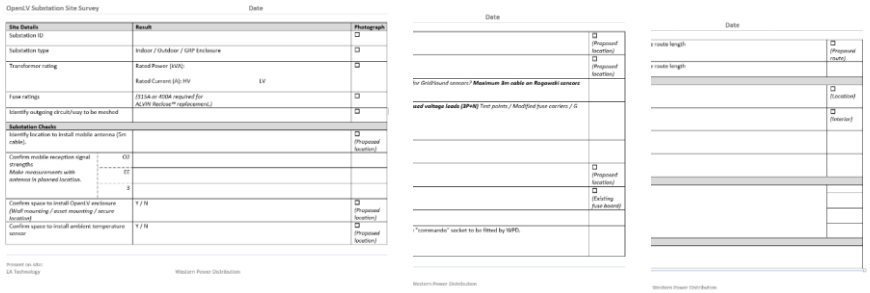
OpenLV Project Guidance for Site Surveys

The site surveys for the OpenLV Project are required to gather sufficient information about each investigated site to determine whether each pair of substations (deemed as 'one site') are:

- **Fully suitable for the trials;** this will be determined by the assets in each substation being capable of supporting all elements of the trial equipment, the network being capable of meshing the two substations and the mobile telecommunication networks being of sufficient strength to enable suitable communications.
- **Partially suitable for the trials;** this will be determined by the assets in each substation being capable of supporting the Intelligent Substation Device (ISD) and monitoring equipment along with suitable communication capability, but not able to support either the ALVIN Reclose™ devices or meshing of the network.
- **Unsuitable for the trials;** this will be determined if any one of the following requirements occurs:
    - the ISD cannot be installed;
    - the sensor equipment cannot be installed;
    - there is insufficient telecommunication capability to provide reasonable communications.

This guidance note details the required considerations as part of the site surveys, providing an explanation behind the requested information. If anything, not directly covered by this guidance, or the site survey form, is identified on-site that may have an impact on the project, please photograph and make notes in the comments section of the form.



The process for completing the form is detailed section-by-section below and allows for terminating the survey if appropriate. If an essential requirement is deemed non-viable, then further investigation of the location is futile; in this instance, record the findings and decision taken, then proceed to the next location planned for survey.

When undertaking each check, wherever possible photograph the item in question, the planned position for mounting equipment, and the cable routes agreed with the WPD representative. Where no WPD representative is present, details on the selected routes will be provided to WPD for approval prior to commencing installation work if the site is selected for equipment deployment.

Commented [RA1]: What if none present?

Site survey required materials

The following equipment will be required to undertake the survey:

- Appropriate PPE (Steel soled and toe-capped safety boots, arc flash protection overalls, gloves and safety glasses).
- Digital camera or smart phone (in both cases sufficient memory capacity should be available to enable photographs to be taken for all site surveys undertaken).
- D2377 4G Signal Analyser
- Understanding of the mounting requirements of:
  - Communications antenna.
  - Radiation shield.
- Understanding of the installation requirements / capabilities of:
  - GridHound CT.
  - Flexible Rogowski Coil.
- Dummy ALVIN Reclose™ device.
- Set of oil pocket test caps (or other means of determine thread size and type).

Photograph examples

External mounting of radiation shield.

External mounting of radiation shield and 4G network antenna.

LV Fuse board fitted with GridHound Sensors and Flexible Rogowski Coils.

ALVIN Reclose™ Unit.

Site survey completion

Always complete the date of the survey, and time of survey commencement. This will enable subsequent analysis of the site survey results to be more easily correlated against photographs taken.

Checks within the substation

The below tests require completing for each substation. If either substation fails the essential requirements, then the pair must be disregarded.

1. Record the substation ID on the form, recording all available identifiers. The current WPD substation identifiers we need are 6-digit numbers, as detailed in the 'Site Survey Tracking' spreadsheet; any alphanumeric identifiers still shown are legacy Midlands board numbers.

   Photograph the ID plate detailing the substation ID as the first photograph of the site-survey; all subsequent photographs will be for that site location.

