ExA Date Monday 20th February 2023.

From Alan B Smith ID 20030110

Re Sunnica Energy farm

Submission Deadline No 7

Further information for the ExA with reference to my WR dated 13th October 2022 in which I reserved the right to provide further information as and when available.

I have already submitted additional information on the Liverpool BESS fire September 2020 in my report of the 10th January 2023.

These further comments follows on from that report.

No 1.

I now refer to 8.86 Applicants Response to other parties Deadline 5 submission; (PDF Attached).

Topic BESS Document reference REP-088 Alan B Smith comments on BESS, Summary of issue raised and Applicants response.

No 2.

7th February 2023 Additional Submission SNTSAG Ltd; (PDF Attached)

Report by Dr Paul Christensen 3-12-22 on the revised Sunnica Energy Farm Application

No 3.

Reference to National Fire Chiefs Council (NFCC) draft guidelines.

COMMENTS ON No 1

(**a)** The applicants' response does not give any indication what guidelines the NFCC consultation document gives or when the final version will be available.

(b) Reference is made to Emergency response planning but no details are given of the ERP and this is not included in the OBFSMP.

(c) Reference is made to my remarks on the Buncefield oil depot explosion and impact on FRS resources and local residents and Sunnica states it bares no comparison with Sunnica risk profile and incident response requirements.

(d) Until Sunnica produces the exact specification for the BESS technology, scientists cannot judge the impact of "Total Energy Release Potential" at any 1 of the 3 sites to compare with BESS incidents globally or that at Beirut. This must be undertaken on a worst case scenario.

(e) Sunnica comment on the involvement with SFRS and CRS and see no reason for each to be registered as an interested party.

(f) I strongly disagree. If it was considered appropriate for Cleve Hill to have KFRS as an interested party then the same should apply to SFRS and CFRS. I will also cover this point in my comments on No 2 above, the report by Dr Paul Christensen.

Cont.

I fully appreciate that the report from Dr Paul Christensen was received after the response from Sunnica.

However the point in writing to the ExA now is to firstly update the Inspectors on the additional report and to question what Sunnica have included in their response to the Deadline 5 Submission.

COMMENTS ON No 2.

I attach a PDF of this report by Dr Paul Christensen for ease of reference.

This covers the 2 OBFSMPs written by Sunnica and the FRS which have been labelled by the author as unsatisfactory.

There are also discrepancies in what Sunnica have included in their Submission and what is dealt with in great detail in the Academics report.

I do not feel it necessary to comment in detail on that report as the facts stated speak for themselves as to what is required before the final OBFSMP is acceptable for the final DCO.

However I would like to draw attention to some points which I find very disturbing.

(a) Section 2.6.4 Consultation. This is not covered in the Sunnica response.

(b) Section 2.9-Safety Standards. The fact cyber security is not mentioned by Sunnica is of great concern to the local communities and the fact within the 40 year term the batteries will need changing means over such a long period cyber-attacks will become more frequently used. If the BESS are not decommissioned the period might extend to 50 years.

(**c)** The statement that scientists in TUV Rheinland have shown that BESS are vulnerable to hacking and could be used to dump energy onto the Grid or turn the BESS into a "Bomb" should be taken very seriously. Surely with such a high risk, BESS cannot be allowed within the Sunnica Energy Farm proposal.

(**d) Section 2.10- Guidelines and Recommendations.** There are lessons to be learnt from the Liverpool fire as per my additional submission 10th January 2023. The cause of that fire have never been solved after 2 years.

(e) Table 6 Item 2.Emergency response plan (ERP). I have already made reference to this under No 1 above. However the fact Red Lodge Parish Council and members of the community at Red Lodge have grave concerns on evacuation make it very desirable the ERP and OBFSMP are interlinked.

(f) Item 3. Location away from residential areas. Again referring to the above para it is vitally important that all comments within item 3 are addressed by Sunnica. The Liverpool report also states BESS should not be close to residential premises. In addition the report in 2019 by Dr Bruno Erasin for the Cleve Hill NSIP states a minimum distance from residential properties is 10 miles. At Cleve Hill the battery compound was 20 acres, Sunnica is 3 sites total 75 acres.

3. NATIONAL FIRE CHIEFS COUNCIL (NFCC).

BACKGROUND.

(a) After the Liverpool BESS fire in September 2020, which was the first such incident in the UK, the NFCC decided to appoint a new lead role designated, Alternative Fuels and Energy Systems, to include BESS.

Cont 2

In January 2021 Matt Deadman was appointed to this position, in addition to his role within Kent Fire and Rescue Service.

I have checked with him the availability of the final report on BESS planning for FRSs and he confirmed by email 19th February 2023 that it is some weeks away and will not be in the public domain until after the close of the ExA examination 28th March 2023.

He emphasises once again the FRS does not have legal powers to require sites to implement specific arrangements, as they are classed as infrastructure.

(b) The Sunnica response to other parties Deadline 5 Submission refers to the recent release by the NFCC of the guidance draft document for BESS planning.

(c) It has taken some 2 years and 5 months since the fire and explosion in September 2020 to produce these guidelines and almost 12 months since the 2 fire reports from MFRS were made public in March 2022.

(d) Even now due to the constitution of the NFCC it is only a guide for FRSs and not national policy.

(e) Therefore Sunnica Ltd the applicant, must rely on Academic reports that have been published by Dr Edmund Fordham and Dr Paul Christensen to complete their final OBFSMP and ERP.

(f) What Sunnica, in conjunction with FRS, has produced in the 2 plans so far has demonstrated that Sunnica has no experience in large scale BESS and neither does the SFRS and CFRS have any technical knowledge on BESS to offer. It is the blind leading the blind with Sunnica in the past admitting they are on a steep learning curve.

(g) What is required is the inclusion of the HSE to provide professional expertise to produce a document worthy of inclusion in a NSIP.

(h) There is evidence to support the fact that Sunnica has no large scale BESS experience in the 2 Funding Statements Sunnica has produced as part of the DCO.

Version 1 dated 18th November 2021 when Sunnica was owned by Solaer Holding SL Appendix B gives a list of small solar developments by Solaer Holding SL.

Version 2 dated 13th January when it announced that Sunnica Ltd was owned by Los Dalton de PozescoS.L. (LDP) and not Solaer Holding SL Appendix C still gives the same list of small solar developments by Solaer Holding SL and nothing for LDP.

CLEVE HILL APPLICANTS DEADLINE 3 SUBMISSION.

I attach a PDF which is a report by Michael Bird of Arcus dated August 2019. This document comprises a written representation by Cleve Hill Solar Park Ltd (The Applicant) in relation to the regulations and standards that would govern the construction and operation of the proposed solar array and energy storage facility which was subject of the DCO application.

As can be noted from their representation, there is a wide and exhaustive range of obligations that the applicant would be under in terms of safety when constructing and operating the Cleve Hill Solar Park. **Given the importance of these obligations, they bring criminal liability for any breach.**

Cont.

