Sphere
ELECTRICAL ENGINEERS
& CONTRACTORS
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OPERATIONS AND MAINTENANCE SERVICES

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Our shared motivation and focus is to effectively combine the skills, knowledge and strengths within our specialist fields. In collaboration, we believe that the complete customer service we offer is highly proficient and well-integrated while remaining efficient in cost.

The working relationships established over many years during numerous successful projects are invaluable to customers that seek to benefit from a complete O&M solution.

We have decades of experience and enforce a rigorous, continual refreshment programme for our employees to stay well-advised of all applicable standards and legislation.

WHY PERFORM PREVENTIVE MAINTENANCE?

Electrical infrastructure can and will deteriorate unfortunately equipment failure is inevitable.
An effective electrical maintenance program will identify factors leading to deterioration. It provides a means to ensure your critical infrastructure performs to its best efficiencies as well as reducing down-time and keeping costly repairs to a minimum.

Industrial users, distributed generation facilities and commercial facilities are becoming progressively more dependent upon their electrical systems. The availability of plant is crucial to provide optimum production and power export. The continued reliability and integrity of an electrical power system is based on an established program of maintenance and operational testing. The maintenance procedures and frequencies should follow those recommended by the industry's institutions of best practice. In addition, insurance premiums can be more costly if the facility has an inadequate or marginal maintenance program

"It is evident that neglecting an installation or equipment until an incident occurs and then taking remedial action does not constitute preventive maintenance and does not comply with the law"

Electrical Safety and the Law
- Ken Oldman Smith, Blackwell Scientific Publications

Aside from getting the most from your assets, it is the employer's responsibility under UK statutory law to prevent workplace accidents, as far as reasonably practicable. We strongly recommend that all employers and Senior Managers pay particular attention to the following standards, regulatory documents and publications (non-exhaustive list, just a select few of particular importance):

- Health & Safety at Work Act 1974
- Electricity at Work Regulations 1989
- Electricity Safety, Quality and Continuity Regulations (ESQCR) 2002 (incorporating 2006 Amendment)
- Wiring Regulations BS 7671:2008+A3:2015 (the 17th edition incorporating Amendment 3:2015)
- The Construction (Design and Management) Regulations 2015
- N.b. inherited, legacy builds with non-compliance issues – responsibility passes to current owner and/or operator. Site appraisals are highly advised to asset owners, know your risk.
- HSE publication HSG230 - Keeping electrical switchgear safe
- HSE publication INDG449 - Health and safety made simple: The basics for your business
- HSE publication HSG268 - The health and safety toolbox: How to reduce risks at work
- BS 6423:2014 - Code of practice for maintenance of low-voltage switchgear and control gear
- BS 6626:2010 - Maintenance of electrical switchgear and control gear for voltages above 1 kV and up to and including 36 kV

There's no need for you to memorise or understand everything – just know your responsibilities. Selecting your O&M contractor wisely can expedite the majority of responsibility to experts in each discipline. We have decades of experience and enforce a rigorous, continual refreshment programme for our employees to stay well-advised of all applicable standards and legislation.

A very brief example; The Health and Safety at Work Act 1974 identifies the obligations placed upon the employer;

- Make arrangements for implementing the health and safety measures identifies necessary by the risk assessment
- Appoint competent people (often themselves or company colleagues) to help them to implement the arrangements

REACTIVE SUPPORT

An attractive proposition for asset owners and facilities managers is to appoint an external contracting team to manage and deliver a bespoke package; to ensure full compliance and peace of mind, whilst reducing unnecessary capital expenditure and maximising productivity. For a fraction of the collateral cost of a single asset failure, a structured annual subscription will provide the assurance sought and may be budgeted and clearly accounted for.

When considering the preventative maintenance package that best suits your business, it would be sensible also to consider aligning remedial works, operational resource and emergency call-out cover. With a dedicated management team ready to deploy the expertise required it will significantly reduce overheads, while maintaining a high-level of cover and competency.

