCH

Indicates that one or more of the CU/FPS cabinet doors are open, and initiates system shut-down.

3. POWER UP/POWER DOWN

As previously stated, the cooling unit section of the CU/FPS may be controlled either locally, by operating the pushbuttons on the control panel, or remotely from the amplifier. This allows testing and set-up to take place without switching the amplifier on. It is recommended that the following sequences be followed when the equipment is powered-up or powered-down using local control:

Check that the available raw water flow rate meets specification requirements, see Table 1.3.

Power-up

1. Check the level of water in the demineralised water expansion tank.
2. Check the level of oil in the hydraulic unit tank.
3. Turn on raw water supply.
4. Switch-on power at the external mains isolator. Check that all Control Panel indicators are lit.
5. Press the Vibrator Cooling On/Off button. Check:
   - The Vibrator Cooling OFF indicator is not lit and that the ON indicator is lit.
   - That the water and hydraulic pumps are operating, and that motor rotation is clockwise when viewed from the motor end (see arrow labels on motor casings).
   - No Control Panel interlock indicators are flashing.

Power-down

1. Press the Vibrator Cooling On/Off button. Check:
   - The Vibrator Cooling ON indicator is not lit and that the OFF indicator is lit.
   - That the water and hydraulic pumps have ceased operating.
   - No Control Panel interlock indicators are flashing.
2. Switch off the mains supply at the external isolator

4. DATA LOGGING

OVERVIEW

Two forms of data logging outputs are available:

Digital signals giving the state of the interlocks and other signals are provided as opto-isolated outputs suitable for actuating secondary indicators or for storing in a digital system.

Analogue outputs are provided for driving analogue recorders e.g. pen recorders.

Digital Outputs

These are opto-isolated signals appearing at socket SK9 on the Data Logging PCB. Only 16 signals are pre-selected for output via the 25 way connector, either direct to the Data Logger, or via the Amplifier and RCP to the Data Logger. Re-assignment may be achieved by re-wiring the 37 way plug to suit requirements.

The signals are open collector. The condition stated is indicated when the transistor closes.

SK9 Pin No.	37 WAY Pin No.	25 WAY Pin No.	DATA LOGGER Ref.	INDICATION
1	1	1	Cooling Unit 8	Armature overtravel
2	2	2	Cooling Unit 6	Armature cooling
3	3	3	Cooling Unit 4	Upper field coil cooling
4	4	4	Cooling Unit 2	Lower field coilcooling
5	5	5	Cooling Unit 16	Armature support
6	6	15	Cooling Unit 5	Bearing oil pressure
7	7	16	Cooling Unit 3	External 1
8	8	6	Cooling Unit 14	External 2
14	14	7	Cooling Unit 12	External 3
15	15	8	Cooling Unit 10	External 4
16	not used		not assigned	Slip table overtravel
17				Slip table bearing oil pressure
18				Slip table oil temperature (high)
19				Slip table oil temperature (low)
20				Slip table moat oil level (high)
21				Head expander load support
26				Head expander bearing oil pressure
28	28	18	Cooling Unit 15	Door switches
29	29	21	Cooling Unit 9	Three phase power fail
30	30	17	Cooling Unit 1	Transformer and rectifier thermostats
32	32	19	Cooling Unit 13	Vibrator cooling
33	33	20	Cooling Unit 11	Vibrator water flow low
34	34	--	-- -- -- -- --	Spare
35	35	14	Cooling Unit 7	Cooling unit On/Off

The emitters of all the photo-transistors are commoned and appear on:

SK9 and 25 Way - pins 9, 10, 11, 12, 13, 22, 23, 24 and 25.

Table 3.1 Digital Data Logging Outputs

4. DATA LOGGING (cont.)

Analogue Outputs

These are provided as current signals on a terminal block on the Data Logging PCB. Each output appears on a pair of pins, one marked + and the other marked - . The pin pairs are labelled. The outputs are current analogues of the following temperatures:

Slip table oil	(SK5)	The current range is from 4.0 mA representing 0°C, to 20.0 mA representing 100°C and is linear.
Armature	(SK1)	
Field coil upper	(SK2)	
Field coil lower	(SK3)	
Cooling unit vibrator water	(SK4)	

Field Current	(SK8)	The current range is from 4.0 mA representing 0 amperes, to 20.0 mA representing 1000 amperes and is linear.
Field Voltage	(SK7)	The current range is from 4.0 mA representing 0 volts, to 20.0 mA representing 1000 volts and is linear.
Degauss Current	(SK6)	The current range is from 4.0 mA representing 0 amperes, to 20.0 mA representing 100 amperes and is linear.

The value of the load resistor can be up to 800 ohms with grounded or floating loads.

CHAPTER 4 MAINTENANCE

1. GENERAL

This chapter details the scheduled maintenance activities recommended by HBK.

Although this publication provides sufficient information for the user to perform simple scheduled and unscheduled maintenance tasks, it is recommended that a maintenance contract be taken out with HBK. The contract provides a comprehensive annual service of the equipment.

Daily Log

Users are strongly advised to keep a daily log, recording the following detail. The equipment's history can prove invaluable should advice be required from HBK:

Number of hours run
Timetable of system faults/interlock trips
Cause of faults/interlock trips (if known)
Action taken to rectify faults
Record conductivity of the demineralised water in the expansion tank.
Any matters of concern.

Service And Spares

Various levels of recommended spares holdings, tooling, and general service advice are available on request from HBK Service Dept

2. ROUTINE MAINTENANCE

WARNING

INCORRECT LIFTING METHODS CAN CAUSE SERIOUS PERSONAL INJURY, AND DAMAGE TO THE EQUIPMENT.

ATTENTION IS DRAWN TO THE SAFETY PRECAUTIONS AND HAZARD WARNINGS CONTAINED WITHIN THE PREFACE TO THIS MANUAL.

LETHAL VOLTAGES AND HIGH TEMPERATURE METALIC AREAS ARE PRESENT WITHIN THE EQUIPMENT CABINET. BEFORE ATTEMPTING TO ALTER ANY LINKS OR CONNECTIONS THE SUPPLY MUST BE SWITCHED OFF AT THE INCOMING ISOLATOR.

IF IT IS NECESSARY TO ACCESS THE EQUIPMENT WITH COVERS OPEN AND THE CU/FPS SWITCHED ON, PRECAUTIONS MUST BE TAKEN TO ENSURE THAT ONLY COMPETENT, HBK TRAINED, ELECTRONIC OR ELECTRICAL ENGINEERS ARE ALLOWED TO WORK ON THE EQUIPMENT

CAUTION

DO NOT ALLOW THE WATER PUMP TO OPERATE DRY OR RUN IN THE REVERSE DIRECTION. WATER PROVIDES THE PUMP'S LUBRICATION. DRY OR REVERSE RUNNING CAN DAMAGE THE SEALS NECESSITATING REFURBISHMENT, OR REPLACEMENT OF THE PUMP.

Closed Circuit Water

The SAFETY CRITICAL, de-ionised water in the closed circuit water must be checked regularly for quantity and quality. A de-ionising filter is incorporated to maintain water quality.

Failure to ensure that low levels of conductivity are achieved through regular monitoring and maintenance can lead to accelerated corrosion damage, particularly within the field coil. Such damage leads to the blockage of internal cooling passages, and ultimately to the destruction of the field coil through overheating.

The recommended quality of water is:

Distilled water with a pH of between 6.3 and 7.0; conductivity not greater than 10 μS.cm (British Standards BS3978). The filter will typically reduce conductivity to 1 μS.cm.

2. ROUTINE MAINTENANCE (cont.)

Replacement Cartridge

The filter cartridge will need to be replaced as a result of either the water conductivity exceeding the limit noted earlier, the cartridge colour panel having changed, or the recommended service period having elapsed.

It is recommended that the reservoir is drained and refilled with new de-ionised water when a new cartridge is fitted. The following procedure should be adopted, refer to the attached drawing:

* Drain the cooling system using the drain cock at the rear of the cooling unit. For systems with the retrofit kit fitted first close the drain cock, remove the filter hose and allow the water to drain from the filter, drain the rest of the system as normal, refit the hose and leave the drain cock open.

* Undo the tap and adaptor at both ends of the filter.

* Cut and remove the plastic clip that secures the cartridge and remove the old unit.
* Fit the new unit with the colour change indicator facing outwards.

* Ensure that the connectors at each end are secure. (Note that the tap at the lower end should not be disturbed unless the flow through the filter is to be adjusted).

* Refill the system and switch on the cooling unit to check that normal flows, pressures and conductivity are still achieved.

Cleaning The Heat Exchanger

The efficiency of a water based heat exchanger reduces as scale and other sediments build-up within the system. The extent of the build-up is determined by many factors including local site conditions and the hardness of the raw water. The procedure for cleaning the heat exchanger is:

1. Drain the raw water and pure water circuits; disconnect both sets of pipes from the heat exchanger. When breaking or handling any pipe joint, cover the openings to prevent debris entering the closed circuit.

2. Swing the heat exchanger out and down.

3. Undo the screws securing the end covers of the heat exchanger and remove the covers.

4. Remove the O-Ring seals from the end of the tube stack and withdraw the complete stack from the casing.

2. ROUTINE MAINTENANCE (cont.)

5. If the tube stack and casing are badly choked, place the assembly in a degreasing bath and loosen any matter adhering to the surface. Push a steel rod through the tube (in the opposite direction to the water flow), to dislodge any foreign matter in the tubes.

6. Clean all parts of the system.

7. Re-assemble the system. Always fit new O-Rings.

Changing The Oil

Drain the oil from the circuit by means of the drain cock. Renew the oil filter and refill with the recommended oil (refer to Chapter 1 - Specification).

The following routine activities are recommended by HBK at the stated intervals. Note however that local operating conditions may require the activities be performed at more frequent intervals than those stated:

2.1 Daily Activities

The following detail should be completed daily, before using the equipment:

a. Ensure the area around the CU/FPS is clear of obstructions which could prevent adequate airflow into the air intake grills.

b. Ensure the area around the CU/FPS is clean, and free of dust.

c. Switch on the 3-phase supply at the mains isolator. Ensure that all cooling fans are operating. Switch off the 3-phase supply at the mains isolator.

d. Check that all cabinet panels are correctly fitted and locked.

e. Check water levels. Check the water system for leaks.

f. Check water condition. Filter colour panel should still be blue and conductivity measure less than 5 μS.cm; record conductivity. Change water filter if condition is not correct.

