[redacted]

From: [redacted] <[redacted]@outlook.com>
Sent: 03 February 2022 16:45
To: [redacted]
Cc: Jacqui Dixon BSc MBA; [redacted] Kerr, Angus
Subject: FW: Official complaint

Caution – This email has been received from outside the NICS network.
Please ensure you can verify the sender's name and email address.
Treat all attachments and links with caution.
FOR INTERNAL NICS STAFF ONLY - If you have any concerns regarding the email please forward to spam@finance-ni.gov.uk.

Dear [redacted]

Official complaint.

As detailed in my e mail below, I formally raise the following complaints:

(1) The failure of Antrim and Newtownabbey Borough Council to take effective timely action to stop an unauthorised development.

(2) The failure by Antrim and Newtownabbey Borough Council to inform residents about an unauthorised development that could endanger lives.

(3) The failure to provide a response to representations made.

(4) Failure to place in the public domain correspondence from all parties relating to the unauthorised development.

(5) The refusing to disclose information pertaining to the unauthorised development requested under EIR regulations.

(6) The refusal to permit public participation in the decision making process.

(7) Failure to seek a new planning application and EIA

(8) The placing of the developer's right to a fair trial above the rights of residents to life.

(9) The acceptance of the material changes, some of which are listed below, without consultation with statutory consultees.

For the avoidance of doubt some of the material changes resulting from the unauthorised development include:

1 Complete change to site layout
2 Increase in size of compound area.
3 Building closer to Doagh Road
4 Raising construction levels
5 Infrastructure moved from rear of building to front of building
6 Increased volume of infrastructure
7 Increased height of infrastructure
8 Removal, due to moving closer to boundaries, of landscaping and planting.

9 Removal, due to moving closer to boundaries, of acoustic barrier.
10 installing water lagoons
11 changing cable routes
12 Water connection
13 Communications connection
14 Intention to install water hydrants
15 Lighting along Doagh Road
16 Increasing battery capacity of each container
17 Increasing size of battery containers
18 Change of cooling fans
19 Change of inverters
20 Placing battery containers closer to residential property.

Due to the refusal to provide information the above list may not be complete. When I have access to the plans for the unauthorised development I will comment further.

Please confirm receipt of this e mail and your stage 1 response to this complaint.

Yours sincerely

[redacted]

From: [redacted]
Sent: 31 January 2022 15:19
To: [redacted] <[redacted]@antrimandnewtownabbey.gov.uk>; [redacted] <[redacted]@antrimandnewtownabbey.gov.uk>; Jacqui Dixon BSc MBA <[redacted]@antrimandnewtownabbey.gov.uk>
Cc: Kerr, Angus <[redacted]@infrastructure-ni.gov.uk>
Subject: FW: Unauthorised unsafe development.

Dear [redacted]

It is now five months since breaches of planning in respect of Kells BESS were notified.

The developer meantime continues to complete the unauthorised development. The extent of the unauthorised infrastructure along the Doagh Road is entirely unacceptable. It appears that battery containers have been sited closer to Number 3 Whappstown Road than was permitted. You are aware that this house could be demolished when the batteries explode. You are aware that the battery containers on site will contain over twice the approved battery capacity. You are aware that noise from the BESS under construction has not been assessed. You are aware that unauthorised water catchment on site will carry toxic fire water to designated sites.

The BESS under construction bears no resemblance to that approved by PAC.

Your refusal to provide residents with any information whatsoever on any possible remedy is not acceptable. It appears that while you tell us about the developers right to a fair trial you ignore our right to life and permit the developer to complete this unauthorised development that has the potential to kill residents.

As previously stated you will have broken the law if you try to grant retrospective planning permission for this unauthorised development.

Please provide us with information on what action has been taken and on what dates that action was taken and what follow up action was taken and when.

If this information is not provided in the next 24 hours please take this e mail as an official complaint regarding

(1)Antrim and Newtownabbey Borough Council's failure to take effective timely action to stop an unauthorised development
(2) failure by Antrim and Newtownabbey Borough Council to inform residents about an unauthorised development that could endanger lives.
(3) Failure to reply to or comment or place in the public domain correspondence from all parties relating to the unauthorised development.
(4) refusing to disclose information under EIR regulations
(3)placing the developers right to a fair trial above the rights of residents to life.

Please place this objection on the portal.

Please reply within 48 hours.

Yours sincerely,

Kells Vocal

3 February 2022

LA05/2021/1117/DC

To Mr David Burns and Mr Conor Hughes, Lisburn and Castlereagh Council

I note the contents of the response from the applicant's consultant to my concerns. I sent you a detailed, reasoned and referenced letter of objection regarding Fire Growth Parameter and a risk classification which was calculated for me to be 'Ultra fast' not 'medium' as claimed in the FRA. The response you have received is purely a statement of opinion on FGP and risk. It is without scientific reference or reference to standards and how they have complied with those standards. The Council must seek independent expert advice to address the issues I have raised, maybe Atkins Ltd as they have already issued a report on the dangers of BESS.

I would note in particular that the figures I supplied are not disputed: the Fire Growth Parameter (FGP), the capacity of the development, the classification of the FGP and so on. These are measures of risk. The scale of the quantities of batteries and their capacity, closely packed on to this site with no mitigation measures taken such as battery reduction per container, spacing of battery racks in containers, fire rating of the containers, fire separation of the containers etc. - none of this is disputed in the response.

In addition please note the original FRA focussed on the Fire Growth Parameter as a key issue of risk. The FRA did not state that it used the beginning of the test as the starting time for the calculation, whereas the referenced scientific experiment (also not disputed by the developer's consultant) used the point of ignition of the battery as the starting time. This is clearly wrong. Imagine a test using a candle which would take a long time to start a fire in a battery. Now compare the same experiment using a flame thrower and the time to start a fire in the battery would be a lot quicker. So using the time it takes for the battery to actually go on fire and adding that time onto the time it actually takes to go from ignition of the battery to it reaching the peak heat point, is just nonsense.

Furthermore, a battery can catch fire from within itself and not from an external source therefore it is the ignition point of the fire in the battery which is the starting point. In addition once the fire takes hold, explosions can take place adding to the dangers of spread of damage between modules and racks.

It is clear that if you are going to cite graphs and calculations from a scientific paper, you must follow the methodology in the paper.

Applying the methodology and figures from the scientific study used in the FRA, the result of the FGP is ‘ultra fast’ - not medium as stated in the FRA.

With an ‘ultra fast’ classification of the FGP, the Council must ask itself: is one of these BESS containers safe? Is the one adjacent to it safe at the distance proposed and without a fire rating of the containers? Is this development safe with this capacity of batteries on this size of a site. This is risk assessment that the Council now needs to carry out and must do so with independent experts in this field if they do not have access to such experts in house.

Why is this important? It is important because if a fire takes hold and explodes there will be significant impacts on neighbours of this development. The HSENI/Atkins report makes this crystal clear. There are people living and working within the zones highlighted in that report. The developer’s consultant’s response makes no reference to our safety at all. It make no reference to the safety of the environment. The Group Commander of the NIFRS has advised that we as neighbours have to be considered and that has not been done. The responsibility for approving or rejecting this report lies entirely with the Council, together with the responsibility for our safety.

Please place this response on the planning portal. As I stated in my previous letter, I have set Planning Application number LA05/2019/0675/F and LA05/2021/1117/DC to be tracked, however, I am not getting a tracking notification alert. I did get a explanation from the council, the Group Commander letter had to be uploaded manually and that was the reason why I did not receive a notification. My letter dated 21 January 2022 has not been uploaded and I did not get a notification of Jenson Hughes letter dated 28 January 2022. Can the Council please look into this.

I await your response.

Yours sincerely
[redacted]


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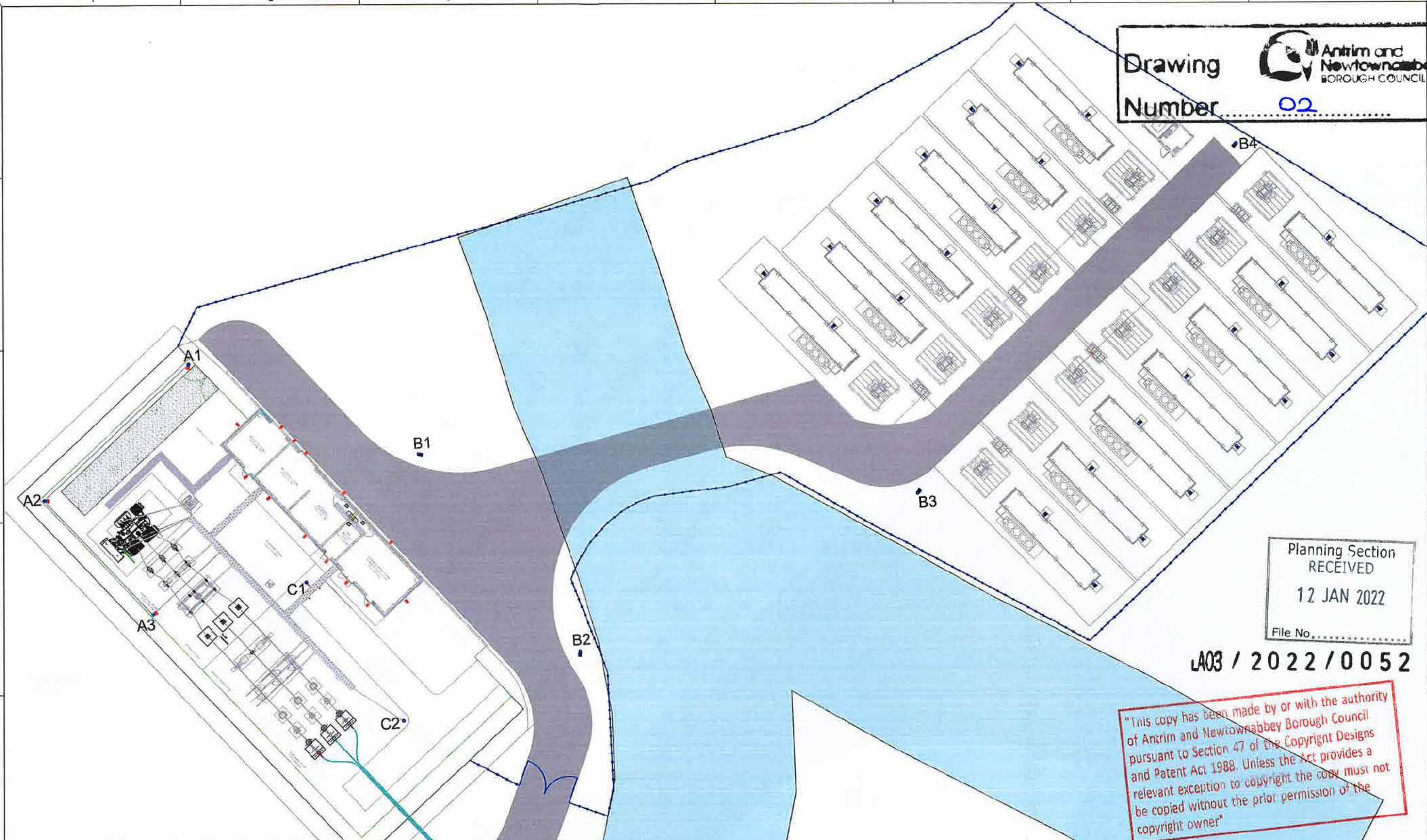
RE: SURE
POLICE WILL BE IMMEDIATELY CALLED

Drawing Number 02

Antrim and Newtownabbey Borough Council



Planning Section RECEIVED 12 JAN 2022 File No.

LA03 / 2022 / 0052

LEGEND

- Substation IPP Lighting on pole (A1, A2, A3)
  please see "DP2021053EX007 - Kells BESS Lighting & CCTV Column_RevA.pdf" and "Kells BESS_Pole mounted light Substation and BESS.pdf" documents
- BESS Lighting on pole (B1, B2, B3, B4)
  please see "DP2021053EX007 - Kells BESS Lighting & CCTV Column_RevA.pdf" and "Kells BESS_Pole mounted light Substation and BESS.pdf" documents
- BESS Lighting - battery containers' entrance doors
  please see "Kells BESS_BESS Lighting - battery containers' entrance doors.pdf" document
- NIE Lighting on pole (C1, C2)
  the specification is detrmined by grid operator NIEN
- BESS & Substation Lightings on control building's walls
  please see "Kells BESS_BESS & Substation Lightings on control building's walls.pdf"

To review the specification of the CCTV cameras please see the following document: "Kells BESS_CCTV_Datasheet.pdf" document

File / Datei: NIKBS_BESS & Substation Lighting Plan.dwg

ABO WIND
Registered company address / Firmensitz
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65195 Wiesbaden
Tel. +49 (0)611 / 26 765 - 0
Fax +49 (0)611 / 26 765 - 599
www.abo-wind.com

Project/Projekt: Battery Energy Storage System KELLs BESS	Map basis: Kartengrundlage:	----	
	Drawn: Gezeichnet: SHP	Project No.: Projekt Nr.:	NIKBS
	Checked: Geprüft: MTA	Code: Code:	BEL_GEL_DWG3014
Plan content/Planinhalt: BESS & Substation Lighting	Approved: Freigegeb.: MAR	Version: Version:	A.13
	Date: Datum: 14.12.2021	Sheet: Seite:	01 of/von: 03
	Format: Format: A3	Scale: Maßstab:	X : XXX

DIN A3

KellsVOCAL
[redacted]
Moorfields
Ballymena
BT42 3DA

1st February 2022

[redacted]
Deputy Director of Planning
Antrim and Newtownabbey Borough Council
Mossley Mill Newtownabbey
BT36 5QA
By e-mail

Letter of objection Kells BESS Ref: LA03/2020/0265/DC- Discharge of Condition 1 - for Kells BESS LA03/2018/0984/F

Dear [redacted]
Planning has partially discharged LA03/2020/0265/DC – Condition 1 – CEMP.

CEMP April 2020 (amended 01/04/2021) -POINT 1.1

> *"It is the purpose of this CEMP to discharge associated Condition 1 requiring a detailed CEMP to be submitted and approved by the Planning Authority. All works will adhere to this plan as approved, thereafter."* (KV underline)

and

> *"A proposed layout drawing showing the consented development is provided in Annex A."*

The CEMP Condition cannot be fully discharged because it pertains to the approved site layout for LA03/2018/0984/F that was passed by PAC. However, as you are aware, the developer has constructed a totally different BESS, which is now under enforcement consideration in LA03/2021/0276/CA.

The ANBC Decision Letter for the CEMP 19/01/2021 states:

> *"The second element of the condition requires the construction work to be carried out in accordance with the specifications in the CEMP and this element can only be discharged once the works are complete…."*

The *works* referred to in the Decision letter can never be completed because the developer has constructed a BESS other than that passed by PAC.

And

> *"The second element of the condition requires the construction work to be carried out in accordance with the specifications in the CEMP."*

The developer's complete departure from the planning application approved by PAC and referenced within the CEMP means that the second element cannot be met*.* ANBC must require the developer to cease construction immediately.

The BESS under construction bears no resemblance to the one approved by PAC. The changes in infrastructure layout, battery container size, battery concentration and overall MW Power/ MWH capacity, which have been introduced by the developer, post-approval, are of a nature and magnitude that cannot be judged non-material.

Clearly, the decision to partially discharge the CEMP must be rescinded because the CEMP is no longer relevant. The BESS that has been constructed is not the one referenced in the CEMP **and all works have not adhered to the plan as approved.**

In addition, the Certificate of Lawfulness of Proposed Use or Development dated 02/09/2021 should be rescinded as the BESS that has been constructed is materially different from that passed at PAC. The developer has not constructed the BESS that is referenced in the site layout drawing attached to the Certificate and stamped LA03/2021/0511/LDP.

> *"this certificate applies only to the extent of the operations described in the First Schedule and to the land specified in the Second Schedule and identified on the attached plan. Any operations which are materially different from that described or which relate to other land may render the owner or occupier liable to enforcement action."*

The Certificate of Lawfulness of Proposed Use or Development was dated 02/09/2021. As early as 7th September 2021 Kells VOCAL emailed the Planning Department asking for information because residents were aware that the layout of the site was not in accordance with what had been approved by PAC. KellsVOCAL then requested Planning to make a site inspection and take enforcement action 23/09/2021. An enforcement case LA03/2021/0276/CA was then opened.

Planning Services must clarify how and why the Certificate of Lawfulness of Proposed Use or Development was issued 02/09/2021 when the construction of an unauthorised site layout was already well underway as reported to Planning by KellsVOCAL.

A new planning application would be required for the BESS that has been constructed.

Will you please ensure that this objection is placed within LA03/2020/0265/DC on the planning portal?

Yours sincerely

[redacted]

Kells
Vocal

N
Issues
134.1
WHAPPSTOWN ROAD
Sinks
Customer switchgear - Refer to P5.300
4.5m Internal roads
137.5
Paladin Fencing
24.500
55.715
Proposed underground Cable Route
110kV Substation - Refer to P8.100
Palisade Substation fencing
New bell mouth from road to form proposed access - Refer to drawing 70052629-102
Visibility Splays [2.4x160m]- Refer to drawing 70052629-102
CCTV and Lighting to be located strategically throughout the site - Refer to P7.100
Battery Container - 25No - Refer to P5.100
Unit Sub - 25No - Refer to P5.200
New security gate and 2.4m security fence to surround site
141.1
143.0
EL P
El P
275kV Kells Sub-station
Planning Section RECEIVED 14 DEC 2018
LA03 / 2018 / 0984
Drawing Number 04A
Antrim and Newtownabbey Borough Council
"This copy has been made by or with the authority of Antrim and Newtownabbey Borough Council pursuant to Section 47 of the Copyright Designs and Patent Act 1988. Unless the Act provides a relevant exception to copyright the copy must not be copied without the prior permission of the copyright owner"
Key:
Land Under Applicant Control
Application Boundary
Sub-station Compound Palisade fencing
Construction Exclusion Zone
Proposed Underground Cable Route
Acoustic Barrier
Drainage Ditch
Paladin Fence
Battery Container + Unit Sub
Customer Switchgear
Site Track
CCTV & Lighting Locations
Retained Trees and Hedges
Proposed Planting
Vegetation to be Removed
Landscaping Updates | Rev A | 14.12.18 | KES
Amendment | amended | Date: | ID:
Stage: Planning
Proj.-no.: NI016
Page no.: P2.100
Date: 22.10.2018
Project: Kells Battery Storage, Co. Antrim
Drawn by: KES
Scale: 1:500@A1
Plan Content: Proposed Site Layout Plan
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Tel. +44 (0) 28 90 996 445

[redacted]
Moorfields
Ballymena
BT42 3DA

Mr Angus Kerr
Chief Planner and Director of Regional Planning
DfI

2nd February 2022

By Email

Objection letter for Kells BESS LA03/2018/0984/F

Dear Mr Kerr

Please find attached a letter of objection for Kells BESS which I have sent to [redacted] of ANBC Planning. It pertains to the partial discharge of the CEMP, Condition 1, imposed by PAC. It is one of a number of objections that you have been copied in to recently. You will note that I believe that the CEMP condition cannot be fully discharged because it does not relate to the BESS that has now been built.

You will be aware that Kells BESS is the subject of an enforcement investigation. The developer has constructed a BESS that is totally different from what was passed by PAC. I believe that the changes that have been made would require a new planning application because consultation with HSENI, NIEA, Environmental Health, DfI Roads and NIFRS is required - the risk to people and the environment, visual impact, drainage, noise, safety of road users, fire risk and fire water containment would need to be assessed for the BESS that has been constructed. In addition, residents have the right to be notified of, and comment on, departures from the approved BESS, that could have an adverse impact on their health, property, and environment.

The developer has constructed a completely different site layout, in which **25 x 2MW power (1MWh capacity) battery containers have been replaced by 13 x 4.1MW power (3.12MWh capacity) battery containers,** 30 metres from the closest residence. I believe that the higher concentration of batteries per container has increased the fire/explosion and toxic gas release risk to human life, property, and the environment in the event of a thermal runaway incident. This is not a non-material change.

A monstrosity of electrical infrastructure items has been built in front of the BESS substation, adjacent to the Doagh Road, contrary to the approved site layout. This is not a non-material change. The Case Officer's Report, relied on by the Commissioner in the PAC Hearing, stated that such infrastructure would lie to the rear of the BESS substation (a large, long pitched roof building that the planners understood would have screened the electrical infrastructure from the road). I have attached the BESS and Substation Lighting Drawing 14/12/2021 to illustrate how this infrastructure has now introduced an unacceptable visual impact along the Doagh Road and a distraction to motorists on a blind summit just before the crossroads. I have also attached the site layout approved at PAC, which you will note contained none of the detailed substation infrastructure now shown in the Lighting drawing, submitted with the application to discharge Condition 8. I have also attached our recently taken photographs.

This planning application was originally refused by ANBC due to visual impact, road safety concerns and noise. These concerns have been heightened by the unauthorised development.

The changes made by the developer are of a magnitude that cannot be judged as non-material. I find it incomprehensible that ANBC Planning continues to consider yet another application to discharge a Condition (Condition 12-Lighting) that references site layout drawings so glaringly different from the layout passed by PAC. I believe that this unauthorised development makes a mockery of the N Ireland planning system.

I urge you to examine what is happening at Kells BESS and to consider the added dangers that this unauthorised development poses for our community. It is now 5 months since KellsVOCAL brought the unauthorised development to ANBC's attention. Despite an ongoing enforcement investigation, the developer has continued throughout to construct a BESS that is contrary to the one approved by PAC.

I would very much appreciate your views on this matter and look forward to hearing from you.

Yours sincerely

[redacted]


PROTECTED BY LIVE CCTV MONITORING
RE: SURE
POLICE WILL BE IMMEDIATELY CALLED
028 8676 1183

[redacted]
Moorfields
Ballymena
BT42 3DA

[redacted]
Deputy Director of Planning
Antrim and Newtownabbey Borough Council
Mossley Mill Newtownabbey
BT36 5QA
By e-mail

23rd January 2022

Regarding Kells BESS – Electrical Infrastructure adjacent to the Doagh Road.

Dear [redacted]

Thank you for your continued assessment of the changes to the Kells BESS.

We have taken photos this weekend of the electrical infrastructure to date which is adjacent and in full view of the Doagh Road.

There are two issues for your consideration:

1. **The development drawings were misleading to the Professional Planners of the Council, the Public and the PAC and as a result the electrical infrastructure has a significantly greater visual impact.**
2. **The electrical infrastructure actually being constructed is much higher and there is more of it than what is shown on the drawings for the Full Planning Permission.**

Point 1.

