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**Appointed examiner's audit of Exceptional Event Claim -
UK Power Networks (Eastern)
132kV incident – Warley Grid
21 July 2015**



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Glossary

Abbreviation	Meaning
AE	Appointed Examiner
CB	Circuit-breaker
CEGB	Central Electricity Generating Board
CI	Customer Interruptions per 100 connected customers
CML	Customer Minutes Lost per connected customer
CT	Current transformer
DNO	Distribution Network Operator
EF	Earth fault (a type of protection scheme)
ENA	Energy Networks Association
ep	energypeople (Ofgem's Appointed Examiner)
EPN	UKPN's Eastern Power Network licensed area
ESQCR	Electricity, Safety, Quality and Continuity Regulations
IDMT	Inverse Definite Minimum Time (a type of protection relay)
OC	Overcurrent (a type of protection scheme)
QoS	Quality of Service
NEDeRS®	The ENA's National Equipment Defect Reporting Scheme
RIGs	Regulatory Instructions & Guidance
SCADA	Supervisory Control and Data Acquisition
SI	Short Interruption
SLD	Single Line Diagram
SoF	Statement of Facts
TM	Time multiplier (as related to a protection relay setting)
ToR	Terms of Reference
UKPN	UK Power Networks

Notes:

Within this document:

1. The term "higher voltage" is used to indicate all voltages greater than 1kV.
2. The calculations of CI and CML within this document are adapted from the annual calculations contained in the RIGs to reflect the CI and CML generated by the actual incidents being audited.

They are as follows:

CI: the number of interruptions to supply – the number of customers interrupted per 100 connected customers generated by the incidents being audited.

It is calculated as:

$$CI = \frac{\text{the sum of the number of customers interrupted for incidents being audited} * 100}{\text{the total number of connected customers}}$$

CML: the duration of interruptions to supply – the number of customers interrupted per connected customer generated by the incidents being audited.

It is calculated as:

$$CML = \frac{\text{the sum of the customer minutes lost for all restoration stages for incidents being audited}}{\text{the total number of connected customers}}$$

In both the formulae above, the total number of connected customers is as declared as at 30 September during the relevant reporting year. Any claims that occur and are audited prior to 30 September in the reporting year during which they occur will be audited using the total number of customers declared at 30 September in the previous reporting year.



Summary

1. Ofgem has commissioned energypeople as its Appointed Examiner (AE) to audit the submission made by UK Power Networks (UKPN) under the "one off" exceptional event mechanism that an incident which affected its 132kV outfeeds from its Warley Grid Substation at 16:16 on Tuesday 21 July 2015 adversely affected the reported performance for its Eastern Power Networks (EPN) licensed area for the reporting year 2015/16.
2. The AE has visited EPN to audit the claim against part 1 of the "one-off" exceptional event process and finds that it passes the exceptionality threshold in terms of both CI and CML.
3. The AE concludes that the event falls within the category of an "other event" as defined in paragraph 2D.34 of Special Licence Condition CRC 2D, including meeting the exceptionality requirements set out in Appendix 3 thereof.
4. The AE therefore proceeded to part 2 of the "one-off" exceptional event process, assessing EPN's performance in mitigating the impact of the event upon its customers.
5. The AE concludes that EPN's inspection and maintenance programme for its equipment at its Warley Grid Substation is consistent with good practice and was up to date at the time of the incident; UKPN would therefore have no reason to doubt the reliability of its equipment.
6. The AE also concludes that, whilst UKPN has declared it had no formal record of a risk assessment for the cable support structure involved in this incident, the evidence provided by UKPN shows it to be a robust structure that would be classified as a low risk.
7. Hence, without any prior incidents affecting it, UKPN would have no reason to doubt the safety of its 132kV cables supported by the structure.
8. The AE commends EPN's control engineers for analysing the alarms generated by the incident and for restoring all supplies as quickly as possible.
9. The AE concludes that EPN had met the criteria of Appendix 4 to paragraph 2D.35 of Special Licence Condition CRC 2D and that the incident therefore is deemed to be eligible for adjustment in the DNO's reported performance.
10. The AE recommends that an adjustment to EPN's 2015/16 reported distribution system performance is made, in line with the part 1 audited CI and CML figures as shown in the following table:

	Audited number	Number above the threshold	Recommended adjustment
CI	3.78	3.08	3.08
CML	0.69	0.13	0.13



