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**Appointed examiner's audit of Exceptional Event Claim -
UK Power Networks (SPN)
132kV incident – Beddington to Sutton Grid
01 September 2015**



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Glossary

Abbreviation	Meaning
AE	Appointed Examiner
CB	Circuit-breaker
CI	Customer Interruptions per 100 connected customers
CML	Customer Minutes Lost per connected customer
DNO	Distribution Network Operator
ENA	Energy Networks Association
ep	energypeople (Ofgem's Appointed Examiner)
ESQCR	Electricity, Safety, Quality and Continuity Regulations
QoS	Quality of Service
RIGs	Regulatory Instructions & Guidance
SCADA	Supervisory Control and Data Acquisition
SI	Short Interruption
SLD	Single Line Diagram
SoF	Statement of Facts
SPN	UKPN's South Eastern Power Networks licensed area
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, caused by a faulty pilot cable, between its Beddington and Sutton Grid Substations at 13:12 on Tuesday 01 September 2015 adversely affected the reported performance for its South Eastern Power Networks (SPN) licensed area for the reporting year 2015/16.
2. The AE has visited SPN 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 CI but not 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 SPN's performance in mitigating the impact of the event upon its customers.
5. The AE concludes that SPN's inspection and maintenance programme for its protection schemes and associated pilot cables was up to date at the time of the incident.
6. The AE also concludes that UKPN had no reason to doubt the integrity of its pilot cable between its Beddington and Sutton Grid Substations.
7. UKPN's 132kV system was running abnormally at the time of the incident due to leak location work on the number one 132kV circuit between its Beddington and Sutton Grid Substations.
8. The AE commends SPN's control engineers for analysing the alarms generated by the incident and for arranging for the rapid re-energisation of the parallel 132kV feeder, thus restoring customers' supplies within four minutes.
9. The AE concludes that SPN 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 SPN'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	2.71	1.60	1.60
CML	0.10	0	0