2. Confirm the substation type. Differing arrangements will be required for the mounting of the equipment so determining the construction of the substation, (e.g. outdoor substation with brick walls, or outdoor substation with fencing), is critical.

   Select the type from the options and ensure sufficient photographs are taken to show the layout of the substation and construction arrangements.

3. Record the date and Time of start of survey. Also record the EA technology representative and the WPD representative on site.

4. Identify the best location for installation of the mobile phone antenna: as high up as possible, and away from large metal objects
   The maximum cable length for the antenna is 5m; bear this in mind whilst considering the location of the antenna and associated cable routes. Additionally, the antenna is of a dipole design, intended to be mounted vertically.

5. Confirm mobile reception suitability using the mobile reception scanner.
   - Attach the antenna to the scanner if not already connected, then place the antenna in a position as close as practicable to the location identified in step 4.
   - Follow the step-by-step instructions in the appendix "Signal Analyser Instructions" below to identify the signal strengths of the available mobile networks.

   Consider the required cable routing, reusing existing cable ducts and similar wherever possible.

   Proceed with following tests whilst waiting for the scan to complete.

   If the mobile reception is unusable on all networks, then the site survey can be halted as the location is unsuitable for the trials.

6. Confirm there is a suitable location for installation of the Intelligent Substation Device (ISD) enclosure and the GridKey MCU520.

   The GridKey MCU520 must be:
   - Within 3m cable run of where the voltage and power connections to the substation will be made.
   - Within 5m cable run of all current sensors although within 3m would be preferred.

   The MCU may be wall mounted or magnetically mounted onto a flat steel surface. If mounted outdoors, then the MCU must be mounted to a vertical surface in order to avoid water ingress.

   The ISD (OpenLV Enclosure) must be:
   - Within 5m cable run of the 4G antenna position.
   - Within 5m cable run of the outdoor temperature sensor position.
   - Within 5m cable run of the transformer temperature sensor position.
   - Mains and ALVIN data cables to the LV board and Ethernet to the MCU are also required but may be of any reasonable length.

   The ISD is capable of wall mounting or magnetic mounting onto a flat steel surface. The enclosure dimensions are 600x400x200 mm (HxWxD).
   - If mounted outdoors, then the MCU must be mounted to a vertical surface in order to avoid water ingress.
   - If ALVIN Reclose™ devices can be installed, then the isolation switch on the front of the ISD must be easily accessible and clearly visible when the enclosure is installed.

If no suitable mounting surface can be identified, then a free-standing floor stand can be used to mount either or both items if there is sufficient floor space.

If there is nowhere suitable for installation of the ISD enclosure, then the site survey can be halted as the location is unsuitable for the trials.

7. Installation of the ISD enclosure and MCU520 must not obstruct safe evacuation from the substation in the event of an incident.

   It must be determined that in the event of an incident within the substation, whilst the enclosure door is open, a safe means of quickly evacuating the substation remains viable. The total depth of the enclosure with the door open is 800mm.

8. Verify the suitability of the oil pocket for use within the trial.

   It is necessary to install a thermal probe into the oil pocket for monitoring of the transformer temperature across the duration of the trials.

   Identify the location of the oil pocket, (example pictures below, although there will be variation between transformers) and unscrew the protective cap.

   If there is no protective cap, draw this to the attention of the WPD representative on-site and photograph the status of the threads.

   Using a long cotton swab, sweep the inside of the oil pocket to determine the conditions of the interior; ideally it will be clean and dry.

9. Using the supplied 'test caps' compare the original pocket cap (if present) to those provided in the 'survey kit' and then attempt to screw the test caps to the oil pocket. Confirm which (if any) is able to be installed and photograph it in-situ.

   After this, remove the 'test cap' and replace the original one (if available).

   Confirm the ability, or otherwise, to install a temperature probe on the transformer.

   If the transformer is suitable for monitoring in the planned manner, it will have an accessible oil pocket, similar to that shown below.

Examples of transformer oil pocket & cap.

Transformer oil pocket with temperature probe installed.

