Appendix 3.1

Fire Hazard Analysis Report

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Project Name: Herbata

Fire Hazard Analysis Report

Issue Log

Issue	**Date**	**Issue**
Rev 1	8th March 2023	Issued for Information
Rev 2	5th July 2023	General Updates Following Fire Officer Review
Rev 3	20th May 2024	General Updates Following Fire Officer Specialists Review
Rev 4	23rd July 2024	Issued for Planning

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1.0 Introduction

1.1 Introduction

This report has been prepared by the Project Design Team on behalf of Herbata Limited at the request of the Kildare County Council Fire officer for a site-specific hazard analysis for the proposals, setting out the risks and associated mitigating provisions associated with the current development and related technology.

The site is proposed to provide for six data centre buildings each with power generation and battery backup as is typical for most critical data centres both in Ireland and in many parts of the world. The components used in the data centre for power generation and power storage are similar to other data centres but are configured slightly differently to provide alternative electrical system topologies. Given that the components are similar, it is expected that the risks in terms of fire hazards are similar; the purpose of this report is to illustrate the similarity of these risks.

1.2 Site Location

As indicated in Figure 1 below, the subject lands are approximately 37ha in extent and are located on the western side of the M7 motorway, positioned between Junctions 9a and 10. The site is bound to the north by the R409 road which provides a direct link to the centre of Naas, c.2.5km to the east.

The lands are located between the existing 'M7 Business Park' and 'Osberstown Business Park'. The Osberstown Wastewater Treatment Plant is located nearby to the north. The site is bounded to the east by the M7 motorway and to the west by agricultural lands. The 'Newhall Retail Park' is located to the south of the site, on the east side of the M7 motorway.

Figure 1: Local Site Location Context Map (Source: Google Maps)

1.3 Development Description

The proposed development comprises 6 no. two storey data centre buildings, an administration / management building, car parking, landscaping, gas storage and gas turbines, energy storage and other associated works as shown in the proposed site layout see figure below:

- Site Area 37.5Ha
- 6no. Data centres
- Two storey buildings
- 7.5m highest floor above ground
- Buildings c.18m in height overall
- Building areas (approx.)
    - Admin space = 2,505 sqm
    - Data hall = 24,756 sqm
    - External yard (2 levels) = 3,082 sqm (per level)
    - Total Building area = 27,261sqm
- Separate administration / management building (indicated in orange below)

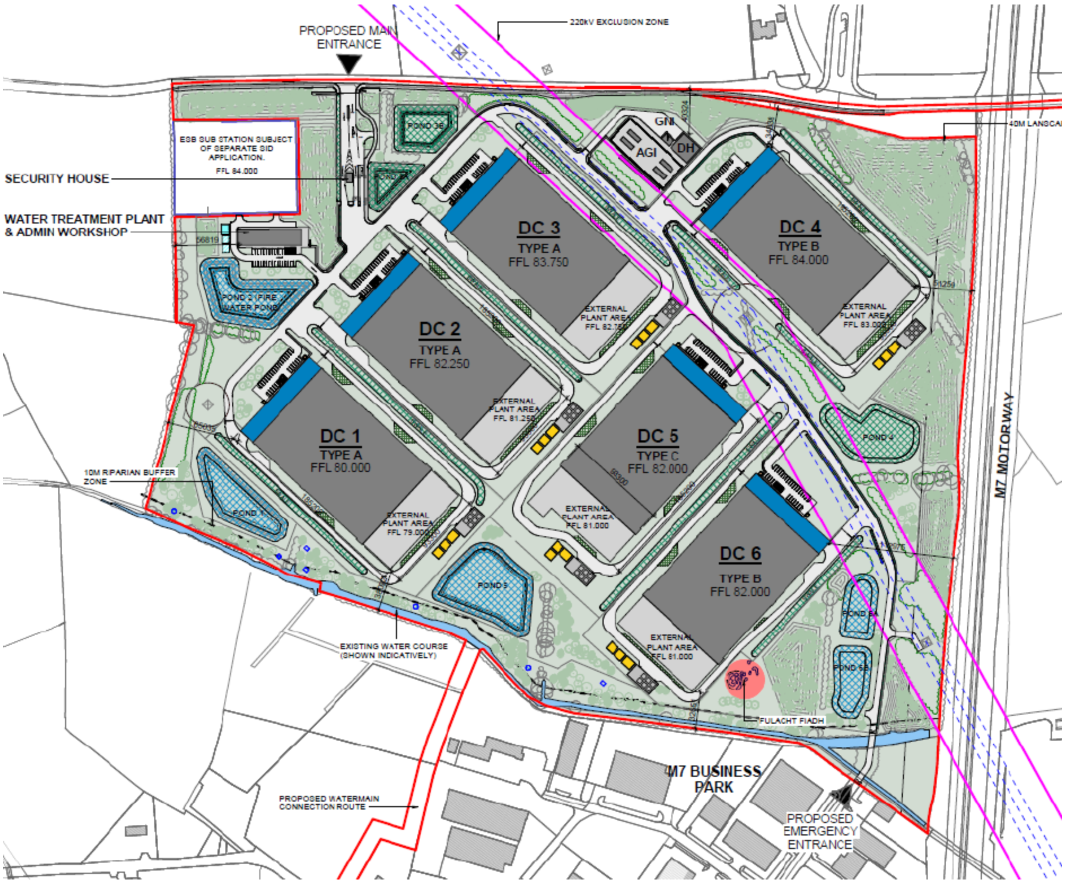


Figure 2: Proposed Development Site Plan

1.4 Building Overview

Each of the Data Centre buildings will comprise of 8no. data halls with an electrical capacity to support up to 30MW of IT equipment load in each building. Most of the electrical plant and equipment will be located externally in the adjoining compounds and will be of modular design. This plant will be adjacent to each building and be enclosed behind a louvred screen barrier with acoustic absorption on the inside face to a similar height to the main buildings. The opposite end of the data centre blocks will accommodate the end-user client's admin areas plus storage areas and the loading/receiving docks for the building.

The buildings will be steel framed with insulated metal faced cladding panels to the façade. The entrance area will have large, glazed windows. The roofs of the data centre buildings will be provided with a reflective finish to improve solar reflectivity and better sustainability.

1.4.1 Data Facility Centres and Industrial Buildings

The fire load will be relatively low in comparison to a typical industrial building, and therefore would not be considered high risk which could be in an assembly line premises manufacturing (e.g., car parts). The fire load within a typical industrial building is quite high due to the equipment used in manufacturing the parts (e.g. Welder Power Supply) and the presence of materials, which when ignited could cause the rapid-fire growth (e.g. gas cylinders). A typical example of this type of building is shown in Figure 3 below:

Figure 3: Typical Example of an Industrial Building

However, the proposed data centre buildings do not present the same risk of a fire occurring and developing when compared to another type of building, such as an office, industrial or a storage building. The proposed buildings will be used primarily for data storage and due to the sensitivity of the information stored will have high levels of management and security. The equipment located in the building will be monitored consistently by computers to ensure it is operating correctly and the presence of flammable materials strictly monitored due to the risks associated. In addition to this, sprinklers for property protection and an automatic fire detection and alarm system will be provided. A typical example of a Data Storage Facility is shown in Figure 4 below:

Figure 4: Typical Example of a Data Storage Facility

1.5 Primary Energy Source

The proposed data centre will have its primary source of power generation on-site. Generation of electricity is proposed on site using highly efficient large scale gas turbines for all power needs and backup power is provided by smaller gas reciprocating engine generators. This is in line with recent EU and Irish Government direction on the use of gas for generation as a transition fuel. It also avoids any negative impact from the proposed development on the public electricity distribution system and allows for any excess power to be exported to the grid to aid Eirgrid in their supply of electricity.

Whilst this site uses components for power generation, the difference here is that the plant is running continuously, however it is monitored constantly and rigorously, it is important to the data centre operator that the plant is running within normal limits and maintenance is carried out as prescribed by the manufacturers. To this end, the risk of mal-operation or failure is extremely low and the fire hazard similarly at a very low level.

The on-site power generation capacity will be greater than what is required for the operation of the campus and will provide an opportunity for the export of energy to the national grid.

Gas will be sourced from the Gas Networks Ireland (GNI) gas network. Above ground installation (AGI) compounds will be located on the site to allow connection to GNI's infrastructure. As a secondary source of fuel supply, it is intended that each building will have good quantities of HVO / diesel storage for the gas turbines with very small amounts of gas storage for the gas engines; these elements of storage will be located separate to each building and the overall aggregated weight of fuel storage will be lower than the Lower Tier of the Seveso III / COMAH regulations threshold.

1.6 Battery Energy Storage Systems

Each data centre building will have dedicated Battery Energy Storage Systems (BESS) for the purposes of providing uninterrupted and conditioned power to the critical building load. A typical module of BESS comprises various strings of batteries in cabinets adjacent to semiconductor power inverters and step-up transformers all housed externally. This arrangement is very similar to other data centres that have large systems of UPS and battery storage. UPS modules include semiconductor power rectifiers and inverters which then are connected by d.c. links to the battery storage usually contained internally. The fire hazard risk of these types of systems is seen as very similar and comparable.

The complete battery system will consist of several individual modules connected in parallel, with the total quantity of modules for each building as required to match the load of the data centre. Within each enclosure are rack mounted lithium iron phosphate battery modules connected to a DC bus. Rectification from AC to DC is achieved via an input inverter and conversion back to AC is achieved via an output inverter. This is identical to a UPS system provided in all data centres.

The battery enclosures include their own dedicated cooling and fire protection systems.

The storage capacity provides a back-up energy source and in addition adds resilience to the wider network, having the capacity to provide immediate export of energy to the national grid, or the capacity to store excess electricity generated externally, if required.

DC BUS Voltage Flow

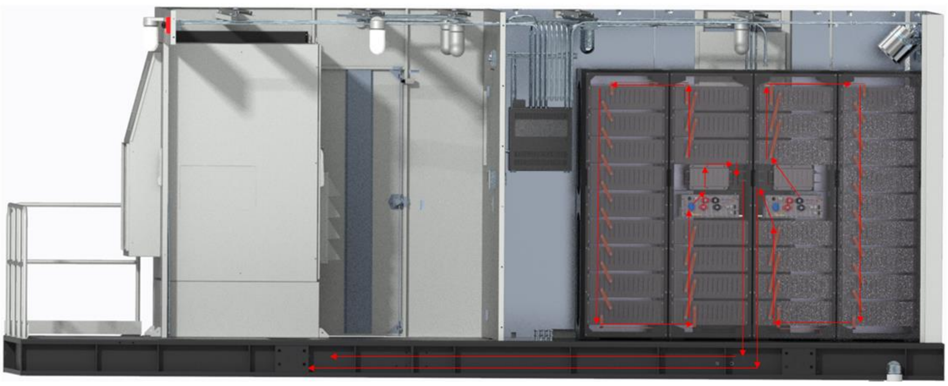


Figure 5: Internal View of a Typical Battery Energy Storage System

1.7 Site Operations

Data centres are considered mission critical infrastructure. Due to the importance of the facility and the requirement to remain operational 24 hours a day all year round. The campus and individual building will have a continuous presence as a result of the operation requirements. This allows for a quick response from the operational team to an emergency which could arise.

2.0 High level overview of fire strategy / site support

2.1 Goals and Objectives

The proposed fire strategy for the proposed buildings on site shall be developed to achieve compliance with Part B (Fire Safety) of the Second Schedule of the Building Regulations 1997-2014. All individual buildings will be subject to obtaining a fire safety certificate through the Building Control process (i.e., data centres, utility buildings, etc.), the fire safety certificate applications will demonstrate full compliance with Part B of the building regulations. External plant items shall be designed to achieve compliance with the Safety Health and Welfare at Work Act 2005.

2.2 Basis of Design

The guidance relating to buildings presented in this report is based on the recommendations of Technical Guidance Document B, 2006 (TGD-B) to the Building Regulations and associated Irish, British and European Standards (IS, BS and EN respectively) where applicable.

Basis of design set out below for the following elements :-

Element	**Basis of Design**
Buildings	TGD-B
Building Suppression systems	NFPA13
Building Fire alarm design	IS 3218 / EN 54
Batteries (BESS)	EN IEC62619:2022, EN IEC62485-5:2021/AC:2022
BESS Suppression System	UL 2775
Gas engines	IEC 88528-11:2004
Gas Turbines	EN ISO 21789:2022
Fuel Storage – Diesel Tanks	BS 799 or equivalent
Fuel Storage – CNG Cylinders	ISO 9809-1:2019
Low Voltage Directive	EN62477-1:2012/A12:2021 EN62479-2010 EN62311:2008
EMC Directive	EC62933-1:2018 IEC62933-5-2:2020 IEC62485-5:2020

Table 1: Basis of Design

2.3 Means of Escape from Data centre buildings

2.3.1 Location of Exits and Stairways

Location of protected stairways, exits and compartment lines have been based on achieving maximum travel distances set out in 1.2 of TGD-B, i.e.

Single Direction - 18m

More than one direction - 45m

A corridor network is proposed within each building providing access to all rooms. Larger rooms are provided with a minimum of two means of escape where required, affording access to separated or separate corridors. Corridors lead directly to storey/final exits at protected stairway locations. To this end, eight protected stairways are provided on the perimeter of the building.

Full compliance of means of escape requirements for the buildings shall be demonstrated within the fire safety certificate application for each individual building. See below Figure 6 and Figure 7 for full details.

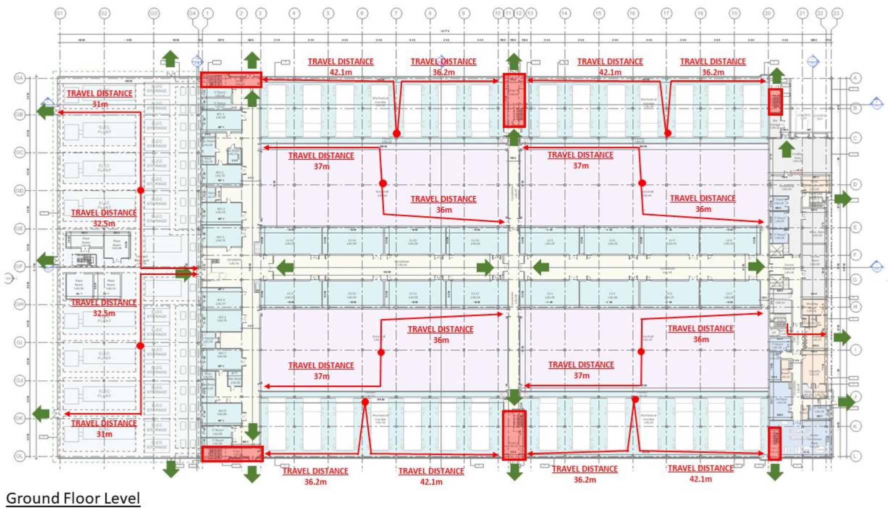


Figure 6: Ground Floor Travel Distances

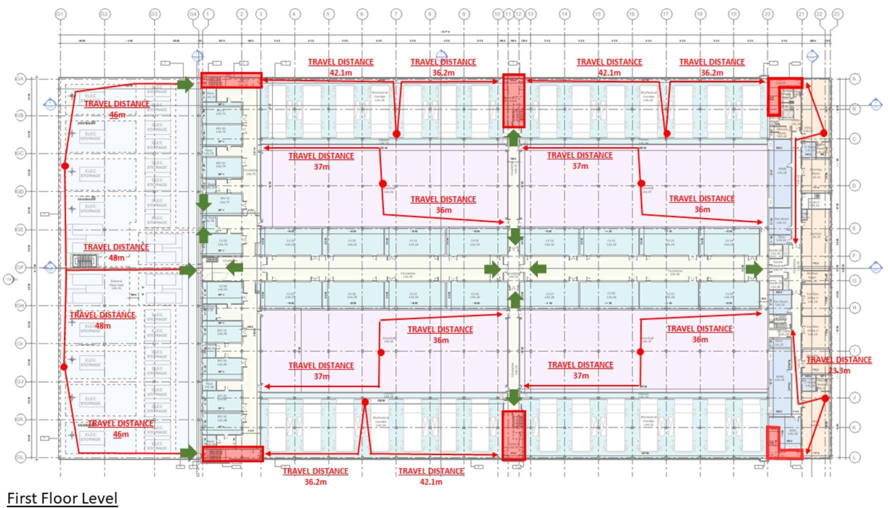


Figure 7: First Floor Travel Distances

2.3.2 Fire detection and alarm system

Each building shall be provided with a fire detection and alarm system to minimum category L2/L3 system to IS 3218. Sites are monitored 24/7 with on-site security staff that shall be trained in procedures on hearing a fire alarm or discovering a fire.

2.3.3 Evacuation strategy

While each building will not be heavily occupied, it is proposed to apply a total evacuation policy on a confirmed fire incident. Buildings shall be provided with a fire detection and alarm system to minimum category L2/L3 system to IS 3218. Sites are monitored 24/7 with on-site security staff that shall be trained in procedures on hearing a fire alarm or discovering a fire.

2.3.4 Escape from Plant Area Compound

The battery and generator containers are located externally to within a fenced area at the end of each data centre. The contents, hazards and provisions are dealt with in section 3.0 and 4.0 of this report. The compound contains generators/batteries containers at ground level with battery containers on a raised steel structure on an upper level. The steel structure forms an open external walkway providing access to the upper containers. Travel distances proposed are well within the levels for external spaces. Refer to Figure 6 and Figure 7 above.

2.4 Fire Service Access

The following section outlines the various TGD B access route provisions to facilitate the fire brigade's operations on the site in the event of a fire to the buildings. The site wide fire vehicle access routes have been assessed in accordance with the requirements of TGD B. As part of the design, fire vehicle access on site is provided using the traffic network as illustrated below. The following sections clearly outline the fire vehicle access route required for the buildings and plant items.

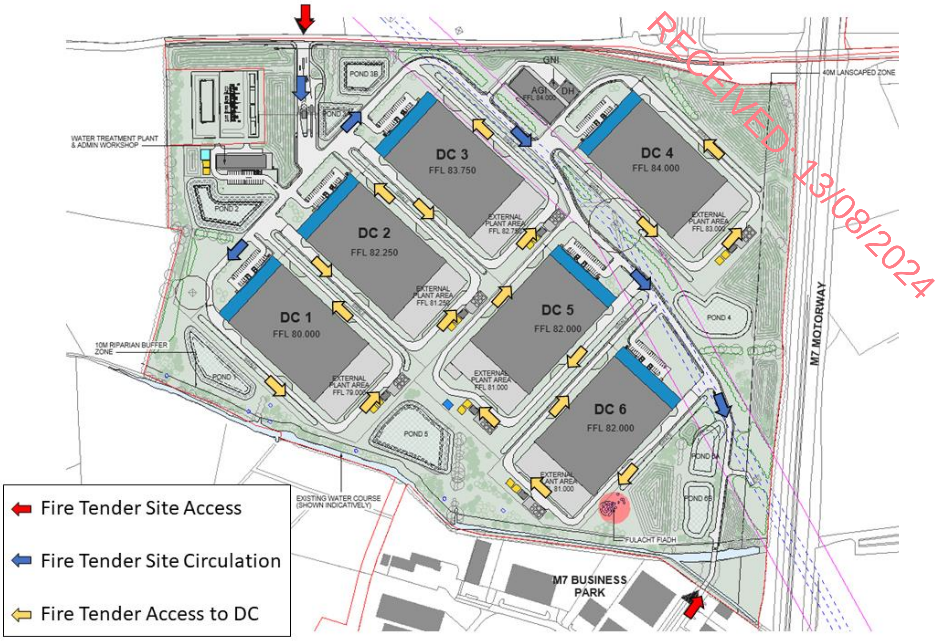


Figure 8: Proposed Site Plan – Fire Service Access

2.4.1 Extent of Access to Buildings

The following section outlines the extent of vehicle access required to new buildings. Please refer to Figure 8above which shows the proposed vehicle access route to meet the requirements.

In accordance with the TGD B fire brigade vehicle access depends on the building volume, height of the top storey above ground, and existence of internal fire mains. The following table outlines the extent of vehicle access required to each new building. It is noted that the top storey of all new buildings on site will be less than 10m above ground. Therefore, all access requirements noted in this section relate to pump appliances only and high reach appliances are not required.

Table 2 outlines fire vehicle access for proposed building.

Building	Volume (m^3)	Vehicle access Perimeter percentage required from Table 5.1 of TGD-	Vehicle access Perimeter percentage proposed
Individual data centres	217,890 approx.	100%	100%

Table 2: Fire Vehicle Access

2.4.2 Access to and within Plant Compounds

Figure 9 below sets out the access points to the external compound for the perimeter of the building. There are three separate access gates to the ground level area:

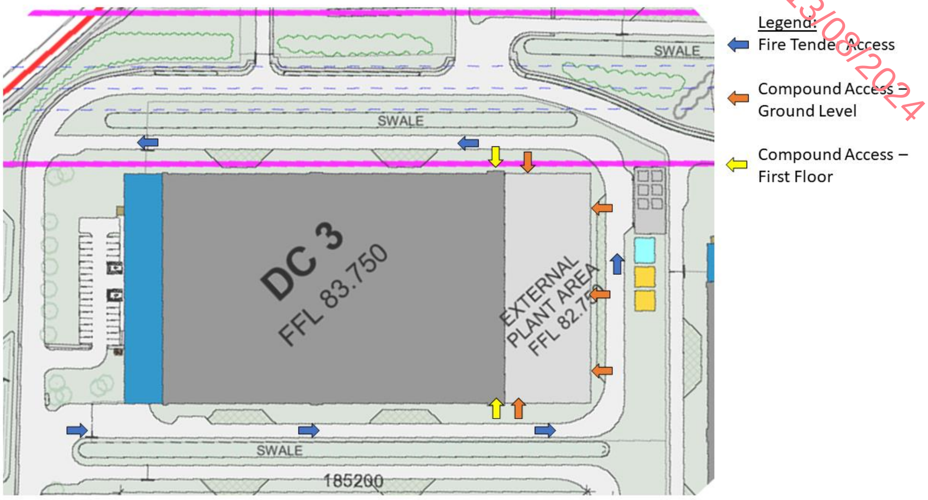


Figure 9: Compound Access Site Plan

Access to the upper level is provided via the stairs as indicated in Figure 10:

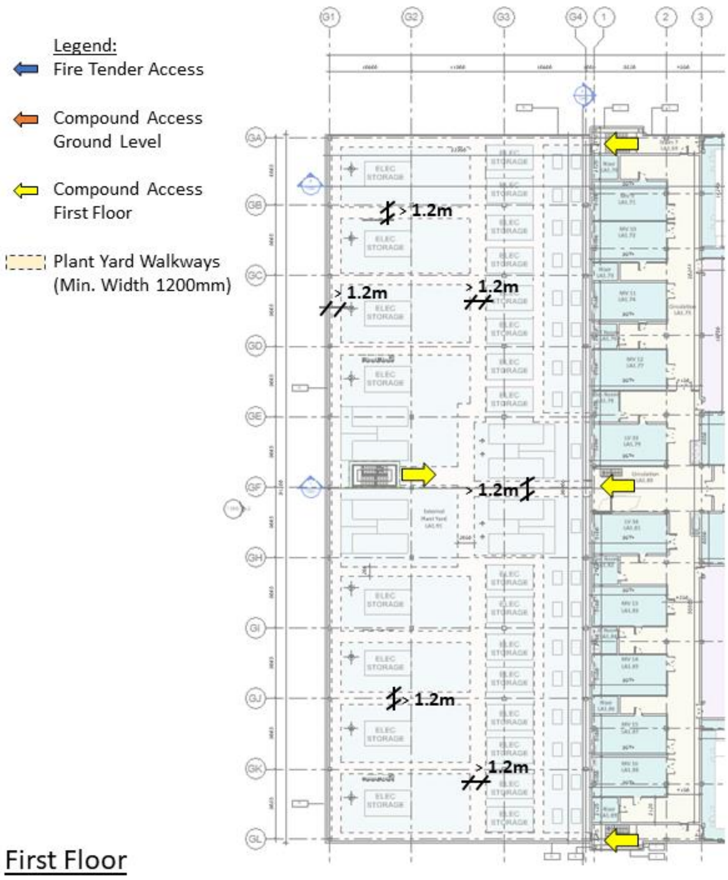


Figure 10: Compound Access

Access in and around the equipment with the compound is in line with TGD Part B as noted in 2.3.1 above.

2.4.3 Fire vehicle access route performance requirements.

Table 3 below outlines the fire vehicle access route design requirements for the proposed buildings.

Road width	3.7m minimum
Maximum distance to building/compound	18m
Road design	12.5 tonnes carrying capacity

Table 3: Vehicle Access Route Design

2.5 External Fire Spread

TGD B defines the following regarding external fire spread: *The external walls and roof of a building shall be so designed and constructed that they afford adequate resistance to the spread of fire to and from neighbouring buildings*. In accordance with TGD B adequate spacing should be provided between the buildings or alternatively parts of the façade need to be fire rated. The following sections outline the requirements for new buildings.

2.5.1 Space separation between buildings

To minimise the need for fire rating the façades, buildings can be spaced to prevent fire spread between one another. The BR187 methodology has been used to determine minimum separation distances for 100% unprotected areas on the external walls. The table opposite outlines the minimum separation distances needed for the façades to be unprotected. This separation distance is measured to the site boundary or notional boundary between buildings as indicated in the figure below. The notional boundary has been conservatively located halfway between all buildings, or to the halfway point of the adjacent road. The width and height relate to the maximum size of internal compartments encompassed with compartment walls or floors.

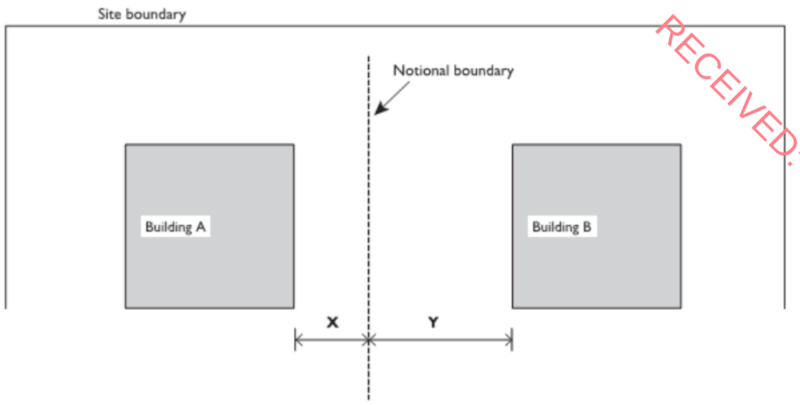


Figure 11: Extract from TGD B – Notional Boundary

Distance between buildings = circa 39m (19.5m to notional boundary)

Height x Width of maximum enclosing rectangle assuming first floor is a compartment floor = 9m high x 60m wide = 540m2. BR187 permits 90% of the enclosing rectangle to be unprotected. Area of unprotected façade = 59m x 7.5 = 443m2 (82% unprotected). Based on the above the space separation without fire resistance to external walls can be achieved. More details space separation calculations will be incorporated in the fire safety certificate application for each building.

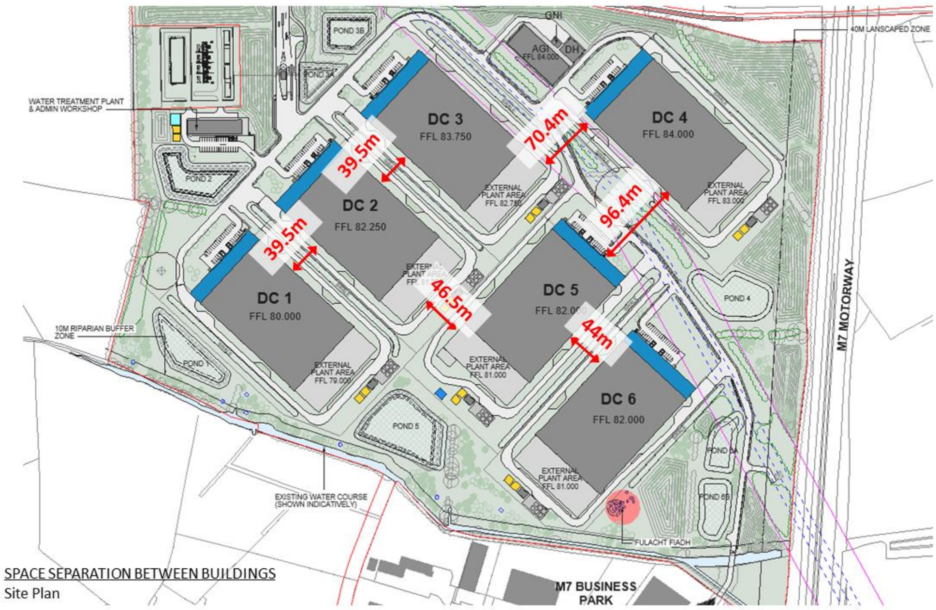


Figure 12: Proposed Site Plan – Building Separation

2.5.2 Separation between Building and Compound

The external wall facing the generator compound on each data centre shall be designed and constructed as a 2-hour fire resistant wall, achieving fire resistance from each side. This will prevent fire spread to or from the compound and the data centre building. Refer to Figure 13 and Figure 14.