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SPHERE ELECTRICAL LTD.
TECHNICAL EXPERT SERVICES

Sphere Electrical Ltd. can offer services as follows;

- Preventive maintenance
- Testing and commissioning
- Repairs
- Supply, maintenance and replenishment of the Spare Parts Stock (Optional)
- A Call out service with multiple points of contact

GENERAL OBLIGATIONS

Sphere Electrical Ltd. Can offer all the necessary labour, supervision, professional and technical assistance, equipment, materials, inspection, assessment, testing and transportation required for the proper operation , maintenance and repair of the works. In performing the Services Sphere shall use appropriately skilled and trained engineers, with regard to the nature of the works being carried out.

All materials, items and components used to carry out maintenance or repairs shall be in accordance with or of an equivalent standard to those specified.

In performing these services Sphere Electrical Ltd. Guarantees the Proper Functioning of the Works.

Sphere shall ensure that the supply of necessary materials and Component Parts are either supplied by the customer or procured as necessary for the Proper Functioning of the Works within the applicable deadlines. (Sample deadlines to follow).

Sphere Electrical Ltd. shall keep the sites free from an accumulation of used materials, debris, refuse or waste generated as a result of the performance of the Services.

Sphere Electrical would expect access tracks to be maintained to gain reasonable access to carry out their works.

PREVENTIVE MAINTENANCE

Sphere shall execute the preventive maintenance activities described in Schedule 1. In addition Sphere shall perform concurrently with such activities, with the consent of the owner, any other reasonable activities which it deems would decrease the likelihood of Failure and ensure the Proper Functioning of the Works.

Sphere shall use Spare Parts or procured components in accordance with Good Industry Standard and Practice so as to ensure they are in Proper Functioning Order.

Sphere shall use its reasonable endeavours to ensure that any stoppages/ Isolations will be carried out during periods outside daylight hours.

All levels of system protection including G59/3_2, over-current (O/C) & earth-fault (E/F) should be periodically tested for correct operation in the form of secondary injection tripping tests. This is to provide confidence that these protective measures put in place will operate and protect the system assets satisfactorily and to original design specification / requirement. ERG59/3_2 states that periodic testing should be carried out on the interface protection relay. This should therefore form part of any continued O&M regime. The single point of connection is crucial to the satisfactory operation of the solar installation.

SPHERE STAFF

Sphere shall appoint a representative with the appropriate technical background and experience, who shall act as sole representative and who shall be responsible for overseeing the proper performance of the services, and who shall be responsible for directing, managing and supervising all the activities performed with the terms and time periods agreed.

SCHEDULE 1 TECHNICAL EXPERT SERVICES

KEY	
Type of Action	**Frequency of Action**
TC Test to be performed, and corrective action to be taken in case of negative outcome of test.	**D** Daily
R Required action to be taken.	**M** Monthly
	T Every three months
	S Every six months
	Y Yearly or on reasonable request

1. Solar modules maintenance

	Description	TC/R	D	M	T	S	Y	Corrective Action in case of negative outcome
1.1	Cleaning						✔	To be completed upon request by the Owner
1.2	Verification of damages on all modules which for the avoidance of doubt includes corrosion					✔		Substitution
1.3	Verification of irregularity on all modules mounting					✔		Correction
1.4	Visual check on screws tightness						✔	Correction
1.5	Verification of absence of flora and fauna						✔	Removal and prevention of recurrence to be completed upon request by the Owner

2. String connection maintenance

	Description	TC/R	D	M	T	S	Y	Corrective Action in case of negative outcome
2.1	Visual check of connection of cables	TC				✔		Correction
2.2	Visual check of cables	TC				✔		Substitution
2.3	Visual check of terminal boxes	TC				✔		Substitution
2.4	Spot verification (10%) of I-V characteristic of strings / (100%) PV Test	TC					✔	Conduct tests on all the modules in the affected
2.5	Verification of proper functioning of disconnection devices	TC				✔		Substitution
2.6	Verification of absence of condensation inside boxes	TC				✔		Substitution

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3. Conductor maintenance

	Description	TC/R	D	M	T	S	Y	Corrective Action in case of negative outcome
3.1	Verification of absence of water in the cable ducts/manholes	TC				✔		Water removal
3.2	Verification of clamping of cables on terminal strips	TC				✔		Correction
3.3	Cleaning	R				✔		Not applicable
3.4	Spot verification of insulation resistance of conductors	TC					✔	Substitution of conductors

