Customer-Led Network Revolution

Overhead Line Real Time Thermal Ratings

Installation Guide

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1 Introduction

Real Time Thermal Rating (RTTR) is one of many network technologies trialled under the Customer Led Network Revolution (CLNR) project. Generally on overhead line installations, the device and thermal rating system consists of a group of monitoring devices measuring conductor loading and environmental conditions, that links to a model construction of the line that complies with existing design and construction standards, the benefits of localised environmental monitoring can infer a potential change to those existing static constraints. (ENA engineering recommendation P27 1986)

One of the Real Time Thermal Rating (RTTR) solutions deployed in the Customer- Led Network Revolution was RTTR of bare-conductor overhead lines at HV (20kV) and EHV (66kV). This document captures the detailed learning about the installation process for the On-Line Sensors, Weather Stations and Local Controllers employed in this RTTR system. Guidance is provided on both dead installation (with a circuit outage) and Live Working installation, depending on the voltage at which the equipment is to be installed and the location.

Examples of the specific processes and procedures created for Live Work installation are given in the appendices, to guide the production of specific policies, procedures and training for Network Operators wishing to implement RTTR on Overhead Lines. The rest of the installation process should be covered by normal working practices and so are not specifically set out here.

The solution installed as part of the CLNR trials was provided by GE Digital Energy; however the guidance should be relevant to any similar OHL RTTR solutions. The communications to link the field equipment to central control and storage servers was not part of the CLNR trial scope, but some useful experience can be found in the wider RTTR Lessons Learned report.

For the lessons learned and the benefit of the application of thermal rating devices please visit the learning library on Customer-Led Network Revolution website[1] where you can also view a video of the installation.[2]

[1] www.networkrevolution.co.uk
[2] http://www.networkrevolution.co.uk/resources/video-library/

2 OHL RTTR Solution Preparation

2.1 Design

This guide assumes that the process of defining the need for the OHL RTTR system, and the locations on the overhead line where RTTR equipment will be required, has already been completed. This process of determining the constraining spans on the network for RTTR installation is described in the RTTR Lessons Learned report. The specification for the purchase of OHL RTTR systems is also available as a CLNR project outcome, with details of the functionality required.

2.2 Installation Technique – Live Line or Not?

The decision as to whether OHL RTTR equipment can be installed using live-line techniques, or an outage will be required, will ultimately depend on the procedures for live working within the network operator, and these must be followed. For some RTTR schemes, the equipment will be installed on lines operating at voltages for which live working is not permitted, and so an outage will have to be secured to perform the installation.

If live working is proposed then, under the Electricity at Work Regulations (1989) a justification must be made for live working. The decision flow chart used to request live line working for the CLNR trial is included as an appendix, but the relevant network operator procedures must be complied with.

2.3 Preparation

As well as obtaining the relevant network construction drawings, a site visit to the locations where the equipment is to be installed will be required. The aims of this visit are:

- Ensure that suitable access to the line is possible, especially vehicle access if Live Line installation is intended.
- Check that 3G data coverage is available on site for communications purposes.
- Identify any changes to the surroundings of the line (e.g. new tall buildings) which may affect the RTTR modelling.
- Confirm that there is no other equipment on the line which will prevent a capacity increase under RTTR (e.g. joints, jumpers or live-line taps with inadequate ratings). This should have been checked at the design stage!
- Plan where equipment will be located on the structures (poles or towers) which support the line, so that the correct mounting hardware is available for installation. Bear in mind that both weather stations and the solar panels used to run Local Controllers must be installed facing in a specific (compass) direction.

Once this information is available, detailed planning for the installation of the equipment can be undertaken. The Local Controller and Weather Station, together with any small-scale renewable power sources, will usually need to be installed above the anti-climb guard (for protection) but outside the conductor clearance zone so that it can be accessed without Live Working or a circuit outage if required.

3 Procedures and Training

Specific training and procedures are likely to be required for the installation of the On-Line Devices using Live Working only. Installation of these during an outage, and installation of the Weather Stations and Local Controllers are expected to be undertaken following standard operational procedures.

3.1 Live Working Installation of On-Line Devices

Because of the weight of the on-line devices used for OHL RTTR (often containing batteries as well as CTs and measurement equipment), and the complexity of their secure installation, 'Hot Stick' installation of on-line devices is not considered practical. 'Hot Glove' installation is possible provided that suitable equipment, procedures and training are in place.

Because Live Working is not generally permitted on tower-type lines, this guide assumes that Live Working installation will be carried out on pole-type constructions where the conductors can be accessed using an Insulating Aerial Device.