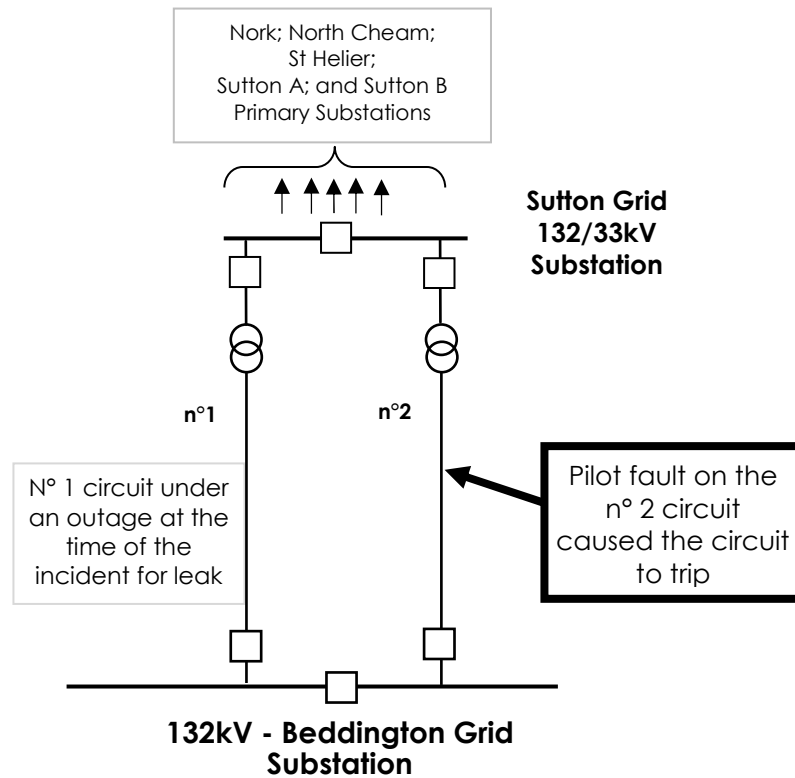
1 Audit part 1

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. SPN's Sutton Grid Substation is equipped with two 132/33kV transformers which are fed via fluid-assisted underground circuits from SPN's Beddington Grid Substation.
13. In turn, Sutton Grid Substation feeds five of SPN's Primary Substations via 33kV feeders.
14. On the day of the incident the number one 132kV circuit between Beddington and Sutton Grid Substations was de-energised for excavation work associated with leak detection on the fluid-filled cable.
15. At 13:12 on 01 September 2015 the pilot cable associated with the unit protection scheme on the number two 132kV circuit between SPN's Beddington and Sutton Grid Substations faulted.
16. The protection scheme operated to trip the circuit-breakers controlling the number two 132kV circuit, resulting in the loss of all infeeds to SPN's Sutton Grid Substation and the five Primary Substations supplied from it.
17. 61,623 of SPN's customers lost supply.
18. SPN's contingency plans for the outage on the number one 132kV circuit between Beddington and Sutton Grid Substations provided for its rapid return to service.
19. It was by this means that SPN restored its customers' supplies within four minutes of the number two circuit tripping.
20. A simplified view of the section of SPN's 132/33kV network affected by this incident is shown in Figure 1.



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



Notes:

1. Only the salient items of switchgear are shown;
2. SPN's network was running abnormally at the time of the incident – as shown above, the number one circuit was de-energised for leak location work.
3. SPN restored its customers' supplies by re-energising the number one circuit.

2 Exceptionality requirements

2.1 Does the event qualify for exclusion

21. 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.
22. 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

23. 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

24. 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	1.11	2.71	2.71	Pass	1.60
CML exceptionality	0.89	0.10	0.10	Fail	0

Notes:

1. Ofgem's CI and CML exceptionality criteria are set out in the AE's ToR¹.
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.

¹ Audits of Electricity Distribution Network Operators' one-off Exceptional Events Claims for 2015/16 to 2018/19



3 SPN's views of its performance

3.1 Dealing with the incident

25. The 33kV busbars at SPN's Sutton Grid Substation are supplied via two 132/33kV transformers which are fed via 132kV underground fluid-assisted cables from SPN's Beddington Grid Substation.
26. SPN's distribution system affected by this incident was running abnormally at the time of the incident due to the number one 132kV circuit between SPN's Beddington and Sutton Grid Substations being de-energised for leak location work.
27. At 13:12 on 01 September 2015, the circuit-breakers controlling the number two 132kV circuit between SPN's Beddington and Sutton Grid Substations tripped.
28. This resulted in the loss of infeeds to SPN's Sutton Grid Substation and the five Primary Substations fed from it.
29. Supplies to SPN's 61,623 customers affected by this incident were restored by re-energising the number one 132kV circuit between SPN's Beddington and Sutton Grid Substations.
30. SPN considers that its duty control engineers reacted well in assessing the alarms generated by the event and restoring supplies within four minutes.
31. SPN considers its protection operated correctly as the cause of the incident was found to be a fault in the pilot cable which is an integral part of the unit protection scheme.

3.2 SPN's answers to questions on its performance

32. Within the last four years, the AE has reviewed SPN's design standards, construction methods and maintenance procedures during previous visits to audit exceptional event claims and found them fit for purpose.
33. The AE confirms that SPN's emergency procedures provide for the type of event being examined here.
34. To aid understanding of the background to SPN'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.
35. The initial questions were discussed during the AE's visit to UKPN's Control Centre on 24 May 2016, when the records of SPN's SCADA system, the incident report and other information were made available.
36. SPN 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 SPN's answers 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. UK Power Networks has reviewed its emergency plans and procedures in line with its natural review cycle; however, there have been no significant changes.



Q2. What type of protection scheme is fitted to the two 132kV circuits between UKPN's Beddington and Sutton Grid Substations?

A2. Both 132kV circuits are protected with Solkor-based biased differential / inter-tripping with main Definite Time Overcurrent and backup IDMT overcurrent and earth Fault. The backup protection is achieved with mechanical protection relays.

Q3. UKPN's Statement of Facts (SoF) indicates that the protection schemes rely on pilot wire connection between the two Grid Substations. How many pilot cables carry these protection circuits?

A3. There are separate pilot cables for each circuit as recorded in UK Power Networks' asset register 00003635051/52.

Q4. What is UKPN's policy for the routine testing of this type of protection scheme?

A4. UK Power Networks' policy is stated in Schedule 1 of Standard EMS 10-2501. The frequency of testing is stipulated in UK Power Networks' Standard EMS 10-0002, which sets-out a 12-yearly cycle in line with the testing of the associated protection scheme.

Q5. When was the protection equipment last tested?

A5. The schemes on both circuits were installed in 2006 – the number 1 circuit on 15 June and the number 2 circuit on 18 May.

Therefore, their next test date is due in 2018 in line with question 4 above.

Q6. What protection operated to trip the number 2 circuit?