2.2 Monthly Activities

a. Inspect the air intake grills. Brush off, or wash with warm soapy water, any dust or fluff that has accumulated. Ensure that the dust filters are clean and free from accumulated dirt. Replace any filters that cannot be fully cleaned.

b. Inspect all the cooling fans. If dirty, clean the blades with a dry soft cloth; do not use fluids of any kind.

2. ROUTINE MAINTENANCE (cont.)

c. Check that all power connections to the CU/FPS (field supply and 3-phase supply) are secure. Check the earth connection is secure.

d. Check water condition. Filter colour panel should still be blue and conductivity measure less than 5 μS.cm; record conductivity. Change water filter if condition is not correct.

e. Switch on the 3-phase supply at the mains isolator. Ensure all cooling fans are operating. Listen for any noise which suggests a cooling fan is not operating smoothly.

2.3 Six-monthly -activities

a. Check the interior of the CU/FPS for accumulations of dust or dirt. Clean, as required, with a soft brush or dry lint-free cloth; do not use fluids of any kind.

b. Replace de-ionising filter and demineralised water.

2.4 Yearly Activities

Replace **all** dust filters (see Note below).

NOTE

TO ENSURE TROUBLE FREE OPERATION OF THE CU/FPS IT IS ESSENTIAL THAT THE AIRFLOW TO THE RECTIFIER ASSEMBLY IS KEPT TO A MAXIMUM. IT IS THEREFORE IMPERATIVE THAT ALL AIRWAYS ARE KEPT CLEAR OF OBSTRUCTION AND THAT ANY DUST FILTER WHICH CANNOT BE ADEQUATELY CLEANED IS IMMEDIATELY REPLACED.

3. FUSES

This section lists the location, type and value of all fuses. See also Figures 5.1 to 5.7.

WARNING

BEFORE ATTEMPTING TO REPLACE ANY FUSE, ENSURE THAT THE MAINS SUPPLY IS SWITCHED OFF AT THE EXTERNAL 3-PHASE ISOLATOR

LOCATION	CCT. IDENT.	FUSE RATING	FUSE TYPE	QUANTITY	LDS Pt. No.
Contactor Panel (Vibrator Distilled Water Pump)	FS1, 2, 3	6 Amp (CU/FPS64) 10 Amp (CU/FPS84) 20 Amp (CU/FPS94)	Type aM 500V	3 3 3	624590 629050 624640
Contactor Panel (Vibrator Hydraulic Pump)	FS4, 5, 6	4 Amp	Type aM 500V	3	624940
Contactor Panel (Air Injection Supply)	FS7, 8, 9	2 Amp (CU/FPS84 and 94 only)	Type aM 500V	3	629100
Contactor Panel (Phase Sequence/Failure Relay)	FS10, 11, 12	100 mA	Type T 250V	3	708170
Contactor Panel (Supply to Control Transformer)	FS13, 14	5 Amp	Type T 250V	2	708200
Contactor Panel (Auxiliary Supply Output)	FS15,	2 Amp	Type T 250V	1	624550
Panel Assembly (upper) (Supply Transformer to 3-phase Rectifier)	FS16, 17, 18	500 Amp (CU/FPS64 and 84) 700 Amp (CU/FPS94)	Type 500FMM Type 700FMM	3 3	629030 624990
Panel Assembly (upper) (Supply to Degauss Control pcb)	FS24, 25, 26	100 mA	Type M 500V	3	624960
FPS/Degauss Panel (3-phase Rectifier to I/O pcb)	FS22, 23	63 mA	Type T250V	2	624570
Input/Output Panel (Supply to Normalising Transformer)	FS19, 20, 21	10 Amp (CU/FPS64) 16 Amp (CU/FPS84) 25 Amp (CU/FPS94)	Type aM 500V	3 3 3	629010 629040 624910
Input /Output Panel (Degauss Output)	FS27, 28	10 Amp	Type FF	2	629000
Mounting Plate Assembly, (Normalising Transformer Output)	FS29, 30, 31	10 Amp (CU/FPS64) 25 Amp (CU/FPS84) 25 Amp (CU/FPS94)	Type aM 500V	3 3 3	629010 624910 624910
Supply Transformer, (Rectifier Cooling Fan Supply)	FS32, 33	3 Amp	Type T 250V	2	708180
Input/Output Panel (Step Start Timer)	FS34, 35	2 Amp	Type T 250V	2	624550
3-phase Rectifier to Degauss Control PCB	FS36	10 Amp	Type FF	1	629000
Mounting Plate Assembly (Control Transformer)	FS37, 38, 39, 40, 41, 42.	1 Amp	Type T 250V	6	708410

Table 4.1 Fuses

CHAPTER 5 INSTALLATION

WARNING

INCORRECT LIFTING METHODS CAN CAUSE SERIOUS PERSONAL INJURY, AND DAMAGE TO THE EQUIPMENT.

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1. GENERAL

The siting of the CU/FPS with respect to the amplifier and vibrator is determined by:

a. The required access for servicing: 1.5 metre clearance must be allowed in order to swing out the heat exchanger. The CU/FPS should be sited on a stable, level floor; with the weight of the cabinet evenly distributed by adjusting the built in jacking screws. There must be clearance of at least 1 metre (39 in.) between the CU/FPS and any wall or other equipment. The area immediately in front, behind and on top of the CU/FPS must be clear to allow free air-flow into and out of the cabinet. Cabling should be contained within ducting/trunking to avoid undue strain on the connection terminals.

b. The length of pipes between the unit and associated equipment.

c. The relative heights of the Cooling Unit and Vibrator. If the cooling unit is required to be operated on a different level to that of the vibrator, contact the HBK Technical Department.

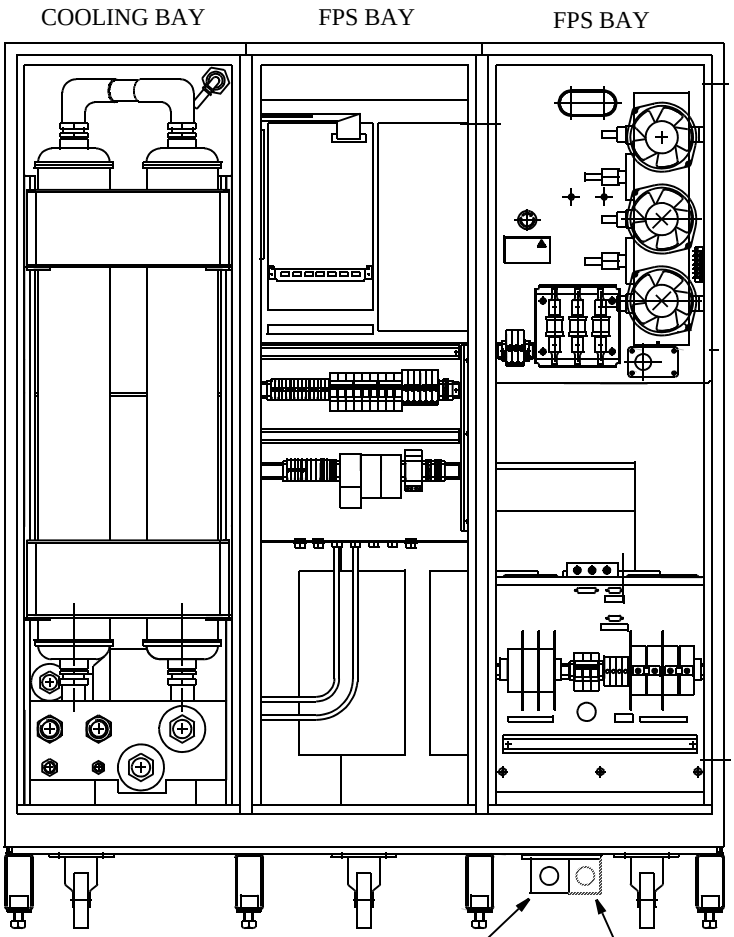
2. ELECTRICAL CONNECTIONS

The electrical supply to the CU/FPS must be routed via an external and exclusive 3-phase isolator. Note that the supply for the air injection pump is taken from the cooling unit (refer Chapter 2.3), not from the isolator. Refer to Appendix A for guidance on choice of isolator.

2. ELECTRICAL CONNECTIONS (cont.)

The isolator output should be connected to the input terminals of the AC RFI filter (mandatory for European installations, optional dependent on customer requirements, for others).

The AC RFI filter output should be connected to the CU/FPS input terminals using the conduit, fittings and cable provided. It is imperative, to maintain EMC compliance, that the conduit is firmly attached to the filter and to the amplifier plinth bracket, see below.



CU/FPS Plinth Bracket Position
(viewed from rear of cabinet)

Earthing

The main protective earth connection is located on the plinth adjacent to the Mains Input Panel. Particular attention must be paid to the earthing system in order to achieve good EMC performance. A substantial low impedance earth connection should be made to the CU/FPS protective earth. Avoid making other connections to this bolt.; see Chapter 6, RFI Filter and EMC compliance. Never operate the equipment with the earth disconnected.

2. ELECTRICAL CONNECTIONS (cont.)

Phase sequence detection comes into operation when the AMPLIFIER ON push-button is pressed. If, after initial installation or maintenance, the amplifier switches on and then immediately off, indicated by the 'POWER FAILURE' LED, it will be necessary to reverse any two phases of the incoming 3-phase supply at the CU/FPS input/output panel terminations. Internal 3-phase 'mains on' indicators are fitted on the FPS degauss panel, the mounting plate assembly and the input/output panel.

After correct phase sequence has been established, check that the rotation of the distilled water pump and hydraulic oil pump 3-phase motors is correct: clockwise when viewed from the motor end (see direction labels on motor casings). If, during installation, the motors rotate incorrectly, reverse any two phases at the motor termination box.

Figure 5.6 shows the control and normalising transformers; Figure 5.7 shows the supply transformer. Check that the primary connections match the incoming supply voltage in order to ensure correct secondary outputs.

Referring to the appropriate system interconnection diagram (see Systems Manual) and Figure 5.1, connect the following:

- Field Power Supply Cables F+ and F-
- Two data links to the DPA K amplifier

Other connections to be made are the following interlock cables. All connections are made to the I/O Board located at the rear of the centre cabinet. The I/O Board is shown on Figure 5.2:

- Field Coil (Lower) Cooling
- Field Coil (Upper) Cooling
- Armature Cooling
- Armature Support
- Bearing Oil Pressure
- Armature Over-Travel

Additionally, any Slip Table or Head Expander interlock signals (refer Figure 3.1) require connecting, if applicable.

