MANUAL

EQUIPMENT AND TOOLS FOR MAINTENANCE AND INSPECTION

Part 4 - Electrical Workshop - Test Equipment and Tools

DEP 70.08.10.13-Gen.

December 1992
(DEP Circulars 08/95 and 17/95 have been incorporated)

DESIGN AND ENGINEERING PRACTICE

USED BY

COMPANIES OF THE ROYAL DUTCH/SHELL GROUP

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1. INTRODUCTION

1.1 SCOPE

This DEP is a revision of that having the same title and number dated August 1982. It provides guidance on the design, layout and equipping of an electrical workshop facility and on the provision of tools and instruments required to perform maintenance and inspection of electrical equipment.

NOTE: In this DEP some references are made to specific Manufacturers' equipment. It is not intended to preclude the use of other equivalent products provided they are approved by the Principal.

1.2 DISTRIBUTION, INTENDED USE AND REGULATORY CONSIDERATIONS

Unless otherwise authorised by SIPM, the distribution of this document is confined to companies forming part of or managed by the Royal Dutch/Shell Group, and to Contractors nominated by them (i.e. the distribution code is "C", as defined in DEP 00.00.05.05-Gen.).

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If national and/or local regulations exist in which some of the requirements may be more stringent than in this DEP, the Contractor shall determine by careful scrutiny which of the requirements are the more stringent and which combination of requirements will be acceptable as regards safety, economic and legal aspects. In all cases the Contractor shall inform the Principal of any deviation from the requirements of this document which is considered to be necessary in order to comply with national and/or local regulations. The Principal may then negotiate with the Authorities concerned with the object of obtaining agreement to follow this document as closely as possible.

1.3 DEFINITIONS

Within this DEP the following definitions apply:

1.3.1 General definitions

The **Contractor** is the party which carries out all or part of the design, engineering, procurement, construction and commissioning for the project. The Principal may sometimes undertake all or part of the duties of the Contractor.

The **Manufacturer/Supplier** is the party which manufactures or supplies equipment and services to perform the duties specified by the Contractor.

The **Principal** is the party which initiates the project and ultimately pays for its design and construction. The Principal will generally specify the technical requirements. The Principal may also include an agent or consultant, authorised to act for the Principal.

The word **Shall** indicates a requirement.

The word **Should** indicates a recommendation.

1.3.2 Specific definitions

The word **portable** denotes electrical equipment which is moved whilst in operation or can easily be moved from one place to another while connected to the supply.

The word **transportable** denotes electrical equipment which is moved by a means of transport or by hand while disconnected from the supply.

1.4 CROSS REFERENCES

Cross references to other parts of this DEP are shown in brackets. Referenced standards are listed in (5).

2. ELECTRICAL WORKSHOP FACILITY

2.1 GENERAL

The following recommendations for electrical workshops are normally applicable to a new process plant facility when located in areas where comparable overhaul/repair services are unavailable from local industry.

Where supporting services are available from local industry, the workshop and the equipment installed may be reduced to meet the balance of the specific plant needs with respect to day-to-day maintenance and emergency repairs.

The electrical workshop is a facility dedicated to the maintenance, repair and testing of electric motors, switchgear and protection relays etc. and usually forms part of a complex of facilities which include the workshops for the mechanical and instrumentation disciplines.

In addition to the central workshop for a large process plant facility which is distributed over a large area, it may be required to provide small, satellite workshops local to the process units to meet their maintenance requirements.

As indicated above, the maintenance tasks carried out in the electrical workshop are varied and require suitably sized floor space and access to the plant. The most space-consuming activity is the overhaul of electric motors, especially during a shut-down period when a number of motors may need to be overhauled at the same time. For reasons of access and safety, part of the facility should be dedicated to a motor test bay. The workshop will also require space for the storage of tools, site test equipment and frequently used spares.

2.2 REQUIREMENTS FOR WORKSHOPS

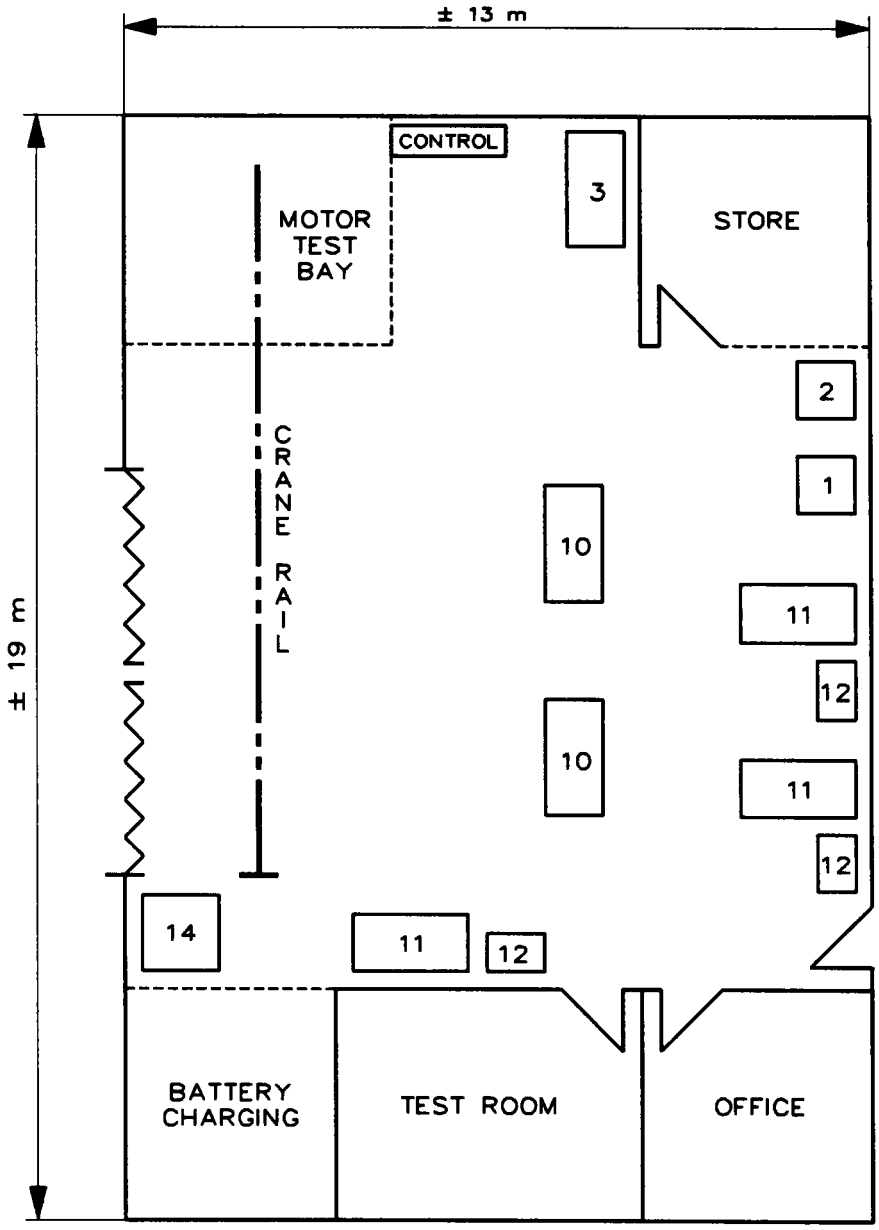
The recommended floor space for the electrical workshop is 250 m^2 and is based on the following requirements (see Figure 1):

Activities:

- ❑ Inspection, repair and overhaul of low voltage motors and high voltage motors up to 1.0 MW.
- ❑ Test running of low voltage motors up to 150 kW at no-load (horizontal or vertical mounting).
- ❑ Maintenance and repair of electrical equipment, e.g. lighting fittings, distribution boards, small generators (up to 150 kVA) and temporary supplies equipment.
- ❑ Testing and repair of protection relays.
- ❑ Training of electrical maintenance staff.

NOTE: The rewinding of electric motors is normally carried out in a third party repair facility.

FIGURE 1. ELECTRICAL WORKSHOP LAY-OUT



NOTE: For equipment numbers refer to Appendix 1.

Typical Space Requirements:

- ❑ Supervisor's office.
- ❑ Main work space.
- ❑ Test room.
- ❑ Motor test bay.
- ❑ Battery charging room or segregated area.
- ❑ Store for consumables and test equipment.
- ❑ Equipment cleaning area (motors etc)
- ❑ Equipment laydown area (external to workshop)

To facilitate the foregoing activities, the workshop should be provided with the permanent services listed below. For details of the maintenance equipment to be installed in the workshop reference is made to Appendix 1.

Permanent Services:

- ❑ Electric motor driven hoist, capacity 10 tonnes, rail mounted.
- ❑ Tool air and potable water supply.
- ❑ Socket outlets for general use, rating 16 ampere, 2P + E (IEC 309).
- ❑ Socket outlets for welding purposes, rating 100 ampere, 3P + E (IEC 309).
- ❑ Socket outlets for test purposes meeting the following requirements:

  Rating 32 ampere, 3P + N + E, switched
  MCB and 30 mA residual current device (IEC 309).

  Rating 63 ampere, 3P + N + E, switched
  MCB and 30 mA residual current device (IEC 309).
- ❑ Power supplies with local isolation for fixed items of electrical equipment.
- ❑ Lighting installation to meet functional requirements of area.
- ❑ Main switchboard with sufficient capacity to serve the total workshop facility including the mechanical and instrument workshop when forming part of the total complex (refer to DEP 33.67.01.31-Gen.).
- ❑ Concrete surfaced laydown area, outside the workshop, for cleaning electric motors, with steam or high pressure water and air outlets with foul water drain connection.
- ❑ Fire fighting and first aid equipment.
- ❑ HVAC systems for the supervisors office, test room and workshop, dependent on climatic conditions.

NOTE : The circuits for the general purpose and welding outlets shall be protected by a 30 mA residual current device.