A6. Solkor unit protection tripped both ends of the circuit.

Q7. What is UKPN's policy for the routine inspection / testing of its pilot cables?

A7. As indicated at A4 above, the frequency of testing is on a twelve-year cycle. A5 above shows that the next test is due in 2018.

Q8. When was (were) the pilot cable(s) between UKPN's Beddington and Sutton Grid Substations last tested?

A8. UK Power Networks' asset register shows that both pilot cables were tested in December 2007 and it is assumed that the pilots were also commissioned along with the protection in 2006.

Q9. What was the result of that (those) inspection test(s)?

A9. The pilot cables are an inherent part of the Solkor unit protection schemes and would have been tested in 2006 as per A5 above with the next test due in 2018.

However, as part of the post-fault investigation the cores of the pilot cable were tested. The cores in use for the Solkor protection were found to have low IR readings. The protection connections were therefore moved to good cores. We have now carried out full testing this year on the No1 circuit and are currently waiting for an outage on the No 2 circuit so this can be tested.

[AE's note: the AE has seen the above for the number 1 circuit].

Q.10. When was the faulted pilot cable installed?

A10. UK Power Networks' records show that the faulted section of this pilot cable was installed in 1965. While the section that faulted was laid in 1965, new sections were laid in 2006 at the time work was carried out on site.



Q11. What type of cable is the faulted pilot cable – i.e. paper insulated / pvc insulated / cores / pairs, etc?

A11. 12 pair, pvc insulated with steel wire armour.

Q12. What was the nature of the pilot cable fault?

A12. The failure was found to be in a pilot cable joint.

Q13. How close to the excavation for the fluid leak on the number 1 circuit was the point of failure of the pilot cable?

A13. UK Power Networks' can confirm the failed pilot cable joint was not in the vicinity of the excavation for the fluid leak on the number 1 circuit.

Q14. What learning points has UKPN incorporated into its procedures as a result of this incident?

A14. There were no specific learning points that came out of this incident.

Q15. What further learning points should be considered as a result of the application of the current one-off exceptional event Claims process?

A15. 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.

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

38. SPN also provided further information both during, and after, the audit visit. This includes:

- Information to show that the affected section of SPN's network is P2/6 compliant. **[AE's note: The SPN planning load estimates were provided during the audit visit. They show the firm capacity for the Beddington Grid Substation site in winter is 106.4MW against an actual winter MD of 89.1MW];**
- Sight of UKPN's policy for the routine testing of its protection schemes and associated pilot cables;
- A discussion to confirm that, prior to the current incident, UKPN's routine maintenance of its protection schemes and associated pilot cables was up to date;
- A discussion regarding UKPN having no previous history of faults affecting the pilot cable;
- The post-incident test results for the pilot cable associated with number 1 circuit;
- UKPN's control room log for this incident;
- UKPN's incident report from which it calculated the CI and CML attributed to this incident;
- The details of UKPN's SCADA alarms received during this incident; and
- A representation of the incident on UKPN's SCADA system.



4 Audit part 2

4.1 SPN's performance in preventing the event

39. In viewing SPN's performance in preventing this incident, the AE has considered what more SPN could have reasonably been expected to have done to ensure that its pilot cables between its Beddington and Sutton Grid Substations were free from defects.
40. These pilot cables form an integral part of the unit protection schemes fitted to these 132kV circuits and are therefore tested during the routine maintenance and testing regime of SPN's protection.
41. Also, due to this integral nature, the pilot cables are constantly monitored for continuity within the unit protection schemes.
42. SPN's contingency plans for the leak location work on its number one 132kV circuit between Beddington and Sutton Grid Substations provided for its speedy return to service.
43. Supplies were restored within four minutes by re-energising the number one 132kV circuit.
44. An examination of UKPN's measurement systems and a SCADA representation of its distribution network confirm that SPN restored supplies lost from its Sutton Grid Substation via the return to service of the number one 132kV circuit between its Beddington and Sutton Grid Substations.
45. The AE concludes that, prior to this incident occurring, SPN had done all it could reasonably have been expected to do in considering that its pilot cables between its Beddington and Sutton Grid Substations were free from any known defects.

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

46. The AE has studied the running arrangements of SPN's 132/33kV distribution networks affected by this incident and concludes that SPN's unit protection scheme worked correctly when the pilot cable faulted.
47. The AE commends SPN's control engineers for analysing the situation, and for restoring supplies using the contingency plans associated with the leak location work on the number one 132kV circuit between SPN's Beddington and Sutton Grid Substations.