3.1.1 Hot Glove Installation Equipment

All of the equipment required for the installation of the OHL RTTR on-line devices is standard equipment, already in use for Live Working on the UK Electricity Distribution system. The relevant Network Operator's standard specifications at the applicable voltage will apply for:

- Insulating Aerial Devices (Insulated 'Bucket Truck')
- Flexible Shrouding
- Live Work Tools and Equipment
- Personal Protective Equipment

3.1.2 Hot Glove Installation Procedures

A procedure for the safe installation and removal of OHL RTTR on-line devices will have to be produced and approved within the Network Operator's safety system, and drawing upon standard Live Work procedures. An example procedure drawn up against Northern Powergrid's Live Working procedures is included in Appendix 2, but a specific procedure based on this and linked to the Network Operator's procedures will be required. Relevant standard procedures will include (but not limited to):

- Tailboard Conferences
- Use of Insulating Aerial Devices
- Installation and Removal of Flexible Shrouding

3.1.3 Hot Glove Installation Training

Specific training will be required for the 'Hot Glove' Live Working team before attempting to install the On-Line Devices in practice. This will enable the team to become familiar with manipulating the On-Line Device in a safe environment. For this training, the usual Network Operator training school facilities are suitable, specifically:

- Classroom space for introductory session and familiarising with the specific equipment and Manufacturer's instructions.
- Low-height, non-energised overhead lines (real conductor and strung at real tension) to trial fitting the On-Line Devices.
- Full construction, non-energised overhead lines for training installations.

The first installation after training will inevitably be significantly slower than subsequent installations, and sufficient time must be allowed so that work is not rushed. In the CLNR project, the first installation took 3 ½ hours, whereas subsequent installations by the same team took only around 1 hour, using suitably prepared equipment kits.

3.2 Dead Installation of On-Line Devices

3.2.1 Dead Installation on Pole Lines

Where the line is constructed using Wood Poles or similar, and an elevated work platform can be employed to reach the conductors, installation is relatively straightforward. Normal Network Operator practices for isolation and earthing of the line can be followed, then the installation location reached using a suitable work platform within standard procedures.

3.2.2 Dead Installation on Tower Lines

Tower lines pose additional challenges because it is not normally possible to access the conductors safely using an elevated work platform. Instead, access has to be gained by climbing the tower steelwork, and then use of a ladder to bridge the insulator string and reach the conductor itself. Standard procedures for tower climbing and access will need to be followed, and a safe means to lift the equipment into place (e.g. using approved maintained ropes from the ground). Network Operator procedures will need to be followed for all of this, which may require planning ahead to have suitable staff and equipment available.

The need to use a ladder to bridge the insulator string means that installation of On-Line Devices is much easier on suspension-type towers (with shorter structures) than on tension-type towers, where the insulator string, bindings and dampers present an issue that is less apparent on suspension structures. This advice should be borne in mind when choosing installation locations (acknowledging that the electrical load and weather measurements at the two ends of a span are normally similar).

4 Preparation

A considerable reduction in the time and effort required to install the OHL RTTR equipment can be achieved by suitable preparation of the equipment. This minimises the amount of onsite wiring and interconnection, fault-finding and testing to be undertaken under field conditions.

On receipt from the manufacturer, the kit of equipment for each location should be unpacked and checked for completeness. In particular, a check should be made that the mounting brackets and hardware provided are suitable for the installation structure (normally coach screws for wood poles, and strut clamps for towers). This is much the best point to identify any shortages, or issues mounting the equipment on the specific structures chosen.

As much wiring up and configuration as possible should be undertaken before the equipment is installed. In particular:

- All internal terminal connections should be made up and secured
- Connections between items should as far as possible be on connectors, not individual terminals, for rapid and reliable connection
- The equipment for one site should be set to communicate between its component parts, for instance 'pairing' On-Line Devices with their associated Local Controller
- All items of equipment should be clearly labelled with their intended installation location (e.g. which phase On-Line Devices should be fitted to)
- 3G communications should be set up, SIM cards installed, and if at all possible a communications check to the outside world undertaken to validate these, as it is much easier to troubleshoot communications in a workshop than up a tower!

The complete sets of equipment for each site can then be packed for transport to their installation location. Ideally this process will involve the team who will perform the installation of the equipment, so that they are familiar with the equipment and exactly what state it needs to be in. Where equipment has or will be stored for some time, precautions must be taken to avoid batteries being flat when installation occurs, as this will slow the process down considerably.

5 Field Installation

When the equipment and installation team arrive on site, they should be clear about what is being installed, where it goes, and what setting up (e.g. alignment of wind sensors with North) is still required.