In addition, the Cleve Hill Solar Park must be constructed in accordance with internationally recognised standards for electrical installation, in order to meet the requirements of National Grid for connection. A summary of the applicable standards are set out in the report.

We are now at Deadline 7 and nothing has been forthcoming so far from Sunnica Ltd by way of an independent report to compare with the Cleve Hill deadline 3 submission.

It is obvious the same rules will apply to Sunnica Ltd and until the public can be convinced Sunnica can be relied upon to honour all International and UK rules and regulations then that part of the DCO cannot be agreed.

END OF REPORT.

Topic	Deadline and Document Ref	Summary of issue raised	Applicant's response
			that low water levels in the aquifer will risk low flows subsequently in surface waters. 4) Claims made of deficiencies in the Applicant's ALC assessment are not substantiated. RAC have presented the Patrick Stephenson assessment work, ignoring clear failures to properly assess ALC drought limitation and only now conceding that there should be no attempt to use cropping in the assessment of ALC Grade. In addition the claim that the ExA needs to decide on the role of irrigation in ALC assessment rather than accept the guidance of Natural England, is irresponsible. This patten is likely to continue in RAC reporting of any joint ALC assessment work within the sites, and so not facilitate decision making. The Applicant would also reiterate that giving access to third party land is not within its control.
BESS	REP5-088 Alan B Smith comments on BESS	Mr Smith's submission mainly concerns the report into the Carnegie Road, Liverpool BESS incident. Comments are made on the engagement and capability of FRS to respond to BESS incidents.	The DCO hearing on BESS safety covered the Carnegie Road explosion. The BESS design did not integrate a gas exhaust or deflagration venting system, the BESS supplier (NEC) offers a design that integrates full explosion protection. In addition, the BESS container integrated a Novec 1230 fire suppression system which was commonly known to be unable to stop thermal runaway in large scale lithium-ion battery systems and would likely lead to the build-up of explosive gases. The Applicant has stated that BESS designs without gas exhaust / deflagration venting will not be considered for the Scheme, and gaseous suppression systems are not fit for purpose. The NFCC has recently released (for consultation) their UK FRS guidance draft document for Grid Scale BESS planning. The Applicant has made a commitment to adhere to these guidelines and is fully engaged with SFRS to input and review all BESS safety literature, BESS test data, and Emergency Response Plans. Emergency response planning will ensure that sufficient resources are available for incident response, and BESS site and system selection is focused on ensuring no explosion occurs. Important design safety lessons have been learned from the Liverpool and Beijing incidents and BESS

Topic	Deadline and Document Ref	Summary of issue raised	Applicant's response
			systems considered for the Scheme will have been designed and tested to mitigate explosion risks. The fire safety strategy for Sunnica will be devised to achieve a high level of safety without the partial or full intervention of SFRS, meaning that the BESS enclosure fire and explosion protection systems must be capable of preventing and controlling thermal runaway incidents without FRS involvement. The Buncefield oil depot explosion and impact on FRS resources and local residents bares no comparison with Sunnica risk profile and incident response requirements. SFRS and CFRS have been consulted by the Applicant and are fully aware of the provisions of the OBFSMP. They may not be registered as separate interested parties, but SFRS is taking the lead on engagement for both FRS and as SFRS are part of the SCC they are involved in the examination. It is therefore not correct to say that they have not been engaged. Both FRS will continue to be fully consulted moving forward with the Scheme. The Applicant has confirmed that a specialist BESS independent Fire Protection Engineer will review all safety and fire protection designs and test data.
Transport	REP5-091 CCC comments on Land and Crown Plans Rev 04 [REP4-003 and REP4-004] – proposed use of land:	The Council requests details from the Applicant of its intended use for the land where it proposes to acquire rights from the local highway authority. In addition, the Council requests details from the Applicant of its intended use for the land where it proposes to temporarily compulsorily acquire rights where highway rights also exist. Without this information, it is hard for the local highway authority to understand the full impact of the proposals on the highway network and the effect that the proposals could have its ability to carry out its statutory functions.	The Applicant notes that the rights that it seeks authorisation to compulsorily acquire will be permanent and not temporary. There is no provision in the statutory regime for the compulsory acquisition of "temporary rights". Rights acquired over land that is also a highway do not affect the status of that land as highway, nor affect the right of the public to enjoy the use of a highway, nor do they affect in anyway the statutory regimes regulating highways nor the highway authorities' functions. The rights are required to ensure that the Applicant has the necessary interests in land it requires to carry out the Scheme and to ensure that it is not prevented from doing so by the assertion of any currently unknown existing private rights in land that are inconsistent with the exercise by the undertaker of the rights it seeks.

Paul Christensen
LITHIUM ION SAFETY

Report on the revised Sunnica Energy Farm Application

By Dr. Paul Christensen, Lithiumionsafety Ltd, 3 December 2022

1. Introduction

I am an academic electrochemist with over 35 years experience in research. I have over 180 papers in international, peer reviewed journals and an H-index of 53. I am an Editorial Board member of Nature Special Reports. I am Senior Advisor to the National Fire Chiefs Council (NFCC), Special advisor to Tyne and Wear Fire and Rescue Service and I am a Subject Matter Expert to DSTL. I serve on the Cross-government Technical Steering Group for EV fire safety, the Department of Business Energy and Industrial Strategy (BEIS) Energy Storage Health and Safety Governance Group, the BEIS Storage Safety - Fire Service Working Group, the British Standards Institute (BSI) PAS 63100 (domestic energy storage systems) Steering Group, the BSI Review Group in the development of the BSI base document for Lithium-ion battery cells, modules and packs – Physical storage – Guide and the BSI FSH/2/-/20 – Working Group (lithium-ion battery extinguishers), the Australian Building Codes Board working group on EV safety and the Tyne & Wear FRS and Envision-AESC Gigafactory fire safety working group. I am the recipient of the 2022 Motorola Foundation-funded AFAC Knowledge Event Series lecture tour of Australia, New Zealand and Tasmania (Oct 2022, presenting to first responders, government officials etc).

I advised Nissan for 3 years on all aspects of lithium-ion battery safety during the construction and commissioning of the battery plant in Tyne & Wear. I am routinely asked for input and advice by OZEV and the Department for Transport. I have conducted tests and experiments to research thermal runaway at module, pack and vehicle levels. I have assessed a number of LiBESS planning applications in the UK and abroad.

2. Executive Summary

I have reviewed 7.6 Outline Battery Fire Safety Management Plan [REP2-033], Chapter 16: Other Environmental Topics [REP2-025] and Appendix 16D: Unplanned Atmospheric Emissions from Battery Energy Storage Systems (BESS) [REP2-265]. I have not reviewed sections not relevant to safety or outside my expertise.

I have already reviewed the initial Outline Battery Fire Safety Management Plan and my comments from this, where unchanged in this latest revision, still stand. This report should be considered along with my previous report.

The revised Outline Battery Fire Safety Management Plan (OBFSMP) is an improvement over the original OBFSMP and includes some examples of Good Practice. However, some significant areas of concern remain.