10. Complete the Transformer Rating details on the form and take photographs of the name-plate. *It is likely that multiple photographs from different angles may be required and possible that photographs are unsuitable regardless.*

    Verify that photographs are usable / readable and if not, record all details from the name-plate in the comments section of the form.

    This information is required to input to fault level calculations that will be required if the site is selected for autonomous meshing operation, and to enable the thermal rating of the transformer to be calculated.

11. Identify the outgoing way, connecting to the partner substation.
    - Photograph the fuse board and ensure photographs specifically focussing on the identified feeder are included.
    - Make sure that the feeder way name plate is legible.

    This should be verified using the WPD Data Portal.

12. Check the fuse ratings on that feeder and record them in the form if possible to do so safely.

    Take photographs of the fuse values if possible and not already included in the photos taken for item 10.

    If the fuse ratings are not either 315A or 400A the site is only partially suitable as the ALVIN Reclose™ devices cannot be utilised to replace any other fuse value.

    If the fuse board is unsuitable for installation of ALVIN Reclose™ units, the site may still be usable in the project trials although cannot be utilised for active autonomous network trials. Therefore, the network-based checks (24 onwards), can be disregarded.

Commented [RA2]: Who does this for EA surveys?

Commented [TB3R2]: All four people have been provided with the portal details for requesting a login and accessing the system. The intention is that at least one person in each pair will be au-fait with the system.

Commented [RA4]: I don't think this will be safely possible for EA teams where enclosed fuse holders are used. Can we get this data from the WPD Data Portal as well?

Commented [TB5R4]: No, we can't get it from the portal, I'd intended they only get it if possible and will re-word. Some of the sites I've been to I've been able to identify the fuses from taking a photograph along the front of the board – it depends entirely on the fuse carriers and board design.

13. Determine whether it is possible to install the ALVIN Reclose™ devices in the fuse board. If not, the site is only partially suitable.

    The dummy ALVIN Reclose™ device can be utilised to determine if they will fit on the fuse board.

    - The board must have 92mm fuse holders – 82mm or 76mm boards are unsuitable.
    - If the LV board is an enclosed type located outdoors, then it must be possible to shut the board doors with the ALVIN Reclose™ device installed.
    - Deeper doors to accommodate ALVIN Reclose™ devices are available from WPD for some LV boards.
        - WPD have provided the following information in relation to deeper LV board doors:
          "Schneider confirm that they already have "deep" door designs for all of their shielded cabinets. The shielded units are the ones with the white plastic covers and phase barriers, made by EMMCO or their successors from around 1990 onwards. The doors can be quickly made to order as required."
    - Alternatively, where the LV board is located indoors (within a locked building) then the LV board doors may be left open to accommodate the ALVIN Reclose™ devices.

    If the fuse board is unsuitable for installation of ALVIN Reclose™ units, the site may still be usable in the project trials although cannot be utilised for active autonomous network trials. Therefore, the network-based checks (23 onwards), can be disregarded.

14. Confirm the best location for installation of the ambient temperature radiation shield.

    The radiation shield should be located in a position that best meets these characteristics:

    - Good air circulation around shield.
    - Away from large masses (buildings, masts, solar panels) especially metal items.
    - Away from exhaust vents, electrical machinery and motors.
    - Away from water fountains and sprinklers.

    Furthermore, that maximum cable length from the ISD enclosure must be no more than 5 metres.

    Consider the required cable routing, reusing existing cable ducts and similar wherever possible. Cable lengths for the planned routes should be measured and detailed.

15. Determine if an indoor air temperature sensor is required.

    For outdoor substations, no sensor is required. If the transformer is located inside a building or cubicle then a sensor must be installed to measure the air temperature the transformer operates in.

Commented [RA6]: We need to know which ones!

16. Confirm ability to install current sensors (either Rogowski coils or GridHound CTs) around the transformer tail or the LV busbars.