2.3 TEST ROOM

The test room facilities should be designed for the purpose of testing protection relays, small general items of electrical and electronic equipment and transformer oil samples. The test room will require, typically, a floor area of 24 m^2.

The room should be provided with work benches and power supplies as generally described below and illustrated in Figure 2. For details of fixed electrical equipment shown in Figure 2, refer to Appendix 1. For details of the electrical test equipment to be provided refer to Appendix 2.

Test bench power supplies (wall mounted above each bench) :

4 No general socket outlets, rating 16 ampere, 2P + E, 220-240 V (ac) IEC 309)
1 No socket outlet, rating 32 ampere, 3P + N + E, 380-415 V (ac) (IEC 309)
1 No socket outlet, rating 16 ampere, 2P + E, 50 V (ac) (IEC 309)

All power outlets, with the exception of the 50 V (ac) outlet, shall be equipped with MCB and 30 mA residual current device protection.

The 50 V(ac) socket outlets shall be supplied via a dedicated isolation transformer.

Note: Alternative voltages, test sockets, and other provisions may be agreed upon locally.

Power supplies shall be provided with local isolation switches for fixed items of electrical test equipment.

Cabinets shall be provided for the storage of test equipment, test data and records.

2.4 MOTOR TEST BAY

The motor test bay is a segregated area of the electrical workshop with facilities specifically designed for the safe testing of electric motors and will require, typically, a floor area of 18 m^2.

The motor test bay shall be fenced-off from the remaining workshop area with the control and monitoring panel located outside the fence within visual range (Figure 1).

The general requirements for the motor testing facilities are listed below. For detailed requirements for the switchboard and socket outlets, refer to Appendix 9 :

- ❑ Steel mesh fence with sliding gate access.
- ❑ Steel bed plate (fixings for clamps and bolts for vertical and horizontal motors).
- ❑ Socket outlets (3) 3 P.E. for connection of motor under test.
- ❑ Motor test control switchboard in accordance with DEP 33.67.01.31-Gen.
- ❑ Warning lamp (Illuminated during testing).
- ❑ Emergency stop push button, mounted inside motor test bay.
- ❑ Common earthing busbar (wall mounted inside test bay).

2.5 EARTHING REQUIREMENTS

The electrical workshop, and the mechanical and instrument workshops, shall be provided with a common earthing ring, 70 mm^2 minimum.

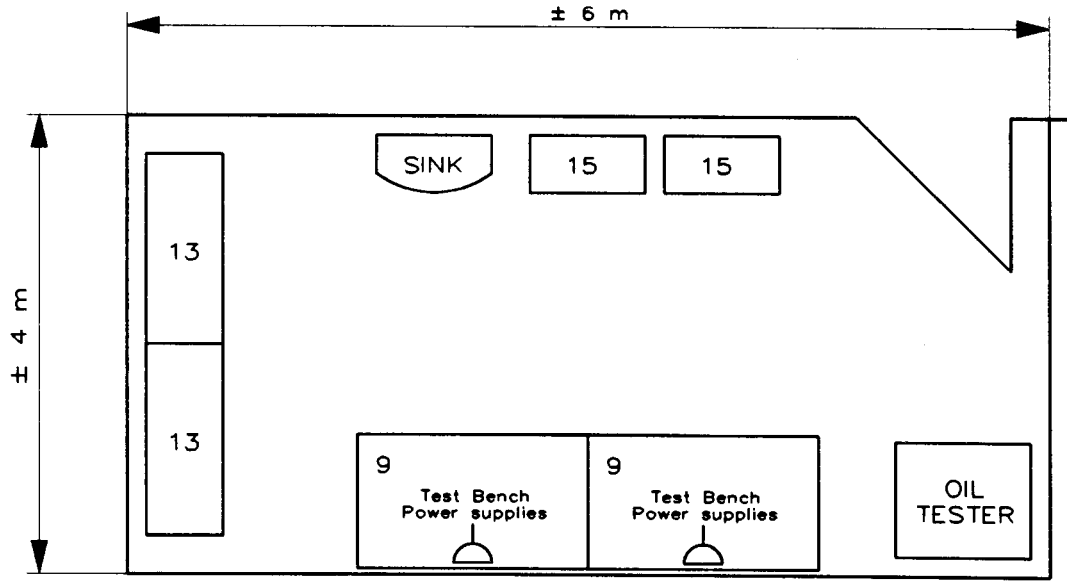
All metallic fixed items of electrical equipment, including test benches, shall be earthed to the common earthing ring via a protective conductor of not less than 16 mm^2.

An earthing busbar shall be installed inside the test bay and shall be connected to the common earth ring via two separate protective conductors of not less than 25 mm^2. All items of electrical equipment including the motor bed plate and the surrounding fence shall be earthed to the earthing busbar via protective conductors of not less than 16 mm^2 minimum.

All earthing connections shall be physically protected and the terminations shall be visible to facilitate inspection.

For details of typical earthing arrangements, refer to the standard drawings S 68.003 and S 68.004 listed in section 5.

FIGURE 2 ELECTRICAL TEST ROOM



NOTE: For equipment numbers refer to Appendix 1.

2.6 LIGHTING INSTALLATION

Fluorescent lighting fittings should be used for general lighting. However, in the main workshop and exterior areas high pressure sodium fittings supplemented with fluorescent fittings, where appropriate, should be selected.

In addition to the general lighting, local lighting may be required for work benches and machines where more detailed work is performed. In these situations, wall mounted adjustable fittings should be used. The power supply circuit to these local, adjustable fittings shall be protected by a 30 mA residual current device.

A proportion of the normal lighting should be connected to the emergency lighting system and, where applicable, supplemented with escape lighting at exit doors.

2.6.1 Illumination Levels

The recommended illumination levels are as follows :

Area	Requirements (lux)	
	Normal	Emergency
Workshop :		
General	250	5
Battery Charging Area	250	-
Motor Test Bay	250	-
Store Room	150	-
Work Benches	400	-
Office	400	-
Test Room :		
General	250	5
Test Benches	400	-

NOTE: Emergency lighting illumination levels are average values measured at floor level.

3. TOOLS AND EQUIPMENT FOR ELECTRICAL MAINTENANCE

3.1 GENERAL

A listing of typical requirements for tools intended for general maintenance and testing of plant electrical equipment is included in Appendices 2 & 3.

In addition, there will normally be a requirement for special tools and test apparatus designed for the maintenance of specific items of electrical equipment, e.g. a tool set for switchgear maintenance. These tools and instruments should be included in the order for the particular equipment.

NOTE : For substations, there will be a requirement for items of test equipment, e.g. voltage test sticks and phasing sticks. Where applicable, these will normally be stored in the substation.

3.2 PERSONAL TOOLS AND INSTRUMENTS

In general, the technician will require a set of personal tools and basic test instruments to assist in day-to-day maintenance activities. A listing of typical requirements is included in Appendix 4.

4. PORTABLE ELECTRICAL EQUIPMENT.

4.1 GENERAL

The listing of typical portable and transportable electrical equipment is included in Appendices 5 & 6. For additional information on utilisation, reference should be made to DEP 33.64.10.10-Gen.

Equipment, tools and power supply cables shall be subject to inspection and test at a frequency based on the recommendations of the manufacturer and local conditions of usage. In the absence of recommendations from the manufacturer regarding the test procedures and the frequency with which they are to be carried out, it is recommended that the requirements of DEP 63.10.08.11-Gen., as referred to below, are followed. A registration system should be implemented to control the inspection and test work. Damaged equipment or cables shall not be used until permanent repair or replacement has been effected.

It is recommended that the storage, issue and maintenance of the portable and transportable electrical equipment should be the responsibility of the electrical workshop supervisor.

For the requirements of inspection and testing of portable equipment refer to DEP 63.10.08.11-Gen.

4.2 WELDING APPARATUS

For requirements of electric arc welding reference shall be made to IEC 974 and the Shell Safety Committee Publication : Welding and Cutting.

Preference shall be given to direct current welding equipment.

Where alternating current welding equipment is used then the open circuit voltage between the electrode holder and the work piece shall be limited to 50 volts maximum. If a separate voltage limiting device (relay) is used then this shall be housed in an enclosure which requires the use of a tool to gain access. Alternatively, alternating current welding equipment which is switched automatically to a direct current output voltage, when operating on open circuit, is acceptable.

4.3 DIESEL/GASOLINE DRIVEN GENERATOR SETS (TRANSPORTABLE)

4.3.1 General Applications

Transportable generators may be used to supply power to locations where there is no local mains power supply, e.g. tank farms. Unit ratings will normally be in the range 2.5 - 5 kVA.

When generators are used in areas where there are no earthing facilities, the generator shall be equipped with an insulation monitoring relay. This relay shall be arranged to disconnect the output power in the event of insulation failure of the connected equipment. Where local earthing facilities are available, e.g. plant earthing electrode pits, then the neutral point of the generator shall be connected to the electrode via a flexible protective conductor and bolted connection. The output of the generator shall be provided with a circuit breaker providing overcurrent and overload protection together with a 30mA residual current device (see Figure 3).