There is still a lack of essential detail including: the vapour cloud explosion hazard is not considered. This is a major omission. Neither is cyber security, and no indication is given of the formulation of the Emergency Response Plan despite there now being many templates and examples available from reputable sources.

The c.a. 65 fires and explosions to date involving lithium-ion BESS are not discussed or analysed for lessons learned. The choice of cell chemistry, cabinet or container is still not made: these have a direct impact on the energy density of the units and the free volume- both of which determine the detection and suppression systems required, or indeed if suppression is possible. These also have a direct impact on appropriate safety features and on realistic fire and emergency service operational procedures.

Mention is also not made of assembly areas for first responders including Fire and Rescue Services (FRS).

It is encouraging to note that the applicants intend to be guided by internationally-recognised standards including UL 9540A & NFPA 855: however no mention is made of retaining an independent expert to assess the test results from UL 9540A as required under NFPA 855 (2023) section 9.1.5.2.2. This is important to prevent “game playing” e.g. showing only the “best” test result out of e.g. 4 tests, and claiming compliance when in reality only UL 9540A tests have been carried out BUT improvements to the design on the basis of the test results have not been made. In addition, no mention is made of testing the Ingress Protection (IP) of the containers/cabinets which is also required under UL 9540A.

The sections on fire detection, suppression and deflagration prevention/amelioration are particularly confusing and make it impossible to review to any suitable extent.

Finally, given the wealth of data routinely logged in BESS and the potential to employ data analytics to provide advance warning of maintenance or even failure, it is disappointing to note that the applicants do not seem to have considered this as an option.

Overall, given that the eventual Battery Fire Safety Management Plan must be "substantially in accordance with the OBFSMP" (as indicated in the draft Development Consent Order) I do not consider that this OBFSMP can be used as a basis for this.

Detailed review

3. Outline Battery Fire Safety Management Plan

Section 2.5.2 - 2.5.4

The indicative layout designs for the two different technology types under consideration (Appendices A & B) do not make reference to an assembly area for fire and rescue services (FRS) which should ideally be placed near the entrance to the site to ensure that FRS do not have to drive through toxic and/or explosive fumes, or near to flames or containers liable to explode (see, for example, [1][2]).

Table 3: BESS Design Parameters

Module.

Mention is made of a liquid cooling system, but there is no mention of leak detection capability, an important consideration arising from learning from previous events. Coolant leaks can cause short circuit.

Such systems have been responsible for fires involving EVs (see, for example, the Chevy Volt fire[3][4]) and BESS (see, for example, the Moorabool fire[5]).

Cell.

The chemistry to be employed remains under discussion and this renders assessment of the safety aspects impossible. The two chemistries under consideration, LFP (Lithium iron phosphate) and NMC (Nickel Manganese Cobalt), present markedly different hazards. I would expect to see safety considerations and data for both options. Thus NMC cells are likely to have a higher fire hazard whilst LFP poses more of an explosion hazard [6] (the only fatal BESS explosion to date involved LFP cells[7]). This is an important consideration due to the potential risks of explosion and the hazards these present to first responders as well as to nearby homes etc.

One of the key reactions that occur before thermal run away is the exothermic structural collapse of the cathode which produces oxygen and is believed to initiate ignition: this collapse occurs at a much higher temperature in LFP cells (310°C [D. Ren et al., “Investigating the relationship between internal short circuit and thermal runaway of lithium-ion batteries under thermal abuse condition”, Energy Storage Mat., 34 (2021) 563 – 573]) hence LFP cells are considered “safer” than for example NMC.

However, this can just delay ignition and hence LFP cells are perceived to have a higher risk of vapour cloud explosion. Further, recent work has shown that the vapour cloud from LFP cells has a lower explosion limit, larger explosion overpressure, higher explosion index and the ignited vent gas has a higher laminar flame speed [H. Wang et al., eTransportation 13 (2022) 100190.]

BESS container/enclosure.

The applicant states that, **“**The construction will be in the form of modified 20-foot / 40-foot ISO shipping containers OR factory built modular cabinets / units”

Cabinets have a far higher energy density than containers and little free volume: this renders any form of suppression extremely challenging as water (which is still the best of the bad options when it comes to dealing with thermal runaway) will not be able to reach the cells in thermal runaway to prevent thermal propagation.
Recognising this, Tesla recommends that their cabinets be allowed to burn out [5].

Hence, safety measures, the FRS operational procedure, impact on those in close proximity, etc will all depend upon the container topography in addition to the cell chemistry.

The cell chemistry and the container topography need to be disclosed at this stage in order to build in suitable safety measures.

BESS compound.
It is noted that the examples shown here are of considerably smaller BESS compounds compared to those being proposed.

Section 2.6.4
Consultation
The consultation with local FRS should be in the spirit of Dame Maria Miller's draft Bill for lithium ion battery storage: *"The Bill would ensure that industrial lithium-ion battery storage facilities are correctly categorised as hazardous, so that the Environment Agency, the Health and Safety Executive and the fire and rescue services would be statutory consultees when planning applications are considered"*

Given the significant size and scale of the proposed BESS I consider it essential that the HSE, EA and the FRS are all fully consulted during the DCO application.

Section 2.9 – Safety Standards

Table 4:
Automatic Fire Protection
This section is not relevant if the high energy-density cabinet design is chosen.

3rd party fire and explosion testing is mentioned in Table 4, subsection Automatic Fire Protection.
No mention is made of the *independent validation* of the test results as stipulated in NFPA 855 9.1.5.2.2.
This is important for the reasons set out in the Executive Summary (with regard to "game playing").

It is noted that cyber security is not covered at all in the plan despite, for example, the 2021 DarkSide ransomware attack on the Colonial Pipeline and the warnings of similar threats to BESS[8][9]. This is a serious omission. For example, scientists in TŰV Rheinland have shown that BESS are vulnerable to hacking and could be used to dump energy onto the Grid or turn the BESS into a "bomb" [9].

Serious concerns over the lack of cybersecurity in BESS were recently raised by DNV[8]. Given the size of the BESS being proposed in this application, a cyber attack could have significant consequences.

Section 2.10 – Guidelines and Recommendations

2.10.1. It is stated that "Experience from other projects of a similar nature for property protection purposes":

The applicant should provide details about the analyses undertaken and any changes that have been made to their proposal to address the learning points from investigations into previous incidents. This would help to inform and assist the overall assessment of the OBFSMP.

Table 5.
The Australian Country Fire Authority guidelines have not been included, which are a useful resource [2].

Section 2.11- Contributors and consultees
It is correct to state that "Effective stakeholder engagement and consultation is a key requirement of the PA 2008"

The comments made by the FRS and HSE should be given in detail at this stage as it is currently unclear what suggestions have been made and how these have been acted upon.

Section 3 – Purpose and Scope

3.1.1 It is stated that "The scope of this Outline Battery Fire Safety Management Plan covers the life safety, welfare and property protection fire safety requirements of the BESS at Sunnica East Site A, Sunnica East Site B and Sunnica West Site A."

I do not agree that this is the case.