4.3 Recommended performance adjustments

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

Table 3 – Recommended performance adjustments

	Amount above threshold	Audit part 2 recommendation
CI	1.60	1.60
CML	0	0



4.4 Detailed justification

49. In reaching a judgement on a recommendation, the AE has firstly considered whether or not SPN could have reasonably taken any different course of action that would have prevented the fault on the pilot cable between its Beddington and Sutton Grid Substations.
50. In viewing SPN'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.
51. The AE confirms that the pilot cable that faulted is an integral part of the protection scheme fitted to the number two 132kV circuit between SPN's Beddington and Sutton Grid Substations.
52. The AE notes that SPN's routine inspection and maintenance regimes for its protection schemes were up to date at the time of the incident and the company had no reason to think that the pilot cable was defective.
53. The AE also notes that the nature of the protection scheme means that the pilot cable is constantly monitored.
54. The AE also noted that SPN has no previous records of incidents of this type affecting its pilot cables between its Beddington and Sutton Grid Substations.
55. The AE therefore concludes that SPN had no cause to consider any additional measures other than those consistent with good UK practice.
56. In considering SPN's restoration strategy, the AE is conscious that its 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, restored supplies by re-energising the number one 132kV circuit between SPN's Beddington and Sutton Grid Substations within four minutes.
57. The AE is satisfied that SPN's distribution network affected by this incident complies with the requirements of Security of Supply Standard P2/6 (106.4MW firm in winter).
58. The Appointed Examiner therefore concludes that UKPN's claim is justified and recommends to Ofgem that the amount of CI above the threshold value should be excluded from SPN'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(SPN)
Date of event	01 September 2015
Cause	132kV incident between Beddington and Sutton Grids
Notification to Ofgem	14 September 2015
SoF received by Ofgem	09 November 2015
SoF information	<ul style="list-style-type: none"> SPN's 132kV distribution system was running abnormally at the time of the incident due to fluid leak location work on the number one 132kV circuit between Beddington and Sutton Grids; At 13:12 on Tuesday 01 September 2015 the number two 132kV circuit tripped resulting in loss of all infeeds to Sutton Grid and the five Primaries fed from it; Supplies were restored by re-energising the number one 132kV circuit within four minutes; and The root cause of the incident was a pilot fault on the number two circuit.
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 SPN's responses, is contained in paragraph 36 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 and Simon Mulcahy.
Information provided during and subsequent to the audit visit	<p>Documentation / information including:</p> <ul style="list-style-type: none"> A discussion of SPN's contingency plans for the de-energising of the number one 132kV circuit between Beddington and Sutton Grids; A discussion on the protection schemes associated with the two 132kV feeders between Beddington and Sutton Grids; A discussion regarding the history and no similar previous faults on these pilot cables; A copy of SPN's switching programme for the incident which shows the tripping of the 132kV circuit-breaker at Beddington Grid controlling the number two infeed to Sutton Grid at 13:12 on 01 September 2015; Sight of SPN's switching programmes showing the restoration of supplies to SPN's customers at 13:16 by re-energising the number one 132kV circuit; A copy of the relevant 132/33kV SLD; Sight of the printout from SPN's SCADA system that shows the alarms generated by the event;

- A copy of UKPN's incident report that shows:
 - the number of customers affected by the incident for longer than 3 minutes to be 61,623; and
 - the customer minutes lost due to the incident to be 231,086;
- The AE confirms that these figures agree with those quoted in UKPN's SoF;
- Using SPN's total connected customers at 30 September 2014 of 2,271,189 the number of customers affected equates to a CI of 2.71 $[61,623 \times 100 / 2,271,189]$
- Similarly, the customer minutes lost for this event equate to a CML of 0.10 $[231,086 / 2,271,189]$;
- No need to visit the site of the incident to clarify anything;
- Confirmed P2/6 compliant (106.4MW firm in winter);
- SPN 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-313610-U)	2.71	2.71	0.10	0.10
EHV	0	0	0	0
HV	0	0	0	0
LV	0	0	0	0
Total	2.71	2.71	0.10	0.10
UKPN (SPN) Threshold (total)	1.11		0.89	
Part 1 Exceptionality Test	Pass		Fail	
Part 1 Precondition of eligibility (meets App 3 to paragraph 2D.34 of CRC 2D)	Pass			

NOTE: SPN'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.