The Professional Planner's Report to the Council clearly stated that:

> *"The site will be laid out with the substation adjacent to the main Doagh Road, associated switch gear to the rear of this…"*

The drawings submitted to the LPA, and which are still on the portal, P2-100 is a small scale site plan with a dotted box labelled '110kv Substation refer to P8-100'. The latter drawing is a larger scale substation building and electrical infrastructure layout. This drawing has no North point and nowhere on the drawing is there a reference to Substation layout's relationship to the adjacent Doagh Road. However, the Substation Elevations drawing P8-200 are critically labelled FRONT ELEVATION and REAR ELEVATION. The ordinary meaning of FRONT ELEVATION is that elevation that fronts on to the road, and REAR ELEVATION is that elevation that faces away from the road. Your professional planners clearly took the ordinary meaning of FRONT and REAR when they assessed the drawings and compiled their Professional Planners' Report stating:

> *"The site will be laid out with the substation adjacent to the main Doagh Road, associated switch gear to the rear of this…"*

The Professional Planners' interpretation of the applicant's drawings meant that their understanding of the development was that the substation building would itself be a visual screen to the electrical infrastructure from the Doagh Road.

This Professional Planners' report was presented to the Council Planning Committee. It was also presented to the public. I personally understood from the drawings, which was confirmed by the Professional Planner's Report, that the substation would be screening the electrical infrastructure from the Doagh Road and it was a shock to me when all this electrical equipment appeared in full view of the Doagh Road with the substation building behind it.

At the Council Planning Committee Meeting, the Applicant did not take the opportunity to correct the Professional Planners' Report nor provide any clarity that they planned to build the electrical infrastructure adjacent to the Doagh Road with the substation building behind it.

When the case was heard by the PACNI, [redacted] represented the Council Planning Authority. He did not make any statement verbal or written to change the Council's Professional Planners' Report and so it must be taken that he stood over the Professional Planners' Report and the Council's interpretation of the drawings and this became the evidence for the Commissioner. At the PAC Hearing, whilst many minor dimensional changes were presented by the applicant for several hours, at no time did the applicant bring to the attention of the Commissioner that the Professional Planners' Report was incorrect in its reading of their drawings. The matter was not discussed at all and neither is this matter mentioned in the Commissioner's report. It therefore has to be assumed that the Commissioner too took the ordinary meaning of the Substation elevations together with the Professional Planner's reading and assessed the visual impact on that basis and approved it accordingly.

So this community now asks the Council to take immediate enforcement action and to advise the PACNI of the situation that has occurred. Please advise me of your decision and actions.

Point 2.

We have had the opportunity to review the 'REAR ELEVATION' on drawing P8-200 and assessed it against photographs we took of the site this weekend. Clearly the work is unfinished as there is further infrastructure to be installed. However, we have transposed what we can see, and foresee from what is there but at present is unfinished, on to the 'REAR ELEVATION' OF P8-200 on the next page. We attach to this letter both this marked up P8-200 and the photographs taken 23-01-22.

People on this area have already nicknamed it 'CAPE CANAVERAL.

No one can understand how such a flagrant monstrosity could have been approved by the PAC and supported in that approval by the Professional Planners of Antrim and Newtownabbey Council.

Worse still, what is being constructed bears not a veil of resemblance to what was declared on the applicants' drawings. Not in the quantity of infrastructure, nor the heights of the individual pieces of equipment.

What is perfectly clear is that no visual impact assessment was carried out by the Council or the PAC based on the electrical infrastructure that is being constructed in front of the substation and in full view of the Doagh Road.

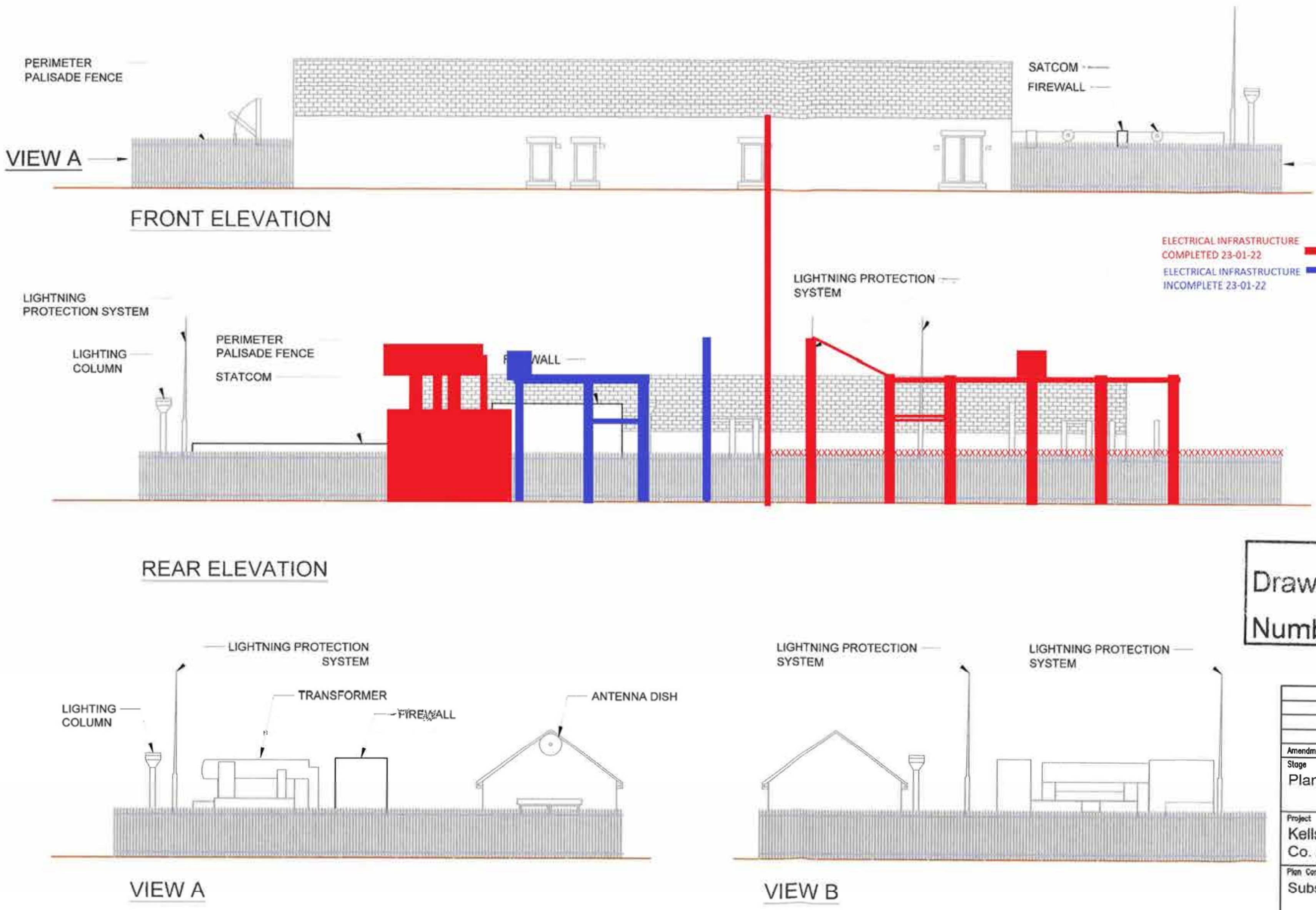
Similarly, no noise impact assessment was ever carried out for this equipment in this layout in this position.

I therefore ask the Council to take immediate enforcement action against this unauthorised development. Please advise me of the actions you have taken.

Yours sincerely

[redacted]

Kells Vocal



Amendment	amended	Date:	ID:
Stage: Planning	Proj.-no.:	NI016	
	Page no.:	P8.200	
	Date:	22.10.2018	
Project: Kells Battery Storage, Co. Antrim	Drawn by:	KES	
	Scale:	1:200@A3	
Plan Content: Substation Elevations			

KELLS BES LTD

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Tel +44 (0) 28 90 996 445

[redacted]

From: Kerr, Angus
Sent: 12 January 2022 15:51
To: [redacted]
Cc: [redacted]
Subject: RE: Update on Declaratory Order

Good afternoon [redacted]

This matter is currently with Judge Humphries. I will let you know as soon as we hear from him.

Regards,

Angus Kerr
Chief Planner & Director of Regional Planning
Department for Infrastructure

Personal Secretary: [redacted]
+44 (0) 28 905 40645 | Ext: [redacted]
[redacted]@infrastructure-ni.gov.uk

From: [redacted] [mailto [redacted]@aol.com]
Sent: 12 January 2022 15:11
To: Kerr, Angus <[redacted]@infrastructure-ni.gov.uk>
Subject: Update on Declaratory Order

Good afternoon Angus
Happy new year to you and I trust you're well.
I was just wondering if you had an update on the Declaratory Order asked for by Judge Humphries? I'd appreciate any update you are at liberty to provide.
Best
[redacted]

Sent from the all-new AOL app for Android

Hazard Assessment of Battery Energy Storage Systems
By [redacted], Atkins Ltd

1 INTRODUCTION

1.1 Scope

HSENI is aware of the hazards associated with large scale lithium-ion Battery Energy Storage System (BESS) sites. Consideration has been given to whether such sites should come under the COMAH and Hazardous Substances Consent Regulations, and following discussions with COMAH colleagues in HSE and HSA the view is that batteries alone would not bring a facility under COMAH (as batteries are regarded as articles and not dangerous substances under CLP).

Nevertheless, HSENI is still interested in the consequences of a fire in a battery container unit as there may be a need for HSENI to provide advice to Local Planning Authorities, comment on an environmental assessment, provide advice to fire fighters or review an operator's own risk assessment.

HSENI is aware that this is a relatively new area, with little available guidance, and has therefore requested that Atkins provide some initial advice based on the following scope:

- Review of incidents involving lithium-ion battery energy storage sites (and manufacturing sites)
- Review of technical papers/information, concentrating on any information relevant to major accident hazards
- Consideration of fire load (associated with the electrolyte)
- Consideration of potential for flammable vapour explosion
- Assessment of HF dispersion toxic hazard ranges to DTL/IDLH using ADMS
- Brief consideration of washout/deposition from fire plumes
- Brief consideration of firewater run-off issue (environmental hazard)
- Summary of key issues

It is emphasised that this Technical Note is only intended to provide brief advice in most of the above areas, and that in some areas there is very little available good information. HSENI has indicated that their main concern is the firefighter who could be facing a fire at one of these facilities, and therefore their principal interest is in the potential toxic fire plume, and potential explosion, associated with a single BESS container. This Technical Note therefore concentrates on those areas.

It is recognised that this has been a rapidly developing area over the last few years, and so the information presented in this Technical Note would benefit from regular review.

1.2 Background

A recent issue of Energy Storage News (11 January 2021) summarises the key hazards for firefighters:

> *Energy storage is a relatively new technology to fire departments across the US. While different fire departments have differing levels of exposure to battery energy storage systems (or BESS for short), the primary concern of each is the same: the safety and well-being of their first responders.*
>
> *Departments and local officials are, however, becoming increasingly aware of the hazards associated with battery storage and it is important that their concerns be properly addressed. Addressing these concerns in a complete and transparent manner has been seen not only to promote overall first responder safety but also to ensure project success. Perhaps the most defining characteristic of lithium-ion battery failures is a state known as 'thermal runaway', in which a battery cell experiences uncontrollable overheating, often accompanied by the release of large quantities of flammable off-gases.*
>
> *Thermal propagation from the failing cell may lead to incipient thermal runaway of adjacent cells, thus creating a cascading failure across the system, resulting in tremendous amounts of heat and gas. When these gases are allowed to accumulate in an enclosed space (such as a BESS container), an explosive atmosphere may develop, which, given an ignition source, may lead to a devastating deflagration (explosion) event. This blast wave can cause damage to nearby buildings and structures, as well as first responders who may be arriving on the scene, as was seen in the incident that unfolded in Arizona in 2019. Deep-seated fires are also common in lithium-ion failure events. These fires are not easily extinguished and may continue for hours, fuelled by heat and gas from cascading cell failures. Even if*

suppressed by water, stranded energy within the cells often causes reignitions, thus perpetuating the event.

Concerns based on environmental risks are also often cited by fire departments across the country. Large quantities of smoke and gas are often released during battery fires, with high levels of carbon monoxide and hydrogen cyanide measured on-site in Arizona at the time of the incident. Contaminated runoff water may also affect the surrounding area. Electrical hazards also exist during and after battery failure events and should not be overlooked.

2 REVIEW OF INCIDENTS

This section provides a brief review of incidents involving lithium-ion cells, and key lessons learned in terms of major hazard assessment. It is not intended to be comprehensive, but highlights important events such as the 2019 McMicken (Arizona) BESS explosion.

2.1 Incidents Involving Single Cells

Many billions of individual lithium-ion cells have been produced worldwide over the last 30 years, and there have been thousands of incidents which have been potentially hazardous. Many of these have been well reported in the press, and some have led to major product recalls. The majority of these incidents relate to Thermal Runaway (TR) events due to a short circuit within a cell between the anode and cathode. Such events are often apparently spontaneous and the precise cause of the short circuit is often not clear. Common causes can include:

- Impact/vibration/penetration
- Manufacturing defect
- Failure of the battery management system
- Overheating
- Overcharging
- Undercharging

It is also noted that as the widespread use of such cells has grown very rapidly, there is relatively little data on incidents that may be related to aging for current cell designs.

Incidents are generally most severe when a cell has a high State of Charge (SOC). Any major failure of a charged cell can lead to the rapid and energetic ejection of the electrolyte liquid, as a short (e.g. 1 to 2 m long) jet flame. It is noted that such failure events with charged cells are highly likely to ignite, but there are also situations where cascading thermal runaway can occur due to heat transfer between cells without any ignition, due to the highly exothermic nature of the thermal runaway.

The precise nature of an incident may depend on the cell size and whether the cell is cylindrical, pouch or prismatic. Large pouch cells are generally used in large scale BESS container units.

2.2 Incidents at BESS Facilities

Table 2-1 lists a number of incidents which have occurred at BESS facilities.

Table 2-1 Incidents at BESS Facilities

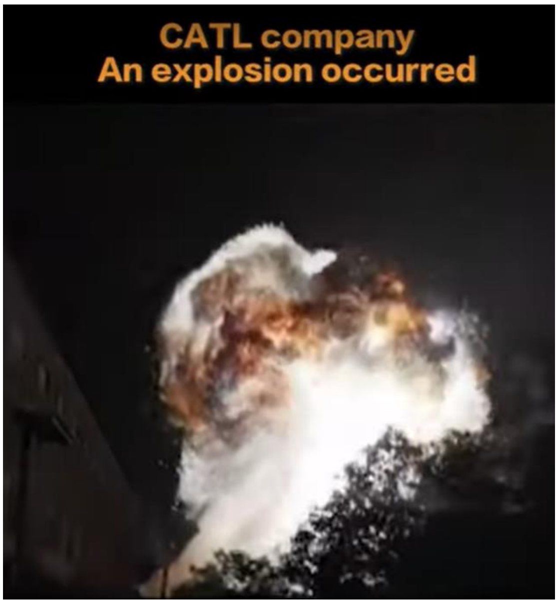
Location (Company)	Date of Incident	Description of Incident
Arizona, USA (Arizona Public Service Company)	Nov 2012	In November of 2012, a fire occurred at a state-of-the-art solar energy storage system that the Arizona Public Service Company (APS) was testing. The system, the relative size of a shipping container with a capacity of 1.5 MW, had been running since February of 2012. Similar to the First Wind fires, the fire department personnel allowed the fire to burn freely for some time. The cause of the fire was not reported. Ref. Blum and Long (2016)
Unknown	2014	A fire in a Li-ion battery storage unit caused an explosion that seriously injured fire fighters. Ref. Ronken (2017)
Yeongju, South Korea	Nov 2018	Fire at lithium-ion PV power plant. Ref. INERIS (2021)
Cheonan, South Korea	Nov 2018	Fire at lithium-ion PV power plant. Ref. INERIS (2021)
Geochang South Korea	Nov 2018	Fire at lithium-ion PV power plant. Ref. INERIS (2021)
Munyeong, South Korea	Nov 2018	Fire at lithium-ion PV power plant. Ref. INERIS (2021)

Location (Company)	Date of Incident	Description of Incident
South Korea Jecheon	Dec 2018	Fire at lithium-ion peak load reduction plant. Ref. INERIS (2021)
Samcheok, South Korea	Dec 2018	Fire at lithium-ion PV power plant. Ref. INERIS (2021)
Yangsan, South Korea	Jan 2019	Fire at lithium-ion peak load reduction plant. Ref. INERIS (2021)
Wando, South Korea	Jan 2019	Fire at lithium-ion PV power plant. Ref. INERIS (2021)
Jangsu, South Korea	Jan 2019	Fire at lithium-ion PV power plant. Ref. INERIS (2021)
Ulsan, South Korea	Jan 2019	Fire at lithium-ion peak load reduction plant. Ref. INERIS (2021)
Chligok, South Korea	May 2019	Fire at lithium-ion PV power plant. Ref. INERIS (2021)
McMicken Substation, Surprise, West Valley, Arizona, USA (Arizona Public Services)	19/4/2019	The incident occurred at two twinned grid-scale energy storage systems of 2 MW / 2 MWh at the McMicken substation. The explosion caused a “significant pressure wave” resulting in the injuries of four firefighters. Technical analysis by certification and standards group DNV GL indicated that the event had begun with internal cell failure in a single LG Chem 0.24 kWh pouch cell in the ESS. The fire suppression system onsite worked as designed, but it was inadequate to prevent or stop the cascading thermal runaway. Heat transfer between the cells in a module, and then between modules, in one of the battery racks caused the thermal runaway to propagate - facilitated by the absence of “adequate thermal barrier protections between battery cells,” which could have stopped or slowed the propagation. Whilst the incident was at first thought to be a fire, it was in fact a cascading thermal runaway from a single cell, through every other cell in the module, and then through all the modules in Rack 15 via heat transfer. It took around two hours from the first report of a suspected fire at the facility, at 17:48 local time on 19 April 2019, to around 20:04 before an explosion happened from inside the BESS. The BESS and its container were “essentially destroyed” and the incident left several firefighters injured. On the day of the incident, the BESS was performing solar smoothing applications - charging during the daytime from local solar generation and discharging electricity to the grid during the evening peak load. Data collected by APS found that just before 5pm on 19 April, there was a sudden drop in voltage during one of the system’s charge cycles. Thermal runaway began shortly after that. Smoke detection systems went into operation but off-gassing of battery cells as the thermal runaway cascaded through neighbouring modules caused a “flammable atmosphere within the BESS,” the DNV GL report said. Then, when firefighters opened the side container door around three hours after thermal runaway began, an explosion occurred within 2-3 minutes, causing the side and rear doors of the BESS as well as other debris to be ejected by the explosion. It is thought that opening the doors agitated flammable gases that remained and brought the gases into contact with a spark or heat source - causing the explosion. Ref. McKinnon, DeCrane and Kerber (2020) – Detailed incident report. DNV GL (2020) – Technical incident report. Energy Storage News (23 April 2019, 29 July 2020, 12 March 2021, 25 March 2021)

Location (Company)	Date of Incident	Description of Incident
Carnegie Road, Liverpool, England (Ørsted) See Figure 2.1	15/9/2020	Large grid battery system container fire at 20 MW BESS site which lasted several hours. Merseyside Fire & Rescue Service, local first-responders, said that crews were alerted shortly before 1am on 15 September and arrived to find a “large grid battery system container well alight”. A "massive bang" was heard as fire crews rushed to tackle the blaze. One resident said he "heard an explosion after midnight" while another said their house "shook”. Five fire engines were immediately on the scene after being alerted at 12.52am to reports of a blaze on Carnegie Road in Tuebrook. The fire service said that it had used main jets and ground monitors in tackling the fire, asking residents nearby to keep their windows and doors closed due to smoke from the incident. The blaze went on for several hours, with an update from the service at 7:30am noting that although operations at the site had been scaled down, firefighting was ongoing, with two ground monitor units and a main water jet still in use. A further update at 11:45am said one fire engine was still at the scene, with firefighting still continuing, although by that stage only one hand-held pump was in use. It was reported that the explosion caused a “significant pressure wave”, causing debris to be thrown between 6 and 20 metres away according to the fire department’s response report. The environmental impact from firewater runoff was also a major concern. Ref. Energy Storage News (16 September 2020 and 25 March 2021) • Fire at 20MW UK battery storage plant in Liverpool - Energy Storage Virtual Summit (solarenergyevents.com)
Ningxiang, Hunan Province, China (CATL Brunp Recycling Technology plant) See Figure 2.2	7/1/2021	Explosion and fire occurred at one of the old workshops of the battery recycling plant - 1 person was killed and 6 were seriously injured. CATL is a battery supplier to Tesla. • https://uk.motor1.com/news/465244/explosion-catl-battery-plant-china/ • #177 Explosion at CATL-owned company #shorts - YouTube

Figure 2.1 Incident at Carnegie Road, Liverpool (15/9/2020)

Figure 2.2 Incident at Ningxiang, Hunan Province, China (7/1/2021)



It is noted that there have been many incidents in Asia relating to BESS facilities, but details are generally scarce or unavailable.

2.3 Incidents at Battery Manufacturing Facilities

Table 2-2 lists a number of incidents which have occurred at battery manufacturing facilities.

Table 2-2 Incidents at Battery Manufacturing Facilities

Location (Company)	Date of Incident	Description of Incident
Koriyama City, Japan	4/11/1995	An explosion occurred at a Sony battery factory in Koriyama City, Japan, where cylindrical lithium-ion batteries for notebook PCs were manufactured. The fire occurred on the floor where batteries underwent final testing. Cells in this location were stored in racks 4-high under ambient temperature conditions. Ultimately, approximately 3 million cells burned, 7,000 m^2 of facility was damaged and two people were injured. Ref. Mikolajczak et al (2011)
Moriguchi, Osaka, Japan (Matsushita Battery Industry Factory)	Aug 1997	An explosion occurred at the Matsushita Battery Industry factory in Moriguchi, Osaka. The owner of the factory, T&T Dream, was a subcontractor for Matsushita. The factory carried out charge/discharge and check processes of cylindrical lithium-ion batteries. Cells in this location were stored on thirteen layers under ambient temperature conditions. Ultimately, approximately 1.22 million cells burned, 1,700 m^2 of facility was burned, buildings within a 175 m radius were damaged, and two people were injured. Ref. Mikolajczak et al (2011)
Karlstein, Germany (BMZ)	Aug 2008	A fire occurred at Batterie-Montage-Zentrum (BMZ) in Karlstein, Germany. The fire destroyed a production area and a warehouse. Ref. Mikolajczak et al (2011)
Pawcatuck, Connecticut, USA (Yardley Technical Products)	Sep 2008	A large format lithium-ion battery that was undergoing testing at Yardney Technical Products in Pawcatuck Connecticut caught fire. Ref. Mikolajczak et al (2011)
Dongguan City, China	2014	Fire in a lithium-ion battery factory in Dongguan City in China, which caused 5 deaths and 6 injuries. Ref. Niu and Li (2018)
China (Samsung SDI battery manufacturing facility)	8/2/2017	The fire occurred in the battery waste area of the factory, after faulty lithium-ion batteries went up in flames. • https://fortune.com/2017/02/09/samsung-battery-factory-explodes/
North Phoenix, Arizona, USA (Gruber Motor Company)	6/5/2017	Pallet of Li batteries caught fire and 5 minutes later the whole building was burning, producing toxic smoke which spread all over the north valley and forced evacuation of nearby buildings. • Fire breaks out at factory that produces lithium batteries - Bing video
Peera Garhi, New Delhi India See Figure 2.3	2/1/2020	Battery factory collapses after explosion in fire during firefighting operations – killing 1 and injuring 19 other firefighters. • Battery Factory In Peeragarhi Collapses During Fire Fighting Operations | CNN News18 (msn.com) • Battery factory collapses in fire in New Delhi, killing 1 (apnews.com)

Figure 2.3 Incident at Peera Garhi, New Delhi, India (2/1/2020)

The incidents in Table 2-2 show that major incidents at battery manufacturing facilities are most likely to occur in the Formation, Aging and Testing stage, where large numbers of cells are being charged for the first time. Such events are less likely at BESS sites as the cells have been through all the necessary testing, but the nature of the potential incidents is similar due to the large number of cells present.