1 Audit part 1

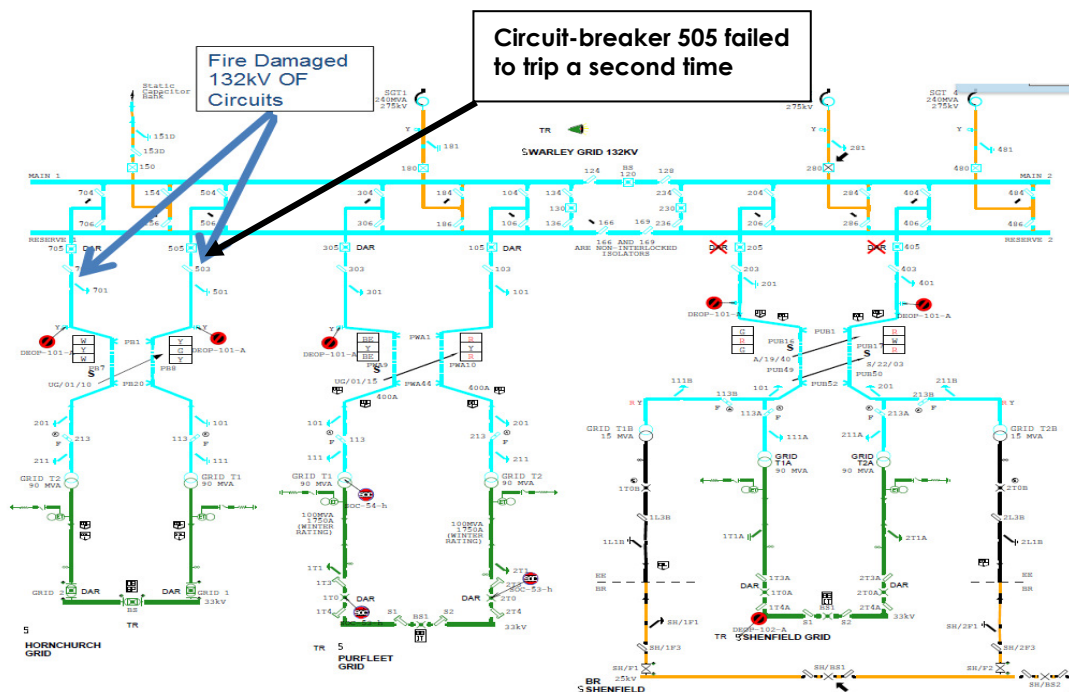
1.1 Summary of the main facts

11. The AE's headline information log for this event is set out in Table A-1 at Appendix A. In addition, the following paragraphs summarise the main facts of the event.
12. EPN's 132kV distribution system affected by this incident was running normally when the incident occurred.
13. The direct cause of the incident is cited to be arson¹ when a fire, immediately under an enclosed cable structure, caused EPN's two fluid-filled cables within it to melt, resulting in the cable fluid fuelling the fire and the cables faulting.
14. The two cables form the 132kV infeeds from EPN's Warley Grid Substation to its Hornchurch 132/33kV Grid Substation.
15. Warley Grid Substation has three super-grid infeeds. Due to fault levels at the site, two of the super grid transformers are on load and the third is on hot standby.
16. The 132kV circuit-breakers at Warley Grid Substation are of the 'air-blast' type which are operated by pressurised air.
17. At 16:16 on 21 July 2005, EPN's measurement and reporting systems indicate that the fire at the cable support structure had affected the number one 132kV circuit;
 - EPN's unit protection operated to de-energise the circuit;
 - The auto-reclose feature operated to reclose the circuit-breaker at Warley Grid Substation;
 - Despite EPN's unit protection 'seeing' the fault for a second time, the 132kV circuit-breaker (n° 505) at Warley Grid Substation failed to trip: UKPN's systems indicated that this was due to low air pressure; and
 - The back-up protection on the 132kV-sides of the two on-load super grid transformers operated to clear the incident, thereby de-energising the 132kV busbars at Warley Grid Substation.
18. Consequently, 132kV infeeds were lost to BR Shenfield and to EPN's Hornchurch, Pufleet and Shenfield 132/33kV Grid Substations.
19. Seventeen of EPN's Primary Substations fed from these three Grid Substations lost their 33kV infeeds.
20. Supplies to 137,501 of EPN's customers were interrupted.
21. EPN's sequence switching restored supplies to 2,102 of these customers within three minutes.
22. At 16:26, following tele-controlled switching of the 132kV circuit-breakers at Warley Grid Substation; supplies were restored to the 44,156 of EPN's customers supplied from its Shenfield 132/33kV Grid substation and to BR Shenfield.

¹ See the article in the "Guardian" Newspaper at web-link <https://www.theguardian.com/uk-news/2015/jul/24/school-leavers-burning-books-power-cuts-across-essex>; and See the article in the "Telegraph" Newspaper at web-link <http://www.telegraph.co.uk/news/uknews/law-and-order/11760855/School-children-burning-books-at-end-of-term-cause-135k-homes-to-lose-power.html>

23. At 16:41, tele-controlled switching re-energised the number 2 132kV infeed to Hornchurch Grid Substation, restoring supplies to 25,537 of EPN's customers fed from its Elm Park and Hornchurch Local Primary Substations.
24. At 16:44, further tele-controlled switching restored supplies to 13,912 of EPN's customers fed from its Purfleet 132/33kV Grid Substation.
25. Supplies to EPN's 51,794 other customers affected by this incident were restored by EPN's control engineers using tele-controlled switching on the 33kV and 11kV networks.
26. At 17:05 the fire had damaged the number two 132kV cable to such an extent that its controlling 132kV circuit-breaker (705) operated to de-energise the circuit, resulting in re-interruptions to EPN's 25,537 customers fed from its Elm Park and Hornchurch Local Primary Substations.
27. EPN's control-engineers used tele-controlled switching on the 11kV network to restore these re-interrupted customer supplies.
28. EPN was alerted to a fire affecting its equipment in Hacton Lane Upminster by the London Fire Brigade.
29. EPN's personnel on site confirmed it was the two 132kV infeeds to EPN's Hornchurch Grid Substation that were affected.
30. As noted above, the fire is cited as being due to arson.
31. Taken from EPN's SoF, a simplified view of the section of EPN's 132/33kV network affected by this incident is shown in Figure 1.
32. EPN's network was running normally at the time of the incident;

Figure 1 – Simplified Network Diagram of EPN's 132/33kV distribution system affected by the incident



Notes:

1. Hornchurch Grid Substation feeds four Primary Substations;
2. Purfleet Grid Substation feeds seven Primary Substations;
3. Shenfield Grid Substation feeds six Primary Substations; and
4. EPN's control engineers used tele-controlled switching to restore supplies.