    It is necessary to determine the total load on the transformer for the purposes of calculating the real time thermal rating (RTTR) of the transformer. The options, in order of preference are:
    a. Current sensors fitted around transformer tails (note this is often not possible where multiple cables per phase are used).
    b. Current sensors fitted around LV busbars between the transformer links and the first outgoing fuseway.
    c. Current sensors fitted around all outgoing feeders (maximum 5 ways) and calculate the total load.

    It is essential that the current in each phase is measured. It is desirable, but not absolutely essential, to directly measure the neutral current as well.
    Cable lengths for the planned routes should be measured and detailed as well.

17. Confirm ability to install current sensors (either Rogowski coils or GridHound CTs) for the outgoing way (identified in stage 11).

    The options, in order of preference are:
    a. Rigid GridHound CTs around the cores of the outgoing cable (up to 300mm^2 waveform).
    b. Flexible Rogowski coils around the cores of the outgoing cable.
    c. Flexible Rogowski coils around the fuse carriers on the board.

    All sensors on a single feeder way must be of the same type.
    It is essential that the current in each phase is measured. It is desirable, but not absolutely essential, to directly measure the neutral current as well.
    Cable lengths for the planned routes should be measured and detailed.

18. Determine the cable route for the network cable between the ISD enclosure and GridKey MCU520. The network cable length required must be measured so that the correct length cable can be supplied.

    Measure the cable route, and photograph.

19. Determine how the 3-phase voltage connection to the GridKey MCU520 will be obtained. The options, in order of preference are:
    a. Modified fuse carriers with dummy fuses fitted installed on a spare way in the LV board.
    b. G-clamps fitted to the LV bus bars.
    c. Modified fuse carriers with standard fuses fitted installed on a used way in the LV board. The selected way must be back fed during installation to maintain supplies.

    In all cases fused connection leads will be utilised, with a G clamp for the neutral connection.

20. The planned and preferred method for powering the ISD enclosure is the temporary installation of a 2-way socket splitter on an extension lead. This enables easy decommissioning at the end of the project whilst still providing a 3-pin, 13A plug socket within the LV pillar.

    Detail within the form the cable route of the extension lead and required length of extension lead. The cable length from the 2-way socket to the ISD must be measured so that the correct length ISD mains cable can be supplied.

21. Determine the cable route for the mains supply to the 2-way extension socket location identified above. The cable length from the 13A plug to the 2-way socket must be measured so that the correct length extension lead can be supplied.

    Measure the cable route, and photograph all key points of note.

22. Ensure the photographed name plate of the transformer is clearly legible. As a minimum record the values listed: Vector Group, Impedance, Power, Earthing Arrangement, Earthing resistor / reactor value.

23. Where available take a clear photo of the substation SLD. Ensure all values listed on the drawing are legible references to CT ratios and protection settings.

24. Where available on site try and obtain as much information about the HV cable specification and lengths as possible

    If markings on the cable are visible, try to obtain a clear picture of them.

25. Where available on site try and obtain as much information about the LV cable specification and lengths as possible.

    If markings on the cable are visible, try to obtain a clear picture of them.

26. Obtain as much information as possible relating to the protection scheme implemented on site. Pay particular attention to the Relay type, cortec codes if available, associated CT ratio and the settings.

    Where mechanical relays are used, photographing the relay should provide all the required information.

    Where electronic relays are used within the substation then assistance from the WPD engineers on site might be required to interrogate the relay to determine the protection settings used.

27. As previous step

28. As previous step, recording the LV Feeder settings in this instance. Where ALVIN Reclose™ units are installed record the setting of each ALVIN Reclose™ installed and serial number where possible.

Checks on the LV Network

If both substations in a given pair prove viable for use in the trials, including the ability to deploy ALVIN Reclose™ devices, the network checks must also be undertaken.

29. Locate the NOP between the two substations.

    On locating the NOP, photograph the asset, and ensure to include sufficient surrounding area to readily locate it again in future if the location is not immediately obvious as some chambers can be located in out of the way locations.

30. The NOP must be verified to be in an acceptable condition for closing the links between the two adjacent networks.

    Importantly, closing the links between the network must not be undertaken as part of these checks. It is only required to confirm that the asset is in a usable condition.