2.4 Other Incidents

Table 2-3 lists a number of incidents which have occurred at other facilities.

Table 2-3 Incidents at Other Facilities

Location (Company)	Date of Incident	Description of Incident
Germany	2017	A major fire broke out in a bicycle warehouse in Germany that also contained a large number of electric bicycles with Li-ion batteries. It proved an extraordinary challenge for the fire brigade and ultimately resulted in a total loss in the warehouse. Four employees suffered minor injuries. Ref. Ronken (2017) • https://rp-online.de/nrw/staedte/emmerich/grossbrand-bei-fahrrad-rose_aid-14299219
Lyons Park industrial estate, Coventry, England	20/2/2020	Factory storing Li batteries goes up in flames. • Factory where lithium batteries stored goes up in flames - CoventryLive (coventrytelegraph.net)

Mikolajczak et al (2011) also lists a number of air transport incidents involving lithium-ion batteries.

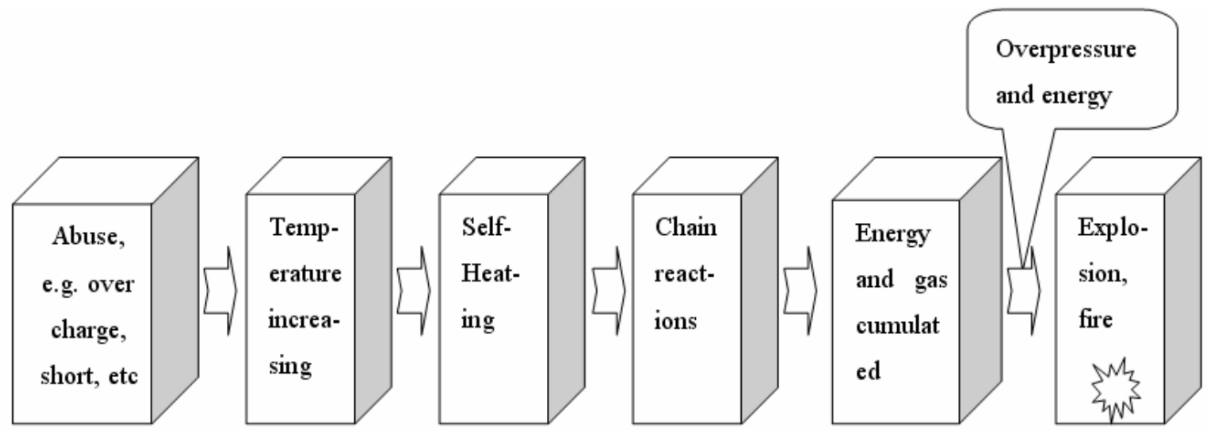
3 REVIEW OF LITERATURE

This section presents a brief literature review concentrating on information which is relevant in terms of major hazard safety issues.

3.1 Published Papers and Reports

Wang, Sun & Chu (2005) provide an overview of how lithium-ion cells can fail, leading to fire and explosion.

Figure 3.1 Development of Cell Failure (Wang, Sun & Chu, 2005)



Ditch and de Vries (2013) and **Ditch (2014)** describe a detailed study of the flammability characterisation of lithium-ion batteries in bulk storage, which tested the effectiveness of sprinklers and measured heat release rates etc. The overall goal was to develop sprinkler protection recommendations for bulk storage of Li-ion batteries. The test results show that fires can develop rapidly, reaching heat release rates of several MW for a single pallet of batteries.

Mikolajczak et al (2011) present a literature review of battery technology, failure modes and events, usage, codes and standards, and a hazard assessment during the life cycle of storage and distribution. The failure modes and root causes are discussed, together with information on flammable cell components and the fire behaviour of cells and battery packs. Key gaps in knowledge, such as the vent gas composition, are identified.

Blum and Long (2016) summarise a literature review and gap analysis related to Li-ion battery ESSs, as well as full-scale fire testing of a 100 kWh Li-ion battery ESS. The overall objective was to help enable the development of safe installation requirements and appropriate emergency response tactics.

Larsson, Andersson, Blomqvist and Mellander (2017) provide a useful study of toxic fluoride emissions from lithium-ion battery fires. It is shown that lithium-ion battery fires generate intense heat and considerable amounts of gas and smoke. It is noted that although the emission of toxic gases can be a larger threat than the heat, the knowledge of such emissions is limited. The paper presents quantitative measurements of heat release and fluoride gas emissions during battery fires for seven different types of commercial lithium-ion batteries. The results are validated using two independent measurement techniques and show that large amounts of hydrogen fluoride (HF) may be generated, ranging between 20 and 200 mg/Wh of nominal battery energy capacity. In addition, 15 to 22 mg/Wh of another potentially toxic gas, phosphoryl fluoride (POF_3), was measured in some of the fire tests. Gas emissions when using water mist as an extinguishing agent were also investigated. It is concluded that fluoride gas emission can pose a serious toxic threat and the results are crucial findings for risk assessment and management, especially for large Li-ion battery packs. The paper states that:

> *If extrapolated for large battery packs the amounts would be 2–20 kg for a 100 kWh battery system, e.g. an electric vehicle and 20–200 kg for a 1000 kWh battery system, e.g. a small stationary energy storage. The immediate dangerous to life or health (IDLH) level for HF is 0.025 g/m^3 (30 ppm) and the lethal 10 minutes HF toxicity value (AEGL-3) is 0.0139 g/m^3 (170 ppm). The release of hydrogen fluoride from a Li-ion battery fire can therefore be a severe risk and an even greater risk in confined or semi-confined spaces.*

Ronken (2017) also describes the risks and safety measures required for lithium-ion batteries, and emphasises the importance of a suitable risk assessment. Several incidents are also identified (see Section 2.2).

Niu and Li (2018) describe a fire risk assessment method for use in lithium-ion battery factories, and summarise the key areas where fire risks are significant, based on experience with such facilities in China. It is suggested that in the event of a short circuit, lithium can react with the various electrolyte components (ethylene carbonate, propylene carbonate, dimethyl carbonate) to form flammable gases such as propene (C_3H_6). A risk matrix is used to assess all stages of the battery manufacturing process. Several events are identified as likely to result in severe injury, but none are identified as likely to result in death. Serious events such as the spontaneous ignition of batteries in storage are identified as unlikely to happen in a lifetime.

Finegan et al (2019) describe detailed experiments where internal short circuits (ISCs) were caused in cylindrical 18650 cells. These ISCs cause the Li-ion battery to fail catastrophically due to thermal runaway. That is, at a critical temperature and in the presence of non-aqueous liquid electrolytes and oxygen, the active materials within a Li-ion battery can exothermically react. Exothermic reactions can become self-sustaining when local heat generation is greater than heat dissipation, resulting in violent combustion and total cell failure. During thermal runaway, it is estimated that about 2 litres of gas is generated per amp hour (Ah) of commercial $LiFePO_4$ and $LiNi_xCo_yAl_zO_2$ 18650 cells. It is noted that modern 18650 cells have capacities greater than 3 Ah, and can generate more than 6 litres of gas within about 2 seconds during thermal runaway, which is mostly flammable. In this short time (< 2 seconds), more than 70 kJ of heat can also be generated.

The Department for Business, Energy & Industrial Strategy (BEIS, 2020) reviewed the safety risks associated with domestic battery energy storage systems. The authors state that even though few incidents with domestic battery energy storage systems (BESSs) are known in the public domain, the use of large batteries in the domestic environment represents a safety hazard. Three hazard categories are identified:

- Excessive heat generated deep inside a battery pack as cells fail and thermal runaway propagates through the pack, highlights the need to design packs to minimize risk for propagation and limit spread of fire between cells/modules. Early detection and means for cooling individual cells as they begin to fail are important for avoiding thermal runaway of the full system.
- Cell and pack failures can generate large volumes of gases resulting from the rapid pressure build-up and vent release as the system heats up. Management of gases generated must be considered in pack and system design.
- The toxicity of gases generated from battery fires may require specific consideration in the design of ventilation systems.

Key considerations regarding risk mitigation are summarised as:

- The Battery Management System (BMS) has a central role in keeping cells within their operating window for voltage, current and temperature. BESS safety standards have specific requirements and tests which apply for the BMS.
- Internal cell faults, though rare, do occur. For well-constructed 18650 cells, the failure rate from an internal event is estimated as one in ten million (0.1 ppm). This translates to a single cell failure in every 10,000 BESS (assuming a 5 kWh BESS containing 500 18650 cells). This is not to say that 1 in 10,000 BESSs will fail, with significant risk of fire. Proper BESS design and construction should be capable of preventing propagation of cell failure across the battery pack. A single cell failure should be controllable.
- If the system is well designed, it should take into consideration propagation of a thermal event arising from a single cell. This is of great importance for the risk mitigation and will have a large impact on the overall risk assessment for the system. Control of single cell failures within a pack reduces the risk of complete system failure and residential fire. Assessment of cell failure propagation is captured in the standards applicable for domestic lithium-ion battery storage systems such as BS EN 62619 and IEC 62933-5-2.

The BEIS report also provides some statistics for the likelihood of failures, although it doesn't deal with large scale BESS installations. Hydrogen fluoride, CO and CO_2 are all identified as potential toxic combustion products following a thermal runaway. The potential for an explosion is also mentioned, either as a result of a cell failing violently due to an internal build-up of pressure, or as a result of ignition of flammable gases released from a cell. The total heat released during total combustion of lithium-ion batteries ranges from 30 to 50 kJ/Wh, or 4 to 10 MJ/kg, which is about 5-10 times less than for organic materials like plastic or paper. No projectiles were observed in any full scale testing of larger racks of batteries for energy storage systems. The violence of thermal runaway, and the gas volume generated, tends to increase with SOC.

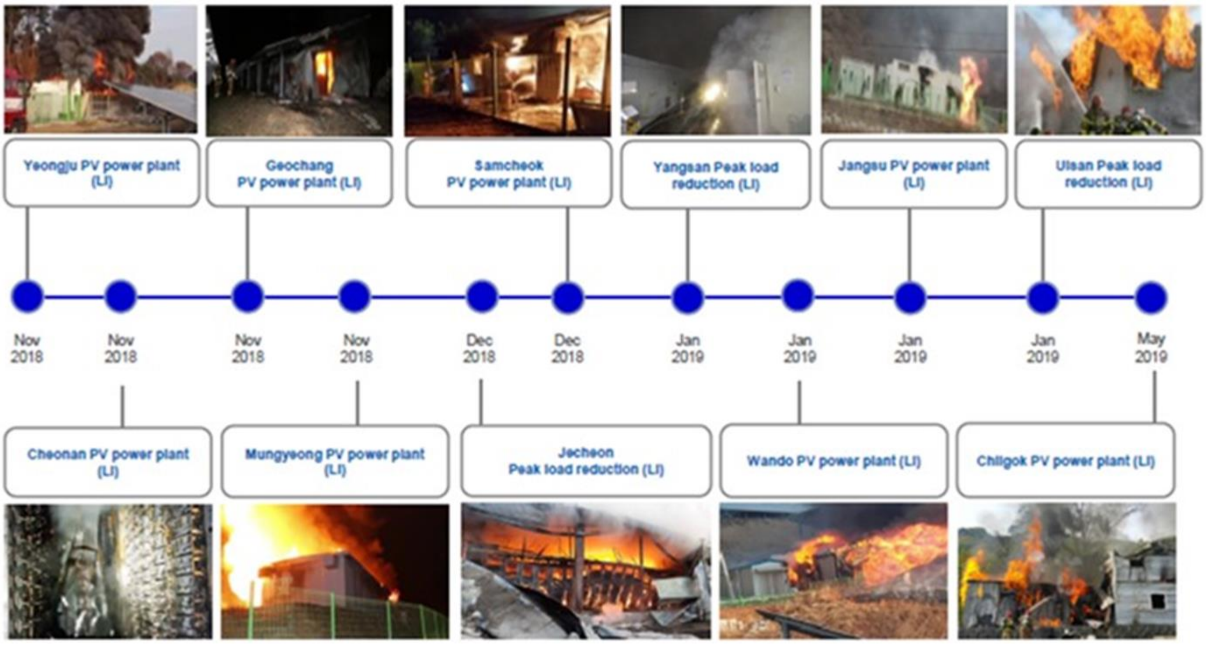
The BEIS report discusses the vent gases that can be generated, including volatile organic compounds (such as alkylcarbonates, methane, ethylene and ethane), hydrogen, carbon monoxide, carbon dioxide, soot and other particulates containing nickel, cobalt, lithium, aluminium, copper. The authors note that a major point of discussion is the amount of HF and other fluorinated compounds found in vent gases, because of their toxicity, and that this is still an open question. Some tests have indicated HF concentrations well in excess of 100 ppm.

Diaz et al (2020) provide a comprehensive review of fire safety information for lithium-ion batteries. The authors note that the majority of research has considered single cells, and there is much less safety information relating to larger scale fires involving pack, modules, or large numbers of cells. The review includes information on the various challenges faced by the industry, including detection and reliability issues and emergency response challenges. The use of water for fire fighting appears to be preferred, although there are still issues with reignition.

Rosewater et al (2020) presents a systematic hazard analysis of a hypothetical, grid scale lithium-ion battery powerplant to produce sociotechnical 'design objectives' for system safety. This includes key considerations for firefighter training objectives.

INERIS (March 2021) recently presented an overview of the lithium-ion cell assessments and modelling that they are currently undertaking in France. The presentation included brief details of fires at large scale energy storage sites in South Korea, as illustrated in Figure 3.2.

Figure 3.2 Examples of Fires at BESS Sites in South Korea (INERIS, 2021)



It was concluded that there was no single root cause for these events.

INERIS noted that there have been similar fires in Belgium, UK, France, US (Arizona) and Australia. A number of issues and uncertainties were identified in relation to fire protection and firefighting for such sites:

- Fixed fire fighting systems: water (sprinklers, water mist)?, Foam?, Inert gas?, Others?
- Fire fighter capacities for such a fire: drowning a battery container in water is not really an option
- Safety aspect of emergency response: gas toxicity and explosivity

One conclusion from their presentation was that the toxic combustion products from a small fire involving a lithium-ion battery are generally not significantly more hazardous than a comparable sized fire with packaging and plastics etc. However, for a large fire involving many lithium-ion cells, the view expressed was that the HF vapour was the most significant toxic concern.

3.2 Project Specific References

HSENI has provided several documents which relate to BESS sites. These are considered briefly below in terms of the key data which is relevant in terms of the assessment of major hazards.

Haigh (2020) provides an analysis of what might occur under a loss of control scenario at the Kells BESS and what chemical reactions might take place. The site is described as having a total energy capacity of 26.3 MWh with:

25 ISO containers
28 racks in each ISO container
6 modules in each rack
22 lithium-ion cells in each module

The total quantity of electrolyte on site is 28.6 tonnes, together with 9.5 tonnes of polyvinylidene difluoride, all of which may generate HF in a fire. A fire involving a single container is predicted to generate 20 to 210 kg of HF. This corresponds to 19 to 200 mg/Wh, consistent with the range suggested by Larsson et al (2017).

Marks (2020) provides technical details for the Newry Energy Storage Ltd BESS located approximately 85 m North of No. 68 Cloghanramer Road, Newry, BT34 1QG. The site is described as having a total energy capacity of 18.635 MWh with:

5 ISO containers (3,727,000 Wh for each ISO container)
10 racks in each ISO container (372,700 Wh for each rack)
26 modules in each rack (14,336 Wh for each module)
16 lithium iron phosphate (LFP) cells in each module (896 Wh for each cell)

Each of the 20,800 cells on site, each with a mass of 5.46 kg, includes:

540 g of polyvinylidenefluoride-hexafluoropropylene copolymer (PVDF-HFP)
486 g of ethylene carbonate
432 g of dimethyl carbonate
432 g of propylene carbonate
378 g of diethyl carbonate
378 g of ethyl methyl carbonate
162 g of lithium hexafluorophosphate ($LiPF_6$)

It is predicted that a full stoichiometric decomposition of $LiPF_6$ will generate 4 moles of HF (plus other fluorine compounds). This corresponds to 354.2 kg of HF per ISO container. Similarly, a full stoichiometric decomposition of the PVDF-HFP would generate 1,679 kg of HF. Marks states that these stoichiometric results are considered worst case, and a more foreseeable prediction is based on the work of Larsson et al (2017) (i.e. 200 mg/Wh) giving 738 kg of HF per ISO container.

3.3 Standards

Standards for energy storage systems include:

NFPA 855 - Standard for the Installation of Stationary Energy Storage Systems, 2020
This debut edition addresses the dangers of toxic and flammable gases, stranded energy, and increased fire intensity associated with BESS sites. It is designed to give first responders and those who design, build, maintain, and inspect facilities the information they need to prepare for ESS safety.

IEC 62619 - Secondary cells and batteries containing alkaline or other non-acid electrolytes - Safety requirements for secondary lithium cells and batteries, for use in industrial applications, 2017
Specifies requirements and tests for the safe operation of secondary lithium cells and batteries used in industrial applications including stationary applications.

There are obviously many other standards which are important, but the above are some of the most directly relevant. NFPA 855 is one of the most useful in terms of major hazard and firefighting considerations.

4 CONSIDERATION OF FIRE LOAD

The main fire load within a BESS container is the electrolyte within each cell. The precise composition of the electrolyte generally involves several flammable liquids and lithium hexaflurophosphate, as detailed in Section 3.2 by Marks (2020).

The overall heat of combustion of the electrolyte is approximately 20,000 kJ/kg.

Electrolyte typically makes up about 40% of the mass of a cell in a BESS. For other cell designs, such as cylinder cells, it is typically closer to 15% of the mass.

Any fire is likely to start as a result of failure of a single cell, which then escalates by involving progressively more cells. In the very early stages, the fire may not be ventilation controlled, but the container would rapidly begin to fill with combustion products, and the fire would become ventilation controlled. If the container becomes breached then the fire will no longer be ventilation controlled.

The growth of the fire is therefore likely to be similar to fire growth in other situations, such as a warehouse fire, although the rate of fire growth is likely to be higher due to the exothermic nature of the thermal runaway event.

For the purposes of assessing the fire, a conservative assumption typically adopted by the HSE is that the entire contents are combusted over a relatively short period of 30 minutes (Atkinson and Briggs, 2019). This assumption can be useful for defining a heat release rate and maximum source term for toxic combustion products, but it is noted that in reality such fires could continue to burn for many hours. Lithium-ion fires are also well known for re-igniting after having been apparently extinguished.

5 POTENTIAL FOR EXPLOSION

The potential for explosion during the course of a major incident in a BESS ISO container is an important issue which has recently become better understood following several incidents.

It is well known that individual cells may fail explosively due to the build-up of pressure within the cell, but this will depend on the cell design. Pouch cells tend to fail easily on seams, and so, considered individually, may be less likely to explode than, for example, cylinder cells. However, when pouch cells are packed into a module it may be more difficult for gases to vent, and so an explosion may still be possible. The energy of such an explosion would depend on the module design. Such an event could produce a loud bang as the module fails, but the event is likely to be contained within the ISO container.

More significantly, it is also known that cell failures can generate quantities of flammable vapour. If a 10 Wh 18650 cell can generate 6 litres of gas (Finegan et al, 2019), an 896 Wh pouch cell could theoretically generate over 500 litres of flammable vapour. Several such failures could occur before the vapour ignites. Suppression systems can prevent flaming, though flammable vent gases can continue to be released due to cascading thermal runaway as a result of heat transfer between cells and modules. Ignition can then lead to a vapour cloud explosion (VCE) within the ISO container. The worst case is if such flammable vapour fills the entire ISO container (typical dimensions are 40 x 8 x 8.5 feet, or 77 m^3). It is noted that the 2019 McMicken incident only involved thermal runaway of the cells in a single rack, and this was still sufficient to generate enough flammable gas for a significant explosion.

Table 5-1 provides hazard ranges to various levels of overpressure for hydrocarbon vapour cloud volumes of 0.5, 5 and 50 m^3, based on a standard analysis using the TNO Multi-Energy Model with a typical ignition strength of 7 (based on the type of approach typically adopted by HSEGB for VCEs).

Table 5-1 Distances to Various Levels of Explosion Overpressure

Volume of vapour involved (m^3)	0.5 m^3	5 m^3	50 m^3
	Distance (m) to various levels of overpressure		
600 mbar	2	5	10
300 mbar	3	7	16
140 mbar	6	12	26
70 mbar	10	21	45

Any flammable vapours released from cells may be ignited almost immediately, without any generation of overpressure, but there have been several incidents where explosions have been reported in containers. This delayed ignition of vapour can occur if a fire suppression system prevents flaming. Continued release of vent gases from failed cells after the suppression system operates can then lead to a build-up of flammable gas, which can then ignite leading to an explosion. There have also been incidents with no suppression system where a build-up of flammable gas has occurred without a fire, until delayed ignition caused an explosion.

It is noted that HSEGB typically use 600, 140 and 70 mbar as the basis for defining the Inner, Middle and Outer land use planning zones for explosion hazards.

Table 5-2 provides some data from HSE (2005) on the effect on structures of various levels of blast overpressure.

Table 5-2 Effect of Various Levels of Explosion Overpressure

Damage Description	Incident Peak Side-On Overpressure (mbar)
General effects on buildings	
5% of exposed glass panes broken	1-3
50% of exposed glass panes broken	6-13
Near 100% of exposed glass panes broken	50-110
Limited minor structural damage	20-30
Doors and window frames may be blown in	50-90
Partial demolition of houses - rendered uninhabitable	70
Lower limit of serious structural damage	140
Partial collapse of walls and roofs of houses	140
Nearly complete destruction of houses	340-480
Probable total destruction of houses	690
Effects on UK brick built houses	
Category A damage (completely demolished)	690-1830
Category B damage (badly damaged and beyond repair)	240-590
Category Cb damage (uninhabitable without extensive repairs)	140-240
Category Ca damage (uninhabitable but repairable)	70-120
Category D damage (inhabitable but repairs required)	20-50
50% destruction of brickwork	280-480
Effects on plant	
Reinforced structures distort and unpressurised storage tanks fail	210-340
Wagons and plant items overturned	340-480
Extensive damage	>480
Failure of a pressurised storage sphere	>700

A recent Energy Storage News (25 March 2021a) focussed on the potential explosion issue at BESS sites, stating:

> *The challenges of explosion prevention – with flammable gases needing to be vented "very rapidly" – in the event of a battery fire have been highlighted at this week's Energy Storage Summit USA.*
>
> *Speaking at the event, hosted by our publisher Solar Media, Matthew Paiss, technical advisor, battery materials & systems at Pacific Northwest National Laboratory (PNNL), referenced the two most recent high-profile battery fires, with one at utility Arizona Public Services's (APS) energy storage facility in 2019 and one at Ørsted's 20 MW project in Liverpool, England in 2020.*
>
> *Both explosions caused a "significant pressure wave", with the APS incident resulting in the injuries of four firefighters and the Liverpool incident causing debris to be thrown between six and 20 meters away according to the fire department's response report.*
>
> *Paiss explained that there are "many similar battery enclosures operating today that could experience the exact same kind of failure".*
>
> *He said that most systems being deployed today do include a deflagration vent – which is used to vent gases after deflagration occurs – but "what is not very common in systems is deflagration prevention" which he described as typically being a mechanical exhaust system.*

It was also stated (Energy Storage News, 25 March 2021b) that:

Per Onnerud … said that statistically, some failures will always happen.