2 Exceptionality requirements

2.1 Does the event qualify for exclusion

33. The AE considers that the event falls within the category of an “other event” as defined in paragraph 2D.34 of Special Licence Condition CRC 2D, and meets the exceptionality requirements set out in Appendix 3 thereof.
34. The AE therefore considers that, subject to satisfying the requirements of Appendix 4 to paragraph 2D.35 of Special Licence Condition CRC 2D, the event qualifies for possible exclusion under the “one-off” exceptional events process.

2.2 Exceptionality test results

35. The number of incidents attributed to the event is shown in Table 1.

Table 1 – The number of incidents attributed to the event

Number of incidents attributed to the event	Claimed number	Audited number
132kV	1	1
EHV	0	0
HV	0	0
LV	0	0
Total	1	1

36. The results calculated by the AE to test this claim against Ofgem's exceptionality criteria are shown in Appendix A. A summary of the results is shown in Table 2.

Table 2 – Summary of exceptionality test results

Test	Threshold	Number in SoF	Audited number	Pass / Fail	Amount above threshold
CI exceptionality	0.70	3.78	3.78	Pass	3.08
CML exceptionality	0.56	0.69	0.69	Pass	0.13

Notes:

1. Ofgem's CI and CML exceptionality criteria are set out in the AE's ToR².
2. The audited CI and CML used in the exceptionality test have been determined from the number of incidents attributed to the event.
3. Where the event passes either or both the exceptionality thresholds, the amount(s) above the threshold(s) is/are carried forward into the Audit part 2 assessment of DNO performance.
4. In accordance with guidance from Ofgem, the AE's calculations use the threshold values contained in the current Distribution Price Control and the number of customers connected to the DNO's network relevant to the date on which the incident occurred.

² Audits of Electricity Distribution Network Operators' one-off Exceptional Events Claims for 2015/16 to 2018/19



3 EPN's views of its performance

3.1 Dealing with the incident

37. The 33kV switchboard at EPN's Hornchurch Grid Substation is supplied by two 132/33kV transformers fed via 132kV circuits from EPN's Warley Grid Substation.
38. The sections of these circuits in Hacton lane, Upminster are underground fluid-assisted cables which cross the Ingrebourne river in a fully-enclosed steel-clad support structure.
39. EPN's distribution system affected by this incident was running normally at the time.
40. Immediately prior to the loss of supplies, EPN's circuit-breaker, 505, controlling the number one 132kV circuit to Hornchurch Grid had tripped on unit protection.
41. Circuit-breaker 505 reclosed but, despite the protection again detecting the fault, it failed to trip a second time.
42. Consequently, at 16:16 on 21 July 2015 the back-up protection on the two on-load supergrid transformers at Warley Grid substation operated, thereby de-energising the 132kV busbars at Warley Grid Substation and the infeeds to BR Shenfield plus three of EPN's 132/33kV Grid Substations: Hornchurch, Purfleet and Shenfield.
43. EPN considers its back-up protection operated correctly to clear the incident from its system.
44. 2,102 of EPN's customers experienced a short-interruption to their supplies.
45. The supplies to the other 135,399 of EPN's customers affected by this incident were restored by EPN's control engineers using a combination of tele-controlled and manual switching.
46. The restoration of supplies to EPN's Elm Park and Hornchurch Local Primary Substations was effected by re-energising the number two 132kV infeed to its 132/33kV Hornchurch Grid Substation.
47. However, at 17:05 the fire had damaged the number two circuit to such an extent that its controlling circuit-breaker, 705, tripped, resulting in re-interruptions to EPN's customers fed from EPN's Elm Park and Hornchurch Local Primary Substations.
48. EPN considers that its duty control engineers reacted well in assessing the alarms generated by the event and restoring supplies via tele-controlled switching on the 33kV and 11kV networks.
49. EPN also considers its control engineers did well in liaising with National Grid's control to re-energise the 132kV busbars at Warley Grid Substation, thus enabling EPN's control engineers to restore the 132kV infeeds to its three 132/33kV Grid Substations affected by the incident and to BR Shenfield.
50. Following a call from the London Fire Brigade, the cause of the incident was confirmed to be due to a fire having been started in the confined space below the cable support structure in Hacton lane, Upminster, catching the undergrowth alight and resulting in the damage to the two fluid-filled cables.



