Technical Appendix 1.1

Letter of Intention to Submit an Environmental Statement for the Proposed Carnbuck Wind Farm

RES UK & Ireland Limited
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County Antrim, Northern Ireland BT40 2SF, United Kingdom
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E info@res-group.com www.res-group.com

Alistair Beggs
DFI Planning,
Clarence Court,
10-18 Adelaide Street,
Belfast,
Bt2 8GB

By email: planning@infrastructure-ni.gov.uk

Our Ref: 03090-3523798

17th February 2022

Dear Alistair,

Re: Intention to Submit an Environmental Statement for the proposed Carnbuck Wind Farm, Co. Antrim

Pursuant with the Planning (Environmental Impact Assessment) Regulations (Northern Ireland) 2017 (Part III: Preparation of Environmental Statements), Regulation 9 (1), RES Ltd duly gives notice of its intention to submit an Environmental Statement in support of a planning application for a wind energy project referred to as Carnbuck Wind Farm, in the townlands of Carnbuck**,** Magheraboy and Moneyneagh, near Corkey, County Antrim. (See enclosed Preliminary Site Boundary).

The Environmental Statement will be submitted in support of a planning application comprising: up to 12 three-bladed horizontal axis wind turbines, each up to 180m maximum height above ground level; associated external electricity transformers; underground cabling; access tracks; turning heads; crane hardstandings; control building and substation compound, energy storage containers, mast, off-site areas of widening to the public road and all ancillary works. The development also comprises upgrades to the existing site entrance and access tracks of Gruig Wind Farm. During construction and commissioning there would be a number of temporary works including a construction compound with car parking; temporary parts of crane hardstandings; welfare facilities and temporary guyed meteorological masts. The purpose of the development is for the generation of electricity.

Under Part III, Regulation 9 (2), we identify the major issues which will be addressed in this Environmental Statement as:

- the implications of siting the wind turbines on the landscape quality and the visual character of the site;
- the impact on local population (traffic generation, noise, shadow flicker, employment);
- the impact on local flora and fauna;
- the impact on the historic and archaeological interest of the site and surrounding area.

We note that on receipt of the developer's notice of intention to submit, the Department for Infrastructure (DFI) will notify the relevant authorities likely to be concerned by the proposed development under Part III,

Regulation 9, Paragraph 3 (b) (i &ii). The developer would like to be informed of the names and addresses of the bodies as detailed under Part III, Regulation 9, Paragraph 3 (b) (iii).

We also request that DFI communicates our intention to enter into consultation, with anybody identified by DFI in order to ascertain whether the body has information in its possession that they consider relevant to the preparation of the environmental statement and that such information should be made available to the developer, under Part III Regulation 8.

Further to this, RES and the various consultants that are carrying out survey work for the Carnbuck site, have notified some authorities regarding the proposed development in order to ascertain whether the body has information which they consider to be relevant to the preparation of the environmental statement.

We trust the information provided is satisfactory, however if you have any queries please do not hesitate to contact us.

Yours sincerely,

Fiona Stevens
Senior Development Project Manager (Lead)
E Fiona.Stevens@res-group.com
T +44 282 844 0594

Enc: Site Boundary (Preliminary) Ref. 03090-RES-LAY-DR-LE-001 Rev 1

Technical Appendix 1.2

Department for Infrastructure (DFI) response to Intention to Submit an Environmental Statement

Strategic Planning Division

Department for Infrastructure
An Roinn Bonneagair
www.infrastructure-ni.gov.uk

Ms F Stevens
RES UK & Ireland Limited
Willowbank Business Park
Willowbank Road
Millbrook Industrial Estate
Larne
County Antrim
BT40 2SF

Clarence Court
10-18 Adelaide Street
Belfast
BT2 8GB

Date: 23rd March 2022
Our Ref: LA01/2022/0230/DETEIA
(Please quote at all times)

Dear Ms Stevens,

Location: **Townlands of Carnbuck, Magheraboy and Moneyneagh, near Corkey, County Antrim.,**

Proposal: **Intention to submit Environmental Statement for Proposed Carnbuck Wind farm with up to 12 three-bladed horizontal wind turbines, each up to 180m maximum height above ground level and associated external electricity transformers.**

I refer to the above and your letter dated 17th February 2022 indicating that you intend to submit an Environmental Statement for the above proposal.

As required by Regulation 9(4) of the Planning (Environmental Impact Assessment) Regulations (NI) 2017, I enclose a list of the District Council and other authorities likely to be concerned by the proposal by reason of their specific environmental responsibilities or local or regional competences. These bodies will be advised of your name and address and of their duty under Regulation 10(1) of the Regulations to make available to you information in their possession

which they or you consider relevant to the preparation of the Environmental Statement. You are strongly advised to consult these bodies.

Schedule 4 to the Regulations sets out matters to be included in any Environmental Statement. You should note that the onus is on the developer to demonstrate the environmental acceptability of his proposal and to deal with issues raised through the Statement. If the Statement proves to contain insufficient information, the Department may be obliged to seek additional information necessary to enable it to properly assess your proposal.

If you wish to discuss the above or seek further guidance, please contact Louise Leighton on telephone number 028 9054 0528.

Yours faithfully

Louise Leighton

for Strategic Planning Division

List of names and addresses of bodies notified under Regulation 9(4)(b)(ii) of the Planning (Environmental Impact Assessments) Regulations (Northern Ireland) 2017 – Proposed Carnbuck Wind Farm (LA01/2022/0230/DETEIA)

NAME	ADDRESS
Adelphi Net1 Limited	Andrew McKeever, Adelphi Net1 Limited, Tullyallen Village Centre, Tullyallen, Co. Louth.
Arqiva Services Limited	Mr Peter Hayne, Crawley Court, Winchester, Hampshire SO21 2QA
Belfast City Airport	Fiona McCurdy Safety And Compliance Manager Belfast City Airport, Sydenham Bypass, Belfast, Co. Antrim, BT3 9JH
Belfast International Airport	Mr Joe McGuigan, Belfast International Airport, Aldergrove, Belfast, Co. Antrim, BT29 4AB
St. Angelo Airport	Mr Alan Cathcart, Enniskillen Airport, Enniskillen, Co. Fermanagh, BT94 2FP
City of Derry Airport	Mr Michael Edwards, Airport Road, Eglinton, BT47 3GY
British Telecom Radio Network Connection - Windfarms	Mr Dale Aitkenhead, Postpoint, 5 CTE, Carlisle Square, Newcastle-Upon-Tyne, NE1 1BB
CAA - Directorate of Airspace Policy	Mr Mark Smailes, Directorate Of Airspace Policy, Civil Aviation Authority, CAA House, 45-59 Kingsway, London WC2B 6TE
Cable And Wireless Worldwide PLC	Mr Martin Kendall, Cable And Wireless Worldwide, Berkeley Square, 99 Berkeley Street, Glasgow, G3 7HR
Chief Exec Causeway Coast And Glens Borough Council	Cloonavin , 66 Portstewart Road, Coleraine, Co Derry, BT52 2PX

DAERA - Countryside Management Branch	John Courtney Inishkeen House Enniskillen County Fermanagh BT74 4EJ
DAERA - Fisheries Division	John O'Hare Fisheries Division Dundonald House, Room 426, Upper Newtownards Road Belfast BT4 3SU
DAERA - Forestry Division	Room37 Dundonald House, Upper Newtownards Road, Ballymiscaw, Belfast, Co. Down, BT4 3SU
DAERA - NIEA	Klondyke Building Cromac Avenue Gasworks Business Park Belfast BT7 2JA N Ireland
DAERA - Veterinary Service	Room 716 Dundonald House Upper Newtownards Road Belfast BT4 3SU
DfE- Geological Survey (NI)	Colby House, Stranmillis Court, Malone Lower, Belfast BT9 5BF
DfE Energy Division	Netherleigh, Massey Avenue, Belfast, BT4 2JP
DfI Roads - Ballymena Office	Stephen Fullerton County Hall, 182 Galgorm Road, Ballymena, Co. Antrim, BT42 1QG
DfI - Economics Branch	Clarence Court 10-18 Adelaide Street Belfast BT2 8GB
DfI Rivers	John Moore Planning Advisory Unit DfI Rivers 44 Seagoe Industrial Estate Craigavon BT63 4 QE
Eircom UK Limited	Mr Mark Nixon, Forsythe House, Cromac Square, Belfast, BT2 8LA
Environmental Health Department Causeway Coast and Glens Borough Council	Ballymoney Office, Riada House, 14 Charles Street, Ballymoney, BT53 6DZ Limavady Office, 7 Connell Street, Limavady, BT49 0HA
Everything Everywhere Limited	RAZ SANGHAR Transmission Deployment Engineer NRO & FS UK D&I Ericsson Ashbrook Court, Central Boulevard, Prologis Park Coventry, CV7 8PE
Foyle Carlingford & Irish Lights Commission	Mr Declan Lawlor, Loughs Agency, Headquarters, 22 Victoria Road, Londonderry. BT47 2AB

Fire Service NI	Group Commander William Boyd, Resilience Department, Northern Ireland Fire & Rescue Service 1 Seymour Street Lisburn BT27 4SX
Historic Environment Division (HED)	Dept For Communities Causeway Exchange 1-7 Bedford Street Belfast BT2 7EG
Hutchison 3G UK Ltd	Mr Robin Haddon, Ericsson Limited, Ashbrook Court, Central Boulevard, Prologis Park, Coventry, CV7 8PE.
HSENI	Health & Safety Executive for NI, Notifications Team, Room 118, 83 Ladas Drive, Belfast, Co. Antrim, BT6 9FR
Mll Telecom Ltd - Windfarms	Mr Martin French Jubilee House Third Avenue Marlow Buckinghamshire SL7 1EY
Mobile Broadband Network Ltd	Ms Amanda Baker, Mobile Broadband Network Ltd, 6 Anglo Office Park, 67 White Lion Road, Amersham, Buckinghamshire, HP7 9FB.
MP & E Trading Company & EMR Integrated Solutions	Mr Derek Glynn, Unit 11, Dunboyne Business Park, Dunboyne, Co. Meath.
National Air Traffic Services	NATS Safeguarding Office, 4000, Solent Business Park, Whiteley, Hampshire, PO15 7FL
Network Repeater Service Limited	Mr Mike Foster, Network Repeater Service Limited, 313 Belmont Road, Belfast, BT4 2NE
NI Water - Strategic Applications	NI Water Strategic Applications, Westland House, Old Westland Road, Belfast, BT14 6TE
N.I Water - Windfarms	Mr Willie Wickens, Bretland House, 115 Duncrue Street, Belfast, BT3 9JS
North West Electronics - Windfarms	Mr Scott McClelland, Unit 16, Skeoge Industrial Estate, Beraghmore Road, Derry, BT48 8SE
Northern Ireland Tourist Board	Policy And Insights Unit Floors 10-12, Linum Chambers Bedford Square Bedford Street Belfast BT2 7ES

P.S.N.I. Information And Communications Services	P.S.N.I, Radio Development, Information And Communications Services, Police Service Of Northern Ireland, 18 Lislea Drive, Lisburn Road, Belfast, BT9 7JG
Royal Society for the Protection of Birds - Headquarters	Ms Michelle Hill Belvoir Forest Park, Belfast, Co. Antrim, BT8 7QT
SONI	Castlereagh House 12 Manse Road Belfast BT6 9RT
The Joint Radio Company	The Joint Radio Company, 6th Floor, Dean Bradley House, 52 Horseferry Road, Lonson, London, SW1P 2AF
UK Crown Bodies - D.I.O. LMS	Building 153, Thiepval Barracks, British Forces Post Office 825, Lisburn, Co. Antrim, BT28 3NP
UK Crown Bodies - D.I.O. Safeguarding	Room B4/3, Ministry Of Defence, Leatherhead Road, Chessington, Surrey KT9 2LU
Vodafone (Cable And Wireless)	Mrs Stephanie Robinson Vodafone, Quarry Corner, Dundonald, Belfast BT16 1UD
The National Association of Areas of Natural Beauty	National Association for AONBs, Belmont House, Shrewsbury Business Park, Shrewsbury, Shropshire SY2 6LG Email: office@landscapesforlife.org.uk
Causeway Coast & Glens Heritage Trust	The Old Bank, 27 Main Street, Armoy, Ballymoney, County Antrim, BT53 8SL info@ccght.org
Ulster Hang Gliding and Paragliding Club	24 Upper Road, Carrickfergus, Co Antrim, BT38 8RL
The Honourable The Irish Society	54 Castleroe Road, Coleraine, BT51 3RL
Mountaineering Ireland	Irish Sport HQ, National Sports Campus Park, Blanchardstown, Dublin 15,Ireland info@mountaineering.ie
Ulster Wildlife Trust	McClelland House, 10 Heron Road, Belfast, BT3 9LE info@ulsterwildlife.org

FOREST SERVICE

Fiona Stevens
Renewable Energy Systems
Willowbank Business Park
Willowbank Road
Millbrook
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BT40 2SF

fiona.stevens@res-group.com

Forest Service
Inishkeen House
Killyhevlin
Enniskillen BT74 4EJ
Phone 028 6634 3124
john.griffin@daera-ni.gov.uk
www.daera-ni.gov.uk/forestry

Ref LA01/2022/0230/DETEIA
22 April 2022

Dear Fiona

Carnbuck Wind farm : Request for information relevant to the preparation of an Environmental Statement

I refer to your letter of notification indicating your intention to submit an environmental statement in support of a planning application for Carnbuck Wind Farm. The information below is based on the boundaries of the proposed wind farm as shown on the map titled 'Carnbuck Wind Farm Site Boundary (Preliminary)' Drawing Number 03090-RES-LAY-DR-LE-001.

Location

The proposed wind farm shares a boundary along approximately 400m metres of land which is managed by DAERA's Forest Service. This area forms part of Slieveanorra Forest most of which is separated from the proposed wind farm boundary by a county road.

Slieveanorra Forest

The forest consists of extensive areas of conifer plantation and unplanted areas, the latter consisting mostly of blanket bog and heathland. The conifer area closest to the wind farm boundary consists primarily of Sitka spruce much of which was planted in the 1960s. However, some conifer plantations close to the boundary of the proposed wind farm have been harvested and replanted with Sitka spruce in 2015.

It should be noted that there are c.30 hectares of unplanted ground also under Forest Service management on Skerry Hill on the same side of the public road as the proposed wind farm and close to the eastern boundary. This area and part of the proposed wind farm lie within Aghenagerragh River Bog - Site of Local Nature Conservation Importance.

Slieveanorra Forest lies almost entirely within the Antrim Hills Special Protection Area for hen harrier and merlin. Breeding records of both species have been recorded within the forest and also in areas within the vicinity of the proposed wind farm.

The entire forest lies within the Antrim Coast and Glens Area of Outstanding Natural Beauty (AONB).

It is noted that this proposal is unlikely to involve woodland removal or tree felling.

Forest Regulation

Our policy on proposals for woodland removal in the course of planned development is to:

- Seek to avoid removal of woodland within the planning application area other than the area required for construction and ancillary works unless there are overriding environmental considerations such as the opportunity to restore priority habitats[1].
- Seek woodland regeneration where clear-felling (as opposed to woodland removal) is permitted within the planning application area in keeping with good forestry practice[2].
- Ensure that the views of the local community are represented in any decision.

[1] "Priority habitat restoration" – is defined as the conversion of forest plantation to those habitats which require conservation action because of their decline, rarity and importance. It includes restoration of open priority habitat such as blanket bog.

[2] "Good forestry practice" – is defined as the sustainable forest management requirements identified in The UK Forestry Standard.

FOREST SERVICE

Under Section 1 of the Forestry Act (Northern Ireland) 2010[3], the Forest Service has the general duty of promoting afforestation and sustainable forestry. Sustainable forest management standards are described in The UK Forestry Standard, 4th edition (Forestry Commission 2017)[4] and set out the UK governments' approach to sustainable forest management.

In accordance with its deforestation policy, Forest Service requires developers to seek to avoid removal of woodland within the planning application area other than the area required for construction and ancillary works, unless there are overriding environmental considerations such as the opportunity to restore priority habitats[5].

If you require clarification on any aspect of this letter, please contact me at the above address.

Yours sincerely,

John Griffin

Policy & Regulation Branch

[3] http://www.legislation.gov.uk/nia/2010/10/contents

[4] https://www.forestry.gov.uk/ukfs

[5] "Priority habitat restoration" – is defined as the conversion of forest plantation to those habitats which require conservation action because of their decline, rarity and importance. It includes restoration of open priority habitat such as blanket bog.

Dfl Strategic Planning Division
Clarence Court
10-18 Adelaide Street
Belfast
BT2 8GB

Netherleigh
Massey Avenue
Belfast BT4 2JP
Tel: 028 9052 9240 (ext: 29515)
Web: www.economy-ni.gov.uk

dfiplanninggroup@infrastructure-ni.gov.uk

29 March 2022

Dear Sir/Madam

Planning Service Ref: LA01/2022/0230/DETEIA

Location: Townlands of Carnbuck, Magheraboy and Moneyneagh, near Corkey, County Antrim.

Proposal: Intention to submit Environmental Statement for Proposed Carnbuck Wind farm with up to 12 three-bladed horizontal wind turbines, each up to 180m maximum height above ground level and associated external electricity transformers.

Your automated notification in respect of the above-mentioned pre application refers.

DfE hold no relevant information to assist with the preparation of an Environmental Statement regarding this application.

RENEWABLE ELECTRICITY BRANCH

Department for the Economy
www.economy-ni.gov.uk

GSNI Geological Survey of Northern Ireland
Celebrating 70 years: 1947–2017

Dundonald House
Upper Newtownards Road
Belfast
BT4 3SB

Phone: 028 9038 8462
Fax: 028 9038 8461
E-mail: gsni@economy-ni.gov.uk

GSNI Ref : E2914
Planning Ref: LA01/2022/0230/DETEIA
Date of Consultation: 23/03/2022
Planning Contact: DfI Strategic Planning Division

Proposed Development: Intention to submit Environmental Statement for Proposed Carnbuck Wind farm with up to 12 three-bladed horizontal wind turbines, each up to 180m maximum height above ground level and associated external electricity transformers.

Location: Townlands of Carnbuck, Magheraboy and Moneyneagh, near Corkey, County Antrim.

Consultation Type: Planning

Comments:

A Peat Slide Risk Assessment (PSRA) is a requirement where there is peat within the boundary of a proposed development site. The presence of peat which can be determined by i) direct observation, ii) reference to published geology or soil maps or iii) by intrusive investigation.

In addition, the following factors should be considered:

1. The presence of past peat landslides or pre-failure indicators.

2. In blanket bogs, which typically mantle hillslopes, where slopes exceed 2° and in raised bogs (which typically occur on very gentle terrain) regardless of the slope angle.

Legislation

Under Schedule 2 of The Planning (Environmental Impact Assessment) Regulations (Northern Ireland) 2017, any installation for the harnessing of wind power for energy production that includes (i) the installation of more than 2 turbines; or (ii) the hub height of any turbine or height of any other

structure exceeds 15 metres, should carry out an Environmental Impact Assessment, of which the PSRA is a component.

Planning Policy Statement 18, Renewable Energy (Policy RE1) applies to all wind energy developments that have the potential to create a significant risk of peat landslide. Planning Policy Statement 2, Natural Heritage (Policies NH1, NH2, NH3 and NH5) and the Strategic Planning Policy Statement apply to all developments that have the potential to impact on designated sites, protected species and priority habitats.

PSRA Requirements

The content and structure of a PSRA is ultimately the responsibility of the developer or their nominated agent. The PSRA should include, as a minimum, the following key elements:

- An assessment of the character of the peatland within the development site boundary including thickness and extent of peat, and a demonstrable understanding of site hydrology and geomorphology;
- An assessment of evidence for past landslide activity and present-day instability e.g. pre-failure indicators;
- Quantitative assessment of the potential for or likelihood of future peat landslide activity;
- Identification of receptors (e.g. habitats, watercourses, infrastructure, human life) exposed to peat landslide hazards; and
- A site-wide qualitative or quantitative risk assessment that considers the potential consequences of peat landslides for the identified receptors.

A PSRA should satisfy;

- An understanding of the geological, geomorphological and hydrology of the site;
- An understanding of peat slide hazards and demonstrate that site specific peat slide hazards have been properly considered;
- A clear outline of the proposed designed changes to the site and full consideration of the impact of proposed changes to the site including any cascading effects;
- The information and data is included to identify and assess the potential impact that the specific development will have on the surface stability of the site;
- Demonstrate that site specific peat stability information has been properly reviewed, analysed and presented within the PSRA;
- A risk based approach has been taken to delimit the site according to the risk rating outlined in table 1; and

- A description of any proposed measures to mitigate and reduce adverse impacts, if required.

The assessment would normally comprise desk study, site reconnaissance, site mapping and probing, hazard and risk assessment and reporting. For more detailed descriptions of each of these elements please see the following best practice documentation.

Best regards,

Planning Team, Geological Survey of Northern Ireland

Date: 31/03/2022

DfI Strategic Planning Division
Clarence Court
10 – 18 Adelaide Street
Belfast
BT2 8GB

5 April 2022

Dear Sir/Madam

Planning Application Ref No:	**LA01/2022/0230/DETEIA**
HSENI Ref No:	**CN202203-0007**
Proposed:	**Proposed Carnbuck Wind Farm, townlands of Carnbuck, Magheraboy & Moneyneagh, near Corkey, Co Antrim**

The Health and Safety Executive for Northern Ireland (HSENI) is a statutory consultee for developments within the consultation distance (CD) of high-pressure gas transmission pipelines and major hazard installations regulated under the Control of Major Accident Hazards Regulations (Northern Ireland) 2015 (COMAH).

The proposed development indicated the inclusion of energy storage. If this energy storage is a large scale battery facilities, also known as BESS (Battery Energy Storage Systems), there is the potential to require a Hazardous Substance Consent and be subject to the COMAH Regulations.

HSENI advises that the applicant should provide details (type and mass) of any dangerous substance;
1. Stored or produced during normal operation
2. That can result from a fire, explosion or other event if there is a loss of control of the process.

Yours faithfully

Notifications Team

Health & Safety Executive
Northern Ireland

83 Ladas Drive, Belfast, BT6 9FR, Northern Ireland
Telephone: 028 9024 3249 Helpline: 0800 0320 121
Textphone: 07854 212477 Facsimile: 028 9023 5383
Email: mail@hseni.gov.uk Web: www.hseni.gov.uk

Technical Appendix 1.3

Potential Grid Connection

Technical Appendix 1.3: Proposed Battery Energy Storage System

Introduction

1.1 This Technical Appendix has been prepared to provide more detailed information on the battery energy storage system (BESS) element of the Proposed Development.

What is Energy Storage?

1.2 Energy Storage is a means of storing electrical energy just like a rechargeable battery, mobile phone or electric car. These are means by which power can be stored and released. The Proposed Development includes 22 no. energy storage containers which is of a larger scale, but the basic principle is the same.

1.3 According to SONI statistics, the electricity demand in Northern Ireland varies significantly day to day, for instance during 2018 the lowest demand ranged from as low as 437MW to as high as 1648 MW. Therefore, power generation and the grid must deal with large transitions between lows and highs, not only over the course of a day or week but second by second. One of the basic roles of energy storage is to act as a power reserve for when electricity generation drops below demand. Its importance then is linked to its ability to ensure a constant supply of electrical energy to our homes and business. That improves efficiency and reduces prices for consumers.