IMPORTANT NOTES:

1. **All interlock and system cables connected to the CU/FPS, excluding the field cables, must be screened. The screen must be terminated on the earth studs provided and must not be used as a signal return or 0 V.**

2. **The EMC shielding wrap around the vibrator thermocouple cables must also be bonded to earth in the CU/FPS, using the gland provided on the contactor panel bulkhead; and also bonded to earth at the vibrator connection assembly using the gland provided. Care must be taken when terminating the knit mesh that a 360^0 connection to the earth bonding point is obtained.**

2. ELECTRICAL CONNECTIONS (cont.)

2.1 Data Link Connections

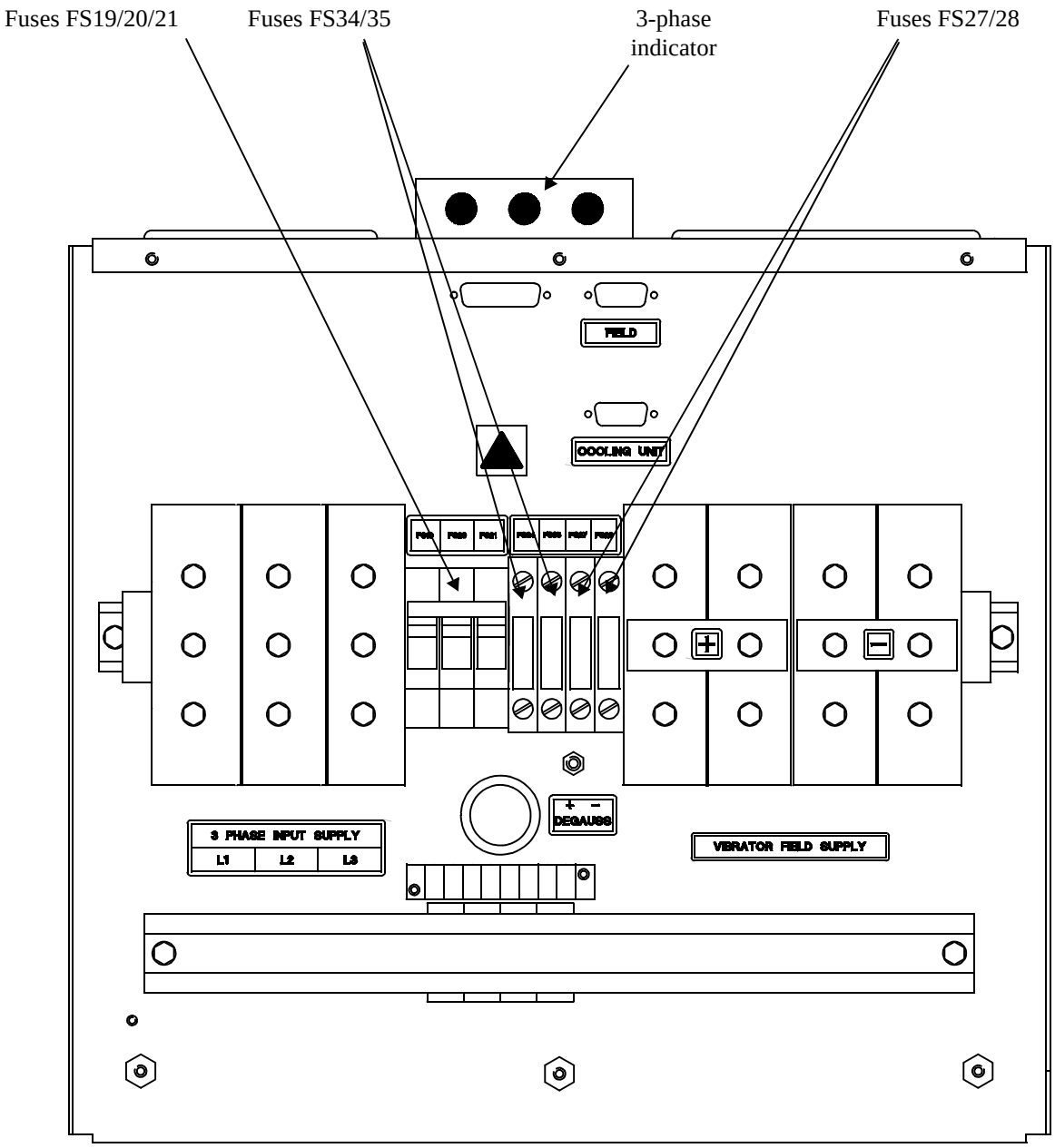
Field Connector - The Field Power Supply control and monitor signals are connected via a 'D' Type socket. Connection details are:

Pin	Title	Type
1	Field On/Off -ve	
2	Field On/Off	Digital (medium power)
3	Auto Field Economy -ve	
4	Auto Field Economy	Digital (medium power)
5	not connected	
6	Field Interlock +ve	Analog (medium power)
7	not connected	
8	Field Interlock -ve	Analog (medium power)
9	not connected	
10	not connected	
11	not connected	
12	not connected	
13	not connected	
14	not connected	
15	not connected	

Cooling Unit Connector - The Cooling Unit control and monitor signals are connected via a 'D' Type socket. Connection details are:

Pin	Title	Type
1	Cooling Unit On/Off -ve	
2	Interlock Reset -ve	
3	Interlock Enable -ve	
4	not connected	
5	not connected	
6	Vibrator Cooling +ve	Digital (low power)
7	Vibrator Cooling -ve	
8	Vibrator Overtravel -ve	
9	Interlock Enable +ve	Digital (medium power)
10	Interlock Reset +ve	Digital (medium power)
11	Cooling Unit On/Off +ve	Digital (medium power)
12	not connected	
13	not connected	
14	not connected	
15	Vibrator Overtravel +ve	Digital (low power)

2. ELECTRICAL CONNECTIONS and FUSES



(14)