4. Low Voltage electrical boxes maintenance

	Description	TC/R	D	M	T	S	Y	Corrective Action in case of negative outcome
4.1	Verification of absence of damages	TC				✔		Substitution
4.2	Verification of integrity and IP degree	TC				✔		Substitution
4.3	Verification of screws tightness with proper tool	TC				✔		Correction
4.4	Verification of screws tightness with proper tool	TC				✔		Correction
4.5	Verification of insulation resistance of circuits						✔	Substitution
4.6	Verification of proper functioning of protection devices						✔	Substitution
4.7	Verification of electrical continuity between metallic parts of the box	TC					✔	Correction
4.8	Cleaning	R				✔		Not applicable
4.9	Verification that the SPD have not been tripped [unless remote inspection possible]	TC				✔		Substitution
4.10	Verification of proper clamping of conductors on terminal strips	TC				✔		Correction

5. Ground System Maintenance

	Description	TC/R	D	M	T	S	Y	Corrective Action in case of negative outcome
5.1	Verification of grounding system resistance	TC					✔	Correction
5.2	Verification of electrical continuity	TC					✔	Correction
5.3	Verification of proper clamping of earth conductors to terminal strips	TC				✔		Correction

6. Substation & Inverter Station Inspection & Periodic Testing

	Description	TC/R	D	M	T	S	Y	3Y	Corrective Action in case of negative outcome
6.1	Substation / Inverter Station Visual Inspection	TC				✔			Recommendations based on check-list
6.2	Loss-of-Mains Operational Testing	TC					✔		Further investigation with protection secondary injection and system integration
6.3	G59/3 Periodic Testing	TC						✔	Further investigation into system integration – possible replacement of interface protection relay
6.4	Protective Relay secondary Injection (including but not limited to O/C & E/F)	TC						✔	Further investigation into system integration, small wiring, current transformer operation and test
6.5	Earth Bonding Integrity	TC					✔		Check for contact cleanliness, torque setting and state of termination crimping. Repair/ replace and re-test.
6.6	Non-invasive Partial Discharge Testing of HV assets	TC					✔		Further investigation with more detailed partial discharge analysis to pinpoint source.

7. LV/MV transformer maintenance

	Description	TC/R	D	M	T	S	Y	Corrective Action in case of negative outcome
7.1	Verification of voltage presence/ absence	TC	✔					In case of values outside the working range, a site visit should be performed, a thorough test of the Inverter should be carried out, and the affected component should be repaired or replaced.
7.2	Verification of tripping temperature alarms of coil	TC	✔					In case of values outside the working range, a site visit should be performed, a thorough test of the Inverter should be carried out, and the affected component should be repaired or replaced.
7.3	Verification of damages	TC				✔		Substitution
7.4	Verification of integrity	TC				✔		Substitution
7.5	Verification of proper functioning of ventilation system (if applicable)	TC				✔		Repairing or substitution
7.6	Cleaning (if necessary)	R				✔		Not applicable
7.7	Verification of proper clamping of conductors to terminal strips	TC					✔	Correction

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8. Medium Voltage electrical box maintenance

	Description	TC/R	D	M	T	S	Y	Corrective Action in case of negative outcome
8.1	Verification absence of damages	TC				✔		Substitution
8.2	Verification of screw tightness with proper tool	TC				✔		Correction
8.3	Verification of proper clamping of conductors on terminal strips	TC					✔	Correction
8.4	Verification of proper functioning of protection devices	TC					✔	Substitution
8.5	Cleaning	R				✔		Not applicable
8.6	Verification of electrical grounding	TC					✔	Correction
8.7	Verification of proper functioning of mechanical interlocks	TC					✔	Substitution or repairing
8.8	Verification of absence of flora and fauna	TC				✔		Removal and prevention of recurrence