1.4 Energy storage can absorb energy at times of high generation and low demand, and release energy at times of peak demand. Customers offering Energy Storage Services (ESS) therefore have the potential of deferring network reinforcement and accommodating the connection of further demand or generation which would otherwise be constrained by thermal capacity. ESS can also play in the System Services market helping to balance demand and generation.

The Need for Energy Storage – Why is it Important?

1.5 The Proposed Development is intended to be used to provide cost effective flexible services to the electricity network, such as adding electricity to, or removing electricity from the system, when this is useful to the operation of the system. SONI, the System Operator in charge of ensuring stable secure power for the island's homes and businesses, procures such services from grid connected energy systems and the flexibility they provide is critical to achieving national decarbonisation targets and a stable supply of electricity at least cost to consumers.

1.6 Energy provision in Northern Ireland is undergoing a transition from one designed primarily around a number of large thermal power stations such as Kilroot, Ballylumford and Coolkeeragh, to one which now includes a number of renewable generators such as wind farms. Renewable generation is now supplying over 40% of the total annual electrical requirement in Northern Ireland. With the recent announcement by the Department for the Economy (DfE) that the Renewable Energy target for Northern Ireland will be 70% by 2030, this transition will be even more important.

1.7 There are, however, technical constraints on the transmission network which are limiting the amount of renewable energy which can be delivered from these renewable generators to the main demand centres in the east of the province.

1.8 Energy Storage is an innovative solution, which is being deployed across the world, to facilitate the shift from traditional thermal generation to low/zero carbon generation. The energy storage containers will help match generation produced from intermittent renewable generation with the peaks and troughs in electricity demand.

1.9 The need for battery energy storage systems has been identified by SONI under their DS3 programme. The delivery of the DS3 programme is required to allow Northern Ireland to meet its renewable energy targets.

1.10 The proposal provides an opportunity to support innovative technology, contribute towards renewable energy targets, ensure a secure electricity supply to its population and play its part in reducing electricity costs for consumers.

1.11 In particular, the Proposed Development will deliver frequency response service to enable the necessary balancing of the emerging low carbon electricity system. The frequency at which the electricity system operates is an indication of the balance between supply and demand and a failure to maintain this frequency within strict boundaries would lead to catastrophic system failure and blackouts. Normally, the system runs at a frequency of 50Hz. If there is not enough supply to meet demand the frequency drops below 50Hz. If there is too much supply for the current demand, the frequency rises above 50Hz. The Proposed Development will be able to respond within a fraction of a second to frequency deviations away from 50Hz (by increasing supply or demand as appropriate) to help keep the system in balance.

1.12 The energy storage element of the Proposed Development would also provide distribution, reinforcement and deferral services. These enable existing electrical network assets such as substations and overhead lines to have their capacity increased without the need for building new infrastructure. All of these uses of the Proposed Development involve charging the battery system with electricity, storing electricity for a period, or discharging electricity. The Proposed Development will make a valuable contribution to Ireland's secure, low carbon and affordable electricity system.

Scope of Assessment

1.13 This Technical Appendix should be read in conjunction with Volume 1 to Volume 4 of the Carnbuck Environmental Statement. The assessment of the Proposed Development is based mainly on a study area of the red line planning boundary and the adjoining lands which have been included in the blue line (land under applicants control).

1.14 The aim of the EIA is to describe and assess the potential effects upon various receptors within the site and the wider environment as applicable.

1.15 Identification and evaluation of the likely significance of effect associated with the BESS element of the Proposed Development during Construction, Operation and Decommissioning phases and the recommendation of appropriate mitigation measures to avoid and or reduce the predicted adverse effects of the Proposed BESS.

Consultation

1.16 In response to pre-application consultation the following queries were received from the Health and Safety Executive for Northern Ireland (HSENI):

1.17 *"The proposed development indicated the inclusion of energy storage. If this energy storage is a large scale battery facilities, also known as BESS (Battery Energy Storage Systems), there is the potential to require a Hazardous Substance Consent and be subject to the COMAH Regulations.*

1.18 *HSENI advises that the applicant should provide details (type and mass) of any dangerous substance;*

i Stored or produced during normal operation

ii That can result from a fire, explosion or other event if there is a loss of control of the process

1.19 This document also takes account of feedback previously received by the Applicant from DfI in relation to other planning applications containing BESS.

Assessment Methodology

1.20 The study methodology includes both desktop and field survey methods in order to assess the potential impact of the proposed BESS on the receiving environment. Volume 2 of the Environmental Statement outlines in detail how the Proposed Development including the BESS development avoids all areas of interest where possible.

Key Terminology and Assessment Criteria

1.21 The following terms and assessment criteria form the basis for the assessment and are summarised below for ease of reference.

Significance of effects

1.22 The importance or value for appraisal of level of importance is set out in Table 1 below, in order to inform this process.

Table 1: Criteria for appraisal of level of importance

Importance / value	Description
Very High	The receptor has a high quality and has no capacity to accommodate change. The receptor is of very high importance and is international in scale.
High	The receptor has a high quality and limited capacity to accommodate change. The receptor has key characteristics which contribute to the character and is of high importance that is international in scale.
Medium	The receptor has limited capacity to accommodate change. The receptor has characteristics which contribute to the character and is of medium importance that is international in scale.
Low	The receptor has moderate capacity to accommodate change. The receptor has characteristics which are locally distinctive and are of low to medium importance. They can be potentially substituted or replaced.
No importance	The receptor is generally tolerant of and can accommodate change. The receptor has characteristics do not make a significant contribution to local character and are of very low importance, they are easily substituted and replaced

Assessment of effects

1.23 To ensure the planning balance is appropriately informed, where an adverse effect is identified, it will be categorised as either Major Adverse, Moderate Adverse, Minor Adverse or Slight Adverse. Where effects would not be adverse these will be categorised as either Negligible or as resulting in no change. This spectrum of effects is summarised in Tables 2 & 3, below, along with brief descriptions of the terms used.

1.24 Assessments of the level of effect on the significance is based upon the extent to which factors that contribute to the significance of the proposed development. This process is not quantitative but relies upon professional judgement at each step. However, the factors considered in informing these judgments and in arriving at the various rankings of value and magnitudes of impacts are observable facts.

Table 2: Significance of impacts

Level of effect	Description
Major Adverse	Loss of resource and or integrity of the resource, severe damage to key characteristics, features or elements. Permanent or irreplaceable change which is certain to occur.

Table 2: Significance of impacts	
Level of effect	Description
Moderate Adverse	Loss of resource but not affecting the integrity of the resources, partial loss of or damage to key characteristics, features or elements. Permanent or irreplaceable change which is likely to occur.
Minor Adverse	Minor loss of, or alteration to the site. Long term though reversible change which is likely to occur.
Slight Adverse	Very Minor loss of, or alteration to the site. Short to medium term though reversible change may possibly occur.
Negligible	Temporary or intermittent, very minor loss of or alteration to the site, short term impact which is unlikely to occur.
No Impact	No change

1.25 The categories of significance of effect are not meant to be prescriptive but are rather meant to allow the professional judgement of the assessor to be articulated clearly and consistently across different types of effects. In recognition of this, where there are two options within a category of significance of effect, the assessor will provide evidence for one or the other of the options. Ultimately, the most appropriate categorisation of the significance of effect must be chosen, using professional judgement which is informed by a thorough understanding of the significance and the nature of the effect.

1.26 Where the significance of effect is assessed as being Moderate or higher, this is considered to be a significant effect as referred to in the Planning (Environmental Impact Assessment) Regulations (Northern Ireland) 2017.

Table 3: Criteria for determining significance of effect					
Level of Importance	Degree of adverse effect				
	Major	Moderate	Minor	Slight	Negligible
Very High	Very Large	Large	Moderate / Large	Minor	Negligible
High	Large	Moderate / Large	Moderate/ Minor	Minor	Negligible
Medium	Moderate / Large	Moderate/ Minor	Minor	Slight	Negligible
Low	Moderate/ Minor	Minor	Slight	Negligible	Negligible

The Proposed BESS

1.27 The proposed design of the battery containers is a low-key containerised scheme involving lithium-ion battery technology which has already been deployed on multiple projects across the UK & Ireland. The containerised energy storage element of the proposed development consists of 22 no. battery containers (up to 100 megawatt hours (MWh) provided), with a maximum export capacity (MEC) of 50 megawatts (MW), with ancillary heating, ventilation and air conditioning (HVAC) units, corresponding power conversion systems (PCS), spares container and auxiliary transformer. These are all housed on an area of hardstanding and enclosed within a compound by appropriate fencing. The containers will be connected by an underground cable to the Carnbuck substation contained within the Proposed Development.

1.28 Lithium batteries are required to store the electricity. The table below outlines the typical quantities for the battery storage.

Table 4: Typical quantities for the battery storage

Chemical Composition of Typical Battery Storage		**Approx. per Module (%)**	**Approx. Weight per Module (Kgs)**	**Approx. Weight per Container (Kgs)**	**Approx. Total Weight for all 22 containers (Kgs)**
Steel		30	40	6,000	132,000
Cell	Lithium Iron Phosphate	23	31	4,650	102,300
	Carbon as Graphite	10	13	1,950	42,900
	Aluminium as Metal	9	12	1,800	39,600
	Copper Metal	9	12	1,800	39,600
Separator	Polyolefin	1	1.5	225	4,950
Electrolyte	Ethylene Carbonate	15	20	3,000	66,000
	Dimethyl Carbonate				
	Ethyl ethyl carbonate				
	Lithium Hexafluorophate				
Connectors	Copper	2	3	450	9,900
Screw	Iron (III) Oxide Dihydrate	1	1.5	225	4,950
Total Weight				20,100	442,200

1.29 The type and quantities of chemicals used for the batteries do not fall within the Schedule listed within the Planning (Hazardous Substances) Regulations (NI) 2015 and therefore do not require Hazardous Substance Consent.

1.30 The Control of Major Accident Hazards Regulations 2015 (COMAH) apply to dangerous substances as classified by the Classification, Labelling and Packaging Regulations 2008. Lithium-ion batteries are considered to be articles, rather than substances, and are therefore outside of the scope of the COMAH Regulations.

Construction Phase

1.31 The construction phase will be aligned and incorporated into the general construction of the wind farm. The BESS container area will be constructed at the later part of the overall construction programme as the containers and their compound will be located within an area which will be used as the temporary construction compound for the wind farm.

1.32 The lithium ion batteries will be manufactured off site and will be delivered to site as fully sealed modules. The batteries will be tested to all the required standards including the UL9540A standard (Appendix A).

1.33 The lithium ion batteries will be enclosed in steel ISO shipping containers, designed and manufactured to a bespoke design for lithium-ion batteries. The enclosures will be mounted on concrete foundations with dc cables connecting the batteries to the power conversion systems (changes the electricity from dc to ac) then ac cables connecting the power conversion systems to the substation.

1.34 The compound area would be constructed by laying stone over a geotextile membrane. During the construction phase temporary drainage measures will be installed to control sediment run-off in line with the SUDS measures outlined in Vol 4 Technical Appendix 10 of the ES.

Operational Phase

1.35 The batteries will operate on average for up to 24 hours per day to support the grid network, times of operation will depend on the grid parameters and requirements. There shall be no emissions from the site with the exception of noise from cooling fans and PCS units. All noise associated with the BESS has been assessed in Vol 2 Chapter 11 of the ES with the full technical details supplied in Vol 4 Technical Appendix 11.

Power Conversion Systems and transformer units

1.36 One or more of the battery containers are connected to a PCS and transformer unit, these may be separate pieces of equipment or one combined PCS and

transformer. The PCSs are inverters which convert the Direct Current (DC) from the batteries to Alternating Current (AC) when the batteries are exporting electricity into the grid. The system works in reverse when the batteries are being charged or importing electricity from the grid. Power transformers will step up the PCS AC voltage from a low voltage to a higher voltage as required by the electricity grid connection.

Decommissioning

1.37 At the end of life, the battery enclosures, power conversion systems, substation, foundations and cables will be removed from site and appropriately disposed of and recycled where possible.

1.38 The battery modules will be removed from the site fully intact (they are sealed units) and sent for recycling. As part of the battery supply agreement the manufacturer shall have an obligation to take the battery enclosures back to their factory for onward recycling at an approved facility. The battery enclosures, PCS's and cables will be recycled more locally at an authorised metal recycling centre.

Assessment of Effects

1.39 Detailed assessment of effects has been covered in Volume 2 of the Environmental Statement. Climate Change is covered within Chapter 2 (Planning Policy); Biodiversity is covered under Chapters 6 (Vegetation & Peatland),7 (Terrestrial Fauna), 8 (Ornithology), 9 (Fisheries) & 10 (Geology & Water Environment; Human Health is covered under Chapter 11 (Noise). A summary of effects and mitigation is described in Chapter 15.

Human Health

1.40 Human Health is covered under Chapter 11 (Noise Assessment) of the ES which assesses the Cumulative effects of the Proposed Development as a whole.

1.41 The nearest residential dwelling to the BESS is 1398 m mitigating any risk to local properties or their occupiers.

1.42 The following table provides some details with regards to the potential effects associated with the battery storage along with details of the mitigation measures that will be employed to further reduce the significance of the potential impact:

Table 5: Summary of Effects of the Proposed BESS

Description	Level of importance	Impact Significance without mitigation	Response/Mitigation	Impact Significance with Mitigation
Transportation of harmful substances Will the Project involve use, storage, transport, handling or production of substances or materials which could be harmful to human health or the environment or raise concerns about actual or perceived risks to human health?	Low	Moderate	All battery cells and modules will be manufactured off site and the system will be designed in accordance with IEC 62485-5:2020 (Safety requirements for secondary batteries and battery installations - Part 5: Safe operation of stationary lithium ion batteries). The batteries will be delivered to site as fully sealed modules. Should any battery fail during the lifetime of the project it will not be repaired on site but will be replaced with a new sealed module. The faulty module will be returned to the manufacturer for inspection/ repair or disposed of at an authorised disposal facility.	Negligible
Waste *Will the Project produce solid wastes during construction or operation or decommissioning*	Low	Moderate/ Minor	No waste will be produced by the batteries during construction or operation or decommissioning apart from the overall battery itself at the end of life, which will be disposed of at an authorised disposal facility. In the event of a fire all wastes will be dealt with appropriately through the procedures agreed within the site specific Fire Management Plan.	Negligible
Air Pollution *Will the Project release pollutants or any hazardous, toxic or noxious substances to air?*	Low	Moderate	Should an individual cell seriously fail during the lifetime of the project (e.g. go into Thermal Runaway), gases will be released from this cell into the battery container. The battery container has a gas detection and forced fan ventilation system that will vent these vented gases to atmosphere	Minor

			(such as hydrogen, CO_2 and carbon monoxide – all of which are present in the atmosphere). Any of the gases that are released (whether Hydrogens etc will be minimal).	
Designated Sites/ Watercourses *Will the Project lead to risks of contamination of land or water from releases of pollutants onto the ground or into surface waters, groundwater, coastal wasters or the sea?*	Low	Moderate	The batteries are sealed units. The UL9540A test show that a cell thermal runaway will not propagate beyond the initiating unit or rack, and therefore the amount of potential pollutants will be restricted, limiting any potential impact of contamination of land. In the event of a fire all wastes will be dealt with appropriately through the procedures agreed within the site specific Fire Management Plan.	Minor
Human Health *Will there be any risk of accidents during construction or operation of the Project which could affect human health or the environment?*	Low	Moderate	The batteries are sealed units which are rigorously tested to withstand external damage (e.g. dropping them). There is only external access to the battery containers, i.e. a person will not be exposed to any potential gases in an enclosed space.	Negligible
Fire Potential for harm to the environment including smoke and toxic gases. Battery fires can potentially give off harmful chemicals or combustion products which may be irritating, corrosive and or toxic and may be harmful to	Low	Moderate	The batteries are sealed units.. The risk of fire spreading to an adjacent battery pack is low as the battery cells will be housed and contained appropriately to mitigate for this. The UL9540A test show that a cell thermal runaway will not propagate beyond the initiating unit or rack, and therefore the amount of potential pollutants will be restricted, limiting any potential impact of contamination of land The BESS will be fitted with a fire detection system comprising of heat and smoke sensors, an extinguishing	Minor

surrounding populations. It is understood that large amounts of hydrogen fluoride (HF) may be generated, ranging between 20 and 200 mg/Wh of nominal battery energy capacity.			system. The battery enclosure itself has a fire rating of a minimum of 90 minutes. The fire control panel will have visual and audible alarms which can be seen and heard from outside of the enclosure. The system will be monitored 24 hours a day, 365 days a year from a remote monitoring facility. A fire management response plan will be prepared in conjunction with the battery supplier post consent and the local Fire Service for both the construction and the operational phases, this will outline appropriate measures required to deal with remote monitoring, first response, air quality, firefighting operations, water application and the disposal of any post fire waste reducing the potential environmental hazards. It is acknowledged that there is no clear consensus on the exact quantities of gases such as HF that could be released by a battery fire. Typically, HF is of a concern in enclosed spaces due to toxicity, RES sites are designed as unmanned with external access enclosures meaning it is very unlikely that personnel outside the enclosure would be exposed to HF concentrations high enough to be of concern. The closest property is at a distance of 1398 m which further mitigates the potential risk.	
Post Fire Waste	Low	Minor	Cells will be segregated and the burnt cells will be removed from site by a licenced carrier and disposed of in line with the battery manufacturers procedures. All cells will be checked for any residual heat using thermal imagery in order	Negligible

			to avoid any further risk of thermal runaway. A fire management response plan will be prepared in conjunction with the battery supplier prior to construction and the local Fire Service for both the construction and the operational phases, this will outline containment measures for firewater and methods which will be implemented to mitigate risk of contamination into groundwater.	
Receptors Are there existing land uses on or around the location e.g. homes, gardens, other private property, industry, commerce, recreation, public open space, community facilities, agriculture, forestry, tourism, mining or quarrying which could be affected by the project?	Low	Minor	The nearest residential dwelling to the BESS at Carnbuck is 1398 m mitigating any risk to local properties or their occupiers.	Negligible
Receptors Are there any areas on or around the location which are occupied by sensitive land uses e.g. hospitals, schools, places of worship, community facilities, which could be affected by the project?	Low	Minor	As stated the nearest residential dwelling to the BESS at Carnbuck is approx. 1398 m mitigating any risk to local properties or their occupiers. Other potentially sensitive receptors including schools are located in the village of Corkey which is over 3 km from the proposed BESS.	Negligible

Mitigation

1.43 In addition to Table 5 above please also refer to Vol 2 of the ES Chapter 15 which outlines all mitigation measures associated with the Proposed Development.

1.44 The below measures summarise the Fire suppression system which will also be installed as a precautionary measure.

Fire suppression system

1.45 Each battery container is fitted with a fire suppression system, the design of which is based on project specific battery technology and enclosure specifications and will meet industry standards and best practice. In general fire suppression systems are composed of:

i) 2 stage detection system consisting of heat and smoke alarms.

ii) Sequencer or control panel

iii) Sounders and/or alarm bells

iv) Suppressant/extinguishant generator

1.46 The energy storage facility will be continually monitored and controlled via a 24hour offsite control centre.

1.47 The facility will be unmanned during normal operations and the battery container enclosures are externally accessed, therefore no personnel entry is required

Risk

1.48 Thermal Runaway would be the main reason for fires in battery storage projects. The batteries selected for the Carnbuck project will be tested in accordance with UL9540A (Test Method for Evaluating Thermal Runaway Fire Propagation in Battery Energy Storage Systems) and the system will be designed in accordance with IEC 62485-5:2020 (Safety requirements for secondary batteries and battery installations - Part 5: Safe operation of stationary lithium ion batteries), there are multiple mitigation measures in place to prevent thermal runaway on a RES designed BESS. The UL9540A is a widely accepted test standard for evaluating thermal runway for propagation in battery energy storage systems.

Mitigation measures to be employed:

1.49 Critical failure of a battery energy storage system component will result in a shutdown from the network, further to this our BESS have a UPS (Uninterruptable

Power Supply) or back up battery in each enclosure ensuring safe shut down of the Batteries and their Battery Management System and the associated PCS even on loss of auxiliary power to the enclosure.

1.50 Should a HVAC system fail on an enclosure the battery system will also include 'Over Temperature Protection' that will enact at a threshold cell temperature well below the Thermal Runaway temperature of the Lithium-ion cells.

1.51 If a cell still reaches a temperature high enough to cause Thermal Runaway despite these multiple layers of protection the system will have been tested to UL9540A standard to show that a battery rack can withstand a forced cell thermal runaway in a way that:

- Explosion hazards are not observed, including deflagration, detonation or accumulation
- No flaming beyond outer dimensions of the initiating Battery Rack, i.e. a fire will be contained within the Rack that has been forced into thermal runaway
- The surface temperature along instrumented wall surfaces around the Battery Rack does not exceed 97 °C above ambient

1.52 The UL9540A test report of our preferred battery supplier (see Appendix A) of the UL9540A shows that all these requirements are passed and in addition a forced thermal runaway of one cell does not cause a thermal propagation to any other cell. This means that the amount of vented gases will be limited to one cell and the fire will be contained within the affected Rack preventing a major fire incident of the entire BESS.

1.53 In the event of a cell failure there may be a minimal amount of gas expelled from the module this would be an airborne gas discharged to atmosphere and no pollution risk to the local area. Any liquid escaping from a cell would again be a very minimal amount and would be contained within the sealed battery unit.

1.54 All RES designed BESS systems utilise battery enclosures with external access only, therefore eliminating the risk of personnel inside the battery enclosure all maintenance is done externally as would any firefighting.

1.55 In addition, our batteries do also comply to the 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) which also contains tests regarding thermal propagation and does not allow any external fire outside of the initiating Battery Rack based on a single cell thermal runaway.

1.56 The nearest residential dwelling to the BESS at Carnbuck is 923m mitigating any risk to local properties or their occupiers.

1.57 The IEC 62933-5-2 Standard (Electrical energy storage (EES) systems – Part 5-2: Safety requirements for grid-integrated EES systems – Electrochemical-based systems) safety standard will also typically apply. This IEC 62933-5-2 is a

European standard which references the UL9540A for large-scale fire testing on BESS.

1.58 Adherence of all of these Standards will ensure that the appropriate mitigation measures will be in place in order to reduce any unlikely significant impacts resulting from the proposed BESS Development. As previously stated a fire management response plan will be prepared in conjunction with the battery supplier post consent and the local Fire Service.

Conclusion

1.59 In conclusion, the potential effects of the proposed BESS have been assessed, and it has been found that, with the benefit of minimal mitigation measures, the proposed BESS will result in no adverse impacts on the receiving environment.

1.60 The importance of energy storage is key to integrating higher levels of renewable energy generation into the grid assisting Northern Ireland in meeting its 2030 renewable energy targets. Energy storage is also a critical in a secure and sustainable supply of energy to homes and businesses. Energy storage projects are part and parcel of a resilient electricity grid. A secure and sustainable grid is of local, regional and national importance.