Figure 5.1 Input/Output Panel

2. ELECTRICAL CONNECTIONS and FUSES (cont.)

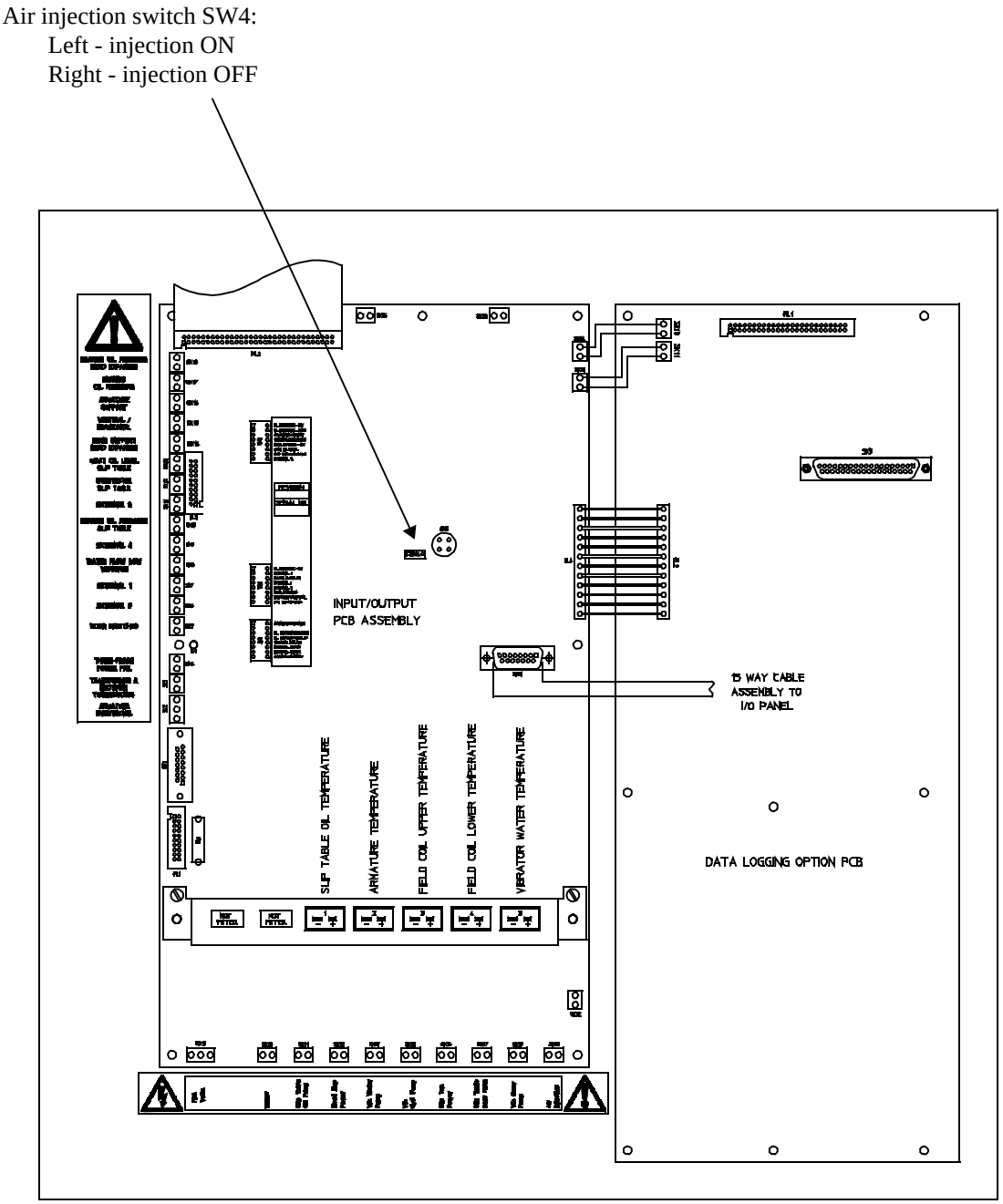


Figure 5.2a I/O Board/Data Logging Board Assembly

2. ELECTRICAL CONNECTIONS and FUSES (cont.)

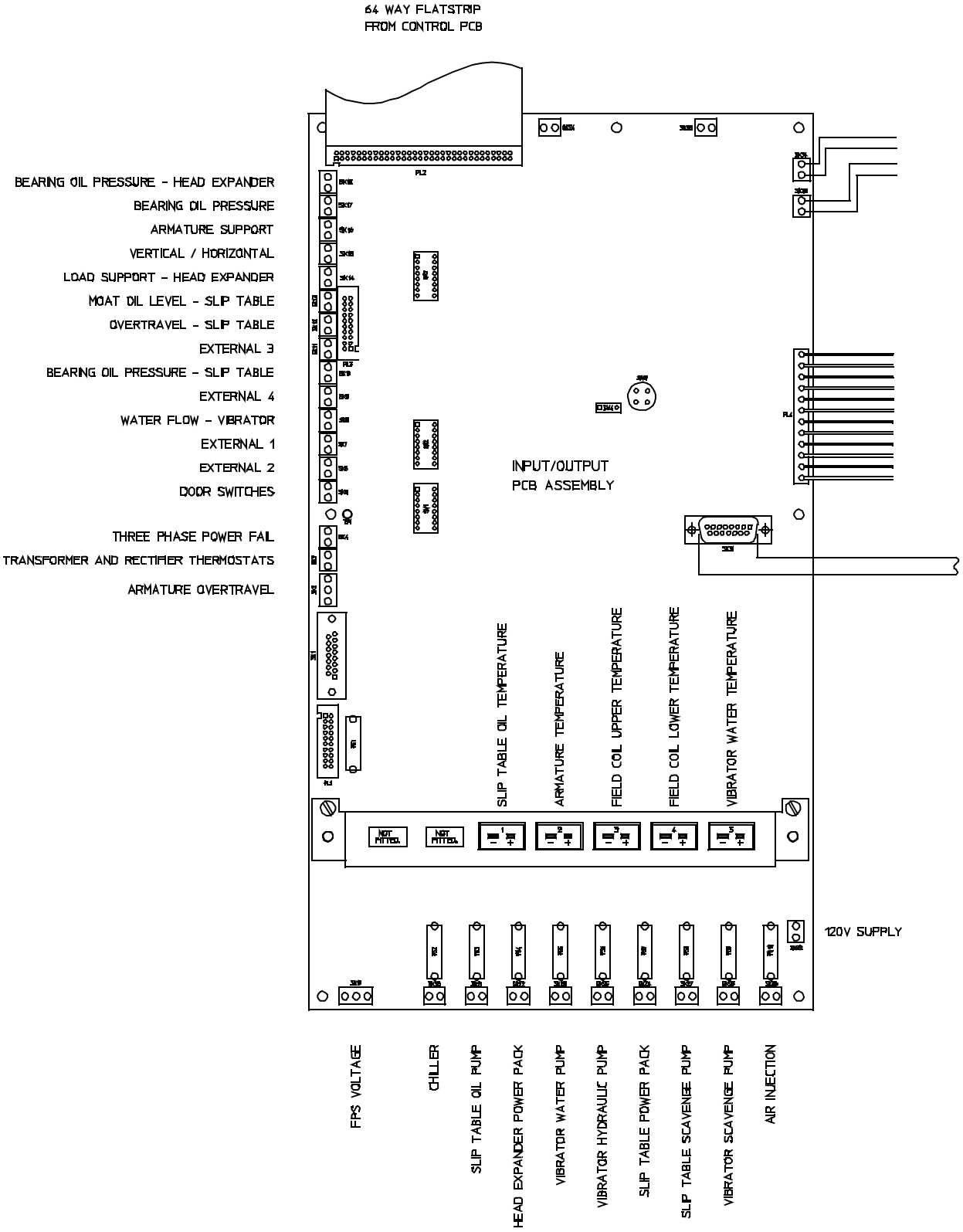


Figure 5.2b I/O PCB Assembly

2. ELECTRICAL CONNECTIONS and FUSES (cont.)

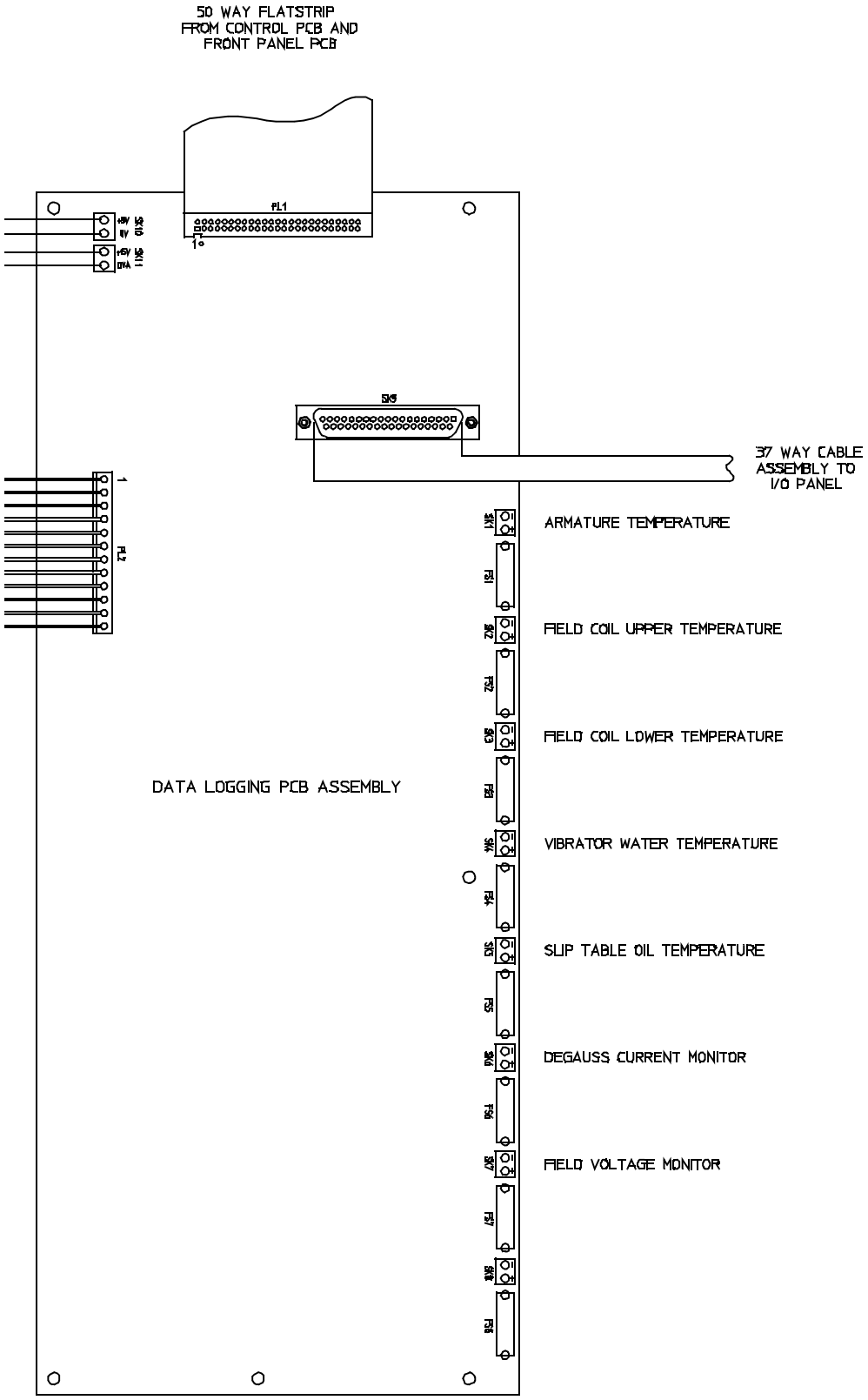


Figure 5.2c Data Logging PCB Assembly (option)