While some experts have said that failure may only occur in one of every 10 million battery cells, energy storage projects are getting larger and contain more cells. Meanwhile the cells themselves are individually getting larger and therefore produce more gas if active materials like electrolyte catch fire.

Explosions caused by that gas and fires caused by propagation should not be acceptable, Onnerud said. Battery design should be such that failures should be prepared for, and so that those failures can be dealt with "elegantly".

The incident report for the 2019 McMicken Arizona incident (McKinnon, DeCrane and Kerber, 2020) provides photos which show that, when the fire service arrived, there was a low level cloud of vapour around the container (possibly associated with the suppression system), as shown in Figure 5.1.

Figure 5.1 Photos of ESS Prior to Explosion (McKinnon, DeCrane and Kerber, 2020)

When firefighters were satisfied that HCN and CO concentration had dissipated sufficiently, they proceeded to open the container door. The report describes what then happened to the four firefighters, stating:

At the moment of the deflagration event, the firefighters outside the hot zone described hearing a loud noise and seeing a jet of flame that extended at least 75 ft outward and an estimated 20 ft vertically from the southeast-facing door. In the event, E193 Capt and E193 FE were ballistically propelled against and under the chain-link fence that surrounded the ESS. E193 Capt came to rest approximately 73 ft from the opened door beneath a bush that had ignited in the event. E193 FE came to rest approximately 30 ft from the opened door. HM193 FF1 was projected toward the transformer and distribution box to the east of the ESS and remained within the fenced area. The entire HAZMAT team lost consciousness in the deflagration event. The event also dislodged or removed the SCBA face pieces and helmets from all of the HAZMAT team members.

6 ASSESSMENT OF TOXIC FIRE PLUME

The literature is clear that a wide range of toxic combustion products could be generated in a fire. However, there seems to be reasonable agreement that for a major fire the most significant in terms of toxicity is hydrogen fluoride.

The quantity of HF generated can be estimated based on stoichiometric decomposition, or on experimental data. The approach of Larsson et al (2017), who suggest 20 to 200 mg/Wh based on experimental data, seems to be the most widely adopted approach, and use of the upper bound is likely to provide a cautious best estimate. For a fire involving an entire 5 MWh ISO container (i.e. slightly more than the 3.7 MWh ISO containers at Newry) this would correspond to 1,000 kg of HF.

The duration of the release is conservatively taken to be 30 minutes, which is consistent with the approach recommended by Atkinson and Briggs (2019) for warehouse fires. This implies a release rate of 0.56 kg/s. It is emphasised that in reality there would not be a constant release rate for 30 minutes, but it would grow exponentially to a maximum before gradually decaying over much longer than 30 minutes. However, it is noted that the HSE SLOT and SLOD are based on integrated dose, and so the precise time variation is not important for such criteria.

The other key factor in any toxic fire plume dispersion assessment is the buoyancy of the fire plume, as defined by the convective heat content of the fire plume. The major source of any heat release is likely to be the electrolyte, of which there could be up to about 10 tonnes in a single ISO container. Based on a typical heat of combustion of 20 MJ/kg for the electrolyte, and a release duration of 30 minutes, this would correspond to about 100 MW. In practice, combustion would not be complete and only a fraction would become convective heat in the fire plume (see below). It is noted that BEIS (2020) indicated a heat release of 30 to 50 kJ/Wh, which would correspond to 83 to 138 MW over 1800 seconds for a 5 MWh facility, which is reasonably consistent with the value of 100 MW.

Any generation of HF which is released from the ISO container will be advected downwind, though the plume will tend to rise due to the buoyancy of the hot fire plume. The container may also entrain some or all of the fire plume into its downwind wake, which may spread the plume out and bring it down to ground level, depending primarily on the wind speed.

The dispersion of a fire plume depends principally on the wind speed. At low wind speeds, a fire plume tends to rise buoyantly (see Figure 2.1) and ground level concentrations tend not to be significant. At higher wind speeds, there is generally more dilution of the plume, but it may not lift off the ground, and so moderate to high wind speeds generally represent the worst case for such fire plumes. A range of weather conditions has therefore been considered, namely D2, D5, D10 and F2. It is noted that atmospheric stability may also have some effect, and so stable F2 conditions have also been considered, although (unlike many toxic gas assessments) it is not expected that F2 will be the worst case in terms of hazard ranges.

As noted above, the heat content of the fire plume is a key parameter in determining the degree of buoyant plume rise - a higher heat flux leads to greater plume rise and lower ground level concentrations. Based on CERC (2018), the heat flux is typically calculated as:

$$F_b = (1 - \alpha_r)\,\varepsilon\,H_c\,m$$

Where F_b = Heat flux (W)
α_r = Fraction of heat radiated (typically 0.3)
ε = Efficiency of combustion (taken as 0.5)
H_c = Heat of combustion (J/kg) - taken as 2×10^7 J/kg (based on electrolyte)
m = Mass rate of combustion (kg/s) (taken as 1,000 kg of electrolyte over 1800 seconds)

This suggests a relatively high heat flux of 4 MW.

However, in view of the considerable uncertainty associated with making such an estimate of the effective heat flux, and the extent of possible heat losses (e.g. to sprinkler water) the approach adopted was to assume an effective source diameter of 5 m, with a flux of hot air with a vertical velocity of 1 m/s and an excess temperature of 100°C. This corresponds to a lower heat flux of $\pi \times 2.5^2 \times 1 \times 100 \times 1012 \times 0.9 / 10^6 = 1.8$ MW (NB heat capacity of air is 1012 J/°C/kg, density of air at 115°C is 0.9 kg/m^3). The source was conservatively assumed to be located on the lee side of the ISO container at a height of 1 m, leading to significant entrainment in the wake of the container.

Dispersion modelling of the HF releases has been conducted using ADMS 5.2.4 which is well suited to modelling the dispersion of such fire plume releases. In addition to the source term and weather categories referred to above, the following input data has also been used in ADMS.

ISO container dimensions	2.6 m high, 2.4m wide, 12.2 m long
Atmospheric temperature	15°C
Surface roughness length	0.1 m
Surface energy flux	0 kW/m^2 for D2, D5 and D10 conditions; -6 kW/m^2 for F2 conditions
Boundary layer height	800 m for D2, D5 and D10 conditions; 100 m for F2 conditions
Relative humidity	65%
Averaging time	30 minutes

Most of these parameters have relatively little effect on the dispersion results; the most significant inputs being the wind speed and heat flux. The entrainment of the release in the container wake has been included in the ADMS modelling. This entrainment increases as the wind speed increases, and in D10 conditions the release is almost fully entrained in the container wake and the plume centreline is effectively at ground level.

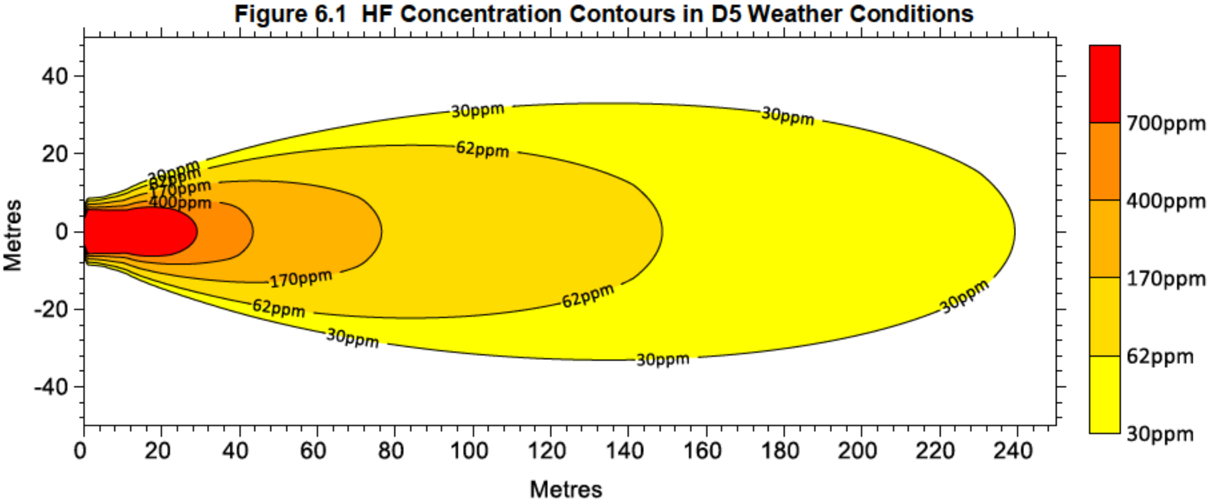
Table 6.1 presents results for the downwind hazard ranges to the HF IDLH, AEGL (10 and 30 minute), HSE SLOT and HSE SLOD for each of the representative weather categories.

Table 6.1 Outdoor Hazard Ranges to SLOT for HF Releases

Criterion	Concentration (ppm)	Outdoor hazard range (m)			
		D2	D5	D10	F2
IDLH	30	85	240	200	85
AELG-3 (30 min)	62	50	150	130	50
AELG-3 (10 min)	170	25	80	70	25
SLOT	400	20	45	40	20
SLOD	700	15	30	30	15

Table 6.1 shows that the worst case hazard ranges tend to occur at moderate wind speeds of 5 m/s. At this wind speed the plume rise is not very significant. As the wind speed increases, the plume rise still decreases, but this is more than compensated by the additional dilution. Figure 6.1 illustrates the ground level concentration results for the worst case D5 weather conditions.

Figure 6.1 HF Concentration Contours in D5 Weather Conditions



It is worth noting that the worst case conditions for toxic hazard ranges may occur in very typical (i.e. D5) weather conditions.

The analysis presented above is considered to be conservative in that the actual heat release rate is likely to be higher, so the worst case conditions would probably occur in higher wind speeds (e.g. D10), but with shorter hazard ranges. There are also some conservatisms in the magnitude of the HF source term, and in the assumption that all the HF is released over 30 minutes, and that people remain exposed in the plume rather than escaping.

It is also noted that, even without a significant fire (due to the fire suppression system), the 2019 McMicken Arizona incident showed that significant concentrations of toxic gases from cell venting, such as HCN and CO, could escape from a container.

7 ASSESSMENT OF WASHOUT AND DEPOSITION

Any fire plume which contains particulates will tend to deposit these particles to the ground, which can lead to issues relating to foodstuffs and clean-up.

Whilst a fire involving a BESS ISO container may generate some such particulate matter, including metal oxides, this has not been regarded as a significant issue in the literature.

Similarly, if there is rain, or water sprays are used on the fire, then there will be some washout (wet deposition) of both particulate and soluble gases. It is noted that gases such as HF are reasonably soluble in water, so water curtains are sometimes used to reduce the airborne concentration of HF following an HF release.

This washout can lead to contamination of ground and water, but again it is not considered to be a significant issue in the literature.

8 FIREWATER RUN-OFF

The HSEGB generally assesses major fires using methods developed by Carter (1989 and 1991) and Atkinson and Briggs (2019). Atkinson and Briggs (2019) state that:

> *There are many examples of chemical warehouses fires that have caused major environmental damage through contaminated firewater run-off. One use of fire plume toxicity assessment is to support "let burn" decisions in planning for and dealing with large fires.*

It is noted that a major concern at the Carnegie Road fire (see Table 2-1) was fire water run-off and potential environmental harm.

There is currently no good data on the significance of firewater from such fires in terms of their impact on the environment, but it is likely to be similar to that from comparable sized fires involving plastics and packaging. There may be specific concerns if the firewater is not contained and can reach sensitive environmental receptors.

9 SUMMARY

This Technical Note provides a high level review of the major hazard issues associated with large scale Battery Energy Storage System (BESS) sites using lithium-ion batteries in an ISO container. It is emphasised that the intention was not to provide a comprehensive review or assessment, but to provide an overall understanding of the key issues, with the principle aim of assisting HSENI to provide more informed advice.

The review has considered published literature and project documents provided by HSENI to establish current best practice for the analysis of such hazards, in terms of source terms and heat loads. A number of incidents involving lithium-ion batteries have been reviewed to provide context and understanding, and some quantitative assessment of fire and explosion hazards has been presented, concentrating on the hazards associated with explosions and dispersion of the toxic fire plume.

Key points which have been identified in the course of producing this Technical Note are:

- Any ISO container BESS has the potential to catch fire due to an unpredictable and spontaneous thermal runaway in a cell. The event may escalate to a fire involving the entire container. There is also a potential for an explosion. The design and mitigation measures in place should ensure that thermal runaway events do not escalate to involve an entire ISO container, but this remains a credible event which should be considered for emergency planning purposes.

- The generation of toxic combustion products from such fires can pose a hazard to those in the vicinity. The main concern appears to be hydrogen fluoride, although there are many other toxic combustion products. Toxic gases such as CO and HCN can also be generated in vent off-gas. This Technical Note provides a reasonably cautious assessment of the HF dispersion and hazard ranges for a worst case fire event, and shows that the HSE SLOT could be exceeded at up to about 45 m, with much higher concentrations in the immediate vicinity.

- The most significant risk to those in the immediate vicinity, or to firefighters, is from potential explosions of flammable vent gases from cells failing due to thermal runaway (either with or without fire). This Technical Note provides some predictions of the potential consequences of such explosion events in terms of the possible levels of blast overpressure. It is noted that there have been several incidents involving significant explosions at BESS sites. It is recognised that cells and modules can undergo cascading thermal runaway without any flaming or ignition, and still generate significant quantities of toxic and flammable gas, with the potential for a delayed explosion.

It is stressed that the assessment of BESS containers in terms of major accident hazard analysis is a new and rapidly developing area, and whilst the assessments here are considered to be reasonably robust, and consistent with current thinking, it is likely that there will be significant developments in the coming months and years.

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Battery Energy Storage Systems (BESS)

The fire risk associated with battery packs is not new to the UK Fire and Rescue Services. There have been a range of incidents in recent years in which a Lithium-ion battery pack was identified as a cause of fire. One fire in London that was judged to have started in a Lithium-ion battery, resulted in a fatality. Various other incidents have seen fires where the battery pack has been ejected across a room.

These have typically been of the small consumer sized batteries normally found in portable devices such as laptops and power tools for example.

As this technology has developed there has been a commercial up scaling of these batteries for the storage of electrical energy, generally from renewable sources and referred to as Battery Energy Storage Systems (BESS).

A number of BESS facilities have been built in Northern Ireland and a number of additional sites are in the planning stages.

Northern Ireland Fire and Rescue Service (NIFRS) do not have statutory powers relating to the planning application of these sites or in granting of permissions for their operation. NIFRS would be a consulted for various planning applications relating to Hazardous Substances Consent (HSC) for example, and NIFRS would also have a statutory role in relation to a Fire Risk Assessment for sites, once they were completed and operating, with a workforce.

The Energy Institute, London, has published a series of documents relating to the use of Battery Storage technologies;

- *Battery storage guidance note 1: Battery storage planning;*
- *Battery storage guidance note 2: Battery energy storage system fire planning and response;*
- *Battery storage guidance note 3: Design, construction and maintenance*.

NIFRS is in receipt of a National Fire Chiefs Council (NFCC) Briefing Note following a recent incident in Merseyside that presented a number of significant risks to emergency responders;

- Well-developed fire in a 20mW/33KV facility (3 container storage site).
- Evidence of blast damage to a container, several large pieces of material projected up to 22m.
- Fire water run-off, in addition to the smoke, contained hydrogen fluoride,
- The incident required significant amounts of water to contain and ultimately extinguish the fire over a prolonged period of time;

The Briefing Note to all UK Fire & Rescue Services recommended that Fire Services should gather Risk Critical Information for any BESS sites.

NIFRS does have a statutory duty and powers to require the provision of information regarding the hazards present on a site (Risk Critical Information), which may pose a danger to firefighters should they be required to respond to an incident there. This information would be essential for NIFRS to maintain the safety of its staff and in protecting the lives of any other persons affected by an incident. It will also determine the level of response and any tactical plan employed to resolve such an incident.

Key areas of Risk Critical Information NIFRS would want to see considered are:

- The identification of any hazardous materials that may be present,
- The quantity of any hazardous materials that may be present,
- The identification and quantity of any materials that may be produced at the site, should there be a loss of control.
- Containment required for polluted fire water run-off and leakage of any hazardous materials from the facility
- Any mitigation strategies determined by the operators relating to extinguishment or burn-out.
  (NIFRS considers the Energy Institute Guidance Note 2 as the basis for any risk information gathering and resultant planning for a NIFRS response to a BESS facility. NIFRS would be particularly focused on section 3 of the guidance 'Pre-fire planning, fire response and aftermath').
- fire monitoring, alerting and suppression systems;
- fire modelling to provide information for risk/hazard/evacuation zones, including any blast distances for debris;
- modelling for the impact of a thermal runaway in one of the units;
- radiated heat generation that may impinge on adjacent units;
- Access and egress to the site for emergency vehicles.
- Details of the capacity of any on-site bund or containment.

This is not an exhaustive list and is used to highlight the nature of the detail required.

NIFRS would consider the information referred to in the Energy Institute Guidance as critical to the safety of fire crews and the public who may be impacted by an incident at a BESS site and therefore require interventions from NIFRS staff.

NIFRS feels that such safety critical information should be provided by the operators at the earliest opportunity.

It would be the view of NIFRS that the elements outlined above (as described in the Energy Institute Guides) should be considered as part of the planning process to ensure that a full and holistic assessment might be undertaken.

NIFRS believe that waiting until a site is in operation before the operator is required to provide risk critical information, would not be appropriate.

17th December 2020

[redacted]

From: [redacted]
Sent: 12 January 2022 15:32
To: [redacted]
Cc: Kerr, Angus; Symington, Scott
Subject: Battery Energy Storage Systems
Attachments: Letter to Council HoPs re Battery Energy Storage Systems - 08.07.21.pdf; BESS - HOP Advice Letter - BESS Report HSENI - June 2021.pdf; BESS - HOP Advice Letter - NIFRS Input.pdf

[redacted]

Further to your request for a copy, please see attached, advice issued to Heads of Planning in July 2021.

[redacted]

Armagh City
Banbridge
& Craigavon
Borough Council

Kells Vocal
[redacted]
Moorfields
Ballymena
BT42 3DA

Armagh City, Banbridge & Craigavon
Borough Council
Bridgewater House
Planning Office
23A Castlewellan Road
Banbridge
BT32 4AX

Date:	10th December 2021
Your Ref:	036-07
Our Ref:	LA08/2021/0611/F (Please quote at all times)
Please Contact:	[redacted]
Contact Number	0300 200 7830

Dear Sir/Madam,

Location: **Land off Drumbroneth Road, 50m North East of 47 Drumbroneth Road, Dromore, BT25 1PP,**

Proposal: **Erection of a battery energy storage system, to include inverter and battery cubes, NIE kiosk, gas genset, 2 x bio-diesel storage tanks, switch room and transformer for the provision of back up electricity enclosed by 1.8m palisade fence**

I note you objected to the above mentioned proposal.

Please be advised that Officers have had regard to the ABO WIND NI LIMITED & ENERGIA RENEWABLES COMPANY 1 LIMITED Judgment.

The Judge looked at whether a BESS would fall wholly within one of the classes 1-8 in the 2015 regulations and decided a BESS facility does not fall wholly within any single class of development. It therefore falls within the "all other development" of class 9."

Therefore, Officers, have applied this threshold to this application and in considering the floor size and / or the area of the site, this is a now a local application.

The application has been placed on the delegated list as an approval.

The application has been placed on the list of planning applications, which Planning Officers propose to deal with under the Council's Scheme of Delegation that are eligible for 'call-in'.

Any applications on this list are eligible for call in, and you can approach an elected member in this case to have it called in.

Where elected members consider an application should not be dealt with under the Scheme of Delegation, and should instead be presented to the Council's Planning and Regulatory Services Committee, they must complete an 'Elected Members Call-in Request Form', providing a sound planning reason for call-in. The Call-in Template should be forwarded to callinrequests@armaghbanbridgecraigavon.gov.uk no later than Thursday 16 December 2021 at 5.00 pm (ie. 5 working days)

If you wish to discuss the contents of this letter please do not hesitate to contact me at [redacted]@armaghbanbridgecraigavon.gov.uk

Yours faithfully

[redacted]

[redacted] **MRTPI Senior Planning Officer (Major Projects Team)**

Armagh City, Banbridge and Craigavon Borough Council
Planning Office | Bridgewater House | 23a Castlewellan Road | Banbridge | Co. Down | BT32 4AX

Mobile: [redacted] **Tel:** 0300 0300 900 | [redacted]

Armagh City
Banbridge
& Craigavon
Borough Council

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2

Letter

Armagh City, Banbridge & Craigavon Local Planning Office
Bridgewater House
Planning Office
23a Castlewellan Road
Banbridge
BT32 4AX

20 May 2021

Dear Sir/Madam

Planning Ref LA08/2021/0586/F

HSENI Ref: CN202105-0007

Lands 170m west of 42 Ballydown Rd, Banbridge BT32 4JB

The Health and Safety Executive for Northern Ireland (HSENI) is a statutory consultee for developments within the consultation distance's (CD's) of high-pressure gas transmission pipelines or major hazard installations regulated under the Control of Major Accident Hazards Regulations (Northern Ireland) 2015 (COMAH). HSENI is also a statutory consultee for planning applications for Hazardous Substances Consent (HSC) and should be consulted regarding developments within 100 metres of the boundary of a quarry.

HSENI advises that the applicant should provide information on the type and mass of dangerous substance stored or produced during normal operation.

This information is required to access the applicability of Hazardous Substance Consent and the COMAH Regulations.

The Classification, Labelling and Packaging of Chemicals (Amendment) Regulations (Northern Ireland) 2015 defines dangerous substances.

HSENI commissioned a study into the risks associated with a fire/explosion in a single BESS container and provides the following information to assist the Local Planning Authority.