9. Structures maintenance

	Description	TC/R	D	M	T	S	Y	Corrective Action in case of negative outcome
9.1	Visual check of screw tightness	TC					✔	Correction
9.2	Verification of alignment with proper instrumentation	TC				✔		Correction
9.3	Verification absence of rust	TC				✔		Correction
9.4	Verification absence of damages	TC				✔		Substitution or repairing

10. Site maintenance

	Description	TC/R	D	M	T	S	Y	Corrective Action in case of negative outcome
10.1	Mowing grass (inside the Site)	R			✔			Not applicable
10.2	Verification of good condition of internal and access road	TC					✔	Restoring
10.3	Verification of good condition of fencing and gate	TC					✔	Restoring
10.4	Verification of good condition of water drainage systems	TC				✔		Restoring

SCHEDULE 2 PERIOD FOR REPAIR

Component Part	**Maximum period for Repair** (expressed in Business Days following the occurrence of the Failure)
Inverters	2 Business Days
Transformers	3 Business Days
Supporting and fixing technology	2 Business Days
Fixing devices	2 Business Days
Panels	1 Business Days
Cables	1 Business Days
Other Component Parts	2 Business Days

SUBSTATION QA INSPECTION SHEET - *SAMPLE*

ITEM	CIVIL WORKS	INSPECTED	ACTION	COMPLETED
1	Substation secure, doors, gates & fencing (fencing suitably earthed)			
2	Authorised access available			
3	Building surrounding & site clean & tidy – i.e. no waste material			
4	Name plate & appropriate Danger/Warning plate fitted with contact Tel. no.			
5	Locks and hinges satisfactory (operation)			
6	Gutters, drains, drips & ventilation satisfactory			
7	Painting, brickwork & weatherproofing satisfactory			
8	No vermin, corrosion, dampness, obnoxious smells (check switchgear enclosures)			
9	Cable trenches covered or sanded – no water evident			
10	Substation interior clean. All unnecessary equipment to be removed			
11	Firefighting equipment to be available & operational			
12	Logbook & resuscitation card prominently located			
13	No signs of water ingress on walls or ceiling			
14	Any ladders or steps for substation use have correct tags fitted			
15	No sign of ground contamination (oil etc.) Check bunds			
	ELECTRICAL WORK			
16	Audible discharge / vibration / scent of ozone etc – use of PD measurement equipment			
17	Lighting & heating working correctly – Small power available			
18	Batteries & chargers satisfactory. Log book completed			
19	Switch circuit labels satisfactory			
20	No relay flag (LED) operations – report immediately any suspect trips not reset			
21	No "open" switchgear unless logged – report immediately			
22	Plant, insulation & earthing gear satisfactory, no oil / compound leaks			
23	External tank or switch lifting / lowering devices satisfactory (if applicable)			
24	Oil levels & breathers satisfactory (if fitted or applicable)			
25	Air filled compartments clean & heaters working			
26	Conservator tank & Buchholz satisfactory (if fitted or appropriate)			
27	Breaker mechanisms clean & smooth in operation (if possible during inspection)			
28	Any broken insulators evident			
29	Switchgear operating handles correctly stored			
30	LV fuseboards & associated equipment satisfactory			
31	Outdoor equipment fitted with appropriate "Danger of Death" signage / labels			
32	Adequate safety equipment securely stored			
33	Rubber mats to BS921 in place in front & behind switchboard			
34	Earthing-down kits and accessories securely stored & labelled			
35	Ductor Testing & sample torque settings for earthing integrity (where appropriate)			

OUTLINE SCOPE OF SERVICE

SECTORS

- Grid Connections
- Distributed Generation
- Renewable Energy Systems
- Energy Storage
- Transmission and Distribution
- Industrial
- Commercial
- Protection and Control Systems
- Active Power Management Systems

SERVICES

1. Preparation and Management:

- Technical feasibility assessments
- Cost estimates
- Completion of technical documents
- DNO grid connection applications
- Review of DNO grid connection offers
- Negotiation of Offers
- Liaison with 3rd party landowners
- Consultation with Statutory and Utility organisations