2. ELECTRICAL CONNECTIONS and FUSES (cont.)

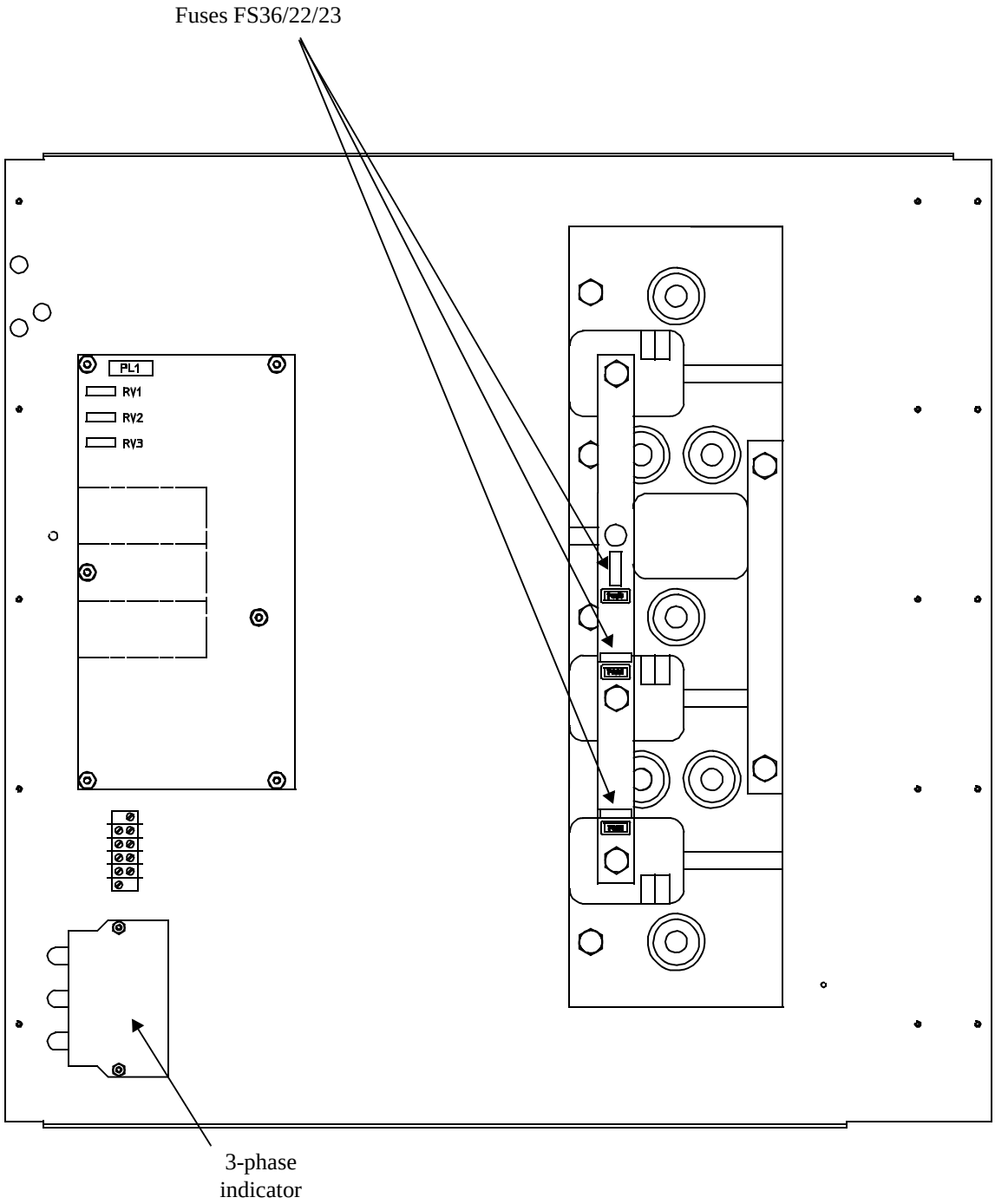
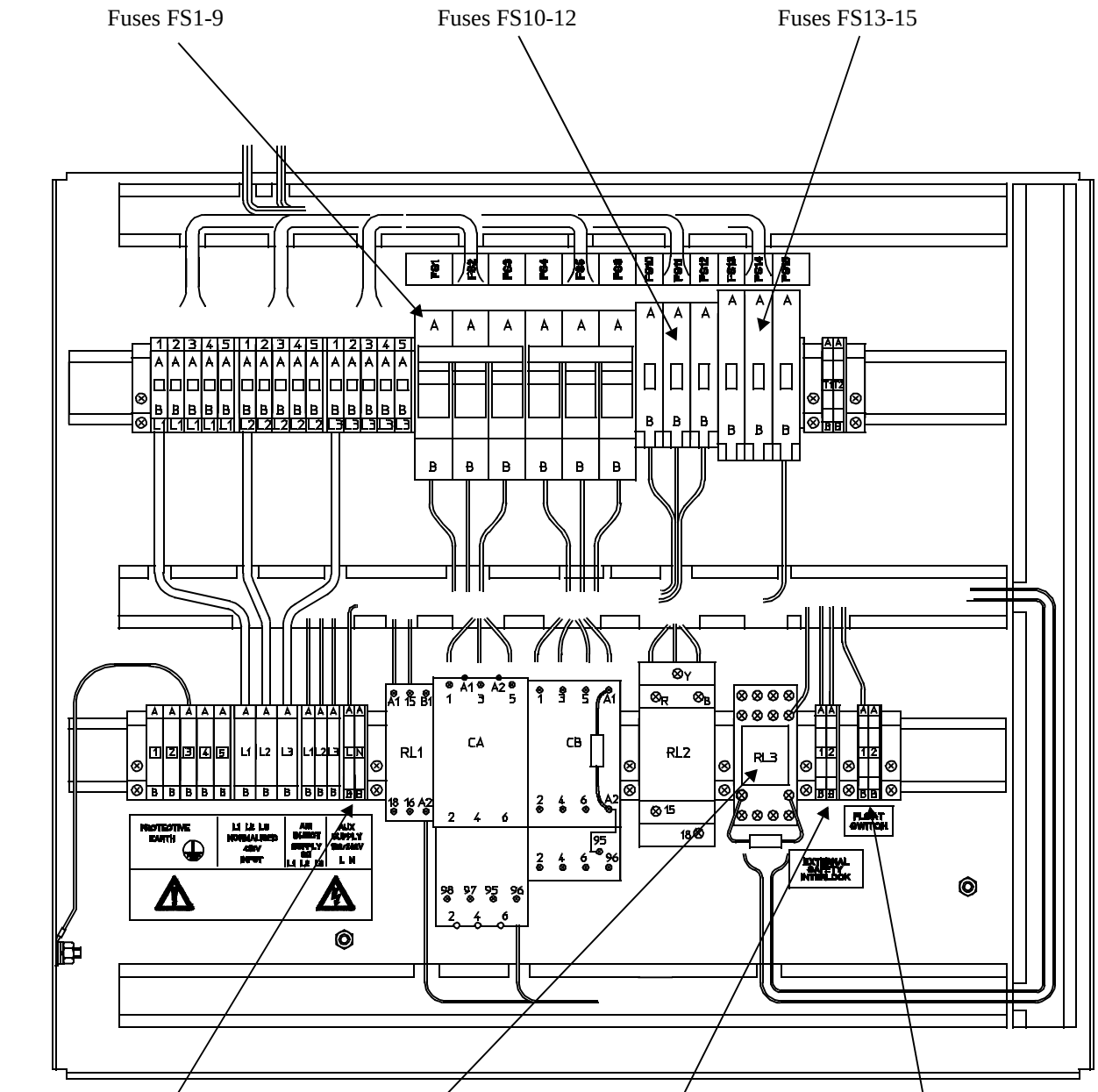


Figure 5.3 Panel Assembly FPS/Degauss

2. ELECTRICAL CONNECTIONS and FUSES (cont.)



Auxiliary supply
240 V, 1 A immediately available once power is applied to the CU/FPS. Protected by Fuse FS15.

Phase sequence/ failure relay

External safety interlock
Contacts closed when all doors are closed, open when door interlock EXT1 activated.
Contacts rated at 250V ac, 3 A.

Float switch
(Note: This output must be linked if not used)

Figure 5.4 Contactor Panel

2. ELECTRICAL CONNECTIONS and FUSES (cont.)

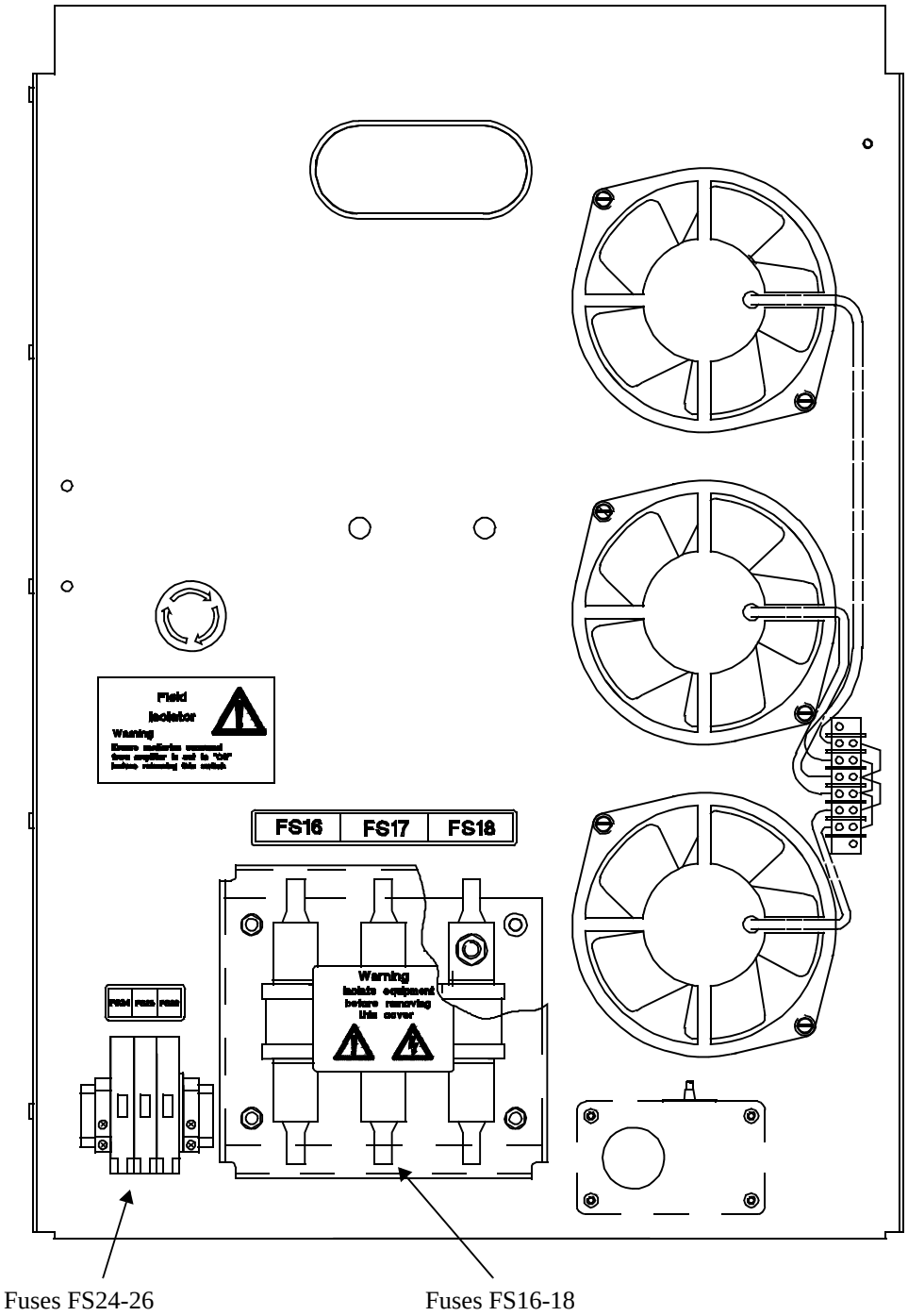


Figure 5.5 Panel Assembly (Upper)