    Specifically, it should be verified that the NOP is not flooded, is not subject to corrosion or any other reason that would preclude the OpenLV Project from proceeding on the network in question.

    If issues are identified that would need to be rectified as part of routine maintenance procedures, detail the required work and photograph the elements requiring resolution.

31. A WPD representative is required to verify the phases on either side of the link box can be inter-connected.

    If the survey is underway without WPD representation, flag this location as requiring a follow-up visit by WPD to verify network phasing and suitability for the full trial deployment.

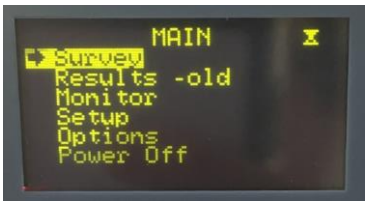
32. Finally, the depot staff for an area will know the local network, particularly known trouble spots, and any information they can provide about the local network should be detailed here.

    We would prefer to not be utilising a network known to experience regular faults as whilst the ALVIN Reclose™ system was originally designed to handle situations like this, it will adversely affect data gathered by the project.

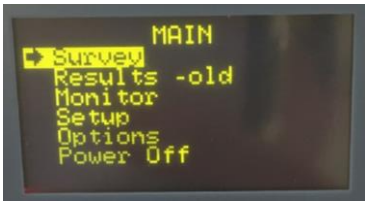
Signal Analyser Instructions

The signal analyser and attached antenna are shown here. Instructions are provided below with the analyser's screen shown for each stage.

Analyser turned off.
Press and hold power button until screen activates.



The device will process through a boot sequence, and pause on this screen; once the hourglass symbol vanishes, the device is ready to commence the test.



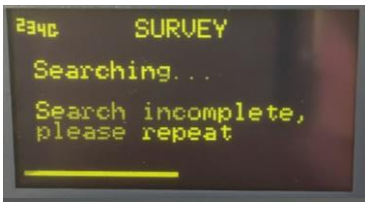
The 'Survey' option should be selected, if not, move the bar using the up / down arrows then press the 'Enter' (right) arrow button.

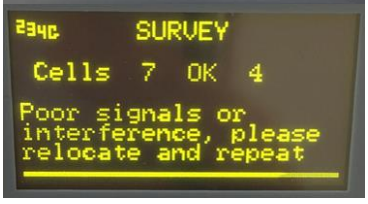
The ‘All’ networks option should be selected, if not, move the bar to select then press ‘Enter’.

You will be presented with this screen; press ‘Enter’.

You will be presented with this screen initially……

….transitioning to a screen like this as the scan progresses.





Alternatively, you may be presented with either of these messages, if so, restart the survey.

If the same message is repeated after a couple of attempts, relocate the antenna to an alternative location and repeat the test.

If an alternative, viable location cannot be identified, there are insufficient communications to consider the location viable for the trials.

A successful scan will result in a screen similar to this.

Press the 'down' arrow.

You will then be presented with a high-level summary of the available networks.

We are only interested in the EE, O2 and 3 mobile networks.

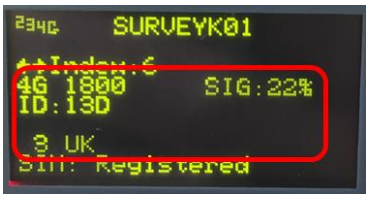
Record the % for each of these networks on the form.

Press 'Enter'.

You will then be presented with a high-level summary of the available mobile cells.

Record the % for each of these cells on the form.

Press 'Enter'.



You will then be presented with a detailed analysis of each mobile cell.

Press 'Enter' until you find a cell for one of those networks, and record the following:

- Mobile network
- 4G / 3G / GSM
- ID
- SIG Strength

Check all analysed cells and record this information for the relevant networks.

- GSM cell IDs will be a decimal number.
- 3G and 4G cells will be a hexadecimal number.

A signal strength of 33% or higher is considered usable.

The system requires at a minimum, a usable 3G network for the trials.