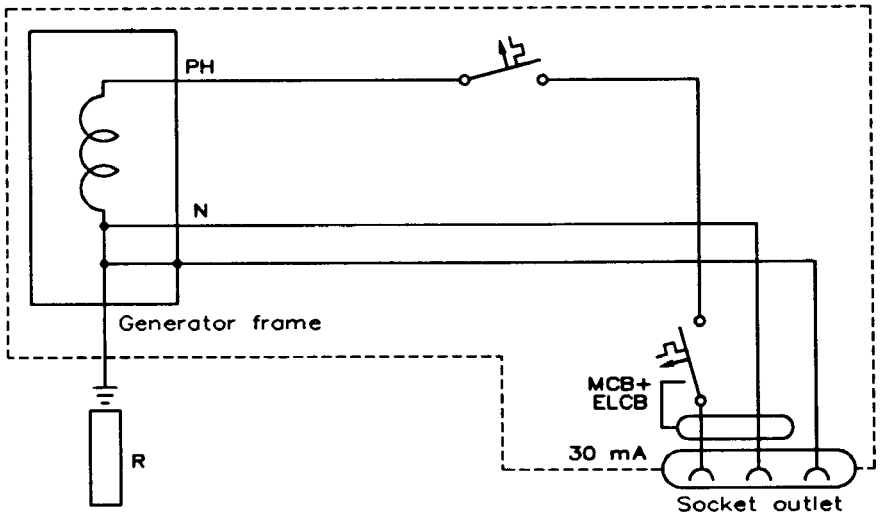
4.3.2 Welding Generators

Transportable welding generators are often provided with an auxiliary single phase winding supplying a 110 V or 220/230 V socket outlet for the use of hand held tools, e.g. grinders. These generators are constructed with the auxiliary winding insulated from the main winding and the frame. As these generators are not normally intended to be earthed and are not normally equipped with an insulation monitoring relay, the connection arrangement for the auxiliary socket outlet indicated in Figure 4 will provide an acceptable safe system.

Only Class 2 hand tools to IEC 745 shall be used in association with welding generator auxiliary supplies.

FIGURE 3 MOBILE GENERATORS IN TEMPORARY INSTALLATIONS

Fig 3a - Earthed Systems (TN-S)



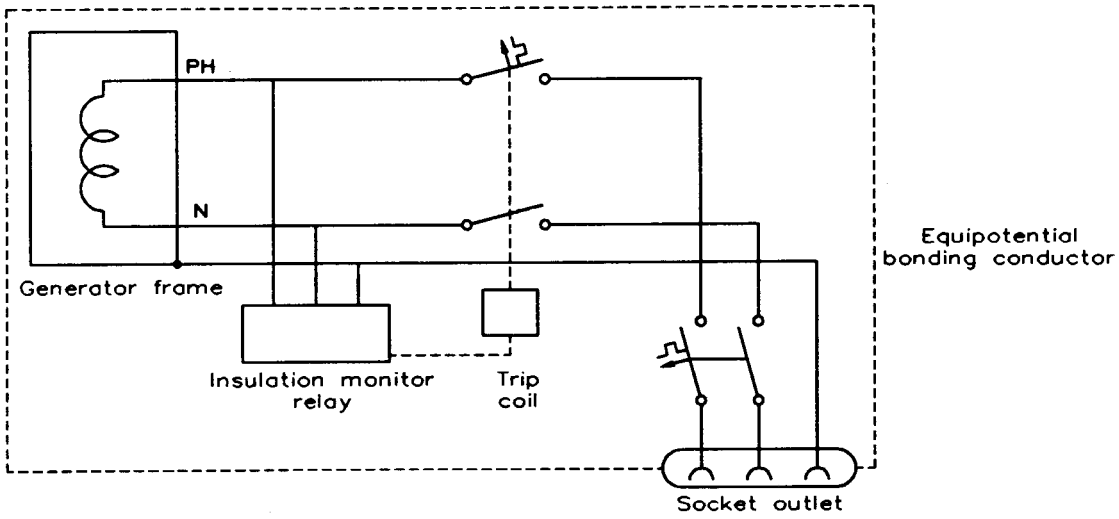
NOTES: 1. R = the earth electrode resistance = U/I ohm (100 ohm maximum)

where U = safe to touch voltage

and I = nominal trip current of residual current device (RCD).

2. The cable between the generator and the outgoing circuit shall be protected against mechanical damage since it is not protected by the residual current device (RCD).

Fig 3b - Unearthed Systems (IT)



NOTES: 1. The generator and distribution circuit shall be connected as indicated.

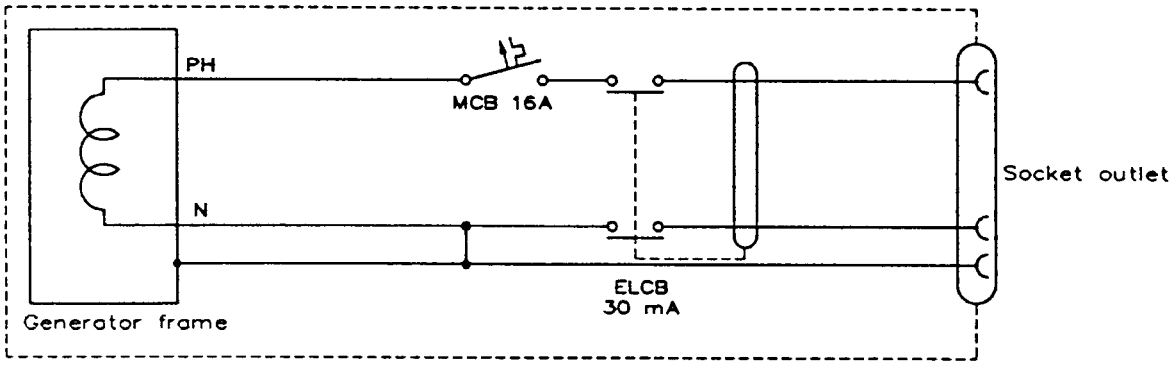
2. An insulation monitoring relay shall be installed which shall automatically disconnect all phases of the generator output if the insulation breaks down.

3. Overcurrent and short circuit protection for the generator shall be located as close as possible to the generator.

4. The phase(s) and neutral of the outgoing circuit shall be disconnected by the protective devices.

FIGURE 4. WELDING GENERATOR - AUXILIARY POWER SUPPLY SOCKET

Amended per Circular 08/95



5. REFERENCES

In this DEP, reference is made to the following publications:

NOTE: Unless specifically designated by date, the latest edition of each publication shall be used, together with any amendments/supplements/revisions thereto.

SHELL STANDARDS

Index to DEP publications and standard specifications	DEP 00.00.05.05-Gen.
Electrical Engineering Guidelines	DEP 33.64.10.10-Gen.
Low-voltage Switchgear and Controlgear Assemblies (Amendments / Supplements to IEC 439-1)	DEP 33.67.01.31-Gen.
Field inspection of electrical installations and equipment	DEP 63.10.08.11-Gen.
Shell Safety Committee - "Welding and Cutting"	Group S 68
Shell Safety Committee - "Electrical Safety"	

STANDARD DRAWINGS:

Typical mounting details of earthing connections	S 68.003
Earthing Boss	S 68.004

INTERNATIONAL STANDARDS

Electrical apparatus for explosive atmospheres	IEC 79
Low-voltage fuses	IEC 269
Plugs, socket-outlets and couplers for industrial purposes	IEC 309
Degrees of protection provided by enclosures (IP Code)	IEC 529
Isolating transformers and safety isolating transformers	IEC 742
Safety of hand-held motor-operated electric tools	IEC 745
Safety requirements for arc welding equipment	IEC 974

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APPENDICES

APPENDIX 1 ELECTRICAL WORKSHOP EQUIPMENT

The equipment listed in this section constitutes the basic requirements for equipment used in the electrical workshop.

Item Description

1 **Drilling Machine**

Bench type, electric driven, capacity in steel: 13 mm hand feed

Accessories : Vice, chuck, arbor and guard.

2 **Grinding Machine**

Bench type, electric driven, two wheels 150 mm diameter (roughing and finishing)

Accessories : Wheel guards, eye protecting shields
Adjustable work rests

3 **Drying Oven (electric)**

Rating : 10 kW (approx), three phase supply, with temperature control
Range : 40 - 150 °C
Dimensions : 1 x 1 x 1.5 m (H x W x D - internal)
Accessories : Temperature indicator, warning lamp

4 **Battery Charger (static)**

Output : 6/12/18/24/36 V and 0-5/10/15/20 A
Input : 220-240 V (ac) 50-60 Hz

5 **Bearing Heater**

Induction type, temperature controlled to 100 °C
Automatic demagnetizing.

Capacity : Diameter 10 mm, external 250 mm
width of bearing maximum 100 mm
Input : 220/240 V (ac) 50/60 Hz 15 A maximum

6 **Bearing Puller**

Mobile hydraulic, two arm type
Capacity : 40-250 mm diameter bearings

7 **Bearing Puller**

Gear race and sprocket type, 3 arm

Capacity : 150 mm diameter bearings

Item Description

8 **Extractor (internal bearing)**

Gear race and sprocket type, 3 arm

Capacity : 115 mm diameter bearings

9 **Test Benches (for test room)**

Make : FACOM
91420 Morangis, France (or equivalent)
Telex 600757 F

10 **Work Bench (heavy duty model)**

Wooden top blade 35-50 mm thick with steel angle iron sides

Dimensions : 0.9 x 2.0 x 0.8 m (H x W x D)
Accesories : 150 mm vice

11 **Work Benches**

Heavy duty model, as in item 10 provided with wall mounted form socket outlets to IEC 309

Power : 380-440 V (ac) 3 P, N + E 50/60 Hz
Convenience : 220-240 V (ac) 1 P, N + E 50/60 Hz
Extra Low Voltage : 50 V (ac) 50/60 Hz
Power and convenience outlets shall be protected by 30mA residual current devices

12 **Tool Cabinet (steel)**

Make : FACOM
91420 Morangis, France (or equivalent)
Telex 600757 F

Dimensions : 1.0 x 0.6 x 0.3 m (H x W x D)

Complete with tools typically as follows :

Spanners, Adjustable wrenches, Hammers, Files, Hacksaw, Pliers, Cutters, Screwdrivers, etc.

13 **Equipment Cabinets (steel)**

Dimensions : 2.0 x 1.2 x 0.8 m (H x W x D)

14 **Lifting equipment, mobile, hydraulic, (capacity 1 t)**

15 **Filing Cabinets (steel)**

For the storage of records, test data etc.

16 **Storage System (store room)**

Comprising racks, shelves and bins for the storage of frequently used components and small parts, e.g. nuts and bolts.