Appendix A: UL9540A Test Report

Test Report

ANSI/CAN/UL 9540A
Test Method for Evaluating Thermal Runaway Fire Propagation in Battery Energy Storage Systems

Report Reference No. ..... :	200801760SHA-002	
Tested by (name + signature)…….:	Albert Zhou	Albert Zhou .....
Approved by (name + signature)……:	Will Wang	Will Wang .....
Date of issue ..... :	2020-10-17	
Total number of pages ..... :	50	
Testing Laboratory..... :	Intertek Testing Services Shanghai	
Address ..... :	Building No.86, 1198 Qinzhou Road (North), Shanghai 200233, China	
Applicant's name ..... :	Zhejiang Narada ESS Integration& Operation Co., Ltd	
Address ..... :	Room 503, Building 1, No.223 Yile Road, Hangzhou, Zhejiang, 310000, P. R. China	
Test specification:		
Standard/or Rule ..... :	ANSI/CAN/UL 9540A:2019, Fourth Edition	
Test procedure ..... :	Testing	
Non-standard test method……..:	N/A	
Test Report Form No. ..... :	UL9540AA	
TRF Originator ..... :	Intertek Shanghai	
Master TRF ..... :	Dated 2019-12	

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Test item description.....:	Battery cell, module and unit
Trade Mark .....:	NARADA
Manufacturer.....:	Hangzhou Narada Motive Power Science&Technology Co., Ltd No.120 Hongda Road, Yuhang Economic Develpment Zone of Yuhang District, Hangzhou, Zhejiang 311100, P.R.China
Model/Type reference.....:	Cell: FE105A Module: 76.8NESP200 Unit: 76.8NESP200*15pcs
Rating.....:	Cell: 3.2V, 105Ah Module: 76.8V, 200Ah Unit: 768V, 200Ah (for 76.8NESP200*15pcs) Up to 1500V, 200Ah, Up to 261kWh (for Unit Configuration)

TRF originator: Intertek Shanghai © 2020 Intertek

Copy of label

Cell:

Narada 南都®

Polarity: + Polarity: -

Secondary (Rechargeable) Li-ion Cell

IFpP36/130/240 (FE105A)

3.2VDC, 105Ah, 336Wh

Data of Manufacture: 14th August 2020

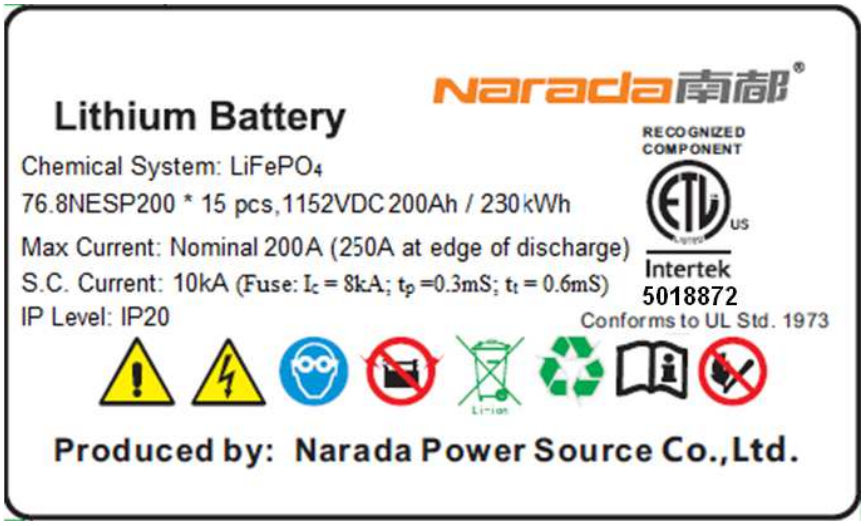
Module:

Narada 南都®

Polarity: + Polarity: -

- Secondary (Rechargeable) Li-ion Battery
- Battery Designation: 76.8NESP200 (24IFpP36/130/240-2)
- Data of Manufacture: dd mm yyyy
- Rated Capacity: 200Ah, 10,240Wh
- Nominal Voltage: 76.8VDC

Unit:



Possible test case verdicts:

- test case does not apply to the test object.....: N/A
- test object does meet the requirement.....: P (Pass)
- test object does not meet the requirement.....: F (Fail)

Testing .....:

Date of receipt of test item .....: 2020-05-29

Date (s) of performance of tests .....: 2020-05-29 to 2020-09-29

General remarks:

The test results presented in this report relate only to the object tested.
This report shall not be reproduced, except in full, without the written approval of the Issuing testing laboratory.
"(See Enclosure #)" refers to additional information appended to the report.
"(See appended table)" refers to a table appended to the report.
Throughout this report a point is used as the decimal separator.

Determination of the test conclusion is based on IEC Guide 115 in consideration of measurement uncertainty.

“Peak smoke release rate and total smoke release data” is achieved by calculation, since Light transmission signal is not accurate when total smoke volume is small.

For Gas Characteristic Test, it is with accordance of ASTM E681 as per requirement of V3 UL9540A, instead of ASTM E918 according to V4 UL9540A, since when apply UL9540A test, Version 4.0 was just released and ASTM E918 test lab is not available.

For Gas Characteristic Test, the result is refer to report < 200101346SHA-003>

For Cell Level Test, the result is refer to report < 200101346SHA-003>

Test results:

Cell Test:

The Cell thermal runaway and test 4 samples；

Module Test:

Initial Cell thermal runaway, and target cell is fine, no thermal propagation;

Not with BMS and Electronics controls

Unit test:

Indoor floor mounted non-residential use BESS

Unit Test: Initial Cell thermal runaway, and target cell is fine; No temperature increase for adjoint racks and walls.

See Annex 6 Diagram and dimensions of the test setup, the testing is conducted under two conditions:

Test condition 1: Testing is in room setup

Test condition 2: The testing is conducted in a container

Total inner height is 2.69m and

The surface of wall is a 75mm thickness 90min fire retarded rock wood and steal plate

9.2.13: The adjacent wall layout depends on end use system design

ANSI/CAN/UL 9540A			
Cl.	Requirement + Test	Result – Remark	Verdict
1	**Scope**		-
1.1	The test methodology in this standard determines the capability of a battery technology to undergo thermal runaway and then evaluates the fire and explosion hazard characteristics of those battery energy storage systems that have demonstrated a capability to undergo thermal runaway.		-
2	**Units of Measurement**		-
3	**Normative References**		-
4	**Glossary**		-
5	**General**		P
5.1	**Cell**		P
5.1.1	The cells associated with the BESS that were tested shall be documented in the test report, including cell chemistry (e.g. NMC, LFP), the physical format of the cell (i.e. prismatic, cylindrical, pouch), cell electrical rating in capacity and nominal voltage, the overall dimensions of the cell, and weight.	**Cell chemistry:** LFP **Format of the cell:** Prismatic **Cell rating:** 3.2VDC, 105Ah **Dimension:** 36.3*130.2*239.8mm (with terminals) **Weight:** 2.276kg	P
5.1.2	The cell documentation included in the test report shall indicate if the cells associated with the BESS comply with UL 1973.	See clause 7.6.1	P
5.1.3	Refer to 7.6.1 for further details to be included in the cell level test report.		P
5.2	**Module**		P
5.2.1	The modules associated with the BESS that were tested shall be documented in the test report, including the generic (e.g., metallic or nonmetallic) enclosure material, the general layout of the module contents and the electrical configuration of the cells in the modules and the modules in the BESS.	**Generic:** metallic **Enclosure material:** galvanized sheet **General layout of module contents:** See Annex 1 **Electrical configuration:** 2P24S	P
5.2.2	The module documentation included in the test report shall indicate if the modules associated with the BESS comply with UL 1973.	See clause 8.3	P
5.2.3	Refer to 8.3 for further details to be included in the module level test report		P
5.3	**Battery energy storage system unit**		P
5.3.1	The BESS unit documentation included in the test report shall indicate the units that comply with UL 9540 and include the manufacturer, model, electrical ratings, and energy capacity of all BESS.	See clause 9.7.3	P

ANSI/CAN/UL 9540A			
Cl.	Requirement + Test	Result – Remark	Verdict
5.3.2	For BESS units for which UL 9540 compliance cannot be determined, the documentation included in the test report shall include the number of modules in the BESS, electrical configuration of the module, and physical layout of the modules in the BESS, battery management system (BMS) and other major components of the BESS.	**Number of modules:** 15pcs **Electrical configuration:** 15S1P **Layout of the modules:** See Annex 2 **BMS:** 200500576SHA-001 and 200801759SHA-005 **Major components:** Refer to report 200801758SHA-001	NA
	It shall be documented as to whether the battery system complies with UL 1973 in addition to the overall BESS compliance to UL 9540.	UL1973 test report: 200601123SHA-001 UL9540 test report: 200801758SHA-001	P
5.3.3	If applicable, the details of any fire detection and suppression systems that are an integral part of the BESS shall be noted in the test report.	Not an integral part	NA
5.3.4	Refer to 9.7, 10.4 and 10.7 for further details to be included in the unit level and if applicable, installation level test reports		P
5.4	**Flow Batteries**	Not flow batteries	NA
5.4.1	For flow batteries, the report will cover the chemistry, a generic description of the electrolyte (s), the overall dimensions of the individual stack as well as the electrical rating in capacity and nominal voltage of the cell stack.		NA
	The report will also include information on the complete flow battery system including the manufacturer's name and model number of the system, the electrical rating in volts and rated storage capacity in Ah or Wh, the number of cells and stacks in the system, and the maximum volume of electrolyte(s) for the system.		NA
5.4.2	The flow battery documentation included in the test report shall indicate if the flow battery system complies with UL 1973.		NA
5.4.3	See 7.6.2 for further details to be included in the flow battery thermal runaway determination level test report.		NA
	PERFORMANCE		P
6	**General**		P
6.1	The tests in this standard are extreme abuse conditions conducted on electrochemical energy storage devices that can result in fires, explosions, smoke, off gassing of flammable and toxic materials, exposure to toxic and corrosive liquids, and potential exposure to hazardous voltages and electrical energy.		P
6.2	At the conclusion of testing, samples shall be discharged in accordance with the manufacturer's specifications. All samples shall be disposed of in accordance with local regulations.		P
7	**Cell Level**		P

ANSI/CAN/UL 9540A			
Cl.	Requirement + Test	Result – Remark	Verdict
7.1	**General**		P
7.1.1	This portion of the test establishes effective methods for forcing a cell into thermal runaway in a repeatable manner. These methods shall be used at the module, unit and installation level of testing.		P
	During this portion of the testing, the vent gas composition shall be gathered and analyzed and cell temperatures shall be monitored to determine the temperature when the cell vents and to verify that thermal runaway as defined in this standard, has occurred.		P
7.2	**Sample**		P
7.2.1	Cell samples shall be conditioned, prior to testing, through charge and discharge cycles for a minimum of 2 cycles using a manufacturer specified methodology to verify that the cells are functional.		P
	Each cycle shall be defined as a charge to 100% SOC and then to an end of discharge voltage (EODV) specified by the cell manufacturer.		P
	During conditioning a relationship between open circuit voltage and SOC shall be determined through measurement of voltage and SOC.		P
	During conditioning the ambient temperature shall be maintained in accordance with the higher of the temperatures derived from 7.3.1.1 or the operating temperature in the cell manufacturer's specifications.		P
7.2.2	The cells to be tested shall be charged to 100% SOC and allowed to stabilize for a minimum of 1 h and a maximum of 8 h before the start of the test.		P
7.2.3	Cells with flexible laminate casings shall be constrained during the test in the manner that simulates the constraint in the BESS module to prevent excessive swelling during the test.		P
7.3	**Determination of thermal runaway methodology**		P
7.3.1	**General**		P
7.3.1.1	Ambient indoor laboratory conditions shall be 25 ±5°C (77 ±9°F) and 50 ±25% RH at the initiation of the test.		P
7.3.1.2	The propensity of the cell to exhibit thermal runaway shall be demonstrated by heating the cell with externally applied flexible film heaters that cover as much of the cell case as possible without covering safety features or terminals, for consistent heating of the internal cell electrode assembly. A surface heating rate of 4° C (7.2° F) to 7° C (12.6° F) per minute shall be applied to the cell.	Heating cell method used	P
	Determination of a maximum surface temperature end point criteria shall be developed based upon a review of cell design and chemistry.		P
	If external heating with a flexible film heater does not cause the cell to exhibit thermal runaway, one of the following methods shall be employed to cause thermal runaway:	Heating cell caused thermal runaway	N/A
	a) Mechanical (e.g. nail penetration);		N/A

ANSI/CAN/UL 9540A			
Cl.	Requirement + Test	Result – Remark	Verdict
	b) Electrical stresses in the form of overcharging, over discharging or external short-circuiting; or		N/A
	c) Use of alternate heating sources (e.g. oven).		N/A
7.3.1.3	With reference to 7.3.1.2, when using another cell abuse method to initiate thermal runaway, the details of that method shall be documented.	Heating cell caused thermal runaway	N/A
	See the Cell Failure Methods Appendix in UL 1973 for various cell abuse test methods that can be utilized.		N/A
7.3.1.4	With reference to 7.3.1.2, in the case of monobloc batteries such as lead acid or nickel cadmium, the monobloc battery can be treated as an individual cell for this testing.	Not monobloc batteries	N/A
7.3.1.5	Before beginning the test, a surface temperature shall be determined to approximate the temperature at which internal short circuiting within the cell will occur that could lead to a thermal runaway condition.		P
	For Li-ion cells, the surface temperature hold point shall be between 5°C (9°F) and 15°C (27°F) greater than the melting temperature of the cell separator material as determined from differential scanning calorimetry (DSC) data of the separator in accordance with UL 2591 (UL 746A).		P
	Thermal runaway may occur before this hold point temperature range is reached.		P
	However, if thermal runaway is not achieved at this hold point temperature after a period of 4 h, the cell heating rate according to 7.3.1.2 shall be reestablished until thermal runaway occurs or it is demonstrated that thermal runaway is not achievable by heating.	Thermal runaway achieved	N/A
7.3.1.6	If the cell is susceptible to thermal runaway by external heating, the cell shall be heated until thermal runaway has occurred.		P
	If the cell is not susceptible to thermal runaway by heating with a film heater, another method included in 7.3.1.2 shall be employed. See 7.3.1.7 – 7.3.1.9.	Heating cell caused thermal runaway	N/A
	If using another external heating method, the temperature ramp and maximum surface temperature outlined in 7.3.1.2 and 7.3.1.5 shall be used.		N/A
7.3.1.7	The cell's exterior surface temperature shall be measured continuously through the cell test with a thermocouple junction formed from 24-gauge or smaller, Type-K thermocouple wire.		P
	The location(s) of thermocouple (s) shall be determined during a construction review.		P
	At least one thermocouple shall be located below the heater film at the center of the cell surface (if the cell is prismatic this would be the center of the wider side of the cell) and one near the positive cell terminals.		P
7.3.1.8	The temperature at which the cell case vents due to internal pressure rise shall be documented.		P
	The thermocouple located below the heater film at the center of the cell surface is used for this measurement.		P

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Cl.	Requirement + Test	Result – Remark	Verdict
	If using the other cell abuse methods, the thermocouples would be located at the same locations on the cells as noted in 7.3.1.7.		P
7.3.1.9	The temperature at the onset of thermal runaway shall be documented.		P
	Onset of thermal runaway shall be determined by the point at which the rate of change of the surface temperature of the cell exceeds that of the externally applied heat input if utilizing the external heater method. As defined in 4.17, thermal runaway is a condition where there is heating of the cell in an uncontrolled manner and should not be confused with overheating leading to venting only.		P
	Cell venting may occur first, but it is necessary to continue heating when using the heater method until thermal runaway occurs.		P
	With other stress methods, it will be necessary to continue applying the stress such as mechanical or electrical stress until onset of thermal runaway occurs.		P
	If there is a transitory temperature dip during the cell venting, the heat input may need to be increased to bring it back to the heating rate range.		P
7.3.1.10	When using methods other than the heater method, the stresses shall be applied to the cell until thermal runaway occurs.		P
	Thermal runaway as defined in 4.17, is considered to have occurred, regardless of the method of stress chosen, when there is a rapid increase in temperature as shown in Figure 7.1 and should not be confused with simple overheating leading to venting.		P
7.3.1.11	If the cell exhibits thermal runaway behavior (using any method), 3 additional samples shall be tested using the same method and exhibit thermal runaway to demonstrate repeatability.		P
	The vent temperature and thermal runaway onset temperatures shall be averaged over the tested samples (excluding the gas vent capture sample).		P
	This average temperature shall be used to establish the temperature limits for the other test levels of this standard.		P
7.3.2	**Flow battery thermal runaway determination tests**	Not Flow battery	NA
7.3.2.1	For flow battery technology, the propensity for thermal runaway shall be demonstrated by testing the energy reservoir according to the test methods of 7.3.2.2 through 7.3.2.6 as applicable to the flow battery technology.		NA
7.3.2.2	The flammability of the electrolytes shall be determined based upon a suitable test method to determine flammability.		NA
7.3.2.3	For flow battery systems with two electrolytes, the flammability of the liquid electrolytes shall be demonstrated by subjecting each electrolyte to the appropriate test method outlined in 7.3.2.2.		NA

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Cl.	Requirement + Test	Result – Remark	Verdict
7.3.2.4	The temperature increase possible due to a flow battery failure where there are two electrolytes shall be demonstrated by charging the energy reservoir in a test flow battery assembly to 100% SOC, and then directly mixing the two electrolyte materials in a closed container within approximately 1 min.		NA
7.3.2.5	For flow battery technologies with one active electrolyte containing solid metal particles the appropriate test method of 7.3.2.2 is conducted to determine the flash point temperature.		NA
7.3.2.6	If a flash point has been observed for a flow battery technology with one active electrolyte containing solid metal particles, a test battery representative of the flow battery system shall be subjected to an overcharge test and short circuit test in accordance with UL 1973 while monitoring the temperature of the energy reservoir.		NA
7.4	**Cell vent gas composition test**		P
7.4.1	Cell vent gas shall be generated and captured by forcing a cell into thermal runaway with the methodology developed in 7.3, inside a pressure vessel, which is large enough to accommodate cells, but not so large as to influence measurement of the gas composition.		P
	An 82-L (21.7-gal) pressure vessel is recommended for this purpose for most sizes of commercially available cells.		P
	The test shall be initiated with an initial condition of atmospheric pressure and less than 1% oxygen by volume. The initial atmospheric conditions prior to testing shall be noted.		P
7.4.2	Cell vent gas composition shall be determined using Gas Chromatography (GC) with detection techniques for quantifying component gases or equivalent gas analysis techniques, to identify hydrocarbon gases that represent an ignition or explosion hazard as well as other additional gases requested to be measured.		P
	Hydrogen gas shall be measured with a sensor capable of measuring in excess of 30% by volume. The initial atmospheric conditions prior to testing shall be noted.		P
7.4.3	Upon determination of the cell vent gas composition per 7.4.2, the lower flammability limit of the cell vent gas shall be determined on samples of the synthetically replicated gas mixture in accordance with ASTM E918, testing at both ambient and cell vent temperatures		P
7.4.4	The synthetically replicated gas mixture shall be used to determine gas burning velocity in accordance with the Method of Test for Burning Velocity Measurement of Flammable Gases Annex in ISO 817.		P
7.4.5	The synthetically replicated gas mixture shall be used to determine Pmax in accordance with EN15967.		P
7.5	**Off gas composition for flow battery systems**	Not flow battery systems	NA

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Cl.	Requirement + Test	Result – Remark	Verdict
7.5.1	The off gas composition from the flow battery testing of 7.3.2 shall be determined by conducting the test method of 7.3.2.2 in a closed container and capturing the off gasses generated, and by collecting the off gasses generated at vent openings and vent ducts during the overcharge and short circuit testing of 7.3.2.4 and 7.3.2.6 as applicable to the flow battery technology. Composition of these captured gases and their flammability limit shall be determined through the methods outlined in 7.4.2 and 7.4.3 at both ambient temperature and the maximum temperature measured.		NA
7.5.2	The volume of flammable gases measured during the testing shall be scaled to the maximum energy reservoir for the intended flow battery system in order to determine the potential total flammable gas that can be produced by the system under a fault condition that leads to off gassing. This information shall be provided in the report.		NA
7.6	**Cell level test report**		P
7.6.1	The report on cell level testing shall include the following:		P
	a) Cell manufacturer name and cell model number	Narada Power Source Co., Ltd. Cell Model: FE105A	P
	b) Cell details		P
	cell chemistry (e.g. NMC, LFP),	LFP	P
	physical format of the cell (i.e. prismatic, cylindrical, pouch	Prismatic	P
	cell electrical rating in capacity and nominal voltage	3.2V, 105AH	P
	overall dimensions of the cell, and weight	2.276kg 36.3*130.2*239.8mm(with terminals)	P
	If comply with UL 1973.	Yes 200601123SHA-001	P
	c) Energy storage technology (and whether UL 9540 compliant);	Yes 200801758SHA-001	P
	d) The rated energy storage capacity of the cell (e.g. Ampere-hours);	3.2V ,105AH	P
	e) Voltage and current obtained during conditioning of the cell;	Charging:3.65V, 105A, Discharging :2.5V, 105A	P
	f) Open-circuit voltage of the cell at initiation of test;	3.385V	P
	G Methods attempted and used to initiate thermal runaway;	Heat	P

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Cl.	Requirement + Test	Result – Remark	Verdict
	h) Surface temperature at which gases are first vented and the average temperature of the samples tested excluding the gas collection sample;	1# 135.5 ℃ 2# 133.2℃ 3#130.9℃ 4#124.4℃ average temperature：131.0℃	P
	I Surface temperature (and location of maximum temperature) prior to thermal runaway and average temperature of the samples tested excluding the gas collection sample;	1# 185.7℃ 2# 161.5℃ 3#192.2℃ 4#145.9℃ average temperature：171.3℃	P
	j) Flammable gas generation and composition measurements	1.55m3 Appended Tables 7.4	P
	k) The lower flammability limit of the cell vent gas;	3.45% (LEL)	P
	l) Burning velocity of the cell vent gas; and	142.216MPa/s (Maximum explosive pressure rising speed)	P
	m) Pmax of the cell vent gas.	Venting Pressure 1# 0.11725 MPa 2# 0.11725 MPa 3# 0.11575 MPa 4# 0.11225MPa Average Pmax：0.11563Mpa Explosion Pressure Pmax：0.733MPa	P
7.7	**Performance – cell level test**		NA
7.7.1	Module level testing in Section 8 is not required if the following performance conditions are met:		NA
	a) Thermal runaway cannot be induced in the cell; and		P
	b) The cell vent gas does not present a flammability hazard when mixed with any volume of air, as determined in accordance with ASTM E918 at both ambient and vent temperatures.	Vent gas is flammable	N/A
7.7.2	BESS that contain cells that all comply with the criteria in 7.7.1 shall be suitable for installation in residential dwelling units.		NA
7.8	**Performance – flow battery thermal runaway determination tests**	Not flow battery	NA
7.8.1	For flow batteries, no further testing is required if the following performance conditions are met during the flow battery thermal runaway determination test:		NA
	a) The electrolyte(s) subjected to the test method in accordance with 7.3.2.2 does not ignite; or		NA
	b) The flash point temperature(s) measured in the test of 7.3.2.2 exceed the maximum temperature measured on the energy reservoir during the overcharge and short circuit tests of 7.3.2.4 or 7.3.2.6 by at least 5°C (9°F); and		NA