3.2 EPN's answers to questions on its performance

51. Within the last four years, the AE has reviewed EPN's design standards, construction methods and maintenance procedures during previous visits to audit exceptional event claims and found them fit for purpose.
52. The AE confirms that EPN's emergency procedures provide for the type of event being examined here.
53. To aid understanding of the background to EPN's Statement of Facts (SoF), the AE prepared a list of initial questions regarding this incident. These questions were used as the basis for the examination of UKPN's claim.
54. The initial questions were discussed during the AE's visit to UKPN's Control Centre on 24 May 2016, when the records of EPN's SCADA system, the incident report and other information were made available.
55. EPN has provided answers to the AE's initial list of questions. For ease of reference, the AE's questions are printed in bold font with EPN's answers being printed in normal font.

Q1. What, if any, changes has UKPN made to its emergency plans and procedures since the Appointed Examiner (AE) last visited to audit the one-off exceptional event (OOEE) claim concerning the incident affecting UKPN's 132kV infeeds to its Fleethall Grid Substation that occurred on 11 October 2014?

- A1. Other than UK Power Networks routine review of process and procedure documentation, there have been no significant changes.

Q2. The AE has previously visited EDF Energy, UKPN's predecessors, on two separate occasions to examine OOEE claims for fire damage to cables contained within cable bridge structures. What lessons from these incidents has UKPN applied to its other cable bridges and similar structures, such as the one in question here, at Hacton Lane, Upminster where the two 132kV cables cross the Ingrebourne River? [AE's notes: the first of these incidents occurred on 23 May 2004 and affected a cable bridge across the A13 at Barking. The second incident occurred on 20 July 2009 and affected a cable bridge at Dartford Creek].

- A2. As can be seen in the photographs provided to the AE at the audit visit, the structure is totally different in this instance to the other 2 structures in question as stated in the SoF. UK Power Networks had no reason to believe there would have been any third party interference and under UKPN risk assessment process the structure would have been classified as low risk.

Q3. What is UKPN's policy for the routine inspection of its cable bridges and cable support structures?

- A3. Section 4 of UK Power Network's Standard 'EDS 10-7003 Cable Bridge Inspection and Maintenance' stipulates that cable bridges are inspected once every 6 months.



Q4. When was the cable support structure at Hacton Lane Upminster last inspected?

A4. Prior to the incident, the Hacton Lane structure was an unrecorded crossing and as such was not formally inspected. UK Power Networks' database has since been updated and a post-incident inspection was carried-out on 26th February 2016. UK Power Networks is currently carrying-out a review of all crossing points to highlight previously unidentified structures. Once this review is completed, the information will be collated, the structures reviewed on site and the information uploaded into UK Power Networks' asset database.

Q5. What was the result of that inspection? [AE's note: the AE will need to see UKPN's associated documentation].

A5. The February inspection showed the bridge to be in good condition following the repairs undertaken in July / August 2015. The AE was provided with a copy of the February 2016 inspection report at the audit visit. **[AE's note: the can confirm that this inspection report records that there are no signs of trespassing or graffiti at the cable support structure].**

Q6. What was the outcome of UKPN's risk assessment for the particular location at Hacton lane Upminster? [AE's note: the AE will need to see UKPN's associated documentation].

A6. Because the bridge was previously unrecorded, but subsequent to the fire the bridge's physical security has been upgraded to improve resilience to vandalism and fire through the installation of fire resilient panels on the underside and improved security fencing at either end – both interventions are shown in the February 2016 report. However, prior to the event UK Power Networks had no reason to believe there would have be any third party interference and under UKPN risk assessment process the structure would have been classified as low risk. **[AE's note: the AE considers that UKPN's risk assessment of the cable support structure would have classified it in the 'low risk' category. As noted above, the AE was given a copy of the most recent inspection report].**

Q7. UKPN's Statement of Facts (SoF) indicates that all outfeeds were lost from the 132kV busbar at Warley Grid Substation. Examination of the 132kV SLD in UKPN's SoF suggests that this incident affected both the main and reserve busbars at Warley Grid Substation whereas the AE infers that the incident should have been cleared from UKPN's system by the tripping of circuit-breakers 505 and 705 at Warley Grid Substation. Why does UKPN consider that the supplies lost from Purfleet and Shenfield Grid Substations, together with BR Shenfield form part of this OOOE claim?

A7. UK Power Networks considers the supply loss to Purfleet and Shenfield Grid Substations, together with BR Shenfield to be part of the OOOE claim as a result of the failure of circuit-breaker 505 to trip for the second time.

Q8. Also, UKPN's SLD shows a bus-section circuit-breaker on the main busbar at Warley Grid Substation. If the number 1 sections of both busbars were affected by this incident, why did this circuit-breaker not trip, thereby maintaining supplies to Shenfield Grid Substation and BR Shenfield via the 132kV circuit selected to section 2 of the main busbar?

A8. The bus-coupler circuit-breaker, 130, tripped; thus disconnecting the main busbar.



Q9. UKPN's SLD also indicates that isolator 166 in the reserve busbar at Warley Grid Substation is normally open. Further to the above question, why were supplies to Shenfield Grid Substation and BR Shenfield lost from section 2 of the reserve busbar?

A9. As stated elsewhere, the back-up protection on both on-load super grid transformers operated to clear the incident from UK Power Networks' distribution system, thus de-energising the whole of the 132kV busbars at Warley Grid.

Q10. UKPN's SLD also indicates that the DAR protection is non-operative on the two 132kV circuits to Shenfield Grid Substation and BR Shenfield.