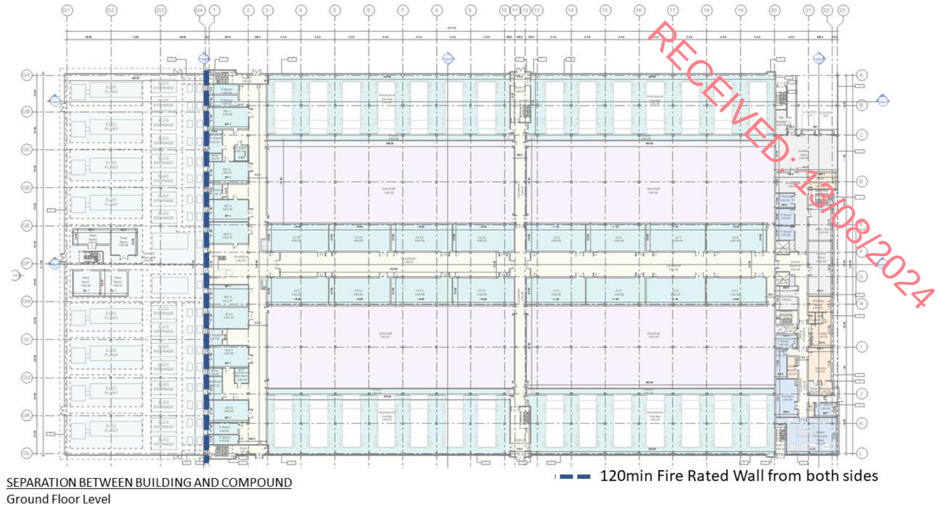


Figure 13: Ground Floor Fire Separation Between Building & External Compound

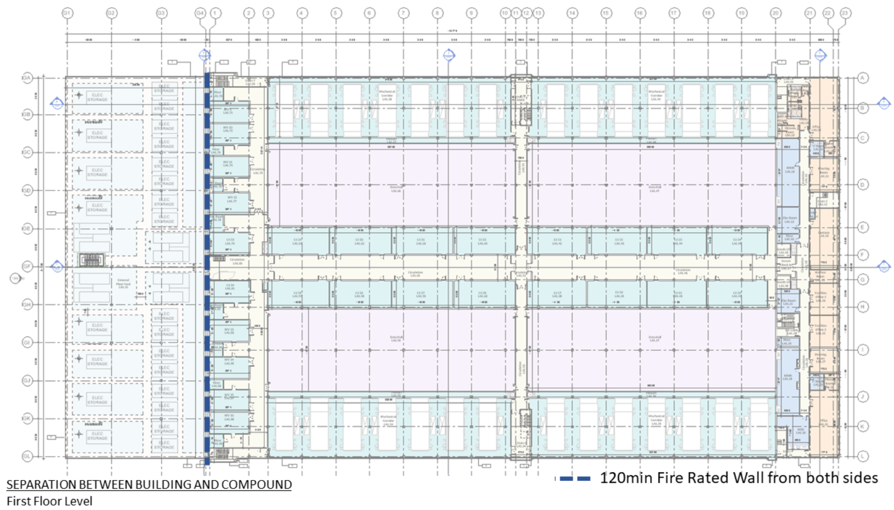


Figure 14: First Floor Fire Separation Between Building & External Compound

2.6 Internal Fire Spread (Compartmentation) and Fire Resistance

2.6.1 Compartmentation

Each data hall coupled with associated mechanical corridor (AHU's) within the buildings shall form separate compartments enclosed with compartment walls and floors where applicable. Additionally, all electrical rooms, risk plant rooms and relevant ancillary areas shall be separated and enclosed to form individual compartments with compartment floors and walls. The admin section of each building shall also be separated from the remainder of the data facility with compartment walls. Full details on internal spread provisions shall be contained within each fire safety certificate application for the buildings. See below typical floor plate showing proposed compartment lines proposed at this stage:

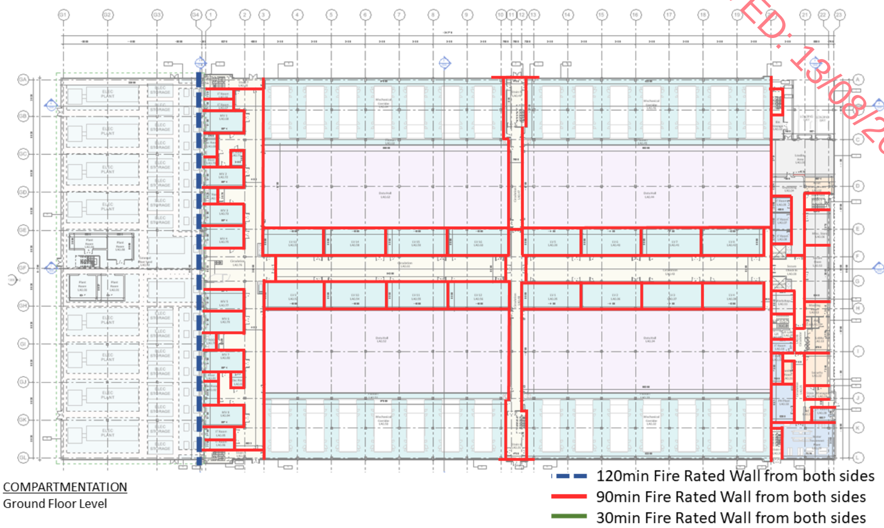


Figure 15: Typical Compartmentation Plan - Ground Floor

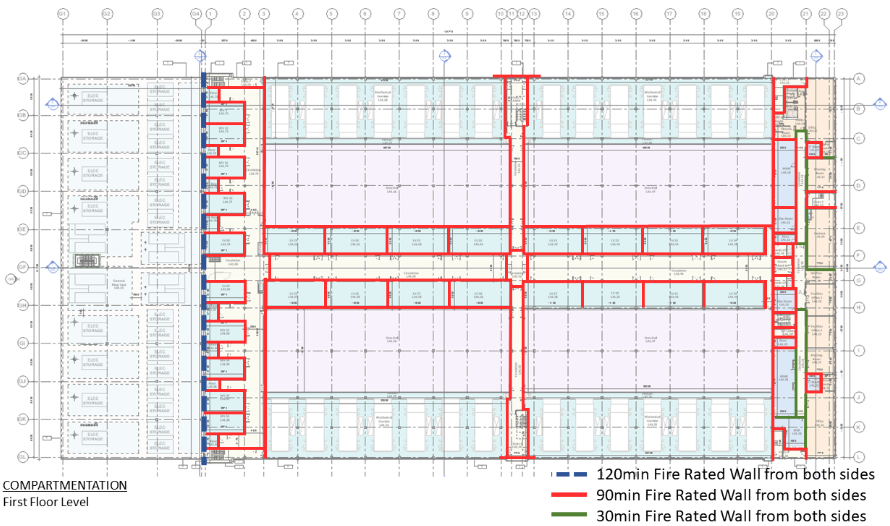


Figure 16: Typical Compartmentation Plan - First Floor

2.6.2 Fire Resistance of elements of Structure

Loadbearing elements of structure are to have fire resistance ratings in accordance with Appendix A and Tables A1 & A2 of TGD-B:2006+A1:2020 (I.e. floor >5m<20m) as follows:

Element	Fire resistance	Method of Exposure
Structural Frame required to be fire resistant	90 minutes fire resistance	Exposed faces
Compartment walls	90 minutes fire resistance	Each side separately
Stairway enclosures	90 minutes fire resistance	Each side separately
Load-bearing elements	90 minutes fire resistance	Each side separately
External walls facing generator/battery compound	120 minutes fire resistance	Each side separately

Table 4: Fire Resistance of Elements of Structure

2.7 Site Wide Fire Safety Systems

2.7.1 Hydrants

As the ground floor area of the buildings are more than 1,000m^2, hydrants are required. A single data centre has a proposed ground floor area of circa 13,450m^2, therefore a minimum of 14 fire hydrants shall be provided to the perimeter of each building located along access routes. Please refer to section 2.7.2 for details on water supply.

2.7.2 Fire Hydrant Water Supply

There is an existing Irish Water potable water supply running beneath the R409 in a 225mm dia. HDPE pipe. As indicated in the Irish Water utility map extract below. This pipe currently serves the Osberstown Industrial Park to the north of the application site with a 150mm dia. UPVC pipe.

Irish Water Web Map

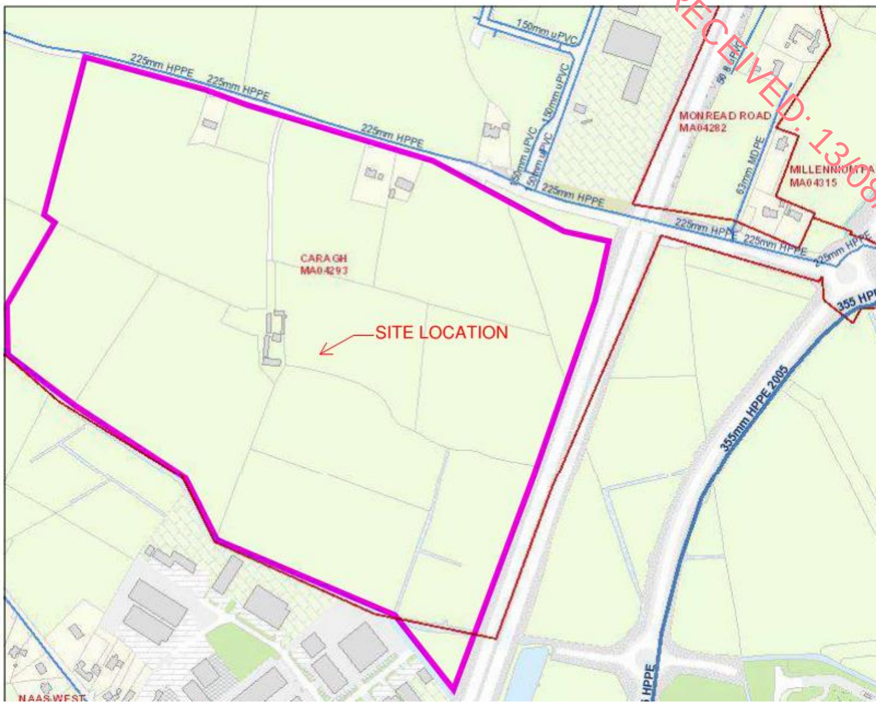


Figure 17: Extract from I.W. Utility Map

Pressure and flow monitoring tests were carried out on two no. Hydrants located at the entrance to the Osberstown Industrial Park (no. 1 & no. 2) and a further hydrant located within Millennium Park on the R445 ring road (no. 3). The tests indicated that the hydrants have the following available flows and pressures:

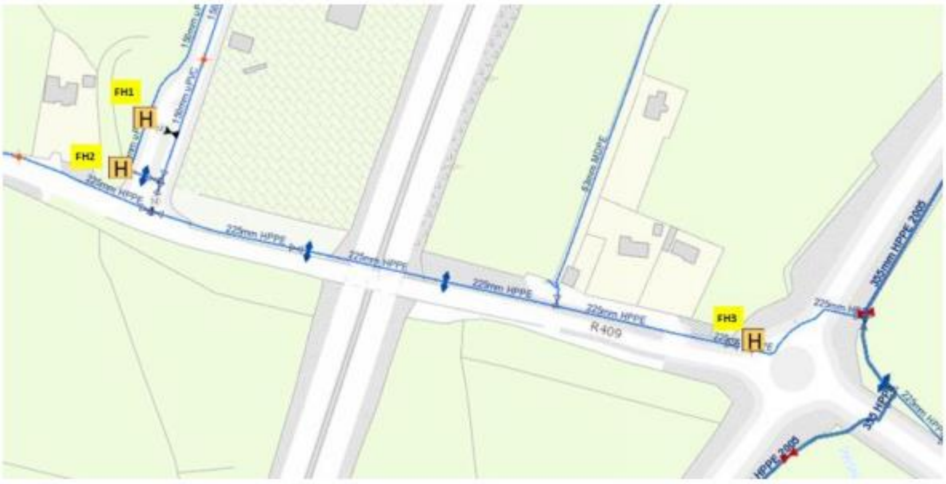


Figure 18: Pressure and Flow Monitoring Test Locations

FH No.	Flow Rate L/Min	Static Pressure (bar)	Residual Pressure (bar)
FH1	1300	3.5	2.8
FH2	1580	3.5	2.3
FH3	1697	4.0	3.2

Table 5: Extract from Hydrant Test Report

The tests carried out recorded a minimum delivery through a hydrant of 21.7l/s during the test. Initial discussions with the Fire Officer during the pre-planning consultations to date noted that the minimum delivery requirement would be 35l/s, however the actual requirement may exceed this level.

The Design Team have also carried out initial consultations with Irish Water regarding the potential of supplying water to the proposed development, including water for fire-fighting purposes. I.W. noted that in general they were not able to guarantee the delivery of sufficient water flow for fire-fighting purposes and that separate water storage should be designed for within the site for this purpose.

As the water supply cannot be guaranteed by I.W. there has been an allowance within the scheme for a site wide full capacity (360m3) hydrant tank and pump set allowing for 2 hydrants discharging in excess of 35 l/s at any one time for 60 minutes.

In addition to the static water storage tank that is to be located on the site a surplus volume of water for firefighting purposes is to be contained within Pond 2 on the site. This pond has a permanent retained volume of water that is fed by surface water run-off from the site. The water volume is below the overflow outlet level of the pond and the pond will be lined with a HDPE waterproof liner to ensure there is no water loss through infiltration. The volume of water retained within the pond is approximately 1,086m3 which is 3 times the volume of the static tank and will ensure sufficient backup water supply for firefighting purposes.

In terms of volume loss during extended dry periods, based on the figures provided by Met Eireann the maximum loss of water through evaporation recorded in recent years for the May, June, July and August periods are 145.7mm, 130.7mm, 134.1mm and 125.5mm respectively. Which can be calculated to 232m3, 209m3, 214m3 and 200m3 for Pond 2 (circa 18 – 21% of pond volume).

Evaporation (mm) for CASEMENT

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	D
2023	21.5	31.2	52.7	80.9	125.8	95.8						
2022	17.1	32.7	65.6	85.1	121.9	128.7	134.1	125.5	64.6	46.8	25.1	14
2021	15.2	36.9	56.1	83.4	111.2	130.7	129.3	93.9	64.2	42.7	18.0	15
2020	22.0	33.2	58.0	89.8	145.7	107.7	112.4	90.2	67.8	40.2	20.5	14
LTA	21.7	32.4	52.9	78.9	105.8	115.9	114.7	96.3	67.6	39.4	21.3	17

Figure 199: Record of Evaporation rates from Met Eireann

During the same periods the lowest rainfall recorded is give as 10.7mm, 17.8mm, 40.4mm and 18.7mm. The total volume of runoff entering Pond 2 from its catchment area (43,430m2 equivalent impermeable area) is 464m3, 773m3, 1,754m3, 812m3. Therefore, based on historical records, the volume of surface water runoff entering Pond 2 during a given month is significantly larger than the volume lost through evaporation. Therefore, it is considered that the proposed backup supply of firefighting water is sufficient to serve the requirements of the development.

Total rainfall in millimetres for CASEMENT

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov
2023	52.1	15.7	109.3	67.3	24.3	29.3					
2022	21.0	99.3	40.1	46.9	59.6	78.3	40.4	18.7	119.2	100.6	51.9
2021	95.8	69.7	29.6	17.9	112.7	17.8	94.0	47.3	42.1	77.2	16.4
2020	49.3	155.4	32.5	19.3	10.7	87.0	114.4	85.1	48.1	81.7	58.6
LTA	63.8	48.5	50.7	51.9	59.1	62.5	54.2	72.3	60.3	81.6	73.7

Figure 20: Record of rainfall rates from Met Eireann

The maximum level difference from the bottom of the pond to the adjacent road is 3.45m (+77.750m to +81.200m).

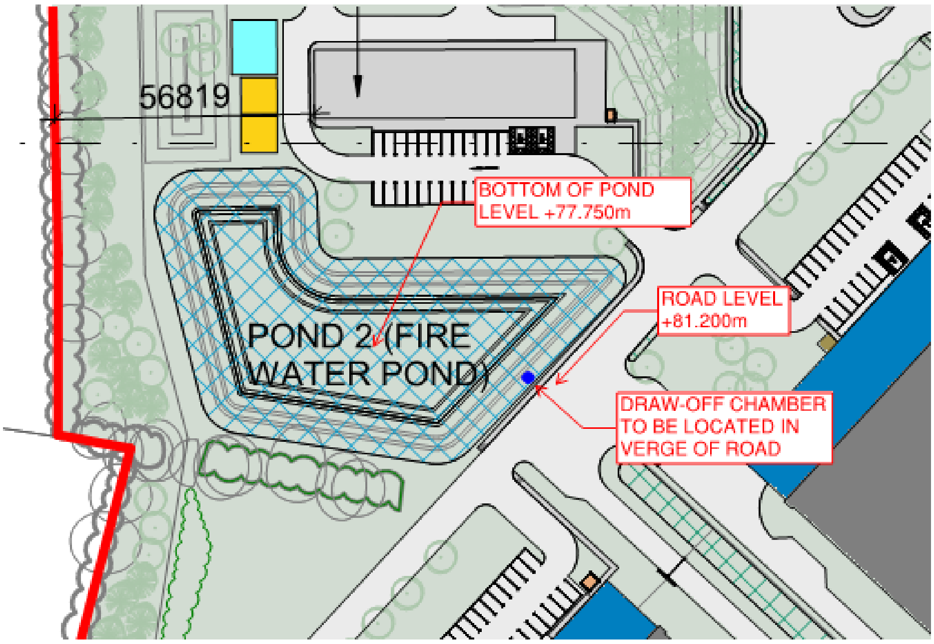


Figure 21: Extract from Site Layout Indicating Fire Pond Location

2.8 Sprinklers to Data Centre Buildings

An automatic sprinkler system will be provided within each data area of the buildings for property protection purposes. The proposed sprinkler system will be designed to control and limit the size of any fire within the buildings. The sprinkler system will comply with NFPA 13:2013 and will be appropriate for the use in question i.e. data facility centre. Data halls and key plant areas will be fitted with pre-action sprinklers in order to mitigate accidental head damage; each pre-action system will be linked to the fire detection and alarm system to provide 1st and 2nd knock alert and alarm status to each pre-action system. This is a conventional and typical arrangement in most data centres protected by sprinklers.

2.9 Proposed Technology

As noted previously, the critical pieces of electrical infrastructure that provide the primary and backup power to each data centre are these within these three systems:

- Battery Energy Storage Systems (BESS)
- Gas Turbines (running on gas, with HVO/diesel as secondary)
- Gas Engines (running on gas, with gas as secondary)

All of these technologies are well known in the power and data centre industry, they are all well established technologies and used in many different sites and for many different uses both on land and in the marine sector.

Battery Energy Storage Systems (BESS)

The Battery Energy Storage Systems (BESS) are identical to industry standard UPS (Uninterruptible Power Supply) systems that are provided as part of almost all data centres in Ireland and throughout the world.

UPS systems consist of electrical equipment that allow switch over to a battery backup system when an outage occurs on the primary power source. These systems are critical to any data centre facility to ensure power is not lost to the final loads.

In this application, the UPS systems are factory assembled in containerised enclosures which enable efficient off-site manufacturing, assembly, testing and commissioning to allow a “plug-n-play" installation on site during the initial construction & future deployment phases.

Gas Turbines

Gas Turbines will be installed locally at each of the six data centre buildings and provide the primary power at each building. Gas is piped underground to each building and will operate the turbines 24/7 to provide power.

The systems proposed are industry standard power generation turbine equipment and solutions are available from multiple manufacturers for this specific application. They operate on a gas supply.

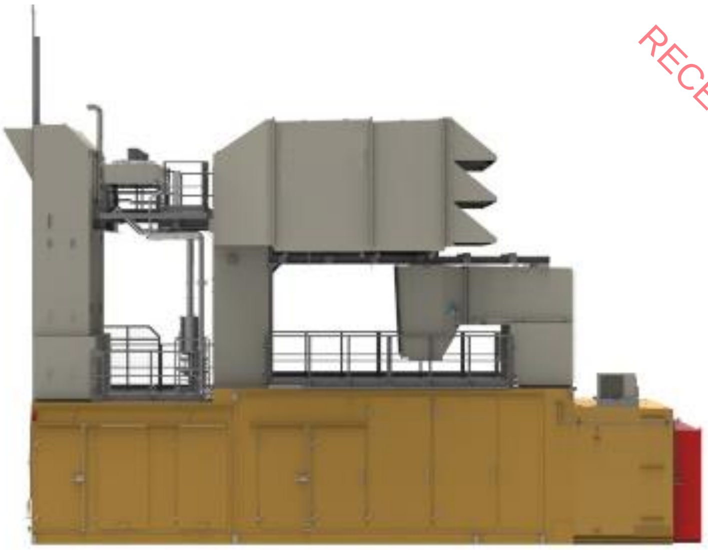


Figure 22: Typical Gas Turbine

3.0 Batteries / BESS

3.1 Introduction

The proposed batteries for the battery energy storage systems (BESS) are similar in technology and format to that used for UPS systems commonly found in data centres to date. The only difference is that BESS does not include a rectifier stage, instead it uses bi-direction inverters to allow power to be drawn from the batteries and to charge the batteries.

This document is provided to present the basic fire-related contingencies of the battery-based energy storage system and protection systems designed to support fire mitigation response.

The battery energy storage system (BESS) based on the LiFePO4 (LFP) chemistry, considered among the safest of high energy storage. The significant safety advantage of LFP is widely accepted among battery experts. An example is the magazine article found in Nature Energy 6, 176-185 (2021), "Thermally modulated lithium iron phosphate batteries for mass-market electric vehicles." In the UK document, FIA Guidance on Li Ion Battery Fires, reference of page 5 graph shows the K2 Energy battery (LFP) with the lowest thermal spike during abuse test. In fact, the high-profile battery fire incidents are Li Ion chemistries using Cobalt in the cathode, not LFP chemistries. Refer to Appendix 4 for this report details.

3.2 Potential for Thermal Runaway

All batteries store and release electrical energy through electrochemical reactions. When a battery purposely discharges electrical energy, ions move from one electrode to the other through a liquid medium called electrolyte. If during this process the battery undergoes some stress, e.g., an internal short, abnormal heat, etc., the cobalt present in the cathode can release fire-sustaining oxygen. This can result in "thermal runaway", which is a heat generating reaction that is greater than the ability of a battery cell to release. The LFP battery does not use Cobalt, greatly reducing the risk of fire ignition or propagation.

As referenced by Zhenpo Wang et al in "Overcharge-to-thermal-runaway behaviour and safety assessment of commercial lithium-ion cells with different cathode materials: A comparison study," (Journal of Energy Chemistry), the severity of thermal runaway hazards were greatest for cobalt-based Li-Ion while the LFP was the least severe. The thermal runaway risk for LFP cathode material is higher but the resulting hazard score of LFP less than 0.35 (compared to >1 otherwise). No explosions during LFP testing, only low-level gas release. In other words, the possibility of thermal runaway exists in all Li-Ion chemistries, with the LFP type of Li-Ion cell showing a safe outcome post thermal event.

LFP is thermally and chemically stable, making it less prone to explosions or fires due to misuse or structural damage. In lithium cobalt oxide batteries, thermal runaway can result from the omission of the cobalt with its negative temperature coefficient.

LFP is said to emit a sixth of the heat of nickel-rich NMC. The Co-O bond is also stronger in LFP batteries, so if short-circuited or overheated, oxygen atoms are released more slowly. What's more, no lithium remains in fully charged cells, making them highly resistant during oxygen loss compared to the exothermic reactions typical of other lithium cells.

3.3 Fire Detection and Protection Measures

Both active and passive fire protection measures have been considered in the design of the BESS enclosures and how they are positioned at each data centre building. Passive fire protection measures consist of physical separation and barriers between the battery compartments and other components within the electrical plant, as well as separation and compartmentalization from the occupied areas of each data centre building. Each BESS enclosure has a separate room to house the batteries with a wall separating the battery room from other components of the BESS system.

The active fire protection measures use a dual stage approach. The first stage is early intervention through the use of a battery management system (BMS). The primary function of the BMS is to monitor and prevent damage to the battery cells from over-charging and over-discharging. If the BMS detects an abnormal condition, the affected battery or group of batteries can be shutdown before it reaches a point where it becomes a safety hazard.

The second stage of active fire protection is a fire detection and suppression system within the BESS enclosure. This measure is necessary to detect and suppress a fire should the BMS system fail to recognize an abnormal condition or does not respond as designed.

Note that gas detection here is not necessary as the high temperature events will drive the gas pressure release from cells.

Each data centre building will have its own independent set of fire detection systems and fire protection systems all monitored locally and remotely on a manned monitored 24/7/365 basis.

3.4 Battery Enclosure Construction

The BESS system enclosure compartmentalizes the batteries and provides the passive fire protection described above. It is constructed of carbon steel wall, roof and floor panels mounted to a carbon steel support structure. The wall panels are 1.5mm thick and are finished with exterior grade powder coat paint suitable for exterior steel enclosures. The powder coat of the BESS exterior is a TGCIC-based polymer, which is a stable and environmentally friendly coating.

The wall panels are insulated with “H” series 3M foam, with a –40C to 107C rating. Internally, the thermal insulation system is H series SM foam with a high R-value. Internal insulating structures have the HB rating where applicable (self-extinguishing). Gaskets and wiring insulation have been respectively selected for withstanding temperatures matching the fire detection and suppression system.

The frame of the enclosure is carbon steel, able to withstand high temperatures (up to about 540°C) which is far below peak thermal runaway of LFP battery system.

All ferrous metal parts are protected against corrosion by painting, plating or the equivalent.

3.5 Battery Management System

The simplest and earliest intervention and first line of defence in active fire protection is effective battery management. A battery management system's (BMS) main role is to prevent damage to the battery cells from over-charging and over-discharging. The BMS also:

1. Calculates the charge remaining on the battery
2. Monitors the temperature of the batteries
3. Monitors for shorts and faulty connections
4. Maintains the charge within the cells in the optimal performance range

If the BMS detects any abnormal conditions, it shuts the battery system down, protecting the cells from damage and before a safety hazard is created. All monitoring is done in real-time and is viewed remotely and continuously.

3.5.1 Protection and Suppression

The second line of defence for a properly operating battery system will include the design of a fire protection safety system. The FIA Guidance on Li Ion Battery Fires separates this coordination in 3 parts:

- Protection
- Detection
- Suppression and extinguishing

These three points are considered in the design of the fire protection system.

Protection

The protection system slows or even stops the propagation of increased temperatures. In the case of LFP chemistries, thermal propagation is recommended to be maintained below the ignition temperature of the cell (270°C).

Thermal runaway temperature must also be avoided (270°C). Thermal runaway is defined as a heat-generating reaction that is greater than the ability of a cell to release the heat. An internally initiated thermal runaway event was tested for UL9540A certification. During the test, thermal runaway did not induce a chain reaction from cell to cell or to other modules. The temperature observed was not greater than 450°C. No explosion or flame events were observed.

A protection system should also provide a method of safely releasing off-gassing from extreme thermal events. Summary of the UL9540A testing shows the measurable gas concentrations:

- Carbon Dioxide (CO_2)

- Carbon Monoxide (CO)
- Hydrogen (H_2)
- Unburned Hydro-Carbons (UHCs)

<u>Suppression and extinguishing</u>

Test data ensures the design of the containment system is effective. The BESS suppression and containment system uses a condensed aerosol system using ionized potassium particles.

The internal fuses will break electrical current on high current and temperature. The fire suppression will release on detection of high temperatures.

The sequence of operations for the detection and suppression system is as follows:

- Upon activation of (one) smoke detector, the system will go into alarm, shutdown the HVAC system, activate the audible and visual appliances on the exterior of the unit and transmit notification to the building fire alarm system.
- Upon activation of a second smoke detector, the system will activate the “ready to discharge” audible and visual signals on the appliances and begin a 30 second countdown.
- Unless manually aborted, the fire suppression system will discharge after the 30 second countdown has expired.

Figure 23: Fire Suppression Discharge Cannister

Figure 24: Example Showing Discharge of Suppression Agent

3.6 Ventilation

Ventilation is possible through the air handling system of the BESS HVAC. Under normal operations, warm ambient air from the BESS enclosure is returned to the HVAC units, cooled and supplied to the enclosure, maintaining normal operating temperatures within the BESS. Filtered ambient air is supplied for makeup to the unit. Each BESS unit has two units and operate as lead-lag. One unit alone is sufficient to meet the cooling demands of the enclosure. See the air-flow diagram below.

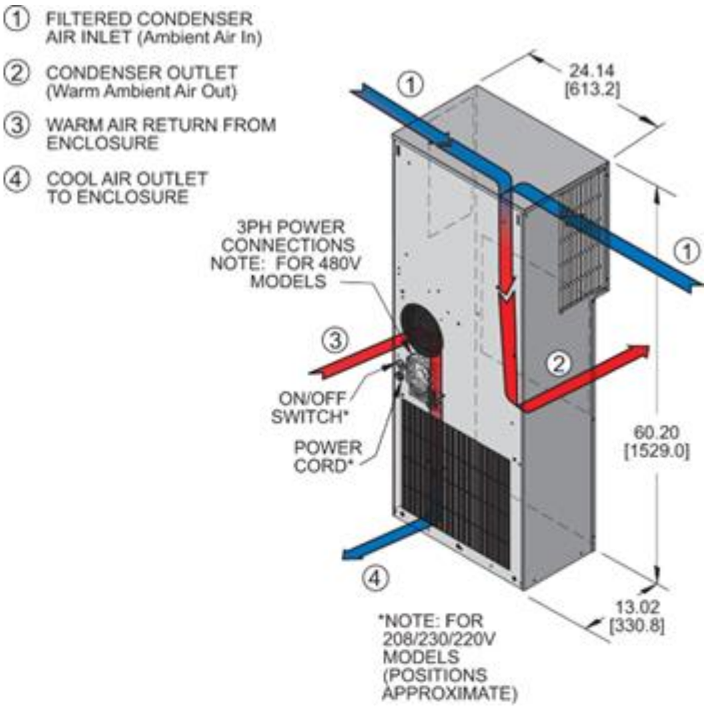


Figure 25: BESS System Air Flow Diagram

It should be noted that the batteries for the BESS or ESS are in a separate compartment to the inverters, charging components and control systems, which are mechanically ventilated by pulling in air from outside through louvres and then discharging the air using extract fans.

3.7 Hazard Mitigation Analysis and Risk Assessment

It is important to review the proposed battery energy storage systems against relevant and up to date standards and codes. The fire safety standard, NFPA 855, is recognised as such a standard and a review has been carried out against the various key elements as identified below:

Aggregate Capacity of the BESS

The NFPA standard includes Table 1.3 on Aggregate Capacity of the BESS for various types of battery types. For generic Lithium-Ion batteries, the max aggregate capacity is 72MJ; it has been confirmed that each building will exceed this capacity and so the NFPA standard 855 will be applicable.

BESS Testing and Certification

The proposed battery block types in each of the battery enclosures are of two different types, tested to UL1973 and UL9540 for the smaller and larger battery offerings respectively. The cover sheets for these tests are included in Appendices 7 and 8 respectively; these are only included as cover sheets or more formally as "Final Authorization to Mark" as the full test reports often contain sensitive commercial information and so are not normally shared externally.

ESS Maximum Stored Energy

Within NFPA 855 there is definition in Table 9.4.1 of the maximum stored energy per BESS unit; for Lithium-Ion batteries this value is 600kWh. Above this value, the Standard recommends that additional measures are presented to the AHJ (local authority). The proposed two types of batteries have maximum energy capacities of 95kWh and 330kWh for the UL1973 and UL9540 test types respectively. As these are both smaller that the limit in the Standard, then no special measures are proposed.

Hazard Mitigation Analysis (HMA)

Within the NFPA 855 standard, Section 4.4 discusses the need for a Hazard Mitigation Analysis to be carried out, given the size of the proposed aggregate capacity of the battery, it was considered appropriate to carry out such an analysis. Section 4.4 and relevant paragraphs are included in Appendix 4 for reference, to carry out such an analysis, reference is made to using a Failure Mode Effects Analysis (FMEA) often used to determine the impacts of failure and mitigations. Appendix 6 provides such an HMA for this project citing a range of elements that could cause failure and what their effects and mitigation are in response. In support of Appendix 6, also provided are the UL top summary test sheets in Appendices 7 and 8, as noted earlier, for the proposed ESS units together with a generic toxicology statement for the proposed Lithium Iron Phosphate batteries in Appendix 9. A RAG review is provided, none of the items is deemed to be a Red item.

4.0 Generators / Turbine

4.1 Introduction

The power systems to each building will be based on gas powered generation systems for primary and backup systems, as follows:

- Gas Turbines – primary power generation
- Gas Generators – backup power generation

Gas Turbines

The gas turbines will provide primary power to each building and each unit will be located in a separate enclosure positioned in the external plant compound adjacent to each building.

Approximately eight (8) gas turbines will be provided to serve all the power needs for a single building. The primary fuel source for the turbines will be gas derived from Gas Networks Ireland (GNI) and piped underground. For backup purposes, a secondary fuel system will be installed for the (unlikely) event that the GNI gas network becomes unavailable. The fuel will be either diesel or HVO (hydrotreated vegetable oil) and will be stored in an above ground tank system located separately to each building.

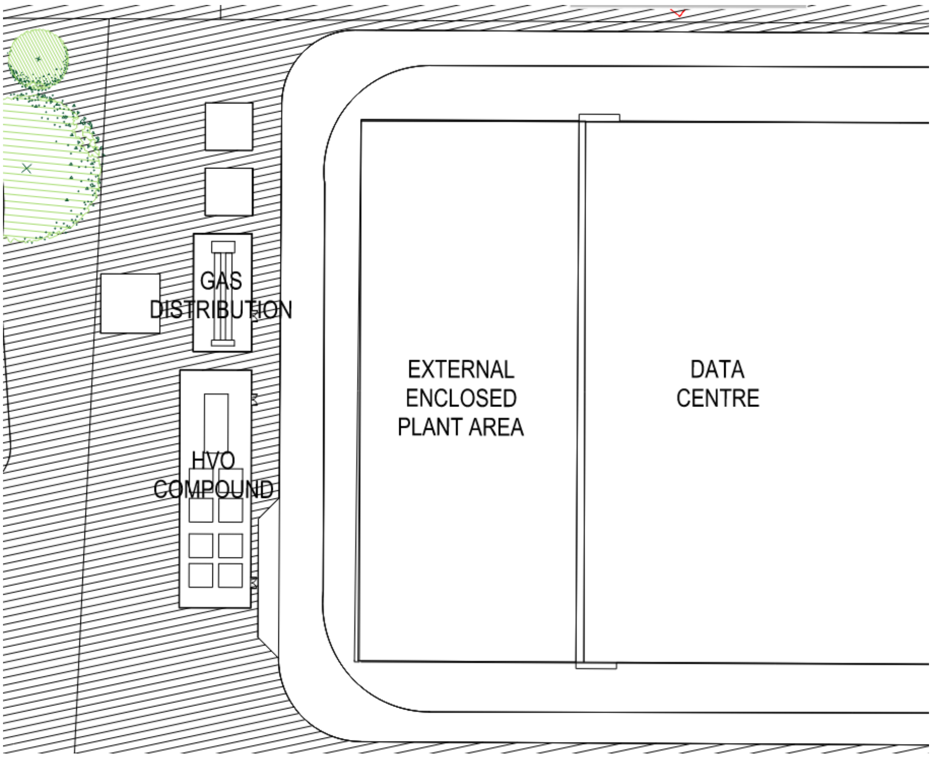


Figure 26: Typical DC building with HVO compound located separately.

Gas Generators

A number of smaller gas generators are provided as backup for situations when 1 or 2 of the main turbines are unavailable. The main turbines could be rendered unavailable due to planned maintenance or an unplanned system or component failure.