APPENDIX 2 ELECTRICAL TEST EQUIPMENT

The equipment listed in this section constitutes the basic requirements for equipment used to carry out inspection and maintenance in accordance with DEP 63.10.08.11-Gen. MESC numbers are provided to facilitate procurement. Some items of equipment which are not routinely used have been marked 'optional' where, in most instances, the item would be hired from a local installation contractor.

Item	Description	MESC Code
1	**Insulating Oil Test Set**	
	Transportable, semi-automatic type	
	Accessories : Glass test vessel and standard electrodes	67.85.59.058.1
	Output : 0-60 kV	
	Make : Baur	
	Type : DPO 60	
	Alternatives :	
1.1	Bench type 0-60 kV, semi automatic	
	Make : Baur	67.85.59.008.1
	Type : DTS 60	
1.2	Bench type	
	Make : Baur	67.85.59.088.1
	Type : OTS 60	
2	**Insulation & Continuity Tester - 500 V (dc)**	
	Type : Analogue, battery operated, voltmeter	
	Range : Insulation 0-200 MΩ Continuity 0-2 Ω, 0-200 Ω Voltage 0-600 V (ac)	
	Make : Megger Instruments	67.84.14.120.1
	Type : BM 100/2 Case 6420-030	
	Alternatives :	
2.1	Type : Analogue, battery operated, voltmeter	
	Range : Insulation 0-200 MΩ Continuity 0-4 Ω Voltage 0-600 V (ac)	
	Make : ABB	67.84.14.140.1
	Type : Metriso 500 VW Case GTY 317 2076 PO1	

Item			Description	MESC Code
2.2	Type	:	Analogue, hand operated	
	Range	:	Insulation 0-200 MΩ Continuity 0-100 Ω	
	Make	:	Megger Instruments	67.84.14.020.1
	Type	:	WM 5/500	
3	**Insulation & Continuity Tester - 1000 V (dc)**			
	Type	:	Digital, battery or hand-operated, voltmeter	
	Range	:	100/250/500/1000 V (dc) Continuity 0-4 Ω Voltage 0-600 V (ac)	
	Make	:	Megger Instruments	
	Type	:	BM 12 (battery-operated)	67.84.14.250.1
	Type	:	MJ 10 (hand-operated)	67.84.14.252.1
			Case 6430-043	67.84.14.902.1
	Alternatives :			
3.1	Type	:	Analogue, battery-operated, voltmeter	
	Range	:	Insulation 1 - 200 MΩ Continuity 0-100 Ω Voltage 0-600 V (ac)	
	Make	:	Hioki Hi tester, with case 3111 - 12	67.84.14.260.1
			Test probes 9044, 500/1000 V	67.84.14.965.1
4	**Insulation Tester - 1000 V (dc)**			
	Type	:	Digital, battery-operated, voltmeter	
	Range	:	250/500/1000 V (dc) Insulation 0-20 MΩ, 0-500 MΩ 0-1000 MΩ Voltage 0-600 V (ac)	
	Make	:	Hioki	67.84.14.262.1
	Type	:	3119-11	
4.1	Type	:	Analogue,battery-operated, voltmeter	
	Range	:	100/250/500/1000 V (dc) Insulation 0-400 MΩ, different range for each test voltage Voltage range 0-100/250/500/1000 V (ac)	
	Make	:	ABB	
	Type	:	Metriso 1000V	67.84.14.240.1
			Case GTY 3172051 PO1	67.84.14.922.1

Item			Description	MESC Code
5	**Insulation Tester - 5 kVDC**			
	Type	:	Analogue, battery or hand-operated, voltmeter	
	Range	:	2.5 / 5 kV (dc) 0 - 5 000 MΩ / 0 - 10 000 MΩ Voltage 0-600 V (ac)	
	Make	:	Megger Instruments	
	Type	:	BM 14 (battery-operated)	67.84.14.350.1
	Type	:	MJ 20 (hand-operated)	67.84.14.352.1
			Case 6420-043	67.84.14.903.1
	Alternatives :			
5.1	Type	:	Analogue battery-operated, voltmeter	
	Range	:	500/1000/2500/5000 V (dc) Insulation 0-20 0000 MΩ, different range for each test voltage Voltage 0-500/1000 V (ac)	
	Make	:	ABB	67.84.14.340.1
	Type	:	Metriso 5000	
6	**High Voltage Test Generator (Cables & Busbars)**			
	Complete with cable set discharge rod and transport case			
	Make	:	Baur	
	Type	:	PGK 25 : 0 - 25 kV 1 mA	67.82.53.030.1
	Type	:	PGK 50 : 0 - 50 kV 2 mA	67.82.53.040.1
7	**Cable Fault Locator (optional)**			
	Reflection type test set for cable fault location, complete with plug in unit for power cables, cable end modulator and viewing hood			
	Make	:	Baur	67.82.53.220.1
	Type	:	IRG 200 with plug-in module ES 200	
7.1	**Polaroid Camera** (for item 6)			
	Supplier	:	Baur	67.82.53.282.1
	Type	:	CU 5	
8	**Burning Rectifier (optional)**			
	Complete with voltage selection switch for 6 positions up to 10.000 V (dc) for burning out high resistance cable faults			
	Input	:	220/240 V	
	Make	:	Baur	67.82.53.320.1
	Type	:	ATG 2	

Item	Description	MESC Code
9	**Measuring Bridge**	
	Hand-operated, 500 V (dc), Insulation, Wheatstone bridge, Varley and Murray tests	
	Range : 0.01-9990 Ω	
	Make : Megger Instruments	67.82.26.050.1
	Type : BR 4/500	
	Alternative :	
9.1	Measuring bridge	
	Battery-operated, 6 kV Gesef and Murray tests	
	Range : 0.01-9990 Ω	
	Make : Baur	67.82.53.112.1
	Type : DMB 5	
10	**Conductivity Tester**	
	Low resistance test set, analogue display, mounted in self-contained hardwood case, complete with batteries, charger and handspikes (battery-operated)	
	Ranges : 0 -100 μΩ and 0 -10 Ω (6 ranges) 0.1 - 10 A	
	Make : Megger Instruments	67.85.52.020.1
	Type : D 007 Ducter	
	Alternative :	
10.1	Digital display, complete with battery and mains adapter	
	Ranges : 0-20 mΩ up to 0-20 kΩ (7 ranges) 100 mA - 10 micro A	
	Make : Hioki	67.85.52.130.1
	Type : Hi tester 3220	
11	**Earth Resistance Tester**	
	Four terminal measurement, direct reading, digital display, hand-operated or battery-operated	
	Ranges : 0.01-1999 Ω (3 ranges)	
	Output voltage : Limited to 50 V	
	Make : Megger Instruments	
	Type : DET 3 (hand-operated)	67.83.10.020.1
	Type : DET 5 (battery-operated)	67.83.10.024.1

Item			Description	MESC Code
	Alternatives :			
11.1	Type	:	Clamp-on, digital display, battery-operated	
	Ranges	:	2-1990 Ω (3 ranges)	
	Make	:	AEMC Corporation, model	
11.2	Three terminal and two terminal measurement			
	Type	:	Analogue display, battery-operated	
		:	0-1000 Ω (3 ranges)	
	Output voltage	:	30 V	
	Accessories	:	Earthing rods (9049) 3 measuring leads (9040) and carrying bag (included)	
	Make	:	Hioki	67.83.10.080.1
	Type	:	3150	
12	**Earth Leakage Circuit Breaker Tester**			
	For testing protective measures for circuit breakers Digital display, trip time indication in ms, no-trip indication			
	Test Currents	:	6/10/15/30/50/100/150/250/300/500 mA,	
	Power supply	:	240 V(ac) 50/60 Hz.	
	Make	:	Megger Instruments	
	Type	:	CBT 2	67.83.06.020.1
			220 V (ac) version	67.83.06.022.1
13	**Earth Loop Tester**			
	Digital display, measures contact potential, earth resistance, tripping time at nominal fault current and increasing fault current, earth loop resistance, earth electrode voltage and line voltage. Battery-operated. Suitable for 230 V 50 Hz			
	Make	:	ABB Universal tester	67.83.06.030.1
	Type	:	M 5010	67.83.06.901.2/902.2
			Measuring adapter K.042 and case F 824	
14	**Secondary Current Injection Test Set**			
	Suitable for non-linear load, undistorted output waveform, with digital timer 0-999 s. Power supply unit + Injection transformer unit/timer			
	Range	:	Current output 0.05-200 A	
			Suitable for 200-250 V (ac) 50/60 Hz	
			Total weight 109 kg	
	Make	:	G.E.C. Measurements	67.82.67.150.1
	Type	:	CFB	

Item		Description	MESC Code
		Alternatives :	
14.1		Secondary Current Injection Test Set	
		Analogue display current, electric timer, 0 - 999.999 s	
	Range	: Current output 0 - 10 A/85 V 0 - 40 A/25 V 0 - 100 A/10 V Voltage ouput 0 - 250 V/3 A (ac) 0 - 350 V/2 A (dc)	
	Terminals	: 110 V/0..3A, 20-220 V/0.3A Suitable for 220 V (ac), 50 Hz Weight 16 kg	
	Make	: Programma Electric AB (ABB)	67.82.67.060.1
		Type SVERKER 650	67.82.67.062.1
		220V No BA-12290	
		240V No BA-12490	
14.2		Secondary Current Injection Test Set	
		Digital display current voltage and time	
	Range	: Time (5 digit) max. 9 min. 59.99 s Current 0-100 A/24 V, 0-30 A/80 V, 0-10 A/240 V	
	Voltage output	: 0-240 V (dc) 1 A, 0-120 V (dc) 0.5 A Suitable for 220/240 V (ac), 50/60 Hz	
	Make	: Foster	
	Type	: SCITS 100	67.82.67.080.1
15		**Primary Current Injection Test Set (optional)**	
		Control unit and current output unit with Ammeter	
	Output current	: 0-100 A/47 V, 0-200 A/23 V, 0-1500 V/4.3 V, 0-2000 A/4.1 V Weight 73 kg	
	Make	: Foster	
	Type	: PCU/STD	
		Suitable for 380 V (ac), 50/60 Hz (240 V (ac) 50/60, Hz available)	
	Make	: Programma Electric AB (ABB)	67.82.67.252.1
	Type	: ODEN 1x (2 units)	