3.1.2 It is stated that
"The purpose of the Outline Battery Fire Safety Management Plan is to demonstrate that the location of BESS within the Scheme does not give rise to a significant increase in fire risk and that any risk that does exist can be addressed by ensuring that the Scheme is constructed, operated and decommissioned in accordance with the approved Outline Battery Fire Safety Management Plan."

I do not consider that this purpose has been achieved with this OBFSMP.

Table 6

Item 2. Emergency Response Plan (ERP).
There are a wealth of templates and guidelines for ERPs available, for example from the NFPA and CFA[2], so it is disappointing that an outline ERP has not been included in the OBFSMP plan. It is essential to protect those attending/ in close proximity to the site that an outline ERP is prepared alongside the OBFSMP. These documents would support each other and ensure that appropriate safety features are designed into the BESS compounds.

Item 3. Location away from residential areas.
There is insufficient evidence presented by the applicants to justify the statement regarding the Unplanned Atmospheric Emissions report that:

"…in the unlikely event that a fire were to break out in a single cell or module, it is considered very unlikely given the control measures that the fire would spread to the rest of the BESS".

Nor that

"the resultant hydrogen fluoride concentration at the closest receptors would be below the level that Public Health England has identified as resulting in notable discomfort to members of the general population" (see later notes on the applicants Unplanned Emissions chapter.

More evidence is required in order to justify the suitability of the BESS location, ideally including the results of actual UL 9540A tests

Regarding the UL 9540A testing, independent review of the results of UL 9540A tests is essential for reasons set out previously (regarding interpretation of test results and the consequent actions that arise from them).

Item 7. Fire detection and suppression.
This will critically depend upon the topography of the battery enclosure, whether container or cabinet. This has not been declared. The FRS response will also be affected by this choice. Cabinets are not explicitly dealt with, which is a major oversight at this planning stage, given that this will determine appropriate safety measures, including water requirements etc.

Items 12 & 13. These sections are confusing. It is not clear if the applicant will employ both gas and smoke detection. No allowance is made for vapour cloud production in the absence of fire as per the McMicken BESS thermal runaway incident in Surprise, Arizona (2019) and Carnegie Road, Liverpool BESS explosion (2020), or of the fact that both heavier than air and lighter than air vapour clouds could be produced[10-12].

This requires clarification before any assessment of the proposals can be made.

Item 15. Water resources.
As with the previous version of the OBFSMP, the significant volumes of water required to deal with a thermal runaway incident have not been given sufficient consideration and this has clearly not been addressed in this latest version. The applicants do not appear to have carried out research into past incidents and in particular about the water requirements used in these situations. This is essential to factor in at the planning stage as it will have consequences on the design and equipment needed for the BESS compounds.

Item 18. Inclusion of Hazard Identification Study (HazID) and Hazard and Operability Study (HAZOP) are examples of Good Practice.

Item 19. Details of the BESS technology.
It is stated "Details of the BESS technology has been provided in Table 3 for each element of the Scheme including cell, module, rack, BESS container enclosure and BESS compound"

This is not correct. The essential details of cell chemistry and form factor, container type (ISO container, cabinet etc), gas sensing system, location of sensors, type of suppression system and the layout of suppression systems etc are not given. These are all essential to know when considering suitable safety measures.

There are no *details* in Table 3 – options only are presented. For this OBFSMP plan to have any validity it should address ALL issues for ALL the options provided in Table 3. In other words, all issues for the two cell chemistries proposed, all issues for container versus cabinet, etc. Only then can an accurate assessment of the suitability of the OBFSMP be made.

Item 25. The removal of contaminated water is an example of Good Practice. It remains the case that the applicant has underestimated the possible water volumes needed.

Item 26. In addition to comments in my initial report I also note that water releasing coatings on containers are suggested.

The Ingress Protection , IP, of containers is not detailed and should be provided. (This is standard nomenclature - IP65 means dust prevention to level 6, water to level 5, as per industry specifications:

[redacted]

Item 30. Residual charge. The applicant has not explained how cells would be discharged and how long this would take (and thus how soon a site could be made safe).

It is stated that "there will be a requirement for first/second responders to analyse the system data".

I consider it unlikely that first/second responders will have the knowledge and experience to analyse system data. This would require a subject matter expert.

Section 4.6.1. Decommissioning.

There is limited information regarding decommissioning. It is not clear on what basis the cells/modules would be assigned for decommissioning. For example, whether this is decided by State-of-Health (SoH i.e. how much maximum capacity remains compared to maximum capacity at the beginning of life) or State-of-Safety.

This is an important consideration as the same risks are present during decommissioning and during installation. Further, the Sunnica scheme would operate for at least 40 years, during which time decommissioning of batteries would be necessary since the batteries do not have such long lifetimes. Decommissioning during the operational lifetime of the scheme also needs to be considered.

It is also surprising that data analytics are not considered at all in the plan.

Section 5.1.2 Mitigation and Control

Table 13

RMM10. It is not clear what trigger temperature(s) would be employed and on what basis. Breaking connection to the external circuit will not stop thermal runaway.

RMM11. Insufficient detail is provided here. The level of cell monitoring, the cell configuration (XS, YP), how this provides effective monitoring, etc., needs to be presented to be able to assess the suitability of the proposals. There are important lessons that can be learned from the 2019 McMicken BESS explosion [10][11].

RMM17. As indicted in my report of the initial OBFSMP, this section is confusing. The term “coincidence detection” requires explanation.
If this refers to the detection of smoke and carbon monoxide to activate an alarm, this needs further consideration.
The positioning of the detectors will be critical given the production of heavier and lighter than air vapour clouds.
In addition, on activation of the alarm: *“The EMS for the BESS container enclosure will engage the first stage alarm and will close access doors, louvres, shut down ventilation system and BESS electrical installation.”*
This would allow the build-up of a potentially explosive vapour cloud should ignition not have occurred and is in conflict with the principles of NFPA 855 (2023).
The vapour cloud hazard does not appear to have been considered in the OBFSMP plan, which is a serious omission (especially considering that such occurrences have resulted in death and serious injury to first responders).

RMM20. The IP rating needs to be specified (see previous comment about this in item 26).

RMM21. Further details about the parameters that will be monitored is required here before any assessments of the suitability of these systems can be made. This is essential to allow early warning of failure.

RMM22 & 23. Further to previous comments (such as those relating to RMM17) this section needs clarification before any assessment can be made

Review of Revised Chapter 16: Other Environmental Topics

Section 16.7.19
Landfill of BESS equipment including batteries.

The applicant has not duly considered waste disposal arising out of the batteries either during the operational lifetime or during decommissioning Landfill of lithium-ion batteries is prohibited in the UK[13].

Review of Revised Appendix 16D: Unplanned Atmospheric Emissions from Battery Energy Storage Systems (BESS)

Overall the applicant's assessment of Unplanned Emissions fails to provide any assurances regarding the potential hazards arising from a likely thermal runaway incident. It fails to consider explosion risk, as a result of the formation vapour clouds. It fails to assess potential emissions arising from the different cell types (NMC and LFP). It fails to account for other toxic emissions that are likely to arise out of thermal runaway events.