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Cl.	Requirement + Test	Result – Remark	Verdict
	c) The flash point temperature(s) measured in the test of 7.3.2.2 exceed the maximum temperature of the mixed solution measured in accordance with 7.3.2.4 by at least 5°C (9°F) for systems with two active electrolytes.		NA
7.8.2	Flammable off gassing during the abnormal tests are addressed as outlined in 7.5.2 by scaling the results in accordance with the largest anticipated flow battery energy reservoir.		NA
8	**Module Level**		P
8.1	**Sample**		P
8.1.1	Module samples shall be conditioned, prior to testing, through charge and discharge cycles for a minimum of 2 cycles, to verify that the module is functional.		P
	Each cycle shall be defined as a charge to 100% SOC and allowed to rest a maximum of 8 h and then discharged to an end of discharge voltage (EODV) specified by the module manufacturer.		P
	During conditioning the ambient temperature and conditions shall be maintained in accordance with 8.2.1.		P
8.1.2	The module to be tested shall be charged to 100% SOC and allowed to rest a maximum of 8 h before the start of the test.		P
	The module voltage shall be determined by measuring at the module terminals after charging up to the fully charged condition and before beginning testing.		P
	The sample module shall stabilize for a minimum of one hour prior to testing.		P
8.1.3	Electronics and software controls such as the battery management system (BMS) are not relied upon for this testing.	Not with BMS and Electronics controls	P
8.2	**Test method**		P
8.2.1	Ambient indoor laboratory conditions shall be 25 ±5°C (77 ±9°F) and 50 ±25% RH at the initiation of the test.	25 ±5°C , 50 ±25% RH	P
8.2.2	The test shall be conducted under a smoke collection hood that is sized appropriately to collect the gasses generated from the module.		P
8.2.3	The weight of the module shall be recorded before and after testing is completed to determine weight loss.		P
8.2.4	The number of cells within the module that are forced into thermal runaway can be one or multiple cells, and is dependent upon the energy contained within the individual cells. A sufficient number of cells shall be forced into thermal runaway to create a condition of cell to cell propagation within the module.		P
	For example, it may be necessary to force nine, 3-Ah cells into thermal runaway as opposed to one, 30-Ah cell in order to get cell to cell propagation.	Energy is big enough for one cell	P

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Cl.	Requirement + Test	Result – Remark	Verdict
	The location of the cell (s) forced into thermal runaway shall be selected to present the greatest thermal exposure to adjacent cells that are not forced into thermal runaway.		P
	Factors to be taken into consideration shall include selecting locations within the module where heat transfer is maximized to other cells, cooling by ventilation is restricted or limited, and thermal sensors, detection and suppression discharge points are remote.		P
8.2.5	The methodology used for initiating thermal runaway pursuant to 7.2 shall be used to initiate thermal runaway within the module.		P
8.2.6	With reference to 8.2.5, occurrence of thermal runaway shall be verified by sustained temperature above the cell surface temperature at the onset of thermal runaway, as determined in Section 7.		P
8.2.7	The module shall be placed on top of a noncombustible horizontal surface with the module orientation representative of its intended final installation.		P
8.2.8	The chemical heat release rate of the module in thermal runaway shall be measured with oxygen consumption calorimetry.		P
8.2.9	The chemical heat release rate shall be measured for the duration of the test. See 8.2.10.		P
8.2.10	The chemical heat release rate shall be measured by a measurement system consisting of a paramagnetic oxygen analyzer, non-dispersive infrared carbon dioxide and carbon monoxide analyzer, velocity probe, and a Type K thermocouple.		P
	The instrumentation shall be located in the exhaust duct of the heat release rate calorimeter at a location that minimizes the influence of bends or exhaust devices. See 8.2.11.		P
8.2.11	With reference to 8.2.10, calculate the chemical heat release rate at each of the flows as follows:		P
	$HRR_1 = \left[E \times \varphi - (E_{co} - E) \times \frac{1-\varphi}{2} \times \frac{X_{co}}{X_{O_2}}\right] \times \frac{\dot{m}_e}{1+\varphi \times (\alpha - 1)} \times \frac{M_{O_2}}{M_a} \times (1 - X^o_{H_2O}) \times X^o_{O_2}$		P
8.2.12	Vent gas composition shall be measured using a Fourier-Transform Infrared Spectrometer with a minimum resolution of 1 cm-1 and a path length of at least 2 m (6.6 ft), or equivalent gas analyzer, and velocity and temperature measurements respectively shall be obtained in the exhaust duct of the heat release rate calorimeter using equipment specified in 8.2.10.		P
8.2.13	The hydrocarbon content of the vent gas shall be measure using flame ionization detection. Hydrogen gas shall be measured with a palladium-nickel thin-film solid state sensor.		P
8.2.14	The light transmission in the exhaust duct of the heat release rate calorimeter shall be measured using a white light source and photo detector for the duration of the test, and the smoke release rate shall be calculated. See 8.2.15.		P

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Cl.	Requirement + Test	Result – Remark	Verdict
8.2.15	Smoke release rate shall be calculated as follows:		P
	$SRR = 2.303\left(\frac{V}{D}\right) Log_{10}\left(\frac{I_o}{I}\right)$		P
8.3	**Module level test report**		P
	a) Module manufacturer name and model number (and whether UL 1973 compliant);	Narada, 76.8NESP200 200601123SHA-001	P
	b) Number of cells in module;	48 pcs	P
	c) Module configuration with cells in series and parallel	2 parallel 24 series	P
	d) Module construction features per 5.2;		
	e) Module voltage corresponding to the tested SOC	100%SOC 86.4V	P
	f) Thermal runaway initiation method used including number and locations of cells for initiating thermal runaway;	Heating; 1 Cell; Detail in Annex 3	P
	g) Heat release rate versus time data;	Appended Curve 8.3	P
	h) Flammable gas generation and composition data	Appended Tables 8.3	P
	i) Peak smoke release rate and total smoke release data.	0.018m^2/s based on 1m* 2m; 1.768m^3 (flammable gas according to 8.3 h))	P
	j) Observation(s) of flying debris or explosive discharge of gases	No flying debris or explosive discharge of gases	P
	k) Observation(s) of sparks, electrical arcs, or other electrical events;	No sparks, electrical arcs, or other electrical events;	P
	l) Identification/location of cells(s) that exhibited thermal runaway within the module		P
	m) Locations and visual estimations of flame extension and duration from the module shall be documented	No Flame extension	P
	n) Module weight loss based on measurements per 8.2.3; and	0.836kg	P
	o) Video of the test		P
8.4	**Performance at module level testing**		NA
	Unit level testing in Section 9 is not required if the following performance conditions are met during the module level test:		NA
	a) Thermal runaway is contained by module design; and	No thermal propagation, but vented gas spill out of module enclosure	NA
	b) Cell vent gas is nonflammable as determined by the cell level test.		NA
9	**Unit Level**		P
9.1	**Sample and test configuration**		P
9.1.1	The unit level test shall be conducted with BESS units installed as described in the manufacturer's instructions and this section.		P

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Cl.	Requirement + Test	Result – Remark	Verdict
	Test configurations include the following:		P
	a) Indoor floor mounted non-residential use BESS;		P
	b) Indoor floor mounted residential use BESS;		NA
	c) Outdoor ground mounted non-residential use BESS;		NA
	d) Outdoor ground mounted residential use BESS;		NA
	e) Indoor wall mounted non-residential use BESS;		NA
	f) Indoor wall mounted residential use BESS;		NA
	g) Outdoor wall mounted non-residential use BESS;		NA
	h) Outdoor wall mounted residential use BESS; and		NA
	i) Rooftop and open garage non-residential use BESS installations.		NA
9.1.2	The unit level test requires one initiating BESS unit in which an internal fire condition in accordance with the module level test is initiated and target adjacent BESS units representative of an installation.		P
	Tests conducted for indoor floor mounted installations shall be considered representative of both indoor floor mounted and outdoor ground mounted installations with fire propagation hazards and separation distances between initiating and target units representative of the installation.	Test condition 1	P
	Tests shall be conducted indoors with fire propagation hazards and separation distances between initiating and target units representative of the installation.	Test condition 1	P
	The results of such tests shall be considered to also represent an outdoor installation. Examples of potential test configurations.	Test condition 1	P
	Exception: Testing can be conducted outdoors for outdoor only installations if there are the following controls and environmental conditions in place:	Test condition 1	P
	a) Wind screens are utilized with a maximum wind speed maintained at ≤ 12 mph;	Test condition 1	P
	b) The temperature range is within 10°C to 40°C (50°F to 104°F);	Test condition 1	P
	c) The humidity is < 90% RH;	Test condition 1	P
	d) There is sufficient light to observe the testing;	Test condition 1	P
	e) There is no precipitation during the testing;	Test condition 1	P
	f) There is control of vegetation and combustibles in the test area to prevent any impact on the testing and to prevent inadvertent fire spread from the test area; and	Test condition 1	P
	g) There are protection mechanisms in place to prevent inadvertent access by unauthorized persons in the test area and to prevent exposure of persons to any hazards as a result of testing.	Test condition 1	P
9.1.3	Depending upon the configuration and design of the BESS, this testing to determine fire characterization can be done at the battery system level.		P

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Cl.	Requirement + Test	Result – Remark	Verdict
	The suitability of this approach shall be determined based upon the overall design of the BESS and an analysis of the battery system as representative of the overall BESS for fire characterization concerns.		P
9.1.4	The initiating BESS unit shall contain components representative of a BESS unit in a complete installation.		P
	Combustible components that interconnect the initiating and target BESS units shall be included.		P
9.1.5	Target BESS units shall include the outer cabinet (if part of the design), racking, module enclosures, and components that retain cells components.		P
	The target BESS unit module enclosures do not need to contain cells.		P
9.1.6	The initiating BESS unit shall be at the maximum operating state of charge (MOSOC), in accordance with the manufacturer's specifications, for conducting the tests in this standard.		P
	After charging and prior to testing, the initiating BESS shall rest for a maximum period of 8 h at room ambient.		P
9.1.7	If a BESS unit includes an integral fire suppression system, there is an option of providing this with the DUT.	No fire suppression	NA
	If the BESS unit is provided with an optional integral fire suppression system, the system shall not be provided on the DUT.		NA
9.1.8	Electronics and software controls such as the battery management system (BMS) in the BESS are not relied upon for this testing.	No such BMS	NA
	This does not include a fire suppression control in accordance with UL 840 that is external to the BESS, but provided as part of an integral fire suppression system per 9.1.7.		NA
9.2	**Test method – Indoor floor mounted BESS units**		P
9.2.1	Samples and test configurations are in accordance with 9.1.		P
	During the test, the test room environment shall be controlled to prevent drafts that may affect test results. At the start of the test, the room ambient temperature shall not be less than 10°C (50°F) nor more than 32°C (90°F).		P
9.2.2	Any access door(s) or panels on the initiating BESS unit and adjacent target BESS units shall be closed, latched and locked at the beginning and duration of the test.		P
9.2.3	The initiating BESS unit shall be positioned adjacent to two instrumented wall sections.		P
9.2.4	Instrumented wall sections shall extend not less than 0.49 m (1.6 ft) horizontally beyond the exterior of the target BESS units.		P
9.2.5	Instrumented wall sections shall be at least 0.61-m (2-ft) taller than the BESS unit height, but not less than 3.66 m (12 ft) in height above the bottom surface of the unit.	Test condition 1	P

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Cl.	Requirement + Test	Result – Remark	Verdict
9.2.6	The surface of the instrumented wall sections shall be covered with 16-mm (5/8-in) gypsum wall board and painted flat black.	Test condition 1	P
9.2.7	The initiating BESS unit shall be centered underneath an appropriately sized smoke collection hood of an oxygen consumption calorimeter.		P
9.2.8	The light transmission in the calorimeter's exhaust duct shall be measured using a white light source and photo detector for the duration of the test, and the smoke release rate shall be calculated as described in 8.2.15.		P
9.2.9	The chemical and convective heat release rates shall be measured for the duration of the test, using the methodologies specified in 8.2.11 and 9.2.12, respectively.		P
9.2.10	With reference to 9.2.9, the heat release rate measurement system shall be calibrated using an atomized heptane diffusion burner. The calibration shall be performed using flows of 3.8, 7.6, 11.4 and 15.2 L/min (1, 2, 3 and 4 gpm) of heptane.		P
9.2.11	With reference to 9.2.9, the convective heat release rate shall be measured using thermopile, a velocity probe, and a Type K thermocouple, located in the exhaust system of the exhaust duct. See 9.2.12.		P
9.2.12	With reference to 9.2.9, the convective heat release rate shall be calculated using the following equation: $HRR_c = V_e A \frac{353.22}{T_e} \int_{T_o}^{T} C_p dT$		P
9.2.13	The physical spacing between BESS units (both initiating and target) and adjacent walls shall be representative of the intended installation as noted in 9.1.	Test condition 1	P
9.2.14	Separation distances shall be specified by the manufacturer for distance between:		P
	a) The BESS units and the instrumented wall sections; and	Test condition 1	P
	b) Adjacent BESS units.	Test condition 1	P
9.2.15	Wall surface temperature measurements shall be collected for BESS intended for installation in locations with combustible construction.		P
	If the intended installation is composed completely of noncombustible construction in which wall assemblies, cables, wiring and any other combustible materials are not to be present in the BESS installation, then the report should note that the installation shall contain no combustible construction and that surface temperature rises can be deemed not applicable.		P
9.2.16	Wall surface temperatures shall be measured in vertical array(s) at 152-mm (6-in) intervals for the full height of the instrumented wall sections using No. 24-gauge or smaller, Type-K exposed junction thermocouples.		P

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Cl.	Requirement + Test	Result – Remark	Verdict
	The thermocouples for measuring the temperature on wall surfaces shall be horizontally positioned in the wall locations anticipated to receive the greatest thermal exposure from the initiating BESS unit.		P
9.2.17	Thermocouples shall be secured to gypsum surfaces by the use of staples placed over the insulated portion of the wires.		P
	The thermocouple tip shall be depressed into the gypsum so as to be flush with the gypsum surface at the point of measurement and held in thermal contact with the surface at that point by the use of pressure-sensitive paper tape.		P
9.2.18	Heat flux shall be measured with the sensing element of at least two water-cooled Schmidt-Boelter gauges at the surface of each instrumented wall:		P
	a) Both are collinear with the vertical thermocouple array;		P
	b) One is positioned at the elevation estimated to receive the greatest heat flux due to the thermal runaway of the initiating module; and		P
	c) One is positioned at the elevation estimated to receive the greatest heat flux during potential propagation of thermal runaway within the initiating BESS unit.		P
9.2.19	Heat flux shall be measured with the sensing element of at least two water-cooled Schmidt-Boelter gauges at the surface of each adjacent target BESS unit that faces the initiating BESS unit:		P
	a) One is positioned at the elevation estimated to receive the greatest heat flux due to the thermal runaway of the initiating module within the initiating BESS; and		P
	b) One is positioned at the elevation estimated to receive the greatest surface heat flux due to the thermal runaway of the initiating BESS.		P
9.2.20	For non-residential use BESS, heat flux shall be measured with the sensing element of at least one water-cooled Schmidt-Boelter gauge positioned at the mid height of the initiating unit in the center of the accessible means of egress.		P
9.2.21	No. 24-gauge or smaller, Type-K exposed junction thermocouples shall be installed to measure the temperature of the surface proximate to the cells and between the cells and exposed face of the initiating module.		P
	Each non-initiating module enclosure within the initiating BESS unit shall be instrumented with at least one No. 24-gauge or smaller Type-K thermocouple(s) to provide data to monitor the thermal conditions within non-initiating modules.		P
	Additional thermocouples shall be placed to account for convoluted enclosure interior geometries.		P
9.2.22	For residential use BESS, the DUT shall be covered with a single layer of cheese cloth ignition indicator.		NA

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Cl.	Requirement + Test	Result – Remark	Verdict
	The cheesecloth shall be untreated cotton cloth running 26 – 28 m2/kg with a count of 28 – 32 threads in either direction within a 6.45 cm^2 (1 in^2) area.		NA
9.2.23	An internal fire condition in accordance with the module level test shall be created within a single module in the initiating BESS unit:		P
	a) The position of the module shall be selected to present the greatest thermal exposure to adjacent modules (e.g. above, below, laterally), based on the results from the module level test; and		P
	b) The setup (i.e. type, quantity and positioning) of equipment for initiating thermal runaway in the module shall be the same as that used to initiate and propagate thermal runaway within the module level test (Section 8).		P
9.2.24	The composition, velocity and temperature of the initiating BESS unit vent gases shall be measured within the calorimeter's exhaust duct.		P
	Gas composition shall be measured using a Fourier-Transform Infrared Spectrometer with a minimum resolution of 1 cm-1 and a path length of at least 2.0 m (6.6 ft), or equivalent gas analyzer. Composition, velocity and temperature instrumentation shall be collocated with heat release rate calorimetry instrumentation.		P
9.2.25	The hydrocarbon content of the vent gas shall be measured using flame ionization detection.		P
9.2.26	The test shall be terminated if:		P
	a) Temperatures measured inside each module within the initiating BESS unit return to ambient temperature;		P
	b) The fire propagates to adjacent units or to adjacent walls; or		P
	c) A condition hazardous to test staff or the test facility requires mitigation.		P
9.2.27	For residential use systems, the gas collection data gathered in 9.2 shall be compared to the smallest room installation specified by the manufacturer to determine if the flammable gas collected exceeds 25% LFL in air.		NA
9.3	**Test method – Outdoor ground mounted units**		NA
9.3.1	Outdoor ground mounted non-residential use BESS being evaluated for installation in close proximity to buildings and structures shall use the test method described in Section 9.2.		NA
	If intended for outdoor use only installations, the smoke release rate, the convective and chemical heat release rate and content, velocity and temperature of the released vent gases need not be measured.		NA
9.3.2	Outdoor ground mounted residential use BESS being evaluated for installation in close proximity to buildings and structures shall use the test method described in Section 9.2 except as noted in 9.3.3 and 9.3.4.		NA

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Cl.	Requirement + Test	Result – Remark	Verdict
	Heat flux measurements for the accessible means of egress shall be measured in accordance with 9.2.20. If intended for outdoor use only installations, the smoke release rate, the convective and chemical heat release rate and content, velocity and temperature of the released vent gases need not be measured.		NA
9.3.3	Test samples shall be installed as shown in Figure 9.2 in proximity to an instrumented wall section that is 3.66-m (12-ft) tall with a 0.3-m (1-ft) wide horizontal soffit (undersurface of the eave shown in Figure 9.2).		NA
	The sample shall be mounted on a support substrate and spaced from the wall in accordance with the minimum separation distances specified by the manufacturer.		NA
	The wall and soffit shall be constructed with 19.05-mm (3/4-in) plywood installed on wood studs and painted flat black.		NA
	The instrumented wall shall extend not less than 0.49-m (1.6-ft) horizontally beyond the exterior of the target BESS units.		NA
	The No. 24-gauge or smaller, Type-K exposed junction thermocouple array on the walls as noted in 9.2.16 shall extend to the surface of the soffit as shown in Figure 9.2.		NA
9.3.4	Target BESS shall be installed on each side of the initiating BESS in accordance with the manufacturer's installation specifications.		NA
	The physical spacing between BESS units (both initiating and target) shall be the minimum separation distances specified by the manufacturer.		NA
9.4	**Test Method – Indoor wall mounted units**		NA
9.4.1	Testing of indoor wall mounted BESS shall be in accordance with Section 9.2, except as modified in this section. See Figure 9.3.		NA
9.4.2	The test shall be conducted in a standard NFPA 286 fire test room, 3.66 × 2.44 × 2.44-m (12 × 8 × 8-ft) high, with a 0.76 × 2.13-m (2-1/2 × 7-ft) high opening. The room shall be constructed with 16-mm (5/8-in) gypsum wall board installed on wood studs and painted flat black.		NA
9.4.3	The initiating BESS unit shall be positioned on the wall opposite of the door opening, with the center located 1.22-m (4-ft) above the floor, and halfway between adjacent walls.		NA
9.4.4	Target BESS shall be installed on the wall on each side of the initiating BESS, at the same height above the floor as the initiating BESS.		NA
	The physical spacing between BESS units (both initiating and target) shall be the minimum separation distances specified by the manufacturer.		NA
9.4.5	The wall on which the initiating and target BESS units are mounted shall be instrumented in accordance with Section 9.2.		NA

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Cl.	Requirement + Test	Result – Remark	Verdict
9.4.6	The gas collection methods shall be in accordance with 9.2. For residential use systems, the gas collection data gathered in 9.2 shall be compared to the smallest room installation specified by the manufacturer to determine if the flammable gas collected exceeds 25% LFL in air.		NA
9.4.7	For residential use BESS, the DUT shall be covered with a single layer of cheese cloth ignition indicator.		NA
	The cheesecloth shall be untreated cotton cloth running 26 – 28 m^2/kg with a count of 28 – 32 threads in either direction within a 6.45 cm^2 (1 in^2) area.		NA
9.5	**Test Method – Outdoor wall mounted units**		NA
9.5.1	Testing of outdoor wall mounted BESS shall be in accordance with Section 9.2, except as modified in this section. See Figure 9.4.		NA
	If intended for outdoor use only wall mount installations, the smoke release rate, the convective and chemical heat release rate; and the content, velocity and temperature of the released vent gases need not be measured.		NA
9.5.2	Test samples shall be mounted on an instrumented wall section that is 3.66-m (12-ft) tall with a 0.3-m (1-ft) wide horizontal soffit (undersurface of the eave shown in Figure 9.4). The wall and soffit shall be constructed with 19.05-mm (3/4-in) plywood installed on wood studs and painted flat black.		NA
	The instrumented wall shall extend not less than 0.49-m (1.6-ft) horizontally beyond the exterior of the target BESS units. The No. 24-gauge or smaller, Type-K exposed junction thermocouple array on the walls as noted in 9.2.16 shall extend to the surface of the soffit as shown in Figure 9.4.		NA
9.5.3	The initiating BESS unit shall be positioned on the instrumented wall, with its center located 1.22-m (4-ft) above the floor, and halfway between wall edges.		NA
9.5.4	Target BESS shall be installed on the wall on each side of the initiating BESS, at the same height above the floor as the initiating BESS.		NA
	The physical spacing between BESS units (both initiating and target) shall be the minimum separation distances specified by the manufacturer.		NA
9.5.5	The wall on which the initiating and target BESS units are mounted shall be instrumented in accordance with Section 9.2.		NA
9.5.6	For residential use BESS, the DUT shall be covered with a single layer of cheese cloth ignition indicator.		NA
	The cheesecloth shall be untreated cotton cloth running 26 – 28 m2/kg with a count of 28 – 32 threads in either direction within a 6.45 cm2 (1 in2) area.		NA
9.6	**Rooftop and open garage installations**		NA
9.6.1	Testing of BESS intended for non-residential use rooftop or open garage installations shall be in accordance with 9.2.		NA