(a). Why is this;

A10 (a). Warley Grid was originally owned and operated by National Grid back in the late seventies early eighties and at the time of transfer of the assets to the then Area Electricity Board the DAR scheme was non-operational.

and

(b). how long has it been in this state?

A10 (b). Once in the ownership of the Area Electricity Board the scheme has been checked against the original design and all was found to be in line with the original design. But when tested the scheme mal operated and it was agreed not to commission the scheme, therefore the scheme has never been operational while in the ownership of UK Power Networks.

Q11. The AE infers that the SLD in UKPN's SoF shows the normal running arrangement for the section of UKPN's 132kV distribution system which is the subject of this OOE claim. How was UKPN's 132kV distribution system running at the time of the incident?

A11. Running normally as indicated in the SoF.

Q12. UKPN's SoF states that the "root cause of the initial fire was caused by children burning their school books under a UK Power Networks cable bridge containing the Warley to Hornchurch No.1 and No.2 132kV oil filled cables, as a celebration of the end of school term at Hacton Lane, Upminster". What evidence can UKPN furnish to justify this statement?

A12. The AE was provided a link to an LFB report into the fire and links to newspaper reports confirming school children burning books at the end of term. *[AE's note: the web-links are cited in the footnote associated with Section 1.1 of this report].*

Q13. When did UKPN receive the call from the London Fire Brigade referred to in its SoF?

A13. UKPN's incident log shows that a call was received from the LFB requesting attendance at 16:49 on the day of the incident.

Q14. How close was the seat of this fire to the cable support structure?

A14. In the confined space under the north slope of the structure as shown to the AE during the audit visit. *[AE's note: the AE can confirm that the damage to the two fluid-assisted cables is consistent with a fire having been started in the confined space below the northern ramp of the cable support structure].*



Q15. What protection is fitted to the Warley Grid Substation to Hornchurch Grid Substation numbers 1 and 2 132kV circuits?

A15. Both 132kV circuits are protected with Reyrolle-based biased differential / intertripping (unit protection) with backup IDMT overcurrent and earth fault. The backup protection is achieved with mechanical protection relays.

Q16. What settings are applied to this protection equipment?

A16. 55-80mA, 1200/1 CT – 0.3TM @75% and 0.325TM @50%.

Q17. What protection is fitted to the 132kV busbars at Warley Grid Substation?

A17. OC and EF IDMT, 2000/1A CT, OC – 150% 0.4TM, EF – 50% 0.425TM.

Q18. What settings are applied to this protection equipment?

A18. 2000/1A CT, OC – 150% 0.4TM, EF – 50% 0.425TM.

Q19. What protection operated to isolate this incident from UKPN's distribution system?

A19. Hornchurch 1 Solkor main protection (unit protection) followed by back-up OC and EF after circuit-breaker 505 reclosed and failed to trip.

Q20. What is UKPN's policy for the routine testing of its protection equipment?

A20. This is covered in UK Power Networks' Standards EMS 10-2501 (schedule 1) and EMS 10-0002. The frequency of testing is 12 years in line with the associated protection scheme.

Q21. When was the protection equipment at Warley Grid Substation last tested?

A21. The Hornchurch Feeders were last maintained in January 2006.

Q22. What was the result of those tests? [AE's note: the AE will need to see the associated test report(s)].

A22. The AE has been provided with the associated test reports.

Q23. When were the most recent studies undertaken to examine the protection arrangements for this part of UKPN's 132kV distribution system?

A23. This protection philosophy is currently under review. The latest 132kV feeder standards were published in March 2014 (EDS 05-0001).

Q24. What action has UKPN taken as a result of the recommendations from these studies?

A24. No action was required as a result of the March 2014 study.

Q25. What is UKPN's policy for the routine trip-testing of its 132kV circuit-breakers?

A25. For air-blast circuit-breakers an open and close operation is carried out every year (via SCADA) depending on the function of the circuit-breaker. Also, a timed trip-test is carried out every 4 years at mechanism maintenance.

Q26. When was the last trip-test carried-out on circuit-breakers 505 and 705 (The Hornchurch Grid circuit-breakers) at Warley Grid Substation?

A26. For circuit-breaker 505, the last operation was on 21 July 2015 and the last timed trip-test was on 02 September 2011.

For circuit-breaker 705, the last operation was also on 21 July 2015 but the date of its last timed trip-test is not available.

Q27. What was the result of those trip-tests?

A27. For circuit-breaker 505 it was 136ms. The data for circuit-breaker 705 is not available.



Q28. What learning points has UKPN incorporated into its procedures as a result of this incident?

A28. As noted above, additional mechanical protection has been added to the cable support structure at Hacton Lane, Upminster and a review is underway to determine whether there are any other outstanding structures that need risk assessing.

Q29. What further learning points should be considered as a result of the application of the current one-off exceptional event Claims process?

A29. As stated following previous audits; the closer to the event the audit can be completed the better, as it makes the retrieval of data and information easier.

56. During the discussion of this claim it was concluded that a visit to the site of the incident would be unnecessary; the AE was satisfied with EPN's date-stamped audit trail.