For the worst-case scenario;
- The pressure wave from a blast can generate an overpressure of 70 mbar, 45m from the container. For reference, a 70 mbar overpressure can partially demolish a house.
- Hydrogen fluoride produced from a fire can cause severe and fatal effects up to 45m and immediate dangers to health 240m away from a container fire.

Analysis of geographic information (GI), indicates several dwellings within 240m of the proposed development.

The above is for guidance only. It is the legal duty of the operator to identify the risks and consequences of their operation.

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HSENI does not have information on the impact of firewater runoff on the environment. There may be specific concerns if the firewater is not contained and can reach sensitive environmental receptors. Agencies such as the Northern Ireland Environment Agency are the appropriate consultees to comment on this matter.

Yours faithfully

Notifications Team, HSENI

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ATKINS

Hazard Assessment of Battery Energy Storage Systems

By [redacted], Atkins Ltd

1 INTRODUCTION

1.1 Scope

HSENI is aware of the hazards associated with large scale lithium-ion Battery Energy Storage System (BESS) sites. Consideration has been given to whether such sites should come under the COMAH and Hazardous Substances Consent Regulations, and following discussions with COMAH colleagues in HSE and HSA the view is that batteries alone would not bring a facility under COMAH (as batteries are regarded as articles and not dangerous substances under CLP).

Nevertheless, HSENI is still interested in the consequences of a fire in a battery container unit as there may be a need for HSENI to provide advice to Local Planning Authorities, comment on an environmental assessment, provide advice to fire fighters or review an operator's own risk assessment.

HSENI is aware that this is a relatively new area, with little available guidance, and has therefore requested that Atkins provide some initial advice based on the following scope:

- Review of incidents involving lithium-ion battery energy storage sites (and manufacturing sites)
- Review of technical papers/information, concentrating on any information relevant to major accident hazards
- Consideration of fire load (associated with the electrolyte)
- Consideration of potential for flammable vapour explosion
- Assessment of HF dispersion toxic hazard ranges to DTL/IDLH using ADMS
- Brief consideration of washout/deposition from fire plumes
- Brief consideration of firewater run-off issue (environmental hazard)
- Summary of key issues

It is emphasised that this Technical Note is only intended to provide brief advice in most of the above areas, and that in some areas there is very little available good information. HSENI has indicated that their main concern is the firefighter who could be facing a fire at one of these facilities, and therefore their principal interest is in the potential toxic fire plume, and potential explosion, associated with a single BESS container. This Technical Note therefore concentrates on those areas.

It is recognised that this has been a rapidly developing area over the last few years, and so the information presented in this Technical Note would benefit from regular review.

1.2 Background

A recent issue of Energy Storage News (11 January 2021) summarises the key hazards for firefighters:

> *Energy storage is a relatively new technology to fire departments across the US. While different fire departments have differing levels of exposure to battery energy storage systems (or BESS for short), the primary concern of each is the same: the safety and well-being of their first responders.*
>
> *Departments and local officials are, however, becoming increasingly aware of the hazards associated with battery storage and it is important that their concerns be properly addressed. Addressing these concerns in a complete and transparent manner has been seen not only to promote overall first responder safety but also to ensure project success. Perhaps the most defining characteristic of lithium-ion battery failures is a state known as 'thermal runaway', in which a battery cell experiences uncontrollable overheating, often accompanied by the release of large quantities of flammable off-gases.*
>
> *Thermal propagation from the failing cell may lead to incipient thermal runaway of adjacent cells, thus creating a cascading failure across the system, resulting in tremendous amounts of heat and gas. When these gases are allowed to accumulate in an enclosed space (such as a BESS container), an explosive atmosphere may develop, which, given an ignition source, may lead to a devastating deflagration (explosion) event. This blast wave can cause damage to nearby buildings and structures, as well as first responders who may be arriving on the scene, as was seen in the incident that unfolded in Arizona in 2019. Deep-seated fires are also common in lithium-ion failure events. These fires are not easily extinguished and may continue for hours, fuelled by heat and gas from cascading cell failures. Even if*

suppressed by water, stranded energy within the cells often causes reignitions, thus perpetuating the event.

Concerns based on environmental risks are also often cited by fire departments across the country. Large quantities of smoke and gas are often released during battery fires, with high levels of carbon monoxide and hydrogen cyanide measured on-site in Arizona at the time of the incident. Contaminated runoff water may also affect the surrounding area. Electrical hazards also exist during and after battery failure events and should not be overlooked.

2 REVIEW OF INCIDENTS

This section provides a brief review of incidents involving lithium-ion cells, and key lessons learned in terms of major hazard assessment. It is not intended to be comprehensive, but highlights important events such as the 2019 McMicken (Arizona) BESS explosion.

2.1 Incidents Involving Single Cells

Many billions of individual lithium-ion cells have been produced worldwide over the last 30 years, and there have been thousands of incidents which have been potentially hazardous. Many of these have been well reported in the press, and some have led to major product recalls. The majority of these incidents relate to Thermal Runaway (TR) events due to a short circuit within a cell between the anode and cathode. Such events are often apparently spontaneous and the precise cause of the short circuit is often not clear. Common causes can include:

- Impact/vibration/penetration
- Manufacturing defect
- Failure of the battery management system
- Overheating
- Overcharging
- Undercharging

It is also noted that as the widespread use of such cells has grown very rapidly, there is relatively little data on incidents that may be related to aging for current cell designs.

Incidents are generally most severe when a cell has a high State of Charge (SOC). Any major failure of a charged cell can lead to the rapid and energetic ejection of the electrolyte liquid, as a short (e.g. 1 to 2 m long) jet flame. It is noted that such failure events with charged cells are highly likely to ignite, but there are also situations where cascading thermal runaway can occur due to heat transfer between cells without any ignition, due to the highly exothermic nature of the thermal runaway.

The precise nature of an incident may depend on the cell size and whether the cell is cylindrical, pouch or prismatic. Large pouch cells are generally used in large scale BESS container units.

2.2 Incidents at BESS Facilities

Table 2-1 lists a number of incidents which have occurred at BESS facilities.

Table 2-1 Incidents at BESS Facilities

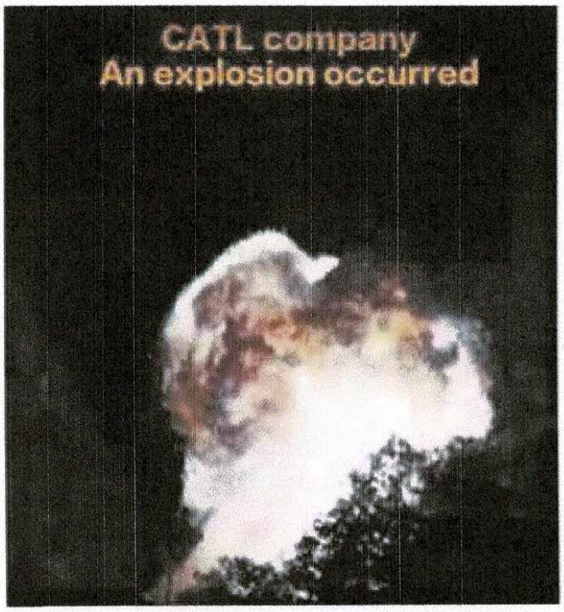
Location (Company)	Date of Incident	Description of Incident
Arizona, USA (Arizona Public Service Company)	Nov 2012	In November of 2012, a fire occurred at a state-of-the-art solar energy storage system that the Arizona Public Service Company (APS) was testing. The system, the relative size of a shipping container with a capacity of 1.5 MW, had been running since February of 2012. Similar to the First Wind fires, the fire department personnel allowed the fire to burn freely for some time. The cause of the fire was not reported. Ref. Blum and Long (2016)
Unknown	2014	A fire in a Li-ion battery storage unit caused an explosion that seriously injured fire fighters. Ref. Ronken (2017)
Yeongju, South Korea	Nov 2018	Fire at lithium-ion PV power plant. Ref. INERIS (2021)
Cheonan, South Korea	Nov 2018	Fire at lithium-ion PV power plant. Ref. INERIS (2021)
Geochang South Korea	Nov 2018	Fire at lithium-ion PV power plant. Ref. INERIS (2021)
Munyeong, South Korea	Nov 2018	Fire at lithium-ion PV power plant. Ref. INERIS (2021)

Location (Company)	Date of Incident	Description of Incident
South Korea Jecheon	Dec 2018	Fire at lithium-ion peak load reduction plant. Ref. INERIS (2021)
Samcheok, South Korea	Dec 2018	Fire at lithium-ion PV power plant. Ref. INERIS (2021)
Yangsan, South Korea	Jan 2019	Fire at lithium-ion peak load reduction plant. Ref. INERIS (2021)
Wando, South Korea	Jan 2019	Fire at lithium-ion PV power plant. Ref. INERIS (2021)
Jangsu, South Korea	Jan 2019	Fire at lithium-ion PV power plant. Ref. INERIS (2021)
Ulsan, South Korea	Jan 2019	Fire at lithium-ion peak load reduction plant. Ref. INERIS (2021)
Chilgok, South Korea	May 2019	Fire at lithium-ion PV power plant. Ref. INERIS (2021)
McMicken Substation, Surprise, West Valley, Arizona, USA (Arizona Public Services)	19/4/2019	The incident occurred at two twinned grid-scale energy storage systems of 2 MW / 2 MWh at the McMicken substation. The explosion caused a "significant pressure wave" resulting in the injuries of four firefighters. Technical analysis by certification and standards group DNV GL indicated that the event had begun with internal cell failure in a single LG Chem 0.24 kWh pouch cell in the ESS. The fire suppression system onsite worked as designed, but it was inadequate to prevent or stop the cascading thermal runaway. Heat transfer between the cells in a module, and then between modules, in one of the battery racks caused the thermal runaway to propagate - facilitated by the absence of "adequate thermal barrier protections between battery cells," which could have stopped or slowed the propagation. Whilst the incident was at first thought to be a fire, it was in fact a cascading thermal runaway from a single cell, through every other cell in the module, and then through all the modules in Rack 15 via heat transfer. It took around two hours from the first report of a suspected fire at the facility, at 17:48 local time on 19 April 2019, to around 20:04 before an explosion happened from inside the BESS. The BESS and its container were "essentially destroyed" and the incident left several firefighters injured. On the day of the incident, the BESS was performing solar smoothing applications - charging during the daytime from local solar generation and discharging electricity to the grid during the evening peak load. Data collected by APS found that just before 5pm on 19 April, there was a sudden drop in voltage during one of the system's charge cycles. Thermal runaway began shortly after that. Smoke detection systems went into operation but off-gassing of battery cells as the thermal runaway cascaded through neighbouring modules caused a "flammable atmosphere within the BESS," the DNV GL report said. Then, when firefighters opened the side container door around three hours after thermal runaway began, an explosion occurred within 2-3 minutes, causing the side and rear doors of the BESS as well as other debris to be ejected by the explosion. It is thought that opening the doors agitated flammable gases that remained and brought the gases into contact with a spark or heat source - causing the explosion. Ref. McKinnon, DeCrane and Kerber (2020) – Detailed incident report. DNV GL (2020) – Technical incident report. Energy Storage News (23 April 2019, 29 July 2020, 12 March 2021, 25 March 2021)

Location (Company)	Date of Incident	Description of Incident
Carnegie Road, Liverpool, England (Ørsted) See Figure 2.1	15/9/2020	Large grid battery system container fire at 20 MW BESS site which lasted several hours. Merseyside Fire & Rescue Service, local first-responders, said that crews were alerted shortly before 1am on 15 September and arrived to find a "large grid battery system container well alight". A "massive bang" was heard as fire crews rushed to tackle the blaze. One resident said he "heard an explosion after midnight" while another said their house "shook". Five fire engines were immediately on the scene after being alerted at 12.52am to reports of a blaze on Carnegie Road in Tuebrook. The fire service said that it had used main jets and ground monitors in tackling the fire, asking residents nearby to keep their windows and doors closed due to smoke from the incident. The blaze went on for several hours, with an update from the service at 7:30am noting that although operations at the site had been scaled down, firefighting was ongoing, with two ground monitor units and a main water jet still in use. A further update at 11:45am said one fire engine was still at the scene, with firefighting still continuing, although by that stage only one hand-held pump was in use. It was reported that the explosion caused a "significant pressure wave", causing debris to be thrown between 6 and 20 metres away according to the fire department's response report. The environmental impact from firewater runoff was also a major concern. Ref. Energy Storage News (16 September 2020 and 25 March 2021) • Fire at 20MW UK battery storage plant in Liverpool - Energy Storage Virtual Summit (solarenergyevents.com)
Ningxiang, Hunan Province, China (CATL Brunp Recycling Technology plant) See Figure 2.2	7/1/2021	Explosion and fire occurred at one of the old workshops of the battery recycling plant - 1 person was killed and 6 were seriously injured. CATL is a battery supplier to Tesla. • https://uk.motor1.com/news/465244/explosion-catl-battery-plant-china/ • #177 Explosion at CATL-owned company #shorts - YouTube

Figure 2.1 Incident at Carnegie Road, Liverpool (15/9/2020)

Figure 2.2 Incident at Ningxiang, Hunan Province, China (7/1/2021)



It is noted that there have been many incidents in Asia relating to BESS facilities, but details are generally scarce or unavailable.

2.3 Incidents at Battery Manufacturing Facilities

Table 2-2 lists a number of incidents which have occurred at battery manufacturing facilities.

Table 2-2 Incidents at Battery Manufacturing Facilities

Location (Company)	Date of Incident	Description of Incident
Koriyama City, Japan	4/11/1995	An explosion occurred at a Sony battery factory in Koriyama City, Japan, where cylindrical lithium-ion batteries for notebook PCs were manufactured. The fire occurred on the floor where batteries underwent final testing. Cells in this location were stored in racks 4-high under ambient temperature conditions. Ultimately, approximately 3 million cells burned, 7,000 m^2 of facility was damaged and two people were injured. Ref. Mikolajczak et al (2011)
Moriguchi, Osaka, Japan (Matsushita Battery Industry Factory)	Aug 1997	An explosion occurred at the Matsushita Battery Industry factory in Moriguchi, Osaka. The owner of the factory, T&T Dream, was a subcontractor for Matsushita. The factory carried out charge/discharge and check processes of cylindrical lithium-ion batteries. Cells in this location were stored on thirteen layers under ambient temperature conditions. Ultimately, approximately 1.22 million cells burned, 1,700 m^2 of facility was burned, buildings within a 175 m radius were damaged, and two people were injured. Ref. Mikolajczak et al (2011)
Karlstein, Germany (BMZ)	Aug 2008	A fire occurred at Batterie-Montage-Zentrum (BMZ) in Karlstein, Germany. The fire destroyed a production area and a warehouse. Ref. Mikolajczak et al (2011)
Pawcatuck, Connecticut, USA (Yardley Technical Products)	Sep 2008	A large format lithium-ion battery that was undergoing testing at Yardney Technical Products in Pawcatuck Connecticut caught fire. Ref. Mikolajczak et al (2011)
Dongguan City, China	2014	Fire in a lithium-ion battery factory in Dongguan City in China, which caused 5 deaths and 6 injuries. Ref. Niu and Li (2018)
China (Samsung SDI battery manufacturing facility)	8/2/2017	The fire occurred in the battery waste area of the factory, after faulty lithium-ion batteries went up in flames. • https://fortune.com/2017/02/09/samsung-battery-factory-explodes/
North Phoenix, Arizona, USA (Gruber Motor Company)	6/5/2017	Pallet of Li batteries caught fire and 5 minutes later the whole building was burning, producing toxic smoke which spread all over the north valley and forced evacuation of nearby buildings. • Fire breaks out at factory that produces lithium batteries - Bing video
Peera Garhi, New Delhi India See Figure 2.3	2/1/2020	Battery factory collapses after explosion in fire during firefighting operations – killing 1 and injuring 19 other firefighters. • Battery Factory In Peeragarhi Collapses During Fire Fighting Operations | CNN News18 (msn.com) • Battery factory collapses in fire in New Delhi, killing 1 (apnews.com)

Figure 2.3 Incident at Peera Garhi, New Delhi, India (2/1/2020)

The incidents in Table 2-2 show that major incidents at battery manufacturing facilities are most likely to occur in the Formation, Aging and Testing stage, where large numbers of cells are being charged for the first time. Such events are less likely at BESS sites as the cells have been through all the necessary testing, but the nature of the potential incidents is similar due to the large number of cells present.

2.4 Other Incidents

Table 2-3 lists a number of incidents which have occurred at other facilities.

Table 2-3 Incidents at Other Facilities

Location (Company)	Date of Incident	Description of Incident
Germany	2017	A major fire broke out in a bicycle warehouse in Germany that also contained a large number of electric bicycles with Li-ion batteries. It proved an extraordinary challenge for the fire brigade and ultimately resulted in a total loss in the warehouse. Four employees suffered minor injuries. Ref. Ronken (2017) • https://rp-online.de/nrw/staedte/emmerich/grossbrand-bei-fahrrad-rose_aid-14299219
Lyons Park industrial estate, Coventry, England	20/2/2020	Factory storing Li batteries goes up in flames. • Factory where lithium batteries stored goes up in flames - CoventryLive (coventrytelegraph.net)

Mikolajczak et al (2011) also lists a number of air transport incidents involving lithium-ion batteries.

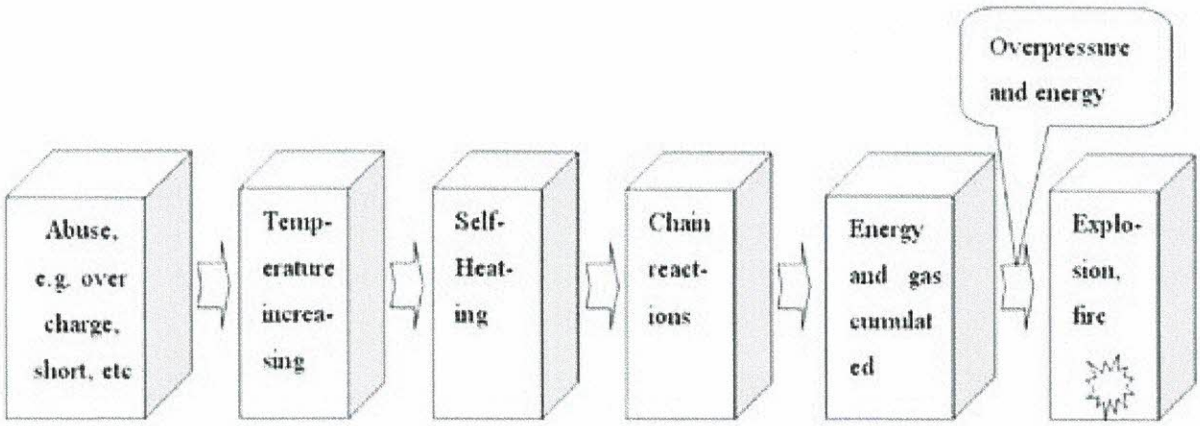
3 REVIEW OF LITERATURE

This section presents a brief literature review concentrating on information which is relevant in terms of major hazard safety issues.

3.1 Published Papers and Reports

Wang, Sun & Chu (2005) provide an overview of how lithium-ion cells can fail, leading to fire and explosion.

Figure 3.1 Development of Cell Failure (Wang, Sun & Chu, 2005)



Ditch and de Vries (2013) and **Ditch (2014)** describe a detailed study of the flammability characterisation of lithium-ion batteries in bulk storage, which tested the effectiveness of sprinklers and measured heat release rates etc. The overall goal was to develop sprinkler protection recommendations for bulk storage of Li-ion batteries. The test results show that fires can develop rapidly, reaching heat release rates of several MW for a single pallet of batteries.

Mikolajczak et al (2011) present a literature review of battery technology, failure modes and events, usage, codes and standards, and a hazard assessment during the life cycle of storage and distribution. The failure modes and root causes are discussed, together with information on flammable cell components and the fire behaviour of cells and battery packs. Key gaps in knowledge, such as the vent gas composition, are identified.

Blum and Long (2016) summarise a literature review and gap analysis related to Li-ion battery ESSs, as well as full-scale fire testing of a 100 kWh Li-ion battery ESS. The overall objective was to help enable the development of safe installation requirements and appropriate emergency response tactics.

Larsson, Andersson, Blomqvist and Mellander (2017) provide a useful study of toxic fluoride emissions from lithium-ion battery fires. It is shown that lithium-ion battery fires generate intense heat and considerable amounts of gas and smoke. It is noted that although the emission of toxic gases can be a larger threat than the heat, the knowledge of such emissions is limited. The paper presents quantitative measurements of heat release and fluoride gas emissions during battery fires for seven different types of commercial lithium-ion batteries. The results are validated using two independent measurement techniques and show that large amounts of hydrogen fluoride (HF) may be generated, ranging between 20 and 200 mg/Wh of nominal battery energy capacity. In addition, 15 to 22 mg/Wh of another potentially toxic gas, phosphoryl fluoride (POF_3), was measured in some of the fire tests. Gas emissions when using water mist as an extinguishing agent were also investigated. It is concluded that fluoride gas emission can pose a serious toxic threat and the results are crucial findings for risk assessment and management, especially for large Li-ion battery packs. The paper states that:

> *If extrapolated for large battery packs the amounts would be 2–20 kg for a 100 kWh battery system, e.g. an electric vehicle and 20–200 kg for a 1000 kWh battery system, e.g. a small stationary energy storage. The immediate dangerous to life or health (IDLH) level for HF is 0.025 g/m³ (30 ppm) and the lethal 10 minutes HF toxicity value (AEGL-3) is 0.0139 g/m³ (170 ppm). The release of hydrogen fluoride from a Li-ion battery fire can therefore be a severe risk and an even greater risk in confined or semi-confined spaces.*

Ronken (2017) also describes the risks and safety measures required for lithium-ion batteries, and emphasises the importance of a suitable risk assessment. Several incidents are also identified (see Section 2.2).

Niu and Li (2018) describe a fire risk assessment method for use in lithium-ion battery factories, and summarise the key areas where fire risks are significant, based on experience with such facilities in China. It is suggested that in the event of a short circuit, lithium can react with the various electrolyte components (ethylene carbonate, propylene carbonate, dimethyl carbonate) to form flammable gases such as propene (C_3H_6). A risk matrix is used to assess all stages of the battery manufacturing process. Several events are identified as likely to result in severe injury, but none are identified as likely to result in death. Serious events such as the spontaneous ignition of batteries in storage are identified as unlikely to happen in a lifetime.

Finegan et al (2019) describe detailed experiments where internal short circuits (ISCs) were caused in cylindrical 18650 cells. These ISCs cause the Li-ion battery to fail catastrophically due to thermal runaway. That is, at a critical temperature and in the presence of non-aqueous liquid electrolytes and oxygen, the active materials within a Li-ion battery can exothermically react. Exothermic reactions can become self-sustaining when local heat generation is greater than heat dissipation, resulting in violent combustion and total cell failure. During thermal runaway, it is estimated that about 2 litres of gas is generated per amp hour (Ah) of commercial $LiFePO_4$ and $LiNi_xCo_yAl_zO_2$ 18650 cells. It is noted that modern 18650 cells have capacities greater than 3 Ah, and can generate more than 6 litres of gas within about 2 seconds during thermal runaway, which is mostly flammable. In this short time (< 2 seconds), more than 70 kJ of heat can also be generated.