2. Design and Compliance Studies:

- HV & LV energy systems complete design packages
- Power quality monitoring and assessment
- ER G5/4: Harmonic distortion assessment
- ER P28: Voltage fluctuations assessment (Transformer Inrush)
- Earthing design studies, incl. soil resistivity test reports
- Cable selection & verification
- Switchgear selection & verification
- Protection systems design
- Protection system grading study
- Controls and communications design
- Civil and construction works designs
- Due Diligence reporting on 3rd party designs

3. Supply and Site Installation Works:

- Complete substation building and compound construction, incl. groundworks, roads, structures and building services.
- High Voltage (HV) conductors, cables and busbar systems supply and installation, including containment, jointing and terminations.
- Low Voltage (LV, incl. control, auxiliary, LV power) cables and busbar systems supply and installation, including containment, jointing and terminations.
- Earthing conductors, cables and electrodes, DNO specific (where req.) and installed to bespoke design.
- Power transformers, instrument transformers and Neutral Earthing Transformers for all applications.
- HV switchgear and ancillary equipment, such as battery charger units, marshalling kiosks, Remote Terminal Units (RTUs), Interface panels, Control panels and active management systems.
- Electrical system protection; whether integral to the HV switchgear, or installed as separate protection panel systems..
- Senior Authorised Person (SAP) duties on 'live' HV systems, such as switching and issuing of safety documents.

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4. Testing and Commissioning:

- Switchgear, Protection and Controls
  - Functional checks and switchgear integrity
  - Ductor testing
  - AC pressure testing
  - Insulation Resistance tests
  - Primary injection tests (CTs and VTs)
  - Protection settings and logic setup
  - Secondary injection of protection relays
  - Protection timing tests
  - Auxiliary relays and intertripping
  - SCADA interface (control & comms)
  - Auxiliary DC supplies and alarms
  - G59/3 setup and testing
  - G59/3_2 setup and periodic testing
- Cables
  - Verification of manufacturer's recommendations
  - Continuity of cores and earth screens
  - Phase Sequence verification
  - Insulation Resistance (before and after acceptance test)
  - DC Overvoltage or Pressure testing
  - AC Low Frequency – VLF
  - Sheath integrity
  - Dielectric quality testing – Partial Discharge / Tan-Delta
- Power Transformers
  - Insulation Resistance (before and after acceptance test)
  - Voltage withstand test
  - Induced voltage test
  - Voltage ratio measurement and check of polarities and connections
  - No-load current and no-load loss measurement
  - Winding resistance measurement
  - Short-circuit impedance and load loss measurement
  - Partial discharge measurement

5. Operation and Maintenance

- Senior Authorised Persons (SAP) duties such as switching, isolations and issuing of Safety Documentation on all system voltage levels up to 132kV.
- System appraisals:
  - Level 1 - Desktop review of system designs and maintenance records.
    Executive summary, with observations and recommendations.
  - Level 2 - Site attendance for high-level visual inspection of system.
    Observations reported as an Executive Summary, with 5 working days of site attendance.
  - Level 3 - Comprehensive site visual inspection and condition assessment, recording and documenting of asset technical data, with photographic reporting and detailed equipment schedules provided within 5 working days of site attendance.
  - Level 4 - May require shutdown, carefully planned with customer consultation to minimise disruption. As Level 3 + Full system functional checks; switchgear operation, protection devices operation, circuit breaker timing tests, interlocking checks, Insulation Resistance testing of cables, bus bars and transformers. Detailed report with functional checklist and test certificates. Full report issued within 48hrs.
- Bespoke packages, tailored site-by-site to expedite all technical and commercial requirements.
  Access to draw upon the complete scope of items listed in section 4. Testing and Commissioning, as required.
  - Non-intrusive methods utilising experience and technology
  - Preventative, periodic inspections
  - Clear, concise, well-presented reporting at all levels
  - Reactive maintenance and repairs
  - 100% reliable Service Level Agreements (SLAs)
  - 100% achievable Key Performance Indicators (KPIs)
  - 24/7 emergency cover
  - Efficient shut-down coordination
  - DNO point-of-contact for all correspondence
  - Any issues found that do not require procurement of parts will be resolved upon discovery where possible, at no additional cost.
  - Every manager, technician, operative employed by us can demonstrate 10yrs+ relevant experience in their field.

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