

Guide to Transmission Equipment Maintenance

March 2018



Revision History

Issue	Date	Update
1	September 2013	First Issue
2	March 2016	Updated in response to SEM-15-071 Decision Paper – Outturn Availability. Standard maintenance tasks included with details on target frequencies and durations.
3	March 2017	Annual review complete - Minor text changes implemented.
4	March 2018	Changes to XLPE Cable Inspection Frequency, Climbing Patrols and Sag check frequency at section 5.1, 6, appendix 1 and 2. Changes to Protection Maintenance at section 3 and appendix 1 'Description of Outage Related Protection Maintenance Tasks' and appendix 2.

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1. Background

This document is a high level guide to the processes and procedures used by EirGrid in consultation with ESB Networks when maintaining transmission customer connection assets¹.

2. Transmission Asset Maintenance Policy

As Transmission System Operator (TSO), EirGrid operates and ensures the maintenance and development of a safe, secure, reliable, economical and efficient transmission system, in accordance with its obligations under Regulation 8(1) of S.I. 445/2000².

It should be noted that physical maintenance works are carried out by ESB Networks, as Transmission Asset Owner (TAO), in accordance with its obligations under Regulation 19(a) of S.I. 445/2000. The arrangements governing the interactions and respective roles of the TSO and TAO in respect to the maintenance of the transmission system are further detailed under Section 8 of the Infrastructure Agreement³.

Transmission maintenance is undertaken in accordance with the Transmission Asset Maintenance Policy to ensure that the transmission system can operate in a safe, secure and reliable manner. The policy comprises preventive, corrective, fault and statutory maintenance tasks as well as continuous and cyclical condition monitoring (on-line and off-line). The Transmission Asset Maintenance policy is kept under review to ensure that it continues to meet the requirements of the system and best international practice.

3. Transmission Protection Maintenance Policy

Transmission Protection Maintenance Policy details the preventive and corrective maintenance tasks, as well as the frequency at which the protection maintenance should be carried out.

The Protection Maintenance Policy is kept under review to ensure that it continues to meet the requirements of the system and best international practice.⁴

¹ This paper relates to customer connection assets, defined as assets that are part of the transmission system that exist between the Customer Connection Point and the busbar clamps at the meshed Transmission System

² S.I. No. 445/2000 – European Communities (Internal Market in Electricity) Regulations, 2000

³ [ESB and EirGrid Infrastructure Agreement CER11084](#)

⁴ Protection Maintenance Policy reviewed and revised 2018

4. Transmission Maintenance Works

4.1 Transmission Maintenance Works - Categorisation

Maintenance works are the works that are carried out on a regular basis to check the operability of the transmission equipment (such as operational tests and cable inspections) or works that arise as a result of inspections or faults to maintain and/repair equipment. There are 4 main categories of maintenance:

Preventive/Routine Maintenance

Preventive/routine maintenance is planned at predetermined intervals to reduce the likelihood of equipment degradation which could lead to plant failure e.g. condition assessment. This type of maintenance is planned in advance and the frequencies of these activities are pre-determined by the EirGrid Asset Maintenance Policy (reference *Appendix 2 – Standard Maintenance Tasks*).

Corrective Maintenance

Corrective maintenance may consist of repair, restoration or replacement of equipment before functional failure. Corrective maintenance requirements are identified through regular inspections. The aim of routine inspections is to identify the potential for failure in time for the solution to be planned and scheduled and then performed during the next available outage.

These corrective maintenance tasks can be categorised as shown in the table below:

Category	Remedial Action Timeline
Non-urgent	Deferred beyond current outage season (Voluntary Outage).
Urgent	Carried out within current outage season ⁵ (Voluntary Outage).
Emergency	Immediate – (Forced Outage / Forced Outage Extension).

Table 1 Categorisation of Corrective/Fault Maintenance Tasks

Fault Maintenance

Fault maintenance includes activities arising from unexpected equipment failure in service which can also be categorised as per the table above.

Statutory Maintenance

Maintenance which is carried out to facilitate statutory requirements e.g. Pressure Vessel Inspections, bund inspections.