Section 2.1.2
The application in general focusses only on the emissions from fire: the documents do not consider the large volumes of vapour cloud that can, and have been, produced. In the Arizona 2019 incident, a heavier-than-air vapour cloud rolling across the prairie in Surprise Arizona an hour after the alarm and deployment of Novec 1230 caused locals to alert the fire service to a prairie fire[10][11].

Despite the fact that only the cells in a single rack went into thermal runaway (c.a. 90 kWh), the vapour cloud was produced for 3 hours and leaked from the container, but sufficient remained to cause a major deflagration with a 75 foot long, 20 foot high fireball when the door was opened. This explosion potential must be factored into the safety features.

Whilst the academic literature also focusses primarily on the fumes from lithium-ion batteries on fire, there are some papers on incidents where ignition has been prevented or simply did not occur, and these provide data on the volume and composition of the vapour cloud.

In addition, Hydrogen Fluoride is not the only hazardous chemical: for example, Hydrogen Cyanide has been detected in vapour clouds. This will burn in fire but is a potential additional hazard regarding the vapour cloud, as are other toxic and combustible compounds.

Section 3.2.1
It is unclear on what basis the emission rate of 1 ug m^{-3} s^{-1} was selected for the modelling calculations. This needs to be explained in order to assess the validity of this.

Section 3.2.2
The emission of vapour cloud rather than smoke has not been considered, which is a major oversight (as per my previous comments).

Section 4.1.4
As stated above – there are too many unknowns at present for this modelling to provide any degree of assurance. For example, this assessment would likely change with a high energy-density cabinet. It would also change as a function of the cell chemistry. All of this needs to be considered to provide valid emission assessments.

Paul Christensen
LITHIUM ION SAFETY

Signed: [redacted]

Dated: 7 Dec 2022

References

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From: [redacted]
To: Cleve Hill Solar Park; [redacted]
Cc: [redacted]
Subject: EN010085 - Cleve Hill Solar Park - The Applicant"s Deadline 3 Submission (email 6 of 7)
Date: 01 August 2019 23:20:11
Attachments: [redacted]

Dear Hefin,

EN010085 - Cleve Hill Solar Park - The Applicant's Deadline 3 Submission (email 6 of 7)

Please find attached the Applicant's Deadline 3 submission.

Please do not hesitate to get in touch if you have any queries.

Kind regards,

Mike

Michael Bird

[redacted]

Arcus
1C Swinegate Court East
3 Swinegate
York
YO1 8AJ

[redacted]

CLEVE HILL SOLAR PARK

OTHER DEADLINE 3 SUBMISSIONS
WRITTEN REPRESENTATION BY THE APPLICANT ON ELECTRICAL SAFETY REGULATIONS AND STANDARDS

August 2019
Revision A

Document Reference: 11.4.1
Submitted: Deadline 3

[redacted]

CLEVE HILL
SOLAR PARK

1 INTRODUCTION AND SUMMARY

1.1 This document comprises a written representation by Cleve Hill Solar Park Ltd ("the Applicant") in relation to the regulations and standards that would govern the construction and operation of the proposed solar array and energy storage facility which is the subject of a DCO application ("Cleve Hill Solar Park").

1.2 As can be noted from the written representation, there is a wide and exhaustive range of obligations that the Applicant would be under in terms of safety when constructing and operating the Cleve Hill Solar Park. Given the importance of these obligations, they bring criminal liability for any breach.

1.3 In addition, the Cleve Hill Solar Park must be constructed in accordance with internationally recognised standards for electrical installation, in order to meet the requirements of National Grid for connection. A summary of the applicable standards are set out below.

2 LEGISLATION

2.1 The Health and Safety at Work Etc. Act 1974 ("HSWA")

2.2 Section 2 of the HSWA provides that an employer owes "general" health and safety duties in respect of the risks arising from its undertaking to its employees, listing matters that the duty extends to include, such as provision and maintenance of plant and systems or work that are safe and without risks to health. There is no definition of "employer" under the HSWA, however, section 53 defines "employee" as "*an individual who works under a contract of employment*", the implication being that the party on the other side of the contract is the employer. In this case, the Applicant does have employees under a contract of employment and hence is an employer under the HSWA.

2.3 This duty is extended[1] to apply broadly to third parties such as members of the public. In this case therefore that includes a duty to ensure the safety of local residents living near Cleve Hill Solar Park.

2.4 In addition to the obvious moral imperative to comply with health and safety law, the duties imposed are subject to an enforcement regime and failure to comply can be treated harshly. A breach of a health and safety duty is a criminal offence punishable by an unlimited fine[2]. Secondary liability also exists for individual directors, officers and managers if a breach of duty is attributable to their "*consent, connivance or neglect*"[3]. An individual convicted of an offence is liable to an unlimited fine and/or a maximum of 2 years imprisonment.

2.5 Following the introduction by the Sentencing Council of the Definitive Sentencing Guideline for Health and Safety Offences and Corporate Manslaughter in 2016 the fines being imposed on organisations has increased significantly even in cases where there has been no injury or death to anyone.

2.5.1 The nature of the duties

2.6 Sections 2 and 3 of the HSWA create absolute duties qualified only by what is reasonably practicable. What is or is not reasonably practicable is not prescribed and will depend on the nature of the circumstances in any individual case. It is a narrower term than what is physically possible[4]. It will usually involve consideration of:

a. The nature of the risk;

b. The foreseeable risk of injury;

c. The gravity of the injury; and

d. Balancing the risk against the sacrifice needed to reduce it further.

2.7 Importantly, the duty requires an employer to ensure against the "risk" of harm and not actual harm[5].

[1] Section 3 of the HSWA
[2] Section 33(1)(a) and Schedule 3A of the HSWA
[3] Section 37(1) of the HSWA
[4] Edwards v National Coal Board [1949] KB704
[5] R v Board of Trustees of Science Museum [1993] 3 ALL ER 853 CA

2.8 These general health and safety duties are not prescriptive; i.e. they do not set out a rigid set of requirements that a duty holder must comply with. However, they exist in parallel with associated regulations that often do set out specific technical legal requirements – in this case the safety of electrical installations.

2.9 Compliance with the general duties and associated regulations is policed by the Health and Safety Executive ("HSE"). The HSE has draconian enforcement powers that are not dependant on bringing criminal prosecutions. For example, where an HSE inspector considers that a duty holder has not complied with its obligations s/he may issue an enforcement notice to either stop a particular activity or requiring changes to be made to meet any perceived risk that the HSE considers has not been managed appropriately; it is a criminal offence not to comply with the requirements of these enforcement notices.

2.9.1 The assessment of risk

2.10 Additional, concurrent duties of risk assessment are set out in regulations. Of particular relevance to the issues here are the Management of Health and Safety at Work Regulations 1999. These would apply throughout the operational lifetime of the facility.

2.11 Regulation 3(1) of the Management Regulations requires a suitable and sufficient assessment of the risks to the health and safety of affected employees and of third parties – such as local residents - arising out of or in connection with the way that the facility is operated.