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Cl.	Requirement + Test	Result – Remark	Verdict
9.6.2	If intended for rooftop and open garage use only installations, the smoke release rate, the convective and chemical heat release rate and content, velocity and temperature of the released vent gases need not be measured.		NA
9.7	**Unit level test report**		P
9.7.1	The report on the unit level testing shall identify the type of installation being tested, as follows:		P
	a) Indoor floor mounted non-residential use BESS;	Indoor floor mounted non-residential	P
	b) Indoor floor mounted residential use BESS;		NA
	c) Outdoor ground mounted non-residential use BESS;		NA
	d) Outdoor ground mounted residential use BESS;		NA
	e) Indoor wall mounted non-residential use BESS;		NA
	f) Indoor wall mounted residential use BESS;		NA
	g) Outdoor wall mounted non-residential use BESS;		NA
	h) Outdoor wall mounted residential use BESS;		NA
	i) Rooftop installed non-residential use BESS; or		NA
	j) Open garage installed non-residential use BESS.		NA
9.7.2	With reference to 9.7.1, if testing is intended to represent more than one installation type, this shall be noted in the report.	Indoor ground mounted	P
9.7.3	The report shall include the following, as applicable:		P
	a) Unit manufacturer name and model number (and whether UL 9540 compliant);	Manufacturer: Narada Model number: 76.8NESP200*15pcs Refer to 5002817-200801758SHA-001	P
	b) Number of modules in the initiating BESS unit;	15 pcs modules	P
	c) The construction of the initiating BESS unit per 5.3;	See Annex 4	P
	d) Fire protection features/detection/suppression systems within unit;	No such systems	NA
	e) Module voltage(s) corresponding to the tested SOC;	100%SOC 86.4V	P
	f) The thermal runaway initiation method used;	Heating	P
	g) Location of the initiating module within the BESS unit;	Middle of battery rack, between two units. See Annex 5.	P
	h) Diagram and dimensions of the test setup including mounting location of the initiating and target BESS units, and the locations of walls, ceilings, and soffits;	See Annex 6	P
	i) Observation of any flaming outside the initiating BESS enclosure and the maximum flame extension;	No flaming outside the initiating BESS enclosure	P
	j) Chemical and convective heat release rate versus time data;	Same as Appended Curve 8.3 g)	P

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Cl.	Requirement + Test	Result – Remark	Verdict
	k) Separation distances from the initiating BESS unit to target walls (e. g. distances A and C in Figure 9.1);	See Annex 6	P
	l) Separation distances from the initiating BESS unit to target BESS units (e.g. distances D and H in Figure 9.1);	See Annex 6	P
	m) The maximum wall surface and target BESS temperatures achieved during the test and the location of the measuring thermocouple;	22 ℃	P
	n) The maximum ceiling or soffit surface temperatures achieved during the indoor or outdoor wall mounted test and the location of the measuring thermocouple;	22 ℃	P
	o) The maximum incident heat flux on target wall surfaces and target BESS units;	0kW/m^2	P
	p) The maximum incident heat flux on target ceiling or soffit surfaces achieved during the indoor or outdoor wall mounted test;	0kW/m^2	P
	q) Gas generation and composition data;	Same as Appended Table 8.3	P
	r) Peak smoke release rate and total smoke release data;	0.018m^2/s based on 1m* 2m; 1.768m^3 (flammable gas according to 8.3 h))	P
	s) Indication of the activation of integral fire protection systems and if activated the time into the test at which activation occurred;		NA
	t) Observation of flying debris or explosive discharge of gases;	No flying debris or explosive discharge of gases;	P
	u) Observation of re-ignition(s) from thermal runaway events;	No re-ignition(s) from thermal runaway events;	P
	v) Observation(s) of sparks, electrical arcs, or other electrical events;	No sparks, electrical arcs, or other electrical events;	P
	w) Observations of the damage to:		P
	1) The initiating BESS unit;	No	P
	2) Target BESS units;	No	P
	3) Adjacent walls, ceilings, or soffits; and	No	P
	x) Photos and video of the test.	See Annex 9	P
9.8	**Performance at unit level testing**		P
9.8.1	Installation level testing in Section 10 is not required if the following performance conditions outlined in Table 9.1 are met during the unit level test.		P
	Non-Residential Installations:		P
	Indoor Floor Mounted:		P
	a) Flaming outside the initiating BESS unit is not observed;	No flaming outside the initiating BESS unit	P
	b) Surface temperatures of modules within the target BESS units adjacent to the initiating BESS unit do not exceed the temperature at which thermally initiated cell venting occurs, as determined in 7.3.1.8;	No temperature increase of target BESS unit	P

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Cl.	Requirement + Test	Result – Remark	Verdict
	c) For BESS units intended for installation in locations with combustible constructions, surface temperature measurements on wall surfaces do not exceed 97°C (175°F) of temperature rise above ambient per 9.2.15;	No temperature increase of the wall surface, remain same as room environment temperature	P
	d) Explosion hazards are not observed, including deflagration, detonation or accumulation (to within the flammability limits in an amount that can cause a deflagration) of battery vent gases; and	No explosion hazards are observed	P
	e) Heat flux in the center of the accessible means of egress shall not exceed 1.3 kW/m^2.	Not exceed 1.3 kW/m^2	P
	Outdoor Ground Mounted:		NA
	a) If flaming outside of the unit is observed, separation distances to exposures shall be determined by greatest flame extension observed during test.		NA
	b) Surface temperatures of modules within the target BESS units adjacent to the initiating BESS unit do not exceed the temperature at which thermally initiated cell venting occurs, as determined in 7.3.1.8;		NA
	c) For BESS units intended for installation near exposures, surface temperature measurements on wall surfaces do not exceed 97°C (175°F) of temperature rise above ambient per 9.2.15;		NA
	d) Explosion hazards are not observed, including deflagration, detonation or accumulation (to within the flammability limits in an amount that can cause a deflagration) of battery vent gases; and		NA
	e) Heat flux in the center of the accessible means of egress shall not exceed 1.3 kW/m^2.		NA
	Indoor Wall Mounted:		NA
	a) Flaming outside the initiating BESS unit is not observed;		NA
	b) Surface temperatures of modules within the target BESS units adjacent to the initiating BESS unit do not exceed the temperature at which thermally initiated cell venting occurs, as determined in 7.3.1.8;		NA
	c) For BESS units intended for installation in locations with combustible construction, surface temperature measurements on wall surfaces do not exceed 97°C (175°F) of temperature rise above ambient per 9.2.15;		NA
	d) Explosion hazards are not observed, including deflagration, detonation or accumulation (to within the flammability limits in an amount that can cause a deflagration) of battery vent gases; and		NA
	e) Heat flux in the center of the accessible means of egress shall not exceed 1.3 kW/m^2.		NA
	Outdoor Wall Mounted:		NA
	a) Flaming outside the initiating BESS unit is not observed;		NA
	b) Surface temperatures of modules within the target BESS units adjacent to the initiating BESS unit do not exceed the temperature at which thermally initiated cell venting occurs, as determined in 7.3.1.8;		NA

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Cl.	Requirement + Test	Result – Remark	Verdict
	c) For BESS units intended for installation on walls with combustible construction, surface temperature measurements on wall surfaces do not exceed 97°C (175°F) of temperature rise above ambient per 9.2.15;		NA
	d) Explosion hazards are not observed, including deflagration, detonation or accumulation (to within the flammability limits in an amount that can cause a deflagration) of battery vent gases; and		NA
	e) Heat flux in the center of the accessible means of egress shall not exceed 1.3 kW/m^2.		NA
	Rooftop and Open Garages:		NA
	a) If flaming outside the unit is observed, separation distances to exposures shall be determined by greatest flame extension observed during test;		NA
	b) Surface temperatures of modules within the target BESS units adjacent to the initiating BESS unit do not exceed the temperature at which thermally initiated cell venting occurs, as determined in 7.3.1.8;		NA
	c) For BESS units intended for installation in locations with combustible construction, surface temperature measurements on wall surfaces do not exceed 97°C (175°F) of temperature rise above ambient per 9.2.15;		NA
	d) Explosion hazards are not observed, including deflagration, detonation or accumulation (to within the flammability limits in an amount that can cause a deflagration) of battery vent gases; and		NA
	e) Heat flux in the center of the accessible means of egress shall not exceed 1.3 kW/m^2.		NA
	Residential Installations		NA
	Indoor Floor Mounted:		NA
	a) Flaming outside the initiating BESS unit is not observed as demonstrated by no flaming or charring of the cheesecloth indicator;		NA
	b) Surface temperatures of modules within the target BESS units adjacent to the initiating BESS unit do not exceed the temperature at which thermally initiated cell venting occurs, as determined in 7.3.1.8;		NA
	c) For BESS units intended for installation in locations with combustible construction, surface temperature measurements on wall surfaces do not exceed 97°C (175°F) of temperature rise above ambient per 9.2.15;		NA
	d) Explosion hazards are not observed, including deflagration, detonation or accumulation (to within the flammability limits in an amount that can cause a deflagration) of battery vent gases; and		NA
	e) The concentration of flammable gas does not exceed 25% LFL in air for the smallest specified room installation size.		NA
	Outdoor Ground Mounted:		NA
	a) If flaming outside the unit is observed, separation distances to exposures shall be determined by greatest flame extension observed during test.		NA

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Cl.	Requirement + Test	Result – Remark	Verdict
	b) Surface temperatures of modules within the target BESS units adjacent to the initiating BESS unit do not exceed the temperature at which thermally initiated cell venting occurs, as determined in 7.3.1.8;		NA
	c) For BESS units intended for near exposures, surface temperature measurements on wall surfaces do not exceed 97°C (175°F) of temperature rise above ambient per 9.2.15;		NA
	d) Explosion hazards are not observed, including deflagration, detonation or accumulation (to within the flammability limits in an amount that can cause a deflagration) of battery vent gases; and		NA
	e) Heat flux in the center of the accessible means of egress shall not exceed 1.3 kW/m^2.		NA
	Indoor Wall Mounted:		NA
	a) Flaming outside the initiating BESS unit is not observed as demonstrated by no flaming or charring of the cheesecloth indicator;		NA
	b) Surface temperatures of modules within the target BESS units adjacent to the initiating BESS unit do not exceed the temperature at which thermally initiated cell venting occurs, as determined in 7.3.1.8;		NA
	c) For BESS units intended for installation in locations with combustible construction, surface temperature measurements on wall surfaces do not exceed 97°C (175°F) of temperature rise above ambient per 9.2.15;		NA
	d) Explosion hazards are not observed, including deflagration, detonation or accumulation (to within the flammability limits in an amount that can cause a deflagration) of battery vent gases; and		NA
	e) The concentration of flammable gas does not exceed 25% LFL for the smallest intended room installation size.		NA
	Outdoor Wall Mounted:		NA
	a) Flaming outside the initiating BESS unit is not observed as demonstrated by no flaming or charring of the cheesecloth indicator;		NA
	b) Surface temperatures of modules within the target BESS units adjacent to the initiating BESS unit do not exceed the temperature at which thermally initiated cell venting occurs, as determined in 7.3.1.8;		NA
	c) For BESS units intended for installation in locations with combustible construction, surface temperature measurements on wall surfaces do not exceed 97°C (175°F) of temperature rise above ambient per 9.2.15; and		NA
	d) Explosion hazards are not observed, including deflagration, detonation or accumulation (to within the flammability limits in an amount that can cause a deflagration) of battery vent gases.		NA
10	**Installation Level**	Not required see clause 9.8	NA
10.1	**General**		NA

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Cl.	Requirement + Test	Result – Remark	Verdict
10.1.1	The installation level test method assesses the effectiveness of the fire and explosion mitigation methods for the BESS in its intended installation. The installation level testing does not apply to residential use BESS.		NA
	a) Test Method 1 – "Effectiveness of sprinklers" is used to evaluate the effectiveness of sprinkler fire protection and explosion mitigation methods installed in accordance with code requirements.		NA
	b) Test Method 2 – "Effectiveness of fire protection plan" is used to evaluate the effectiveness of other fire and explosion mitigation methods.		NA
10.1.2	Installation level testing is not appropriate for units only intended for outdoor use or residential use.		NA
10.2	**Sample**		NA
10.2.1	The samples (initiating BESS and target BESS) and their preparation for testing, including separation distances from walls, shall be identical to that used for the unit level test in Section 9.		NA
10.2.2	A flame indicator consisting of a cable tray with fire rated cables that complies with UL 1685 and representative of the installation per the manufacturer's specifications shall be deployed above the BESS at a distance specified by end-use installation.		NA
	If the installation requires that cabling be installed below the BESS, then the flame indicator is not needed.		NA
10.3	**Test method 1 – Effectiveness of sprinklers**		NA
10.3.1~10.3.11	Prepared according standard		NA
10.3.12	An internal fire condition in accordance with the module level test shall be created within a single module in the initiating BESS unit:		NA
10.3.13	The composition of BESS unit vent gases shall be measured using a Fourier-Transform Infrared Spectrometer with a minimum resolution of 1 cm-1 and a path length of at least 2.0 m (6.6 ft), total hydrocarbon analyzer, and hydrogen analyzer. The gas composition sampling port shall be located in the ceiling jet, 25-mm (1-in) below the ceiling.		NA
10.3.14	The test shall be terminated if:		NA
	a) Temperatures measured inside each module of the initiating BESS return to below the cell vent temperature;		NA
	b) The fire propagates to adjacent units or to adjacent walls; or		NA
	c) A condition hazardous to test staff or the test facility requires mitigation.		NA
10.3.15	The initiating unit shall be under observation for 24 h after conclusion of the installation test to determine that re-ignition does not occur.		NA

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Cl.	Requirement + Test	Result – Remark	Verdict
10.4	**Installation level test report – Test method 1 – Effectiveness of sprinklers**		NA
10.4.1	The report on installation level testing shall include the following:		NA
	a) Unit manufacturer name and model number (and whether compliant with UL 9540);		NA
	b) Number of modules in the initiating BESS unit;		NA
	c) The construction of the initiating BESS unit per 5.3;		NA
	d) Module voltage(s) of initiating BESS corresponding to the tested SOC;		NA
	e) The thermal runaway initiation method used;		NA
	f) Diagram and dimensions of the test setup including location of the initiating and target BESS units, and the locations of walls and ceilings;		NA
	g) Location of initiating module within the BESS unit;		NA
	h) Separation distances from the initiating BESS unit to;		NA
	i) Separation distances from the initiating BESS unit to target BESS units;		NA
	j) Distances of the flame indicator (if used) with respect to the BESS;		NA
	k) Maximum temperature at the ceiling;		NA
	l) Distance of fire spread within the flame indicator;		NA
	m) The maximum wall surface and target BESS unit temperatures achieved during the test and the location of the measuring thermocouple;		NA
	n) The maximum incident heat flux on target wall surfaces and target BESS units;		NA
	o) Voltages of initiating BESS;		NA
	p) Total number of sprinklers that operated and length of time the sprinklers operated during the test;		NA
	q) Gas generation and composition data, if measured;		NA
	r) Observation of flaming outside of the test room;		NA
	s) Observation of flying debris or explosive discharge of gases;		NA
	t) Observation of re-ignition(s) from thermal runaway events;		NA
	u) Observations of the damage to:		NA
	1) The initiating BESS unit;		NA
	2) Target BESS units; and		NA
	3) Adjacent walls;		NA
	v) Photos and video of the test;		NA
	w) Fire protection features/detection/suppression systems within unit; and		NA
	x) Sprinkler K-factor, RTI, manufacturer and model, number of sprinklers and layout.		NA

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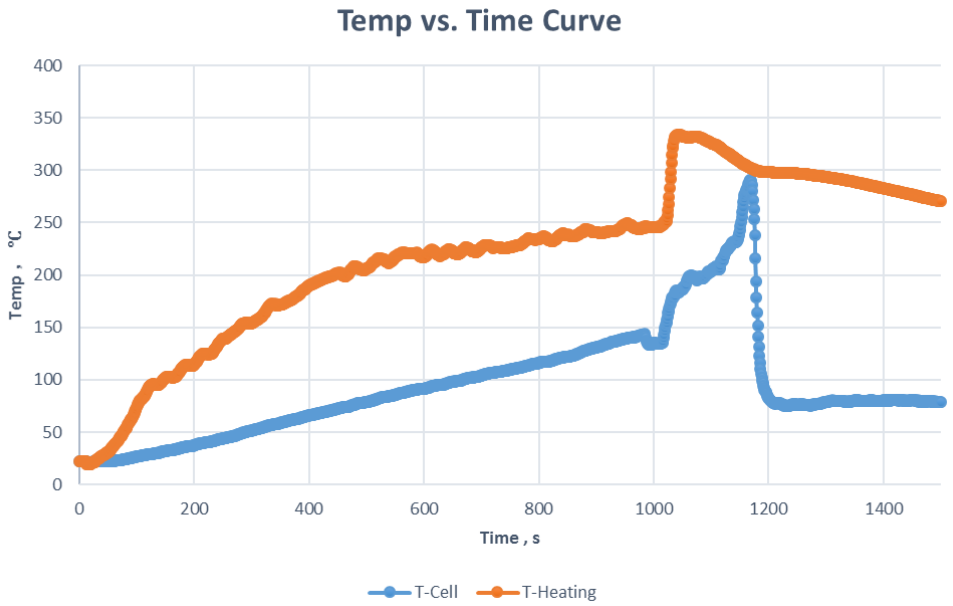
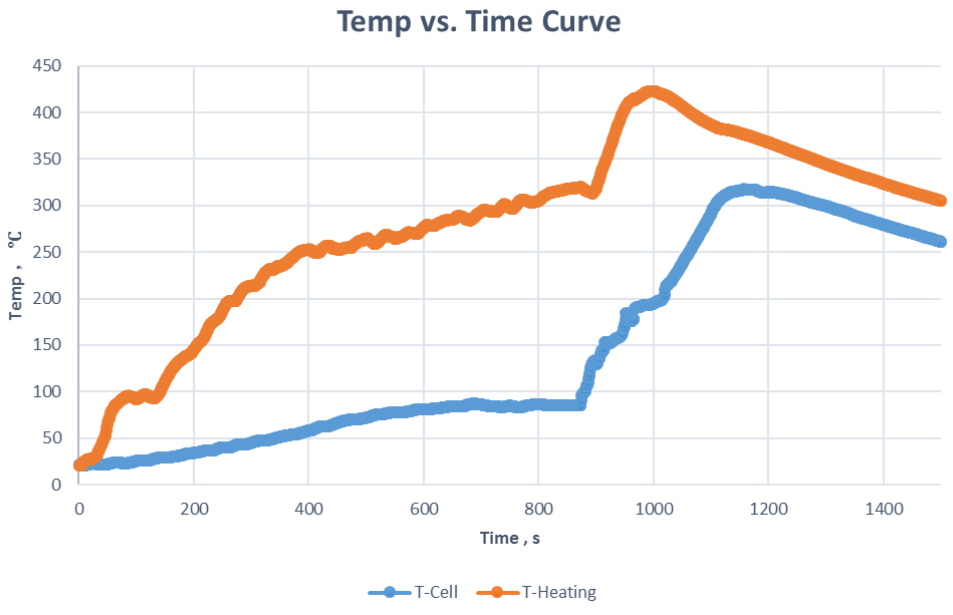
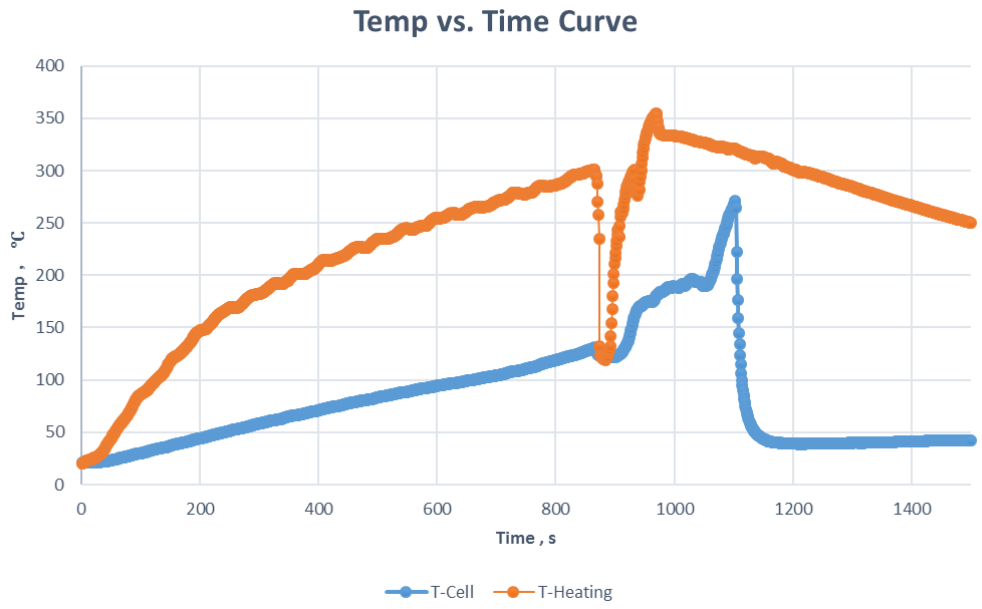
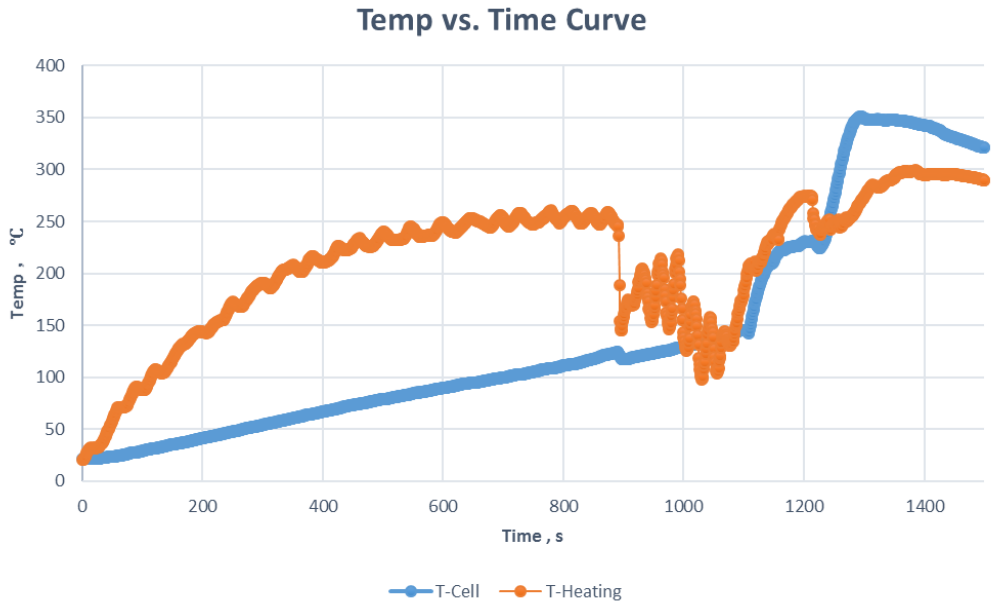
Cl.	Requirement + Test	Result – Remark	Verdict
10.5	**Performance – Test method 1 – Effectiveness of sprinklers**		NA
10.5.1	For BESS units intended for installation in locations with combustible construction, surface temperature measurements along instrumented wall surfaces shall not exceed a temperature rise of 97°C (175°F) above ambient. Surface temperature rise is not applicable if the intended installation is composed completely of noncombustible materials in which wall assemblies, cables, wiring and any other combustible materials are not to be present in the BESS installation. In this case, the report shall note that the installation shall contain no combustible materials.		NA
10.5.1~10.5.8	Prepared according standard		NA
10.6	**Test method 2 – Effectiveness of fire protection plan**		NA
10.6.1	The test method 2 test set-up and test procedures are identical to that in 10.3, except instead of the sprinkler system set up of 10.3.2, the room shall be fitted with the specified fire protection and explosion mitigation equipment representative of a planned installation for the tested BESS system.		NA
10.7	**Installation level test report – Test method 2 – Effectiveness of fire protection plan**		NA
10.7.1	The report on installation level testing shall include the following:		NA
	a) The report information in 10.4.1 items (a) – (u), and (v) if applicable;		NA
	b) Fire protection features/detection/suppression systems within installation; and		NA
	c) Length of time of operation of the clean agent, or other suppression system in addition to any sprinklers used.		NA
10.8	**Performance – Test method 2 – Effectiveness of fire protection plan**		NA
10.8.1	See 10.5 for performance criteria.		NA
ANNEX A (INFORMATIVE)	**Test Concepts And Application Of Test Results To Installations**		-
ANNEX B (INFORMATIVE)	**Safety Recommendations for Testing**		-