Standard Maintenance Tasks are listed in Table 2 (reference Appendix 2). Table 2 identifies routine maintenance tasks and the more common corrective and fault maintenance tasks with standard durations and target intervals as required by the supporting maintenance policies. This list attempts to provide clarity to customers on the maintenance works planned by EirGrid and

⁵ Target to carry out works within outage season. Any deferral into the following year's outage season is subject to a risk assessment.

ESB Networks for overhead transmission lines, HV underground cables and HV equipment within substations.

This is not an exhaustive list of all maintenance works.

Standard durations are provided where possible, in some cases due to local conditions it is not feasible to provide a standard duration. The standard durations have been collated using information provided by ESB Networks, the physical works are carried out by ESB Networks therefore standard durations are subject to ESB Networks maintenance work instructions.

4.2 Transmission Outages to Facilitate Maintenance Works

Transmission outages are necessary to isolate equipment to facilitate works. These outages are progressed as either a planned outage (voluntary outage) or in response to unplanned events/conditions (forced outage). These are described below:

- **Voluntary Outages**
Voluntary outages are planned outages of transmission equipment to facilitate planned activities. This includes routine, corrective, fault and statutory maintenance activities.

- **Forced Outages**
Forced outages are un-planned outages of transmission equipment to facilitate unplanned activities. This may be in response to failed transmission equipment and/or un-safe system conditions. Forced outages facilitate remedial works which may include corrective or fault maintenance of existing equipment or the replacement of existing equipment.

- **Forced Outage Extensions**
Forced outage extensions are unplanned extensions to a voluntary outage. While completing transmission works within a voluntary outage, discovered works may be identified that require emergency remedial works. Due to the unplanned nature of the works these outage extensions are known as forced outage extensions.

5. Preventive/Routine Maintenance

5.1 Preventive / Routine Asset Maintenance

The minimum annual preventive/routine maintenance programmed on every transmission customer connection asset is an operational test⁶. An operational test consists of a number of tests/checks including confirmation of correct operation of bay equipment.

An ordinary service⁷ includes tasks such as corrosion inspections and equipment cleaning. The ordinary service is carried out every 4-5 years as defined by maintenance policy. When an ordinary service is scheduled, it replaces the operational test.

A condition assessment⁸ is a detailed equipment evaluation including equipment performance tests, mechanism checks and gas analysis where appropriate. A condition assessment is scheduled to align with every second ordinary service.

The minimum annual preventive/routine maintenance programmed on every underground transmission cable is an Annual Inspection⁹. Depending on the type of cable (fluid filled/XLPE), this inspection can consist of checks, inspections and sheath testing.

For safety reasons an operational test and cable inspection cannot be carried out in parallel.

Outage related overhead lines maintenance works are condition/age based. To the greatest practical extent, inspections and condition assessments are carried out with the lines energised.

5.2 Preventive / Routine Protection Maintenance

Protection relay maintenance varies accordingly to the type of protection relay installed. Transmission bays can be fitted with a number of different types of protection relays, including electromechanical, static or numerical. The maintenance requirements, along with frequency, vary according to type installed.

Detailed protection maintenance plans for relay type have been developed by ESBI in order to ensure that all protection maintenance is completed correctly and in a consistent manner.

Routine Protection Relay Maintenance – This is planned maintenance of the protection relay hardware at regular and pre-determined intervals.

⁶ See Appendix 1 for more detailed description

⁷ See Appendix 1 for more detailed description

⁸ See Appendix 1 for more detailed description

⁹ Annual inspection on fluid filled cables, XLPE is every 3 years or 1/3 of cable per year for cables >10km.

6. Deferrals/Prioritisation of Maintenance

On an annual basis, transmission maintenance activities dictated by the asset maintenance policy and protection maintenance policy, along with work identified from analysis of plant condition and work carried over from the previous year combine to form the planned maintenance requirements for the year. This is then included in the Transmission Outage Plan.

During the relevant year, due to a variety of reasons (including resource limitations, outage restrictions, material availability, system conditions, CAPEX projects etc.), it may be necessary to defer programmed maintenance activities. The TSO will consider the appropriateness or otherwise of deferring preventive and/or corrective maintenance activities. This is subject to prioritisation and deferral assessments in accordance with established EirGrid procedures. These assessments which consider system / safety / environmental impact, duration of outage, controls and mitigation measures. Deferrals are kept under review, as any increase in backlog could have a negative impact on the reliability and performance of the transmission system.