57. EPN also provided further information both during and subsequent to the audit visit. This includes:

- Sight of UKPN's policy for the routine inspection and maintenance of the type of cable support structure that was affected by this incident;
- Sight of UKPN'S policy for the routine testing of its protection schemes;
- Sight of UKPN's policy for the routine trip-testing of its 132kV circuit-breakers;
- A copy of the time-stamped information received during the call from the London Fire Brigade;
- A discussion of UKPN's risk assessment for its cable support structures;
- A discussion of the post-incident investigations into the root cause of this incident;
- A discussion of the post-incident investigation into why the incident was not cleared by the tripping of circuit-breakers 505 and 705 at Warley Grid Substation;
- A discussion regarding UKPN having no previous problems with circuit-breaker 505 at its Warley Grid Substation;
- A discussion to confirm that circuit-breaker 505 is annually trip tested via SCADA;
- Confirmation that the last recorded timing test on circuit-breaker 505 was carried-out on 02 September 2011;
- As shown in paragraph 59 below, confirmation UKPN's post-incident investigations have found no conclusive cause why circuit-breaker 505 failed to trip a second time;
- UKPN's report that a post-incident learning point has resulted in modifications to the protection arrangements fitted to its air-blast circuit-breakers at its Warley Grid Substation – the circuit-breakers now fail in the open position if there is insufficient air to complete a sequence e.g. close and then re-open;



- Information regarding the inoperative state of the DAR protection on the Warley Grid to Shenfield 132kV circuits;
 - Information to show that the affected section of EPN's network is P2/6 compliant [**AE's note:** The EPN planning load estimates were provided during the site visit. They show the firm capacity for the Warley Grid Substation site in winter is 553MW against an actual winter MD of 239.6MW];
 - Examination of the alarm log generated by this incident;
 - Examination of the incident and switching logs associated with this incident;
 - A representation of this incident on UKPN's SCADA system;
 - UKPN's incident report from which it calculated the CI and CML it attributes to this incident; and
 - Sight of other UKPN photographs taken at the time of the incident that obviated the need for the AE to visit site.
58. Following the audit visit and the confirmation that circuit-breaker 505 failed to trip a second time, it is apparent that the exceptionality of this claim centres around what UKPN could have reasonably done to mitigate against it happening.
59. Accordingly, the AE pressed UKPN for further information regarding this matter; UKPN responded as follows:
- Following the incident on the 21 July 2015 the protection scheme and setting for CB 505 were checked and all was found to be in order;
 - CB 505 was also inspected and a number of tests carried out on the night of the incident to see whether any issues could be identified;
 - However, the inspection and tests were found to be inconclusive with no issues identified;
 - Prior to the restoration of CB 505 it was maintained and a full functional test carried with all operations working within the predefined limits of operation;
 - The air circuit ring was found to be on the low side of the operating tolerance, but this should not have affected the operation of the CB;
 - For completeness, the air circuit ring pressure was reset to the midpoint in the tolerance bandwidth;
 - In conclusion, following extensive inspection and testing of CB 505 the failure to open for a second trip could not be recreated;
 - Therefore, the inspection and testing were found to be inconclusive in identifying the cause why the CB failed to operate for a second trip; and
 - To date, following the incident, CB 505 has been operated on a number of occurrences for routine maintenance / trip-testing and has operating successfully every time.



4 Audit part 2

4.1 EPN's performance in preventing the event

60. In viewing EPN's performance in preventing this incident, the AE has considered what more EPN could have reasonably been expected to have done to ensure that its 132kV underground fluid-filled cables supported on the structure at Hacton Lane Upminster were safeguarded from third-party interference.
61. EPN has no record of any previous incident affecting its equipment in this location.
62. Photograph 1 copied from UKPN's SoF shows the robust nature of the metal-clad, totally-enclosed cable support structure with metal anti-trespass structures to prevent third parties accessing the top of the structure.
63. Photograph 2, also copied from UKPN's SoF is an aerial view showing the proximity of the support structure to Hacton Lane and its semi-rural setting.
64. Photograph 3, also copied from EPN's SoF, taken at the time of the incident shows the seat of the fire below the sloping ramp at the northern end of the cable support structure. The cordon put in place by the emergency services is clearly visible.
65. Photograph 4, copied from "Google Earth" shows the scene during August 2015 when EPN was working to repair the damaged cables and to improve the measures put in place to prevent third-party interference. The intensity of the fire can be gauged by the damage to the trees.
66. Photograph 5, specifically requested by the AE during the audit visit, shows the cable support structure after EPN had completed its repair work. As can be seen, new metal fences have been installed to prevent third-party access to the areas beneath the ramps of the cable support structure.
67. Whilst EPN has declared that this cable support structure was not on its records, EPN's photographs show it to be robust and an inspection would assess it to be in the low risk category.
68. Without any history of previous interference, EPN would have no cause to consider applying any further preventative measures than those noted above.
69. EPN's inspection and maintenance regime for its equipment at its Warley Grid Substation was up to date at the time of the incident.
70. EPN had no reason to think that its 132kV switchgear at its Warley Grid Substation was either defective or unreliable.
71. EPN's measurement systems confirm the initial restoration of supplies lost during this incident via tele-controlled from alternative 33kV and 11kV sources.
72. EPN's measurement systems also show the liaison with National Grid's control regarding restoring the 132kV infeeds to EPN's Warley Grid Substation and the subsequent restoration of 132kV infeeds to EPN's three 132/33kV Grid Substations and to BR Shenfield by EPN's control engineers using tele-controlled switching.