2. ELECTRICAL CONNECTIONS and FUSES (cont.)

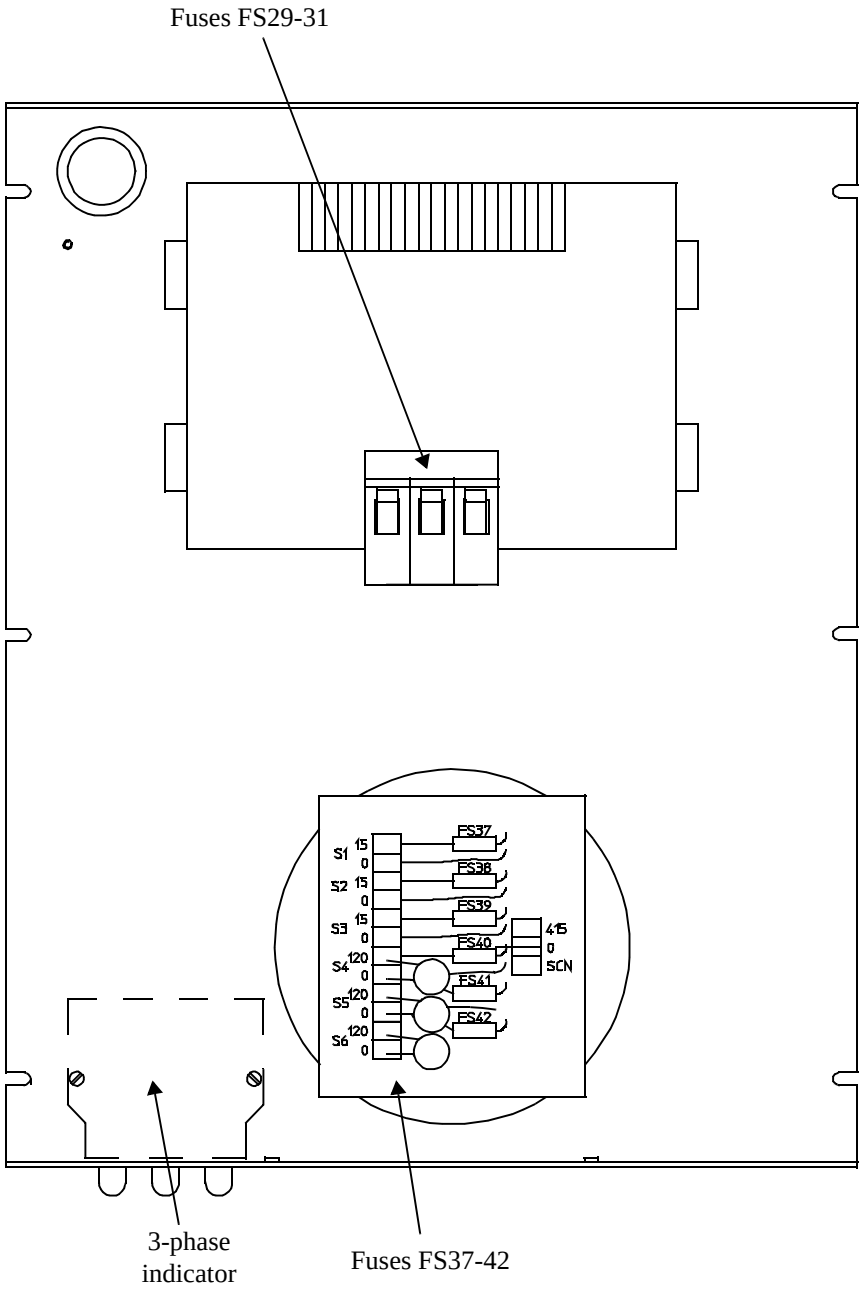


Figure 5.6 Mounting Plate Assembly

2. ELECTRICAL CONNECTIONS and FUSES (cont.)

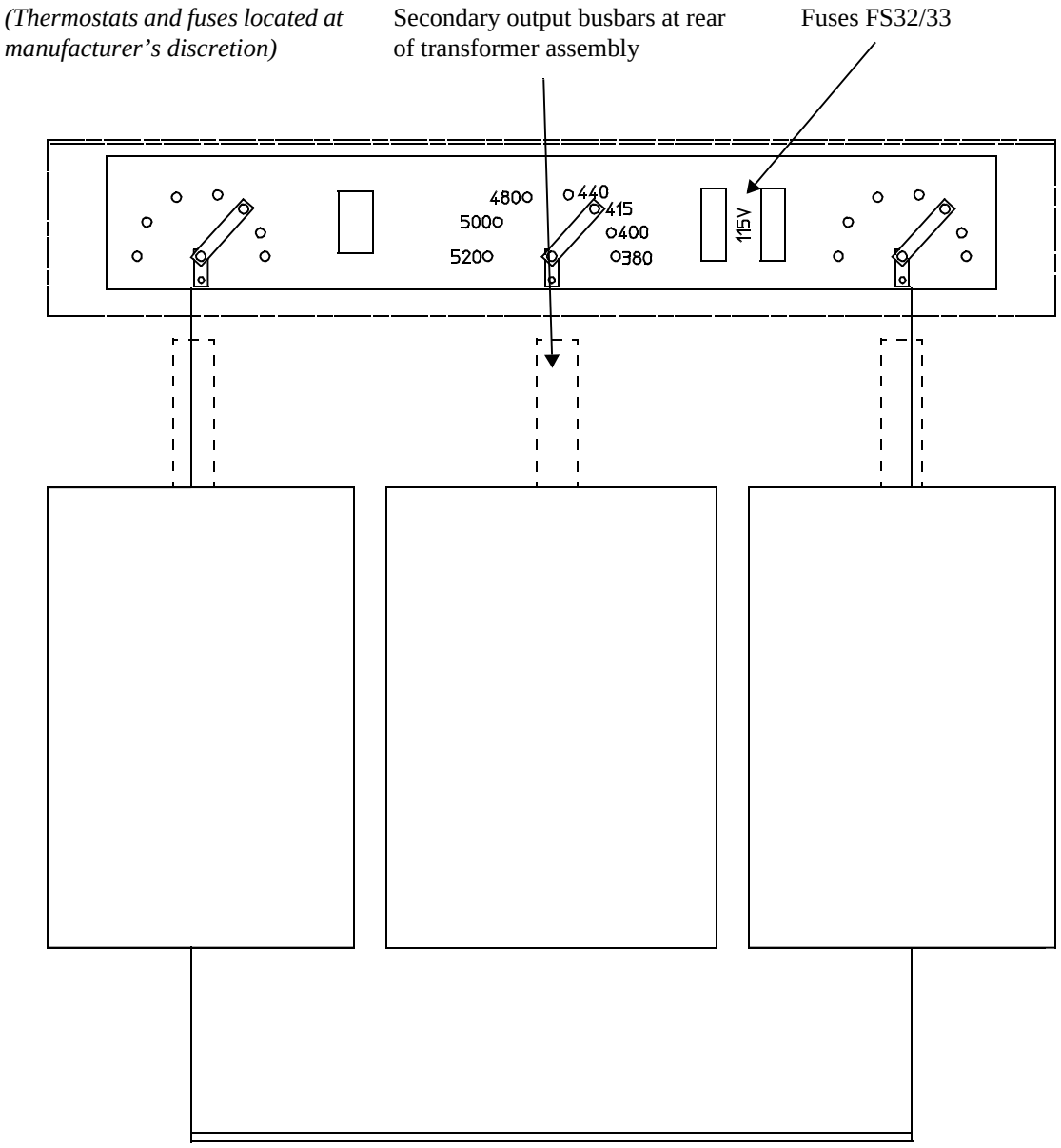


Figure 5.7 Supply Transformer

3. FLUID CONNECTIONS

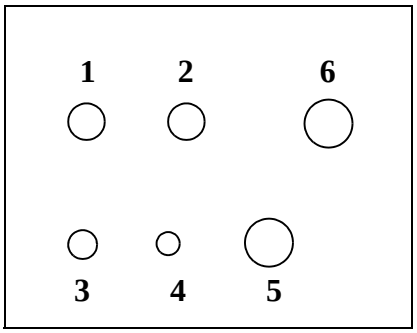
3. Fluid Connections

The pipes which require connection to the Cooling Unit are:

1	Pure water supply	28 mm outer diameter pipe
2	Pure water return	28 mm outer diameter pipe
3	Hydraulic oil return	5/8 in. outer diameter standpipe
4	Hydraulic oil supply	3/8 in. outer diameter standpipe
5	Raw water inlet	2 in. bore flexible hose
6	Raw water outlet	2 in. bore flexible hose

Note: Connection 1, Pure Water Supply, is fitted with a Tee Piece to supply the vibrator field coil and the chiller unit.

All pipe fittings are at the rear of the right-hand cabinet as shown:



Filling The System

Instructions for filling the system are contained in Chapter 4 - Maintenance. The system is flushed with anti-freeze before leaving the factory. When installing the equipment, the closed water circuit must be flushed twice to remove all traces of anti-freeze. The water filter should not be included in the system until the circuit has been flushed, see Page 2.1. *(12)*

NOTE

DEMINERALISED WATER IS A SAFETY CRITICAL COMPONENT. UNDER NO CIRCUMSTANCES USE TAP OR CONTAMINATED WATER. ENSURE THAT THE CONDUCTIVITY OF THE DEMINERALISED WATER IS NO GREATER THAN 10 μS.cm. *(12)*

4. INITIAL ADJUSTMENTS and CHECKS

The following components require checking, and may require adjustment prior to using the equipment:

1. The vibrator's hydraulic pressure switch. Refer to the vibrator manual for instructions.

2. The flow switch (see Figure 2.1) in the pure water circuit is factory set such that the DISTILLED WATER FLOW - LOW indicator is flashing before the cooling unit is switched on, but extinguishes immediately after the cooling unit is started and flow established. It may need adjustment if local conditions differ from those at the factory, or if the air injection condition changes. Air injected water has less mass to actuate the switch; the switch must therefore be adjusted to a lower setting.

   Adjustment is made by sliding the reed switch assembly within the clamp to achieve the conditions described above.

3. Check the flow through the filter as follows:

   * Close the taps at each end of the filter.

   * Open the drain cock at the rear of the cooling unit fully.

   * Open the tap at the outlet (upper) end of the filter.

   * Switch on the cooling system, at this stage there should be no flow through the filter.

   * Slowly open the tap at the inlet (bottom) end of the filter until a flow of 0.5 - 1.0 l/min is established. This flow is the type of flow seen from a quarter-open domestic tap, and can be checked using a measuring vessel and timer.

     Vessels of various capacities will take the following lengths of time to fill:

250 ml	15-30 seconds.
330 ml	20-40 seconds.
500 ml	30-60 seconds.
1 litre	60-120 seconds.

   * Check to ensure that the cooling water pressure has not dropped, if necessary reset the pump bypass valve to achieve the desired pressure.