Item		Description	MESC Code
	Alternative :		
15.1	Primary Control Unit (used with primary loading unit)		
	Output current	: 0-50 A (0-10 V), 0-15 A (0-270 V) Suitable for 220/240 V (ac), 50/60 Hz Weight 36 kg	
	Make	: Foster	67.82.67.272.1
	Type	: PCU/STD	
	Primary Loading Unit with Ammeter		
	Output current	: 1000 A (0-6V), 2000 A (0-3V) Weight 73 kg	
	Make	: Foster	
	Type	: PLU 2000	67.82.67.274.1
	Optional timer	: TM-2, Electronic, range 0-999.999 s	67.82.67.276.1
16	**Live Conductor Indicator & Phasing Tester**		
	With rods, carrying case and hand test generator (50/60 Hz)		
	Make	: ELSEC	
	Type	: CL-9-40 Range 5 - 10 kV	67.87.35.210.1
		Box K-74, Test gen. CL-1-06	67.87.35.214.1/216.1
	Type	: CL-9-40, Range 10 - 30 kV	67.87.35.212.1
		Box K-74, Test gen. CL-1-06	67.87.35.214.1/216.1
17	**Phase Sequence Indicator**		
	With leads for use on 100-600 V (ac) 20/500Hz		
	Make	: ABB	67.85.80.040.1
	Type	: RZL-2 (with phase lamp)	
	Alternative :		
17.1	Hioki phase detector 3126 (110-480, 40-70 Hz)		67.85.80.070.1

Item Description

18 **Multi-Range Meter**

Amended per Circular 17/95

Analoge type; complete with leads, safety clips and carrying case 6320-052, including the optional accessory FPK2-6110-877 Test leads with fused prods (660 V (ac) / 500 mA fuse, 50 kA breaking capacity)

Ranges	:	0-1000 V (ac)/(dc), 0-10 A (ac)/(dc) 0-20 MΩ
Impedance	:	All dc ranges 20 kΩ/V Above 30 V ac 2 kΩ/V
Make	:	Megger Instruments
Type	:	AVO type 8 Mark 7

Alternative:

18.1 **Multi-Range Meter**

Amended per Circular 17/95

Analoge type; complete with leads,and carrying case F 786, including the optional accessories KS 400, and KY 435/436 Test leads with fused prods (500 V/ 10 A fuse, 100 kA breaking capacity)

Ranges	:	0- 1000 V (ac)/(dc), 0-10 A (ac)/(dc) 1 Ω - 1 MΩ
Impedance	:	All dc ranges 31.6 kΩ/V All ac ranges 3.16 kΩ/V
Make	:	ABB
Type	:	MA 4 H

19 **Multi-Range Meter**

Amended per Circular 17/95

Digital Type; complete with leads, safety prods and carrying case 6420-056, including the optional accessory FPK4-6110-920 Test leads with fused prods (660 V ac / 500 mA fuse, 50 kA breaking capacity)

Ranges	:	0-1000 V (ac)/(dc), 0-10 A (ac)/(dc) 0-30 MΩ 30 nF - 30 µF
Make	:	Megger Instruments
Type	:	AVO multimeter M 3005 *

Alternative :

19.1 **Multi-Range Meter**

Amended per Circular 17/95

Digital type; complete with leads, and carrying case F 829, including the optional accessories KS 30 Voltage probe (15 kΩ), KS 400, and KY 435/436 Test leads with fused prods (500 V/ 10 A fuse, breaking capacity 100 kA)

Ranges	:	0-1000 V (ac)/(dc), 0-10 A (ac)/(dc) 0-30 MΩ 30 nF - 30 µF
Make	:	ABB
Type	:	Metrahit M 2016 *

* "S" versions are available which are fitted with an RS 232C transmission of measured values to electronic data processing systems.

Item	Description

20 **Recording Multimeter**

Amended per Circular 17/95

Continuous line, inkless on waxed paper, mains and battery operated,complete with carrying case ZB 750, including the optional accessories KS 30 Voltage probe (15 kΩ), KS 400, and KY 435/436 test leads with fused prods (500 V / 10 A fuse, breaking capacity 100 kA)

Speeds	:	1/2/6/12/30/60 cm/h 2/3/6/12/30/60 cm/min.
Ranges	:	0-750 V (ac)/(dc) 0-6 A (ac)/(dc)
Make	:	ABB
Type	:	SE 111

Alternative :

20.1 **Recording Multi-meter**

Amended per Circular 17/95

3-channel thermal graphic printer, mains operated, complete with carrying case 9354 and clamp on probe 9132

Speeds	:	30/12/6/3/1 DIV/min. and 30/12/6/3/1 DIV/h
Ranges	:	0-750 V (ac), 0-1000A (ac) using clamp probe
Make	:	Hioki
Type	:	Print Hicorder 8710

Item	Description			MESC Code
21	**Clamp-on Current Transformer** (for ABB meters in items 16,17 and 18.)			
	Ratio	:	1000/500/250 : 1 A	
	Make	:	ABB (Universal Technic)	67.85.14.912.1
	Type	:	US 1000/1 A	
22	**Clamp-on Volt/A Ohm Meter**			
	Digital type, complete with test leads, batteries and case Peak reading lock facility			
	Make	:	Amprobe	
	Type	:	CD - 2 (300 A jaws)	67.85.14.390.1
	Type	:	ACD - 1 (1000 A jaws)	67.85.14.392.1
	Alternatives :			
22.1	Clamp-on Meter			
	Digital display, with data storage			
	Range	:	0-1000 A, 0-650 V (ac), 0-2000 Ω	
	Make	:	ABB	67.85.14.340.1
	Type	:	DZA 1000	
22.2	Clamp-on Meter			
	Range	:	0-1000 V, 0-1000 A, 0-10 kΩ, 10-300 Hz, -50 to +150 °C	
	Make	:	Hioki	67.85.14.360.1
	Type	:	3262-50	
23	**Clamp-on Watt Meter & Multimeter**			
	Range	:	0-200 kW (ac)/(dc), 0-200 kVA (ac) 0-1000 A, 0-750 V 10-1000 Hz, P.F.3 cap, 1 - .3 ind.	
	Make	:	ABB	
	Type	:	M5110	67.85.14.310.1
			3 phase adapter	
	Type	:	DV 1	67.85.14.914.1

Item			Description	MESC Code
	Alternatives :			
23.1	Range	:	1 ph/3ph 3 wire, 3 ph 4 wire 20/200 kW/kVAr	
	Make	:	Hioki	67.85.14.320.1
	Type	:	3135	
23.2	Range	:	ditto 200/1000 kW/kVAr	
	Make	:	Hioki	67.85.14.322.1
	Type	:	3136	
24	**Appliance Tester**			
	Portable, mains operated, Earth bond test, Insulation test, Flash test, Load test			
24	Make	:	Megger Instruments	
	Type	:	PAT 2	67.82.20.050.1
			Voltage 240 V (ac)	67.82.20.052.1
			Voltage 220 V (ac)	
25	**Thermometer**			
	Digital display with probe for surface temperature measuring, with extension lead			
	Range	:	-99 to +500 °C	
	Make	:	Aulborn	
	Type	:	Therm 2230-11, Probe WB 24, extension lead WKB	67.86.71.430.1/432.1
	Alternative :			
25.1	Thermometer			
	Digital display with probe for surface temperature measuring			
	Range	:	-50 to +400 °C	
	Make	:	Hioki	67.86.71.440.1
	Type	:	3412-02, Probe 9181	
26	**Light Meter**			
	Direct reading, analogue			
	Range	:	0-500/1000 lux	
	Make	:	Megger Instruments AVO	67.84.50.130.1
	Type	:	LM 4	

Item	Description	MESC Code
	Alternatives :	
26.1	Light Meter	
	Digital lux tester	
	Range : 0 - 20/2000 lux Make : Hioki Type : 3422	67.84.50.140.1
26.2	Light Meter	
	Range : 0 - 150/500/1500/5000 lux Make : ABB Type : Metrux 4 MX-4	67.84.50.240.1
27	**Stator & Armature Tester (if motor repairs are performed)**	
	With test meter, audio and visual signal, for fault location in rotor and stator coils	
	Voltage : 220 V (ac) 50 Hz Make : Prufrex Type : A 15/2	67.82.22.062.1
28	**Vibration Meter**	
	Hand-held type, vibration velocity in mm/s	
	Make : Vibrations Technik AB Type : VTM 37	67.87.26.052.1
29	**Hand Tachometer**	
	Universal type, digital display, battery-operated	
	Range : 30 - 100 000 rpm Make : Hioki Type : 3404-01	83.62.80.050.1
30	**Variable Transformer**	
	Bench type	
	Input : 240 V (single phase). Output : 0-275 V, rated current 10 A Make : Claude Lyons Type : 710-R	65.37.16.350.1

Item	Description	MESC Code
31	**Pedometer** (for measuring length of cable routes)	83.62.62
	Make : Truemeter Type : Road measurer	
32	**Stopwatch**	93.44.75
33	**Transient Disturbance Analyser**	
	Range : 3 phase, 45-65 Hz 50-4000 Vpk Make : Dranez Series 626 Type 626-PA-6030G	
	Alternative :	
33.1	Make : ABB Type : SE 561	
34	**Oscilloscope**	
	Make : Siemens - Oscillostore K Type : 7KE 4122	

APPENDIX 3 GENERAL TOOLS FOR WORKSHOPS

Some items of equipment which are not routinely used have been marked 'optional' where, in most instances, the item would be hired from a local installation contractor.