2.12 **Design risks and the Construction (Design and Management) Regulations 2015 ("CDM")**

2.13 CDM sets out the duties on all those involved in a construction project. This includes the construction "Client", "Designers" and the "Principal Contractor" responsible for actual construction.

2.14 The definition of who is a designer is very wide. It is defined as[6]:

"any person (including a client, contractor or other person referred to in these Regulations) who in the course or furtherance of a business—

(a) prepares or modifies a design; or

(b) arranges for, or instructs, any person under their control to do so,

relating to a structure, or to a product or mechanical or electrical system intended for a particular structure, and a person is deemed to prepare a design where a design is prepared by a person under their control;

2.15 On this definition, the Applicant would be a designer of the Cleve Hill Solar Park.

2.16 CDM requires consideration to be given to issues of design during the early stages of an evolving project.

2.17 The key duties of a designer are[7]:

"When preparing or modifying a design the designer must take into account the general principles of prevention and any pre-construction information to eliminate, so far as is reasonably practicable, foreseeable risks to the health or safety of any person—

[6] Regulation 2 CDM
[7] Regulations 9(2) and (3) CDM

(a) carrying out or liable to be affected by construction work;

(b) maintaining or cleaning a structure; or

(c) using a structure designed as a workplace.

(3) If it is not possible to eliminate these risks, the designer must, so far as is reasonably practicable—

(a) take steps to reduce or, if that is not possible, control the risks through the subsequent design process…. "

2.18 Further specific duties are in place in relation to the construction of project in relation to ensuring that sufficient steps are in place to prevent the risk of injury due to fire[8], and that suitable and sufficient fire fighting equipment, detecting and alarm systems are provided[9].

2.19 In summary, all those involved in the development and design of the facility are required to consider the safety of the overall design as the project evolves. A failure to comply with these obligations is again a criminal offence punishable by an unlimited fine with potential secondary liability for individuals.

2.20 **Regulatory Reform (Fire Safety) Order 2005 ("FSO")**

2.21 The FSO provides that any person who has some level of control in premises must take reasonable steps to reduce the risk from fire and make sure people can safely escape if there is a fire. Premises is very broadly defined, to include "*any place*", such as "*any installation on land*"[10]. Therefore the Cleve Hill Solar Park would fall within its remit.

2.22 Article 8 places a duty on the person in control of the premises to take such general fire precautions as may be reasonably necessary to ensure that employees and the premises are safe. Underneath the general duty are specific requirements including for fire risk assessment of the premises on an ongoing basis[11], institution of fire prevention measures[12], installation of fire fighting and detection equipment[13], maintenance of the premises[14], and provision of staff safety training[15].

2.23 The provisions of the FSO are enforceable by the fire and rescue authority for where the premises are situated, in this case Kent and Medway Fire and Rescue Authority. Enforcement is undertaken by inspectors appointed by the enforcement authority, who have wide powers including to enter premises and make any inquiry as is necessary to ascertain that the premises are compliant with the FSO[16]. The ultimate penalty for breach of the fire safety duties under the FSO is criminal prosecution with a penalty of a fine and up to two years imprisonment.

2.24 **The Building Regulations 2010 ("BR")**

2.25 The construction of most buildings requires compliance with the BR, which set minimum standards for design and construction.

[8] Regulation 29 CDM
[9] Regulation 32 CDM
[10] Article 2 FSO
[11] Article 9 FSO
[12] Article 11 FSO
[13] Article 13 FSO
[14] Article 17 FSO
[15] Article 21 FSO
[16] Article 27 FSO

2.26 The Building Act 1984 gives the Secretary of State power to approve and issue documents containing practical guidance with respect to the requirements contained in the BR. These are known as "Approved Documents" and are aimed broadly at safety. Approved documents A (Structure), B (Fire Safety), and P (Electrical Safety) are relevant to Cleve Hill Solar Park.

2.27 The effect of the BR is that approval must be sought from the local authority or privately appointed approved inspector prior to construction and sign off achieved by that inspector or local authority following completion of works to confirm compliance with the relevant approved documents standard. If this is not obtained, the local authority have enforcement powers under section 36 of the Building Act 1984 to require rectification of non-compliant works. Additional to this, the local authority have power to seek an injunction to stop construction works taking place, or pursue a criminal prosecution where works have been completed.

2.28 **Electricity Safety, Quality and Continuity Regulations 2002 ("ESQCR")**

2.29 The ESQCR provide safety standards for electricity generators, suppliers and distributers, aimed at protecting the general public from danger. The Applicant would be a generator under the ESQCR.

2.30 Specifically, a generator has a duty to ensure that its equipment is constructed, installed and protected, used and maintained to prevent danger[17] (which is defined to include danger to health and life from fire or explosion)[18], including in relation to substations[19], which have a specific requirement to minimise fire risk[20].

2.31 The ESQCR provides for inspections by the Secretary of State to confirm compliance, with the ultimate penalty being criminal prosecution for any breaches.

[17] Regulation 3 ESQCR
[18] Regulation 1(5) ESQCR
[19] Regulation 11 ESQCR
[20] Regulation 11(d) ESQCR

3 SAFETY STANDARDS

3.1 The Cleve Hill Solar Park battery storage installations must be undertaken in accordance with certain international and UK standards in order to meet the requirements of National Grid, as network operator.

3.2 The background for the respective standards organisations are set out below. The Applicant provides this information as compliance with recognised international and national standards and guidance for the design for the Cleve Hill Solar Park will give assurance to interested parties that it is not only fit for purpose, but more importantly safe.

3.3 **The Standards Bodies**

3.4 Below is a brief summary of the three standards bodies that set standards relevant to the Cleve Hill Solar Park infrastructure:

a. The International Electrotechnical Commission ("IEC") is an international standards organization. IEC standards cover a wide range of technologies from power generation, transmission and distribution to home appliances and office equipment, semiconductors, fibre optics, batteries, solar energy, nanotechnology and marine energy. The IEC also manages four global conformity assessment systems that certify whether equipment, system or components conform to its International Standards.

b. The Institution of Engineering and Technology ("IET") is a multidisciplinary professional engineering institution. The IET was formed in 2006 from two separate institutions: the Institution of Electrical Engineers (IEE), dating back to 1871, and the Institution of Incorporated Engineers (IIE) dating back to 1884. In the United Kingdom, the IET has the authority to establish professional registration for the titles of Chartered Engineer, Incorporated Engineer, Engineering Technician, and ICT Technician, as a licensed member institution of the Engineering Council.

c. British Standards Institution ("BSI") is the independent national body responsible for preparing British Standards. It presents the UK view on standards in Europe and at the international level. It is incorporated by the Royal Charter.

3.5 **The Relevant Standards**

3.6 Each of the IEC, IET and BSI have published standards which relate to all or part of Cleve Hill Solar Park.

3.6.1 Electrical installation

3.7 In relation to the whole electrical installation, this will be undertaken in accordance with IET BS7671 18th edition. This standard is co-published by IET and BSI.