   * The water conductivity may be found to rise initially. After 15 minutes of running the cooling unit re-check to ensure that the conductivity is falling, with further running the level should fall to 1 μS.cm

Check conductivity after one hour as follows:

Switch on the pocket conductivity meter included in the kit and dip the sensor end in the water reservoir, a reading in μS.cm will appear on the sensor display. The filter will need to be replaced when the reading exceeds 5 μS.cm, the colour panel changes from blue to brown, or after 6 months service. A log should be kept recording when each filter cartridge is installed, and the conductivity recorded on at least a weekly basis. Note that HBK cannot guarantee the calibration of the conductivity of the meter, calibration samples of de-ionised water are available from laboratory suppliers.

4. A thermocouple (see Figure 2.1) measures the temperature in the closed circuit; it should be adjusted to the lowest workable setting. The lower the setting, the better is the protection against overheating. However, the lower the setting, the greater is the risk of false interlock indications. The thermocouple is factory set to 77ºC.

   If local conditions deem it necessary, the setting should be altered. For example, 77ºC is based on the assumption that the raw water will always be at or near the maximum permissible temperature of 32ºC. If the raw water is permanently below the maximum allowed, the thermocouple setpoint should be lowered.

   The setpoint is altered by adjusting the thermocouple amplifier (located on the I/O Board), not the thermocouple. To adjust the setpoint, monitor test point TP16 with respect to earth, and adjust RV10 until a voltage indication, one tenth of the required temperature, is set:

   for example, 77ºC = 7.7 V d.c.
   65ºC = 6.5 V d.c.
   68ºC = 6.8 V d.c.

5. Check that the FPS/Degauss PCB is fitted with links as per customer requirements (refer to Chapter 2.4 and Figure 2.2).

6. Check that the supply transformer (figure 5.7), and normalising transformer (Figure 5.6) primary tap connections match the incoming 3-phase supply voltage.

7. With the incoming mains switched on at the isolator, and at the main circuit breaker, check that the three cooling fans are **extracting** air from the equipment cabinet.

8. Check the output of the FPS conforms to the link settings. Make any necessary adjustments to field voltage and current in accordance with Chapter 2.4.

CHAPTER 6 SPARES

This chapter lists the recommended spares holding for the CU-FPS unit. Recommendations are for a typical site installation and may require adjustment to suit particular site conditions/operational circumstances.

Spares within each section are classified as follows:

a.	Lifed Items:	Any item that, as a result of its use in the equipment, will wear, deteriorate or fail is included in this section. Items considered are fuses, bulbs, 'O' rings, seals, filters, load supports etc.
b.	High Value Items:	This category comprises items of high value that have a history of movement. Items such as armature kits or armatures, field coils, pumps, motors etc are considered
c.	Components	Items in this category are electrical and mechanical items hat have a spares movement history or due to the nature of the design of the product have a history of usage. Items of this nature are normally active electronic or electrical components such as relays, transistors, air switches, pneumatic valves etc.
d.	Consumables	This category comprises all items that will require replenishment on an on-going basis. Such items will include oils, grease, cleaning materials, recording paper, adhesives, silicon, rubber gloves, water purifiers etc.
e.	Options	Comprises items from any of the above categories which are specific to an option.
f.	Tools	Lists the tool kit recommended to undertake the level of maintenance specified in Chapter 4.

Spares lists are applicable to all sizes of CU-FPS unless otherwise stated.

1. CU/FPS - (all types)

	Part No.	Description	Quantity
*	**Lifed Items**		
	624590 (CU/FPS64 only)	Fuse, 6A, type aM, 500 V	3
	629050 (CU/FPS84 only)	Fuse, 10 A, type aM, 500 V	3
	624640 (CU/FPS94 only)	Fuse, 20 A, type aM, 500 V	3
	624940	Fuse, 4 A, type aM, 500 V	3
	629100 (CU/FPS84, 94 only)	Fuse, 2 A, type aM, 500 V	3
	708170	Fuse, 100 mA, type T, 250 V	3
	708200	Fuse, 5 A, type T, 250 V	2
	624550	Fuse, 2 A, type T, 250 V	2
	629030 (CU/FPS64, 84 only)	Fuse, 500 A, type 500FMM	3
	624990 (CU/FPS94 only)	Fuse, 700 A, type 700FMM	3
	624960	Fuse, 100 mA, type M, 500 V	3
	624570	Fuse, 63 mA, type T, 250 V	2
	629010 (CU/FPS64 only)	Fuse, 10 A, type aM, 500 V	6
	629040 (CU/FPS84 only)	Fuse, 16 A, type aM 500V	3
	624910 (CU/FPS94 only)	Fuse, 25 A, type aM 500V	6
	629000	Fuse, 10 A, type FF	3
	624910 (CU/FPS84 only)	Fuse, 25 A, type aM 500V	3
	708180	Fuse, 3 A, type T 250 V	2
	624550	Fuse, 2 A, type T 250 V	2
	624780	Lamp, 12 V, 100 mA	2
	629230	Lamp, 14 V, 100 mA	2
*	**High Value Items**		
	811960	PCB Assembly, Control	1
	812770	PCB Assembly, Front	1
	927370	PCB Assembly, Input/Output	1
	927380	PCB Assembly, Degauss Control	1
	634310	Pump, 50 Hz, (CU/FPS84)	1
	664405	Pump Unit Oil, Painted,50 Hz, (CU/FPS84)	1
	634340	Pump, 50 Hz, (CU/FPS64)	1
	664405	Pump Unit Oil, Painted,50 Hz, (CU/FPS64)	1
	634350	Pump, 50 Hz, (CU/FPS94)	1
	664405	Pump Unit Oil, Painted,50 Hz, (CU/FPS94)	1

*** Components**

043600	Pocket Conductivity Meter	1	*(12)*
866460	Diode, Zener, 5V5	1	
866480	Diode, Zener, 14V5	1	
872500	Regulator, Voltage, LM350K	1	
835020	Switch, Pushbutton, Hall effect	1	
832700	Switch, Pushbutton	1	
618540	Relay	1	
618550	Relay, Thermal overload	1	
618660	Time Delay	1	
618710	Relay, Thermal overload	1	
619270	Contactor	1	
619410	Relay, power failure detect	1	
619420	Contactor	1	
652670	Fan	1	
712930	Indicator, 3-phase	1	
618660	Time delay	1	
618670	Contactor	1	
618690	Coil, Contactor	1	
619240	Contact, Auxiliary	1	
619300	Time delay	1	
619340	Contactor	1	
666330	Resistor, 2R35	3	
618800	Relay, Solid state	2	
661930	Relay, Sub-miniature	1	
835600	Diode, Zener	2	
848750	Integrated Circuit, RVC420KP	1	
840800	Integrated Circuit, INA114AP	1	
866550	Diode, precision reference	1	
661700	Relay, 12 V	2	
632710	Flow Switch	1	
618640	Switch, body	1	
618650	Switch, Button	1	

*** Consumables**

043590	De-ionising filter cartridge	1	*(12)*
579120	Filter, Dust, lower	2	
579130	Filter, Dust, upper	2	

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APPENDIX – EARTHING, SUPPLY AND CABLING

When planning and carrying out the installation of a vibration testing system, special attention must be paid to earthing, mains supply and routing of cables.

This appendix gives advice on the following issues in relation to systems including a CU-FPS:

- System earthing
- Mains supply, including the choice of supply isolator and RFI filtering
- Routing of armature drive and field supply cables
- Routing of signal cables (including fibre optic cables)

LDS equipment installed as described in this appendix will conform where applicable to the EU directives specified in the Preface.

1. Earthing

There are two primary considerations for correctly earthing a vibration test system:

- Safety earth (protective earth)
- EMC earth

Safety earth

Each element of the vibration test system must have a suitably sized, continuous conductor to the facility safety earth and this conductor must have a low impedance at 50/60 Hz. This is a statutory requirement for compliance with the Low Voltage Directive and local Health & Safety at Work regulations, and is usually provided by and routed with the 3-phase mains connection.

RFI earth

To ensure compliance with the EMC Directive it is essential for a vibration system to be provided with a good RFI earth (target impedance of 1 Wat 150 kHz).

Ideally (for instance in new vibration test facilities) this earth should take the form of a ground mesh set in the sub-soil beneath the amplifier as shown in Figure A1. Where this is not practical (for instance in pre-existing facilities) earth rods may be sunk into the subsoil outside the building but as near to the amplifier as possible.

In either case, connection between the RFI earth and the system element must be made using multi-strand RFI ‘rope’ (or similar) or an appropriately sized and profiled copper bar.