73. EPN's measurement systems also show the re-interruption to supplies to EPN's customers fed from its Elm Park and Hornchurch Local Primary Substations and their subsequent restoration by EPN's control engineers using tele-controlled switching on EPN's 11kV network.
74. An examination of UKPN's measurement systems and a SCADA representation of its distribution network confirm that EPN did all it could to restore supplies as expeditiously as possible.
75. The AE concludes that, prior to this incident occurring, EPN had done all it could reasonably have been expected to do in considering that its 132kV switchgear at its Warley Grid Primary Substation was free from any known defects.

4.2 EPN's performance in mitigating the effects of the event

76. Prior to the incident, EPN had no reason to believe that its cable support structure at Hacton Lane Upminster would be affected by third-party interference and that it would be classified as a 'low-risk' location.
77. The report from site confirmed that the fire beneath the cable support structure at Hacton Lane had affected the 132kV Infeeds to EPN's Hornchurch Grid Substation.
78. EPN's inspection and maintenance for its 132kV installation at its Warley Grid Substation was up-to-date at the time of the incident and EPN was unaware of any problem affecting the ability to trip of its circuit-breakers.
79. The AE has studied the running arrangements of EPN's 132/33kV distribution networks affected by this incident and concludes that EPN's back-up protection systems worked correctly to clear it from EPN's distribution system.
80. The AE commends EPN's control engineers for analysing the situation, and for beginning to restore supplies from alternative 33kV and 11kV sources before the 132kV system was restored.
81. Following the restoration of the 132kV infeeds to EPN's Warley Grid Substation the AE also commends EPN's control engineers for the restoration of the infeeds to the three 132/33kV Grid substations affected by this incident and to BR Shenfield.

4.3 Recommended performance adjustments

82. The AE's recommendations to Ofgem are shown in Table 3.

Table 3 – Recommended performance adjustments

	Amount above threshold	Audit part 2 recommendation
CI	3.08	3.08
CML	0.13	0.13

4.4 Detailed justification

83. In viewing EPN's performance in preventing this event, the AE has taken into account his personal knowledge of the United Kingdom's distribution system practice and that of his colleagues who have considerable operational experience of incidents due to many causes.
84. EPN's evidence shows the structure to be a robust metal-clad design used throughout the UK which would have been classified as low risk.



85. In reaching a judgement on a recommendation, the AE has firstly considered whether or not EPN could have reasonably been expected to have taken any different course of action that would have prevented a third-party lighting a fire below its cable support structure in Hacton Lane Upminster.
86. Also, without any history of previous incidents prior to the one under review here, and without any other robust justification, EPN's routine inspection regime would have been unlikely to have changed this low-risk classification.
87. That said, EPN's photographic evidence clearly shows the additional measures it has applied to this cable support structure to further safeguard its equipment from third-party interference.
88. Not shown in the photograph but an important part of EPN's additional measures is the fact that it has lined the underside of the support structure with fire-resistant material.
89. EPN's evidence also shows that its routine inspection and maintenance regimes for its equipment at its Warley Grid Substation is consistent with good practice and was up-to-date at the time of the incident.
90. UKPN's post-incident investigations have found no conclusive cause of the failure of circuit-breaker 505 to trip a second time.
91. EPN would therefore have no cause to doubt the capability of its 132kV air-blast circuit-breakers at its Warley Grid Substation to clear a fault for a second time.
92. Nevertheless, since the incident, EPN has been proactive in modifying the protection of these circuit-breakers to include a fail-safe monitor of the air pressure whereby a low pressure indication would inhibit the auto-reclose feature.
93. The AE notes that EPN has no previous records of incidents affecting its cable support structure at Hacton lane Hornchurch.
94. The AE therefore concludes that EPN had no cause to consider any additional measures other than those consistent with good UK practice.
95. In considering EPN's restoration strategy, the AE is conscious that UKPN's duty control engineers acted with commendable skill and speed in analysing the SCADA alarms and indications generated by this incident; and, using tele-controlled switching, began to restore supplies from alternative 33kV and 11kV sources as rapidly as possible.
96. The AE is also conscious of the liaison between EPN's control engineers and National Grid's control that enabled the restoration of 132kV infeeds to EPN's three 132/33kV Grid substations and to BR Shenfield as speedily as possible.
97. The AE is also conscious of the speed with which EPN's control engineers restored supplies to EPN's customers affected by the re-interruption of supplies following the tripping of the number two 132kV infeed to its Hornchurch Grid Substation.
98. The AE is satisfied that EPN's distribution network affected by this incident complies with the requirements of Security of Supply Standard P2/6.
99. The Appointed Examiner therefore concludes that UKPN's claim is justified and recommends to Ofgem that the amount of CI and CML above the threshold values should be excluded from EPN's performance for reporting year 2015/16.