3.8 BS 7671:2018 applies to the design, erection and verification of electrical installations. It is used as a standard for various regulations that apply to safety of electrical installations as a standard for compliance.

3.8.1 Energy storage

3.9 The Applicant would highlight that the energy storage component will be constructed in accordance with the following IEC standards:

a. 62933-2-1:2017 – Electrical energy storage (EES) systems - Part 2-1: Unit parameters and testing methods - General specification

b. 62933-1:2018 – Electrical energy storage (EES) systems - Part 1: Vocabulary

c. TS 62933-3-1:2018 – Electrical energy storage (EES) systems - Part 3-1: Planning and performance assessment of electrical energy storage systems - General specification

d. TS 62933-4-1:2017 – Electrical energy storage (EES) systems - Part 4-1: Guidance on environmental issues - General specification

e. TS 62933-5-1:2017 – Electrical energy storage (EES) systems - Part 5-1: Safety considerations for grid-integrated EES systems - General specification

3.9.1 Panels, inverters and transformers

3.10 There are several standards relevant to the solar panels, inverters and transformers. This list is extensive, and are set out in Part 1 of the Appendix to this representation. Part 2 of the Appendix provides a list of the relevant guidance documents that the Applicant can draw upon when constructing and installing this infrastructure.

Appendix

Part 1: Standards

1. BRE NSC, Planning Guidance for the development of large-scale ground mounted solar PV systems, 2013
2. BS 5839-6:2013, Fire detection and fire alarm systems for buildings. Code of practice for the design, installation, commissioning and maintenance of fire detection and fire alarm systems in domestic premises
3. BS 6626:2010, Maintenance of electrical switchgear and contra/gear for voltages above 1 kV and up to and including 36 kV. Code of practice
4. BS 7430:2011, Code of practice for protective earthing of electrical installations
5. BS 7671 :2008+A3:2015, Requirements for Electrical Installations. IET Wiring Regulations
6. BS EN l 990:2002+A1 :2005, Eurocode. Basis of structural design
7. BS EN 1991, Eurocode 7: Actions on structures
8. NA to BS EN 1991-1-3:2003, UK National Annex to Eurocode 1. Actions on structures. General actions. Snow loads
9. NA to BS EN 1991-1-4:2005+Al:2010; UK National Annex to Eurocode 1. Actions on structures. General actions. Wind actions
10. BS EN 50178:1998, Electronic equipment for use in power installations
11. BS EN 50272-1:2010, Safety requirements for secondary batteries and battery installations. General safety information
12. BS EN 50272-2:2001, Safety requirements for secondary batteries and battery installations. Stationary batteries
13. BS EN 50464-1+Al :2012, Three-phase oil-immersed distribution transformers 50 Hz, from 50 kVA to 2,500 kVA with highest voltage for equipment not exceeding 36 kV. General requirements
14. BS EN 50464-2-1:2007, Three-phase oil-immersed distribution transformers 50 H2 from 50 kVA to 2,500 kVA with highest voltage for equipment not exceeding 36 k\ Distribution transformers with cable boxes on the high-voltage and/or low-voltage side.
15. BS EN 50464-2-2:2007, Three-phase oil-immersed distribution transformers 50 Hz, from 50 kVA to 2,500 kVA with highest voltage for equipment not exceeding 36 kV. Distribution transformers with cable boxes on the high-voltage and/or low-voltage side. Cable boxes type 7 for use on distribution transformers meeting the requirements of EN 50464-2-7
16. BS EN 50464-2-3:2007, three-phase oil-immersed distribution transformers 50 Hz, from 50 kVA to 2,500 kVA with highest voltage for equipment not exceeding 36 kV. Distribution transformers with cable boxes on the high-voltage and/or /ow-voltage side. Cable boxes type 2 for use on distribution transformers meeting the requirements of EN 50464-2-1
17. BS EN 50464-3:2007, three-phase oil-immersed distribution transformers 50 Hz, from 50 kVA to 2,500 kVA with highest voltage for equipment not exceeding 36 kV. Determination of the power rating of a transformer loaded with non-sinusoidal currents
18. BS EN 50464-4:2007+Al:201 l, Three-phase oil-immersed distribution transformers 50Hz, from 50 kVA to 2,500 kVA with highest voltage for equipment not exceeding 36 kV. Requirements and tests concerning pressurised corrugated tanks
19. BS EN 50521:2008+Al:2012, Connectors for photovoltaic systems. Safety requirements and tests
20. BS EN 50522:2010, Earthing of power installations exceeding 7 kV AC

21. BS EN 50539-11:2013+A1:2014, Low-voltage surge protective devices. Surge protective devices for specific application including de. Requirements and tests for SPDs in photovoltaic applications
22. PD CLC/TS 50539-12:2013, Low-voltage surge protective devices. Surge protective devices for specific application including de. Selection and application principles. SPDs connected to photovoltaic installations
23. BS EN 50541-1:2011, Three phase dry-type distribution transformers 50 Hz, from l00 kVA to 3, 150 kVA, with highest voltage for equipment not exceeding 36 kV. General requirements
24. BS EN 50541-2, Three phase dry-type distribution transformers 50 Hz, from 700 kVA to 3,750 kVA, with highest voltage for equipment not exceeding 36 kV. Determination of load ability of a transformer loaded with non-sinusoidal current
25. BS EN 50618:2014, Electric cables for photovoltaic systems (BT(DE/NOT)258)
26. BS EN 60076-1:2011, Power transformers. General
27. BS EN 60076-11 :2004, Power transformers. Dry-type transformers
28. BS EN 60947-1:2007+A2:2014, Low-voltage switchgear and control gear. General rules
29. BS EN 60947-2:2006+A2:2013, Low-voltage switchgear and control gear. Circuit breakers
30. BS EN 60947-3:2009+Al:2012, Low-voltage switchgear and contra/gear. Switches, disconnectors, switch-disconnectors and fuse-combination units
31. BS EN 61140:2002+Al:2006, (IEC 61140:2001), Protection against electric shock. Common aspects for installation and equipment
32. BS EN 61557-2:2007, Electrical safety in low voltage distribution systems up to 1,000 v a.c. and 1,500 V d.c. Equipment for testing, measuring or monitoring of protective measures. Insulation resistance
33. BS EN 61557-8:2015, Electrical safety in low voltage distribution systems up to 1,000 v a.c. and 1,500 V d.c. Equipment for testing, measuring or monitoring of protective measures. Insulation monitoring devices for IT systems
34. BS EN 61557-9:2015, Electrical safety in low voltage distribution systems up to 1,000 V a.c. and 1,500 V d.c. Equipment for testing, measuring or monitoring of protective measures. Equipment for insulation fault location in IT systems
35. BS EN 61936:2010-1:2010+Al:2014, Power installations exceeding l kV o.c. Common rules
36. BS EN 62109-1:2010, Safety of power converters for use in photovoltaic power systems. General requirements
37. BS EN 62109-2:2011, Safety of power converters for use in photovoltaic power systems. Particular requirements for inverters
38. BS EN 62020:1999, IEC 62020:1998, Electrical accessories. Residual current monitors for household and similar uses (RCMs)
39. BS EN 62271-200:2012, High-voltage switchgear and control gear. AC metal-enclosed switchgear and control gear for roted voltages above l kV and up to and including 52 kV
40. BS EN 62305-1:2011, Protection Against lightning. General principles
41. BS EN 62305-2:2012, Protection against lightning. Risk management
42. BS EN 62305-3:2011, Protection against lightning. Physical damage to structures and life hazard
43. BS EN 62305-4:2011, Protection against lightning. Electrical and electronic systems within structures
44. BS EN 62446:2009, Grid connected photovoltaic systems. Minimum requirements for system documentation, commissioning tests and inspection
45. CEI 14-4, Power transformers
46. CEI 14-8, Dry power transformers
47. CENELEC HD 464 51:1988, Dry-Type Power Transformers