The Department for Business, Energy & Industrial Strategy (BEIS, 2020) reviewed the safety risks associated with domestic battery energy storage systems. The authors state that even though few incidents with domestic battery energy storage systems (BESSs) are known in the public domain, the use of large batteries in the domestic environment represents a safety hazard. Three hazard categories are identified:

- Excessive heat generated deep inside a battery pack as cells fail and thermal runaway propagates through the pack, highlights the need to design packs to minimize risk for propagation and limit spread of fire between cells/modules. Early detection and means for cooling individual cells as they begin to fail are important for avoiding thermal runaway of the full system.
- Cell and pack failures can generate large volumes of gases resulting from the rapid pressure build-up and vent release as the system heats up. Management of gases generated must be considered in pack and system design.
- The toxicity of gases generated from battery fires may require specific consideration in the design of ventilation systems.

Key considerations regarding risk mitigation are summarised as:

- The Battery Management System (BMS) has a central role in keeping cells within their operating window for voltage, current and temperature. BESS safety standards have specific requirements and tests which apply for the BMS.
- Internal cell faults, though rare, do occur. For well-constructed 18650 cells, the failure rate from an internal event is estimated as one in ten million (0.1 ppm). This translates to a single cell failure in every 10,000 BESS (assuming a 5 kWh BESS containing 500 18650 cells). This is not to say that 1 in 10,000 BESSs will fail, with significant risk of fire. Proper BESS design and construction should be capable of preventing propagation of cell failure across the battery pack. A single cell failure should be controllable.
- If the system is well designed, it should take into consideration propagation of a thermal event arising from a single cell. This is of great importance for the risk mitigation and will have a large impact on the overall risk assessment for the system. Control of single cell failures within a pack reduces the risk of complete system failure and residential fire. Assessment of cell failure propagation is captured in the standards applicable for domestic lithium-ion battery storage systems such as BS EN 62619 and IEC 62933-5-2.

The BEIS report also provides some statistics for the likelihood of failures, although it doesn't deal with large scale BESS installations. Hydrogen fluoride, CO and CO_2 are all identified as potential toxic combustion products following a thermal runaway. The potential for an explosion is also mentioned, either as a result of a cell failing violently due to an internal build-up of pressure, or as a result of ignition of flammable gases released from a cell. The total heat released during total combustion of lithium-ion batteries ranges from 30 to 50 kJ/Wh, or 4 to 10 MJ/kg, which is about 5-10 times less than for organic materials like plastic or paper. No projectiles were observed in any full scale testing of larger racks of batteries for energy storage systems. The violence of thermal runaway, and the gas volume generated, tends to increase with SOC.

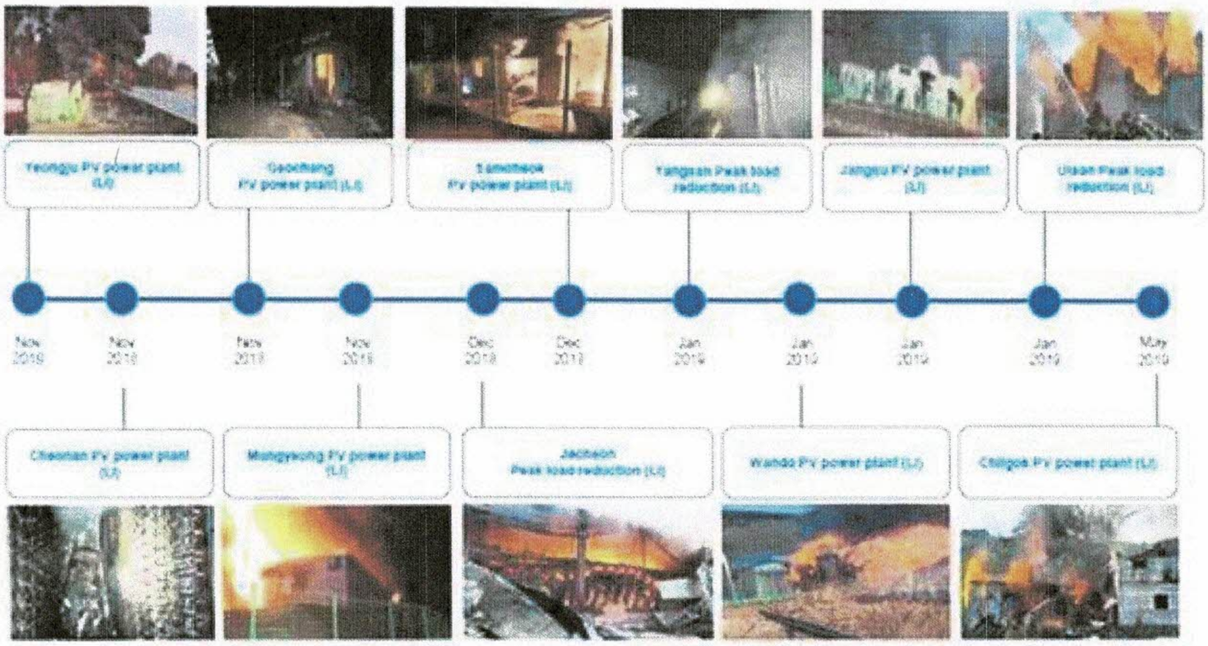
The BEIS report discusses the vent gases that can be generated, including volatile organic compounds (such as alkylcarbonates, methane, ethylene and ethane), hydrogen, carbon monoxide, carbon dioxide, soot and other particulates containing nickel, cobalt, lithium, aluminium, copper. The authors note that a major point of discussion is the amount of HF and other fluorinated compounds found in vent gases, because of their toxicity, and that this is still an open question. Some tests have indicated HF concentrations well in excess of 100 ppm.

Diaz et al (2020) provide a comprehensive review of fire safety information for lithium-ion batteries. The authors note that the majority of research has considered single cells, and there is much less safety information relating to larger scale fires involving pack, modules, or large numbers of cells. The review includes information on the various challenges faced by the industry, including detection and reliability issues and emergency response challenges. The use of water for fire fighting appears to be preferred, although there are still issues with reignition.

Rosewater et al (2020) presents a systematic hazard analysis of a hypothetical, grid scale lithium-ion battery powerplant to produce sociotechnical 'design objectives' for system safety. This includes key considerations for firefighter training objectives.

INERIS (March 2021) recently presented an overview of the lithium-ion cell assessments and modelling that they are currently undertaking in France. The presentation included brief details of fires at large scale energy storage sites in South Korea, as illustrated in Figure 3.2.

Figure 3.2 Examples of Fires at BESS Sites in South Korea (INERIS, 2021)



It was concluded that there was no single root cause for these events.

INERIS noted that there have been similar fires in Belgium, UK, France, US (Arizona) and Australia. A number of issues and uncertainties were identified in relation to fire protection and firefighting for such sites:

- Fixed fire fighting systems: water (sprinklers, water mist)?, Foam?, Inert gas?, Others?
- Fire fighter capacities for such a fire: drowning a battery container in water is not really an option
- Safety aspect of emergency response: gas toxicity and explosivity

One conclusion from their presentation was that the toxic combustion products from a small fire involving a lithium-ion battery are generally not significantly more hazardous than a comparable sized fire with packaging and plastics etc. However, for a large fire involving many lithium-ion cells, the view expressed was that the HF vapour was the most significant toxic concern.

3.2 Project Specific References

HSENI has provided several documents which relate to BESS sites. These are considered briefly below in terms of the key data which is relevant in terms of the assessment of major hazards.

Haigh (2020) provides an analysis of what might occur under a loss of control scenario at the Kells BESS and what chemical reactions might take place. The site is described as having a total energy capacity of 26.3 MWh with:

25 ISO containers
28 racks in each ISO container
6 modules in each rack
22 lithium-ion cells in each module

The total quantity of electrolyte on site is 28.6 tonnes, together with 9.5 tonnes of polyvinylidene difluoride, all of which may generate HF in a fire. A fire involving a single container is predicted to generate 20 to 210 kg of HF. This corresponds to 19 to 200 mg/Wh, consistent with the range suggested by Larsson et al (2017).

Marks (2020) provides technical details for the Newry Energy Storage Ltd BESS located approximately 85 m North of No. 68 Cloghanramer Road, Newry, BT34 1QG. The site is described as having a total energy capacity of 18.635 MWh with:

5 ISO containers (3,727,000 Wh for each ISO container)
10 racks in each ISO container (372,700 Wh for each rack)
26 modules in each rack (14,336 Wh for each module)
16 lithium iron phosphate (LFP) cells in each module (896 Wh for each cell)

Each of the 20,800 cells on site, each with a mass of 5.46 kg, includes:

540 g of polyvinylidenefluoride-hexafluoropropylene copolymer (PVDF-HFP)
486 g of ethylene carbonate
432 g of dimethyl carbonate
432 g of propylene carbonate
378 g of diethyl carbonate
378 g of ethyl methyl carbonate
162 g of lithium hexafluorophosphate ($LiPF_6$)

It is predicted that a full stoichiometric decomposition of $LiPF_6$ will generate 4 moles of HF (plus other fluorine compounds). This corresponds to 354.2 kg of HF per ISO container. Similarly, a full stoichiometric decomposition of the PVDF-HFP would generate 1,679 kg of HF. Marks states that these stoichiometric results are considered worst case, and a more foreseeable prediction is based on the work of Larsson et al (2017) (i.e. 200 mg/Wh) giving 738 kg of HF per ISO container.

3.3 Standards

Standards for energy storage systems include:

NFPA 855 - Standard for the Installation of Stationary Energy Storage Systems, 2020
This debut edition addresses the dangers of toxic and flammable gases, stranded energy, and increased fire intensity associated with BESS sites. It is designed to give first responders and those who design, build, maintain, and inspect facilities the information they need to prepare for ESS safety.

IEC 62619 - Secondary cells and batteries containing alkaline or other non-acid electrolytes - Safety requirements for secondary lithium cells and batteries, for use in industrial applications, 2017
Specifies requirements and tests for the safe operation of secondary lithium cells and batteries used in industrial applications including stationary applications.

There are obviously many other standards which are important, but the above are some of the most directly relevant. NFPA 855 is one of the most useful in terms of major hazard and firefighting considerations.

4 CONSIDERATION OF FIRE LOAD

The main fire load within a BESS container is the electrolyte within each cell. The precise composition of the electrolyte generally involves several flammable liquids and lithium hexaflurophosphate, as detailed in Section 3.2 by Marks (2020).

The overall heat of combustion of the electrolyte is approximately 20,000 kJ/kg.

Electrolyte typically makes up about 40% of the mass of a cell in a BESS. For other cell designs, such as cylinder cells, it is typically closer to 15% of the mass.

Any fire is likely to start as a result of failure of a single cell, which then escalates by involving progressively more cells. In the very early stages, the fire may not be ventilation controlled, but the container would rapidly begin to fill with combustion products, and the fire would become ventilation controlled. If the container becomes breached then the fire will no longer be ventilation controlled.

The growth of the fire is therefore likely to be similar to fire growth in other situations, such as a warehouse fire, although the rate of fire growth is likely to be higher due to the exothermic nature of the thermal runaway event.

For the purposes of assessing the fire, a conservative assumption typically adopted by the HSE is that the entire contents are combusted over a relatively short period of 30 minutes (Atkinson and Briggs, 2019). This assumption can be useful for defining a heat release rate and maximum source term for toxic combustion products, but it is noted that in reality such fires could continue to burn for many hours. Lithium-ion fires are also well known for re-igniting after having been apparently extinguished.

5 POTENTIAL FOR EXPLOSION

The potential for explosion during the course of a major incident in a BESS ISO container is an important issue which has recently become better understood following several incidents.

It is well known that individual cells may fail explosively due to the build-up of pressure within the cell, but this will depend on the cell design. Pouch cells tend to fail easily on seams, and so, considered individually, may be less likely to explode than, for example, cylinder cells. However, when pouch cells are packed into a module it may be more difficult for gases to vent, and so an explosion may still be possible. The energy of such an explosion would depend on the module design. Such an event could produce a loud bang as the module fails, but the event is likely to be contained within the ISO container.

More significantly, it is also known that cell failures can generate quantities of flammable vapour. If a 10 Wh 18650 cell can generate 6 litres of gas (Finegan et al, 2019), an 896 Wh pouch cell could theoretically generate over 500 litres of flammable vapour. Several such failures could occur before the vapour ignites. Suppression systems can prevent flaming, though flammable vent gases can continue to be released due to cascading thermal runaway as a result of heat transfer between cells and modules. Ignition can then lead to a vapour cloud explosion (VCE) within the ISO container. The worst case is if such flammable vapour fills the entire ISO container (typical dimensions are 40 x 8 x 8.5 feet, or 77 m^3). It is noted that the 2019 McMicken incident only involved thermal runaway of the cells in a single rack, and this was still sufficient to generate enough flammable gas for a significant explosion.

Table 5-1 provides hazard ranges to various levels of overpressure for hydrocarbon vapour cloud volumes of 0.5, 5 and 50 m^3, based on a standard analysis using the TNO Multi-Energy Model with a typical ignition strength of 7 (based on the type of approach typically adopted by HSEGB for VCEs).

Table 5-1 Distances to Various Levels of Explosion Overpressure

Volume of vapour involved (m^3)	0.5 m^3	5 m^3	50 m^3
	Distance (m) to various levels of overpressure		
600 mbar	2	5	10
300 mbar	3	7	16
140 mbar	6	12	26
70 mbar	10	21	45

Any flammable vapours released from cells may be ignited almost immediately, without any generation of overpressure, but there have been several incidents where explosions have been reported in containers. This delayed ignition of vapour can occur if a fire suppression system prevents flaming. Continued release of vent gases from failed cells after the suppression system operates can then lead to a build-up of flammable gas, which can then ignite leading to an explosion. There have also been incidents with no suppression system where a build-up of flammable gas has occurred without a fire, until delayed ignition caused an explosion.

It is noted that HSEGB typically use 600, 140 and 70 mbar as the basis for defining the Inner, Middle and Outer land use planning zones for explosion hazards.

Table 5-2 provides some data from HSE (2005) on the effect on structures of various levels of blast overpressure.

Table 5-2 Effect of Various Levels of Explosion Overpressure

Damage Description	Incident Peak Side-On Overpressure (mbar)
General effects on buildings	
5% of exposed glass panes broken	1-3
50% of exposed glass panes broken	6-13
Near 100% of exposed glass panes broken	50-110
Limited minor structural damage	20-30
Doors and window frames may be blown in	50-90
Partial demolition of houses - rendered uninhabitable	70
Lower limit of serious structural damage	140
Partial collapse of walls and roofs of houses	140
Nearly complete destruction of houses	340-480
Probable total destruction of houses	690
Effects on UK brick built houses	
Category A damage (completely demolished)	690-1830
Category B damage (badly damaged and beyond repair)	240-590
Category Cb damage (uninhabitable without extensive repairs)	140-240
Category Ca damage (uninhabitable but repairable)	70-120
Category D damage (inhabitable but repairs required)	20-50
50% destruction of brickwork	280-480
Effects on plant	
Reinforced structures distort and unpressurised storage tanks fail	210-340
Wagons and plant items overturned	340-480
Extensive damage	>480
Failure of a pressurised storage sphere	>700

A recent Energy Storage News (25 March 2021a) focussed on the potential explosion issue at BESS sites, stating:

> *The challenges of explosion prevention – with flammable gases needing to be vented "very rapidly" – in the event of a battery fire have been highlighted at this week's Energy Storage Summit USA.*
>
> *Speaking at the event, hosted by our publisher Solar Media, Matthew Paiss, technical advisor, battery materials & systems at Pacific Northwest National Laboratory (PNNL), referenced the two most recent high-profile battery fires, with one at utility Arizona Public Services's (APS) energy storage facility in 2019 and one at Ørsted's 20 MW project in Liverpool, England in 2020.*
>
> *Both explosions caused a "significant pressure wave", with the APS incident resulting in the injuries of four firefighters and the Liverpool incident causing debris to be thrown between six and 20 meters away according to the fire department's response report.*
>
> *Paiss explained that there are "many similar battery enclosures operating today that could experience the exact same kind of failure".*
>
> *He said that most systems being deployed today do include a deflagration vent – which is used to vent gases after deflagration occurs – but "what is not very common in systems is deflagration prevention" which he described as typically being a mechanical exhaust system.*

It was also stated (Energy Storage News, 25 March 2021b) that:

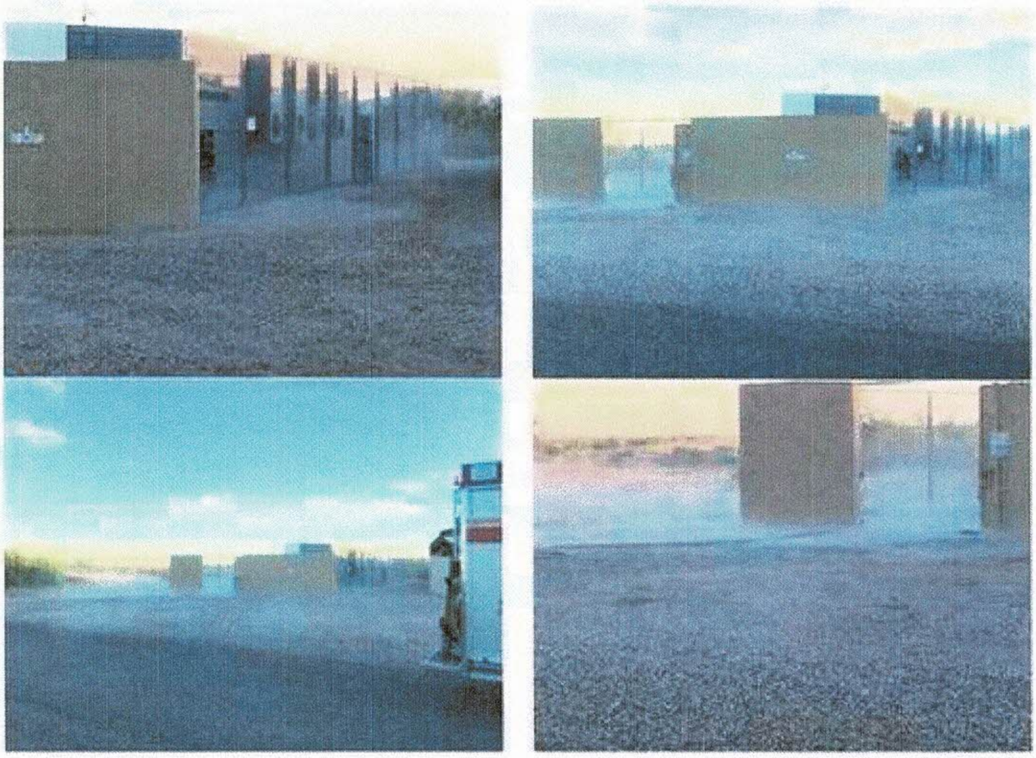
Per Onnerud … said that statistically, some failures will always happen.

While some experts have said that failure may only occur in one of every 10 million battery cells, energy storage projects are getting larger and contain more cells. Meanwhile the cells themselves are individually getting larger and therefore produce more gas if active materials like electrolyte catch fire.

Explosions caused by that gas and fires caused by propagation should not be acceptable, Onnerud said. Battery design should be such that failures should be prepared for, and so that those failures can be dealt with "elegantly".

The incident report for the 2019 McMicken Arizona incident (McKinnon, DeCrane and Kerber, 2020) provides photos which show that, when the fire service arrived, there was a low level cloud of vapour around the container (possibly associated with the suppression system), as shown in Figure 5.1.

Figure 5.1 Photos of ESS Prior to Explosion (McKinnon, DeCrane and Kerber, 2020)



When firefighters were satisfied that HCN and CO concentration had dissipated sufficiently, they proceeded to open the container door. The report describes what then happened to the four firefighters, stating:

At the moment of the deflagration event, the firefighters outside the hot zone described hearing a loud noise and seeing a jet of flame that extended at least 75 ft outward and an estimated 20 ft vertically from the southeast-facing door. In the event, E193 Capt and E193 FE were ballistically propelled against and under the chain-link fence that surrounded the ESS. E193 Capt came to rest approximately 73 ft from the opened door beneath a bush that had ignited in the event. E193 FE came to rest approximately 30 ft from the opened door. HM193 FF1 was projected toward the transformer and distribution box to the east of the ESS and remained within the fenced area. The entire HAZMAT team lost consciousness in the deflagration event. The event also dislodged or removed the SCBA face pieces and helmets from all of the HAZMAT team members.

6 ASSESSMENT OF TOXIC FIRE PLUME

The literature is clear that a wide range of toxic combustion products could be generated in a fire. However, there seems to be reasonable agreement that for a major fire the most significant in terms of toxicity is hydrogen fluoride.

The quantity of HF generated can be estimated based on stoichiometric decomposition, or on experimental data. The approach of Larsson et al (2017), who suggest 20 to 200 mg/Wh based on experimental data, seems to be the most widely adopted approach, and use of the upper bound is likely to provide a cautious best estimate. For a fire involving an entire 5 MWh ISO container (i.e. slightly more than the 3.7 MWh ISO containers at Newry) this would correspond to 1,000 kg of HF.

The duration of the release is conservatively taken to be 30 minutes, which is consistent with the approach recommended by Atkinson and Briggs (2019) for warehouse fires. This implies a release rate of 0.56 kg/s. It is emphasised that in reality there would not be a constant release rate for 30 minutes, but it would grow exponentially to a maximum before gradually decaying over much longer than 30 minutes. However, it is noted that the HSE SLOT and SLOD are based on integrated dose, and so the precise time variation is not important for such criteria.

The other key factor in any toxic fire plume dispersion assessment is the buoyancy of the fire plume, as defined by the convective heat content of the fire plume. The major source of any heat release is likely to be the electrolyte, of which there could be up to about 10 tonnes in a single ISO container. Based on a typical heat of combustion of 20 MJ/kg for the electrolyte, and a release duration of 30 minutes, this would correspond to about 100 MW. In practice, combustion would not be complete and only a fraction would become convective heat in the fire plume (see below). It is noted that BEIS (2020) indicated a heat release of 30 to 50 kJ/Wh, which would correspond to 83 to 138 MW over 1800 seconds for a 5 MWh facility, which is reasonably consistent with the value of 100 MW.

Any generation of HF which is released from the ISO container will be advected downwind, though the plume will tend to rise due to the buoyancy of the hot fire plume. The container may also entrain some or all of the fire plume into its downwind wake, which may spread the plume out and bring it down to ground level, depending primarily on the wind speed.

The dispersion of a fire plume depends principally on the wind speed. At low wind speeds, a fire plume tends to rise buoyantly (see Figure 2.1) and ground level concentrations tend not to be significant. At higher wind speeds, there is generally more dilution of the plume, but it may not lift off the ground, and so moderate to high wind speeds generally represent the worst case for such fire plumes. A range of weather conditions has therefore been considered, namely D2, D5, D10 and F2. It is noted that atmospheric stability may also have some effect, and so stable F2 conditions have also been considered, although (unlike many toxic gas assessments) it is not expected that F2 will be the worst case in terms of hazard ranges.