The minimum annual maintenance programmed on all transmission customer connection assets is an operational test and, where installed, an annual cable inspection⁹. An operational test will replace an ordinary service where an ordinary service is deferred.

The safe, secure, reliable, economical and efficient operation of the transmission system is EirGrid's priority at all times.

Appendix 1 – Description of Outage Related Routine Maintenance Tasks

Description of Outage Related Routine Station Maintenance Tasks

Preventive/routine maintenance is carried out at routine intervals on all station assets. The following summarises the primary preventive/routine outage related maintenance tasks on station equipment:

Operational tests: These involve, among other activities, opening and closing the breakers and disconnects locally and remotely, carrying out tripping checks on the breakers and checking of interlocking. These tests are designed to ensure that equipment will operate correctly when called upon to do so. The minimum annual preventive/routine maintenance programmed on every transmission customer connection asset is an operational test.

Ordinary services: Every 4 or 5 years (depending on asset type as defined in maintenance policies), more detailed inspection and measurements are taken. All measurements and test values are checked for conformity with standards or other norms established by best industry practice or experience. The measurements and test values are compared to those of previous measurements and tests. Any significant changes or trends are noted and satisfactory explanations sought. Breakers and disconnects are also operated locally and remotely during an ordinary service.

Condition assessment: This non-invasive procedure combines an evaluation of the asset's operational, maintenance and fault histories with a detailed site inspection and site and laboratory tests. The condition assessment evaluates the asset's present condition and residual life and provides data for life management decisions such as required corrective maintenance, further monitoring and future operation (including loading/over-loading restrictions, refurbishment and replacement). As per maintenance policy condition assessments are scheduled at 8 – 10 year intervals depending on the asset type.

Description of Outage Related Routine Cable Maintenance Tasks

High Pressure Fluid Filled Cables (HPFF): An annual cable inspection is required on all HPFF cables on the transmission system. This involves maintenance of gauges and alarms. The cable terminations and the fluid feeding system are also inspected.

Low Pressure Fluid Filled Cables (LPFF): An annual cable inspection is required on all LPFF cables on the transmission system. This involves maintenance of gauges and alarms and link boxes where necessary. Sheath testing is carried out. Inspections of cable terminations and the fluid feeding system are also necessary.

Cross Linked Polyethylene (XLPE): XLPE cables on the transmission system are to be inspected every 3 years¹⁰ or for cables >10km an inspection can be carried out for a third of the length of the cable every year. This involves sheath testing as well as inspection of cable terminations and link boxes.

Description of Outage Related Protection Maintenance Tasks

Protection Relay Maintenance: These are detailed inspections/tests of the protection relays to ensure that the relay is operating correctly. Such maintenance may also involve the installation of new or revised protection settings/firmware. This maintenance is carried out at various intervals, once yearly for electromechanical relays extending to once every 5 years for electronic relays with self-monitoring.

Corrective Protection Relay Maintenance: This may involve the repair, restoration or replacement of a protection relay before or after a fault. Such corrective protection maintenance may be driven following the identification of a type fault or other issue

Anti-islanding protection schemes maintenance: These schemes are installed primarily on DSO 110 kV / MV transformers. The purpose of this maintenance is to confirm operation of the anti-islanding protection. This maintenance involves, but may not be limited to:

- Verification of alarms, commands and controls.
- Trip testing of the circuit breakers, associated with the scheme.

Protection Trip Testing: This can be carried out on a relay or scheme basis. The purpose of the testing is to confirm the operation of the relay or the scheme from the protection cabinet to the associated circuit breaker(s). This testing may be completed on the following basis:

- An individual bay or relay.
- BZP/CBF schemes;

Such testing is carried out on a station basis once every five years. While the maintenance of the scheme may involve taking the scheme in question out of service for 1 to 2 days, the actual

¹⁰ This 3 year frequency is being introduced from 2018 on a gradual basis over the next 3 years.

trip testing should have the same duration as the annual operational test for the bay in question.