Each particular site will present its own key hazards over and above the installation of the line monitoring equipment itself. It is normal practice that a risk assessment and method statement is completed prior to work on site, and it is essential that the risk assessment is reviewed on the day of installation to identify any changes in site circumstances or environmental conditions.

Figure 1 OHL RTTR Typical installation in progress on Wood Pole Line

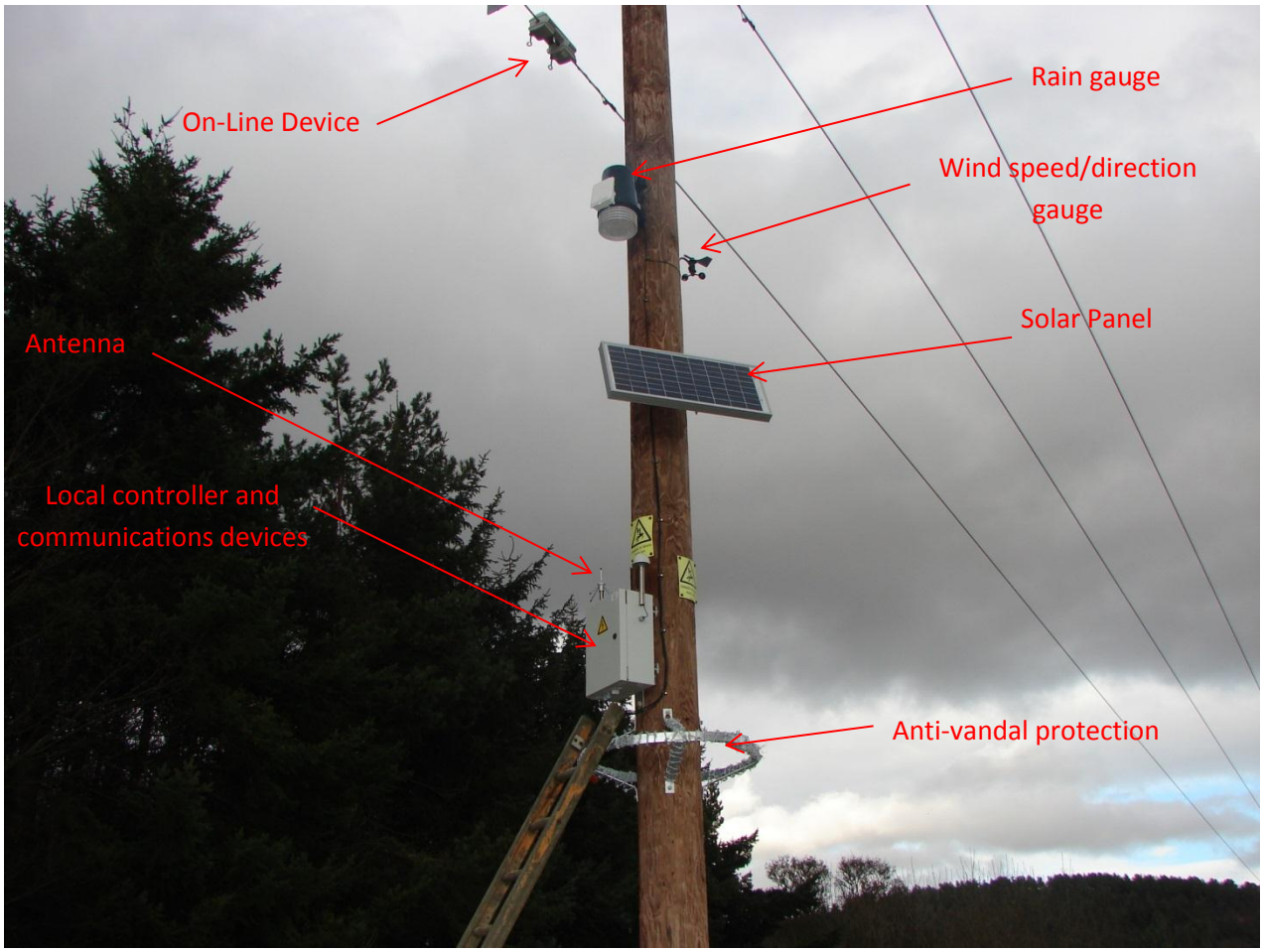


Figure 1 shows an example installation on a wood pole line, with the Local Controller, solar panel and Weather Station all installed directly onto the pole, and On-Line Devices hung above. The Weather Station components supplied may differ slightly from those shown.

Note that the wind speed / direction gauge shown is too close to the pole to give accurate results, and a longer bracket should be used to move it clear of the wind flow effects of the pole itself. If a wind direction sensor is fitted, it must be aligned relative to North so that correct wind direction information is provided. The manufacturer's instructions and markings will need to be consulted to determine the correct orientation of the sensor.