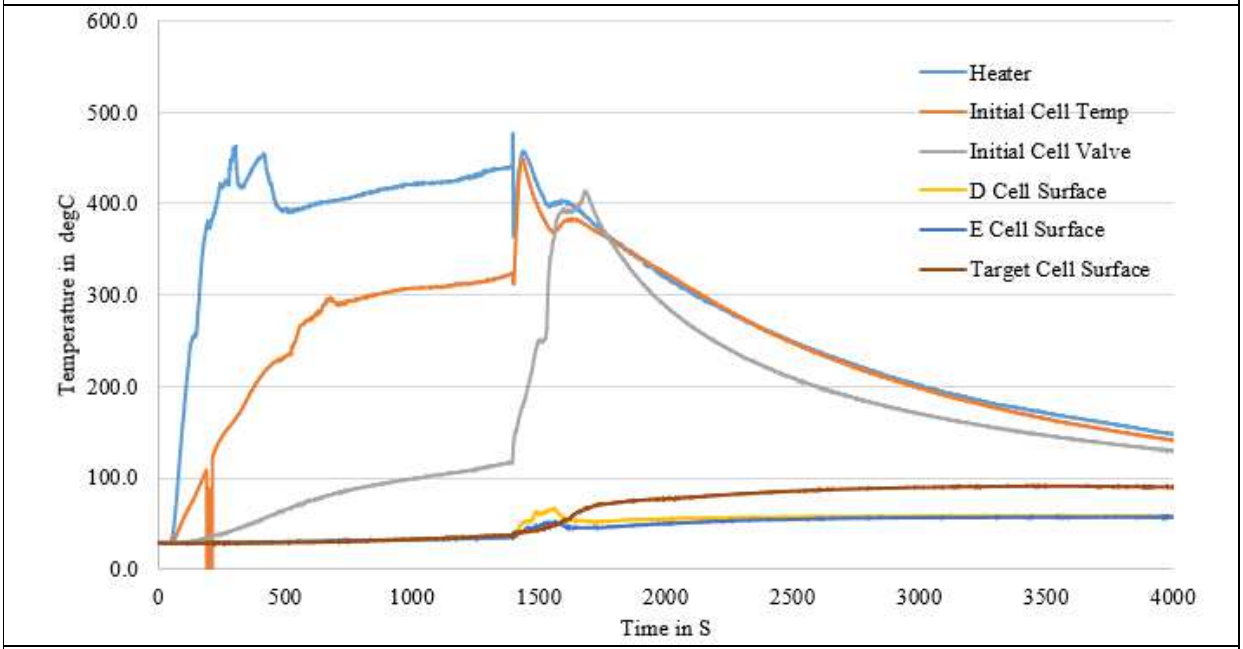
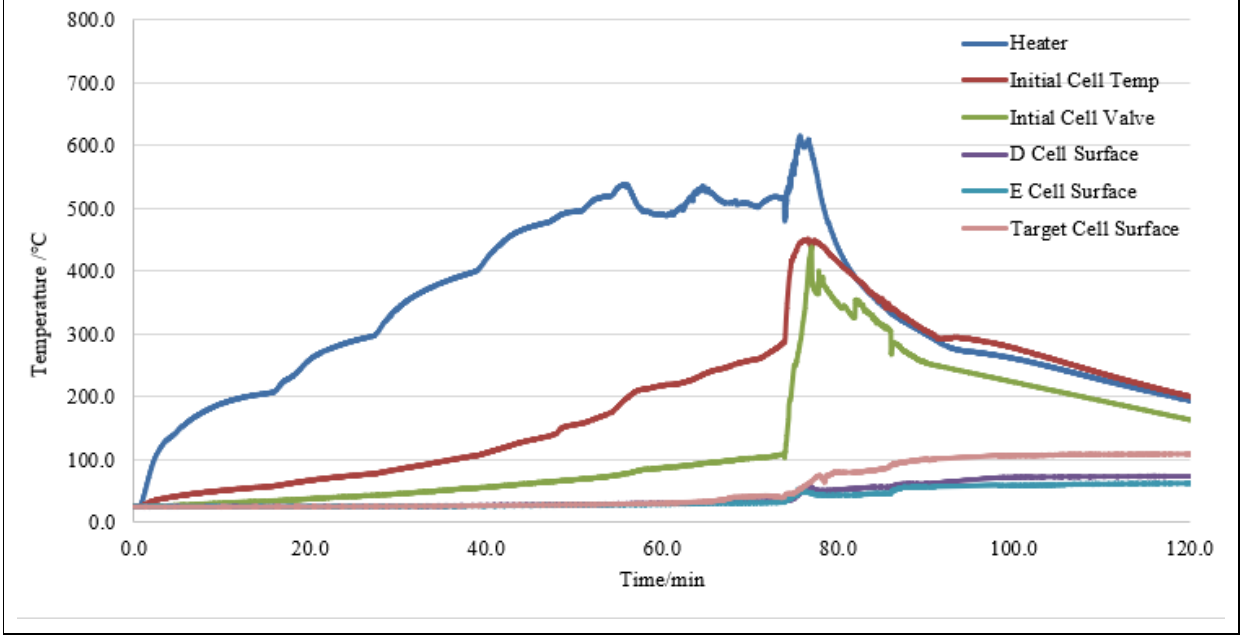
Appended Tables:

Table 7.4 Cell vent gas composition -Gas Components								
CO2	CO	H2	CH4	C2H2	C2H4	C2H6	C3H6	C3H8
22.84	6.65	45.33	5.55	0.24	10.51	2.15	3.56	0.59

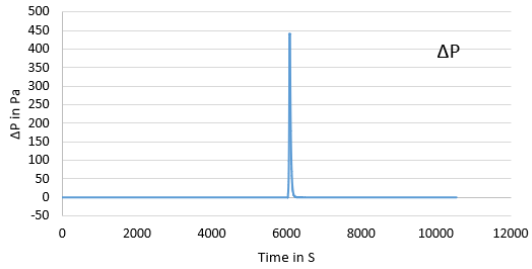
Temperature measure curve Cell

Curve of Temperature
Sample1

Sample 2


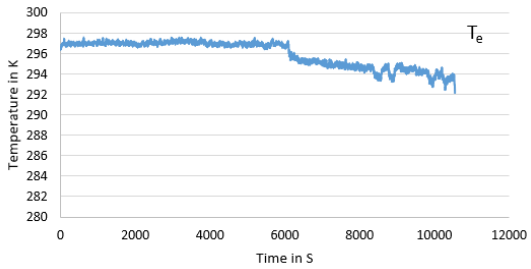
Curve of Temperature
Sample3

Sample 4


Curve of Temperature
Module

Unit


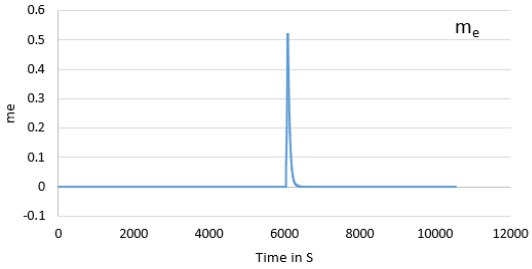
Appended Curve: 8.3 g) Heat release rate versus time data



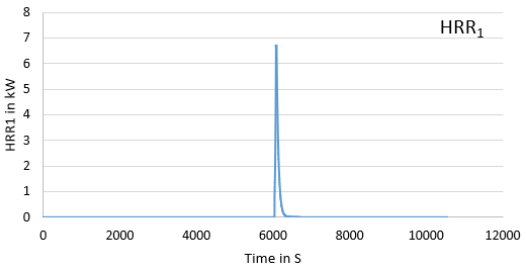
ΔP is adjusted to 0, before cell venting and after smoke is cleared



Orifice plate is 3m higher than test sample, so, its temperature is same as room temperature



m_e is a caculated result according to ΔP and T_e

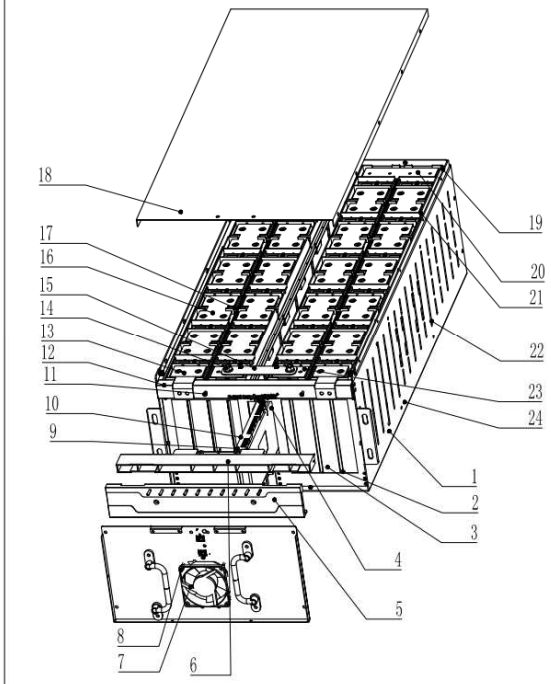


HRR_1 is a calculated result.
Test sample has no flame, so HRR_1 is small.

Appended Table: 8.3 h) Flammable gas generation and composition data

Table 8.3 Flammable gas generation and composition data								
CO2	CO	H2	CH4	C2H2	C2H4	C2H6	C3H6	C3H8
17.15	4.90	58.38	4.37	0.23	7.80	1.64	3.20	0.48

Annex 1: Drawing



NO.	Name	Description	quantity	Materials	SUM Weight	Mark
24	PFES250X24A.00-02	Bottom epoxy	1	ERB t=0.5mm		
23	PFES250X16.00-03	Transfer LvPai	2	AL1060		
22	PFES250X24A.00-01	Side epoxy	2	ERB t=0.5mm		
21	PFES250X16.00-08	upper bracket	6	PP+20%GF		
20	PFES250X16.00-01	Connection LvPai	2	AL1060 H24		
19	PFES210X16A1.00-08	Front	4	Epoxy t=0.5mm		L=60mm
18	PFES250X24A.00-03	Top epoxy plate	1	ERB t=0.5mm		
17	PFES250X16.00-12	Low voltage acquisition	1			
16	PFES250X16.00-02	Connection LvPai	20	AL1060 H24		
15	PFES250X16.00-05	connected copper bar	1	red copperT2		
14	Nuts /M8	Nuts/M8	2			
13	PFES250X16.00-04	Terminal bracket	2	AL1060 H24		
12	PFES250X16.00-06	Terminal support	1	PP+20%GF		
11	Bolt/M4×16	Bolt/M4×16	2	304		
10	PFES210X16A1.00-05	Bracket insulating board	2	ERB t=0.5mm		
9	BMU,PCB,WH	BMU,PCB,WH	1			
8	Nuts/M3	Nuts/M3	4	304		
7	fan/3414NHH	fan/3414NHH	1			
6	PFES250X16.00-07	mound layer	1	PP+20%GF		
5	PFES250X16.00-11	shield	1	PP+20%GF		
4	Nuts /M4	Nuts /M4	4	304		
3	FE125A batteries	FE125A batteries	48			
2	PFES250X16.00-09	lower bracket	6	PP+20%GF		
1	PFES250X24A.01	PFES250X24A	1	SGCC		

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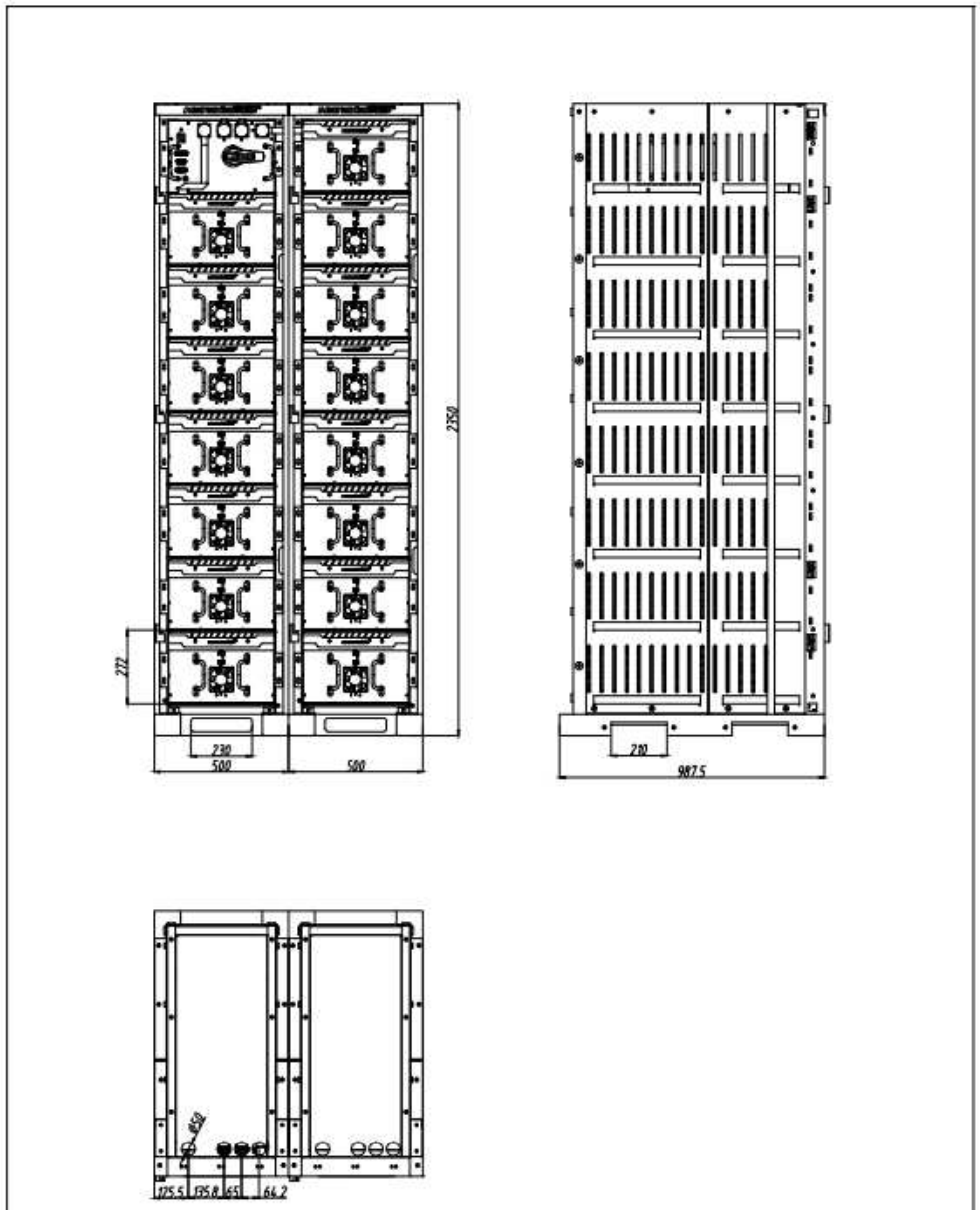
Mark | Place | Rev. document NO. | Signature | Date

Design | Standard check up | Drawing mark | Weight (kg) | Proportion

Proof

Technology check | Approve | Total:1 page | First page

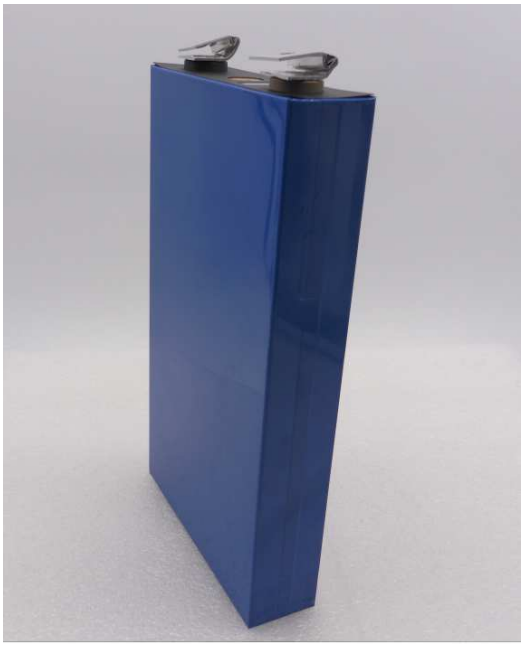
Annex 2: Drawings



							NARADA
Mark	Place	Rev. document NO.		Signature	Date		
Design			Standard check up			Drawing mark / Weight (kg) / Proportion	76.8V NESP Rack drawing
Proof							
Technology check							ZNG
			Approve			Total:1 page First page	

Annex3: Photos

Overview-cell

Overview-cell


Annex1: Photos

Overview -after testing

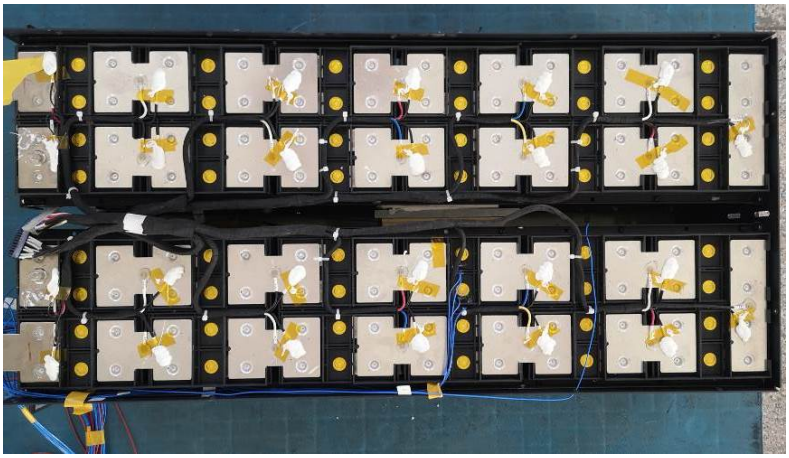
Overview -after testing


Annex 4-Photos

Overview - module

Overview - module


Annex4x-Photos

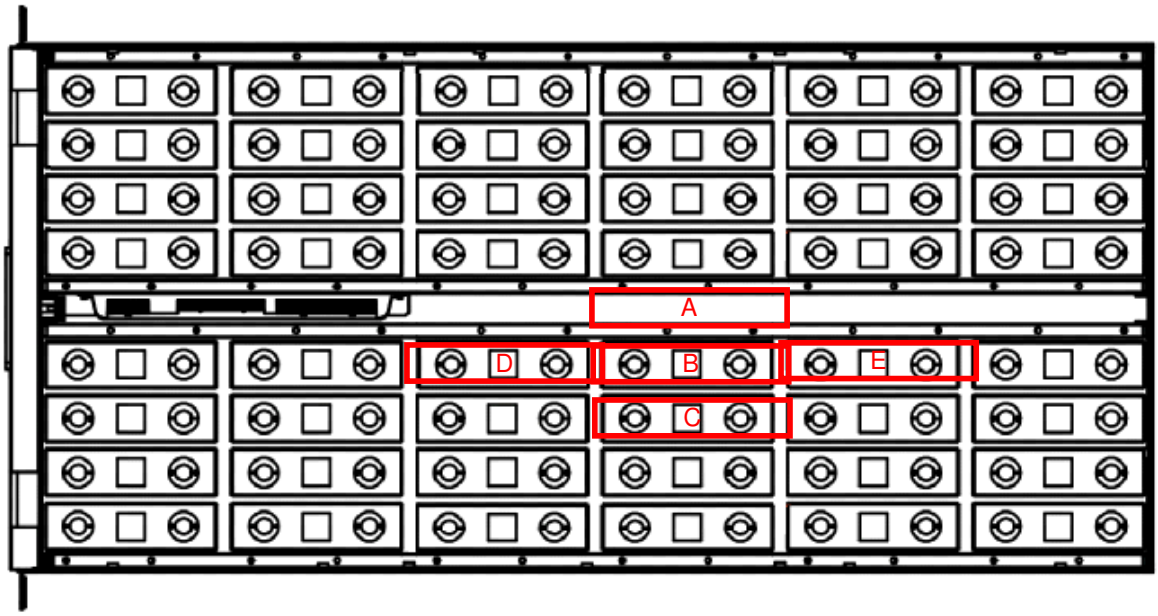
Overview – module before test

Overview – module at test


Annex3-Photos of Unit

Overview – Unit

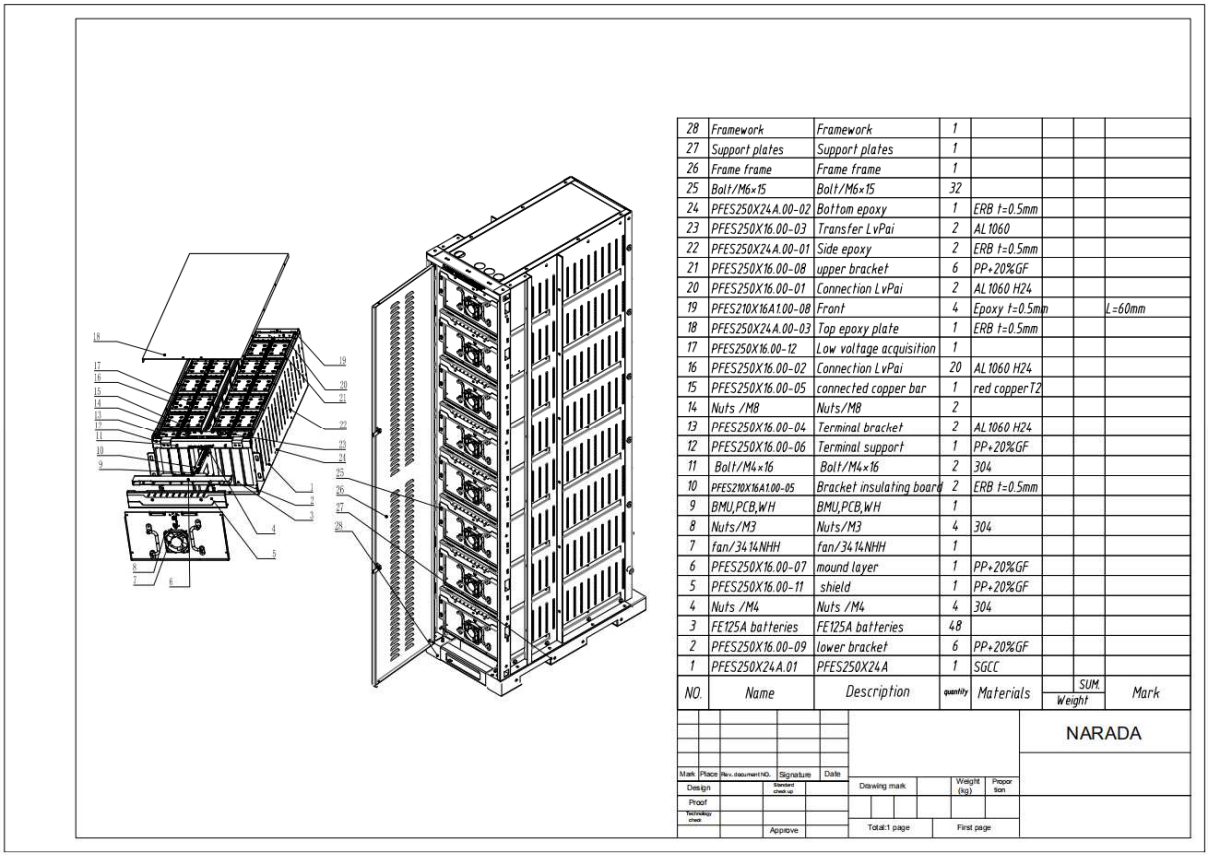
Overview – Unit


Annex 5 Description of 8.3

Thermal runaway initiation method used including number and locations of cells for initiating thermal runaway