Trip testing of Protection Relays / Buszone Protection (BZP) / Circuit Breaker Fail (CBF) Protection Schemes: This involves the testing of the entire protection scheme from the protection relay cabinet to the transmission system and customer MV circuit breakers. The purpose of this protection maintenance is to ensure that the scheme operates in line with expectations, by testing the scheme from beginning to end, identify any issues and make repairs, if necessary. Please note that given the nature of BZP/CBF schemes, this protection maintenance is carried out on a station basis.

Interface testing: This testing is completed at the interface point between:

- TSO protection and a generator
- TSO protection and Demand customer.

The purpose of this testing is to verify that the correct exchange of critical commands and signals to/from the TSO and the generator or demand customer.

Appendix 2 – Standard Maintenance Tasks

Corrective / Routine Maintenance (CM/RM)	Plant	Task Summary	Standard Duration (Calendar days)	Target Intervals (Years)
RM	Lines	Climb Patrols (per km)	N/S*	As required
RM	Lines	Sag Checks / Re-sag	N/S*	As required
RM	Lines	Cormon Corrosion testing (per km)	N/S*	As required**
RM	Lines	Conductor Sampling	N/S*	As required**
CM	Lines	Corrective maintenance - specific remedial works	N/S*	As required
CM	Lines	110kV Insulator & Hardware Replacement (per pole)	1*	As required
CM	Lines	220kV Insulator & Hardware Replacement (per pole)	2*	As required
CM	Lines	400kV Insulator & Hardware Replacement (per pole)	2*	As required
CM	Lines	Plumb Polesets (per pole)	1*	As required
CM	Lines	Poleset Replacement	1-4*	As required
CM	Lines	Inspect hot-spots	1-4*	As required
CM	Lines	Birds nests	1-3*	As required
CM	Lines	Replace joints, jumpers, connectors, conductors, vibration dampers	N/S*	As required
CM	Lines	Repair Structure Damage	N/S*	As required
RM	Station	110kV Cubicle Condition Assessment	3	8/10***
RM	Station	110kV Air Blast Cubicle OPT	1	1
RM	Station	110kV Air Blast Cubicle OS	6	4/5***
RM	Station	110kV MO Cubicle OPT	1	1
RM	Station	110kV MO Cubicle OS	6	4/5***
RM	Station	110kV Sec/Dis OPT (per Dis)	1	1
RM	Station	110kV Sec/Dis OS	2	5
RM	Station	110kV GIS Cubicle OPT	1	1
RM	Station	110kV GIS Cubicle OS	4	4/5***
RM	Station	110kV SF6 Cubicle OPT	1	1
RM	Station	110kV SF6 Cubicle OS	4	4/5***
RM	Station	220kV Cubicle Condition Assessment	3	8/10***
RM	Station	220kV Air Blast Cubicle OPT	1	1
RM	Station	220kV Air Blast Cubicle OS	10	4/5***
RM	Station	220kV MO Cubicle OPT	1	1
RM	Station	220kV MO Cubicle OS	10	4/5***
RM	Station	220kV Sec/Dis OPT	1	1
RM	Station	220kV Sec/Dis OS	2	5
RM	Station	220kV GIS Cubicle OPT	1	1
RM	Station	220kV GIS Cubicle OS	5	4/5***
RM	Station	220kV SF6 Cubicle OPT	1	1
RM	Station	220kV SF6 Cubicle OS	5	4/5***
RM	Station	400kV Cubicle Condition Assessment	4	8/10***
RM	Station	400kV Sec/Dis OPT	1	1
RM	Station	400kV Sec/Dis OS	2	5