48. IEC 60269-6:2010, Low-voltage fuses - Part 6: Supplementary requirements for fuse links for the protection of solar photovoltaic energy systems
49. IEC 60694:1996, Common specifications for high-voltage switchgear and contra/gear standards
50. IEC 60726:1982+Al:1986, Dry-type power transformers
51. IEC 61215:2005, Crystalline silicon terrestrial photovoltaic (PV) modules - Design qualification and type approval
52. IEC 61646:2008, Thin-film terrestrial photovoltaic (PV) modules - Design qualification and type approval
53. IEC 61701:2011, Salt mist corrosion testing of photovoltaic (PV) modules
54. IEC 61724:1998, Photovoltaic system performance monitoring - Guidelines for measurement, data exchange and analysis
55. IEC 61730-1:2004+AMD1:2011+AMD2:2013, Photovoltaic (PV) module safety qualification - Part 1: Requirements for construction
56. IEC 61730-2:2004+AMD1:201 l, Photovoltaic (PV) module safety qualification - Part 2: Requirements for testing
57. IEC 62716:2013, Photovoltaic (PV) modules -Ammonia corrosion testing
58. IEC 62804, System voltage durability qualification test for crystalline silicon modules
59. IEC 62930, Electric cables for photovoltaic systems
60. IET Code of Practice for Electrical Safety Management, 2013
61. IET Guidance Note 3: Inspection & Testing, 2015
62. IET Guidance Note 8: Earthing & Bonding, 2015

Part 2: Guidance

1. CIBSE Guide K, Electricity in buildings, 2004
2. CITB-Construction Skills, Solar panel installation - What you need to know to work safely (GSOOl), 2014
3. The Distribution Code and the Guide to the Distribution Code of Licensed Distribution Network Operators of Great Britain, Issue 25, 2014
4. ENA Engineering Recommendation (ER) G5/4, Planning Levels for Harmonic Voltage Distortion and the Connection of Non-Linear Equipment to Transmission Systems and Distribution Networks in the United Kingdom, 2005
5. ENA Engineering Recommendation (ER) G59/3, Recommendations For The Connection Of Generating Plant To The Distribution Systems Of Licensed Distribution Network Operators, 2014
6. ENA Engineering Recommendation (ER) G81, Framework for design and planning, materials specification and installation and record for Greenfield low voltage housing estate installations and associated, new, HV/LV distribution substations. Part 1: Design and Planning, Part 2: Materials Specification, Part 3: Installation and Records, 2008
7. ENA Engineering Recommendation (ER) G81, Part 4: Framework for Design and Planning of Industrial and Commercial Underground Connected Loads up to and Including 11 kV, 2008
8. ENA Engineering Recommendation (ER) G81, Part 5: Framework for Materials Specification for Industrial and Commercial Underground Connected Loads up to and Including 17 kV, 2008
9. ENA Engineering Recommendation (ER) G81, Part 6: Framework for the Installation and Records of Commercial and Industrial Underground Connected Loads up to and Including 11 kV, 2008

10. ENA Engineering Recommendation (ER) G81, Part 7: Framework for Contestable Diversionary and Reinforcement Underground and Overhead Works not Exceeding 33 kV and HV/LV Distribution Substations, 2008
11. ENA Engineering Recommendation (ER) G83/2, Recommendations for the Connection of Type Tested Small-scale Embedded Generators (Up to 76A per Phase) in Parallel with Low-Voltage Distribution Systems, 2012
12. ENA Engineering Recommendation (ER) 534, A Guide for Assessing the Rise of Earth Potential at Substation Sites, 1986
13. ENA Engineering Recommendation (ER) 536, Procedure to Identify and Record "Hot" Substations, 2007
14. ENA Technical Specification (TS) 12-23, Polythene protection tape for buried electricity supply cable, 2013
15. ENA Technical Specification (TS) 12-24, Plastic ducts for buried electric cables, 2014
16. ENA Technical Specification (TS) 35-1, Distribution Transformers (from 76 kVA to 2,000 kVA), Part 7 Common clauses, Part 2 Ground mounted transformers - not close coupled, Part 3 Ground mounted transformers - close-coupled, Part 4 Pole mounted transformers, 2014
17. ENA Technical Specification (TS41-24, Guidelines for the Design, Installation, Testing and Maintenance of Main Earthing Systems in Substations, 2009
18. ENA Technical Specification (TS) 41-36, Switchgear For Service Up To 36 kV. (Cable and Overhead Conductor Connected), 2012
19. ENA Technical Specification (TS) 41-37, Port 1: Switchgear for Use on 66 kV to 132 kV Distribution Systems (Common Clauses), 2004
20. ENA Technical Specification (TS) 41-37, Port 2: GIS Switchgear for Use on 66 kV to 732 kV Distribution Systems, 2004
21. ENA Technical Specification (TS) 41-37, Port 3: Circuit-breakers for Use on 66 kV to 132 kV Distribution Systems, 2004
22. ENA Technical Specification (TS) 41-37, Port 4: Disconnectors and Earthing Switches for Use on 66 kV to 732 kV Distribution Systems, 2004
23. ENA Technical Specification (TS) 97-1, Special backfill materials for cable installations, 1997
24. EU Directive 2012/19/EU, Waste Electrical and Electronic Equipment Directive (WEEE)
25. EU Regulation 548/2014, Eco-design requirements for small, medium and large power transformers
26. Health and Safety Executive, HSG85, Electricity at work: Safe working practices
27. Health and Safety Executive, HSG230, Keeping electrical switchgear safe, 2013
28. Health and Safety Executive, HSR25, Memorandum of guidance on the Electricity at Work Regulations 1989: Guidance on Regulations, 2007
29. Health and Safety Executive, INDG 163 (rev4), Risk assessment. A brief guide to controlling risks in the workplace, 2014
30. Health and Safety Executive, INDG372 (rev l), Electrical switchgear safety. A guide for owners and users, 2013
31. MCS O12 (1.2), Product Certification Scheme Requirements - Pitched Roof Installation Kits, 2013
32. National Joint Utilities Group (NJUG) Volume 1, Guidelines on the Positioning and Colour Coding of Underground Utilities' Apparatus (Issue 8), 2013