As noted above, the heat content of the fire plume is a key parameter in determining the degree of buoyant plume rise - a higher heat flux leads to greater plume rise and lower ground level concentrations. Based on CERC (2018), the heat flux is typically calculated as:

$$F_b = (1 - \alpha_r)\, \varepsilon\, H_c\, m$$

Where
- F_b = Heat flux (W)
- α_r = Fraction of heat radiated (typically 0.3)
- ε = Efficiency of combustion (taken as 0.5)
- H_c = Heat of combustion (J/kg) - taken as 2×10^7 J/kg (based on electrolyte)
- m = Mass rate of combustion (kg/s) (taken as 1,000 kg of electrolyte over 1800 seconds)

This suggests a relatively high heat flux of 4 MW.

However, in view of the considerable uncertainty associated with making such an estimate of the effective heat flux, and the extent of possible heat losses (e.g. to sprinkler water) the approach adopted was to assume an effective source diameter of 5 m, with a flux of hot air with a vertical velocity of 1 m/s and an excess temperature of 100°C. This corresponds to a lower heat flux of $\pi \times 2.5^2 \times 1 \times 100 \times 1012 \times 0.9 / 10^6 = 1.8$ MW (NB heat capacity of air is 1012 J/°C/kg, density of air at 115°C is 0.9 kg/m³). The source was conservatively assumed to be located on the lee side of the ISO container at a height of 1 m, leading to significant entrainment in the wake of the container.

Dispersion modelling of the HF releases has been conducted using ADMS 5.2.4 which is well suited to modelling the dispersion of such fire plume releases. In addition to the source term and weather categories referred to above, the following input data has also been used in ADMS.

ISO container dimensions	2.6 m high, 2.4m wide, 12.2 m long
Atmospheric temperature	15°C
Surface roughness length	0.1 m
Surface energy flux	0 kW/m^2 for D2, D5 and D10 conditions; -6 kW/m^2 for F2 conditions
Boundary layer height	800 m for D2, D5 and D10 conditions; 100 m for F2 conditions
Relative humidity	65%
Averaging time	30 minutes

Most of these parameters have relatively little effect on the dispersion results; the most significant inputs being the wind speed and heat flux. The entrainment of the release in the container wake has been included in the ADMS modelling. This entrainment increases as the wind speed increases, and in D10 conditions the release is almost fully entrained in the container wake and the plume centreline is effectively at ground level.

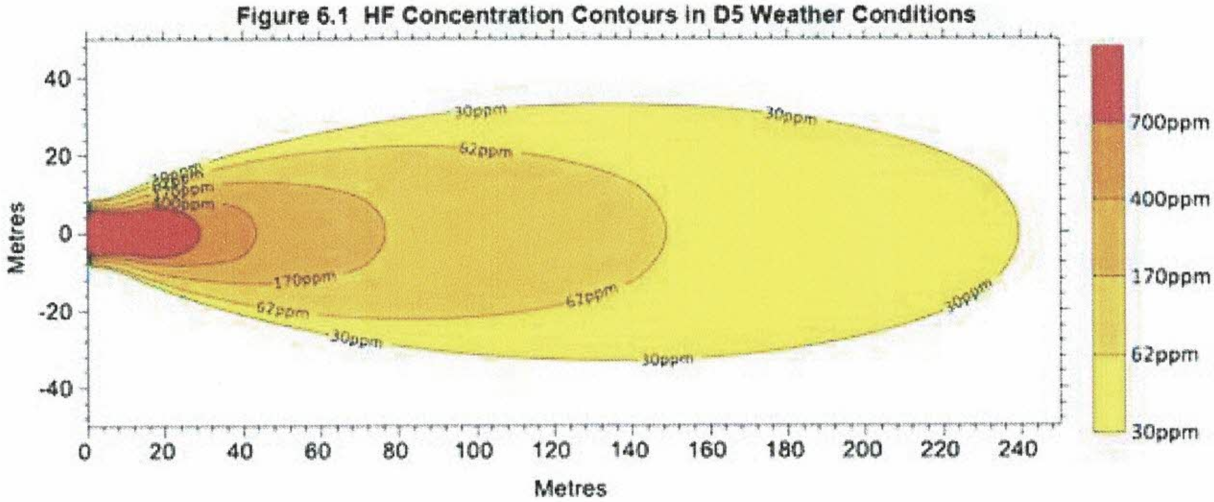
Table 6.1 presents results for the downwind hazard ranges to the HF IDLH, AEGL (10 and 30 minute), HSE SLOT and HSE SLOD for each of the representative weather categories.

Table 6.1 Outdoor Hazard Ranges to SLOT for HF Releases

Criterion	Concentration (ppm)	Outdoor hazard range (m)			
		D2	D5	D10	F2
IDLH	30	85	240	200	85
AELG-3 (30 min)	62	50	150	130	50
AELG-3 (10 min)	170	25	80	70	25
SLOT	400	20	45	40	20
SLOD	700	15	30	30	15

Table 6.1 shows that the worst case hazard ranges tend to occur at moderate wind speeds of 5 m/s. At this wind speed the plume rise is not very significant. As the wind speed increases, the plume rise still decreases, but this is more than compensated by the additional dilution. Figure 6.1 illustrates the ground level concentration results for the worst case D5 weather conditions.

Figure 6.1 HF Concentration Contours in D5 Weather Conditions



It is worth noting that the worst case conditions for toxic hazard ranges may occur in very typical (i.e. D5) weather conditions.

The analysis presented above is considered to be conservative in that the actual heat release rate is likely to be higher, so the worst case conditions would probably occur in higher wind speeds (e.g. D10), but with shorter hazard ranges. There are also some conservatisms in the magnitude of the HF source term, and in the assumption that all the HF is released over 30 minutes, and that people remain exposed in the plume rather than escaping.

It is also noted that, even without a significant fire (due to the fire suppression system), the 2019 McMicken Arizona incident showed that significant concentrations of toxic gases from cell venting, such as HCN and CO, could escape from a container.

7 ASSESSMENT OF WASHOUT AND DEPOSITION

Any fire plume which contains particulates will tend to deposit these particles to the ground, which can lead to issues relating to foodstuffs and clean-up.

Whilst a fire involving a BESS ISO container may generate some such particulate matter, including metal oxides, this has not been regarded as a significant issue in the literature.

Similarly, if there is rain, or water sprays are used on the fire, then there will be some washout (wet deposition) of both particulate and soluble gases. It is noted that gases such as HF are reasonably soluble in water, so water curtains are sometimes used to reduce the airborne concentration of HF following an HF release.

This washout can lead to contamination of ground and water, but again it is not considered to be a significant issue in the literature.

8 FIREWATER RUN-OFF

The HSEGB generally assesses major fires using methods developed by Carter (1989 and 1991) and Atkinson and Briggs (2019). Atkinson and Briggs (2019) state that:

> *There are many examples of chemical warehouses fires that have caused major environmental damage through contaminated firewater run-off. One use of fire plume toxicity assessment is to support "let burn" decisions in planning for and dealing with large fires.*

It is noted that a major concern at the Carnegie Road fire (see Table 2-1) was fire water run-off and potential environmental harm.

There is currently no good data on the significance of firewater from such fires in terms of their impact on the environment, but it is likely to be similar to that from comparable sized fires involving plastics and packaging. There may be specific concerns if the firewater is not contained and can reach sensitive environmental receptors.

9 SUMMARY

This Technical Note provides a high level review of the major hazard issues associated with large scale Battery Energy Storage System (BESS) sites using lithium-ion batteries in an ISO container. It is emphasised that the intention was not to provide a comprehensive review or assessment, but to provide an overall understanding of the key issues, with the principle aim of assisting HSENI to provide more informed advice.

The review has considered published literature and project documents provided by HSENI to establish current best practice for the analysis of such hazards, in terms of source terms and heat loads. A number of incidents involving lithium-ion batteries have been reviewed to provide context and understanding, and some quantitative assessment of fire and explosion hazards has been presented, concentrating on the hazards associated with explosions and dispersion of the toxic fire plume.

Key points which have been identified in the course of producing this Technical Note are:

- Any ISO container BESS has the potential to catch fire due to an unpredictable and spontaneous thermal runaway in a cell. The event may escalate to a fire involving the entire container. There is also a potential for an explosion. The design and mitigation measures in place should ensure that thermal runaway events do not escalate to involve an entire ISO container, but this remains a credible event which should be considered for emergency planning purposes.
- The generation of toxic combustion products from such fires can pose a hazard to those in the vicinity. The main concern appears to be hydrogen fluoride, although there are many other toxic combustion products. Toxic gases such as CO and HCN can also be generated in vent off-gas. This Technical Note provides a reasonably cautious assessment of the HF dispersion and hazard ranges for a worst case fire event, and shows that the HSE SLOT could be exceeded at up to about 45 m, with much higher concentrations in the immediate vicinity.
- The most significant risk to those in the immediate vicinity, or to firefighters, is from potential explosions of flammable vent gases from cells failing due to thermal runaway (either with or without fire). This Technical Note provides some predictions of the potential consequences of such explosion events in terms of the possible levels of blast overpressure. It is noted that there have been several incidents involving significant explosions at BESS sites. It is recognised that cells and modules can undergo cascading thermal runaway without any flaming or ignition, and still generate significant quantities of toxic and flammable gas, with the potential for a delayed explosion.

It is stressed that the assessment of BESS containers in terms of major accident hazard analysis is a new and rapidly developing area, and whilst the assessments here are considered to be reasonably robust, and consistent with current thinking, it is likely that there will be significant developments in the coming months and years.

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[redacted]

From: Kerr, Angus
Sent: 06 January 2022 14:54
To: Symington, Scott; [redacted]
Subject: FW: Planning application LA08/2021/0611/F [UNSCANNED]
Attachments: ABC BC to Kells Vocal received 15th December 2021.pdf; Bann battery HSENI.docx; HSENI Atkins report 30 March 2021.pdf

Folks,

Another one for info only.

Angus

From: [redacted] [mailto [redacted]@outlook.com]
Sent: 15 December 2021 22:17
To: [redacted]@armaghbanbridgecraigavon.gov.uk; [redacted]
<[redacted]@armaghbanbridgecraigavon.gov.uk>; [redacted]
<[redacted]@armaghbanbridgecraigavon.gov.uk>; [redacted]
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Cc: [redacted]@armaghbanbridgecraigavon.gov.uk; DfI Private Office <Private.Office@infrastructure-ni.gov.uk>; Kerr, Angus <[redacted]@infrastructure-ni.gov.uk>; Beggs, Alistair <[redacted]@infrastructure-ni.gov.uk>
Subject: FW: Planning application LA08/2021/0611/F

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Dear Chief Executive and Councillors,

Your planning department is attempting to approve a planning application without due scrutiny and assessment of the dangers and without debate by you or the planning committee.

I apologise for the short notice which requires your immediate "call-in" notice, but it was only today that I received a letter that was dated 10th December but was not posted until 13th December by second class thus ensuring that the five-day response period had all but expired. A copy of this letter and its envelope is attached.

The planning application relates to a battery storage and electricity generating facility. HSENI commissioned a report that states that if one battery container caught fire houses within 40m would be partially demolished and people within this zone could suffer fatality from toxic gas. Within 240m people could suffer health damage from toxic gas clouds. These facilities pose great risks to the public and their siting should ensure that they are well away from houses and public facilities. The attached HSENI Atkins report confirms that there is a real danger of these battery storage facilities catching fire and exploding. No decision can be made until a full assessment is made of the dangers of this planning application.

HSENI notified your planning office of these dangers, copy letter attached, yet this planning department attempt to approve an application without assessment of the dangers to residents, buildings, and the environment.

I will copy you into a detailed letter of objection to [redacted] tomorrow.

In the interim I urge all of you complete an **"Elected members Call-in Form"** requesting details of the assessment of this planning application in relation to the safety of ratepayers. This should be done now in order to protect the safety of your constituents.

Thank you for taking the time to read this e mail.

Pleaser reply to this e mail if you require further details or information.

Yours sincerely

[redacted]
KellsVOCAL

[redacted]
Moorfields
Ballymena
BT42 3DA
29 December 2021

[redacted]
Deputy Director Planning
Antrim and Newtownabbey Borough Council.

Dear [redacted]

Re: Kells BESS New Layout Under Construction

Introduction:

I wish to make you aware that at the Kells BESS site adjacent to the Doagh Road, the developer is currently constructing a completely different layout to that which received planning approval. ANBC has opened an enforcement file because the developer has not made either an application for a Non Material Change or a fresh planning application and I believe ANBC are currently considering whether the changes are material changes requiring a fresh application or non-material changes requiring a Non-material Change Application.

I write to advise you that whilst the number of containers on site has decreased from 25 to 13, a recent application by the developer to the Utility Regulator reveals that the capacity per container, which is what determines the risks of fire, explosion and toxic gas release per container on human health and the environment, has increased three-fold from the risk assessments submitted to ANBC, namely the Golder Report October 2020 and the Fire Risk Assessment, July 2020. Please refer to the Evidence section of this letter for further detail.

This three-fold increase in capacity per container, the subsequent requirement of assessments and consultation with statutory authorities, and the increased visual impact of additional and higher electrical infrastructure adjacent to the Doagh Road requires, in my opinion, a fresh planning application and that to process them as a Non Material Change Application would be procedurally incorrect and open to legal challenge.

Policy and Reasoning

The Development Management Practice Note *Non-Material Change* April 2015 states under 6.0 Publicity that:

> *6.1 As an application for a non-material change is not an application for planning permission, the existing provisions relating to statutory consultation and publicity will not apply. <u>If consultation and/or notification is considered necessary, it is likely that the proposal would not then be acceptable as a non material change.</u>*
> https://www.infrastructure-ni.gov.uk/sites/default/files/publications/infrastructure/dmpn-25-non-material-change-v1-april-2015_0.pdf

The increase in capacity of each container will impact the fire risk assessment and the potential impact on human health and the environment in a loss of control event. Therefore, consultation with NIFRS, HSENI, NIEA, will be required.

The increase in the number of batteries per container will affect the heat output per container which will affect the cooling requirements which will affect the air conditioning units required per container. This will require a fresh acoustic assessment and consultation with Environmental Health for impact on identified receptors such as adjacent dwellings.

It is reasonable to assume that, since an enforcement case has been opened, such assessments have already been requested from the developer and may even have been received. If such assessments have already been sent out to consultation with any of the statutory consultees, or independent risk assessors, then in accordance with 6.1 *' it is likely that the proposal would not then be acceptable as a non material change.'*

The Development Management Practice Note *Non-Material Change* April 2015 states under 7.5 that:

In deciding whether or not a proposed change is non-material, consideration should be given to the effect of the change, together with any previous changes made to the original permission. A local council may wish to assess whether a proposal change may give rise of any of the following:

1. *any potential conflict with planning policy;*

Judge Humphries Decision in the recent JR on CPU 7 stated that whilst BESS do not generate electricity all the time, and therefore were deemed to not fall wholly within the category of an electricity generating station for Planning purposes, BESS are used for the production of electricity. The Chief Planner has already identified to you that BESS are likely to require an EIA under Schedule 2 Category 3(a) and Schedule 3. The Kells BESS facility has a site area in excess of the 3(a) threshold of 0.5H and has the potential to have significant effects on the environment and human health in a loss of control of process (see HSENI/Atkins Report 2021) it being over 50MW. It therefore has to be assumed that an EIA is therefore required for this development. Please note that Direction 4 of The Planning (Environmental Impact Assessment) Regulations (Northern Ireland) 2017 places a prohibition on the *'grant planning permission or subsequent consent for EIA development unless an environmental impact assessment has been carried out in respect of that development.'* Therefore, a fresh application for this new scheme is required so that the Council avoids conflict with planning policy.

3. *any potential conflict with any of the conditions on the planning permission;*

The new scheme is not in compliance with Condition 1 CEMP which was partially discharged on the planning approved layout and associated plan.

The new scheme is not in compliance with Condition 7 as the assessment submitted is based on the planning approved layout and not the new layout.

The new scheme is not in compliance with Condition 8 as the noise assessment submitted, and mitigation measures determined, were based on the planning approved layout and not the new layout.

The new scheme is not in compliance with Condition 9 as the noise assessment submitted, and calculations determined, were based on the planning approved layout and not the new layout.

4. *an exacerbation of concerns raised by third parties at the original application stage;*

The fire risk concerns in a loss of control of process were raised to the PAC by third parties and the increase in capacity of each container is an exacerbation of those concerns.

The noise from air conditioning units was raised by third parties and the increase in capacity and associated cooling requirements exacerbates those concerns.

The increase in height and additional electrical infrastructure immediately adjacent to the Doagh Road is an exacerbation of the visual impact concerns raised by third parties and unacceptable visual impact was a reason for refusal of the original application by the Planning Committee.

> *6. an increase in height of the building or extension ;*

There has been an increase in height to the electrical equipment, and additional electrical equipment has been added, in the area immediately adjacent to the Doagh Road.

> *8. a material change in the design of the building;*

The layout of the battery containers is entirely different. The layout of electrical equipment adjacent to the Doagh Road is entirely different.

> *9. new works or elements not considered by any environmental statement submitted with the application;*

No EIA was submitted for this approved development. No scoping/screening exercise is published on the portal. I have to assume therefore that none was done or sought. Following the Chief Planner's advice, this development requires an EIA under Schedule 2 Category 3(a) and Schedule 3. A fresh application for this new scheme is required so that the Council avoids conflict with planning policy.

> *10.the requirement for any consultations to be undertaken or any public advertising or neighbour notification.*

As previously stated above, the three-fold increase in the capacity of each container will impact the fire risk assessment and the potential impacts on human health and the environment in a loss of control event. Therefore, consultation with NIFRS, HSENI, NIEA, DEARA will be required. Therefore, a fresh application is required.

The increase in the number of batteries per container will affect the heat output per container which will affect the cooling requirements which will affect the air conditioning units required per container. This will require a fresh acoustic assessment and consultation with Environmental Health for impact on identified receptors such as adjacent dwellings. Therefore, a fresh application is required.

As both the risks in a loss of control and operational noise may affect residents, neighbour notification is required.

> *7.6 It should be noted that the criteria above are intended to provide guidance about changes that are likely to be material and therefore not likely to be acceptable as a non-material change. It is not a comprehensive list and each non-material change application must be considered on its own merits. <u>Furthermore, the criteria are designed to prevent changes being accepted that would have a detrimental impact upon neighbours or amenity in the wider public interest.</u>*

The Atkins/HSENI report on BESS identified clear risks to both human health and damage to the environment. A fresh application with advertising to permit public participation in decision making, and consultation with the statutory consultees and an EIA is required so that this new layout is fully assessed in accordance with all relevant legislation.

Alignment of Follow-on consents

The planning approval together with the follow-on consents and licenses for the Kells BESS are all required to align. If all the legislations were followed correctly, they would. However, as I set out below, they will not:

- Planning Approval for the Kells BESS - there is no planning permission in place for the layout that is being constructed. I believe there is an EIA requirement for this development and no EIA has been sought or submitted as it has not appeared on the public portal.
- Consent from DfE to Construct and Operate the Kells BESS: Under Article 39 of the Electricity NI Order 1992 - Consent has been granted for a Kells BESS of 25 containers, each of 2MW, and the associated planning approved layout was submitted. Consent requires planning approval to be in place and no such planning approval has been given for the 13 container layout that is currently being constructed. Furthermore, DfE rely on Planning to have carried out an Environmental Impact Assessment, if required, before granting planning permission because the consent requires confirmation under development (EU Article 8(2) of Directive (EU) 2019/944 that public health and safety and protection of the environment have been approved. No scoping/screening exercise has been carried out or published on the portal for either the planning approved layout or the new layout that is being constructed. The Chief Planner has advised that BESS are likely to require an EIA. The new layout currently being constructed cannot be granted a consent by DfE without a fresh planning application and EIA being approved.
- Utility Regulator's Electricity Generating Licence – this was applied for in Dec 2021 with data from the new layout which has no planning approval.

One would assume that it is the intention that all three consents - planning approval, consent from DfE, UR Electricity Generating Licence - would align. If all the legislations were correctly implemented, as described above, they would align. It would appear that this is not the case with this new layout for the Kells BESS.

I believe that the only way forward is that a fresh planning application together with an EIA is submitted for the new layout so that it can be assessed along with any other risk assessments required under legislation. The consent by DfE and the license by the UR would follow-on from the planning approval, if granted.

Evidence

Dec 2021: Application to the Utility Regulator for an Electricity Generating License for the Kells BESS confirms the following:

- **Date: UR Application Dec 2021**
- Number of containers 13
- Power per container. 4.1MW
- Total power MW 53.3 MW
- Total on site capacity MWh 40.56MWh
- **Capacity per container 3.12MWh**

https://www.thegazette.co.uk/notice/3958584

From the number of containers, thirteen, we must deduce that this is the data for the Kells BESS layout that is currently under construction.

Nov 2019: Planning permission granted for a Lithium-ion BESS development of:

- **Date: Planning Permission Nov 2019**
- Number of containers 25
- (Deduced Power per container). 2 MW
- Total power MW 50 MW

April 2020: Application to Discharge Condition 7 Fire
You will recall that an application LA03/2020/0264/DC to Discharge the Fire Condition (FRA April) was made on 02 April 2020. Document 02 carries out a Fire Load and Fire Risk Assessment based on the stated use of use of 78AH whilst providing the manufacturer's data sheets for a 94Ah battery. (The latter would have given a Total power of 63.77MW.)

Based on the 78 Ah batteries: the developer states

- **Date: FRA April 2020**
- Number of containers 25
- (Deduced Power per container) 2 MW
- Total power MW 50 MW
- Capacity on site 53.3MWh
- **Capacity per container 2.13MWh**

July 2020: Revised FRA
Following several detailed letters of objection by KellsVOCAL to the contents of FRA April, the applicant submitted a revised Fire Risk Assessment on 3rd July 2020 (FRA July). This revised FRA reduced the number of batteries in each container by half reducing the capacity per container to 1 MW.

- **Date: FRA July 2020**
- Number of containers 25
- (Deduced Power per container) 2MW
- Total power MW 50 MW
- Capacity on site 26.3 MWh
- **Capacity per container 1.05Mh**

Oct 2020: Submission of Golder Report
Following several further detailed letters of objection to the contents of FRA July, the applicant submitted an assessment by Golder on the 22nd October 2020 (Golder Report) which was based on the data of FRA July (1MW per container).

- **Date: Golder Report Oct 2020**
- Number of containers 25
- (Deduced Power per container) 2MW
- Total power MW 50 MW
- Capacity on site 26.3 MWh
- **Capacity per container 1.05MWh**

It is important to understand that the capacity in MWh is the basis of the Fire Risk Assessment within a container.

The FRA April, which the related to the Planning Approval, declared a capacity of 2MWh.This was revised to 1.05 MWh per container in the July FRA and used in the Golder Report Oct 2020 which was submitted to the Council as a further risk assessment.