Item	Description	MESC Code
1	**Compression Tool**	
	Cable lugs/connectors, hand-operated	
	Make : Burndy	
	Type : MR89Q (up to 6 mm^2)	83.10.90.700.1
	Type : MR4CQ (10-25 mm^2)	83.10.90.710.1
2	**Compression Tool**	
	Cable lugs and connectors, hydraulic type, hand/foot operated, with adapter and indenters	
	Range : 35-70 mm^2, 95-240 mm^2 with crimping dies.	
	Make : Burndy	
	Type : Y 35(hydr.hand opr.)	83.10.90.720.1
	Type : Y 35 BH (hydr.foot opr.)	83.10.90.730.1
4	**Spiking Gun (optional)**	
	Cables up to 115 mm OD	
	Make : Accles & Shelvoke	
	Type : Ackvoke	
	Types : 20/250 Watt	83.46.75.065.1/228.1
5	**Battery Maintenance Tool Kit**	
	Toolbox containing hydrometer, spanner, topping-up bottle and spare parts for NiCd batteries.	
	Make : NIFE	65.27.90.002.1
6	**Transformer & Switchgear Oil Filter (optional)**	
	Trailer mounted complete with heater, vacuum pump, press filter and hoses,3 phase supply.	
	Capacity : 500 l/h for transformers up to 4 MVA 1000 l/h for transformers up to 10 MVA	
	Make : Stream Line Hering	
	Type : EOF	
7	**Ladder Trailer**	
	Electric (rechargeable batteries)/ hydraulically operated with basket. Height approx. 12 m	

APPENDIX 4 PERSONAL TOOLS & INSTRUMENTS

Item	Description	MESC Code
1	**Clamp-on Multimeter.**	
	Digital type, complete with test leads, batteries and case Peak reading lock facility	
	Make : Amprobe	
	Type : ACD -2 (300 A jaws)	67.85.14.390.1
	Type : ACD -1 (1000 A jaws)	67.85.14.392.1
2	**Voltage Tester**	
	Range : 0-750 V (ac)/(dc)	
	Make : Benning	67.87.35.010.1
	Type : Duspol	
3	**Volt & Ohm Probe**	
	Pencil tester digital readout, data hold, continuity display	
	Range : 500 V (ac)/(dc), 200-20 MΩ	
	Make : Hioki	67.82.60.040.1
	Type : 3218	
	Alternative :	
3.1	Universal voltage and continuity tester	
	Probe type with buzzer and LED indication	
	Range : 6-600 V (ac)/(dc)	
	Make : Weidmuller	67.82.60.050.1
	Type : UT 3	
4	**General Tools (typical)**	
4.1	Set of screwdrivers, insulated type, slotted and cross-cut.	
4.2	Off-set screwdriver.	
4.3	Pliers : combination, long nose, pointed nose; side cutter, wire stripper.	
4.4	Set of metric spanners, 6x7 to 16x17 mm	
4.5	Set of metric socket snap-on tools, 6x7 to 20x22 mm, including ratchet and extension bars.	
4.6	Adjustable wrenches, 150 mm, 200 mm, 300 mm.	
4.7	Set of Allen keys	
4.8	Files, round, flat, set of needle files.	
4.9	Junior hacksaw, cable knife, hammer 250 g, pocket ruler.	

APPENDIX 5 INDUSTRIAL EQUIPMENT

Item	Description	MESC Code
1	**Socket Outlet Distribution Switchgear** Almaplast distribution board, transportable, galvanized frame mounted (refer to Appendix 7). Make : Mennekes	
2	**Welding Switchgear** (Refer to Appendix 8)	
3	**Safety Isolating Transformer** Supply for portable electrical apparatus, 50 V max, Single phase, 50/60 Hz, air-cooled,for industrial use, portable type in accordance with IEC 742 Class 2, non-inherent short circuit proof provided with hand reset, short circuit/overload protection. Enclosure to IP 54-IEC 529. Output : 50 V max. Input : 220/240 V (or alternative local voltage) Ratings : 250 VA - 2x 16 A socket outlets 630 VA - 3x 16 A socket outlets 1600 VA - 3x 16 A socket outlets 1x 32A socket outlet	65.37.38.068.1/076.1
4	**Isolating Transformer** (Specifications as Item 3) Voltages 220/220, 240/240 (or other local voltage), with socket outlet to IEC 309, enclosure protection IP 55 (IEC529). Ratings : 250, 630, 1600 VA - 1 x 16 A, 3 pole.	65.37.38.168.1/176.1

Item	Description	MESC Code
5	**Earth Leakage Circuit Breaker** Encapsulated, plug-in type, IP 30, (round, 2 pole, scraping earth) with flexible lead and rubber connector (round, 2 pole, scraping earth). Rating : 30 mA, 16 A Voltage : 250 V (ac) 50 Hz Make : Felten & Guilleaume Type : Steckmat FIST-16	67.94.65.50.1
	Alternative :	
5.1	As Item 5, but IP 54, and without flexible lead Make : Felten and Guilleaume Type : Steckmat TNX	67.94.65.060.1
6	**Hand Lamp** Industrial type, 50 V, vibration resistant, double insulated, lamp max 200 W tungsten GLS, lampholder ES butyl rubber enclosure, polycarbonate cover and chromitised suspension hook, protection IP 65. Make : Chalmit Type : 494 H	69.55.20.405.1
7	**Floodlight** Portable type, 50 V industrial type, vibration resistant, lamp max. 200 W tungsten GLS or T/Halogen, lamp holder ES Heavy duty moulded rubber enclosure, polycarbonate cover with steel wire guard. Complete with cast AL alloy bracket suitable for post or foot mounting (specify on order), protection IP 65. Make : Chalmit Type : 487 H	69.55.20.425.1
8	**Tripod** Collapsible type for flood light, hot-dip galvanised, adjustable height 1250 - 2000 mm Make : Van Alfen Type : MS-2614	69.82.64.008.1

Item	Description	MESC Code
9	**Flashing Obstruction Warning Light**	
	Portable, weatherproof polypropylene enclosure, battery operated, 12 V, photocell control	
	Make : BICC Dorman Smith	69.65.34.802.1
	Type : TrafiLite Lamp TW1/S/12V, Circuit RCTW1/S/12V.	

APPENDIX 6 EXPLOSION PROTECTED EQUIPMENT

Item	Description	MESC Code
1	**Hand Lamp** Explosion proof, EEx de II C T3 BVS-nr. 84.8.2012, protection IP 54. Halogen lamp, 24 Volt 70 W, with built-in reflector. Housing is metal alloy with a hard rubber handle. The glass is surrounded by a hard rubber ring for additional mechanical protection. Push button switch. Flexible cable, 2 x 2,5 mm^2, 15 m shall be ordered to the recommendations by the lamp manufacturer. Make : ABB-CEAG Type : KHLE 70 EN	69.58.30.010.1
2	**Explosion Proof Lighting System** SEPTRE, suitable for use in Zone 1 areas. The system consists of a transformer/control unit with four 24 V socket outlets, four hand lamps, (tungsten halogen) with cable and plugs. Make : NEI Victor UK	
2.1	Ex d II B T5, BASEEFA cert. No Ex 81120 Order No. 042974 (sytem without lamps, 220-240 Volt)	69.58.30.050 .1
2.2	Hand lamps, 4 pieces, cast aluminium alloy, stainless steel, overall guard, toughened glass, 24 Volt 70 W tungsten halogen lamp, complete with 15m cable and plug. BASEEFA certificate No. Ex 7600/1.	69.58.30.060.1/066.1
3	Explosion Proof, Battery operated, Hand-held Floodlight The flood light is suitable for use in Zone 1, protection IP 54. The lamp produces 256 lux at 5 m. The flood light is mounted on the battery pack. The battery is rechargeable, capacity of 7 hours with a 5 W lamp. A second, smaller lamp (1.4 W) has been installed. With this lamp the battery will last 25 hours. The battery charger is separate, suitable for 220/240 V 50/60 Hz EEx eib II C T3PTB No. Ex-89.C. 2044 (cert. of conformity) Make : ABB CEAG Type : SEB5 LN EN 5 W lamp Battery charger Type : LG 442	69.55.30.201.1 69.55.30.291

Item	Description	MESC Code
4	**Flood Light**	
	Transportable, suitable for use in Zone 1, with HP sodium lamp, 70 W, 210/270 V (ac) (437 x 283 x 284 mm, 20 kg). The flood light enclosure is aluminium alloy with a bracket and a toughened glass window. Protection IP 67. Cable entry consists of 2 x20 mm tapped entries. Control gear built in. Unit shall be ordered with electrical interlock on front cover and 15 m cable, min 3 x 2.5 mm^2 flexible cable of a type recommended by the manufacturer and suitable for this type of lamp. EEx de II A/B T3BASEEFA EX 86 B 1235	
	Make : Chalmit	69.56.23.314.1
	Type : 204	
5	**Lighting Fitting (air driven)**	
	Portable, explosion proof, or fluorescent single pin lamps (TL X type) suitable for Zone 1 and under special circumstances for use in Zone 0. (For information refer to manufacturer or ABB CEAG catalogue.) Brass housing (containing air-driven generator) with tube of seamless plexiglass with wire guard. Protection IP 54. Ex's' G 5 PTB Nr III B/E 11640 Ex's' Zone 0 PTB Nr III B/E 4072B	
	Make : ABB CEAG	
	Type : s PL 73020 - 1x20 W (Zone 0)	69.57.30.812.1
	Type : s PL 73020 - 1x40 W (Zone 0)	69.57.30.814.1
6	**Lighting Fitting (air-driven)**	
	Portable, explosion proof, for tungsten halogen lamp, 24 Volt, 250 W. Unit available with reflector head, flood light type or Ball glass protected by polycarbonate hood, general purpose light. Housing made of brass and gun metal. Min. air pressure 4-4.5 bar. Weight 8 kg. Ex(s) II T 4 , BASEEFA certificate Ex 78209X/2/3.	
	Make : The Wolf Safety Lamp Co. Ltd.	
	Type : Turbolite type 45, reflector head With part 129, 250 W 24 V lamp, (2000 hr).	69.58.30.320.1
	Type : Turbolite type 44, Ball Glass With part 129, 250 W, 24 V lamp, (2000 hr)	69.58.30.310.1

Item		Description	MESC Code
7	**Flexible Cable**		
	For certified equipment copper stranded conductor rubber insulated, oil resistant, flame retardant, neoprene outer sheath, to CENELEC HD 22 (check with equipment manufacturer for recommended type of cable).		
	HO5 RN-F	300/500 V-	2 x 0.75 mm^2	68.19.25.512
			- 5 x 2.5 mm^2	68.19.25.664.1
	HO7 RN-F	450/750 V-	1 x 4.0 mm^2	68.19.27.064
			- 5 x 25 mm^2	68.19.27.274.1

APPENDIX 7 SPECIFICATION - SOCKET OUTLET DISTRIBUTION BOARD

1. **General**

   This description applies to the specification of transportable type socket outlet distribution boards. Distribution boards shall comply with the requirements of DEP 33.67.01.31-Gen.

