WESTERN POWER DISTRIBUTION

INNOVATION

NEXT GENERATION NETWORKS

Airborne Inspection Phase 1

Project Closedown Report

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Glossary

Abbreviation	Term
Business As Usual	BAU
Distribution Network Operator	DNO
Work Package	WP

Executive Summary

Existing helicopter overhead line inspections mainly rely on the observer to visually assess the line to identify defects. This project aimed to examine the usage of modern sensors and cameras that could provide the data required, to be able to perform automatic line condition assessments and defect reporting. Such a system could provide a more efficient inspection style over a greater length of network resulting in cost savings and improved network reliability.

The work was split into two Work Packages. Through observing a number of WPD overhead line inspection sorties, Work Package 1 assessed and determined the nature and extent of the workload of the operators conducting visual inspections. Work Package 2 then provided recommendations for the setup of the helicopter-mounted sensor by examining the suitability of different types of sensors to detect defects and assessing how the sensor data and asset information can be integrated.

The recommendations made as part of this project were used in order to procure, install and trial a suitable camera as part of WPD's Business As Usual Activities. The data collected from the flight trials will be used in a further innovation project in order to analyse it, examine the integration of existing asset information with the data and perform automatic defect identification.

1 Project Background

Currently, helicopter based overhead electricity line inspections rely on the observer visually (either directly or through cameras) assessing the line and documenting their findings with any significant issues relayed back to the local maintenance team for rectification on return to base.

The availability of much improved sensors together with image recognition and wider system integration (Asset records, GIS, GPS, etc.) means that there is now scope for a much more efficient inspection style over a greater length of network resulting in cost savings and improved network reliability.

This project aimed to produce recommendations for a helicopter based system which could provide the data required to be able to perform automatic line condition assessments and defect reporting.

2 Scope & Objectives

Distribution Network Operators have statutory duties under the Electricity Safety Quality and Continuity Regulations 2002 to maintain its system in a safe condition and to undertake an assessment of the risk of unauthorised access, interference or vandalism. Regular inspection and subsequent condition based maintenance also reduces customer interruptions. By improving the existing helicopter based inspection regime, cost savings in a number of areas can be achieved together with an improvement in network performance.

This project has assessed the existing sensing capabilities and made recommendations for a helicopter based system which can provide the data required to be able to perform automatic line condition assessments and defect reporting.

Objective	Status
Identify the optimum helicopter mounted sensing system which will enable long range data acquisition in the most operator friendly manner. The system should be able to present data in a format which can be integrated with other technologies and also used within analysis software.	✓

3 Success Criteria

Success Criteria	Status
Production of a firm recommendation for the helicopter mounted sensor setup.	✓

4 Details of Work Carried Out

This project aimed to produce recommendations for a helicopter based system which could provide the data required to be able to perform automatic line condition assessments and defect reporting.

The project consisted of 2 Work Packages:

- Work Package 1 assessed and determined the nature and extent of the workload of the operators conducting visual inspections.
- Work Package 2 produced recommendations for the setup of a helicopter-mounted sensor. More specifically, it examined the suitability of different types of sensors to detect defects and assessed how the sensor data and asset information can be integrated and whether asset condition can be reported in real-time back to interested parties on the ground.

5 Outcomes

Work Package 1 focused on assessing and determining the nature and extent of the workload of the operators conducting visual inspections.

As a part this, Scimitar staff flew in 3 overhead line inspection sorties with WPD, in order to understand the workload associated with inspection activities and collect information about the operating environment and the procedures currently followed. Additionally, the nature of asset defects was examined to understand the different types of asset defects. The following conclusions were made from Work Package 1:

- The design of the sensor setup should explore the potential to reduce levels of frustration experienced by the crew during the defect capture and risk assessment tasks.
- It is recommended that in the flight trials, procedures that could reduce crew frustration are explored.
- The analysis of the flight trial data should assess the crew frustration levels before and after the trials.
- The design of the sensor setup should consider how the workload of the observer could be reduced.
- Sensor management, task management and wider sortie management should be integrated as much as possible in the design of the sensor setup.
- In order to ensure that the workload management is as efficient as possible, it is recommended that in the flight trials the potential for tasks to be transferred between Observers and Pilots is explored.
- Since the crew were experiencing the highest workload during 132kV sorties, it is recommended that the flight trials explore the potential for modern mission-management tools to simplify sortie management and reduce workload.
- The observer should be able to operate the sensor, perform risk assessment, navigate and perform sortie management tasks through one interface during the flight trials.
- The sensor that will be used in the flight trials should be able to detect defects at ranges beyond those of the naked eye.
- The design of the sensor setup should consider the provision of equipment that could assist the observer with maintaining an “eyes-out” (enabling the observer to have full visibility of their environment) survey capability whilst conducting other non-survey tasks.
- The observer should be assisted to maintain an effective and efficient visual survey by using technology that allows them to have full visibility of their environment.
- It is recommended that the design of the sensor setup includes provision of sortie/mission management system that supports a shared understanding of factors impacting sortie conduct.

- The flight trials should include activities that explore the benefits of a sortie/mission management system that could result in an improved, shared understanding of factors affecting sortie conduct.