Corrective / Routine Maintenance (CM/RM)	Plant	Task Summary	Standard Duration (Calendar days)	Target Intervals (Years)
RM	Station	400kV GIS Cubicle OPT	1	1
RM	Station	400kV GIS Cubicle OS	5	4/5***
RM	Station	400kV SF6 Cubicle OPT	1	1
RM	Station	400kV SF6 Cubicle OS	5	4/5***
RM	Station	HV Pressure Vessel Inspection	2	As required
RM	Station	Overhaul of Foolproof Unit	5	As required
RM	Station	SF6 Leak Detection	3	As required
CM	Station	SF6 top up	1	As required
CM	Station	SF6 Leak repair (per leak)	5	As required
CM	Station	SF6 Gas fitting replacement	3	As required
CM	Station	Earth Connections repair / replace (per bay)	5	As required
CM	Station	Earth Straps repair / replace	1	As required
CM	Station	Earth Disconnect repair / replace	1-2	As required
RM	Station	HV Earth Grid Inspection	3	12
CM	Station	Repair / replace - Densimeter / Gauge / Counter	1	As required
CM	Station	HV Disconnect repair (per Dis)	1-2	As required
CM	Station	Inspect hot-spots	1-2	As required
CM	Station	Instrument Transformers (per bay) - Oil sampling / Bellow repair	2	As required
CM	Station	Painting of galvanised steel	N/S	As required
CM	Station	Corrective maintenance - specific remedial works	N/S	As required
RM	UGCs	110kV Cable Inspections (Fluid filled) - (<1km)	2	1
RM	UGCs	400kV-220kV Cable Inspections (Fluid filled) - (<1km)	2	1
RM	UGCs	400kV-220kV Cable Inspections (Fluid filled) - (1-4km)	3	1
RM	UGCs	400kV-220kV Cable Inspections (Fluid filled) - (>4km)	N/S*	1
RM	UGCs	Cable Inspections all voltages (XLPE) - (<1km)	2	3
RM	UGCs	Cable Inspections all voltages (XLPE) - (1-4km)	3	3
RM	UGCs	Cable Inspections all voltages (XLPE) - (4-10km)	4-10*	3
RM	UGCs	Cable Inspections all voltages (XLPE) - (>10km)	N/S*	3 Or 1/3 of Cable Annually
CM	UGCs	Locate Fluid Leak	N/S*	As required
CM	UGCs	Locate & Repair a Sheath Fault	N/S*	As required
CM	UGCs	Repair Fluid Leak (using sleeve)	N/S*	As required
CM	UGCs	Link box repair	N/S*	As required
CM	UGCs	CSE repair / replace	N/S	As required
CM	UGCs	Corrective maintenance - specific remedial works	N/S*	As required
RM	Protection relays	Maintenance of the bay protection relays - Electromechanical	1	1
RM	Protection relays	Maintenance of the bay protection relays - Static	1	2

Corrective / Routine Maintenance (CM/RM)	Plant	Task Summary	Standard Duration (Calendar days)	Target Intervals (Years)
RM	Protection relays	Maintenance of the bay protection relays - Numerical	1	5****
RM	Protection schemes	Protection Trip Testing (including BZP/CBF Schemes)	5	5
RM	Anti-islanding Schemes	Maintenance of anti-islanding schemes	1	5/6 years, dependent on connection and protection type
RM	Interface Testing	Verification of the correct exchange of signals and commands between the TSO protection and the generator and/or demand customer	1 *****	Completed as part of the transformer protection maintenance
CM	Protection relays	Maintenance of the bay protection relays - Electromechanical	N/S	Connection point specific
CM	Protection relays	Maintenance of the bay protection relays - Static	N/S	Connection point specific
CM	Protection relays	Maintenance of the bay protection relays - Numerical	N/S	Connection point specific

Table 2 Standard Maintenance Tasks (Duration/Frequencies)

Notes: Please also refer to **Table 1** Categorisation of Corrective/Fault Maintenance Tasks.

- * Dependant on location and access arrangements.
(It should be noted that for forced outages to facilitate remedial works on underground cables, whilst EirGrid and ESB Networks will attempt to keep impact on system operation and customers to a minimum, the carrying out of such works are generally subject to agreement of road opening licences with the appropriate local authority).
- ** Dependant on age of asset (older > more frequent).
- *** Asset specific as defined by Maintenance Policy.
- **** An increasing number of bays on the transmission system are fitted with duplicate numerical protection relays. These relays are equipped with self-monitoring functions and as a result, protection maintenance intervals can be and have been extended to five (5) years.
- ***** This one day of interface testing is in addition to the routine protection maintenance testing.
- N/S Non-standard duration.
For specific details please refer to the annual outage programme.