It is important that the solar panel is installed facing south, with an elevation that provides sufficient power all year round to operate the system reliably. This is not the same as the position which yields the maximum total energy output, because energy storage in the Local Controller is limited by the battery capacity. The optimum elevation (angle from the horizontal plane to the plane of the solar panel) varies with the latitude at which the system is installed, as given in Figure 2.

Figure 2 Optimum solar panel installation angle

Latitude	Tilt Angle
46-50˚ N	50˚
51-55˚ N	55˚
56-60˚ N	60˚
61-65˚ N	65˚

Other than this the installation of the Local Controller and Weather Station is not expected to be complex. Installation onto tower lines will be similar, except that access by ladder and tower climbing procedures will be harder work because of the greater height of the towers. An example installation onto a steel tower is shown in Figure 3.

Figure 3 Local Controller installation on tower line

(Figure 3, image displays a set of bespoke mounting brackets that need to be identified, measured, designed and fabricated before installation of the on line equipment)

The On-Line Sensors can be installed before or after the other equipment is put up, but cannot be tested until all the components are in position. As well as physically placing the On-Line Device onto the conductor, this represents the final opportunity to verify that the conductor type and size recorded in the Network Operator's records is correct and matches what is installed on site.

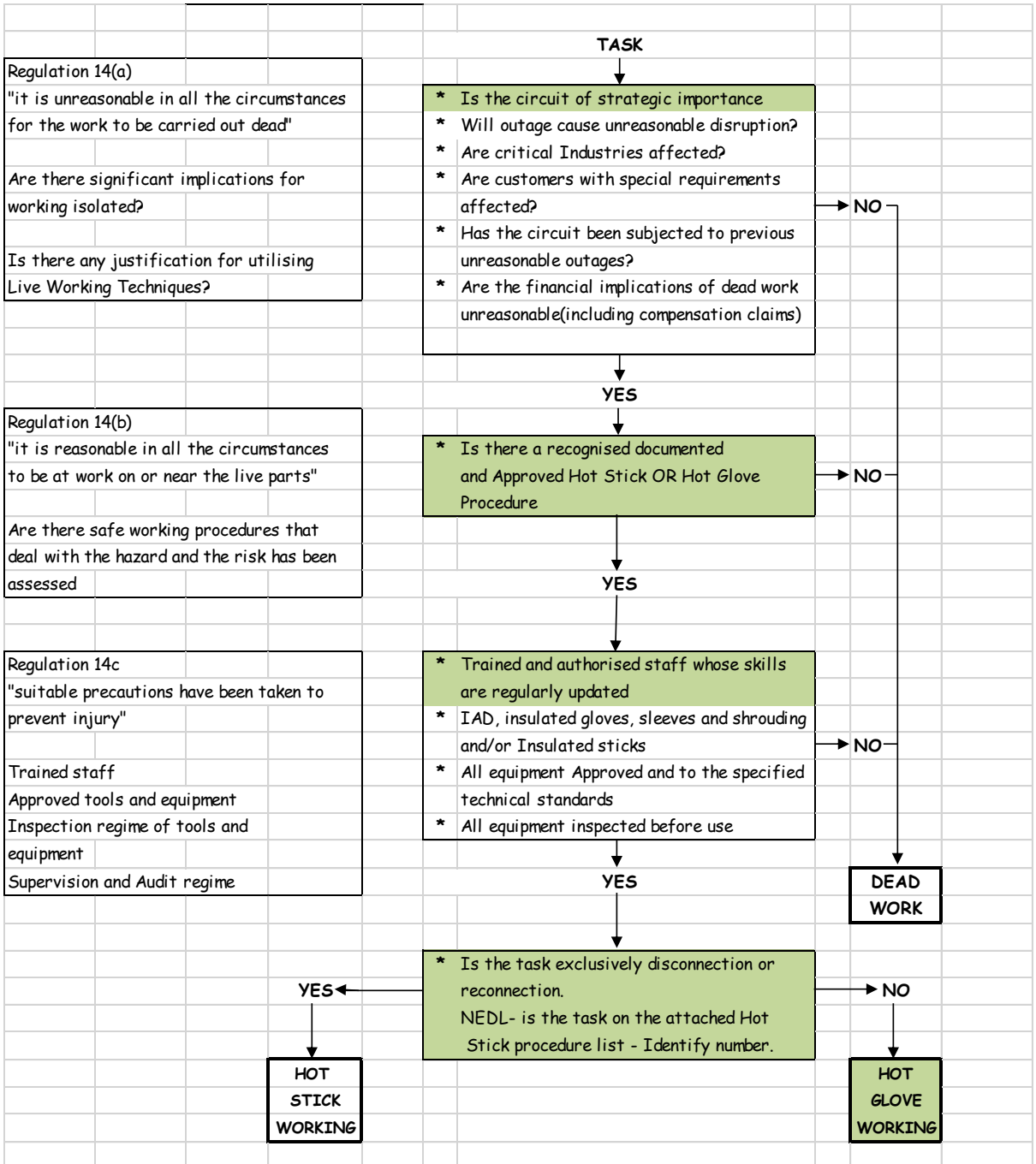
If this is not the case, then the RTTR model will return inaccurate results, possibly over-loading the line as result, and presents an opportunity to rectify records information and design models.