Work Package 2 produced the following recommendations for the helicopter-mounted sensor:

- It is recommended that the flight trials explore the benefits and burdens associated with detecting defects across multiple sensor bands.
- In the design of the sensor setup tools that support image enhancement should be considered.
- It is recommended that the flight trials exclude activities to explore the extent to which image enhancement techniques improve (or otherwise) the detectability of identified defects.
- The flight trials should include activities to explore the impact of viewing aspect on the detectability of identified defects, so as to inform the identification and development of optimal survey profiles.
- The utility of IR and UV wavebands against small defects at both long and short range should be explored the flight trials.
- The usage of OFIL DayCor Rom or SWE Systems Quad-400 should be considered.
- Empirical data related to defect signatures should be collected in the flight trials.
- It is recommended that the flight trials explore the benefits and burdens of turret operations using flights profiles of increasing stand-off range.
- The efficacy of presenting multiple sensor imagery to the observer should be explored in the flight trials.
- The design of the sensor setup should include the provision of a helmet mounted display.
- It is recommended that any activity to upgrade the EMU (Air) laptop should be cognisant of the recommendations and observations made, including mission management system hosting and docking/interface requirements to the platform.
- It is recommended that the BAE Systems Q-Sight should be integrated into the EC135 helicopter and flight tested in flight trials.
- An appropriate screen should be integrated with the turret and mission management system and tested in flight trials.
- It is recommended that the Cartenav mission management system hosted on a GETAC X500 ruggedised laptop computer, docked and interfaced with centre-console-mounted Keyboard/Cursor Control Unit, and hosting mission, mapping and turret interface software, be integrated into the EC135 and flight tested for Work.
- It is recommended that in the flight trials an activity should be included to explore the benefits and burdens associated with the transmission, ingestion, analysis and presentation of full motion video via a modern video streaming/analytics toolset.

- The image detail required to support network survey operations should be explored in flight trials.
- The flight trials should include activities to establish the actual bandwidth burdens associated with the transmission of full motion video in the powerline survey context.
- It is recommended that in the flight trials, the Evenlode datalink system, produced by Enterprise Control Systems should be employed.
- The flight trials should include activities to explore the benefits and burdens associated with the transmission of priority reporting, post-sortie summary reports and full motion video to a surrogate operating base, from incrementally increasing ranges.
- It is recommended that the flight trials should include activities to explore the issues associated with the format of priority reporting, post-sortie summary reports and full motion video, in order to make subsequent recommendations on how they might be constructed operationally.
- The utility of near real time priority reporting, post-sortie summary reports and full motion video should be explored in flight trials.
- It is recommended that flight trials should explore the relative merits of constant false alarm rate and defect characteristic filtering.
- The relationship between sensor-defect geometries required for automatic detection and the sensor-defect geometries required for visual detection should be explored in flight trials.

6 Performance Compared to Original Aims, Objectives and Success Criteria

Objective	Status	Performance
Identify the optimum helicopter mounted sensing system which will enable long range data acquisition in the most operator friendly manner. The system should be able to present data in a format which can be integrated with other technologies and also used within analysis software.	✓	The OFIL DayCor and the SWE Systems Quad-400 sensor have been identified as suitable sensor technologies.

Success Criterion	Status	Performance
Production of a firm recommendation for the helicopter mounted sensor setup.	✓	The BAE Systems Q-Sight helmet mounted display and the Cartenav mission management system hosted on a GETAC X500 ruggedised laptop have been recommended for the helicopter mounted setup.

7 Required Modifications to the planned approach during the course of the project

The project would initially consist of another 4 Work Packages:

- Work Package 3 would design, produce and install the selected sensor to WPD's helicopter.
- Work Package 4 would involve the flight trials that would demonstrate the real-time defect detection and reporting.
- Work Package 5 would perform the analysis of the data obtained from the flight trials in Work Package 4 to assess the performance of the sensor.
- Work Package 6 would involve 5 days of demonstrations to show the integration of existing asset information with camera data, automatic defect identification and "in air" data transfer.

The planned approach was changed to remove the above Work Packages from the scope of the project due to the fact that only 2 suitable cameras had been identified in Work Package 2.

Therefore, it was decided that it was appropriate to deliver the procurement of the camera, its installation and flight trials as part of Business As Usual (BAU) activities. Work Packages 5 and 6 will be delivered as part of a future innovation project.

8 Significant Variance to Cost and Benefits

Activity	Budget	Actual
WPD Project Management	£25000	£15715
2EXCEL WORK PACKAGES 1 & 2	£115000	£115000
Total	**£140000**	**£130715**

The small variance in the costs is due to the fact that less time was spent on the project than originally expected.

9 Lessons Learnt

One of the main learning points obtained from the project is the fact that there are not as many sensors or camera setups available suitable for the helicopter mounted setup as originally expected. Work Package 2 identified only two suitable technologies, which meant that it was more appropriate for the procurement of the camera, its installation and flight trials to be delivered as part of BAU activities. As a result, a further innovation project will be undertaken that will analyse the data collected from the flight trials and examine the integration of existing asset information with the data and perform automatic defect identification.

Additionally, from Work Package 1, it was recognised that it was very important to ensure that the sensor setup is designed such that the crew frustration levels are kept to a minimum and the workload of the observer is reduced. Recommendations have been made to ensure that this is succeeded.

10 Planned Implementation

A further innovation project will be undertaken in the future which will have the following deliverables:

- The analysis of the data obtained from the flight trials to assess the performance of the sensor.
- Usage of the data obtained from the flight trials to examine the integration of existing asset information with the data.
- The development of automatic defect identification using the data collected from the flight trials.
- Demonstrations to show the integration of existing asset information with camera data and automatic defect identification.

11 Facilitate Replications

There is no requirement to replicate the project.

12 Contact

Further details on replicating the project can be made available from the following points of contact:

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