Each generator is located in containers located in the external plant area and will only operate when a main turbine is unavailable as their primary purpose is to operate as backup only.

The generators are standard internal combustion backup generators as used in any typical data centre facility provided in Ireland and throughout the world. The primary power for these engines will be gas with diesel / HVO also available as backup to the gas network.

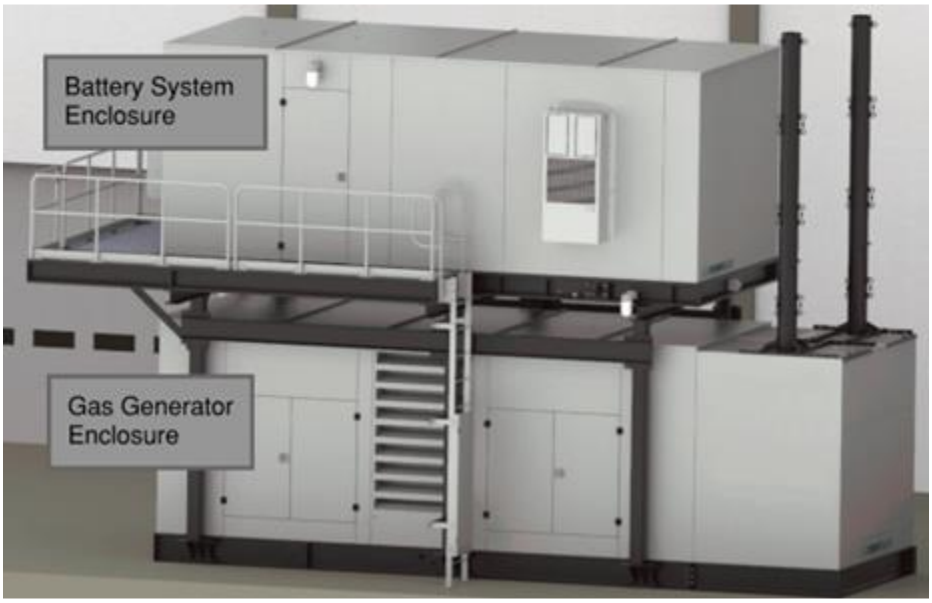


Figure 27: Typical Combines Gas Generator + Battery System Enclosures

Fire and gas monitoring and detection are managed by a separate control system within each turbine enclosure. It consists of a control unit, a local operating network and a number of sensors of different types that detect the presence of combustible gas, excessive heat, or flame. The detection of combustible gas concentrations above certain established levels generates an alarm or a package shutdown as appropriate. The detection of fire or excessive heat results in the immediate shutdown of the package and activation of the fire suppression system using carbon dioxide (CO2) as the extinguishing agent.

4.2 Fuel

As noted previously, the proposed turbines and engines will normally be run using natural gas as provided via AGI by Gas Networks Ireland (GNI). As is typical for critical data centres there is a requirement to provide typically 48 hours of fuel on a site in the event of the primary fuel (in this case GNI's gas supply) being lost. For the secondary fuel, it has been recognised that storing diesel, which is much more inert and much less explosive than natural gas, would be best to be used as the stored fuel on the site. Consideration has been given as to whether the gas turbines and gas engines could be used with diesel as their back up fuels. The output of this consideration is shown below:

Generator Type	Diesel as Secondary Fuel?	Comments
Turbine	Yes	Diesel can be atomised as it is introduced into the turbine and give normal running.
Engine	No	Reciprocating gas engines require a combination of compression and spark ignition, similar to that of a petrol engine. If diesel were to be used instead then the engine would not compress the fuel to provide ignition.

Table 6: Secondary Fuel Assessment

As can be seen from the table above, gas turbines can have diesel as a back-up fuel, but gas engines cannot.

Based on these results, an assessment has been made on the combination of using diesel for the turbines and gas for the engines, noting that in order to keep below the Seveso III (COMAH) Lower Tier level, care will have to be taken on the amount of gas storage used. The output of calculations is contained in an Appendix 3 and relates to the use of diesel and natural gas for storage, the output of which can be summarised as follows in

Table *7*:

Fuel Storage Type	Used to support which technology	Total Capacity of Power Units (MW)	Proposed Hours of Storage	Aggregation result (calculation)
Diesel (or HVO)	Turbines	201MW	40 hours	0.9427
Natural Gas (as CNG or LNG)	Engines	30MW	2 hours	0.9842

Table 7: Seveso Lower Tier Assessment

Seveso Lower Tier Assessment (both must be <1)

In terms of fire hazard and risk, by keeping below the Seveso III Lower Tier level, then the overall site risk is therefore more allied to a normal commercial building development.

Containment

Both turbines and generators are fully enclosed / containerised equipment. The enclosure has in-built bund system that can fully contain all liquids within the enclosure should a leak occur.

Every enclosure will be provided with leak detection systems that alarm to a central Building Management System that is monitored 24/7.

4.3 Fire Protection Measures

The following section outlines the fire detection and suppression or protection measures that are intended for each building as they are brought online.

4.3.1 Detection

Each building will be provided with fire detection and system using a combination of point heat and smoke detectors, High Speed Sampling Detection (HSSD) units and manual call points all to national and local fire codes. All of the devices will be connected into multiple monitored detection loops back to an analogue addressable networked fire detection and alarm panels complying with EN54.

Each fire detection and alarm system will be programmed with an agreed cause and effect matrix identifying all of the conditions under which alarms are given, shutdowns are enacted (e.g. non data hall fresh air plant and grounding of lifts) and signalling with two stage alert and alarm stages to fire suppression systems.

The control and acknowledgement of alarms will be received in the network operations and control room, where communications with Kildare's Fire Service will also be made and received.

4.3.2 Suppression

Each building will have its own automatic sprinkler system to protect the building for property protection purposes. The proposed sprinkler system will be designed to control and limit the size of any fire within the buildings. The sprinkler system will comply with NFPA 13:2013 and will be appropriate for the use in question i.e. data facility centre. Data halls and key plant areas will be fitted with pre-action sprinklers in order to mitigate accidental head damage; each pre-action system will be linked to the fire detection and alarm system to provide 1st and 2nd knock alert and alarm status to each pre-action system. This is a conventional and typical arrangement in most data centres protected by sprinklers.

Each building will also have its own sprinkler tank to provide enough volume to meet code and the above standard; tanks will be provided with top-up from the mains water supply.

For the external plant in the external compound, each item of plant will be provided with suppression systems triggered in the event of fire being detected.

In addition, all gas turbines and engines will have gas shut-off valves activated on detection of a potential fire in any of the individual items of plant.

5.0 Environmental

5.1 Seveso III / COMAH Assessment

An assessment has been made as to whether the proposed quantum and type of fuel storage would be above either of the Seveso III regulation risk or tier levels. Careful analysis has been carried to satisfy both the critical support of the data centres and the fire risk and hazard levels.

Details of this assessment is contained in Section 4.2 above and in Appendix 3.

5.2 Drainage Strategy in the Event of an Emergency:

Internally from Fire Sprinklers:

Fire water runoff from within the building is to be collected by internal floor gullies to discharge into the site-wide foul drainage network. The foul drainage network is to be designed to collect effluent from each building within the proposed development and direct it to a proposed foul pump station that is to be located on the site. The storage capacity of the foul pump station has been designed to provide for storing the effluent generated by the activation of the sprinklers within one data hall (440m3 based on the capacity of the sprinkler tank) in addition to the domestic wastewater generated within the development prior to pumping the effluent off site.

Externally from Fire-Fighting Appliances:

It is proposed to provide a hardstanding apron around the perimeter of the data hall buildings that is to drain into an underground surface water network. Fire water runoff from around the perimeter of the buildings will be collected in this local network and discharge into the local SW drainage network. The local network will discharge into the nearest attenuation pond/basin that are to be distributed around the site. Due to the potential for contaminates to be contained within the fire water run-off the outlet from the attenuation pond/basin is to be fitted with a valve that will close upon activation of the relevant fire alarm. This will allow the fire water to be retained within the attenuation feature so that it can be pumped out and disposed of offsite in an appropriate manner. Any remedial or replacement works that are required to the attenuation structure, such as replacement of the liner surface can be carried out subsequent to the removal of the contaminated water.

6.0 Maintenance

All components and functionality of the electrical infrastructure including turbines, reciprocating engine generators, batteries (BESS) and associated systems will be continuously monitored remotely from our Network Operations Centre. This provides the assurance of immediate technician dispatch to the site when warranted. In addition, regular maintenance of equipment, usually annual, includes testing of sensors and recalibration of the equipment by qualified personnel to factory / manufacture standards.

Turbines and Reciprocating Engine Generators

The maintenance program will consist of regular inspections, minor parts replacement as needed and progressing to a full engine overhaul, then repeating the cycle. The program will provide a keen focus on all parts of the gas turbine that are exposed to hot gases from the combustion process.

BESS Systems

In addition to the predictive maintenance program through continuous monitoring, annual O&M shall be conducted to verify that the BESS is performing as intended in accordance with the battery storage strategy and manufacturer recommendations.

Note that the internal structure of the BESS is a confined space and requires specialised equipment when entering for maintenance. Non-qualified persons will not have access to the turbines, BESS or associated systems under any circumstances.

7.0 Summary

A new data centre campus is proposed at Jigginstown, Naas, Co. Kildare. This report sets out the outline fire safety strategy employed to date in the design. All individual buildings shall full comply with Part B of the building regulations and are subject to the fire safety certificate process at a later stage. This document also sets out the fire hazards and mitigation measures associated with the generation and storage of electrical energy, specifically with the generator turbines and battery units locate externally to the building.

Data Centre Buildings

The main fire safety provisions at preplanning design stage with respect to compliance with Part B of the building regulations are as follows:

- Eight protected stairs provided to the permitter of each data building.
- 100% fire appliance access provided to the perimeter of each building and external plant compound area.
- Automatic sprinklers, either in pre-action or wet form are provided to all data hall areas within each building.
- Fully addressable fire detection systems employed throughout each building point detection and HSSD, and links to the pre-action sprinkler systems.
- Internal layouts are heavily compartmentalised with fire resistant compartment walls and floors, minimising the extent of any fire incident.
- Façades of building are space separated by circa 39.5m.
- The generator and battery compound are separated from the building by way of a 2-hour fire resistant wall / construction.
- Suppression systems provided to battery and generator containers.
- All gas turbines and engines have gas shut-off valves activated on detection of a potential fire.
- Spread of fire from plant at the lower level to the upper level or vice versa is considered very low risk given the level of continuous monitoring, the use of addressable fire detection and alarms, the ability to shut off all fuel sources and the provision of suppression systems in each item of plant.
- UPS and supporting battery systems in data centres are normally located within the building, however the proposal in this instance is to locate battery and generator containers external to the building, thereby increasing ease of access and firefighting than would be in the case of approved data centres within Ireland.

Please see attached Appendix 1 for the Fire Hazard Risk Review. The result of the review shows that there are items of low manageable risks or no risk at all.

Power Generation and Conditioning

Electrical power supplies to data centres must be constantly available and conditioned within the operating tolerances of the IT equipment. The strategy proposed for this site provides on-site power generation through a combination of gas-fired turbines as the primary power source and smaller reciprocating engine generators for redundancy and load tuning. Uninterrupted, conditioned power is achieved through the use of battery energy storage systems (BESS) coupled with power conversion equipment.

This is common data centre strategy that has been the industry standard for decades. The Herbata site design is based on this standard. It has simply taken a new approach by packaging components differently, whilst following all appropriate safety practices and standards as described in detail herein text.

8.0 Appendices

8.1 Appendix 01: Fire Hazard Risk Review

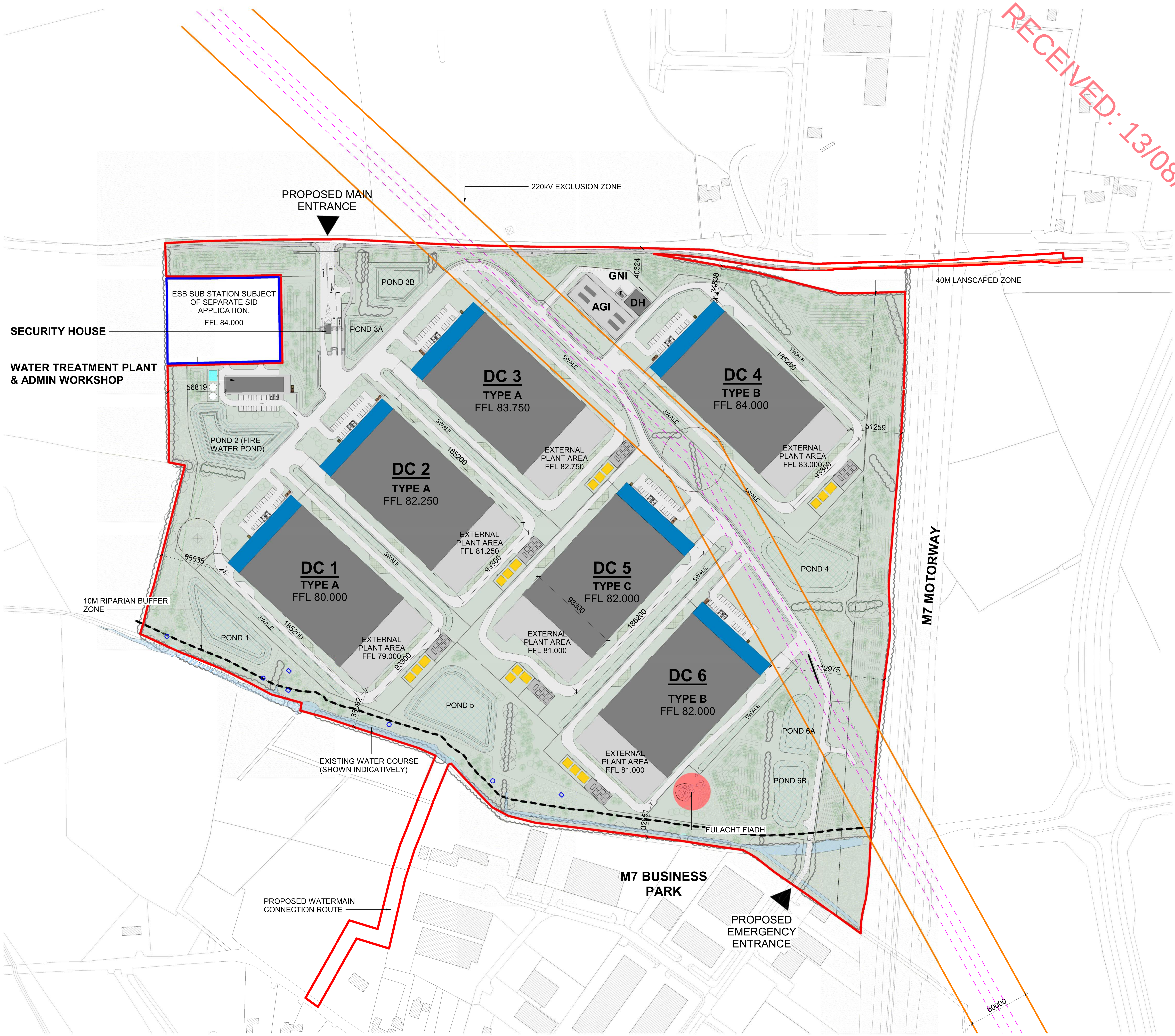
HERBATA DATA CENTRE CAMPUS
FIRE HAZARD RISK REVIEW
03rd March 2023, Rev 1

ITEM No.	ITEM DESCRIPTION	RISK	Assessment			Mititgations proposed to be included	Residual Risk
			Likelihood	Severity	Result		
			0 to 10, 10 = high				
1	Battery Energy Storage Systems (BESS)	Thermal runnaway due to internal failure in battery	2	7	14	- The chemistry selected for The batteries is Lithium Iron Phosphate (LFP) which has a much lower fire load and is more stable. - There is no cobalt used in these typesa of battery.	Low risk, systems are monitored 24/7/365
2	Battery Energy Storage Systems (BESS)	Fire suppression in the event of a fire	2	7	14	- Monitoring will be provided to both a BMS and the fire detection systems. - Each battery cabinet will be provided with a fire extinguishing system. - Battery cabinets are exernal in a plant compound.	Low risk, systems are monitored 24/7/365
3	Battery Energy Storage Systems (BESS)	Building fire suppression measures	1	7	7	- The building will be provided with a conventional sprinkler system with pre action systems to data hall and electrical room in accordance with code - Fire hyrants will be available around the building to code or better	Low risk, systems are monitored 24/7/365
4	Gas turbines	Fire development within turbine package	1	7	7	- Gas turbine enclosures will have heat and smoke detection and be constantly monitored - in the event of a fire, the gas will be shut-off at the gas shut off valve	Low risk, systems are monitored 24/7/365
5	Gas turbines	Overspeed of turbine	1	7	7	- Turbine has fail-safes within its controls system	Standard control system check, turbine is monitored 24/7/365 whilst running
6	Gas turbines	Gas leak within and around enclosure	1	7	7	- Gas turbine enclosures are external, so gas leak will rise into atmosphere - Leaks within enclosures will be detected by checking different gas pressures.	Low risk, systems are monitored 24/7/365
7	Gas engines	Fire development within engine package	1	7	7	- Gas engine enclosures will have heat and smoke detection and be constantly monitored - in the event of a fire, the gas will be shut-off at the gas shut off valve	Low risk, systems are monitored 24/7/365
8	Gas engines	Overspeed of turbine	1	7	7	- Engine has fail-safes within its controls system	Standard control system check, engine is monitored 24/7/365 whilst running
9	Gas engines	Gas leak within and around enclosure	1	7	7	- Gas engine enclosures are external, so gas leak will rise into atmosphere - Leaks within enclosures will be detected by checking different gas pressures.	Low risk, systems are monitored 24/7/365
10	Fuel storage - diesel	Size of storage above Lower or Upper Tier Seveso III regulations	1	9	9	- storage of diesel has been reduced to 40 hours and aggregated with gas storage	Assessment has been carried out
11	Fuel storage - diesel	Risk of ignition	1	9	9	- flash point is high, difficult to ignite.	Low risk, inspections required at least weekly to check on condition
12	Fuel storage - diesel	Risk of leaks	1	5	5	- all tank areas are bunded with suitable drainage	Low risk, inspections required at least weekly to check on condition
13	Fuel storage - diesel	Fuel delivery spills	2	9	18	- strict delivery tanker procedures to be followed	Low risk, method statements to be reviewed and adhered to
14	Fuel storage - natural gas	Size of storage above Lower or Upper Tier Seveso III regulations	1	9	9	- storage of gas has been reduced to 2 hours and aggregated with diesel storage	Assessment has been carried out
15	Fuel storage - natural gas	Risk of ignition	2	9	18	- flash point is low, and easier to ignite - quantum of storage is very low per building - all storage is external and away from building	Low risk, inspections required at least weekly to check on condition
16	Fuel storage - natural gas	Risk of leaks	1	7	7	- all gas systems are monitored - gas tanks and pipework are external	Low risk, inspections required at least weekly to check on condition
17	Fuel storage - natural gas	Fuel delivery spills/leaks	2	9	18	- strict delivery tanker procedures to be followed	Low risk, method statements to be reviewed and adhered to

Risk Level Grading

Score range		
0 to <10	Green	Little or no significant risk
10 to <20	Yellow	Low risk, requires monitoring
20 to <30	Orange	Medium risk, requires higher level of monitoring
>30	Red	High risk, requires further mitigation

8.2 Appendix 02: Architectural Drawings



1 **A1010 - PROPOSED SITE PLAN**
1 : 1500

LEGEND:

(red line)	PLANNING APPLICATION BOUNDARY
(blue line)	OTHER LANDS UNDER CONTROL OF THE APPLICANT
(magenta dashes)	220KV EXISTING OVERHEAD POWERLINES
(orange lines)	EXCLUSION ZONE SURROUNDING 220kV POWERLINES (63 METRES)
(symbol)	PYLON
(symbol)	PROPOSED HYDRANT PUMP ROOM
(symbol)	PROPOSED HYDRANT PUMP ROOM STORAGE - REFER TO ENGINEERS DRAWINGS
(symbol)	PROPOSED SPRINKLER TANK COMPOUND - REFER TO ENGINEERS DRAWINGS
(symbol)	ADMIN BLOCK OF DATA CENTRE
(symbol)	PROPOSED FUEL COMPOUND - REFER TO ENGINEERS DRAWINGS
(symbol)	PROPOSED FENCING
(symbol)	PROPOSED LOCATION FOR BAT HOUSE (4MX4M)
(symbol)	PROPOSED LOCATION FOR BAT BOX
(symbol)	PROPOSED BICYCLE STORAGE
(symbol)	PROPOSED SMOKE SHELTER
(symbol)	EXISTING TREES/HEDGES
(symbol)	PROPOSED TREES/HEDGES
(symbol)	PROPOSED 'WET' PONDS (PERMANENT WATER BODIES)
(symbol)	PROPOSED 'DRY' PONDS & SWALES
(symbol)	PROPOSED FIREFIGHTING ACCESS LAY BY
DC	PROPOSED DATA CENTRE
AGI	PROPOSED ABOVE GROUND INSTALLATIONS
DH	PROPOSED DISTRICT HEATING
GNI	PROPOSED BIO-GAS INJECTION POINT COMPOUND

TOTAL NO. CAR PARKING: 210
NO. EV CHARGING POINTS: 63
NO. DISABLED CAR PARKING: 14
TOTAL NO. BICYCLE PARKING: 104

All levels shown are to the Irish Transverse Mercator (ITM) and are displayed in meters (m).
All levels shown relate to the Malin Head datum.
All dimensions shown in millimeters (mm)

All dimensions to be checked on site. Figured dimensions take preference over scaled dimensions. Any errors or discrepancies to be reported to the Architects. This drawing may not be edited or modified by the recipient.

A0

HERBATA GREEN ENERGY DATA

Notes:

LEGEND

1. PROPRIETARY INSULATED METAL CLADDING SYSTEM ON STEEL STRUCTURE (EUROBOND FLAT PROFILE PANELS OR OTHER APPROVED) TO DATA HALL AREA. COLOUR TONE - MEDIUM GREY.
2. PROPRIETARY INSULATED METAL CLADDING SYSTEM ON STEEL STRUCTURE (EUROBOND FLAT PROFILE PANELS OR OTHER APPROVED) TO ADMIN AREA. COLOUR TONE - MEDIUM DARK GREY.
3. PROPRIETARY INSULATED METAL CLADDING SYSTEM ON STEEL STRUCTURE (EUROBOND FLAT PROFILE PANELS OR OTHER APPROVED) TO ADMIN AREA. COLOUR TONE - DARK GREY.
4. PROPRIETARY INSULATED METAL CLADDING SYSTEM ON STEEL STRUCTURE (EUROBOND FLAT PROFILE PANELS OR OTHER APPROVED) TO ADMIN AREA. COLOUR TONE - OFF-WHITE.
5. PROPRIETARY INSULATED METAL CLADDING SYSTEM ON STEEL STRUCTURE (EUROBOND FLAT PROFILE PANELS OR OTHER APPROVED) TO ADMIN AREA. COLOUR TONE - LIGHT GREY.
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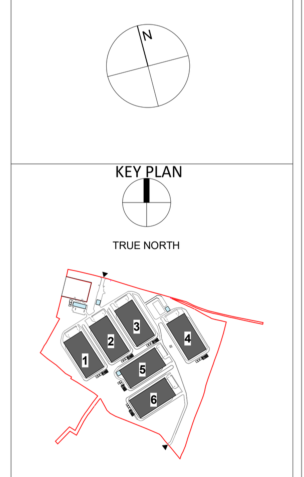
7. SELECTED GLAZED CURTAIN WALL SYSTEM WITH GLAZED AND SPANDREL PANELS IN SELECTED COLOUR.
8. SELECTED VERTICAL ALUMINIUM FINS IN SELECTED COLOUR.
9. SELECTED HORIZONTAL MICRO LOUVRES SET INTO PANELS TO PLANT ROOM FACADE.
10. SELECTED PARALON OR OTHER APPROVED ROOF FINISH LAID TO MANUFACTURERS SPECIFICATION ON STEEL STRUCTURE TO ENGINEERS FUTURE DETAILS.
11. SELECTED SEDUM ROOF FINISH ON BLUE ROOF ATTENUATION LAYER.
12. ALUMINIUM CANOPY IN SELECTED COLOUR. COLOUR TONE - LIGHT GREY.
13. 2.4m HIGH PALLISADE SECURITY FENCE AROUND PLANT AREAS, DATA BUILDINGS AND ASSOCIATED STRUCTURES.
14. 1.2m HIGH AGRICULTURAL TIMBER POST AND WIRE MESH FENCING TO WESTERN BOUNDARY HEDGE.
15. 1.2m HIGH TIMBER POST AND RAIL FENCE TO SURROUND PONDS.
16. 2.4m HIGH PALLISADE SECURITY FENCE AROUND ENTIRE SITE.
17. SELECTED SEDUM ROOF FINISH.
18. EXTERNAL METAL LOUVRE TO ACOUSTIC SCREEN WALL.
19. ACOUSTIC PANEL.



Rev.	Date	Description
P09	22/04/2024	ISSUE FOR PLANNING
P08	03/11/2023	PLANNING ISSUE
P07	02/08/2023	PLANNING ISSUE
P06	11/07/2023	PLANNING ISSUE
P05	02/06/2023	DRAFT PLANNING ISSUE
P04	28/04/2023	STAGE 2 ISSUE
P03	10/03/2023	DRAFT ISSUE
P02	28/02/2023	DESIGN FREEZE - STAGE 2
P01	24/02/2023	Pre-Planning

STATUS: PLANNING
PROJECT: HERBATA DATA CENTRE CAMPUS
PROJECT ADDRESS: NAAS, CO. KILDARE
DWG TITLE: OVERALL PROPOSED SITE PLAN
DWG NO.: 22217-RKD-ZZ-ZZ-DR-A-1010

REV.	SUITABILITY	PROJECT NO.	22217
P09	S3	SCALE	1:1500
DATE 03/11/2023		DRN RCD	CHK KOS

RKD
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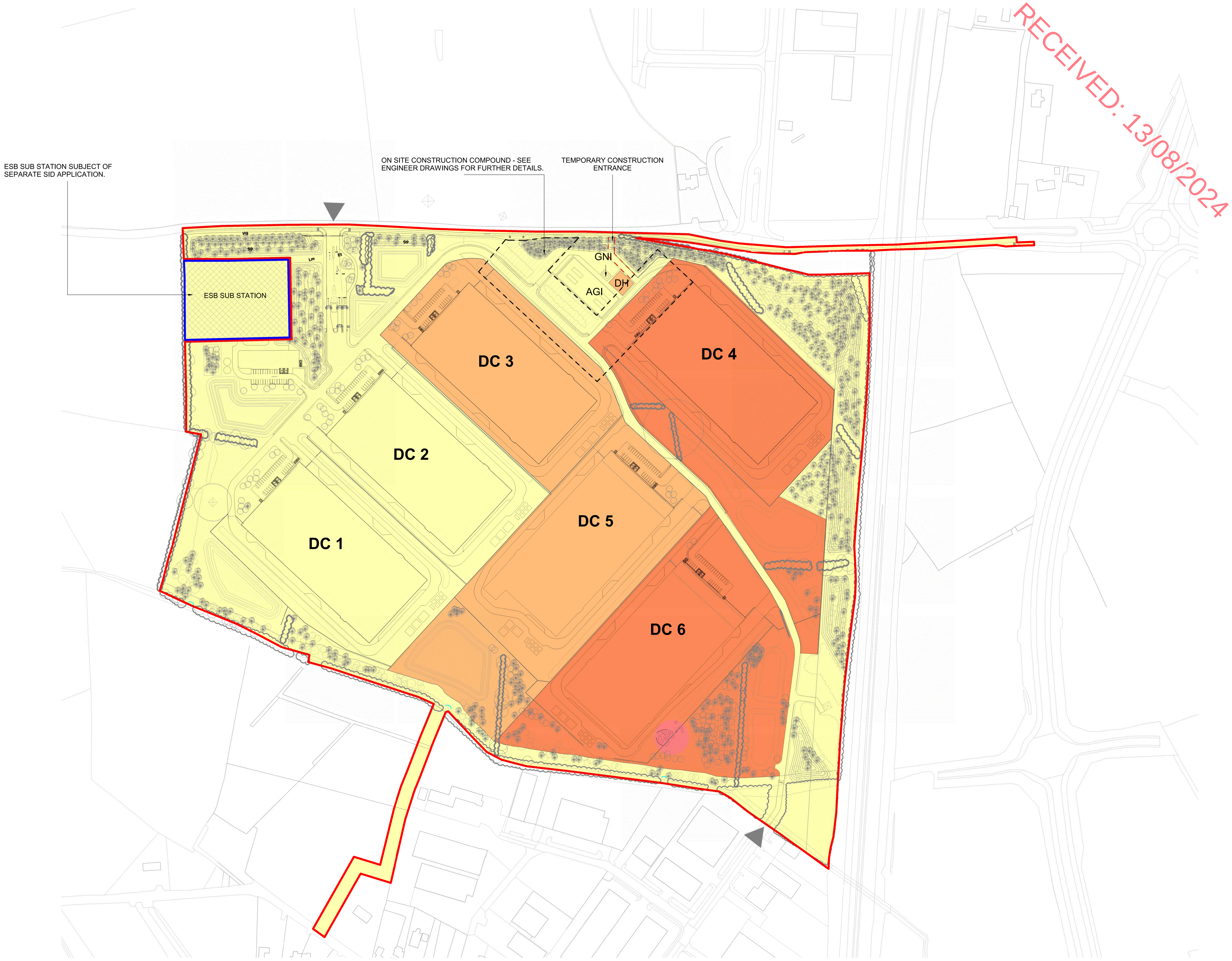
BSM Est. 1968

DONNACHADH O'BRIEN & ASSOCIATES CONSULTING ENGINEERS



1 A1030 - PROPOSED SITE PHASING PLAN
1 : 1500

SITE PHASING :

	PHASE 1* - DC 1 & DC 2, GENERAL SITE WORKS
	PHASE 1* - SUB STATION SUBJECT OF SEPARATE APPLICATION
	PHASE 2* - DC 3 & DC 5
	PHASE 3* - DC 4 & DC 6
	ON-SITE CONSTRUCTION COMPOUND
	TEMPORARY CONSTRUCTION ACCESS
DC	PROPOSED DATA CENTRE
AGI	PROPOSED ABOVE GROUND INSTALLATIONS
DH	PROPOSED DISTRICT HEATING
GNI	PROPOSED ACCESS TO GAS NETWORKS IRELAND

* Note: Please refer to Outline Construction Traffic Management Plan (OCTMP) 10360452-HDR-XX-XX-RP-T-000002 for anticipated Construction Program.

All trees/hedgerows to be retained are to be protected in accordance with BS 5837:2012, Trees in relation to design, demolition & construction. Prior to the commencement of any work, or any materials being brought on site as part of Phase 1, existing trees to be retained are to be protected with temporary fencing. These shall be maintained in good and effective condition until the work is completed. Allow for stabiliser struts to secure fence for duration of construction. Fully remove when construction is complete/site demobilised. Please refer drawing *BSM-ZZ-ZZ-DR-L-0211-0214* for further detail.

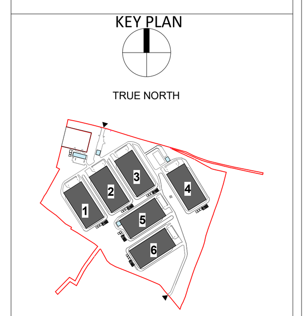
All dimensions to be checked on site. Figured dimensions take preference over scaled dimensions. Any errors or discrepancies to be reported to the Architects.This drawing may not be edited or modified by the recipient.