Make initial cell thermal runaway by heating; Heat 1 cell, its position is marked as B. Note: A: Heat Film B: Initial Cell C: Target Cell D: Adjoint Cell 1 E: Adjoint Cell 2

Annex 6 The construction of the initiating BESS unit

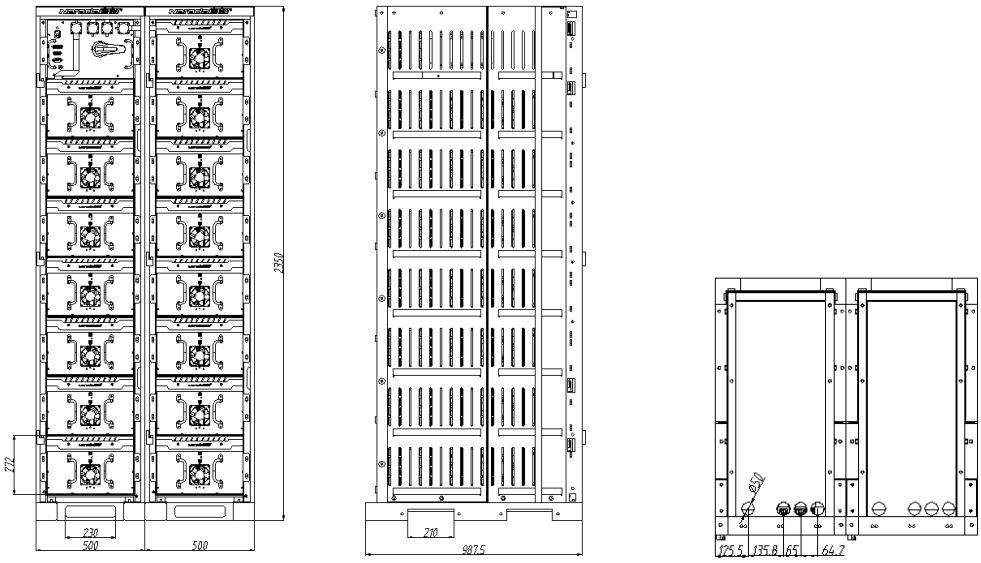
Internal construction for BESS unit



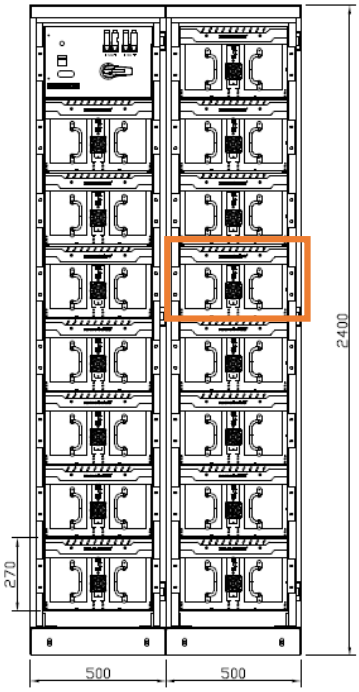
NO.	Name	Description	quantity	Materials	SUM. Weight	Mark
28	Framework	Framework	1			
27	Support plates	Support plates	1			
26	Frame frame	Frame frame	1			
25	Bolt/M6×15	Bolt/M6×15	32			
24	PFES250X24A.00-02	Bottom epoxy	1	ERB t=0.5mm		
23	PFES250X16.00-03	Transfer LvPai	2	AL1060		
22	PFES250X24A.00-01	Side epoxy	2	ERB t=0.5mm		
21	PFES250X16.00-08	upper bracket	6	PP+20%GF		
20	PFES250X16.00-01	Connection LvPai	2	AL1060 H24		
19	PFES210X16A1.00-08	Front	4	Epoxy t=0.5mm		L=60mm
18	PFES250X24A.00-03	Top epoxy plate	1	ERB t=0.5mm		
17	PFES250X16.00-12	Low voltage acquisition	1			
16	PFES250X16.00-02	Connection LvPai	20	AL1060 H24		
15	PFES250X16.00-05	connected copper bar	1	red copperT2		
14	Nuts /M8	Nuts/M8	2			
13	PFES250X16.00-04	Terminal bracket	2	AL1060 H24		
12	PFES250X16.00-06	Terminal support	1	PP+20%GF		
11	Bolt/M4×16	Bolt/M4×16	2	304		
10	PFES210X16A1.00-05	Bracket insulating board	2	ERB t=0.5mm		
9	BMU,PCB,WH	BMU,PCB,WH	1			
8	Nuts/M3	Nuts/M3	4	304		
7	fan/3414NHH	fan/3414NHH	1			
6	PFES250X16.00-07	mound layer	1	PP+20%GF		
5	PFES250X16.00-11	shield	1	PP+20%GF		
4	Nuts /M4	Nuts /M4	4	304		
3	FE125A batteries	FE125A batteries	48			
2	PFES250X16.00-09	lower bracket	6	PP+20%GF		
1	PFES250X24A.01	PFES250X24A	1	SGCC		

NARADA

Dimensions for BESS Unit



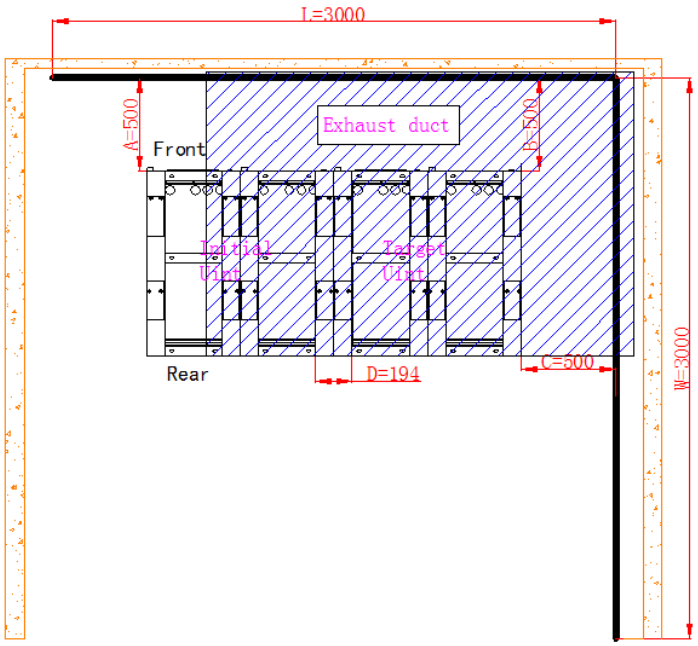
Annex 7 Location of the initiating module within the BESS unit;



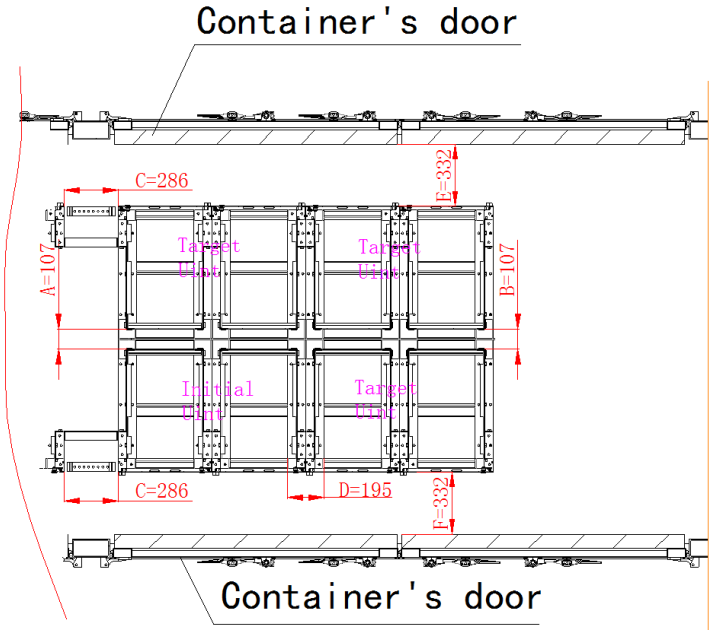
Location of Intial Module is marked as in orange square.

Annex 8 Diagram and dimensions of the test setup

Test1: In room setup



Test 2: In container setup



Annex 9 Photos of the unit test
Test 1

Overview – Unit before test

Overview – Unit at test


Annex 9 Photos of the unit test

Test 1

Overview – Unit after test


Annex 9 Photos of the unit test
Test 2

Overview – Unit before test

Overview – Unit at test


Annex 9 Photos of the unit test
Test 2

Overview – Unit after test

Overview – Unit after test


Technical Appendix 1.4

Potential Grid Connection

Technical Appendix 1.4: Potential Grid Connection Route

Introduction

The Consenting Context

1. Although a grid connection is an integral, requisite part of any wind farm project, it typically follows a completely separate consenting route. Depending upon its scale and significance, consent for the wind farm grid connection is sought either from the relevant owner of the local distribution or transmission network, in this case Northern Ireland Electricity Ltd or SONI Ltd.

2. The Best Practice Guidance to PPS 18 states that whilst the routing of such lines by NIE is usually dealt with separately to the application for the wind farm, developers will generally be expected to provide details of indicative routes and method of connection.

3. Any Environmental Impact Assessment should assess the complete project, rather than a portion thereof and this is the purpose of this Technical Appendix.

4. This chapter contains the following:

   - Appendix A - Figure Appendix 1 is referenced in the text as appropriate.
   - Appendix B – Heritage assets reviewed as part grid route assessment, including Figures 1.1 to 1.4

Potential Grid Connection

5. Given the consenting context the exact means of grid connection is unknown at the time of writing. However, based on RES's knowledge of the grid connection system and NIE's published plans for future upgrades, RES has been able to undertake an assessment to determine the grid connection option most likely favoured by the network operator, which is proposed to Rasharkin Substation.

6. The Proposed Development would be connected by approximately 23 km of underground cable to Rasharkin Substation.

7. The route would begin at the substation within the Proposed Development and would then follow the proposed site tracks to turbine 5 (T5), from where it would follow the route of an existing farm track, and then laneway, before meeting the public road corridor on the Tullykittagh Road. The route would then turn right onto the Lislaban Road, before turning left onto the Loughill Road. The route would then follow the Drumadoon Road, Frosses Road, Killagan Road, Boyds Road and Anticur Road, before following the Glenbuck Road and Gortahar Road into Rasharkin. The route would then turn right onto the Finvoy Road, and proceed to the substation, which is accessed off the Finvoy Road.

8. For an underground cable connection, the trench would be similar to those used on the main site of the Proposed Development, as shown in Volume 3 Figure 1.16. The trench will be approximately 0.5 m – 0.75 m wide and 1.2 m deep and could run in the road side verges adjoining the carriageway, or within footways adjoining the carriageway, although it is also possible that the cable would be laid within the carriageway itself. Cables would typically be laid to a depth of 0.75m to 1.2 m. To lay this cable a trench is dug, bedding material, normally sand, is placed along the trench-base, the cable laid and then covered with more sand. The cables are then protected by a layer of protective plastic covers and then backfilled with subsoil and original topsoil and turfs.

9. For bridge crossings along the road, the cable could be laid within the bridge, if there is sufficient excavation depth, or otherwise via directional drilling under the watercourse.

10. The construction activities would include the following:

- Clearance of land (including vegetation strip as appropriate)
- Digging of trenches
- Backfilling of trenches and remediation.

11. The land should be reinstated as near as reasonably practicable to its original condition.

12. It is anticipated that the works would be implemented by NIE using its permitted development rights as a statutory undertaker.

Potential Impacts

13. An assessment of the likely significant environmental impacts of the proposed underground grid connection route has been undertaken under the following headings:

- Landscape and visual
- Cultural heritage and archaeology
- Vegetation & Terrestrial fauna
- Ornithology
- Geology and the water environment
- Noise
- Traffic and transport

Landscape and Visual

14. It is anticipated that there will be no disturbance to existing trees, hedgerows or adjacent fields but that there will be disturbance to grass verges adjacent to the road surface. Where the road corridor is particularly narrow it is possible that some existing hedgerows and trees may need to be trimmed in order to allow sufficient working space for construction machinery. The following sections include mitigation for each section of the route.

15. The first section of the grid connection route would be below the proposed new access track forming part of the Proposed Development. This would cross open moorland comprising heath and peatland but devoid of trees and hedgerows and result in no significant changes to the landscape and visual character of this part of the route. From here the route would then follow an existing farm lane which is bounded by some established hedgerows and mature trees which are often associated with farmsteads and dwellings. These have visual amenity value for the properties in proximity to them and their removal should be avoided for this reason.

16. The route joins the tertiary road network at Tullykittagh Road which is a relatively narrow road corridor closely bounded by established thorn hedgerows with limited verge space. There are some mature specimen ash, sycamore and beech trees, particularly in the mid-section of this road and at the northern end at the crossroads with Corkey and Moneyduff Roads as well as a mature yew tree in a private garden near the crossroads. These trees are a valuable element of the physical landscape character of this road and could not be easily replaced. The loss of mature Ash trees in particular should be avoided if at all possible because, due to the dangers of Ash Die-Back disease, it is not possible to replace them and they are becoming a rarer element of the landscape despite being a key feature. On narrow road corridors such as this where verge space is limited the grid connection route will be installed so as to avoid vegetation removal, being placed within the carriageway if necessary.

17. The grid connection route then turns right onto the Lislaban Road for a short period. This is a slightly wider road corridor with a bridge over Cloughmills Water and a gappy over mature hedgerow. Lislaban Road widens at the junction with Loughill Road and it is anticipated that the connection may be accommodated within the verge without significant effect. Loughill Road has a similar character with wider verges and gappy hedgerows which have been replaced with post and wire fences in places. There are several valuable landscape features on Loughill Road including; very well maintained hedgerows associated with residential properties; a number of mature beech and ash trees located particularly on the northern side of the mid –section of Loughill Road; a tall ash hedgerow on the southern side of the road corridor past this latter point; a very narrow section of road corridor around Caldwellstown where construction within the areas bounding the carriageway would result in a significant loss of vegetation Impacts on these features will be avoided by constructing within the carriageway where verge width is insufficient.

18. Loughill Road enters the town of Cloughmills at its western end and here there is likely to be sufficient space in the adjacent verges and footpaths to install cables with no significant effects on landscape or visual character. Drumadoon Road, Frosses Road, and Killagan Road are similar. These are wider road corridor with simple grass verges and existing tarmac footpaths running along one or both sides of the carriageways. There is some recently planted vegetation on Frosses Road which would have been established as part of the recent road widening here.

19. The first section of Boyds Road has a similar character to that described above but the road corridor then becomes narrower and more tightly enclosed by hedgerows on banks. Some of this vegetation is unmanaged and overgrown There are a number of established ash trees along Boyds Road that should be avoided for the reasons noted previously. The western end of this road has a greater number of valuable mature trees but also wider verges.

20. Anticur Road is narrow with lots of established hedgerows and mature trees. There are number of stands of mature Beech and Ash which are particularly valuable. Where verges are present they could be utilised but the installation of cables in soft ground either side of this road is likely to result in substantial loss of vegetation and a significant detrimental effect on landscape and visual character. Glenbuck Road appears to have sufficient soft verges in many places but space is more limited in proximity to the Bridge Road junction. Therefore, in relation to Anticur Road and this one section of Glenbuck Road, construction work should take place within the carriageway.

21. The junction of Glenbuck and Gortahar Roads is tightly defined by vegetation including valuable stands of mature ash trees and established gardens on the north side of the road corridor. The south side of the road corridor is defined by gappy hedgerows. The central section of Glenbuck Road either side of the pronounced bend in the road is also narrow and tightly enclosed by vegetation as is the section on the outskirts of Rasharkin. Here a similar approach to that proposed in the preceding paragraph should be taken, i.e. construction work should take place within the carriageway in order to avoid substantial loss of established vegetation and a significant detrimental change to the appearance and physical character of the road corridor. Within Rasharkin village and along Finvoy Road to the substation there is sufficient space in verges and footpaths to accommodate cable trenches with no significant alteration to the appearance of the road corridor and no loss of trees of hedgerows.

22. Provided the measures detailed above are implemented there would be no significant landscape or visual effects from the proposed works.

Archaeology & Cultural Heritage

23. This section provides an assessment of the potential effects of the proposed grid connection route for Carnbuck Wind Farm upon cultural heritage and archaeology. The proposed grid connection route runs from the proposed substation within the Site to the existing Rasharkin substation. It supplements the EIA Report Chapter 5: Archaeology and Cultural Heritage.

24. In this section, assessment of potential direct (physical) effects upon heritage assets as a result of ground-breaking works for the proposed grid connection route is considered, including:

- Clearance of land (including vegetation strip as appropriate)
- Cable trench excavation

25. Setting effects during construction and operational phases of the proposed grid connection are also considered.

Policy Context

26. Scheduled Monuments and Listed Buildings are protected by statute.

27. The policies of the Department of the Environment Northern Ireland (DOENI) regarding protection and management of cultural heritage assets are contained in Planning Policy Statement 6 (PPS 6): Planning, Archaeology and the Built Heritage. Revised criteria for the designation of Listed Buildings are contained in an Addendum to PPS 6 published in 2011. Additional planning policies relating to areas of Townscape character are provided in an Addendum to PPS 6.

28. The policies in PPS 6 make the preservation of archaeological and built heritage a material consideration in the planning process. This applies specifically to archaeological remains (Policies BH 1 and BH 2), World Heritage Sites (Policy BH 5), Parks, Gardens and Demesnes of Special Historic Interest (Policy BH 6), Listed Buildings (Policies BH 7 – BH 11), and Conservation Areas (Policies BH 12 – BH 14). The setting of an asset covered by any of these designations is also a material consideration.

29. The assessment accounts for the Draft Local Development Plan 2030 for Mid and East Antrim. Policies relevant to this assessment include: Policy HE1 Archaeological Remains and their Settings and Policy HE5 Development affecting the Setting of a Listed Building.

Methodology

30. The archaeology and cultural heritage assessment has been carried out in the following stages:

- Desk-based study leading to the identification of heritage assets potentially affected by the proposed grid connection;
- Assessment of the importance of heritage assets potentially affected by the proposed grid connection;
- Identification of the magnitude of potential impacts on identified heritage assets;
- Assessment of the significance of effects, broadly a product of the asset's importance and the magnitude of the impact; and
- Proposal of mitigation measures, to eliminate, reduce or offset adverse effects;
- Assessment of residual effects.

31. To ensure consistency of approach, the same significance criteria and impact assessment methodology as referred to in the EIA Report has been followed.

32. All designated and non-designated heritage assets have been gathered for a Study Area of 30m either side of the proposed grid connection route.

33. The following sources of information were consulted:

- Northern Ireland Sites and Monuments Record (NISMR);
- Gazetteer of Historic Nucleated Urban Settlements;
- Buildings Database;
- Areas of Significant Archaeological Interest;
- Areas of Significant Archaeological Potential;
- Scheduled Monument data;
- Register of Historic Parks, Gardens and Demesnes;
- Battle Sites;
- Industrial Heritage Record;
- Defence Heritage Record;
- Historic maps and records held by Public Records Office Northern Ireland (PRONI); and
- Modern aerial imagery and 'streetview' images available online.

34. Potential heritage assets have been identified through a review of historic and modern mapping and modern aerial imagery. Any potential heritage assets identified through this assessment have been assigned the prefix HAGC (Heritage Asset Grid Connection) in order to differentiate these from the newly identified features within the proposed Wind Farm site as discussed in the EIA Report.

Baseline Conditions

35. All heritage assets and features are shown in Appendix B. All features considered of low importance or higher are considered to be heritage assets and are shown in Appendix B, Figures 1.1 – 1.3.

Designated Heritage Assets

36. There is one Grade B Listed Building within the Study Area: HB04/16/002, Killagan Parish Church located on Drumadoon Road approximately 830 m west of the village of Clough Mills.

37. There are no further designated heritage assets within the Study Area.

Non-designated Heritage Assets

38. There are seven non-designated Industrial Heritage Records (IHR) within the Study Area.

39. There is one Historic Nucleated Urban Settlement (Rasharkin HNUCS 116) within the Study Area.

40. There are a further 51 features within the Study Area identified on historic mapping for this assessment. The majority of these features relate to agricultural buildings, with cottages and schools also noted. Of these, 33 are considered of negligible importance; these features are shown in Appendix B but are discounted from the impact assessment. The remaining 18 assets are considered below and in Appendix B.

Assessment of Effects

Construction Phase Effects

41. It is understood that excavations for the proposed grid connection construction would take place within road verges, existing footpaths or roads and would involve no ground breaking works outwith these areas. These areas have already been disturbed and are considered to be of negligible archaeological potential. The heritage assets within the Study Area are either currently occupied or used structures and considered unlikely to be directly impacted by the proposed grid connection or are located outwith the areas of existing road verges, footpaths or roads within which the proposed grid connection would be located. As such, the only potential direct construction phase impacts may arise from accidental damage caused by uncontrolled plant movement to extant structures which are no longer occupied and located immediately adjacent to the proposed grid connection route. These include:

- HAGC44, building at corner of Tullykittagh Road and Corkey Road
- HAGC46, extant remains of school walls of Tullahbane school

42. These assets are both no longer in use and located immediately adjacent to the proposed grid connection route. It is considered that without mitigation, should any such accidental damage occur, there would be a low adverse impact on assets of low importance resulting in a significance of effect of negligible which is not significant in EIA terms.