When the Council was alerted to the revised layout that was being constructed without your knowledge or consent, the Council opened an enforcement case. I assume the Council have since requested the developer to submit amended drawings and/assessments for fire risk, noise and CEMP. I await the release of these documents under EIR.

Let us now look again at the recent application by Kells BESS Ltd to the Utility Regulator for an Electricity Generating License:

- **Date: UR Application Dec 2021**
- Number of containers 13
- Power per container. 4.1MW
- Total power MW 53.3 MW
- Total on site capacity MWh 40.56MWh
- **Capacity per container 3.12MWh**

Any fire risk assessment carried out on a single container is based on the capacity of that container measured in MWh.

So, the fact that the capacity per container at the Kells BESS has risen threefold from 1 MWh in the Golder Report (and FRA July) to 3.12 MWh in this new layout is a very significant rise in fire risk which must be assessed. The proper procedure for this assessment, with the statutory consultees of HSENI and NIFRS and NIEA, together with neighbour notification and public advertisement, is a fresh planning application.

In the light of the above, please confirm that the applicant will be asked to submit a fresh planning application accompanied by an EIA and that a discontinuance notice will be issued on the current works on site.

Yours sincerely

[redacted]

Ref: LA05/2021/1117/DC

To: Mr David Burns, CEO, Lisburn and Castlereagh City Council
To: Mr Conor Hughes, Planning Office, Lisburn and Castlereagh City Council

Date: 30-12-21

To Mr David Burns and Mr Conor Hughes, Lisburn and Castlereagh City Council

I have only recently become aware of the Fire Risk Assessment (FRA) submission for the BESS at Lisnabreeny Road East. I had already set Planning Application number LA05/2019/0675/F to be tracked, however, the related application LA05/2021/1117/DC did not trigger a tracking alert. Can the Council please respond to me with an explanation for this. As a result, the processing of LA05/2021/1117/DC has continued without me, or any other member of the public, having the opportunity to participate in your decision making process, which we are entitled to have under the Aarhus Convention.

You will already be aware of my concerns regarding this development in respect of danger to human health and the environment. In carrying out your assessment of LA05/2021/1117/DC the applicant is required to submit a Fire Risk Assessment in order to *'Identify and minimise any potential fire hazards'* and the Council are required to satisfy themselves that this Condition has been met before approving that batteries can be brought on to the site.

I note that NIFRS have been consulted with and have not provided you with such an approval.

I note that you have not consulted with HSENI.

If the Council do not have the expertise to assess this Fire Risk Assessment, the Council are required to obtain that professional and independent advice externally before making a decision on LA05/2021/1117/DC.

The commentary below has identified some key findings:

- The capacity of the development is 80.5MWh. No clarification of the capacity of the development was sought by the Council prior to issuing its Approval thus rendering the capacity limitless. This makes Condition 9 FIRE even more critical as it would now appear that the only limiting factor to the capacity of this Planning Approval is the Council's assessment of its fire risk.

- The Fire Growth Parameter is the key calculation for fire risk within the Applicant's submitted FRA and their conclusion that their development is '*considered reasonable from a fire strategy perspective'* is a result of achieving a Fire Growth Parameter of '*medium'* rating. However, there is a major discrepancy in their calculation of the Fire Growth Parameter which when corrected increases it from the Applicant's stated '*medium'* to *'ultra high'.* The applicant's statement of reasonable cannot stand if the risk is 'ultra high'. This major discrepancy requires resolution before proceeding.

These and the other identified issues are explained below and I ask that this letter be placed on the public portal as an Objection to LA05/2021/1117/DC and that all relevant consultees, and external experts employed by the Council, are asked to respond to this submission.

Capacity of the development: 80.5 MWh

The FRA submission states that:

- Each container has *12 racks* of batteries with each rack having *416 cells*.
- Each individual rack of *416 cells* has a total voltage of *1331.2v* and a rating of *280Ah.*(See Sheet 3 Apdx in FRA)
- The capacity (MWh) of each container is therefore 12 x 1331.2 x 280 = 4,472,832Wh or 4.472MWh.
- The total capacity on site is therefore: 18 containers x 4.472MWh = 80.5MWh

80.5 MWh capacity is significant especially in a location with residents within 50m of the BESS. To put this into context, Elon Musk situated his 100MWh BESS in the Australian desert, miles from houses for safety reasons.

No clarification of the capacity of this development was sought by the Council prior to issuing its Approval thus effectively rendering the capacity limitless.

This makes Condition 9 FIRE even more critical as it would now appear that the only limiting factor to the capacity of this Planning Approval is the Council's assessment of the development's fire risk. The Council should

be completely clear about the enormity of their liability in respect of discharging this Condition and hence they must seek appropriate expert, independent advice if they do not have it within the Council.
Risk Profile: Fire Growth Parameter

The FRA document (Fig 3 graph) shows that, in the event of a fire in a container rack, the maximum heat release is *42.5kW after 748 seconds.*

The FRA states that the maximum heat rate release after *748 seconds* is (416 cells x 42.5kW) = *17,680kW*

The FRA states that to calculate the Fire Growth Parameter within the containers, the following calculation is followed:

Fire Growth Parameter = *17,680* divided by (*748 seconds* minus the Time to Ignition) squared.

The key here is that the 'Time to Ignition' is identified as being zero because the Ignition point is assumed by the applicant as being the start of the experiment - not the time when the batteries actually begin to ignite. The result of this assumption is to give a low Fire Growth Parameter

Fire Growth Parameter =17,680 divided by (748-0) squared
= **0.03**

The Fire Growth Parameter is a key measure of fire load. So this figure is a critical measure of fire risk.
There are four classifications as indicated below:

Classification	α
Slow	0.0029
Medium	0.012
Fast	0.047
Ultra-fast	0.188

Table 1. Fire growth parameters proposed by BS 7974-1.

The FRA goes on to state that their Fire Growth Parameter of 0.03 is identified in BS7974-1 FGP as being within the *Medium* bracket of Fire Growth Parameter's. The conclusion to Council and the NIFRS is that a container of batteries has a Medium fire growth parameter and therefore medium risk. This is the key plank, referred to throughout the FRA, and upon which the Applicant relies in concluding the development to be '*considered reasonable from a fire strategy perspective'*.

What needs to be established is: In this particular experiment, what is the Ignition Point on the graph?

Is it the point at which this experiment begins? Or is it when the batteries ignite/begin to produce their own heat?

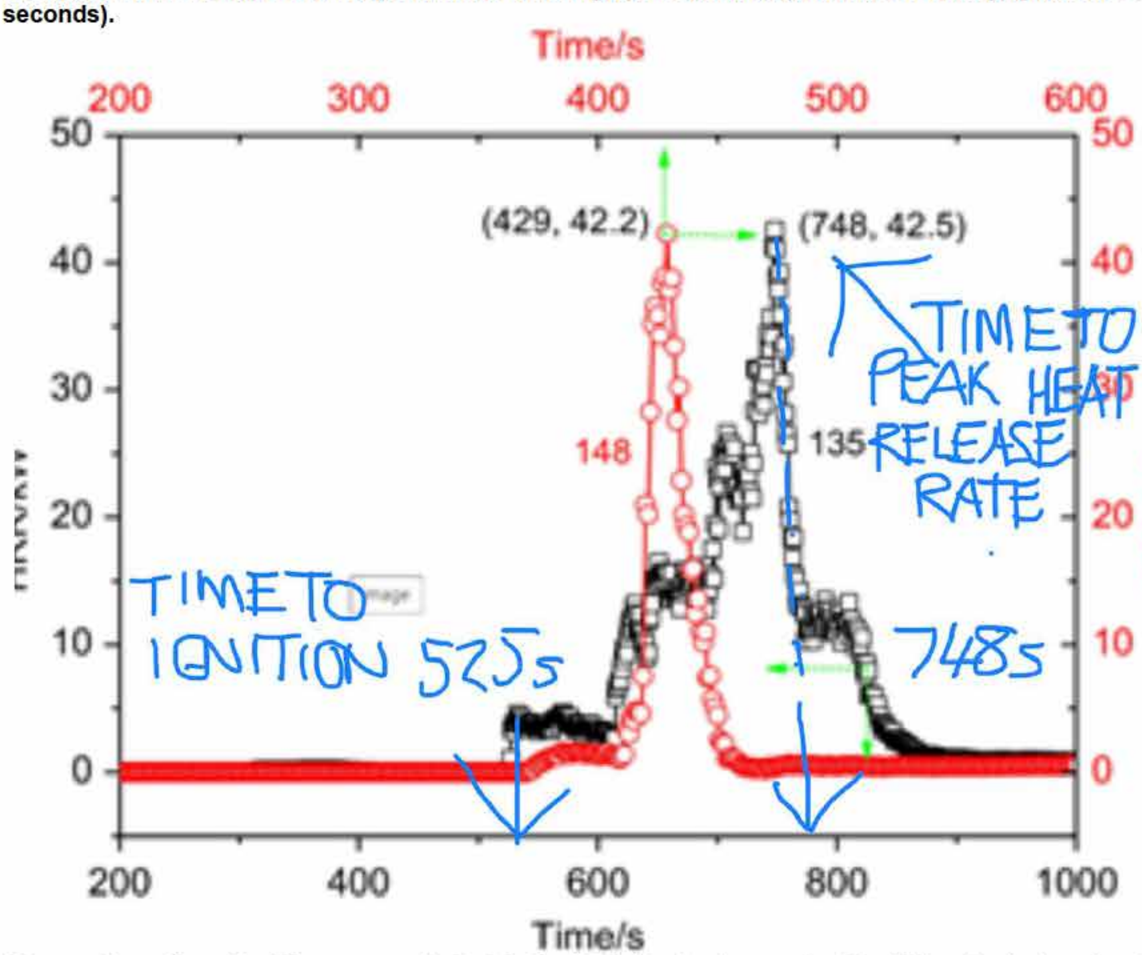
- If it is when this particular experiment begins then the Time to Ignition would always be zero.
- If it is when the batteries ignite/start to produce their own heat then it would be a figure related to the graph in this experiment.

The original source material for that particular graph has been identified. It is *Figure 7 Heat release rate of the lithium ion battery* from the scientific paper *'Study on the fire risk associated with a failure of large-scale commercial LiFePO4/graphite and LiNixCoyMn1-x-yO2/graphite batteries'* by Zhi Wang,Kang Zhu,Jianyao Hu,Jian Wang. First published: 31 January 2019. You can access the paper here:
https://onlinelibrary.Wiley.com/doi/full/10.1002/ese3.283

This scientific paper refers to two significant points on the graph:
- Time to Ignition
- Time to peak Highest Heat Rate

This scientific paper then identifies the figures related to each of these two points on the graph as being:
- Time to Ignition: 525 seconds
- Time to peak Highest Heat Rate: 748 seconds

Therefore, the original scientific paper, from which the graph is taken, identifies that the Ignition point is **not taken to be the start of this experiment** (where the Time to Ignition would be zero as claimed by the Applicant) but measured **from the start of the experiment to when Ignition occurred (identified on the graph to be 525 seconds).**



Above: From the scientific paper and cited in the FRA. *Heat release rate of the lithium ion battery (mark ups added)*

Below from Scientific Paper: ***Table 2.*** *Comparison of main parameters related to the fire hazards of the lithium ion batteries (LIBs)*

LIB	**135**	**148**
Maximum AST, °C	535.3	658.7
Maximum AST increasing rate, °C/s	18.04	64.84
Time to ignition, s	**525**	**368**
Time to peak HRR, s	**748**	429
Peak HRR, kW	42.5	42.2

Returning to the applicant's FRA, the Fire Growth Parameter can now be calculated using the ignition time identified in the scientific paper which was 525 seconds.

Actual Fire Growth Parameter	= *17,680* divided by (*748* – Time to Ignition) squared.
	= 17680 / (748 - 525) squared
	= 0.355

Therefore in summary, the applicant's FRA uses a graph from a scientific paper but claims the ignition point to be the start of the experiment, rather than when ignition actually occurs which was at 525 seconds from the start of the experiment and which was the figure identified in the scientific paper identifies as being the Time to Ignition.

The Council therefore must ask the applicant to give a full explanation as to why they have used a graph from a scientific paper, did not include the reference to it, and then used an ignition point that was contrary to that identified in the scientific paper. The Council must then ask the applicant to amend his FRA using the Time to Ignition of 525 seconds as measured from the start of the experiment to the point of ignition.

Furthermore, when the Applicant uses zero as his Time to Ignition, the difference between that and the Time to Peak Highest Heat Rate is maximised which results in minimising the Fire Growth Rate and a figure of just **0.03** is achieved.

However, when the Time to Ignition as measured as identified in the original source paper, and the actual Fire Growth Parameter is calculated as **0.355. This is a significantly different figure.**

The Applicant's FRA identifies a table from *BS 7974-1* grading fire growth parameters of four classifications ranging from '*slow' at 0.0029* to' *Ultra-fast' at 0.188.*

The Applicant's Fire Growth Parameter at 0.03 falls into the *Medium* classification. However, the Fire Growth Parameter calculated using the Time to Ignition as identified in the original scientific paper gives a figure of **0.355 which is far in excess of the 0.188 threshold for the Ultra-fast category, and two classifications higher than that calculated in the Applicant's FRA.**

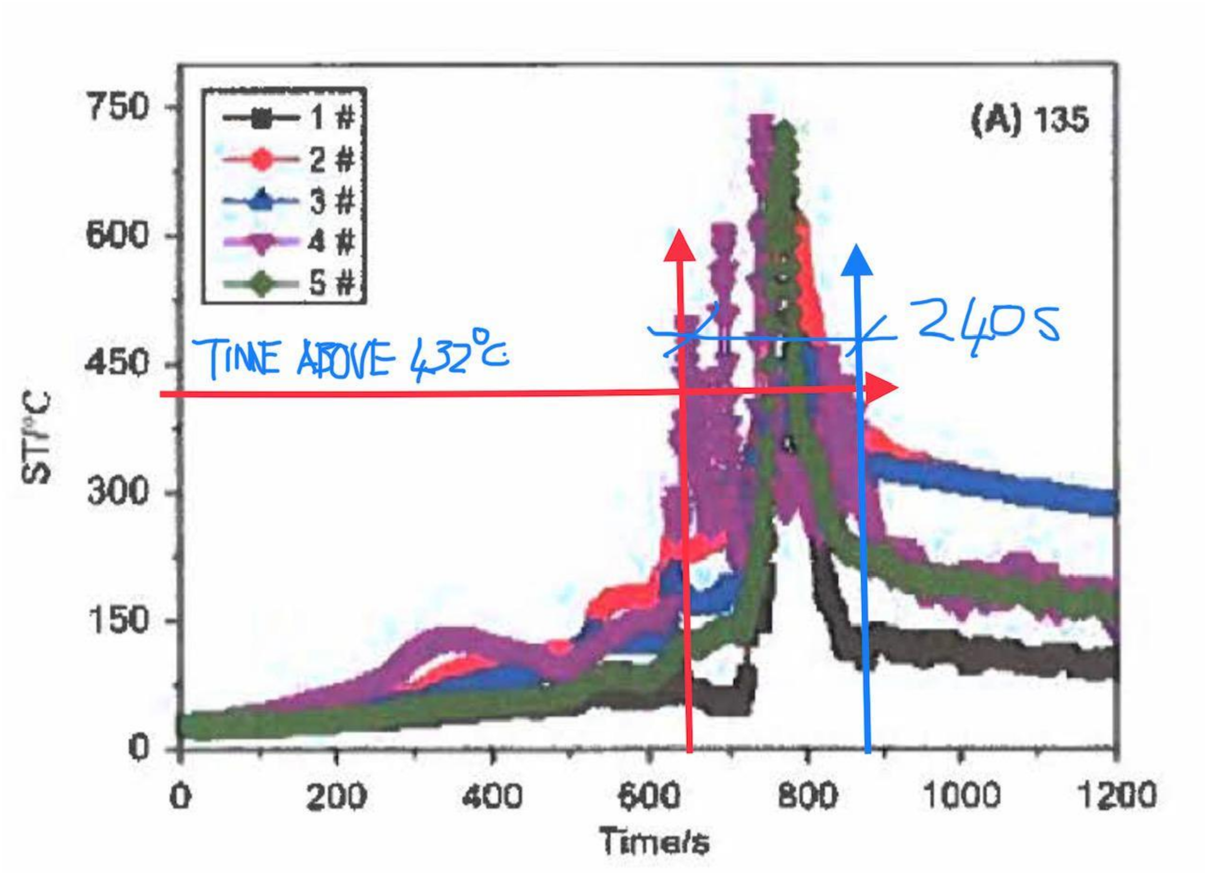
As the Fire Growth Parameter is a key to measuring the fire risk, the Council must now to ask the Applicant to amend their FRA identifying the revised Fire Growth Parameter category for their development.

Please note that this is important knowledge for the NIFRS to have and we ask that the Council re-consults with NIFRS and draw this letter to their attention. It is important that the NIFRS are fully aware that the fire load of a single 4.472MWh BESS container is extremely high.

Fire Spread Risk within a container of batteries

This section of the Applicant's FRA also relies on a graph from the same scientific paper *'Study on the fire risk associated with a failure of large-scale commercial LiFePO4/graphite and LiNixCoyMn1-x-yO2/graphite batteries'* by Zhi Wang,Kang Zhu,Jianyao Hu,Jian Wang. First published: 31 January 2019. You can access the paper here: *https://onlinelibrary.Wiley.com/doi/full/10.1002/ese3.283*
The Applicant's FRA claims that an initial fire will not spread between the rack aisles in the container.

However, the graph they refer to, which is taken from the scientific paper, shows the radiant surface of one row of battery racks on fire will exceed the FRA calculated maximum compartment temperature of *432* degrees C (See appendix B) for over three minutes which together with the associated explosions will endanger the other batteries on the other side of the aisle which is only 0.59m wide. The assessment is not clear on the implications of temperatures exceeding *432* degrees C for that length of time.



The applicant's FRA states *that 'each module will be enclosed in a non-combustible steel case'.* However, 'non-combustible' is not the same as 'fire rating' which is a measure of fire protection/containment. The Council must ask the applicant to identify the fire rating of the casings, if they indeed have a fire rating, and they provide the manufacturer's data sheets and certification for that fire rating.

The applicant's FRA states that *'each rack will be partly enclosed in a non-combustible metal case, significantly reducing the ignition of adjacent racks'.* However, no certification, data or calculations have been provided to back up this statement. It is hard to imagine a 'partly enclosed' 'non-combustible' casing that would be able to obtain such certification. The Council must ask the Applicant to provide proof of their claim by way of certification and/or calculations.

In determining the discharge of Condition 9 the Council needs to be very clear on what they are approving. If a fire starts within a container, the temperature will potentially exceed the maximum compartment temperature, regarded as the threshold above which a fire will spread, for a period of four minutes - making the risk of fire spread to adjacent racks more likely.

The FRA notes the provision of a fire suppression system, however, we draw your attention to actual experience reported by HSE at the Liverpool BESS Fire, Carnegie Road, Liverpool, September, 2020, in their Investigation Note – Initial Enquiries which stated:

> *At the time of my visit it appeared that most or all of the battery cells within the container were destroyed by the fire…*
>
> *Although there was a fire suppression system in the container, the speed of propagation indicated that this hadn't activated. It was thought that activation would have had little or no effect on the resultant fire / explosion.*

In determining the discharge of condition 9 you need to be very clear what you are approving. A full assessment is required of the implications of the extremely dense packing of batteries in one container with no fire rating for the cabinets to the total of 4.472MWh where on the ground experience has shown that fire suppression system cannot be assumed to work.

Risks to relevant persons

Condition 9 requires the Planning office to have assured themselves that the FRA has identified '**the people at risk including those who may be especially at risk**'.

HSENI commissioned a report by Atkins, published in summer 2021, into the risks associated with a fire/explosion in only one single BESS container which HSENI has shared with you and which is relevant to review in relation to the FRA.

> ***'The pressure wave from a blast can generate an over pressure of 70mbar, 45m from the container. For reference a 70mbar overpressure can partially demolish a house.'***
>
> ***'Hydrogen fluoride produced from a fire cause severe and fatal effects up to 45m and immediate dangers to health 240m away from a container fire.'***

The Council must ask the applicant to identify *'the people at risk including those who may be especially at risk', and include them* in any assessment for Fire Risk and the potential implications. This will include people who live or work near the development. The current FRA fails to identify the people at risk in this community and as a result no provision is made for our safety.

Relevant Fire Codes

The applicant cites the relevant fire code to be the International Fire Code US 2015 when in fact the NFPA 855 Standard for the Installation of Stationary Energy Storage Systems 855 ® NFPA 2020 is the new standard for <u>all battery storage installations in the US</u>.

While NFPA 855 is naturally a very detailed standard, its most important section is Section 4.6 "Size and Separation" for which it is explained:

> *This section includes requirements designed to keep fires originating in a single energy storage unit from easily spreading to adjacent energy storage units or out of the fire area in which the ESS is installed. This is done by limiting potential fire size within an individual energy storage unit by limiting the total energy capacity of individual units. It also reduces the potential of fire originating in one unit from igniting an adjacent unit, or breaching a fire resistance rated wall through radiant heat transfer by requiring spacing between individual energy storage units, and between units and walls.*

For example, as the NFPA website goes on to explain in relation to 'size and separation ESS installations':

> *Another key requirement in NFPA 855 applies to the size and separation of ESS installations. Three feet of clear space is required between every 50 KWh grouping of ESS, as well as between the 50 KWh groupings and the walls of the room.*
>
> *The intent of this requirement is to prevent horizontal propagation of fire through an ESS installation. Horizontal propagation of a fire can overwhelm a fire suppression system and render it ineffective.*

The Council must therefore consider how, in the Applicant's FRA, the layout of a single BESS container meets this code in any way when the aisle width alone is only 0.59m.

The Code goes on to identify the need to reduce the risk of fire spread between containers through fire rating of the containers themselves (please note that the FRA says nothing about this), significant separation between the containers (please note that the FRA says nothing about this). The Council must now ask the applicant to explain how they are reducing the risk of fire spread between containers on the site which has 18 containers located closely together.

Hazardous Substances Consent

The Chief Planner's Update No 7 (CPU 7) in which he advises that when a battery application is made that:

> *In order to consider and assess relevant material considerations and associated risks appropriately, LPA's should seek the details of the batteries including numbers, the substances contained, and the capacity of the system from potential developers.*

The FRA does not address the substances contained in the batteries. From the HSENI/Atkins Report the Council is fully aware of the toxic gas releases and their potential fatal effects to people within 45m of the development and harm to health of people 240m from the development. The Council must seek this data from the applicant and make an assessment of the risks. Only after that data is obtained can an assessment for the need for HSC application be carried out.

The public have a right to participate in the decision making process of Hazardous Substances Consent.

Summary

This letter has raised a number of matters that require expert scrutiny by the Council and in particular a major discrepancy in the calculation of Fire Risk Parameter that raises the risk from 'medium' to 'ultra fast' classification. All these matters are required to be resolved before proceeding.

I await your response.

Yours sincerely

[redacted]
Castlereagh.