A0

HERBATA
GREEN ENERGY DATA

Notes:

KEY PLAN



Rev.	Date	Description
P08	03/11/2023	PLANNING ISSUE
P07	02/08/2023	PLANNING ISSUE
P06	11/07/2023	PLANNING ISSUE
P05	02/06/2023	DRAFT PLANNING ISSUE
P04	28/04/2023	STAGE 2 ISSUE
P03	10/03/2023	DRAFT ISSUE
P02	28/02/2023	DESIGN FREEZE - STAGE 2
P01	24/02/2023	Pre-Planning

STATUS: PLANNING

PROJECT: HERBATA DATA CENTRE CAMPUS

PROJECT ADDRESS: NAAS, CO. KILDARE

DWG TITLE: SITE PHASING PLAN

DWG NO. 22217-RKD-ZZ-ZZ-DR-A-1030

REV.	SUITABILITY	PROJECT NO.	SCALE
P08	S3	22217	1:1500

DATE 03/11/2023 | DRN RCD | CHK KOS

RKD
59 Northumberland Rd
Ballsbridge, Dublin 4
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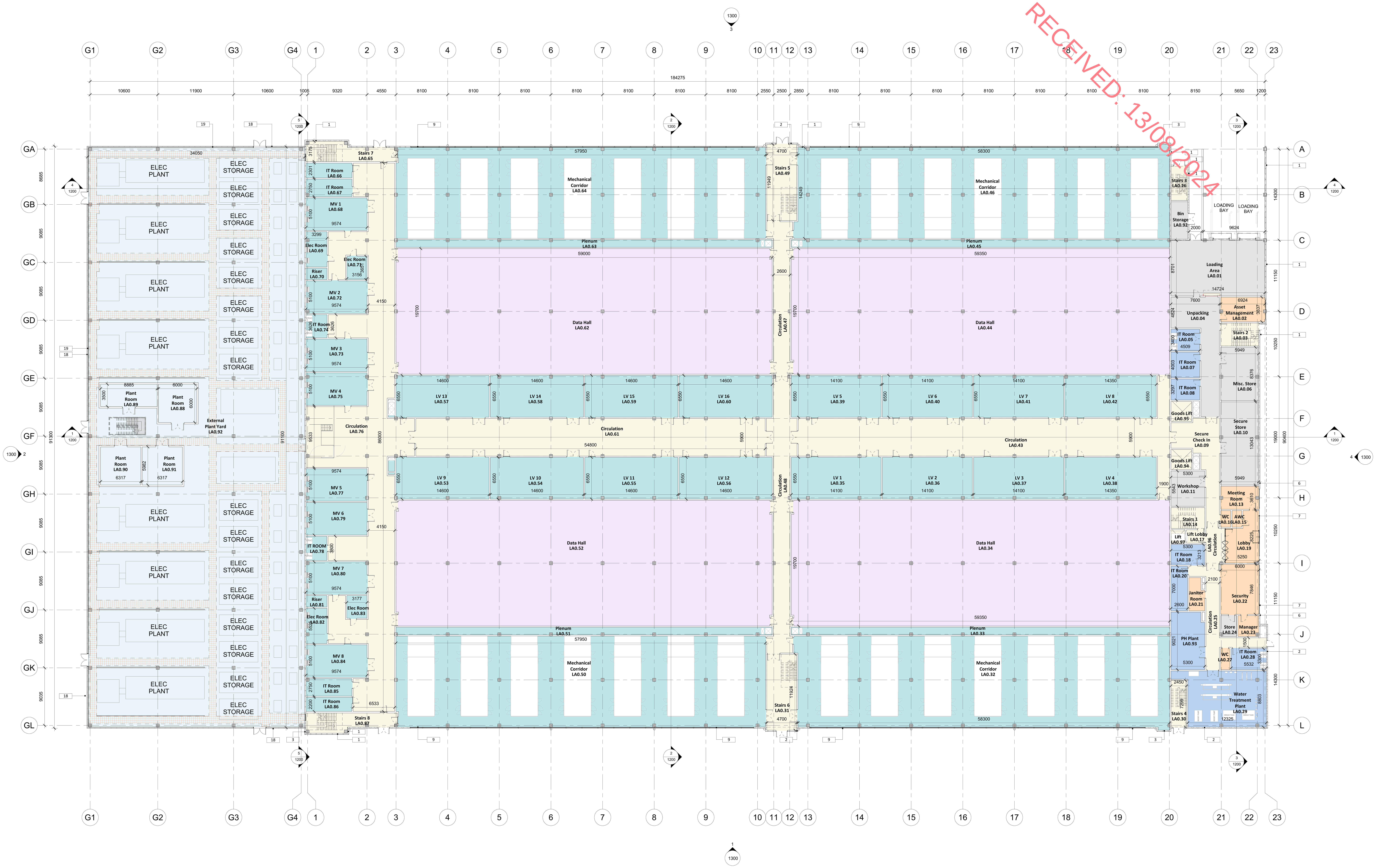
D: +44 (0)20 8763 5900

BSM Est. 1968

DONNACHADH O'BRIEN & ASSOCIATES CONSULTING ENGINEERS



1 A1100_Overall Ground Floor Plan
1 : 200

All dimensions to be checked on site. Figured dimensions take preference over scaled dimensions. Any errors or discrepancies to be reported to the Architects.This drawing may not be edited or modified by the recipient.

A0

HERBATA GREEN ENERGY DATA

Notes:

LEGEND

1. PROPRIETARY INSULATED METAL CLADDING SYSTEM ON STEEL STRUCTURE (EUROBOND FLAT PROFILE PANELS OR OTHER APPROVED) TO DATA HALL AREA. COLOUR TONE - MEDIUM GREY.
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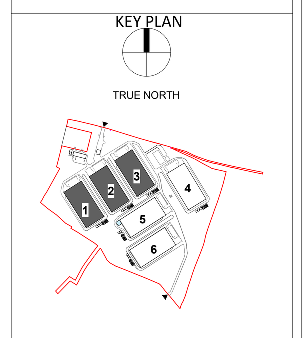
19. ACOUSTIC PANEL.

AREA LEGEND

- ADMIN
- BACK OF HOUSE
- CIRCULATION
- DATA HALL
- EXTERNAL PLANT YARD
- MECHANICAL / ELECTRICAL
- STORAGE
- PLANT YARD WALKWAYS (MIN. WIDTH 1200mm)

KEY PLAN



Rev.	Date	Description
P08	03/11/2023	PLANNING ISSUE
P07	02/08/2023	PLANNING ISSUE
P06	11/07/2023	PLANNING ISSUE
P05	02/06/2023	DRAFT PLANNING ISSUE
P04	28/04/2023	STAGE 2 ISSUE
P03	10/03/2023	DRAFT ISSUE
P02	28/02/2023	DESIGN FREEZE - STAGE 2
P01	24/02/2023	Pre-Planning

STATUS: PLANNING

PROJECT: HERBATA DATA CENTRE CAMPUS

PROJECT ADDRESS: NAAS, CO. KILDARE

DWG TITLE: DATA CENTRE - OVERALL GROUND FLOOR PLAN TYPE A

DWG NO. 22217-RKD-ZZ-00-DR-A-1100

REV.	SUITABILITY	PROJECT NO.	22217
P08	S3	SCALE	1:200

DATE 03/11/2023 | DRN RCD | CHK KOS

RKD
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Ballsbridge, Dublin 4
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rkd.ie

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CR0 6SR, United Kingdom
D: +44 (0)20 8763 5900

BSM Est. 1968

DONNACHADH O'BRIEN & ASSOCIATES CONSULTING ENGINEERS

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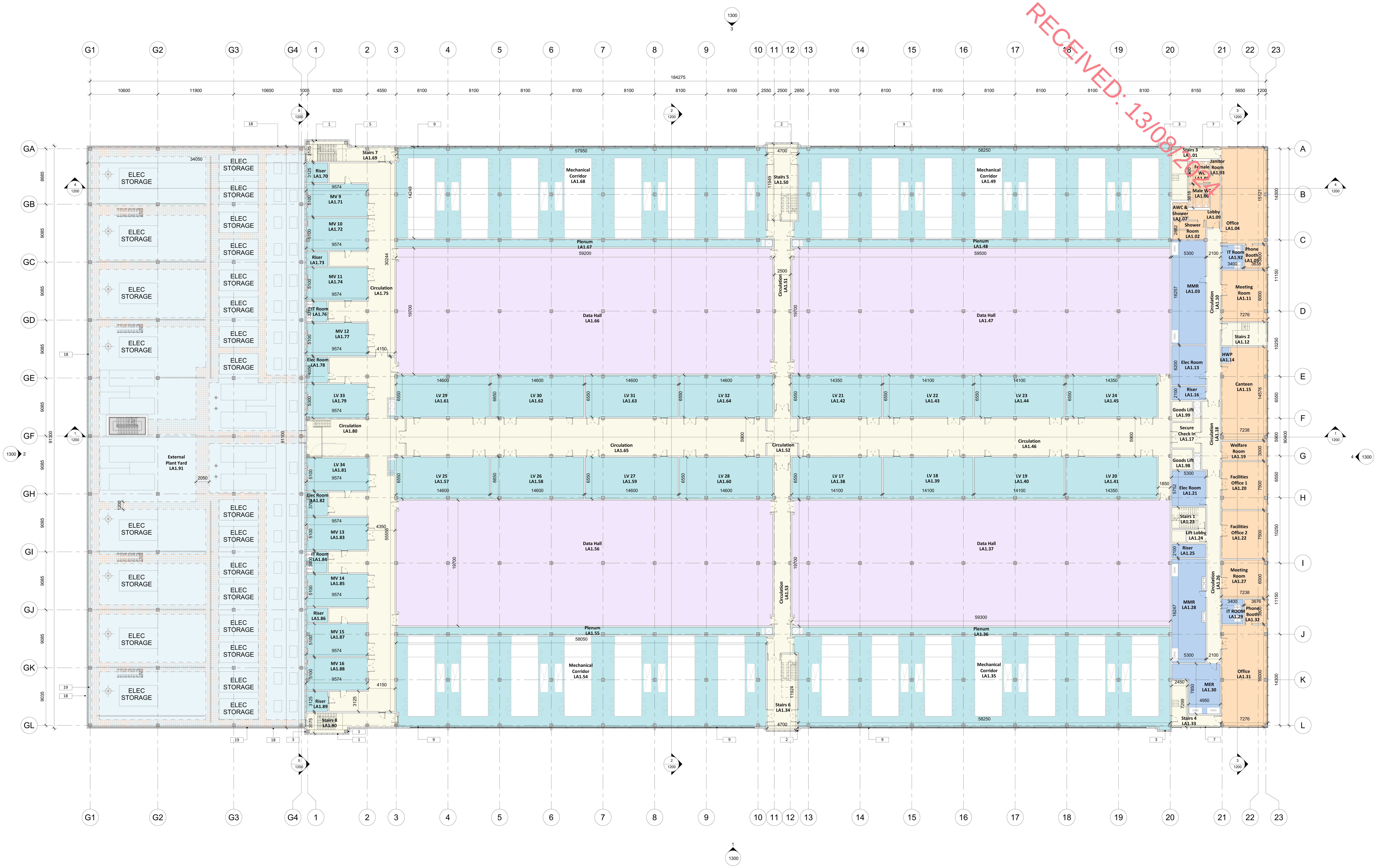
HERBATA GREEN ENERGY DATA



1 A1101_Overall First Floor Plan
1 : 200

Notes:

LEGEND

1. PROPRIETARY INSULATED METAL CLADDING SYSTEM ON STEEL STRUCTURE (EUROBOND FLAT PROFILE PANELS OR OTHER APPROVED) TO DATA HALL AREA. COLOUR TONE - MEDIUM GREY.

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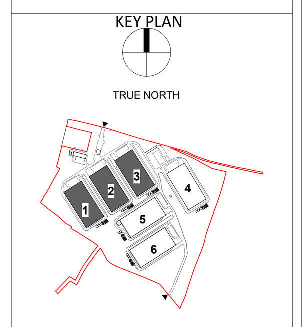
19. ACOUSTIC PANEL.

AREA LEGEND

- ADMIN
- BACK OF HOUSE
- CIRCULATION
- DATA HALL
- EXTERNAL PLANT YARD
- MECHANICAL / ELECTRICAL
- STORAGE
- PLANT YARD WALKWAYS (MIN. WIDTH 1200mm)



Rev.	Date	Description
P08	03/11/2023	PLANNING ISSUE
P07	02/08/2023	PLANNING ISSUE
P06	11/07/2023	PLANNING ISSUE
P05	02/06/2023	DRAFT PLANNING ISSUE
P04	28/04/2023	STAGE 2 ISSUE
P03	10/03/2023	DRAFT ISSUE
P02	28/02/2023	DESIGN FREEZE - STAGE 2
P01	24/02/2023	Pre-Planning

STATUS PLANNING

PROJECT HERBATA DATA CENTRE CAMPUS

PROJECT ADDRESS NAAS, CO. KILDARE

DWG TITLE DATA CENTRE - OVERALL FIRST FLOOR PLAN TYPE A

DWG NO. 22217-RKD-ZZ-01-DR-A-1101

REV.	SUITABILITY	PROJECT NO.	22217
P08	S3	SCALE	1:200
DATE 03/11/2023	DRN RCD	CHK KOS	

RKD

59 Northumberland Rd
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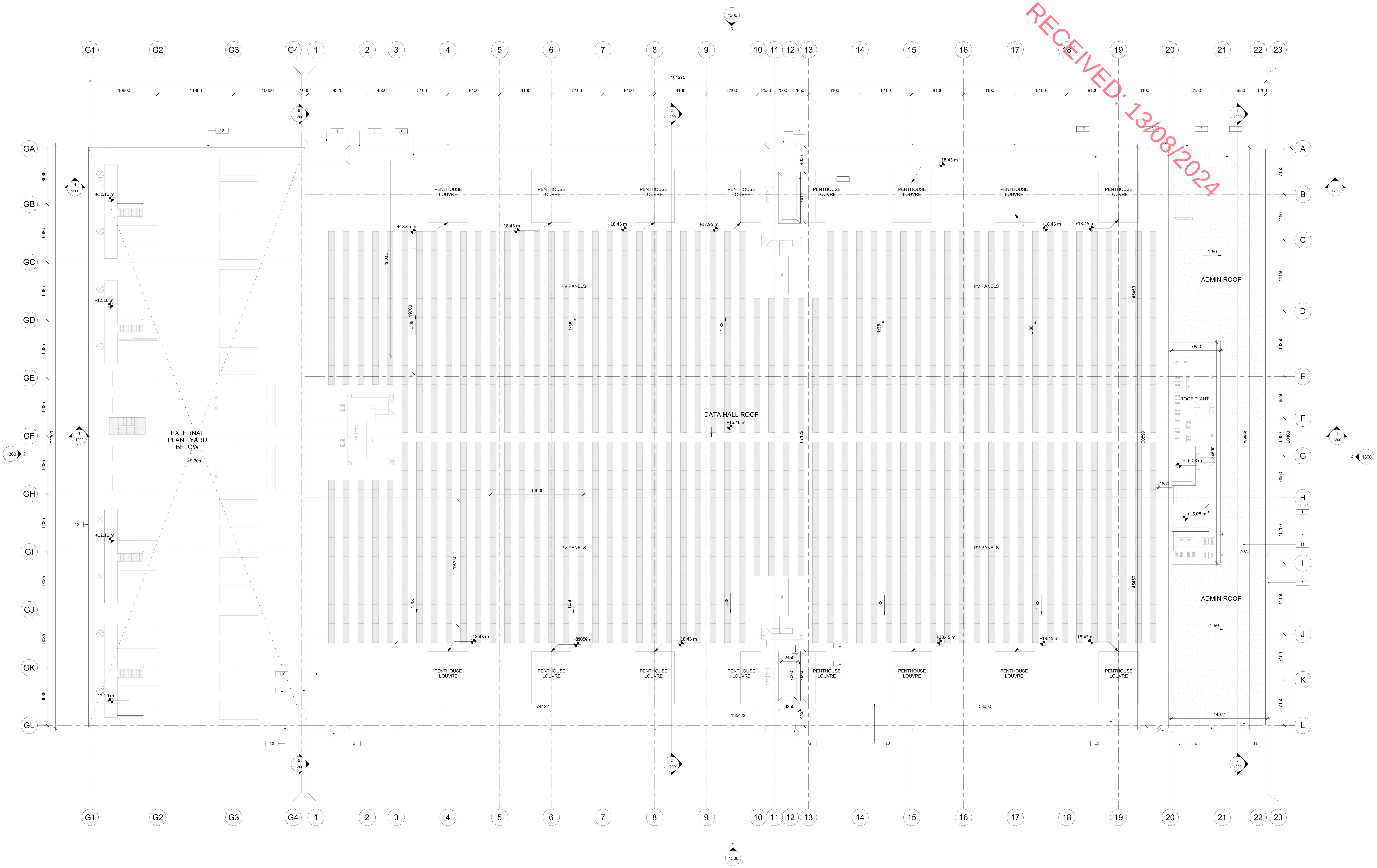
D: +44 (0)20 8763 5900

BSM Est. 1968

DONNACHADH O'BRIEN & ASSOCIATES CONSULTING ENGINEERS

A0

HERBATA GREEN ENERGY DATA



1 **A1102_Overall Roof Plan**
1 : 200

Notes:

LEGEND

1. PROPRIETARY INSULATED METAL CLADDING SYSTEM ON STEEL STRUCTURE (EUROBOND FLAT PROFILE PANELS OR OTHER APPROVED) TO DATA HALL AREA. COLOUR TONE - MEDIUM GREY.
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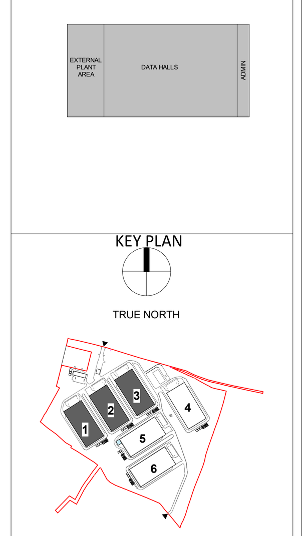
19. ACOUSTIC PANEL.

AREA LEGEND

- ADMIN
- BACK OF HOUSE
- CIRCULATION
- DATA HALL
- EXTERNAL PLANT YARD
- MECHANICAL / ELECTRICAL
- STORAGE



Rev.	Date	Description
P08	03/11/2023	PLANNING ISSUE
P07	02/08/2023	PLANNING ISSUE
P06	11/07/2023	PLANNING ISSUE
P05	02/06/2023	DRAFT PLANNING ISSUE
P04	28/04/2023	STAGE 2 ISSUE
P03	10/03/2023	DRAFT ISSUE
P02	28/02/2023	DESIGN FREEZE - STAGE 2
P01	24/02/2023	Pre-Planning

STATUS: PLANNING

PROJECT: HERBATA DATA CENTRE CAMPUS

PROJECT ADDRESS: NAAS, CO. KILDARE

DWG TITLE: DATA CENTRE - OVERALL ROOF PLAN TYPE A

DWG NO. 22217-RKD-ZZ-RF-DR-A-1102

REV. P08 | SUITABILITY S3 | PROJECT NO. 22217 | SCALE 1:200

DATE 03/11/2023 | DRN RCD | CHK KOS

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+353 1 668 1055
mail@rkd.ie
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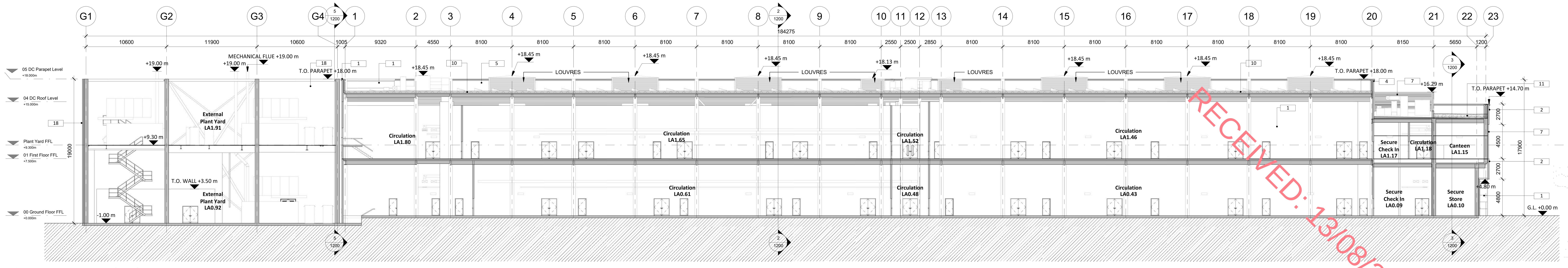
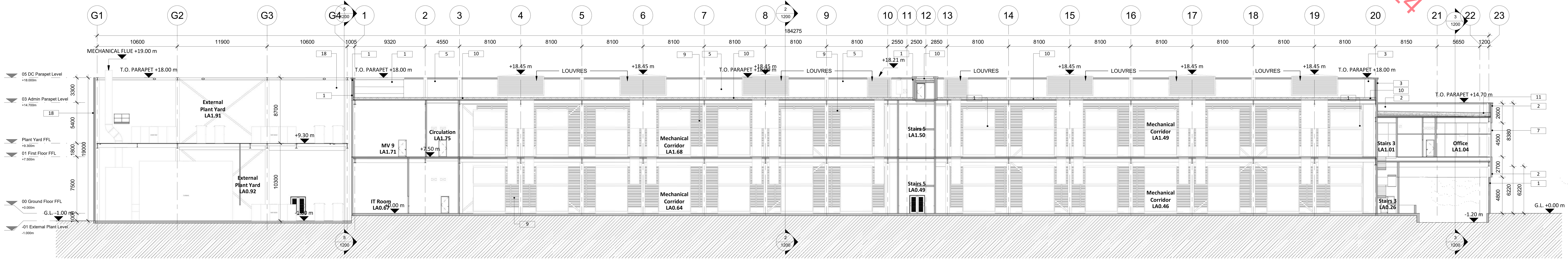
HDR

BSM Est. 1968

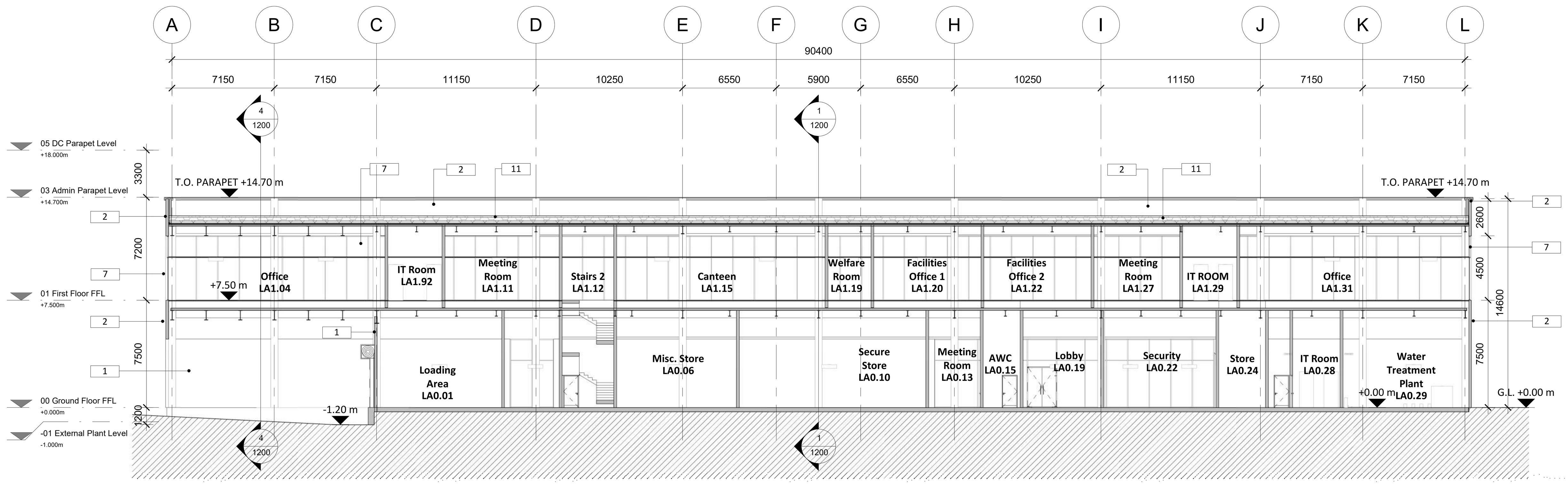
DONNACHADH O'BRIEN & ASSOCIATES CONSULTING ENGINEERS



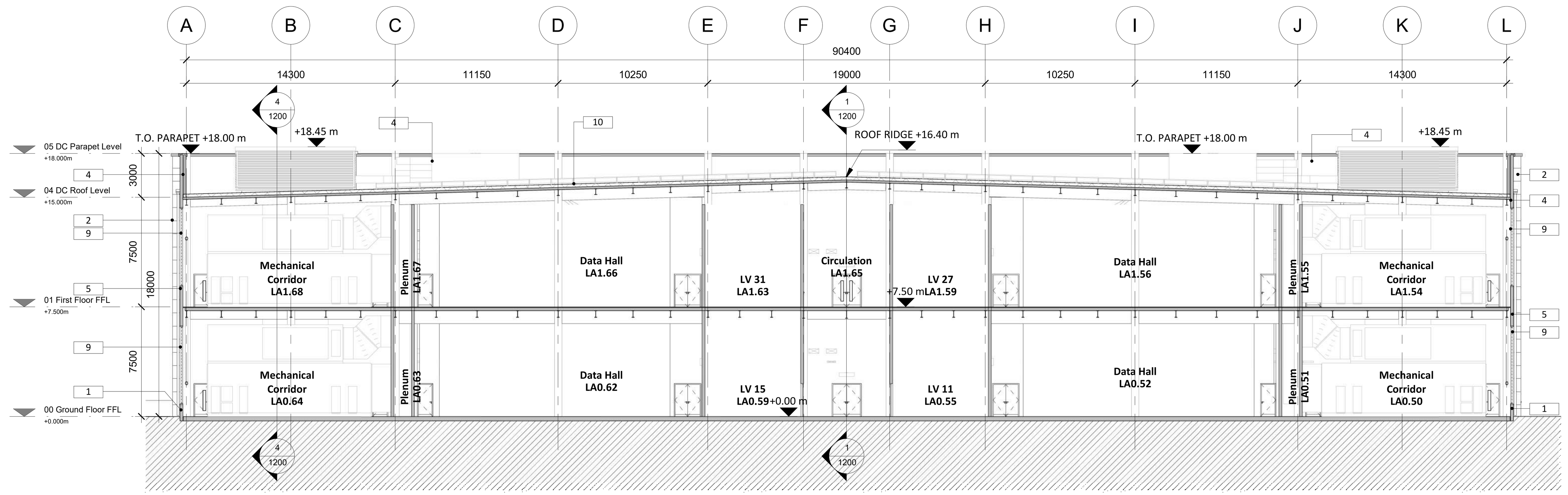
1 A1200_Proposed GA Section A-A
1 : 200



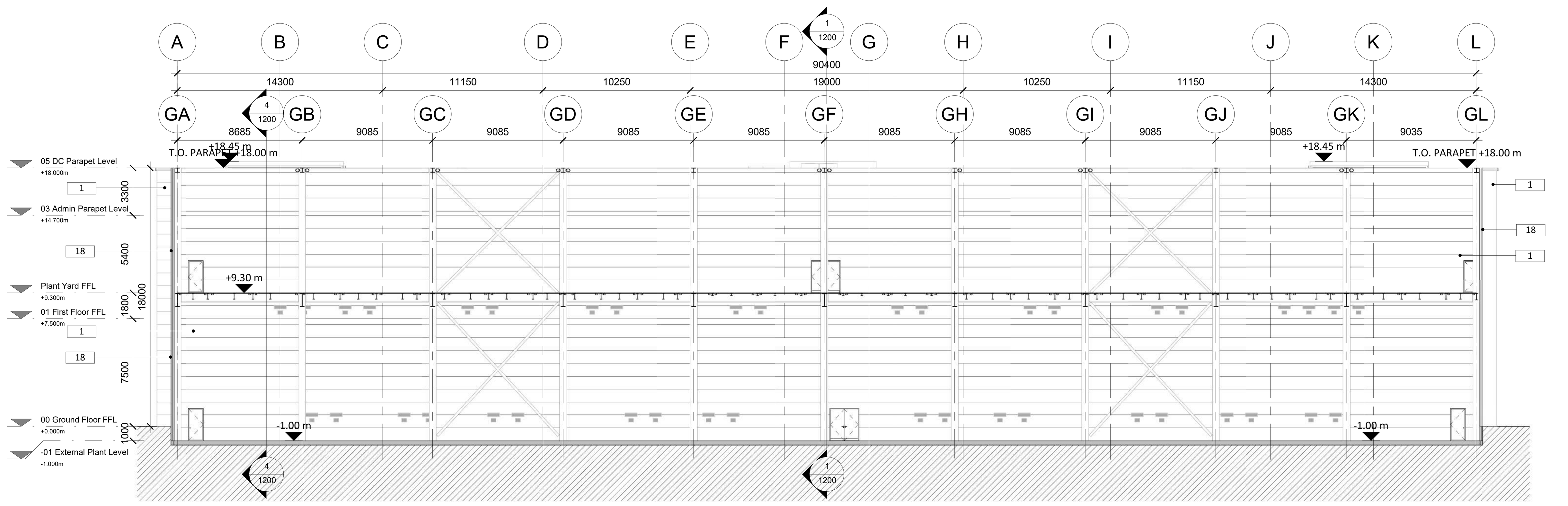
4 A1200_Proposed GA Section B-B
1 : 200



3 A1200_Proposed GA Section C-C
1 : 200



2 A1200_Proposed GA Section D-D
1 : 200



5 A1200_Proposed GA Section E-E
1 : 200

A0

HERBATA GREEN ENERGY DATA

Notes:

LEGEND

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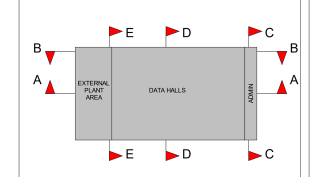
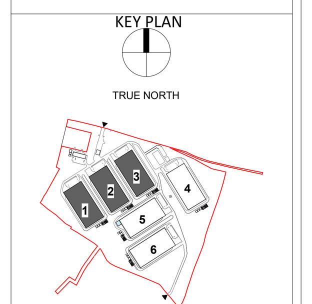


KEY PLAN



TRUE NORTH

Rev.	Date	Description
P07	03/11/2023	PLANNING ISSUE
P06	02/08/2023	PLANNING ISSUE
P05	11/07/2023	PLANNING ISSUE
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P03	28/04/2023	STAGE 2 ISSUE
P02	10/03/2023	DRAFT ISSUE
P01	28/02/2023	DESIGN FREEZE - STAGE 2

STATUS: PLANNING

PROJECT: HERBATA DATA CENTRE CAMPUS

PROJECT ADDRESS: NAAS, CO. KILDARE

DWG TITLE: DATA CENTRE - PROPOSED GA SECTIONS TYPE A

DWG NO.: 22217-RKD-ZZ-ZZ-DR-A-1200

REV.: P07 | SUITABILITY: S3 | PROJECT NO.: 22217 | SCALE: 1:200

DATE: 03/11/2023 | DRN: RCD | CHK: KOS

RKD
59 Northumberland Rd
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mail@rkd.ie
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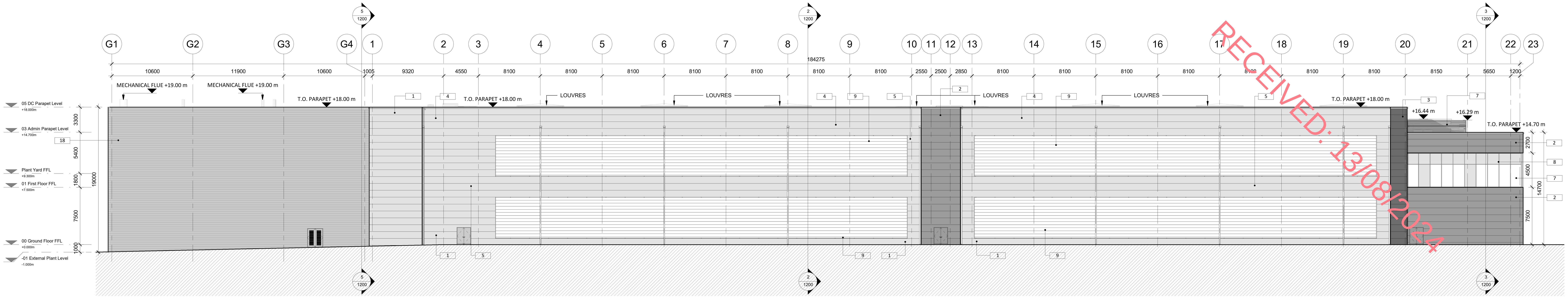
HDR | BSM Est. 1968