2. **Supply Systems**

   Operating voltage and frequency shall be specified, e.g. 380, 400, 415 or 440 V, three phase, earthed neutral, 50 or 60 Hz.

3. **Degree of protection provided by enclosures**

   Degree of protection against harmful deposits of dust and protection from water ingress in accordance with IEC 529. Minimum requirement IP 54.

4. **Material**

   Boxes, covers, housings of socket outlets manufactured from plastic materials, e.g. polyester or polycarbonate shall be designed for outdoor use and resistant to degradation from ultra violet radiation.

   Supporting frames shall be manufactured from hot-dip galvanised steel.

5. **Construction**

   Free-standing frame with base, hoisting eyes, and rain canopy. Cable entry shall be arranged from the bottom.

6. **Switchgear Requirements**

   Switchgear shall be pre-internally wired and plugs shall be supplied with all sockets. All live parts shall be shrouded with protection IP 20 minimum with covers removed.

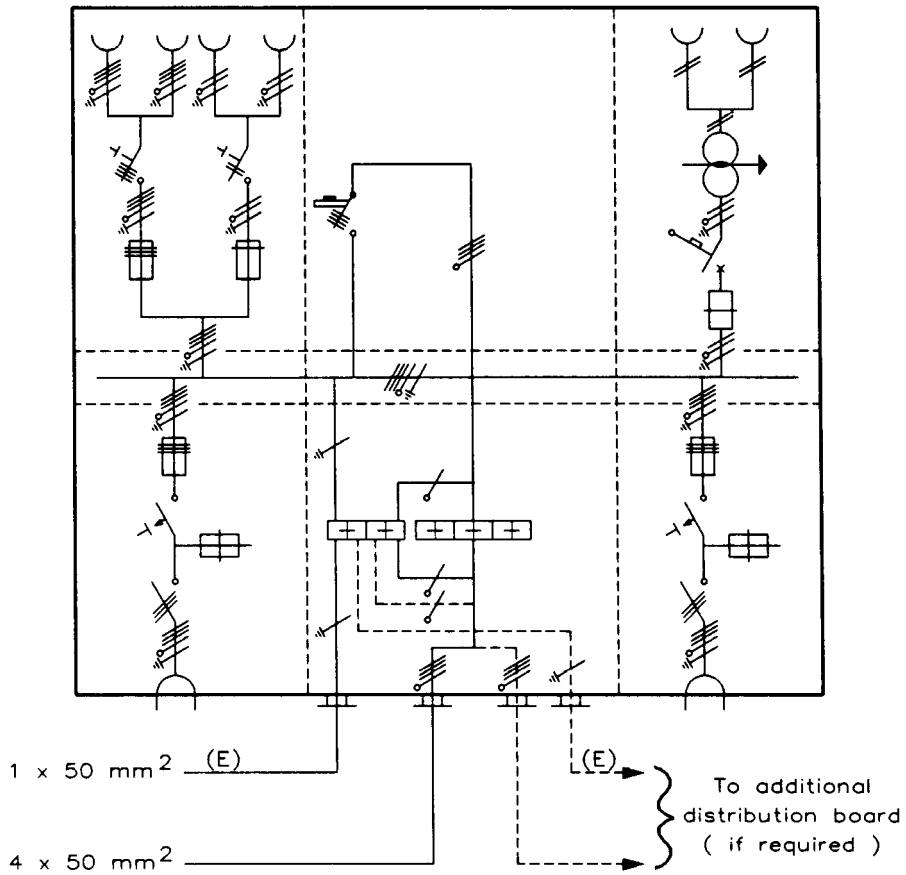
   INCOMING:

Load break isolator switch	4 pole	160 A	With locking facilities in the OFF position
Terminals	5 x 2	50/70 mm^2	For feeder cables in separate terminal box.
Cable glands (feeders)	2	4 x 50 mm^2	Plastic or metal
Cable gland (protective conductor)	1	12 - 16 mm^2	Plastic

OUTGOING :

Socket outlets	2 x 3P N, E	125 A	IEC 309, with pilot contact for interlocking
Contactors	2 x 3P	125 A	For control via pilot contact
Fuse Base	3 x 3P	160 A	
Fuse Base	2 x 1P	160 A	
Fuses	6	125 A	Type gG (IEC 269)
Fuses	3	32 A	Type gG (IEC 269)
Fuses	2	16 A	Type gG (IEC 269)
Fuses (control)	2	2 A	Z -Type , E16 and caps
Socket outlets	2 x 3P N, E	125 A	IEC 309
Socket outlets	2 x 2P E	16 A	IEC 309, flush mounted
Socket outlets	2 x 3P N, E	32 A	IEC 309, flush mounted
Socket outlets	2 x 2P	16 A	IEC 309 , 42 V
Earth Leakage Circuit Breaker	1 x 2P	25 A	30 mA trip
Earth Leakage Circuit Breaker	1 x 4P	40 A	30 mA trip
Earth Leakage Circuit Breaker	2 x 4P	125 A	500 mA trip
Safety Isolating Transformer (optional)	1	630 VA	IEC 742, output 24-50 V
Miniature Circuit Breaker	1	6 A	Thermal / Short Circuit Protection of transformer

SINGLE LINE DIAGRAM - Socket Outlet Distribution Board (Transportable Type)



APPENDIX 8 SPECIFICATION - WELDING SWITCHBOARD

1. **General**

   This description applies to the specification of transportable welding switchgear. Distribution boards shall comply with the requirements of DEP 33.67.01.31-Gen.

2. **Supply Systems**

   Operating voltage and frequency shall be specified, e.g. 380, 400, 415 or 440 V, three phase, earthed neutral, 50 or 60 Hz.

3. **Degree of protection provided by enclosures**

   Degree of protection against harmful deposits of dust and protection from water ingress in accordance with IEC 529. Minimum requirement IP 55.

4. **Material**

   Boxes, covers, housings of socket outlets manufactured from plastic materials, e.g. polyester or polycarbonate shall be designed for outdoor use and resistant to degradation from ultra violet radiation.

   Supporting frames shall be manufactured from hot-dip galvanised steel.

5. **Construction**

   Free-standing frame with base, hoisting eyes, and rain canopy. Cable entry shall be arranged from the bottom.

6. **Switchgear Requirements**

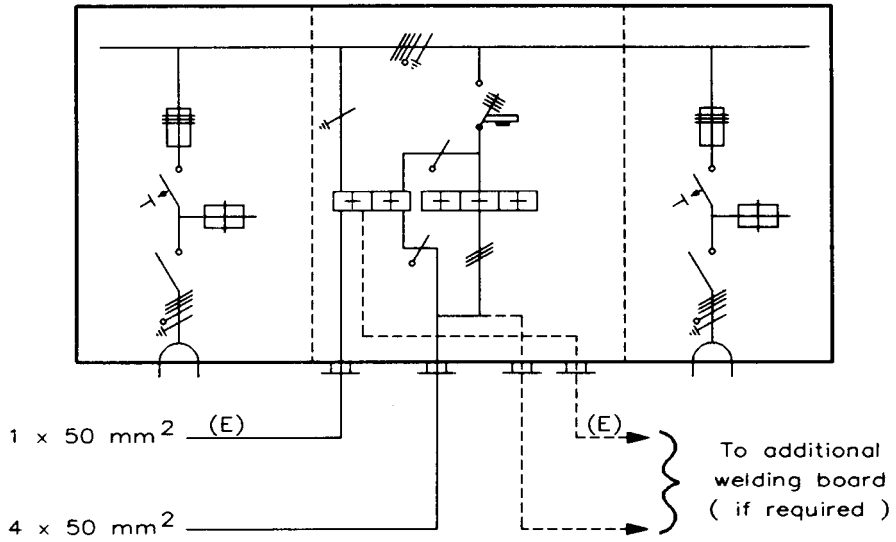
   Switchgear shall be pre-internally wired and plugs shall be supplied with all sockets. All live parts shall be shrouded with protection IP 20 minimum when covers are removed.

   INCOMING:-

Load break isolator switch	4 pole	160 A	With locking facilities in the OFF position
Terminals	5 x 2	50/70 mm^2	For feeder cables in separate terminal box
Cable glands (feeders)	2	4 x 50 mm^2	Plastic or metal
Cable gland (protective conductor)	2	12 - 16 mm	Plastic

OUTGOING :			
Socket outlets	2 x 3P + N + E	125 A	IEC 309, with pilot contact for interlocking
Contactors	2 x 3P	125 A	For control via pilot contact
Fuse Base	2 x 3P	160 A	
Fuses	6	125 A	Type gG (IEC 269)
Fuses (control)	2	2 A	Z -Type , E16 and caps
Earth Leakage Circuit Breaker	2 x 4P	125 A	500 mA trip

SINGLE LINE DIAGRAM - WELDING SWITCHBOARD (Transportable Type)



APPENDIX 9 SPECIFICATION - MOTOR TEST CONTROL SWITCHBOARD

1. **General**

   This description applies to the specification of a low voltage motor control centre suitable for the test running of low voltage motors (0.5 - 150 kW) associated with the electrical workshop motor test bay. Switchboards shall comply with the requirements of DEP 33.67.01.31-Gen.