Figure 4 Installing On-Line Device using Hot Glove techniques

Where the on-line device includes a temperature probe, it is necessary to ensure that this is in good thermal contact with the conductor (removing any corrosion or dirt), following the manufacturer's instructions.

If the equipment has been prepared before installation, then it should be possible to verify that data is being collected and transmitted to the central systems whilst all staff are still on site. This greatly reduces the effort required to bring them back if there are any difficulties in obtaining satisfactory communications, or any component has been miss-installed by accident.

Appendix 1: Live Working Justification



Appendix 2: Live Work Procedure

Purpose

The purpose of this document is to define the procedure for installing and removing conductor mounted devices (CMD) from the basket of an IAD.

Scope

This document is applicable to Northern Powergrid.

Document Relationship

This document refers to a composite set of Codes of Practice which provide the salient and fundamental information in order to perform Live Work using the Hot Glove technique.

On-Line Device

The Company has a duty to maximise utilisation of its assets which includes operating the overhead line network at maximum efficiency. As such, devices may be installed on the network which provide, in real time, information such as monitoring conductor temperature and current flowing

Precautions

i) Refer to Code of Practice 03 - Principles and Precautions for generic requirements.

ii) The On-Line Device may be heavy and therefore requires proper control at all times.

iii) By installing the On-Line Device a suitable distance from the cross arm may obviate the need to shroud that area. However, it should not be installed too far away due to the weight of the device.

Preliminary

i) Refer to Codes of Practice 04, 05, 06, 07 and 08 for generic requirements.

ii) Hold tailboard conference and determine optimum position for Insulating Aerial Device be aware that the hinge of the On-Line Device means that it only opens on one side and good visibility of the work area is required.

iii) Consider the sequence of installation/removal and what shrouding is required to allow work to proceed safely. The sequence of covering may be different depending on the configuration of the construction e.g.: horizontal, wishbone, etc. The sequence below is an example of installation/removal for horizontal/flat configuration.

iv) All second points of contact within the work area shall be either relocated or shrouded and major hazards must be either eliminated or controlled.

Procedure

Installation of On-Line Device

Figure 5

i) In accordance with Code of Practice 07, install shrouding as required on the road/near phase followed by the centre phase or as determined during the tailboard conference.

ii) Prepare the On-Line Device for installation by unscrewing its centre conductor clamp and the two end clamps. Check to ensure the arrow moulded into the base of the On-Line Device is pointing down the feeder. If the direction of the source is not known then ensure all the arrows of each device point in the same direction on installation.

iii) The On-Line Device will become a 1st point of contact as soon as it touches the conductor. Maintain personal limits of approach and position the On-Line Device over the conductor as shown in Figure 5.

Note: care should be exercised so as not to over-reach.

Figure 7

Figure 6

iv) One operator should hold the unit to provide positive control whilst the other operator tightens the **centre** conductor clamp

Once the centre clamp has been secured, tighten the two end clamps (Figure 6) with similar pressure to the centre clamp.

Note: there is a torque limitation and these clamps should not be over-stressed. When tightening, screw up until finger tight pressure then rotate a quarter of a turn only.

v) Relocate to allow work on the centre phase.

vi) Remove superfluous shrouding and repeat the installation process.

vii) Relocate to allow work on the road (near) phase.

viii) Remove superfluous shrouding and repeat installation process.

Removal of On-Line Device

i) Commence with road (near) phase.

ii) Whilst one operator supports the monitor to provide positive control, the other should loosen first the two end clamps followed by the centre conductor clamp allowing the On-Line Device to be removed.

iii) Apply shrouding as required in accordance with Code of Practice 07 to road (near) phase.

iv) Repeat for centre phase installing shrouding as necessary.

v) Repeat for field (far) phase installing shrouding as necessary.

vi) Remove shrouding in reverse order of application.

For enquires about the project
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