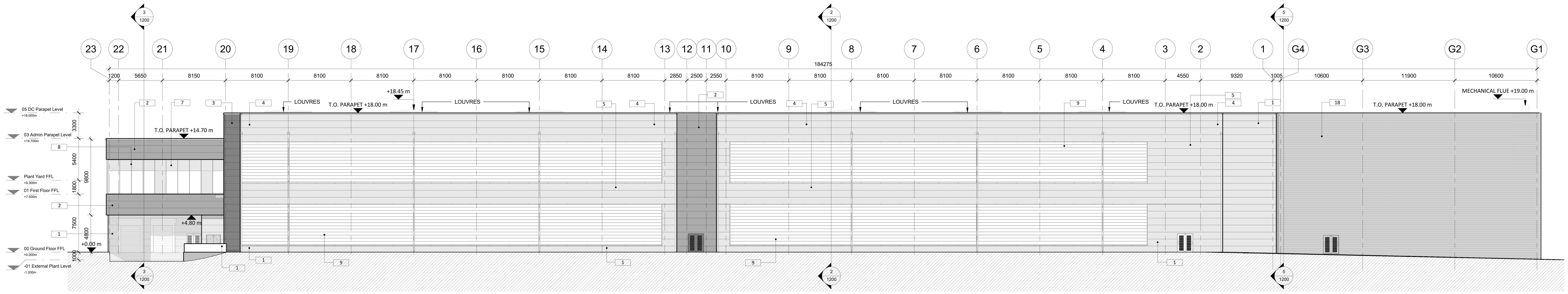
DONNACHADH O'BRIEN & ASSOCIATES CONSULTING ENGINEERS

RECEIVED: 13/08/2024

RECEIVED: 13/08/2024



1 **A1300_Proposed GA Elevation 01**
1 : 200



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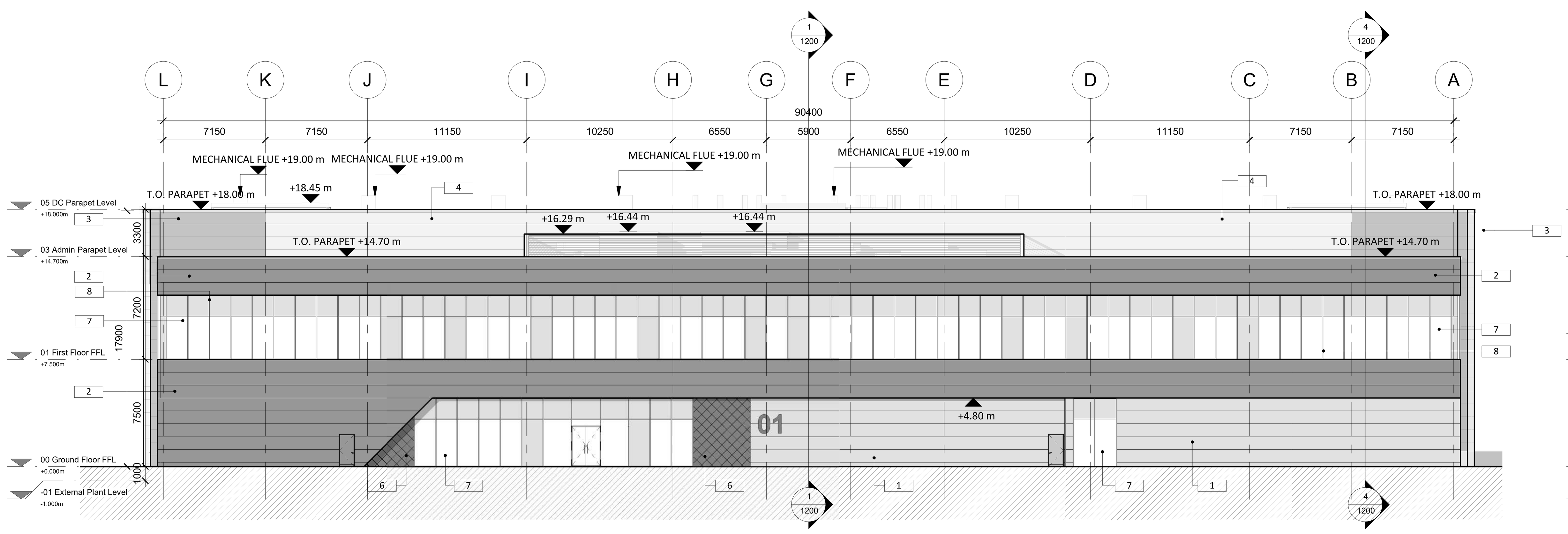

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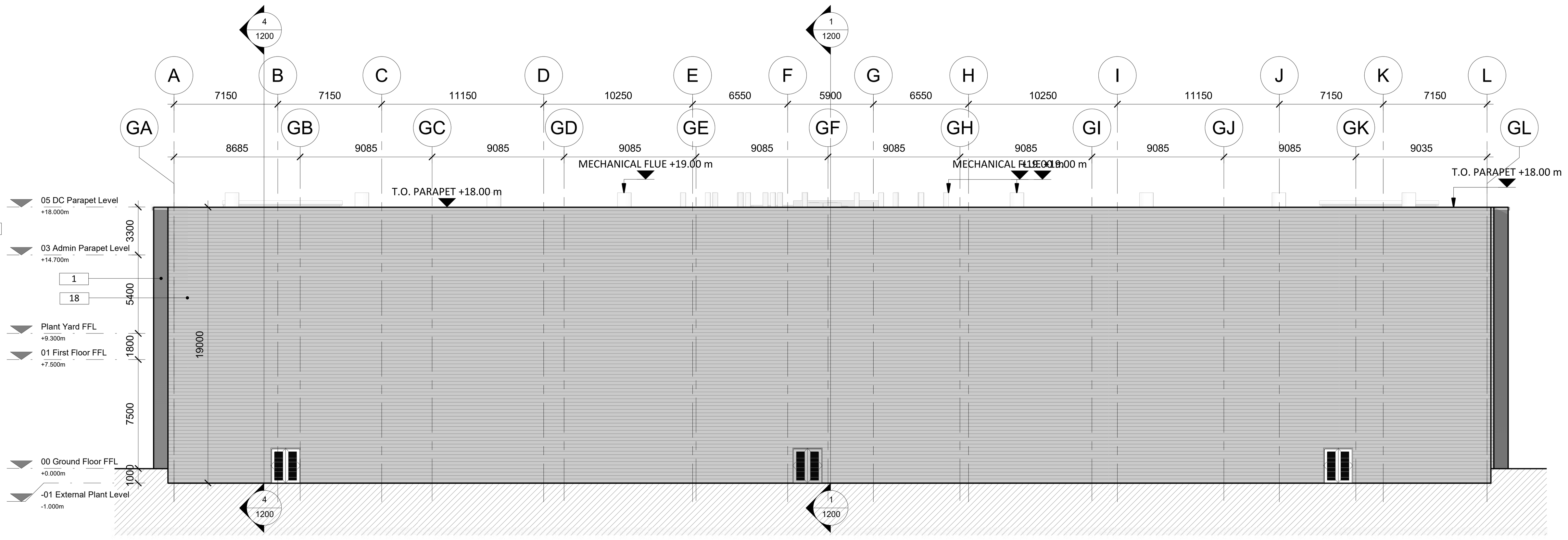

2 **A1300_Proposed GA Elevation 02**
1 : 200

All dimensions to be checked on site. Figured dimensions take preference over scaled dimensions. Any errors or discrepancies to be reported to the Architects.This drawing may not be edited or modified by the recipient.

A0

HERBATA GREEN ENERGY DATA

Notes:

LEGEND

1. PROPRIETARY INSULATED METAL CLADDING SYSTEM ON STEEL STRUCTURE (EUROBOND FLAT PROFILE PANELS OR OTHER APPROVED) TO DATA HALL AREA. COLOUR TONE - MEDIUM GREY.
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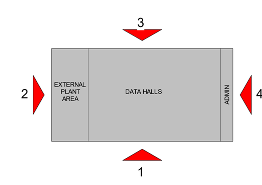
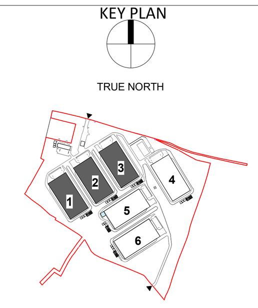
19. ACOUSTIC PANEL.



KEY PLAN



Rev.	Date	Description
P08	03/11/2023	PLANNING ISSUE
P07	02/08/2023	PLANNING ISSUE
P06	11/07/2023	PLANNING ISSUE
P05	02/06/2023	DRAFT PLANNING ISSUE
P04	28/04/2023	STAGE 2 ISSUE
P03	10/03/2023	DRAFT ISSUE
P02	28/02/2023	DESIGN FREEZE - STAGE 2
P01	24/02/2023	Pre-Planning

STATUS PLANNING

PROJECT HERBATA DATA CENTRE CAMPUS

PROJECT ADDRESS NAAS, CO. KILDARE

DWG TITLE DATA CENTRE - OVERALL PROPOSED ELEVATIONS TYPE A

DWG NO. 22217-RKD-ZZ-ZZ-DR-A-1300

REV.	SUITABILITY	PROJECT NO.	22217
P08	S3	SCALE	1:200

DATE 03/11/2023 DRN RCD CHK KS

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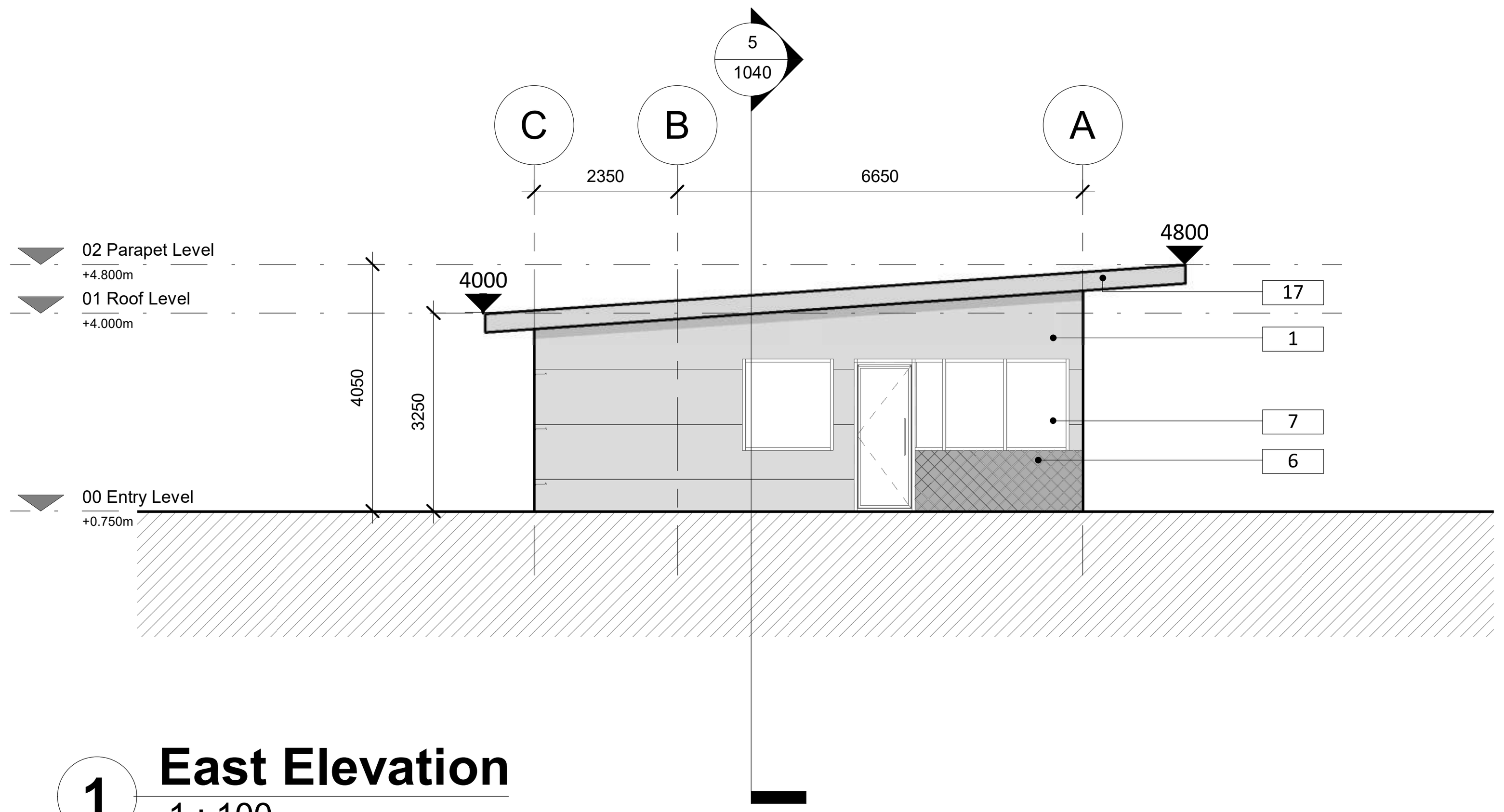
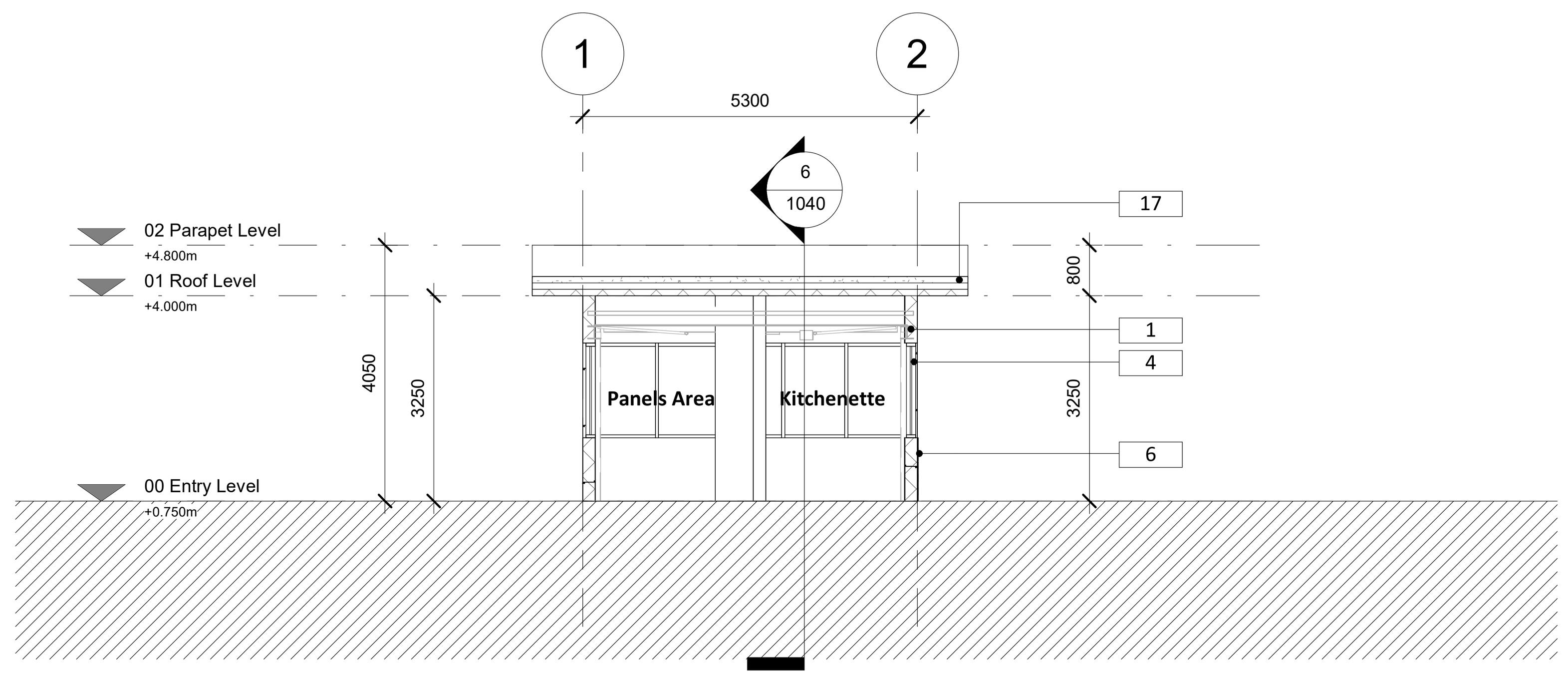
D: +44 (0)20 8763 5900

BSM Est. 1968

DONNACHADH O'BRIEN & ASSOCIATES CONSULTING ENGINEERS



1 **East Elevation**
1 : 100



5 **Section 01**
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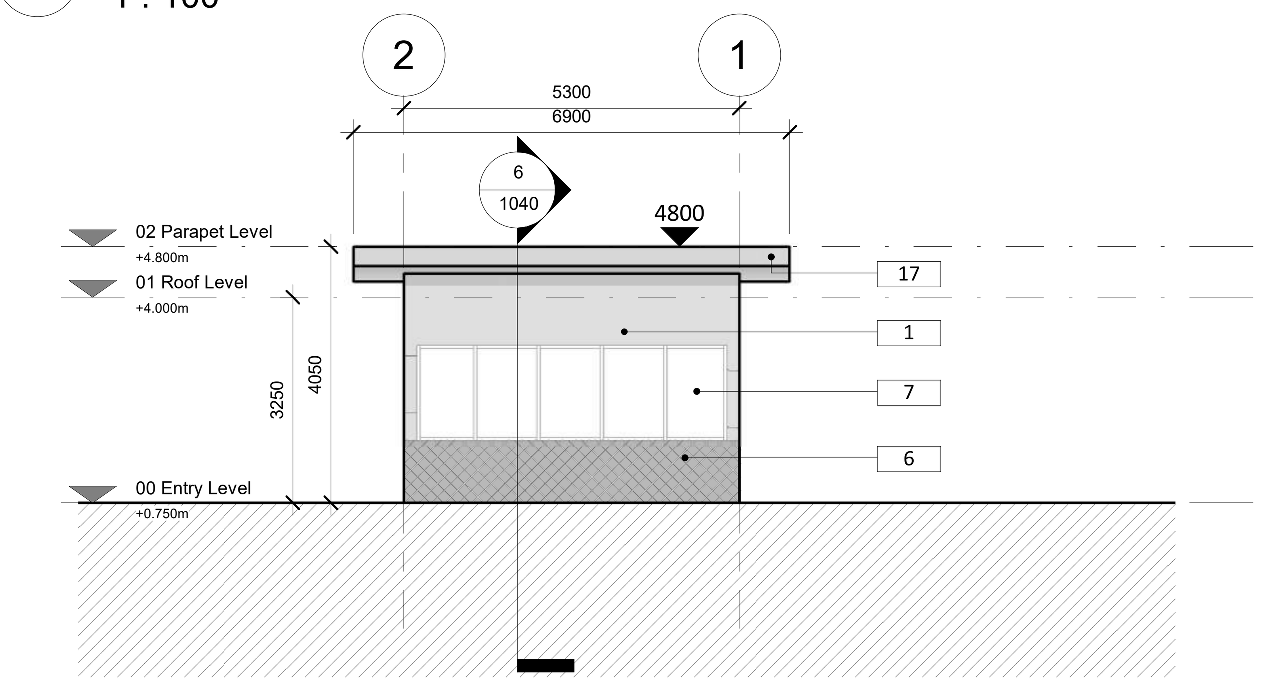
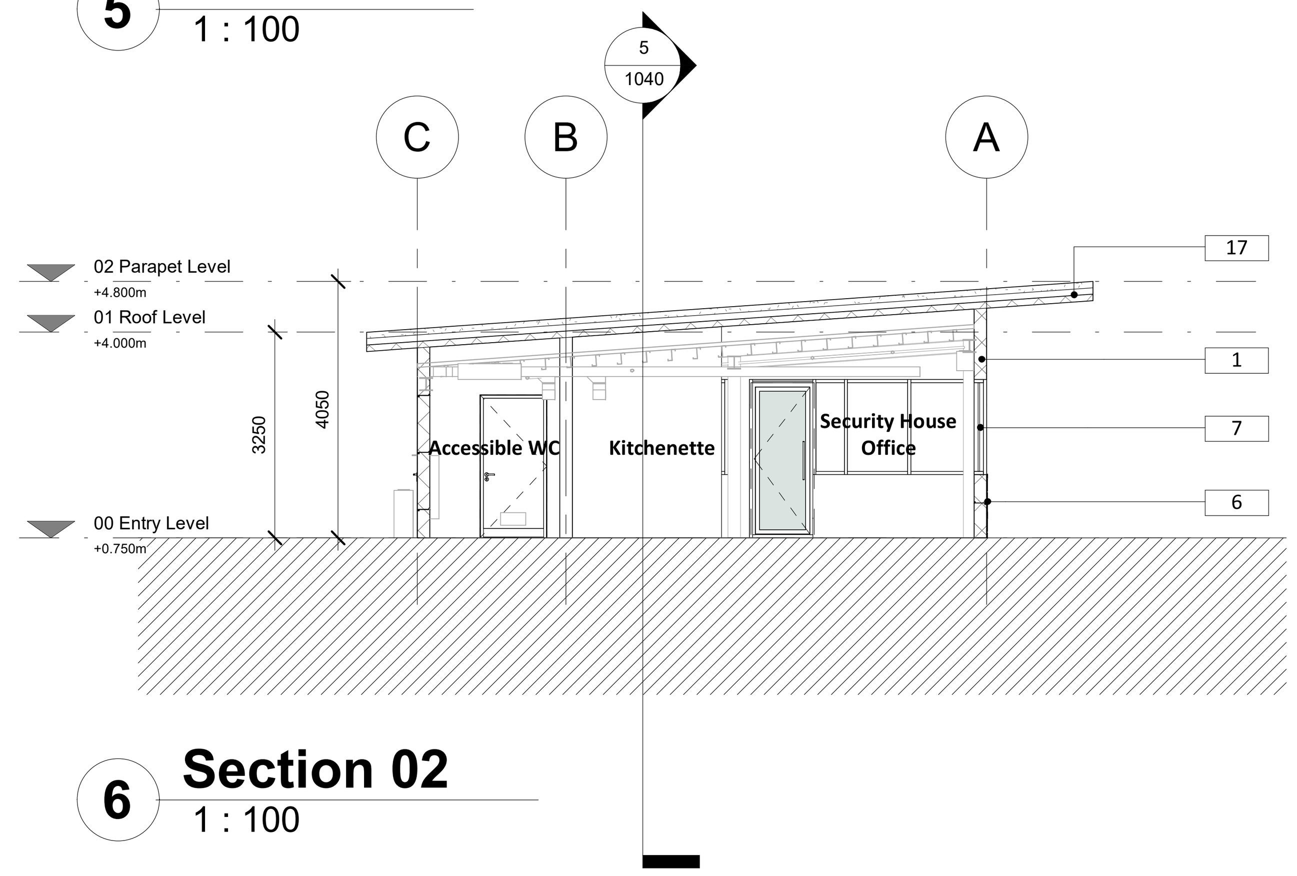
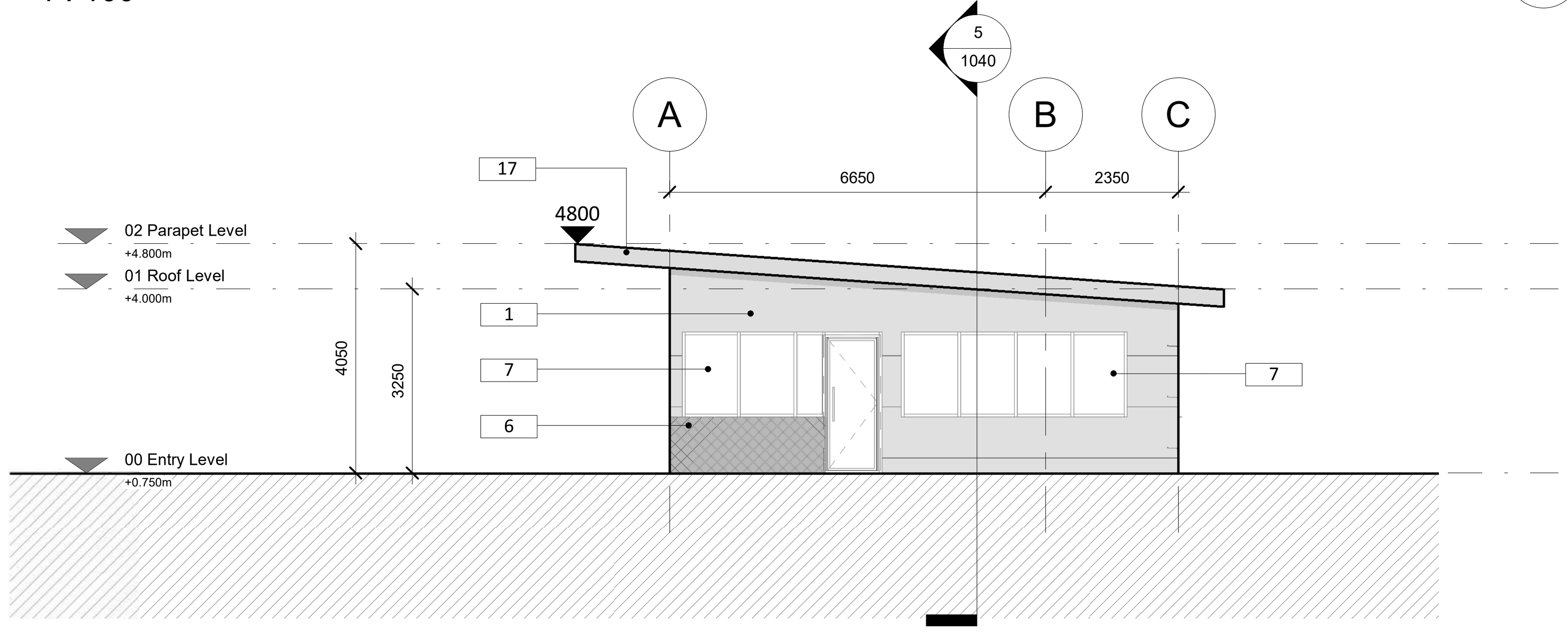


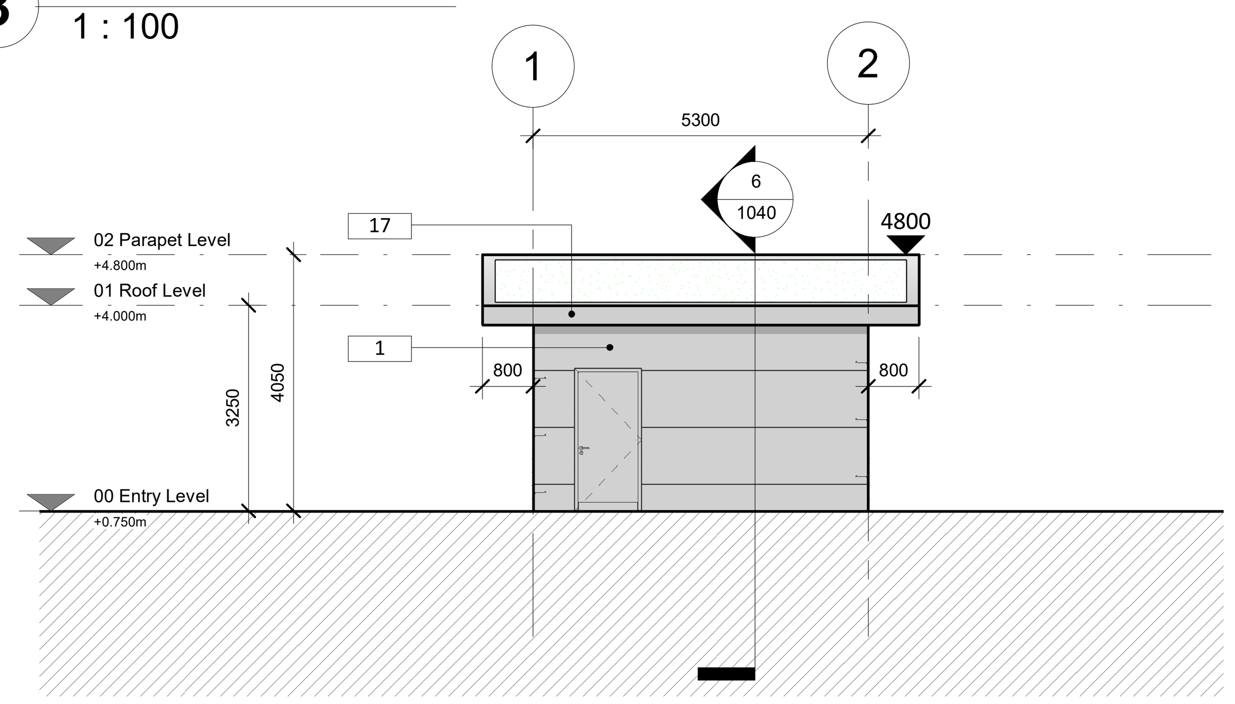
2 **North Elevation**
1 : 100



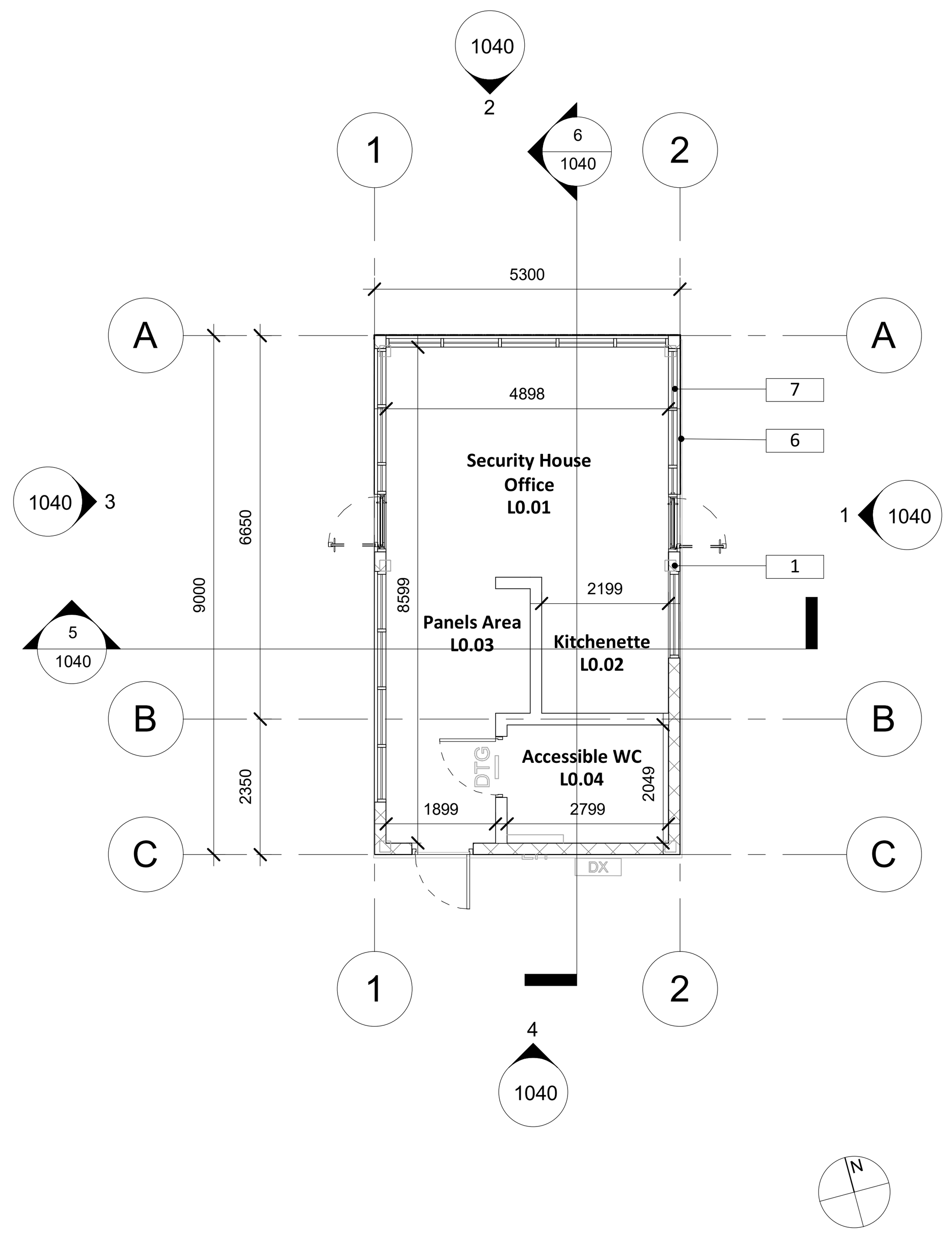
6 **Section 02**
1 : 100



3 **West Elevation**
1 : 100



4 **South Elevation**
1 : 100



7 **Ground Floor Plan**
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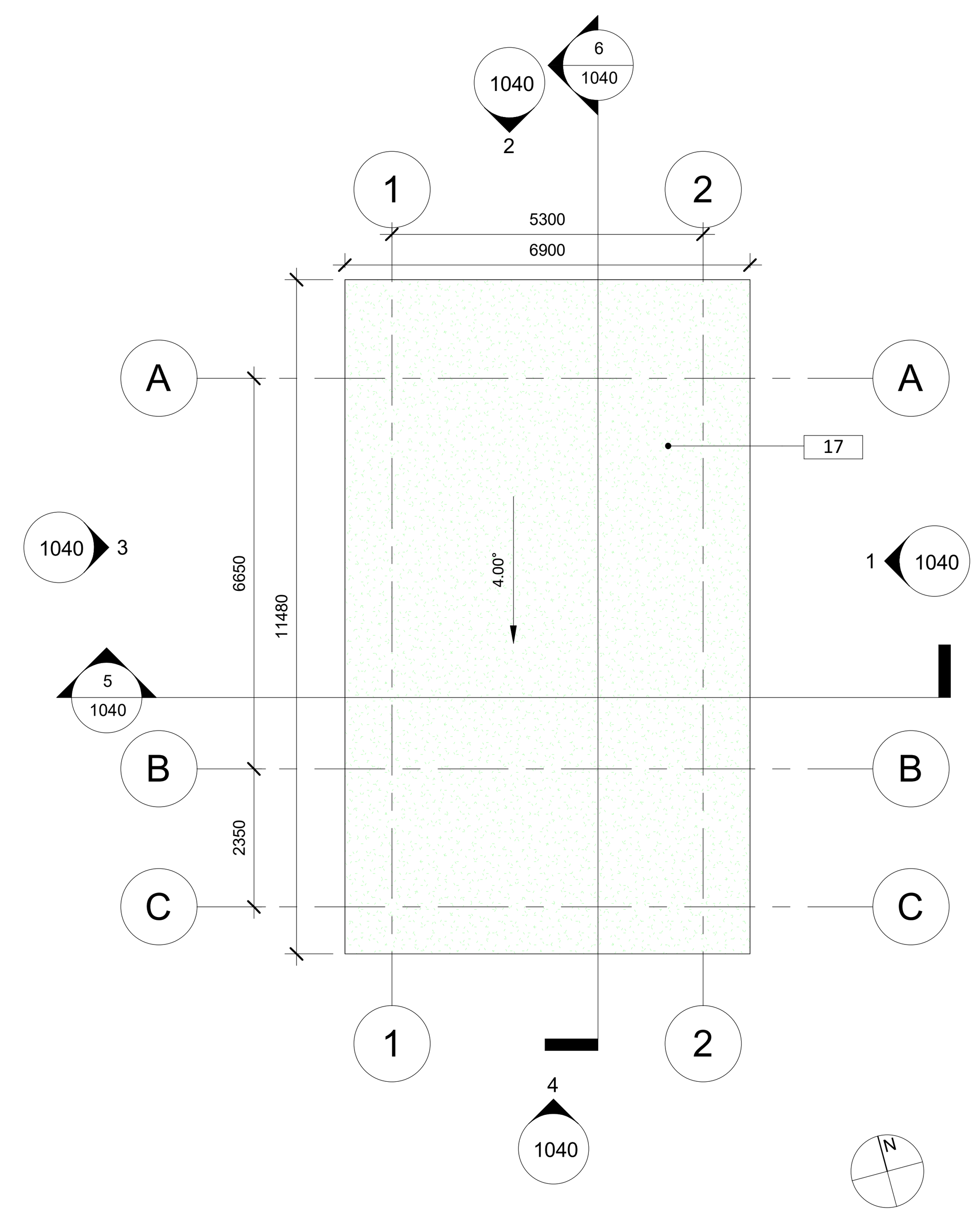