Appendix A - Record of Audit part 1

Table A-1: Appointed Examiner's Information Log

"One-Off" Exceptional Event	Reporting Year 2015/16
Licensed Area	UKPN(EPN)
Date of event	21 July 2015
Cause	132kV incident affecting Warley Grid Substation
Notification to Ofgem	03 August 2015
SoF received by Ofgem	25 September 2015
SoF information	<ul style="list-style-type: none"> • EPN's 132/33kV distribution system was running normally at the time of the incident; • At 16:16 on Tuesday 21 July 2015 all supplies were lost from the 132kV busbars at Warley Grid when the back-up protection tripped the 132kV circuit-breakers of the two on-load super grid transformers; • Hornchurch Grid (four Primary substations), Purfleet Grid (seven Primary substations) and Shenfield Grid (6 Primary Substations) lost their infeeds, as did BR Shenfield; • A fire had damaged the Warley Grid to Hornchurch Grid fluid-filled 132kV cables at Hacton Lane Upminster; • The Hornchurch number one 132kV circuit-breaker (505) at Warley Grid tripped and reclosed but failed to trip a second time – hence the back-up protection clearing the incident from EPN's distribution system; • Sequence automation restored 2,102 customers in under 3 mins; • Initial supplies were restored via tele-control from alternative 33kV and 11kV sources; • The 132kV infeeds to Warley Grid were restored by National Grid allowing 132kV infeeds to be sequentially restored to Shenfield, Hornchurch, and Purfleet Grid Substations; • At 17:05 the number two 132kV circuit into Hornchurch tripped, causing re-interruptions to Elm Park and Hornchurch Local Primary Substations; • The re-interrupted supplies were restored using tele-controlled switching of 11kV alternatives; and • The root cause of the incident is cited as being a fire deliberately set below EPN's cable support structure.
Additional pre-visit information provided	Based on the SoF the AE drew up a list of initial questions. These were discussed during the audit visit. This initial list of questions, together with EPN's responses, is contained in paragraph 55 of the report.
Location of audit visit	UKPN's Control Centre
Date of audit visit	24 May 2016
Visiting Auditor	Geoff Stott (ep)
UKPN's Representatives	Bill d'Albertanson, David Child and Stuart Plant.
Information provided during and subsequent to the audit visit	<p>Comprehensive documentation / information including:</p> <ul style="list-style-type: none"> • A discussion of EPN's risk assessment process and the classification of the cable support structure;

- A discussion regarding the history of any similar previous incidents;
- A discussion regarding the post-incident learning and measures put in place following the incident - at both Warley Grid and at Hacton Lane;
- A discussion of the protection arrangements on the 132/33kV network affected by this incident;
- The settings applied to the above protection schemes;
- A copy of EPN's switching programme for the incident which shows the tripping of the 132kV circuit-breakers controlling the infeeds to the 132kV busbars at Warley Grid Substation
- Sight of EPN's switching programmes showing the restoration of supplies to EPN's customers off supply for more than three minutes – initially via tele-controlled of alternative 33kV and 11kV sources before the 132kV was restored;
- Sight of the relevant 132/33kV system diagrams;
- Sight of the printout from EPN's SCADA system that shows the alarms generated by the event;
- A chronological listing of the sequence of events, particularly how the liaison with national grid 'inter-leaved' - with EPN's supply restoration activities;
- A copy of UKPN's incident report that shows:
 - the number of customers affected by the incident for longer than 3 minutes to be 135,399; and
 - the customer minutes lost due to the incident to be 2,458,632;
- The AE confirms that these figures agree with those quoted in UKPN's SoF;
- Using EPN's total connected customers at 30 September 2014 of 3,581,606 the number of customers affected equates to a CI of 3.78 $[135,399 \times 100 / 3,581,606]$
- Similarly, the customer minutes lost for this event equate to a CML of 0.69 $[2,458,632 / 3,581,606]$;
- No need to visit the site of the incident to clarify anything;
- Discussed post-fault learning points;
- Confirmed P2/6 compliant (239.6MW firm in winter);
- EPN provided answers to the initial questions plus additional information both during and subsequent to the audit visit; and
- Okay regarding compliance with Appendix 4 of paragraph 2D.35 of CRC 2D.

Table A-2: Impact on CI and CML

	CI		CML	
Voltage + DNO's incident references	Claimed	Audited	Claimed	Audited
132kV (INCD-879770-H)	3.78	3.78	0.69	0.69
EHV	0	0	0	0
HV	0	0	0	0
LV	0	0	0	0
Total	3.78	3.78	0.69	0.69
UKPN (EPN) Threshold (total)	0.70		0.56	
Part 1 Exceptionality Test	Pass		Pass	
Part 1 Precondition of eligibility (meets App 3 to paragraph 2D.34 of CRC 2D)	Pass			

NOTE: EPN's measurement systems are subject to QoS audits for accuracy of reporting and it is not within the AE's ToR to repeat that work as part of the examination of exceptional event claims, although any consequential adjustments to reporting accuracy will be reflected in Ofgem's final adjudication of reported performance for the regulatory reporting year 2015/16.

Appendix B – Photographs

Photograph 1 - the steel-clad cable support structure adjacent to Hacton Lane



Photograph 2 – an aerial view of the cable support structure at Hacton lane



Photograph 3 - the seat of the fire below the cable support structure



Photograph 4 - the scene of the incident in August 2015



Photograph 5 - the support structure following the additional preventative measures