43. It is assumed that any historic structures which are still in use will be avoided during construction works and plant appropriately managed to avoid any accidental impacts.

Archaeological Potential

44. Within the Site of the proposed Carnbuck Wind Farm, areas of archaeological potential are considered to be focussed on Aghanageeragh River, the vicinity of known heritage assets, and within areas of improved farmland at the south and west of the Site. The proposed grid connection route would run from the proposed substation at the east of the Site and run south-west towards Magheraboy Farm. The majority of this area is considered to be of negligible-low archaeological potential with much of this eastern area of the Site having been disturbed by drainage channels and areas of peat cutting which would have at least partially truncated any previously existing archaeological remains.

45. The vicinity of HA12 (Figure 1.4), an area of rig and furrow enclosed by a low bank, at the south of the Site, is within improved agricultural land and is considered to be of medium potential for previously unknown remains of post-medieval date. Any such remains would be considered of low importance. Given the relatively narrow width of the cable trench for the proposed grid connection, it is considered that without mitigation, there would be a low adverse impact on any previously unknown post-medieval remains, which would be considered to be of low importance, resulting in a significance of effect of negligible which is not significant in EIA terms.

46. Outwith the Site, the proposed grid connection would be routed within road side verges adjoining carriageways, within footways adjoining the carriageway, or within the carriageways themselves. Given the likely levels of disturbance arising from the construction of these existing modern infrastructure, the route of the proposed grid connection is considered to be of negligible archaeological potential.

Setting Effects

47. Any construction phase changes to the setting of any heritage asset, brought about by increased construction traffic and movement, would be temporary, limited to this phase only and would be reversed following the completion of the construction phase. As such, no setting effects are predicted.

48. No operational phase setting effects are predicted as there would be no above ground elements of the proposed grid connection likely to cause any visual change to the setting of any heritage asset.

Mitigation

Construction Phase Effects

49. It is recommended that the following unoccupied historic structures located immediately adjacent to the proposed grid connection route are signposted prior to construction commencing in order to mitigate the potential for accidental construction phase damage:

- HAGC44, building at corner of Tullykittagh Road and Corkey Road
- HAGC46, extant remains of school walls of Tullahbane school

Vicinity of HA12

50. This area of the Site is considered to be of medium potential for below ground remains of post-medieval date. A watching brief on ground breaking works for the access track leading to and the vicinity of HA12 during construction works for Carnbuck Wind Farm has been recommended in Chapter 5: Archaeology and Cultural Heritage and is shown in Figure 1.4. It is anticipated that the watching brief for this area will have been carried out prior to the installation of the grid connection route. As this area of access track lies in close proximity to the proposed grid connection route, it is considered this area will have already been sufficiently assessed for archaeological remains prior to the installation of the grid connection route. As such, assuming no significant archaeological remains are noted during the watching

brief carried out during the construction phase of the proposed Carnbuck Wind Farm, no further watching brief works are recommended in this area.

Additional Mitigation

51. In addition to the above mitigation measures, it is recommended that a toolbox talk on archaeology and cultural heritage should be delivered to contractors carrying out the construction phase of the proposed grid connection prior to works commencing. Maps showing the locations of all heritage assets and historical features identified in this assessment should also be included on contractors plans and recognised in method statements.

Statement of Significance

52. Following implementation of the recommended mitigation measures, no significant effects arising from the proposed grid connection upon cultural heritage are predicted.

Vegetation & Terrestrial Fauna

53. This section considers the potential impacts of the proposed grid connection on the flora & terrestrial fauna interests along the proposed route. Desk records were identified from the NIEA Environment Map Viewer and the NBN (National Biodiversity Network) Gateway. The route follows the wind farm access track from the substation to a minor lane and on to the public road (approx. 4000 m) and it is proposed to bury the cable in the road verges or under the public road for approximately 23 km of underground cable to Rasharkin Substation.

54. The proposed route westwards to the substation lies along the road network for almost its entire length. The proposed route was assessed as part of a desktop study in July 2022. These methods were aimed at identifying the habitats and species found or likely to be found along the proposed grid connection route.

55. Within the wind farm Site, the proposed grid connection follows the route of the proposed access track which lies within a mosaic of marshy grassland/blanket bog/wet heath and improved grassland. Between the site and the substation, the proposed grid connection option would be buried in the carriageway, or in the roadside verge, which primarily consists of rank semi-improved grassland with occasional trees/scrub. The wider landscape is a mix of improved/semi-improved agricultural grassland.

56. Mature trees, hedgerows and river crossings are the areas of conservation value along the proposed grid connection route. However, it is proposed to bury the cable in the roadside verge or under the carriageway, away from these habitats of conservation value. Tree roots will be avoided by the use of British Standard BS5837: 2005 Trees in relation to Construction - Recommendations.

57. Given the length of the proposed grid connection there are several thousand species records on the National Biodiversity Network (NBN) records within a 10 km radius of the centre point of the route corridors. There are too many records to address individually, especially given that the route lies primarily within the curtilage of the public road. However, pine marten, red squirrel, bats, badger, hedgehog, smooth newt and common lizard are all considered to be likely to occur in the area (at least in certain foci) between the wind farm entrance and either of the substations.

Construction Phase

58. The direct potential impacts on important ecological receptors are related mostly to any potential habitat loss and disturbance of habitats as a result of activities to excavate a trench for an underground cable. Any trenching to lay an underground cable should involve immediate reinstatement of the low-quality habitats found in the roadside verges. Therefore, the net habitat loss should be neutral.

59. The direct potential impacts on faunal receptors are related mostly to habitat loss and disturbance of habitats as a result of activities to excavate a trench for an underground cable. In addition, there is the potential for direct disturbance to protected fauna from construction noise and associated activities themselves. Any trenching to lay an underground cable would involve immediate reinstatement of the habitats. Therefore, the net habitat loss would be neutral.

60. Disturbance of habitats along the route also has the potential to result in indirect impacts on faunal species which inhabit those habitats and this could include, pine marten, red squirrel, bat species, smooth newt, badger and common lizard all of which have been recorded along or in close proximity to the route.

Operational Phase

61. No operational impacts from normal operation of an underground connection are predicted. Should the cable be required to be excavated for maintenance this would result in habitat disturbance but this should be reinstated following works.

Mitigation & Conclusion

62. On the basis of the desk study undertaken the significance of the potential impacts is assessed to be low-negligible, however pre-construction mitigation measures that should be adopted by the construction contractor are proposed below:

- Pre-construction surveys to identify areas of sensitive habitat which should be avoided;
- Pre-construction protected species to identify species or features supporting species along the route and allow the preparation of appropriate mitigation;
- Preparation of a construction method statement for the grid connection stating how impacts on protected species and habitats would be avoided; and
- The use of an ECoW (Ecological Clerk of Works) during construction to ensure that all of the above measure is properly implemented.

- Tree roots will be protected by the implementation of BS5837:2005, where excavations will not be permitted inside the RPA (Root Protection Area).
- No spoil, vehicles, fuel, materials, temporary buildings or ancillary equipment shall be stored inside the RPA. Existing ground levels within the RPA should not be raised or lowered.
- It is not possible at this stage to completely rule out the need to remove small sections of hedgerow or trees but if this was required, these should be replanted or replaced.

63. Completion of a programme of ecological mitigation works would offset the loss of the ecological resource that would occur as a result of the construction of the grid connection. Taking the proposed mitigation into account, no significant residual effects are anticipated to occur.

Ornithology

64. The underground cable is to run within the roadside verges adjoining the carriageway or within the carriageway itself therefore it is highly unlikely that either the construction or operation of the cable route would have any significant adverse effects on birds either directly (due to loss of habitat or disturbance of active nests) or indirectly (due to displacement effects).

Geology and the water environment

65. Potential direct effects of the proposed grid connection route option are on water quality, morphology, water resource and flood risk to surface and groundwater in the affected sub-catchments. Potential indirect effects on water dependent habitats are addressed separately within the ecology section.

Geology & Hydrogeology

66. The proposed grid connection route begins within the site boundary and travels south-west beyond the lands under applicant control / survey boundary for c. 1.5 km until it meets Tullykittagh Road.

67. Between the site and the junction of Tullykittagh Road and Lislaban Road, the underlying superficial geology is predominantly till diamicton. The proposed grid connection route then crosses a range of alluvium, moraine deposits and till as it travels along Loughill Road.

68. The shift between till, moraine deposits and alluvium continues as the route passes through Cloughmills until it reaches Frosses Road. Beyond this, glaciofluvial ice contact deposits, alluvium, and peat are prevalent until the route meets Anticur Road. At this section, the road follows the boundary between glaciofluvial ice contact deposits and moraine deposits.

69. Moraine deposits and till between Ballaghy Road and Rabbit Rock (the junction of Glenbuck Road, Mullan Road, and Gortahar Road) have large discrete areas peat throughout. Between the proposed development boundary and this location, the proposed grid connection route is located upon the Ballymena groundwater body. The Ballymena groundwater body has a Water Framework Directive (WFD) water quality status of 'Poor'.

70. Beyond this section towards the existing Rasharkin Substation, the superficial geology of the area is comprised of till. This section of the and the proposed grid connection route is located upon the Coleraine-Kilrea groundwater body which has a WFD water quality status of 'Poor'.

71. The aquifers underlying the route are largely uniform in nature; GSNI mapping indicates the bedrock aquifer underlying the site is classified as Bm(f), indicating they have high to moderate productivity but dependence on fracture flows makes poorer yields possible.

72. The aquifers underlying the route are largely uniform in nature; GSNI mapping indicates moderate productivity and fracture flow across the wider region along both routes. GSNI mapping indicates the presence of potential[1] superficial aquifers where the grid connect route is in proximity to the River Main (north-west of Cloughmills).

73. Groundwater vulnerability is categorised from Highest (5) to Lowest (1) and is variable along the length of the proposed connection route:

- Within the site boundary and for c. 700 m of Tullykittagh Road, the groundwater underlying this area is noted as having a vulnerability Class 4c.
- From this point until west of Cloughmills (near Boyd's Bridge), groundwater underlying this area is noted as having a vulnerability Class 2.
- For approximately 3 km the proposed connection route then passes through an area mapped as Class 4e.
- Thereafter, groundwater vulnerability Class 2 and Class 4c are present within short distances of each other and the connection routes passes between the two several times. Areas of Class 4c tend to coincide with underlying peat.
- Near to Rabbit Rock an area of vulnerability Class 5 is noted. This coincides with an area shown on GSNI mapping to be absent of superficial deposits.
- Beyond this section towards the existing Rasharkin Substation, the groundwater underlying this area is noted as having a vulnerability Class 2.

74. Given trench excavation will be shallow (i.e., 1.0 m deep and could run in the roadside verges), they are unlikely to adversely impact groundwater and / or potential superficial aquifers. However, good practice guidance on pollution prevention (as outlined in Volume Technical Appendix 10.1) should be adhered to

[1] GSNI state that 'A regional, detailed assessment of the individual deposits in terms of their aquifer potential (aerial extent, thickness, saturated depth etc.) has not yet been undertaken. Hence formal classification of each deposit as an aquifer area is not possible at present.' (https://mapapps2.bgs.ac.uk/GSNI_Geoindex/LayerHelp/superficials_aquifer.htm)

during works across the proposed route, with particular focus on areas identified as vulnerable where potential superficial aquifers may be located.

75. Consultation with statutory stakeholders regarding private water supplies (PWS) and review of Drinking Water Inspectorate (DWI) online mapping was undertaken during the preparation of the Environmental Statement for the proposed development. No PWS were identified in proximity to the proposed grid connection route.

76. Review of NIEA Water Information online mapping did not identify any registered groundwater abstractions in proximity to the proposed grid connection route.

Hydrology

77. The proposed grid connection route crosses several surface water catchments.

78. NIEA catchment data indicates that the initial 18 km of the route from the site is within the wider River Main catchment. The remaining 5 km is located within catchments discharging to the River Bann. The initial 18 km section is located within the Braid and Main Local Management Area (LMA) whilst the remaining 5 km are located within the Lower Bann LMA.

79. As the cable laying route is located within the wider River Main catchment which ultimately discharges into Lough Neagh, it is hydrologically connected to downstream designated sites. This includes Lough Neagh ASSI / Lough Neagh & Lough Beg Ramsar site designated for its physical, chemical and biological characteristics. The route also passes in proximity to the Glarryford ASSI (and area of importance designated for its deglacial landform assemblage).

80. The area located within the River Bann catchment is hydrologically connected to Bann Estuary SAC / ASSI designated for habitats and / species which are rare or threatened within a European context.

81. Therefore, qualifying features of these designated sites may be sensitive to potential changes in flow regimes or introduction of potential pollutants as a result of works associated with the proposed development. Details are outlined in the table below.

Technical Appendix 1.4 Table 1: Summary of Catchments along Proposed Cable Route

Catchment	Approx. cable length (km)	Approx. % of overall proposed cable route	NIEA WFD Status (2018)	Local Management Area	Catchment Stakeholder Group	River Basin District	Associated Protected Areas
Cloghmills Water	10 km	43.5%	Good	Braid and Main	Lower Neagh Bann	Neagh Bann	Lough Neagh ASSI / Lough Neagh & Lough Beg; Glarryford ASSI
River Main (Dunloy)	6 km	26%	Moderate	Braid and Main	Lower Neagh Bann	Neagh Bann	Lough Neagh ASSI / Lough Neagh & Lough Beg; Glarryford ASSI
River Main (Glarryford)	1 km	4.5%	Moderate	Braid and Main	Lower Neagh Bann	Neagh Bann	Lough Neagh ASSI / Lough Neagh & Lough Beg; Glarryford ASSI
Dunnstown Burn	1 km	4.5%	Good	Braid and Main	Lower Neagh Bann	Neagh Bann	Lough Neagh ASSI / Lough Neagh & Lough Beg
Culmore River	3.5 km	15%	Moderate	Lower Bann	Lower Neagh Bann	Neagh Bann	Bann Estuary SAC / ASSI
Lower River Bann (Kilrea)	1.5 km	6.5%	Moderate Ecological Potential	Lower Bann	Lower Neagh Bann	Neagh Bann	Bann Estuary SAC / ASSI

82. Review of NIEA Water Information online mapping did not identify any registered surface water abstractions in proximity to the proposed grid connection route.

83. Construction works associated with the proposed development (underground cable to a depth of 1.0 m) will follow the route of existing road corridors and cross watercourses via existing bridges and culverts. The cable routes affect no significant fluvial floodplains other than those contiguous with existing road bridges and culverts. The cable route will not further encroach into existing floodplains compared to existing conditions.

84. Similarly, during the operational phase of the proposed development, the cable route would by its nature (buried) have no effect on flooding by causing restrictions or disruption to flood flows.

85. While risk of flooding given the nature of the proposal is not deemed significant, the Applicant will take a precautionary approach and adopt appropriate measures to avoid earthworks becoming inundated and potentially transporting sediment off-site into the water environment. Measures may include, but not be limited to:

- Routinely checking weather warnings and planning for adverse weather conditions;
- Storing plant and materials in areas outside areas prone to flooding;
- Implementing temporary drainage systems to alleviate localised surface water flood risk and prevent surface water ingress to the construction working areas; and

- Prevent obstruction of existing surface runoff pathways.

86. The nature of the proposed development (underground cable) and the methods used to cross watercourses (i.e., within existing bridge decks or by directional drilling) would have no potential to affect watercourse morphology, and so potential for effects at watercourse crossings are not considered further.

87. Other effects associated with typical construction activities would be similar to those described in **Chapter 10: Geology and Water Environment** and would be solely associated with the construction phase. No operational effects are anticipated.

88. The following table summarises the potential surface and ground water constraints to development of the grid connection, as well as likely potential effects.

Technical Appendix 1.4 Table 2: Summary of Geology and Water Constraints and Effects

Baseline Characteristic / Summary Description		Receptor	Unmitigated Potential Effect	
Groundwater	Aquifers with moderate productivity and local flow.	Abstractions / Private Water Supplies in proximity to the proposed cable route.	Reduced Groundwater Quality	Limited potential for short term slight deteriorations in water quality due to excavations that would release sediments; use of mechanical plant with associated fuels and lubricants.
			Reduced Groundwater Quantity	Shallow excavations associated with cable laying would not be anticipated to cause any change in groundwater flow routes.
Surface Water	Waterbodies with current WFD status of "Moderate / MEP" to "Good".	Water feature crossings and works in proximity to water features.	Reduced water quality	All watercourse crossings coincide with existing road crossings and culverts; the cable will be laid within the road deck over the existing culvert, or via directional drilling under the watercourse. Methods will not cause requirement for any in-stream work or work that would directly affect watercourse morphology or cause potential for pollution of the watercourse.
			Changes to watercourse morphology	

Baseline Characteristic / Summary Description		Receptor	Unmitigated Potential Effect	
Surface Water	Floodplains	Route in proximity to discrete areas of fluvial and surface water floodplain.	Flood risk to the development	The cable route would by its nature (buried) be unaffected by flooding. Appropriate techniques to manage surface water around working areas would be implemented.
			Increased flood risk elsewhere	The cable route would by its nature (buried) have no effect on flooding by causing restrictions or disruption to flood flows.
Protected Areas	Waterbodies protected for species	Route in upper reaches of the River Bush / River Main catchment which is hydrologically connected to downstream protected areas designated for their flora, fauna, and / or geological features.	Reduced water quality	All watercourse crossings coincide with existing road crossings and culverts; the cable will be laid within the road deck over the existing culvert, or via directional drilling under the watercourse. Methods will not cause requirement for any in-stream work or work that would directly affect watercourse morphology or cause potential for pollution of the watercourse.
			Changes to watercourse morphology	

89. Mitigation to address potential deterioration of water quality (due to excavations, runoff from the works, and use of oils fuels and lubricants) associated with the types of construction activities anticipated shall be similarly addressed by the surface water management and pollution prevention measures stated in Chapter 10: Geology and Water Environment and accompanying Technical Appendix 10.1: Surface Water Management Plan.

90. Given the short duration of construction and limited localised areas of disturbance proposed during the construction of the grid connection route, it is considered that there would be no significant impacts on the water quality or flow of the surface water and groundwater, or on the use of groundwater by identified abstractions and water supplies provided the mitigation measures set out above are adopted.

Noise

91. During the construction phase, noise generating plant would be used and it is likely that noise levels would temporarily increase at residential properties within the vicinity of the construction works along the grid connection route.

92. Construction activities with the potential to generate noise from grid connection construction are likely to include clearance of land, digging of trenches and backfilling of trenches and remediation.

93. In Northern Ireland, advice on construction noise assessment is referred to in 'The Control of Noise (Codes of Practice for Construction and Open Sites) Order (Northern Ireland) 20022. This legislation advises the use of British Standard BS 5228: Part 1:1997 as being suitable for giving guidance on appropriate methods for minimising noise from construction and open sites in Northern Ireland.

94. Since the 1997 version has been superseded by British Standard BS 5228-1:2009 'Code of practice for noise and vibration control on construction and open sites - Part 1: Noise'3 this has been identified as being suitable for the purpose of giving guidance on appropriate methods for minimising noise from construction activities.

95. The ABC method described in Annex E of BS 5228-1:2009 sets threshold noise levels for specific periods based on the ambient noise level. Category A would be deemed appropriate due to the relatively low levels of ambient noise along the proposed route. This category sets minimum LAeq criteria of: 65 dB(A) during weekdays (0700-1900) and Saturdays (0700-1300); below 55 dB(A) at evenings and weekends; and below 45 dB(A) for night-time (2300-0700) periods.

96. Noise levels due to the construction of the grid connection route will be mitigated by the short-term nature of the activity but further mitigation including the installation of acoustic barriers or the restriction of working hours per day could also be considered, if required.

97. There are many strategies to reduce construction noise and any mitigation adopted should not be limited to the measures suggested.

98. The Pollution Control and Local Government (NI) Order 1978 provides information on the need for ensuring that best practicable means are employed to minimise noise4. For all activities, measures will be taken to reduce noise levels with due regard to practicality and cost.

99. With appropriate mitigation, if required, it is assessed that there will be no residual significant effects during the construction phase.

100. There are no anticipated effects during the operational phase.

[2] 'The Control of Noise (Codes of Practice for Construction and Open Sites) Order (Northern Ireland) 2002', The Department of the Environment, November 2002

[3] 'Code of Practice for Noise and vibration control on construction and open sites - Part 1: Noise', British Standards Institution, BS 5228-1:2009

[4] 'Pollution Control and Local Government (NI) Order 1978', published by Her Majesty's Stationary Office, 1978

Traffic and transport

101. All grid connection construction works should be undertaken in accordance with a Construction Method Statement and any associated road opening licences, agreements or permits. A Traffic Management Plan including details of any temporary road closures should be agreed with Transport NI prior to the commencement of works. The Traffic Management Plan should be developed to ensure any disruption during the underground cable works will be kept to a minimum. However, it is likely that there will be temporary, local traffic disruptions for the duration of the underground cable installation works.

102. It is expected that there will be some disruption to traffic flows along the carriageways flanking the proposed grid route that will be managed but some narrower routes (i.e. bridge crossings) may require temporary road closures.

103. No significant residual effects are anticipated to occur.

104. When installed, the underground cable will have no adverse effect upon traffic during the operational phase.

Summary

105. **Technical Appendix 1.4 - Table 3** provides a summary of the potential environmental effects and proposed mitigation.

Topic	Potential Construction Impacts	Potential Operational Impacts	Mitigation	Residual Effects
Landscape & Visual	Loss of landscape character and visual amenity	None	Avoidance of tree and hedge removal, as proposed, with the cable being placed under the carriageway where verge width is insufficient.	No significant impacts
Archaeology & Cultural Heritage	Negligible direct effects possible on HAGC44 and HAGC46	None	HAGC44 and HAGC46 to be signposted prior to construction works commencing to highlight their presence. A toolbox talk highlighting the presence of all identified historic features identified in this assessment to be delivered to contractors prior to construction work commencing. Maps showing the locations of all heritage assets and historical features identified in this	Following mitigation no residual effects are predicted

Topic	Potential Construction Impacts	Potential Operational Impacts	Mitigation	Residual Effects
			assessment should also be included on contractors plans and recognised in method statements.	
Vegetation & Terrestrial Fauna	Low quality habitat loss and disturbance. Disturbance to protected species from construction noise and habitat loss/disturbance.	None	Pre-construction surveys to identify areas of sensitive habitat which should be avoided. Pre-construction protected species to identify species or features supporting species along the route and allow the preparation of appropriate mitigation. Preparation of a construction method statement for the grid connection stating how impacts on protected species and habitats would be avoided. The use of an ECoW (Ecological Clerk of Works) during construction to ensure that all of the above measure is properly implemented. Tree roots will be protected by the implementation of BS5837:2005, where excavations will not be permitted inside the RPA (Root Protection Area). No spoil, vehicles, fuel, materials, temporary buildings or ancillary equipment shall be stored inside the RPA. Existing ground levels within the RPA should not be raised or lowered. It is not possible at this stage to completely rule out the need to remove small sections of hedgerow or trees but if this was	No significant impacts