8 **Roof Plan**
1 : 100

SECURITY HOUSE - GROSS INTERNAL AREA		
LEVEL	NAME	AREA
00 Entry Level	SECURITY HOUSE - GIA	42.1 m²
GROSS INTERNAL TOTAL AREA		42.1 m²

SECURITY HOUSE - NET INTERNAL AREA		
ROOM No.	NAME	AREA
L0.01	SECURITY HOUSE OFFICE	19.5 m²
L0.02	KITCHENETTE	5.2 m²
L0.03	PANELS AREA	10.0 m²
L0.04	AWC	5.7 m²
00 Entry Level		40.5 m²
NET INTERNAL TOTAL AREA		40.5 m²

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A1

HERBATA GREEN ENERGY DATA

Notes:

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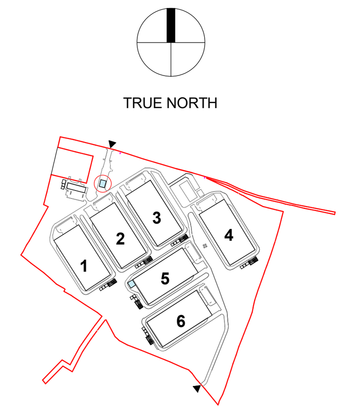
19. ACOUSTIC PANEL.

KEY PLAN

TRUE NORTH



Rev.	Date	Description
P08	03/11/2023	PLANNING ISSUE
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P06	11/07/2023	PLANNING ISSUE
P05	02/06/2023	DRAFT PLANNING ISSUE
P04	28/04/2023	STAGE 2 ISSUE
P03	10/03/2023	DRAFT ISSUE
P02	28/02/2023	DESIGN FREEZE - STAGE 2
P01	24/02/2023	Pre-Planning

STATUS: PLANNING

PROJECT: HERBATA DATA CENTRE CAMPUS

PROJECT ADDRESS: NAAS, CO. KILDARE

DWG TITLE: PROPOSED SECURITY HOUSE

DWG NO.: 22217-RKD-ZZ-ZZ-DR-A-1040

REV.	STATUS	PROJECT NO.	SCALE
P08	S3	22217	1:100

DATE: 03/11/2023 | DRN: ROC | CHK: KOS

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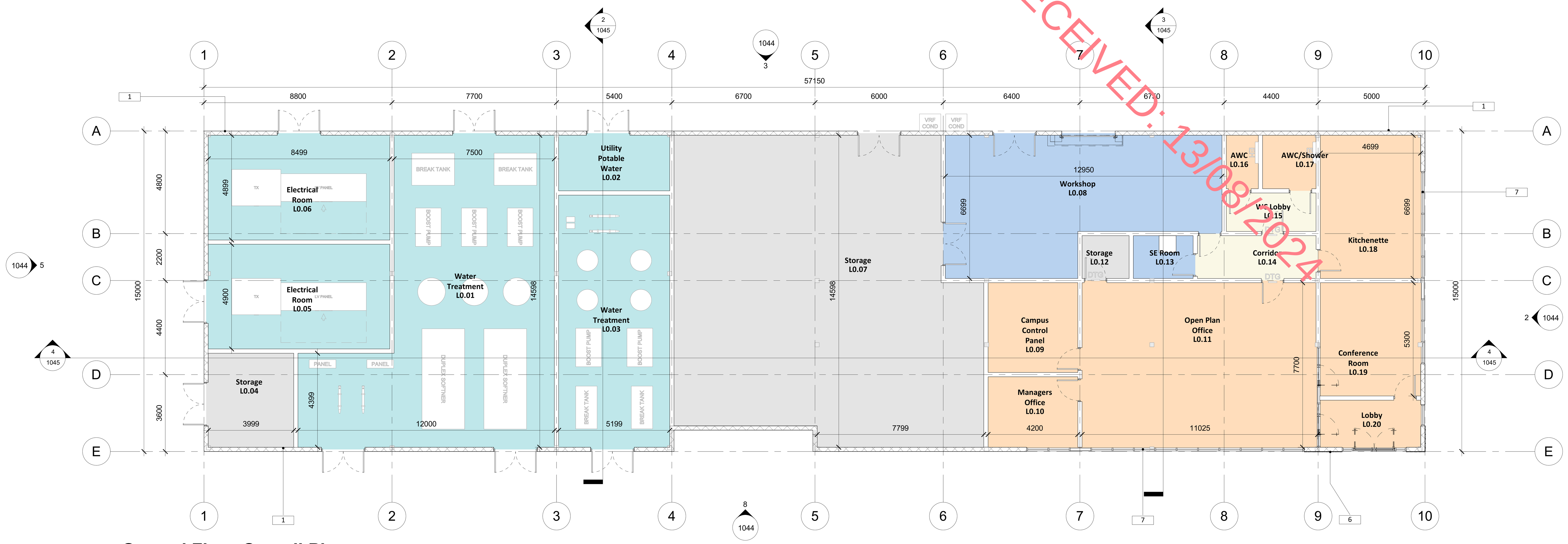
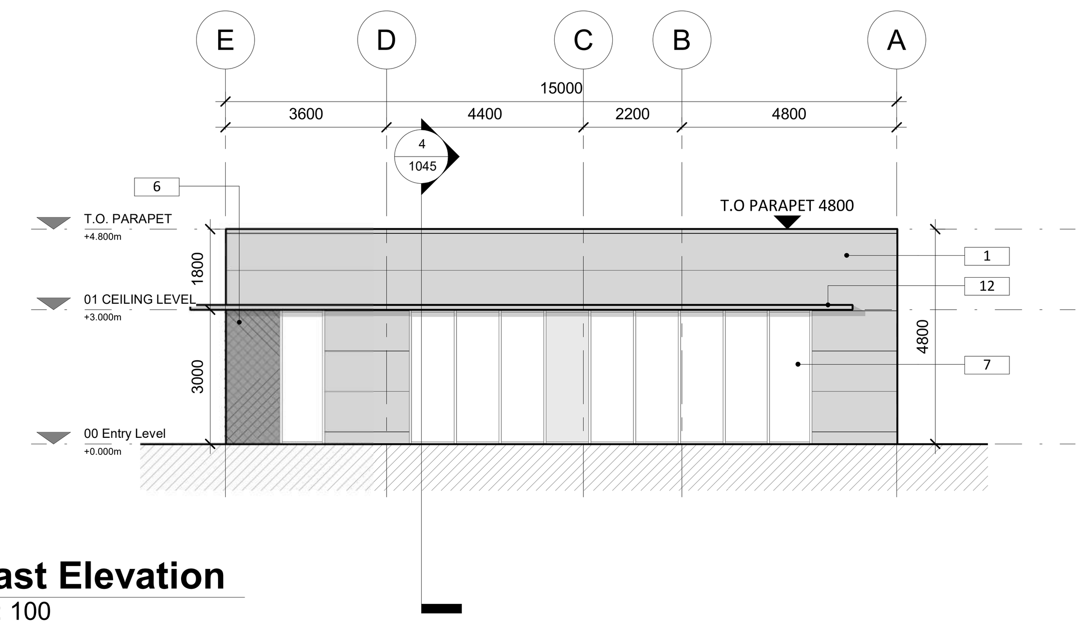
BSM
Est. 1968

DONNACHADH O'BRIEN
& ASSOCIATES CONSULTING ENGINEERS



1 Ground Floor Overall Plan
1 : 100



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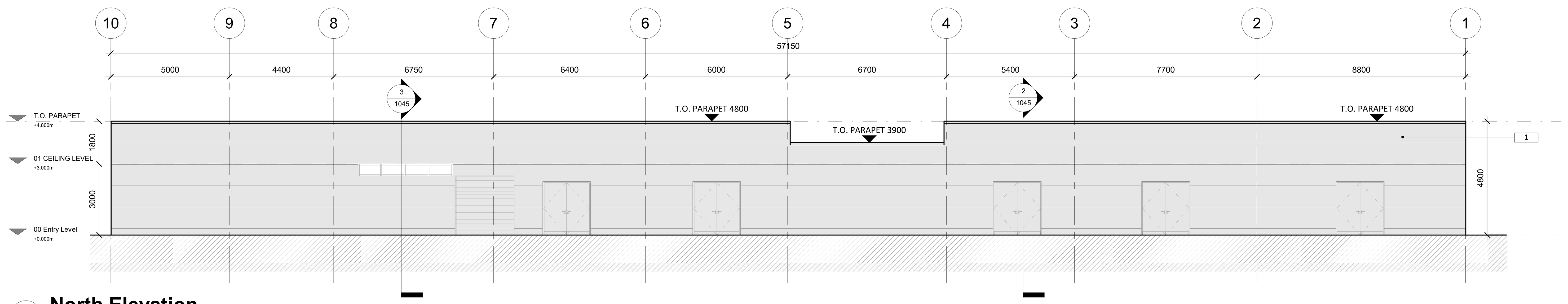

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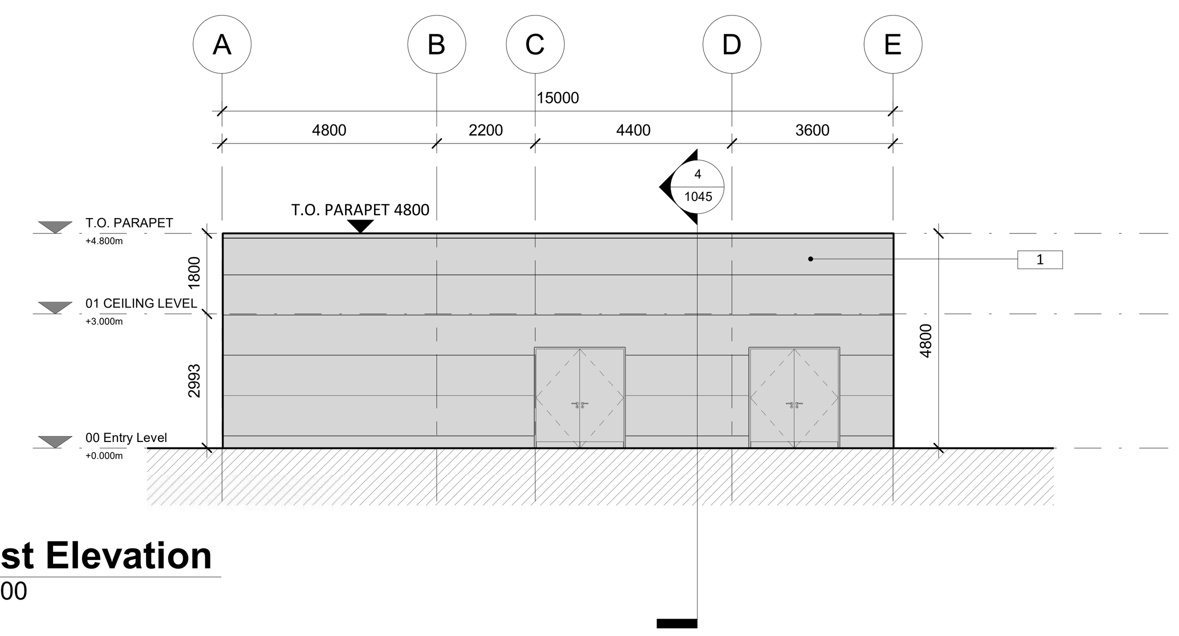

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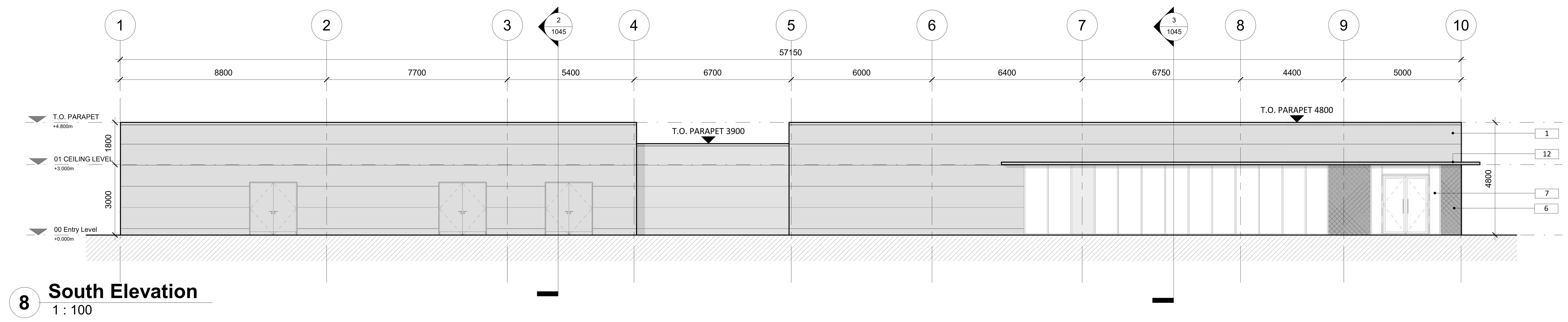

8 South Elevation
1 : 100

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A0

HERBATA GREEN ENERGY DATA

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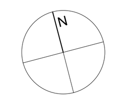
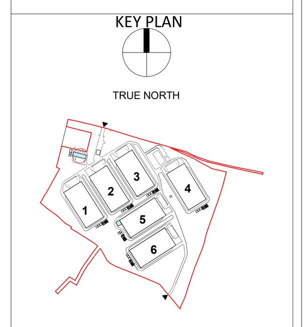
AREA LEGEND

- ADMIN
- BACK OF HOUSE
- CIRCULATION
- MECHANICAL / ELECTRICAL
- STORAGE





Rev.	Date	Description
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P06	11/07/2023	PLANNING ISSUE
P05	02/06/2023	DRAFT PLANNING ISSUE
P04	28/04/2023	STAGE 2 ISSUE
P03	10/03/2023	DRAFT ISSUE
P02	28/02/2023	DESIGN FREEZE - STAGE 2
P01	24/02/2023	Pre-Planning

STATUS PLANNING

PROJECT HERBATA DATA CENTRE CAMPUS

PROJECT ADDRESS NAAS, CO. KILDARE

DWG TITLE PROPOSED ADMINISTRATION WORKSHOP & WATER TREATMENT PLANT - SHEET 1

DWG NO. 22217-RKD-ZZ-ZZ-DR-A-1044

REV.	SUITABILITY	PROJECT NO.	22217
P08	S3	SCALE	1:100

DATE 03/11/2023 DRN ROC CHK KOS

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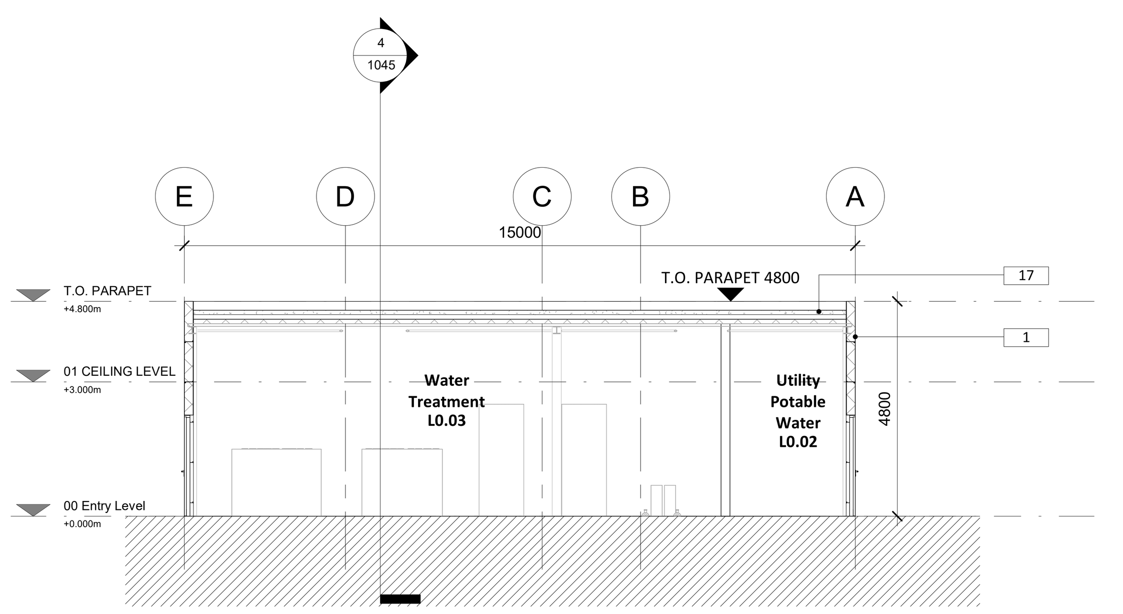
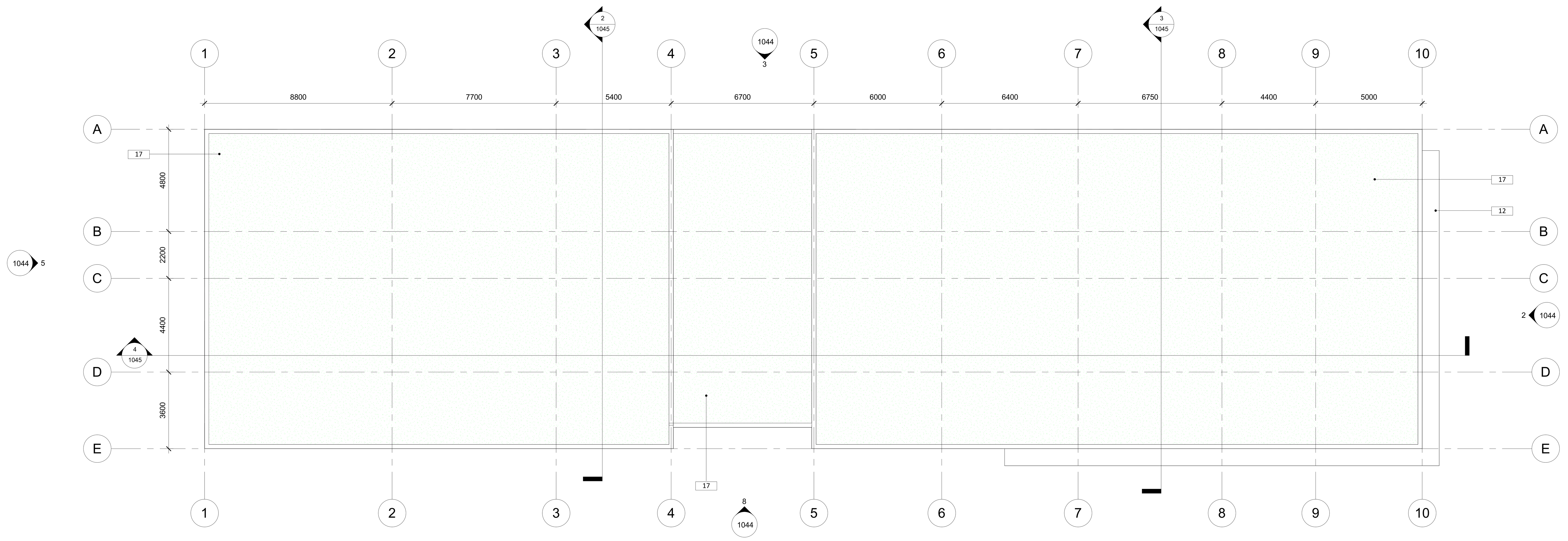
BSM Est. 1968

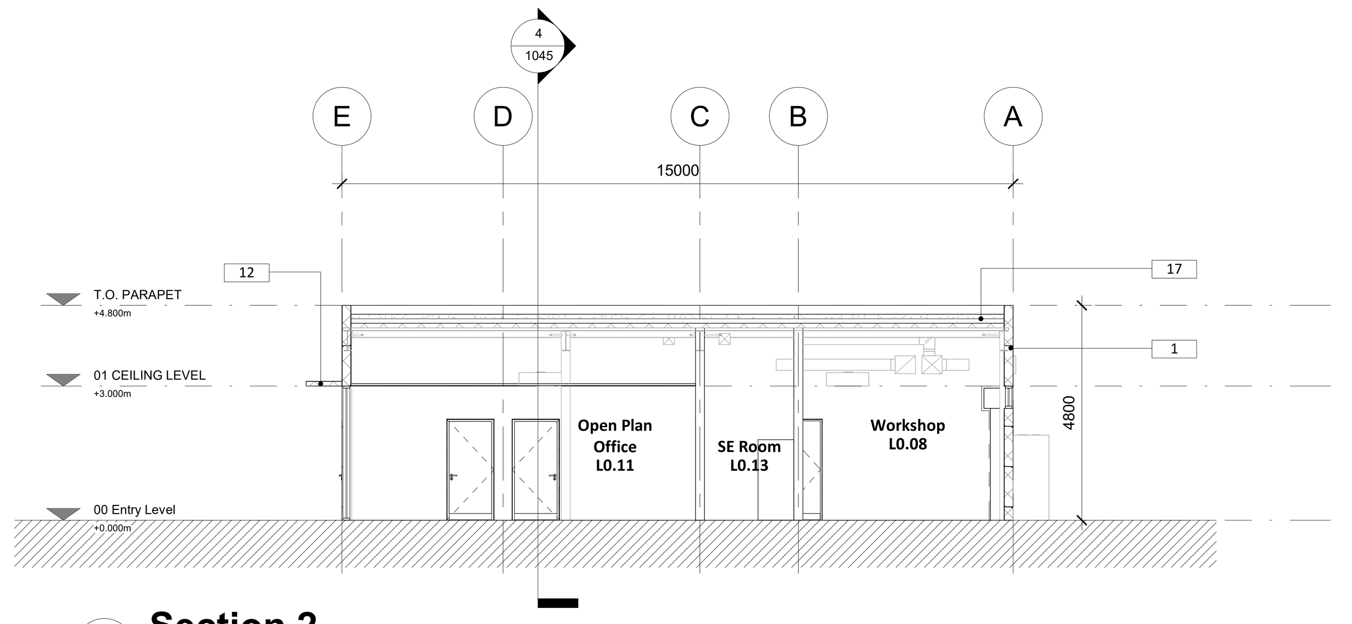
DONNACHADH O'BRIEN & ASSOCIATES CONSULTING ENGINEERS



2 **Section 1**
1 : 100



1 **Roof Plan**
1 : 100



3 **Section 2**
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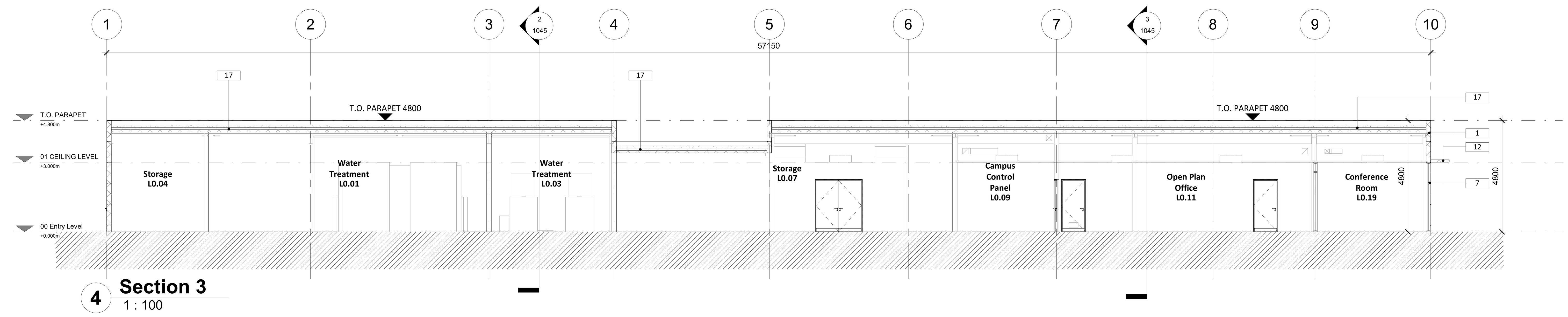

4 **Section 3**
1 : 100

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A0

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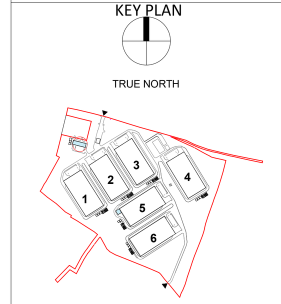
AREA LEGEND

- ADMIN
- BACK OF HOUSE
- CIRCULATION
- MECHANICAL / ELECTRICAL
- STORAGE

KEY PLAN



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P01	28/02/2023	DESIGN FREEZE - STAGE 2

STATUS: PLANNING

PROJECT: HERBATA DATA CENTRE CAMPUS

PROJECT ADDRESS: NAAS, CO. KILDARE

DWG TITLE: PROPOSED ADMINISTRATION WORKSHOP & WATER TREATMENT PLANT - SHEET 2

DWG NO.: 22217-RKD-ZZ-ZZ-DR-A-1045

REV.	SUITABILITY	PROJECT NO.	22217
P05	S3	SCALE	1:100

DATE 03/11/2023 | DRN ROC | CHK KOS

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BSM Est. 1968

DONNACHADH O'BRIEN & ASSOCIATES CONSULTING ENGINEERS

8.3 Appendix 03: Seveso III / COMAH Assessment

Herbata – Data Centre Campus, Naas
Proposed Fuel Storage Technical Review
24th February 2023 Rev 0

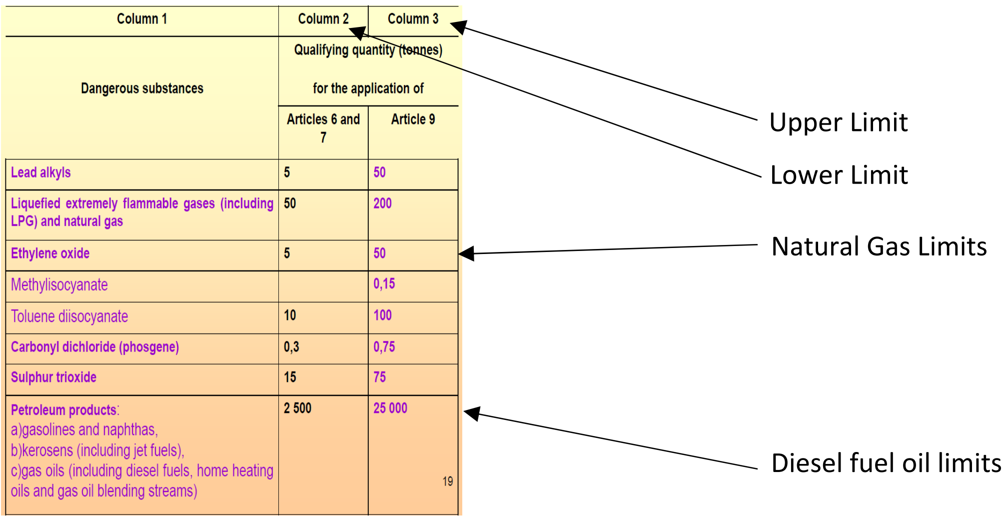
1.0 Introduction

The data centre buildings proposed at the Data Centre site at Naas for Herbata Ltd; include power production facilities within compounds at each building. The primary energy source and normal running of the power production units is by use of a combination of gas turbines and gas engines, is using natural gas from Gas Networks Ireland; these units are directly connected to the local gas infrastructure via Above Ground Infrastructure (AGI) open compound areas which reduce the gas pressure to a more useable pressure.

Consideration is required be given to how the gas turbines and gas engines would continue to run in the event of a supply issue from Gas Networks Ireland, as is usually the requirement for critical data centres. Previously, it had been suggested that significant gas storage could be included on the site in order to support the turbines and engines, however concerns have been raised about exceeding Seveso III[1] Regulations tier limits, as defined in EU Directive 2012/18/EU, for this type of fuel, in response this technical note proposes an alternative arrangement to ensure Seveso tier limits are not exceeded.

2.0 Seveso III Tier Limits

The relevant Seveso III Tier Limits for differing dangerous substances are shown in the extracted table in Table 1 below. The relevant substances are natural gas and the alternative of diesel which would also include HVO version of diesel. By inspection it can be seen that the Lower and Upper Tier limits are significantly higher for diesel reflecting the much lower risk in ignition as compared to natural gas.



Column 1	Column 2	Column 3
Dangerous substances	Qualifying quantity (tonnes) for the application of	
	Articles 6 and 7	Article 9
Lead alkyls	5	50
Liquefied extremely flammable gases (including LPG) and natural gas	50	200
Ethylene oxide	5	50
Methylisocyanate		0,15
Toluene diisocyanate	10	100
Carbonyl dichloride (phosgene)	0,3	0,75
Sulphur trioxide	15	75
Petroleum products: a)gasolines and naphthas, b)kerosens (including jet fuels), c)gas oils (including diesel fuels, home heating oils and gas oil blending streams)	2 500	25 000

Table 1 – Seveso Limits by Substance

[1] https://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2012:197:0001:0037:EN:PDF

The Seveso III Regulations also consider the risk where multiple fuel sources are stored on a site. Attached is a copy of Note 4 from Annex I from the Seveso III Regulations, this describes the procedure for where multiple fuels are stored on a site. In the case of this site, consideration has been given to the storage of diesel and natural gas and how the contribute to the overall risk profile.