   The switchboard type shall be Holec Halyester type or equivalent.

2. **Supply Systems**

   Operating voltage and frequency shall be specified e.g. 380, 415 or 440 V, three phase, earthed neutral, 50 or 60 Hz.

3. **Degree of protection provided by enclosures**

   Degree of protection against harmful deposits of dust and protection from water ingress IP 56 in accordance with IEC 529.

4. **Material**

   Switchboard shall be constructed from glass-mat reinforced polyester.

5. **Construction**

   Wall mounted or freestanding cubicle type switchboard with removable hoisting eyes. Cable entry shall be arranged from the bottom.

6. **Switchgear Requirements**

   Switchgear shall be pre-internally wired and all live parts shall be shrouded with protection IP 20 minimum. Components shall be typically in accordance with the following listing:

INCOMER :			
Load break switch	4P	315 A	With key locking facilities in the OFF position
MEASURING & CONTROL :			
Control circuit key switch, two position (ON/OFF)	1 x 2P		
ON push button	1		
OFF push button	1		
Voltmeter selector switch, (0-6 position)	1		
Voltmeter 0 - 500 V	1		
Drive selector switch : Position 1 - 0.5 - 3.7 kW Position 2 - 4.0 - 25 kW Position 3 - 30 - 150 kW	1		
Fuses (control)	5	2 A	Z - Type, E25 and caps
Indicator lamp	3		
Digital elapse time clock with separate reset button	1		
OFF push button (emergency,	1		

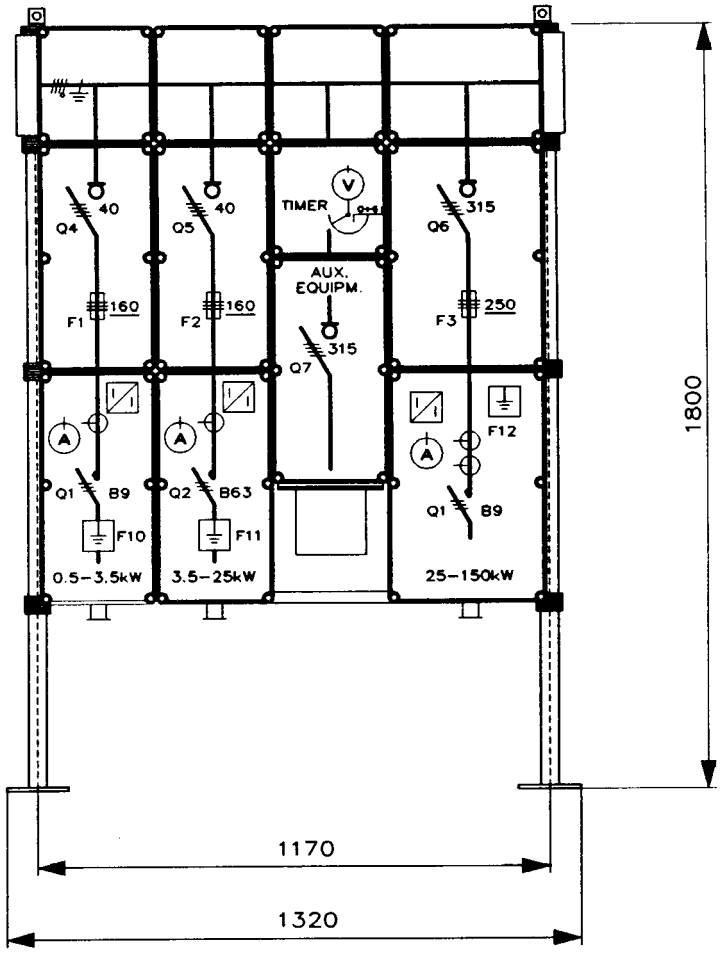
stay-put, inside test bay)			
Warning lamp, rotating type (outside test bay)	1		
MOTOR CIRCUIT, 0.5 - 3.7 kW			
Isolator switch	4P	32 A	
Contactor	3P	4 kW	ABB - B9
Fuse base	3P	160 A	
Fuses	3P	6 A	Type gG (IEC 269)
Current transformer	1	10/1	Class 1M5, 10 VA
Ammeter	1	0-10/60 A	
Transducer	1	4-20 mA	
Earthfault relay	1		300 mA trip
Transducer output terminals	2		Shrouded, face mounted
MOTOR CIRCUIT, 4.0 - 25 kW			
Isolator switch	4P	32 A	
Contactor	3P	30 kW	ABB - B63
Fuse base	3P	160 A	
Fuses	3P	35 A	Type gG (IEC269)
Current transformer	1	50/1	Class 1M5, 10 VA
Ammeter	1	0-50/300 A	
Transducer	1	4-20mA	
Earthfault relay	1		300 mA trip
Transducer output terminals	2		Shrouded, face mounted
MOTOR CIRCUIT, 30 - 150 kW			
Isolator switch	4P	315 A	
Contactor	3P	160 kW	ABB - EH250
Fuse base	3P	250 A	
Fuses	3P	225 A	Type gG (IEC269)
Current transformer	1	300/1	Class 1M5, 10 VA
Ammeter	1	0-300 A	

Transducer	1	4-20 mA	
Earthfault relay	1		300 mA trip
Transducer output terminals	2		Shrouded, face mounted

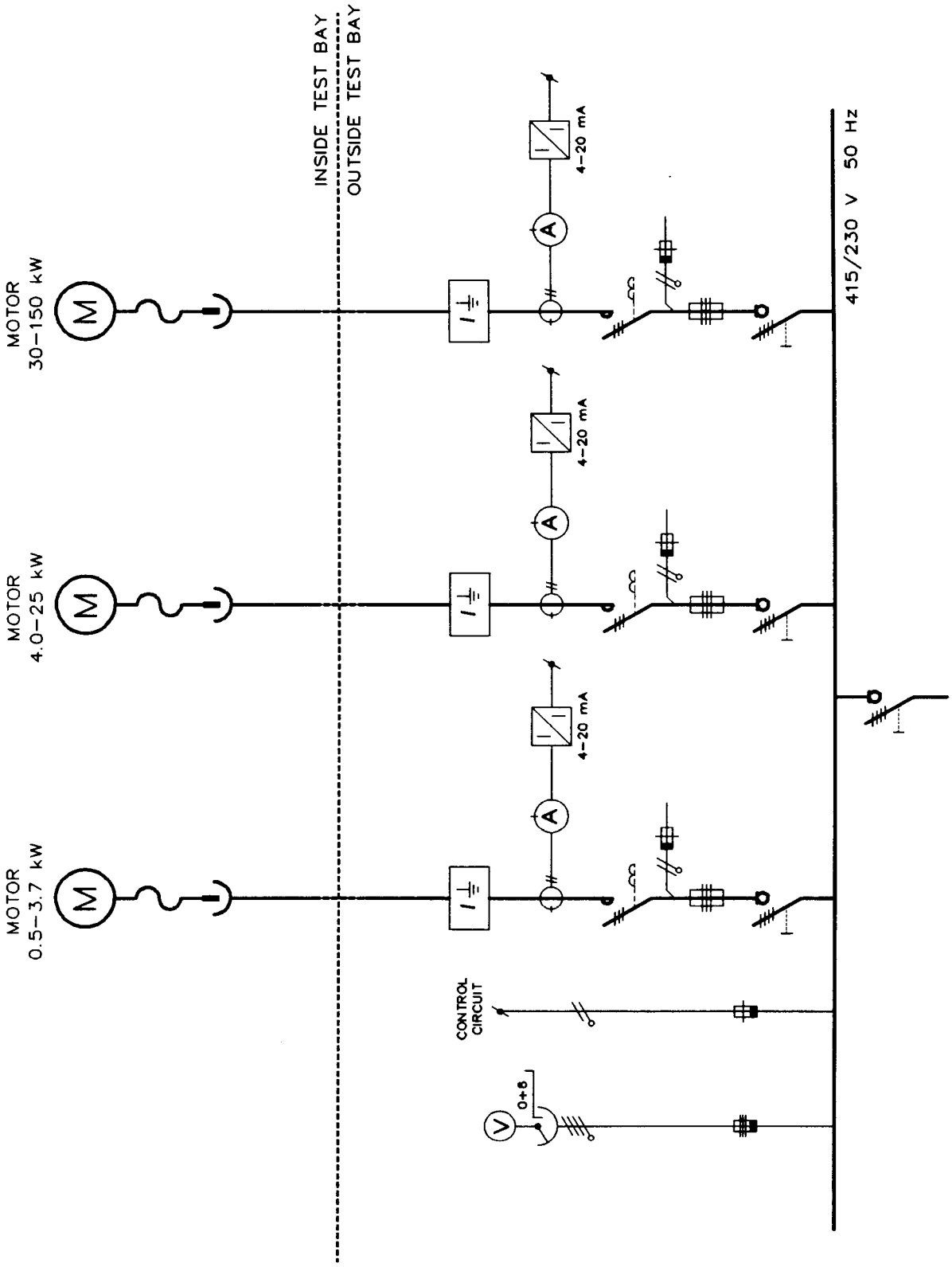
ADDITIONAL ITEMS :

Socket outlets (inside test bay)	1 x 3P + E	125 A	IEC 309
		32 A	IEC 309
		16 A	IEC 309

LAYOUT DIAGRAM -MOTOR TEST BAY SWITCHBOARD



SINGLE LINE DIAGRAM - MOTOR TEST BAY SWITCHBOARD



CONTROL CIRCUIT DIAGRAM - MOTOR TEST BAY SWITCHBOARD