Earthing

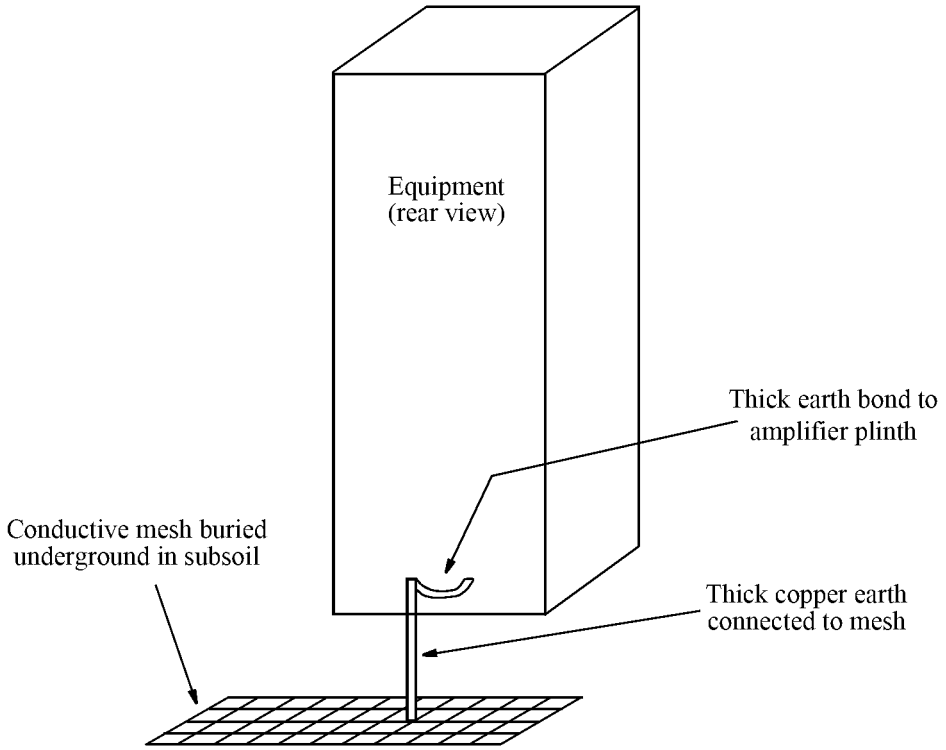

Figure A1 RFI earth connection

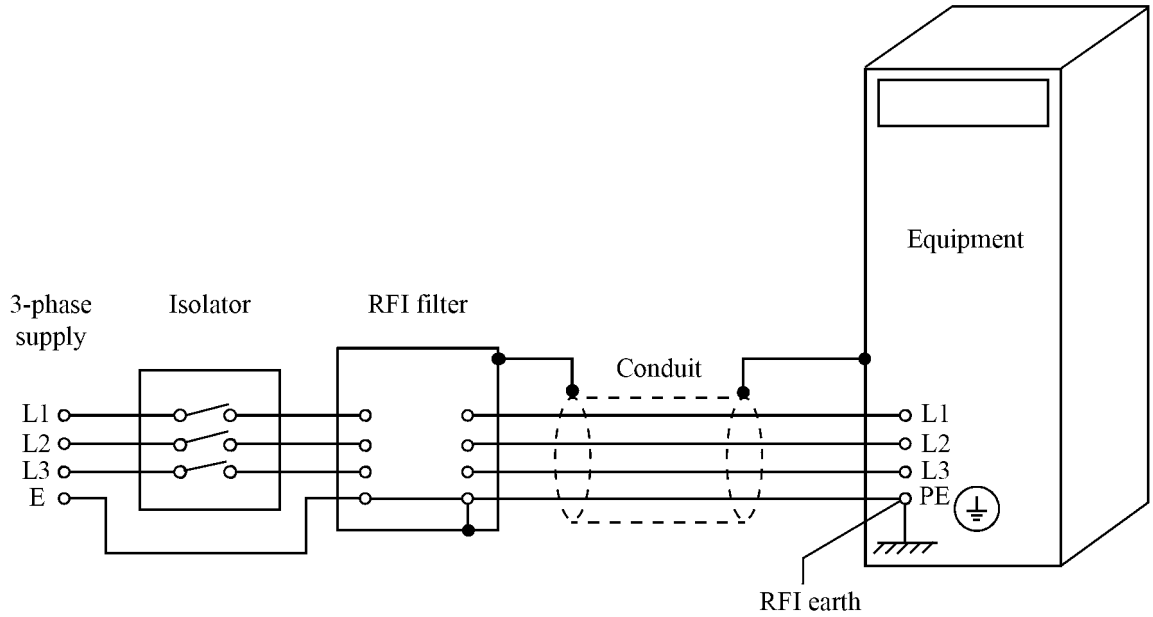

Figure A2 Mains supply and RFI filter

2. Mains supply

Supply isolator

To avoid nuisance fuse failure caused by high inrush currents, the primary 3-phase circuits within the equipment are not fuse-protected. It is the responsibility of the customer to ensure that these circuits are fully protected against overload or short-circuit by an external isolator with integral trip sensor.

The supply isolator must be connected on the incoming supply as shown in Figure A2. With this arrangement it is physically impossible to mount the isolator on the equipment as specified in the Machinery directive; HBK therefore recommend that the isolator be

- fitted adjacent to the equipment.
- easily accessible to the operator
- clearly marked
- lockable in the off position only

The supply current requirement can be calculated as in the following example:

- CU-FPS64
- Maximum input requirement of ?70.26 kVA
- 3-phase supply of 415 V

Maximum line current I_L will be ?97.7 A, calculated from $I_L = \frac{\text{Max input kVA x 1000}}{\sqrt{3} \text{ x line voltage}}$

RFI mains filter and associated EMC compliance

For compliance with the EMC Directive it is necessary to include an a.c RFI filter in the 3-phase supply to the equipment as shown in Figure A2.

Filter kit

The filter kit includes supply and earth cable and termination lugs, together with suitable conduit. Cables are supplied in 3 metre lengths which should be tailored to suit the installation.

It is important that all cable provided is used and divided equally between each supply line ie L1, L2 and L3. All earth cables provided must be used.

Location of filter

The RFI filter should ideally be wall-mounted. If this is not possible, the filter can be sited on the floor providing it has no ventilation holes susceptible to the ingress of fluids or dirt.

Alternative siting of RFI filters or points of cable entry into equipment may only be implemented with agreement from HBK.

Installation

To ensure compliance with the EMC directive the following points must be observed during installation and checked during routine maintenance and service repairs.

- It is **imperative** that all mains supply cables between the amplifier and the RFI filter are completely enclosed in metal conduit. This conduit must have good galvanic connection and 360° metal-to-metal contact at both ends: to a bracket on the amplifier and to the metal housing of the RFI filter.
- The bracket supplied with the RFI filter kit is plated (not painted) to ensure good electrical (galvanic) connection with the amplifier plinth and with the conduit protecting the cables to the filter.

  Note: The amplifier plinth is the ground reference plane and must have a very low RFI impedance connection to earth (see Section 1, 'RFI earth').

  The bracket is fitted on the underside of the plinth below the internal mains terminals.
- The 2 m conduit supplied with the RFI filter kit has a plastic covering. This should be stripped at both ends, sufficient to ensure good 360° galvanic contact.
- Good surface-to-surface contact must be maintained between equipment outer panels and cabinet frame.

3. Armature drive and field supply cables

Cable characteristics

Armature drive cablesets comprise one or more 7-core 10 mm² cables. The cores, which are tightly twisted together within an outer sheath, provide three positive, three negative and one earth connection. The tight bonding minimises the cable inductance (impedance) and therefore high-frequency losses.

Field power supply cables consist of lengths of multi-strand welding cable, which do not need to be tightly bonded as do armature cables.

As with all cables, and particularly with the high currents carried by the armature drive cables, some losses and consequent heat dissipation will occur with both types of cable, which will be proportional to cable length. For this reason the guidelines given below for routing and installation of these cables should be followed.

Routing of cables

IMPORTANT

IN ORDER TO KEEP THE TEMPERATURE LEVEL OF THESE CABLES TO A MINIMUM, THE FOLLOWING RECOMMENDATIONS MUST BE ADHERED TO. FAILURE TO COMPLY COULD RESULT IN OVERHEATING OF THE CABLES WITH A CONSEQUENT FIRE RISK.

- Cables should be laid in a suitable steel cable tray designed for the purpose (see Figure A3(a).
- Cables should be individually fixed to the tray, with sufficient space between to ensure good ventilation around the cables.
- Cables should not be laid on top of each other but tiered in the cable troughing to allow the maximum circulation of air around the cables as shown in Figure A3(a).
- Cables that pass through a duct or wall should be given special care in that insulation must not be wrapped around the cable at the entry and exit points to seal the duct.

  For applications where cables pass from, for example, a clean room test area to an air conditioned amplifier room where the cables must be sealed, a special interface bulkhead, made from Tufnol material, must be fitted as shown in Figure A3(b).

  Note: Insulation around the cables at this point will impede cooling and cause a local hot spot in the cable.

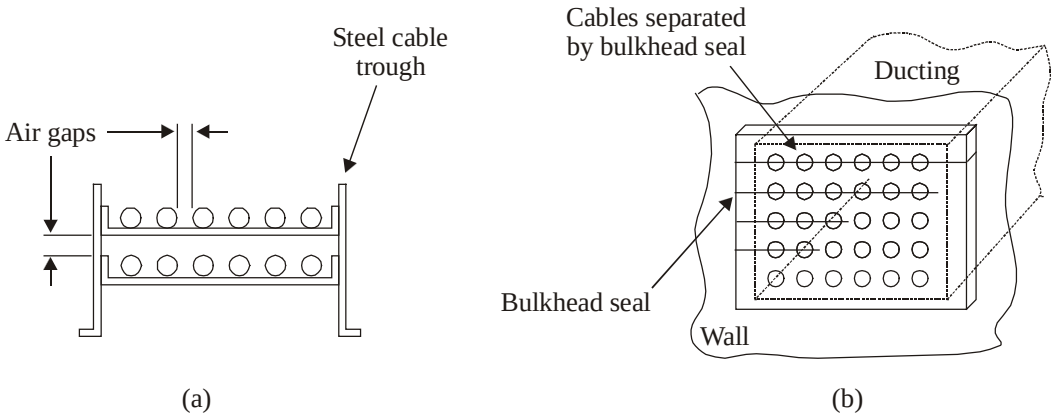

Figure A3 Routing vibrator drive cables

4. Signal cables

The following considerations should be borne in mind when routing and installing system signal cables.

Amplifier signal

To ensure full EMC compliance, the drive signal to the amplifier should be supplied using triaxial cable. On SPA-K amplifiers the amplifier terminations are BNC connectors with adjacent earth studs to terminate the outer screen of the triaxial cable.

Most drive sources (controllers) have BNC output connectors. It is essential for good EMC performance that the outer screen of the triaxial cables is bonded to the case of the drive equipment via the 'pigtail' provided.

System interlock

All system interlock cables supplied by HBK are at least 2-core with an outer screen. The inner cores carry the signals while the screen provides protection from RFI interference. It is essential that the screen is earthed at both ends of the cable.

Routing of cables

Switching amplifiers such as SPA-K amplifiers generate high levels of electromagnetic interference that can affect system signal cables.

Filter units on the DC circuit and 3-phase supplies of LDS amplifiers provide the necessary suppression to comply with European legislation. However very low levels of radiated RFI signals will occur. All LDS cables are screened to ensure that no interference from the amplifier or other sources can affect the signals carried.

Where other cables are introduced into the system it is equally important to ensure that both ends of the cable screen are taken to a good earth.

It is always good practice to route signal cables away from vibrator drive cables to reduce further the possibility of any interference. Where signal cables cannot be routed in a separate trench or duct they should be run in conduit and kept as far away as practical from drive cables.

Installing cables

Great care must be taken when installing signal cables to prevent any undue strain on the terminations. Cables should be carefully routed to allow an excess at each end which should be coiled to avoid any possibility of the termination being pulled if disturbed.

When routing cables avoid sharp corners that could damage the insulation.

Extra special care is needed where fibre optic cables are used:

- They should not be routed around tight bends as kinking and damage to the cable will occur.
- The fibre optic termination is easily damaged and must not be strained in any way.

- Failure to maintain a secure connection at both ends could result in spurious fault conditions occurring.

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