3.0 New Storage Proposal

It has been recognised that storing diesel, which is much more inert and much less explosive that natural gas, would be best to be used as the stored fuel on the site. Consideration has been given as to whether the gas turbines and gas engines could be used with diesel as their back up fuels. The output of this consideration is shown in Table 2 below:

Generator Type	Diesel as Secondary Fuel?	Comments
Turbine	Yes	Diesel can be atomised as it is introduced into the turbine and give normal running.
Engine	No	Reciprocating gas engines require a combination of compression and spark ignition, similar to that of a petrol engine. If diesel were to be used instead then the engine would not compress the fuel to provide ignition.

Table 2 – Secondary Fuel Assessment

As can be seen from Table 2, gas turbines can have diesel as a back up fuel, but gas engines cannot.

Based on these results, an assessment has been made on the combination of using diesel for the turbines and gas for the engines, noting that in order to keep below the Seveso Lower Tier level, care will have to be taken on the amount of gas storage used. Attached is the output of calculations that relate both the use of diesel and natural gas for storage, the output of which can be summarised as follows in Table 3:

Fuel Storage Type	Used to support which technology	Total Capacity of Power Units (MW)	Proposed Hours of Storage	Aggregation result (calculation)
Diesel (or HVO)	Turbines	201MW	40 hours	0.9427
Natural Gas (as CNG or LNG)	Engines	30MW	2 hours	0.9842

Table 3 – Seveso Lower Tier Assessment (must be <1)

4.0 Conclusions

A review has been carried out of the proposed form and volume of fuel storage for the turbines and engines proposed for the Herbata Data Centres at Jigginstown, Naas. The outcome of this review has led to the following changes:

- Use of diesel as a secondary fuel for the normal gas-based turbines
- Continue to use natural gas as a secondary fuel for the gas engines
- Reduce the number of hours of storage for the turbines from 48 hours to 40 hours, but now as diesel or HVO
- Significantly reduce the amount of gas storage to 2 hours or less for the gas engines

With the changes noted above, by calculation using the aggregated process within the Seveso III regulations, it can be shown that the fuel storage will be below the Lower Tier noted within the Seveso III regulations.

END

Attached:

- Seveso III Annex I extract – Note 4
- Fuel Storage Options - Gas Turbines on Diesel, Recip Engines on Gas (CNG)

SEVESO III REGULATIONS - ANNEX I — DANGEROUS SUBSTANCES

NOTE 4 (Mixture of substances)
The following rules governing the addition of dangerous substances, or categories of dangerous substances, shall apply where appropriate:

In the case of an establishment where no individual dangerous substance is present in a quantity above or equal to the relevant qualifying quantities, the following rule shall be applied to determine whether the establishment is covered by the relevant requirements of this Directive.

This Directive shall apply to upper-tier establishments if the sum:

$q_1/Q_{U1} + q_2/Q_{U2} + q_3/Q_{U3} + q_4/Q_{U4} + q_5/Q_{U5} + \ldots$ is greater than or equal to 1,

where q_x = the quantity of dangerous substance x (or category of dangerous substances) falling within Part 1 or Part 2 of this Annex,

and Q_{UX} = the relevant qualifying quantity for dangerous substance or category x from Column 3 of Part 1 or from Column 3 of Part 2 of this Annex.

This Directive shall apply to lower-tier establishments if the sum:

$q_1/Q_{L1} + q_2/Q_{L2} + q_3/Q_{L3} + q_4/Q_{L4} + q_5/Q_{L5} + \ldots$ is greater than or equal to 1,

where q_x = the quantity of dangerous substance x (or category of dangerous substances) falling within Part 1 or Part 2 of this Annex,

and Q_{LX} = the relevant qualifying quantity for dangerous substance or category x from Column 2 of Part 1 or from Column 2 of Part 2 of this Annex.

This rule shall be used to assess the health hazards, physical hazards and environmental hazards. It must therefore be applied three times:

for the addition of dangerous substances listed in Part 2 that fall within acute toxicity category 1, 2 or 3 (inhalation route) or STOT SE category 1, together with dangerous substances falling within section H, entries H1 to H3 of Part 1;

for the addition of dangerous substances listed in Part 2 that are explosives, flammable gases, flammable aerosols, oxidising gases, flammable liquids, self-reactive substances and mixtures, organic peroxides, pyrophoric liquids and solids, oxidising liquids and solids, together with dangerous substances falling within section P, entries P1 to P8 of Part 1;

for the addition of dangerous substances listed in Part 2 that fall within hazardous to the aquatic environment acute category 1, chronic category 1 or chronic category 2, together with dangerous substances falling within section E, entries E1 and E2 of Part 1.

The relevant provisions of this Directive apply where any of the sums obtained by (a), (b) or (c) is greater than or equal to 1.

Fuel Storage Options - Gas Turbines on Diesel, Recip Engines on Gas (CNG)
Jigginistown, Naas Site
24th February 2022 Rev4

Column 1	Column 2	Column 3
Dangerous substances	Qualifying quantity (tonnes) for the application of	
	Articles 6 and 7	Article 9
Lead alkyls	5	50
Liquefied extremely flammable gases (including LPG) and natural gas	50	200
Ethylene oxide	5	50
Methylisocyanate		0,15
Toluene diisocyanate	10	100
Carbonyl dichloride (phosgene)	0,3	0,75
Sulphur trioxide	15	75
Petroleum products: a)gasolines and naphthas, b)kerosens (including jet fuels), c)gas oils (including diesel fuels, home heating oils and gas oil blending streams)	2 500	25 000 19

1) Base Criteria - Diesel Storage for Turbines

Number of Data Centre buildings	6	Nr.
IT load per data centre building	30.84	MW
Peak PUE assumed	1.25	Nr.
Maximum load per building	38.6	MW
Total Load demand for site (less recip capacity)	201	MW
Number of hours of storage required (Option A)	40	hours
Diesel Storage Energy Capacity per building	1542	MWh
Diesel Storage Site Energy Capacity	8052	MWh

Seveso / COMAH Regulations regarding fuel types

Gas Oil/Diesel (Column 2) - Lower Tier	2500	tonnes
Gas Oil/Diesel (Column 3) - Upper Tier	25000	tonnes

Mix of fuel types is provided on a proportional basis

Diesel Fuel Usage (turbines assumed similar to recips)

			Aggregation Calculation 1	Aggregation Calculation 2
Diesel Fuel Usage for turbines	260	litres per hour/MW		
Total quantity of diesel for site	**2,094**	m3		
Weight of diesel per litre	0.84	tonnes/cu.m		
Weight of diesel required for site	**1,759**	**tonnes**	**0.7034**	**0.7034**

(Weight is below Lower Tier Seveso level for gas oil/diesel)

2) Base Criteria - Gas Storage for Recips

Number of Data Centre buildings	6	Nr.
IT load per data centre building	5	MW
Peak PUE assumed	1	Nr.
Maximum load per building	5.0	MW
Total Load demand for site	30	MW
Number of hours of storage required	2	hours
Gas Storage Energy Capacity per building	10	MWh
Gas Storage Site Energy Capacity	60	MWh

Seveso / COMAH Regulations regarding fuel types

LPG / LNG /CNG (Column 2) - Lower Tier	50	tonnes
LPG / LNG /CNG (Column 3) - Upper Tier	200	tonnes
Gas Oil/Diesel (Column 2) - Lower Tier	2500	tonnes
Gas Oil/Diesel (Column 3) - Upper Tier	25000	tonnes

Mix of fuel types is provided on a proportional basis

Recip Gas Usage (assumed similar to turbines)

Gas input fuel flow (imperial) for 5.539MW	60.82	mmBTU/hr	
Gas input fuel flow (converted to metric)	1723	m3/hr	
Gas turbine power size	5.539	MW	
Total quantity of natural gas (uncompressed) per MWh	311	m3 per MWh	
Total quantity of natural gas (uncompressed)	**18,664**	m3	
Assumed compression ration of natural gas to CNG	200		
Volume of CNG required for site	**93**	m3 NTP	
https://www.aqua-calc.com/calculate/volume-to-weight			
Weight of gas required for site (CNG)	**12**	**tonnes**	**0.2393**

(Weight is below Lower Tier Seveso level for gas)

Gas input fuel flow (imperial) for 1MW	12870	ft3/hour	
Gas input fuel flow (converted to metric)	365	m3/hr	
Gas engine power size	1	MW	
Total quantity of natural gas (uncompressed) per MWh	365	m3 per MWh	
Total quantity of natural gas (uncompressed)	**21,900**	m3	
Assumed compression ration of natural gas to CNG	200		
Volume of CNG required for site	**110**	m3 NTP	
https://www.generatorsource.com/Natural_Gas_Fuel_Consumption.aspx			
Weight of gas required for site (CNG)	**14**	**tonnes**	**0.2808**

(Weight is below Lower Tier Seveso level for gas)

3) Overall Site Seveso Assessment (both fuels)

	Calculation 1	Calculation 2
Aggregation	**0.9427**	**0.9842**

Where an establishment has no individual substance or preparation present in a quantity above or equal to the relevant thresholds Schedule 1 requires the quantities of all the dangerous substances present in an installation to be added together as partial fractions of their threshold quantities. If the total equals or exceeds 1, the Regulations apply. See Note 4 to Schedule 1 Part 3 of the COMAH Regulations for partial fraction method.

8.4 Appendix 04: Guidance on Li Ion Battery Fires Report

RECEIVED: 13/08/2024

Guidance Note

Fire Industry Association

Guidance on Li Ion Battery Fires

1. INTRODUCTION

This document has been prepared by the FIA Li-ion battery SIG, which comprises FIA members and other interested parties and organisations.

The SIG is open to FIA members and others with an interest in increasing the understanding of the issue of lithium-ion battery fires and protecting people and property from consequences of these fires.

This document represents the current understanding of the industry and will be updated as more information becomes available.

2. SCOPE

This FIA guidance paper provides information on the issues related to the use of Lithium-ion batteries, how fires start in batteries and on how they may be detected, controlled, suppressed and extinguished. It also provides guidance on post fire management. Excluded from the scope are explosion and ventilation issues.

3. TERMS AND DEFINITIONS

The block plan should be located at the entrance to the building or close to the fire panel, in a location easily accessible by fire and rescue services or other interested parties.

3.1 Battery
a container consisting of one or more cells, in which chemical energy is converted into electricity and used as a source of power.

3.2 Lithium-ion Battery
a rechargeable battery that uses lithium-ions as the primary component of its electrolyte.

3.3 Energy Storage
the capture of energy produced at one time for use at a later time.

3.4 Energy Storage System
collection of batteries used to store energy.

3.5 Electric Vehicle
vehicle which uses one or more electric motors for propulsion.

3.6 Battery Management System (BMS)
electronic system that manages a rechargeable battery.

3.7 Thermal Runaway
exothermic chemical reaction generating more heat than is being dissipated,
note: this can be characterised where a self-heating rate of 10oC/min or greater occurs.

3.8 Thermal Propagation
Where a single battery cell thermal runaway spreads to neighbouring cells.

3.9 Fire Tetrahedron
elements required to sustain a fire - Fuel, Heat, Oxygen and a Chemical Chain Reaction.

3.10 Off-gassing
venting of flammable/ toxic electrolyte vapours.

4. BATTERY TYPES

Lithium-ion batteries vary widely, and continue to evolve, in terms of their materials of construction, chemistry and configuration. Lithium-ion batteries are rechargeable (as opposed to lithium batteries which are not) and all contain lithium-ions in a flammable electrolyte. They do not contain any free lithium metal.

Cell enclosures may typically be metal or polymer used to configure as cylinders (jellyroll), pouch/polymers (squashed jelly roll/ books/sheets) or prismatic. Cathodes are an oxide coated lithium, such as lithium cobalt oxide with an anode, such as graphite, in an electrolyte with a poly film separator.

The batteries vary in size and configuration depending on their use and application. Larger batteries may be found in Energy Storage Systems (ESS) and vehicles whilst smaller batteries are used in laptops and mobile phones with lots of intermediate applications. Batteries are arranged in series to increase voltage, and in parallel to increase capacity.

5. FIRE ISSUES

As Lithium-ion batteries do not contain any free lithium metal (as stated above) they should not be regarded as a ‘metal’ fire threat.

Ways fires can start:

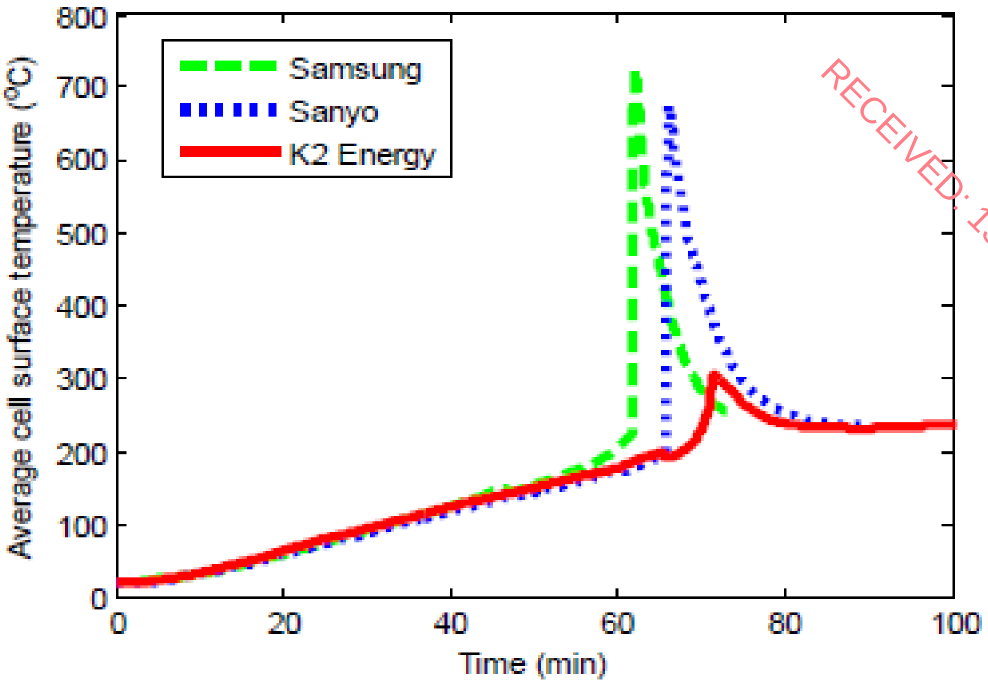
- Internal manufacturing defects (material defects, construction, contamination).
- Physical damage (during assembly, shipping, handling, waste disposal, accidental during product use).
- Electrical abuse (overcharging, over - discharging, short circuit).
- Thermal abuse (exposure to high temperatures).

Cell failure results in a voltage drop and increasing heat release and signals the start of ‘thermal runaway’. This typically develops through the following events:

1. Temperature increase
2. Venting/gassing off of flammable/toxic electrolyte vapours
3. Flare
4. Steady burn
5. Flash fireball
6. Explosion

Thermal Runaway starts in a single cell before thermal propagation creates a domino effect through the adjacent cells.

Defects and physical damage can create internal short circuits leading to cell failure. Other events which could lead to cell failure arise external to the cells and so may be detected. The thermal runaway phase exhibits increasing temperature and heat release plus venting/ gassing off of flammable/ toxic electrolyte. This accelerates as cell failure approaches.



The battery cell surface temperature during external heating (oven) abuse test, showing the temperature rise upon external heating and the rapid temperature peak due to thermal runaway for two types of cobalt based cells (Samsung and Sanyo) and for a lithium iron phosphate cell (K2 Energy). All three cells are of the 18650 type. Reprinted with permission of F. Larsson [3].

Lithium-ion batteries, for example those used to power electric vehicles are in fact many hundreds, even thousands of individual cells, which may look similar in some respects to a packaging of regular AA battery and the issue is that, if they overheat and catch fire or even explode, the reaction quickly passes to the next cell and so on. This can happen due to short circuits, faulty design, physical damage, poor manufacturing processes etc; Battery manufacturers introduce safety devices/controls that aim to detect abnormal conditions developing and shutting down the batteries before it gets to thermal runaway. Monitoring of off-gases is also used to detect abnormal conditions developing.

6. FIRE SOLUTIONS

6.1 General

This section considers the various fire solutions available which are

- protection,
- detection,
- suppression and extinguishing.

It describes how the various options function and where data is available provides examples of where the solution has been used on a lithium-ion battery fire.

6.2 Protection

6.2.1 Containment

One method of handling fires in Lithium-ion batteries is to contain the battery and fire to prevent it spreading to other cells or materials.

This can be a solution for small portable battery powered devices.

At this time, most commercial airlines issue a fireproof bag to aircraft crew which have been successful in containing small battery fires on aircraft. Examples from FAA reports[1]) include:

"On SWIA flight 5598 from Los Angeles (LAX) to Mammoth, CA (MMH), after push back, a flight attendant's electronic flight attendant device (EFAD) battery caught on fire. The fire was extinguished quickly and the EFAD was placed in the fire containment bag. The crew declared an emergency with ground control and the fire department met the flight at the gate. The fire containment bag was removed from the aircraft and the aircraft was cleared. The flight deplaned through the jet bridge normally. The flight attendant reported that prior to the incident, he had dropped the device but it did not appear to be damaged so he placed it in his apron when it subsequently caught fire"

"During flight, approximately :45 minutes prior to arrival into Cleveland, OH (CLE), a passenger gave the Flight Attendant a cell phone battery charger with flashlight that was hot and began to smoke. The device was placed in the on-board fire containment bag."

As the size of the battery increases, selecting the methods of containment become more complicated.

For example, when looking at vehicle systems, containment will add weight to the vehicle which might not be the best solution, but protecting the battery pack from mechanical damage is being used as a compromise.

For large Energy Storage Systems, the use of fire walls between the cell packs and housing them in separate ISO containers can mitigate the spread of fire from one to another. Using fire rated containers (typically 90+ minutes fire resistance) with explosion relief can be used for large systems and even for vehicles after a crash. These containers can also be fitted with a suppression/extinguishing system.

6.3 Gas detection

Off-gassing occurs early in cell/battery failure. Some battery cells provide vents specifically intended to release the over-pressure that may develop within individual cells as a result for abuse or failure, others (such as pouches) may expand to accommodate a degree of off gassing but at some point these may burst – perhaps along a seam or pre-designed weak point. Systems that can detect off-gases in low concentrations can provide an early warning of an impending thermal runaway – and trigger shut down systems to electrically isolate the individual, or bank of, or rack of battery cells – and thus avoid thermal runaway occurring in a single cell. Such systems generally rely on a degree of enclosure around the batteries, such as an ESS container or a room housing large banks of batteries. It is not uncommon for effective off gassing detection, specifically tailored to be sensitive to the concoction of gases (predominately H_2, CO_2, CO, Hydrocarbon gases and battery electrolyte solvents) being generated by off gassing, to detect it within 30 seconds of it's initial release from the cell.

Note, the presence and build-up of significant quantities of H_2 and Hydrocarbon gases may present an explosion hazard. While such matters are beyond the scope of this document, it is worth noting that ventilation is an important feature in the mitigation of potentially explosive risks. Such hazards are traditionally associated with the slow accumulation of the gases given off during normal operation (e.g. charging of lead-acid batteries) but they may also occur relatively quickly as a result of the gases emitted during failure or thermal runaway of lithium-ion batteries. Thus, off gassing detection can play an important part in the control of ventilation systems.

It is also worth noting that early detection of off gassing is most effective when the ventilation is limited/minimal or at least fully understood. However, it is often the case that air movement is used to keep batteries cool during normal charging operations. Hence, off gassing sensors need to be strategically positioned and sensitive enough to detect the first signs of off gases before they become too diluted. Reference sensors are often used as well as off-gas sensors and are installed to monitor the ambient air conditions. Moreover, off gassing detection can provide situational awareness of the conditions within a facility; for example, providing information on where the incidence started to assist personnel responding to an event as well as more general information on any hazardous or toxic risks which may indicate that entering the facility is not appropriate.

6.4 Fire detection

As with all fires, a fire event in a lithium-ion cell/battery/installation is basically the rapid oxidation of the cell materials in an exothermic chemical process of combustion, releasing heat, light, and various reaction products, which can be gaseous or solid. Fire detection specialists have developed their products and systems to be capable of detecting one or several of these 'fire' phenomena.

A fire event starts long before flames are visible. Indeed, in certain circumstances a flame may not be produced at all i.e. if the combustible vapours and particles do not have the correct conditions, such as the equipment is contained within an inert gas atmosphere.

To detect the onset of a catastrophic fire event may require the use of several detection methods dependent on the number and layout of the cells and their positioning within their application.

Various phenomena produced throughout the stages of a cell failure event can be detected by different technologies such as: electromagnetic radiation (from IR to UV), visible smoke particles, invisible particulates, vapours, gases and light.

Early detection of a developing situation is key to preventing a fire developing.

Detection can be performed at many physical locations but may be limited by the application – e.g. within or local to the cell/battery (usually provided by the BMS), within the battery package, at equipment level, distant from the equipment, enclosure or room level. Each would have its advantages and be selected on merit to give appropriate and timely signals to other systems as required (e.g. to shut down the battery charging circuit, alert engineering or security staff, trigger the automatic suppression system, evacuation alarms for the building occupants, off-site signalling, etc.).

Detection within tightly assembled battery packaging/systems where, often bulky sensors cannot be placed, can be accomplished by extracting an air sample via a network of tubes and pipes to be analysed by an appropriate detector remotely. Detection of more accessible individual or groups of cells and batteries can be undertaken by video detection employing applicable algorithms. Individual point sensors can achieve in-cabinet and room detection.

A successful detection and prevention of a catastrophic fire event may require several of the methods mentioned above together with the appropriate extinguishing system(s) discussed below.

Significant visible smoke is generated once battery failure starts. Where battery enclosures exist, detectors sensitive to the smoke emitted by batteries may provide warning and be linked to battery management and fire protection systems. Both conventional and early warning type smoke detectors may be used.

Heat is given off once battery failure occurs. Where battery enclosures exist, detectors sensitive to the heat emitted by batteries may provide warning and be linked to battery management and fire protection systems. These may take the form of linear heat sensing cables or infra-red fire detectors.

The smoke and off-gases may be sensed by 'video' cameras with smoke obscuration algorithms and able to link to battery management and fire protection systems.

Smoke detection is unlikely to provide a warning early enough to prevent thermal runaway.

In order to avoid unwarranted release of firefighting agent, it is industry good practice to use 'coincidence' of two or more fire detection signals before initiating release of firefighting agent. A method of manually delaying the automatic release of the agent should be considered as well as a manual release method to by-pass the coincidence in order to release the agent immediately should the situation demand it.

6.5 Suppression and extinguishing

6.5.1 Fixed Systems

6.5.1.1 Gaseous Fire Extinguishing Systems

A gaseous system comprises of one or more containers containing an extinguishing agent. When the system is operated it discharges the agent into an enclosure through one or more discharge nozzles. Systems may be activated manually or automatically through a connection to an appropriate fire detection system.

When considering the protection that may be offered by gaseous fire extinguishing systems, it is important that we separate the protection of enclosures that could house lithium-ion batteries, which is certainly possible and practical in many situations. A scenario where the lithium-ion batteries enter a phase of thermal runaway, which results in a rapid progressive fire and presents a very specific scenario and where the aim is to contain that event and where currently conventional fire protection methods are not yet proven.

Protecting an enclosure where lithium-ion batteries are stored, may be treated as any other gaseous extinguishing system application, taking due account what the most likely hazards within the enclosure would be from normal combustibles that could at some stage create an issue for the lithium-ion batteries themselves, or leakage of the electrolytes from the batteries. In these scenarios, concentrations of agent are selected based on those combustibles, following the Class A, B or C protection given in EN 15004-1. Agent concentrations for several of the common electrolytes have been established for a number of the gaseous agents, but it is important to reiterate that protection is not based on a lithium metal fire. Fires involving lithium metal require different considerations to those applied for lithium-ion batteries.

In the scenario where the lithium-ion batteries have entered an advanced thermal propagation stage, extinguishing gases may not have the heat capacity to remove sufficient heat to allow the battery to cool fast enough and until the materials of combustion are consumed, the fire will continue. The fire is also not dependent on an oxygen supply.

So, protecting even with very high concentrations of any agent, including halocarbon agents that extinguish principally by heat absorption or with the Inert Gas systems designed to displace oxygen may not extinguish the fire.

After off-gases have been released, they could create a flammable atmosphere and should be ventilated. If this is not possible, gaseous agent may be deployed to develop an inerting concentration.

6.5.1.2 Condensed Aerosol Systems

Condensed aerosol systems use similar control and monitoring equipment to gaseous fire suppression systems. They also flood the room with a fire suppression agent. Unlike gaseous fire suppression systems, condensed aerosol systems consist of a solid block compound stored in a non-pressurised container (or generator).

Condensed aerosol generator sizes vary from very small (a few grams) to large (several kilograms). The operation is common to all. Each generator stores its respective volume of agent and has suitably sized discharge outlets. The condensed aerosol generators that store the fire suppression agent are mounted directly in the protected area.

The aerosol consists of micro or nano sized solid particles suspended in another substance such as gas without being dissolved into the gas.

Fire is extinguished by inhibiting the chemical reaction that is a fire (by removing the fourth side of the Fire Tetrahedron).

The number and position of condensed aerosol generators should be in accordance with the guidance given by the equipment manufacturer and with the recommendations of EN 15276: 2019.

EN 15276 states that condensed aerosols should only be used in unoccupied or normally unoccupied areas.

6.5.1.3 Watermist systems

Water mist systems uses small water droplets to provide flame cooling and steam smothering of fires. Their design basis is always determined by full scale fire testing. therefore, water mist should only be used for the protection of lithium-ion batteries where there is an established test protocol.

Note: *There are currently a number of research projects currently investigating the application of watermist on vehicle fires.*

6.5.1.4 Sprinklers systems

Automatic fire sprinkler systems consist of special nozzles, held closed by heat sensitive frangible elements, mounted in steel pipework, at ceiling/roof level, and connected to a dedicated water supply via control valves. The heat from a fire causes one or more sprinklers to open to discharge water onto the seat of the fire and adjacent combustibles. The amounts of water and the number of sprinklers expected to open will increase as the fire load density increases.

In heated buildings, they may be charged with water, but in areas subject to freezing, they will be primed with air until a sprinkler opens. In areas where water damage could be problematic, systems may be primed with air and water admitted when smoke is detected ahead of sprinkler operation.

Only sprinklers in the immediate vicinity of a fire open when subjected to the heat from a fire. Sprinklers provide direct wetting of combustibles and surroundings. Sprinkler protection of lithium-ion batteries is outside the scope of current standard sprinkler design standards e.g. EN, NFPA/FM, however, specialist standards are being developed for example NPFA 855, see next page:

Energy Storage Systems:

National Fire Protection Association (USA) Standard NFPA 855[2]) provides design criteria for Energy Storage Systems (ESS) based upon The NFPA Research Foundation Report 'Sprinkler Protection Guidance for Li-Ion Based Energy Storage Systems' published in June 2019.

Based upon the tests the recommended design basis is a follow:

- K80 sprinklers, at 3m x 3m spacing, with an application density of 12.2 litre/minute/m^2 and an assumed area of operation of 230m^2, with a water supply duration of 90 minutes.

The system is envisaged to 'control' the growth and spread of fire. It is not being claimed to be able to suppress or extinguish a fire in Energy Storage Systems.

WARNING: This is strictly on the basis that the hazard being protected is within the limits of the tests carried out under a 4.6m high ceiling. It is also on the basis that the other fire safety design features addressed in the report are also adopted.

Sprinklers rely on a build-up of heat at ceiling/roof level to activate the sprinkler heads. Their speed of response depends upon the size/ heat output of the fire and the height of the heads above the fire. Sprinklers should be considered as providing fire suppression rather than extinguishment.

6.5.1.5 Water Deluge systems

Deluge systems, unlike sprinklers, use open nozzles so that, when actuated, water discharges from all nozzles in the system. Deluge is used primarily as a means of cooling surfaces exposed to fire. When activated by fire detection systems, they can come into operation more rapidly and provide more comprehensive coverage than sprinklers.

6.5.1.6 Foam systems

Foam systems use foam additives proportioned into a water stream. Foams are generally formulated for use for blanketing and smothering flammable liquid fires. Testing on battery fires has not been published to date.

6.5.1.7 Wetting Agents

Wetting Agents (WA), are defined as;

"liquid concentrates which, when added to plain water in proper quantities, materially reduce the surface tension of plain water and increases its penetration and spreading ability."

There is a range of wetting agents available, but there are key differences between these due to their manufacture or their end use, unlike foams which have a common derivation. However, WA are different.

Some WA are used on ships and are heavily reliant on salt to perform fire suppression, and benefit from saltwater as their mixing agent; some are found in powdered form and require mixing at the pump via a dip tube, some Class A wetting agents, generally used in CAFS, are derivatives of Class B foams and still contain PFAS chemicals and can have significant usage issues, another uses a modified co-polymer, and yet another is based upon tree extracts (saps). Accordingly, they have a wide range of abilities and benefits. Not all WAs are equal, being a WA does not mean that all achieve suppression by reducing the material temperature alone.

As a result, judgements on the efficacy of WAs in this area are more complex, in that the primary WA ability to suppress a high temperature threat, through its penetration and spreading benefits, has to be allied to other benefits to suppress fire incidents and thereby meet the operational need.

Examples of these benefits could include:

- The speed to reduce the battery and/or collateral material temperature below the flash point, and that this is maintained for an extended period, i.e., there is no re-ignition,
- the range of materials which can be extinguished, i.e., not just Class A,
- economic quantities of suppressant needed,
- impact on, and flexibility of delivery methods,
- 'green' qualities of the suppressant,
- scale and complexity of post-event clean-up.

Wetting agents have been used, on fires started by batteries going into thermal runaway, in fire suppression system at industrial sites by exhibiting the benefits outlined above, examples are given below.

WA Applications in the industrial and domestic waste industry.

A) Large scale 'raw' waste re-cycling centres.

These are generally modern constructions, with operating areas both external and enclosed. The primary elements of the approach are:

- A sophisticated software controlled, automated, scanning camera seeking temperature changes in piles of waste, often of several thousand tonnes.
- A high-powered pumping system.
- One or a number of water cannons, able to be directed to the point of temperature increase, with an 80-metre operating range.
- A water-based fire suppressant solution, either pre-mixed or inducted, including Cold Fire at a percentage of 1-3% depending upon the waste mix.
- The system operates 24/7, and can be set to operate totally automatically or manually to meet site needs.
- The control over volume and duration, (e.g., three-minute delivery runs, followed by status checks), is to minimise suppressant usage and therefore run-off volumes (if any), to ensure a speedy clean-up and return to normal operation, within say one hour.

- A number of systems are installed, with a considerable pipeline of orders due in the coming year. A high percentage of incidents are caused by ‘crushed’ batteries from the waste handling process. For example, one large scale site has had nineteen fires in the past twelve months, the great majority from batteries, all successfully dealt with the minimum of downtime.

B) Sorted waste bunkers

These maybe standalone sited pre-delivery storage units or the final stage in the process described in A.

- These are groupings of relatively small storage units with capacities of a few hundred tons of re-saleable waste awaiting onward shipment.
- These bunkers are monitored by fixed smoke detection cameras, allied to high resolution software analysis tools.
- Suppressant, including for example “Cold Fire”, either pre-mixed or inducted is supplied to each bunker through fixed sprinkler pipework.
- Run times will be adjusted to reflect the nature of the waste.

NB. These approaches have not yet been tested where batteries alone are the product being protected. However, one could see that either of the above could have applications if an off-gassing warning system was available to warn at the earliest stage.

6.5.1.8 Aqueous Vermiculite Dispersion

Aqueous dispersions include an aqueous dispersion of chemically exfoliated Vermiculite which is applied in the form of a mist. Vermiculite is the name given to a group of hydrated laminar aluminium-iron-magnesium silicates. Raw vermiculite consists of thin, flat flakes containing microscopic layers of water.

The chemical exfoliation of vermiculite produces microscopic, individual platelets that are freely suspended in water, which yields a stable aqueous dispersion of vermiculite. Vermiculite particles are deposited on the surface of the burning cell, creating a film over the surface. The film dries instantly and the vermiculite platelets overlap each other and bind together. This forms a non-flammable physical oxygen barrier between the fire source and the atmosphere. This process has a cooling effect on the fire. As vermiculite platelets begin to build up the fire is brought under control.

The dispersion simultaneously cools the fuel source as well as encapsulating it and insulating the cells preventing further thermal runaway; this prevents the propagation of the fire.

It is used in the following systems:

- Fixed Installations.
- Portable Extinguishers.
- Mobile Fire Extinguishers.
- Backpack Extinguishers.

Fixed installations are designed to suit the specific requirements of the location and application. These are often specified as a mixed strategy, combined with the dispersion in portable and mobile fire extinguishers to enable an agile response in a fire situation. Current projects using the product in fixed installations include electric vehicle manufacturing production lines, battery processing and storage facilities as well as onboard systems in public service and industrial electric vehicles.

Vermiculite dispersions have been successfully tested using established test protocol, by lithium battery specialists, ZSW.

Vermiculite is a naturally occurring mineral that is exempt from REACH regulations. It is chemically and physically inert, releasing only steam when exposed to raised temperatures rendering it sterile. It is non-toxic to humans, flora and fauna.

Some benefits of using vermiculite dispersions when considering a lithium-ion battery-based risk are:

- The water content cools the fire source immediately.
- Vermiculite platelets encapsulate the fuel source creating a physical oxygen barrier which withstands further exposure to heat.
- The vermiculite film is not electrically conductive.
- It can be applied as a fire break to prevent the propagation of fire.
- It can be easily deployed using standard firefighting equipment.

It is environmentally friendly.

6.5.1.9 Powder systems

Powder comprises very fine particulates of metal salts which inhibit the combustion process, similar to aerosols (see above). Powder does not have any cooling properties.

As these are not metal fires, class D powders such as L2 (for lithium metal fires), are not suitable for lithium-ion battery fires.

6.5.1.10 Oxygen Reduction Systems

Oxygen reduced air is used as a fire prevention method, creating a closely controlled environment with continuously lowered oxygen concentrations within an enclosure.

Oxygen reduced air (often through the addition of Nitrogen) is introduced into the enclosure to produce an oxygen concentration below that necessary for combustion.

Reduced oxygen concentrations can be used to prevent or suppress flaming combustion, thus creating conditions in which fires cannot freely develop.

The level of oxygen reduction must be defined by the ignition threshold of risks within the enclosure.

The design basis should be determined through fire testing (see EN 16750:2017) but, to date specific test data has not been published in relation to lithium-ion batteries.

Oxygen Reduction Systems can prevent Flame Stacks but this can lead to excess toxic & flammable fumes leaving the enclosure which then need to be dealt with.

Therefore, oxygen reduction systems should only be used for the protection of Li-Ion batteries where specific testing has first taken place.

6.5.2 Portable fire Extinguishers

Portable fire extinguishers should only be used on individual small rechargeable devices (such as laptops, mobile phones, e-cigarettes, power tools etc.) containing lithium-ion batteries which have been disconnected from mains power. Complete extinguishment may not be possible but use of a nearby water or water-based extinguisher should prevent the fire from spreading to other nearby materials, whilst the alarm is raised.

7. POST FIRE MANAGEMENT

7.1 Batteries

When a battery fire is extinguished a significant fire hazard may still remain; those batteries involved in and affected by the fire are likely to be hot and still pose the potential to vent combustible and toxic gases and also have the potential to reignite.

It is therefore necessary that post fire management operations commence as soon as practicable by suitably equipped and trained personnel. This may include:

- Ventilation
- Extraction
- Isolation
- Fire watch (using thermal imaging cameras to monitor the temperature)
- Recovery

The level of post fire management of the battery will be dependent on battery size for single cell/pouch devices once the fire is extinguished the risk of further fires is minimized.

7.2 Media

Media should be disposed of via an environmentally suitable method.

The design and installation standard for the various fire fighting systems include information on the post discharge provisions.

Toxic gases dampened down by water-based systems can lead to contaminated run-off which will need to be contained.

8. CONCLUSIONS

Lithium-ion batteries can develop into significant and unstoppable thermal runaway fires so carefully considered measures are required to address the hazards that these pose and the options available to manage such risks.

Incipient and pre-fire conditions in lithium-ion batteries can be detected by monitoring several phenomena such as gas & vapour emissions and abnormal temperatures.

Evidence has shown that the key to successful extinguishing of a lithium-ion battery fire is suppressing/extinguishing the fire and then cooling the adjacent cells that make up the battery pack/module.

The fire hazard may remain after the operation of the fire protection system due to the likely damage to adjacent cells caused by the original failure; therefore, remedial actions may be required to prevent a re-escalation.

The use of lithium-ion batteries is widespread and in applications using cell quantities large and small. For this reason, consideration of any fire protection measures must take into account the particular circumstances and hazard configuration and whether any fire protection measures have been validated for the particular application.

In all cases, a risk assessment is required to determine the nature and extent of the fire challenges and the safety measures that should be put in place.

9. REFERENCES

1) FAA Office of Security and Hazardous Materials Safety

2) NFPA 855, NFPA 1 Batterymarch Park, Quincy, Massachusetts, USA 02169-7471

Fire Industry Association

Tudor House, Kingsway Business Park, Oldfield Road, Hampton, Middlesex TW12 2HD
Tel: +44 (0)20 3166 5002 • www.fia.uk.com

8.5 Appendix 05: Extract from NFPA 855

(5) Response considerations similar to a safety data sheet (SDS) that will address response safety concerns and extinguishment when an SDS is not required
(6) Procedures for dealing with ESS equipment damaged in a fire or other emergency event, including contact information for personnel qualified to safely remove damaged ESS equipment from the facility
(7) Other procedures as determined necessary by the AHJ to provide for the safety of occupants and emergency responders
(8) Procedures and schedules for conducting drills of these procedures

4.3.2.1.5 The emergency operations plan in 4.3.2.1 shall not be required for electric utility facilities under the exclusive control of the electric utility located outdoors or in building spaces used exclusively for such installations.

4.3.2.2 Facility Staff Training.

4.3.2.2.1 Personnel responsible for the operation, maintenance, repair, servicing, and response of the ESS shall be trained in the procedures included in the emergency operations plan in 4.3.2.1.

4.3.2.2.2 Refresher training shall be conducted at least annually and records of such training retained in an approved manner.

4.4 Hazard Mitigation Analysis (HMA).

Δ **4.4.1*** A hazard mitigation analysis shall be provided to the AHJ for review and approval where any of the following conditions are present:

(1) Technologies not specifically addressed in Table 1.3 are provided
(2) More than one ESS technology is provided in a single fire area where adverse interaction between the technologies is possible
(3) Where allowed as a basis for increasing maximum stored energy as specified in 9.4.1.1 and 9.4.1.2
(4) Where required by the AHJ to address a potential hazard with an ESS installation that is not addressed by existing requirements
(5) Where required for existing lithium-ion ESS systems that are not UL 9540 listed in accordance with 9.2.2.1
(6) Where required for outdoor lithium-ion battery ESS systems in accordance with 9.5.2.1

Δ **4.4.2 Failure Modes.**

Δ **4.4.2.1*** The hazard mitigation analysis shall evaluate the consequences of the following failure modes and others deemed necessary by the AHJ:

(1) A thermal runaway or mechanical failure condition in a single ESS unit
(2) Failure of an energy storage management system or protection system that is not covered by the product listing failure modes and effects analysis (FMEA)
(3) Failure of a required protection system including, but not limited to, ventilation (HVAC), exhaust ventilation, smoke detection, fire detection, fire suppression, or gas detection

4.4.2.2 Only single failure modes shall be considered for each mode given in 4.4.2.1.

Δ **4.4.3** The AHJ shall be permitted to approve the hazard mitigation analysis as documentation of the safety of the ESS installation if the consequences of the analysis demonstrate the following:

(1) Fires will be contained within unoccupied ESS rooms for the minimum duration of the fire resistance rating specified in 9.6.4.
(2) Fires and products of combustion will not prevent occupants from evacuating to a safe location.
(3) Deflagration hazards will be addressed by an explosion control or other system.

4.4.4 The hazard mitigation analysis shall be documented and made available to the AHJ and those authorized to design and operate the system.

4.4.5* Construction, equipment, and systems that are required for the ESS to comply with the hazard mitigation analysis shall be installed, tested, and maintained in accordance with this standard and the manufacturer's instructions.

4.5 Combustible Storage.

4.5.1 Combustible materials not related to the ESS shall not be stored in dedicated rooms, cabinets, or enclosures containing ESS equipment.

4.5.2 Combustible materials related to the ESS shall not be stored within 3 ft (0.9 m) from ESS equipment.

4.5.3 Combustible materials in occupied work centers shall not be stored within 3 ft (0.9 m) of ESS equipment.

4.5.4 Combustible materials in occupied work centers shall comply with Section 10.19 of NFPA 1 or other applicable fire codes.

4.5.5 Section 4.5 shall not apply to dwelling units.

4.6 Equipment.

4.6.1* Listings. ESS shall be listed in accordance with UL 9540, unless specifically exempted in other sections of this standard.

4.6.2 Repairs.

4.6.2.1 Repairs of ESS shall only be performed by qualified persons and documented in the maintenance, testing, and events log required in 4.2.3.

N **4.6.2.2** Where installed in an electrical substation or electrical power plant, repairs shall be documented in accordance with the operating practices adopted by the responsible electrical utility.

4.6.2.3 Repairs with other than identical or equivalent parts shall be considered a retrofit and comply with 4.6.3.

4.6.3 Retrofits.

4.6.3.1 Retrofits of ESS shall be approved and comply with the following unless modified in other sections:

(1) Battery systems and modules and capacitor systems and modules shall be listed in accordance with UL 1973 and installed in accordance with the manufacturer's instructions.
(2) ESS management and other monitoring systems shall be connected and installed in accordance with the manufacturer's instructions.

8.6 Appendix 06 - Hazard Mitigation Analysis

Hazard Mitigation Analysis

External Plant/Equipment Compound

Index	Item	Failure Mode	Local Effect	Effect on System	Detection means	Safeguards	Mitigation	RAG
1	Thermal runaway of ESS (battery energy storage system)	Internal Lithium-ion cell fault	Rapid increase in temperature and flame production	ESS is disconnected from the system	Contactors are opened control and monitoring system, also protected by fuses	Each ESS has multiple heat & current sensors	Lithium Iron Phosphate (LFP) type cells selected (lower thermal rise) in separate metal cabinets. Sprinklers are provided external to spray over cabinets.	
2	Mechanical ESS failure	Busbar, cable, inductor or inverter failure	Potential short-circuit within each ESS cabinet	ESS is disconnected from the system	Contactors are opened control and monitoring system, also protected by fuses	Each ESS has multiple overcurrent monitoring on d.c. and a.c.sides	Short circuit disconnects individual ESS cabinets before becoming an issue	
3	Supply ventilation to ESS failure	Potential overheating of ESS inverter cabinet (separate to battery compartment)	Fast rise in temperature	ESS is disconnected from the system	Contactors are opened control and monitoring system, also protected by fuses	Each ESS has multiple temperature sensors. There are good cell to cell and rack to rack clearances	High temperature disconnects individual ESS cabinets before becoming an issue	
4	Exhaust ventilation to ESS failure	Potential overheating of ESS inverter cabinet (separate to battery compartment)	Fast rise in temperature	ESS is disconnected from the system	Contactors are opened control and monitoring system, also protected by fuses	Each ESS has multiple temperature sensors	High temperature disconnects individual ESS cabinets before becoming an issue.	

External Plant/Equipment Compound

Index	Item	Failure Mode	Local Effect	Effect on System	Detection means	Safeguards	Mitigation	RAG
5	Cooling system serving battery compartment	Cooling system (refrigerant based) fails to operate	Fast rise in temperature	ESS is disconnected from the system	Contactors are opened control and monitoring system, also protected by fuses	Each ESS battery compartment has multiple temperature sensors	High temperature disconnects individual ESS cabinets before becoming an issue.	
6	Smoke detection failure	Single smoke detector unable to detect smoke in each ESS	Monitoring of potential smoke in individual ESS cabinet is reduced	Fire detection system is partially incapacitated	All smoke detectors are monitored continuously by pulsing, fire alarm system is alerted to engineering personnel	Each ESS cabinet has at least two smoke detectors, both monitored. Failure of one is alerted but second detector still operates	Monitoring of all smoke detectors along with dual detectors for each ESS cabinet	
7	Fire (heat) detection failure	Single heat detector unable to detect high or high rate of rise in temperature in each ESS	Monitoring of potential heat in individual ESS cabinet	Fire detection system is partially incapacitated	All heat detectors are monitored continuously by pulsing, fire alarm system is alerted to engineering personnel	Each ESS cabinet has at least two heat detectors, both monitored. Failure of one is alerted but second detector still operates	Monitoring of all heat detectors along with dual detectors for each ESS cabinet	
8	Fire suppression failure - internal	Internal fire gas suppression is not able to function	None immediately, but would mean ESS has no fire protection capability	ESS cabinet will be required to disconnect	All fire suppression systems in each ESS are monitored continuously by pulsing.	If fire suppression system on an individual ESS is not available, then it is disconnected	Monitoring of each fire suppression system in place with disconnection of ESS if required	

Index	Item	Failure Mode	Local Effect	Effect on System	Detection means	Safeguards	Mitigation	RAG
9	Gas detection failure	No gas detection used	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	
10	Sprinkler system failure	Fractured pipework or sprinkler head	Water suppression not available in the event of a fire	No immediate effect	Loss of pipework pressure on overall sprinkler system	Continuous pressure monitoring	Monitoring as per local code and NFPA standards	
11	Combustibility of materials. Each ESS has two separate fire compartments, with the batteries in one and inverters etc in the other. Both are in metal cabinets with non-combustible components.	Incidence of a fire is supported by combustible materials	Increase in potential fire load	ESS is disconnected from the system	Full fire and heat detection (see notes above). Detection of overcurrents and undervoltage of batteries leading to disconnection of individual ESS cabinets	Disconnection of a.c. and d.c. connection points in each ESS cabinet	All materials are selected with either zero combustibility or low smoke and fume components. Battery cells are LFP chemistry which has the lower fire load of its type.	
12	Installation and Testing	Cabinets and components are not installed correct or are not tested	Incorrect operation leading to fire or overload	ESS is disconnected from the system	A full set of checks will be put in place for installation and testing.	Testing and commissioning will follow the ASHRAE guides, with an independent Cx manager overseeing and reporting.	Installing contractor will be required to certify, test and their installation to the Cx manager. There will be independent verification.	

Index	Item	Failure Mode	Local Effect	Effect on System	Detection means	Safeguards	Mitigation	RAG
13	Maintenance of the complete ESS system and protection systems	Lack of maintenance does not respond to monitoring and allows faults to occur	Incorrect operation leading to fire or overload	ESS is disconnected from the system	An on-site engineering maintenance team will be on site to monitor. BMS also monitors and can disable ESS.	Key suppliers for the fire detection, fire suppression, ESS systems will be in place for regular checks and maintenance.	There will be regular reviews and plans to deal with alarms and alerts. A max 4-hour call out system will be in place for key elements.	
14	Toxicology analysis	Chemicals released in the event of fire or severe damage	Release of chemicals that are toxic, see example	ESS is disconnected from the system	Fire/heat and current/voltage detection	Disconnection of ESS. Full COSHH assessment	Maintenance teams are made aware of toxicology.	

8.7 Appendix 07 - UL 1973 Final Authorization

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AUTHORIZATION TO MARK

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This authorizes the application of the Certification Mark(s) shown below to the models described in the Product(s) Covered section when made in accordance with the conditions set forth in the Certification Agreement and Listing Report. This authorization also applies to multiple listee model(s) identified on the correlation page of the Listing Report.

This document is the property of Intertek Testing Services and is not transferable. The certification mark(s) may be applied only at the location of the Party Authorized To Apply Mark.

Applicant: e2comply, LLC
Address: 8901 Quality Road
Bonita Spring, FL 34135
Country: USA

Manufacturer: e2comply, LLC
Address: 8901 Quality Road
Bonita Spring, FL 34135
Country: USA

Party Authorized To Apply Mark: Same as Manufacturer
Report Issuing Office: Intertek Testing Services NA, Inc., Cortland, NY

Control Number: ***5025000***   **Authorized by:** Lluvia Medina
for L. Matthew Snyder, Certification Manager

RECOGNIZED COMPONENT
C ETL LISTED US
Intertek

This document supersedes all previous Authorizations to Mark for the noted Report Number.

Intertek Testing Services NA Inc.
545 East Algonquin Road, Arlington Heights, IL 60005
Telephone 800-345-3851 or 847-439-5667 Fax 312-283-1672

Standard(s):	Batteries for Use in Stationary, Vehicle Auxiliary Power and Light Electric Rail (LER) Applications [ANSI/CAN/UL 1973:2018 Ed.2]
Product:	BESS
Brand Name:	Image only
Models:	LFPHV-ESS

8.8 Appendix 08 - UL 9540 Final Authorization

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AUTHORIZATION TO MARK

This authorizes the application of the Certification Mark(s) shown below to the models described in the Product(s) Covered section when made in accordance with the conditions set forth in the Certification Agreement and Listing Report. This authorization also applies to multiple listee model(s) identified on the correlation page of the Listing Report.

This document is the property of Intertek Testing Services and is not transferable. The certification mark(s) may be applied only at the location of the Party Authorized To Apply Mark.

Applicant:	e2comply, LLC	**Manufacturer:**	e2comply, LLC
Address:	8901 Quality Rd Bonita Springs, FL, 34135 USA	**Address:**	8901 Quality Rd Bonita Springs, FL, 34135 USA
Country:	USA	**Country:**	USA

Party Authorized To Apply Mark: Same as Manufacturer
Report Issuing Office: Intertek Testing Services NA, Inc., Cortland, NY

Control Number: ***5025000*** **Authorized by:** Lluvia Medina
for L. Matthew Snyder, Certification Manager

C ETL LISTED US
Intertek

This document supersedes all previous Authorizations to Mark for the noted Report Number.

Intertek Testing Services NA Inc.
545 East Algonquin Road, Arlington Heights, IL 60005
Telephone 800-345-3851 or 847-439-5667 Fax 312-283-1672

Standard(s):	Energy Storage Systems and Equipment [ANSI/CAN/UL 9540:2020 Ed.2]
Product:	R3Di Energy Storage System
Brand Name:	Image e2
Models:	002-0001

8.9 Appendix 09 - LiFePO4 Safety Data Sheet

RECEIVED: 13/08/2024

Material safety data sheet

For POWERSYNC Energy Solutions, LLC

LiFePO4 Battery Module

Section 1 - Chemical Product and Company Identification

Product Identification:	**Model No** / **Voltage** / **Capacity** / **Energy**: LFP3250-HV512100 / 48V / 100Ah / 4.8 kWh LFP3250-HV512100 / 51.2V / 100Ah / 5.12 kWh LFP32100-LV512100 / 51.2V / 100Ah / 5.12 kWh LFP32100-LV256200 / 25.6V / 200Ah / 5.12 kWh LFP32100-LV128400 / 12.8V / 400Ah / 5.12 kWh
Manufacturer's/ Supplier Name:	POWERSYNC Energy Solutions, LLC
Address:	1910 8th Ave. N. Lake Worth, FL 33461
Telephone:	(877) 459-4591
Emergency Telephone No. (24h):	+1 (404) 606-6153
E-mail address:	Info@powersyncenergy.com

Model No	Voltage	Capacity	Energy
LFP3250-HV512100	48V	100Ah	4.8 kWh
LFP3250-HV512100	51.2V	100Ah	5.12 kWh
LFP32100-LV512100	51.2V	100Ah	5.12 kWh
LFP32100-LV256200	25.6V	200Ah	5.12 kWh
LFP32100-LV128400	12.8V	400Ah	5.12 kWh

Section 2 – Hazards Identification

Preparation hazards and classification	Not dangerous with normal use. Do not dismantle, open or shred the LiFePO4. Battery ingredients contained within or their ingredients products could be harmful.
Apperance, Color, and Odor	Solid object with no odor, no color.
Primary Route(s) of Exposure	These chemicals are contained in a sealed enclosure. Risk of exposure occurs only if the cell is mechanically, thermally or electrically abused to the point of compromising the enclosure. If this occurs, exposure to the electrolyte solution contained within can occur by Inhalation, Ingestion, Eye contact and Skin contact
Potential Health Effects:	**ACUTE (short term):** see Section 8 for exposure controls In the event that this battery has been ruptured, the electrolyte solution contained within the battery would be corrosive and can cause burns. **Inhalation:** Inhalation of materials from a sealed battery is not an expected route of exposure. Vapors or mists from a ruptured battery may cause respiratory irritation. Ingestion: Swallowing of materials from a sealed battery is not an expected route of exposure. Swallowing the contents of an open battery can cause serious chemical burns of mouth, esophagus, and gastrointestinal tract. **Skin:** Contact between the battery and skin will not cause any harm. Skin contact with contents of an open battery can cause severe irritation or burns to the skin. **Eye:** Contact between the battery and the eye will not cause any harm. Eye contact with contents of an open battery can cause severe irritation or burns to the eye. **CHRONIC (long term):** see Section 11 for additional toxicological data
Medical Conditions Aggravated by Exposure	Not applicable
Reported as carcinogen	Not applicable

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Section 3 – Composition/Information on Ingredients

LiFePO4 Battery is a mixture.

Hazardous Ingredients (Chemical Name)	Concentration or concentration ranges (%)	CAS Number
Lithium Iron phosphate(LiFePO4)	25-30	15365-14-7
Graphite (C)	8-12	7782-42-5
Lithium hexafluorophosphate (LiPF6)	15-22	21324-40-3
Aluminum	5-8	7429-90-5
Copper (Cu)	10-15	7440-50-8
High molecular polymer	3-5	N/A
Nickel	0.5-1	7440-02-0
Iron	22-30	7439-89-6

Labeling according to EC directives.
No symbol and risk phrase are required.
Note: CAS number is Chemical Abstract Service Registry Number.
N/A=Not applicable.

Section 4 – First-aid Measures

Inhalation	If contents of an opened battery are inhaled, remove source of contamination or move victim to fresh air. Obtain medical advice.
Skin contact	If skin contact with contents of an open battery occurs, as quickly as possible remove contaminated clothing, shoes and leather goods. Immediately flush with lukewarm, gently flowing water for at least 30 minutes. If irritation or pain persists, seek medical attention. Completely decontaminate clothing, shoes and leather goods before reuse or discard.
Eye contact	"If eye contact with contents of an open battery occurs, immediately flush the contaminated eye(s) with lukewarm, gently flowing water for at least 30 minutes while holding the eyelids open. Neutral saline solution may be used as soon as it is available. If necessary, continue flushing during transport to emergency care facility. Take care not to rinse contaminated water into the unaffected eye or onto face. Quickly transport victim to an emergency care facility."
Ingestion	"If ingestion of contents of an open battery occurs, never give anything by mouth if victim is rapidly losing consciousness, or is unconscious or convulsing. Have victim rinse mouth thoroughly with water. DO NOT INDUCE VOMITING. Have victim drink 60 to 240 mL (2-8 oz.) of water. If vomiting occurs naturally, have victim lean forward to reduce risk of aspiration. Have victim rinse mouth with water again. Quickly transport victim to an emergency care facility."

Section 5 – Fire-fighting Measures

Flammable Properties	In the event that this battery has been ruptured, the electrolyte solution contain within the battery would be flammable. Like any sealed container, battery cells may rupture when exposed to excessive heat; this could result in the release of flammable or corrosive materials.
Suitable extinguishing Media	Use extinguishing media suitable for the materials that are burning.
Suitable extinguishing Media	Not available
Explosion Data	**Sensitivity to Mechanical Impact:** This may result in rupture in extreme cases **Sensitivity to Static Discharge:** Not Applicable
Specific Hazards arising from the chemical	Fires involving LiFePO4 Battery are controlled with water. When water is used, however, hydrogen gas may evolve. In a confined space, hydrogen gas can form an explosive mixture. In this situation, smothering agents are recommended to extinguish the fire.
Protective Equipment and precautions for firefighters	As for any fire, evacuate the area and fight the fire from a safe distance. Wear a pressure-demand, self-contained breathing apparatus and full protective gear. Fight fire from a protected location or a safe distance. Use NIOSH/MSHA approved full-face self-contained breathing apparatus (SCBA) with full protective gear.
NFPA	Health: 0 Flammability: 0 Instability: 0

Section 6 – Accidental Release Measures

Personal Precautions, protective equipment, and emergency procedures	Restrict access to area until completion of clean-up. Do not touch the spilled material. Wear adequate personal protective equipment as indicated in Section 8.
Environmental Precautions	Prevent material from contaminating soil and from entering sewers or waterways.
Methods and materials for Containment	Stop the leak if safe to do so. Contain the spilled liquid with dry sand or earth. Clean up spills immediately.
Methods and materials for cleaning up	Absorb spilled material with an inert absorbent (dry sand or earth). Scoop contaminated absorbent into an acceptable waste container. Collect all contaminated absorbent and dispose of according to directions in Section 13. Scrub the area with detergent and water; collect all contaminated wash water for proper disposal.

Section 7 – Handling and Storage

Handling	Don't handle LiFePO4 Battery with metalwork. Do not open, dissemble, crush or burn battery. Ensure good ventilation/ exhaustion at the workplace. Prevent formation of dust. **Information about protection against explosions and fires:** Keep ignition sources away- Do not smoke.
Storage	If the LiFePO4 Battery is subject to storage for such a long term as more than 3 months, it is recommended to recharge the LiFePO4 Battery periodically. 3 months: -10°C~+40°C, 45 to 85%RH And recommended at 0°C~+35°C for long period storage. The capacity recovery rate in the delivery state (50% capacity of fully charged) after storage is assumed to be 80% or more. Do not store LiFePO4 Battery haphazardly in a box or drawer where they may short-circuit each other or be short-circuited by other metal objects.

	Keep out of reach of children. Do not expose LiFePO4 Battery to heat or fire. Avoid storage in direct sunlight. Do not store together with oxidizing and acidic materials.

Section 8 – Exposure Controls and Personal Protection

Engineering Controls	Use local exhaust ventilation or other engineering controls to control sources of dust, mist, fumes and vapor. Keep away from heat and open flame. Store in a cool, dry place.
Personal Protective Equipment	**Respiratory Protection:** Not necessary under normal conditions. **Skin and body Protection:** Not necessary under normal conditions, Wear neoprene or nitrile rubber gloves if handling an open or leaking battery. **Hand protection:** Wear neoprene or natural rubber material gloves if handling an open or leaking battery. **Eye Protection:** Not necessary under normal conditions, Wear safety glasses if handling an open or leaking battery.
Other Protective Equipment	Have a safety shower and eye wash fountain readily available in the immediate work area.
Hygiene Measures	Do not eat, drink, or smoke in work area. Maintain good housekeeping.

Section 9 – Physical and Chemical Properties

Physical State	Form: Solid Color: Black Odor: Odorless
Change in condition:	
pH, with indication of the concentration	Not applicable
Melting point/freezing point	Not available.
Boiling Point, initial boiling point and Boiling range:	Not available.
Flash Point	Not available.
Upper/lower flammability or explosive limits	Not available.
Vapor Pressure:	Not applicable
Vapor Density: (Air = 1)	Not applicable
Density/relative density	Not available.
Solubility in Water:	Insoluble
n-octanol/water partition coefficient	Not available.
Auto-ignition temperature	130°C
Decomposition temperature	Not available.
Odout threshold	Not available.
Evaporation rate	Not available.
Flammability (soil, gas)	Not available.
Viscosity	Not applicable

Section 10 – Stability and Reactivity

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Stability	The product is stable under normal conditions
Conditions to Avoid (e.g. static discharge, shock or vibration)	Do not subject LiFePO4 Battery to mechanical shock. Vibration encountered during transportation does not cause leakage, fire or explosion. Do not disassemble, crush, short or install with incorrect polarity. Avoid mechanical or electrical abuse.
Incompatible Materials	Not Available
Hazardous Decomposition Products	This material may release toxic fumes if burned or exposed to fire
Possibility of Hazardous Reaction	Not Available

Section 11 – Toxicological Information

Irritation	Risk of irritation occurs only if the cell is mechanically, thermally or electrically abused to the point of compromising the enclosure. If this occurs, irritation to the skin, eyes and respiratory tract may occur.
Sensitization	Not Available
Neurological Effects	Not Available
Teratogenicity	Not Available
Reproductive Toxicity	Not Available
Mutagenicity (Genetic Effects)	Not Available
Toxicologically Synergistic Materials	Not Available

Section 12 – Ecological Information

General note:	Water hazard class 1(Self-assessment): slightly hazardous for water. Do not allow undiluted product or large quantities of it to reach ground water, water course or sewage system.
Anticipated behavior of a chemical product in environment/possible environmental impace/ecotoxicity	Not Available
Mobility in soil	Not Available
Persistence and Degradability	Not Available
Bioaccumulation potential	Not Available
Other Adverse Effects	Not Available

Section 13 – Disposal Considerations

Product disposal recommendation: Observe local, state and federal laws and regulations. Packaging disposal recommendation: Be aware discarded batteries may cause fire, tape the battery terminals to insulate them. Don't disassembly the battery. Completely discharge containers (no tear drops, no powder rest, scraped carefully). Containers may be recycled or re-used. Observe local, state and federal laws and regulations.

Section 14 – Transport Information

With regard to transport, the following regulations are cited and considered:

- The International Civil Aviation Organization (ICAO) Technical Instructions, Packing instruction 965, section A (2019-2020 Edition).
- The International Air transport Association (IATA) Dangerous Goods Regulations, Packing instruction 965, section A (60th Edition, 2019).
- The International Maritime Dangerous Goods (IMDG) Code (Amendment 38-16 Edition).
- The US Hazardous Materials Regulation 49 CRF (Code of Federal Regulations).
- The UN Recommendations on the Transport of Dangerous Goods, Manual of Tests and Criteria 38.3 Lithium batteries.
- Proper shipping name and UN ID number: LITHIUM ION BATTERIES UN No.: UN3480.

Our products are properly classified, described, packaged, marked, and labeled, and are in proper condition for transportation according to all the applicable international and national governmental regulations, and should be transported as Class 9 hazardous material. We further certify that the enclosed products have been tested and fulfilled the requirements and conditions in accordance with UN Recommendations (T1 – T8) on the Transport of Dangerous Goods Model Regulations and the Manual of Tests and Criteria.

Test results of the UN Recommendation on the Transport of Dangerous Goods

Manual of Test and Criteria (38.3 Lithium battery)			
No.	Test items	Test results	Remark
T1	Altitude simulation	Pass	-
T2	Thermal test	Pass	-
T3	Vibration	Pass	-
T4	Shock	Pass	-
T5	External short circuit	Pass	-
T6	Crush	Pass	-
T7	Overcharge	Pass	-
T8	Forced discharge	Pass	-

The following information is provided for domestic and international transportation:

DOT REGULATIONS:		
UN Classification (Transport Hazard class):	9	
UN number:	3480	
Packing group:	II	
UN Proper shipping name(technical name):	LITHIUM ION BATTERIES	
Marine pollutant(Y/N)	N	
Label:	Class 9	
LAND TRANSPORTATION ADR/RID (CROSS-BRODER):		
ADR/RID class:	9 Miscellaneous dangerous substances and articles	
Danger code(Kemler):	9	
UN-Number:	3480	
Packaging group:	II	
Marine pollutant(Y/N):	N	
Label:	Class 9	
Description of goods:	LITHIUM ION BATTERIES	
SEA TRANSPORT IMDG:		
Class or division:	Class 9	
UN Number:	3480	
Label:	Class 9	
Packaging group:	II	
EMS Number:	F-A, S-I	
Marine pollutant(Y/N):	N	
Propper shipping name:	LITHIUM ION BATTERIES	
AIR TRANSPORT ICAO-TI AND IATA-DGR:		
Class or division:	Class 9	
UN Number:	3480	
Label:	Class 9	
Packaging group:	II	
Marine pollutant(Y/N):	N	
Propper shipping name:	LITHIUM ION BATTERIES	

Section 15 – Regulatory Information

OSHA hazard communication standard (29 CFR 1910.1200)

________________Hazardous ________X_______Non-hazardous

Section 16 – Other Information

The information above is believed to be accurate and represents the best information currently available to us. However, POWERSYNC makes no warranty of merchantability or any other warranty, express or implied, with respect to such information, and we assume no liability resulting from its use. Users should make their own investigations to determine the suitability of the information for their particular purposes. Although reasonable precautions have been taken in the preparation of the data contained herein, it is offered solely for your information, consideration and investigation. This material safety data sheet provides guidelines for the safe handling and use of this product; it does not and cannot advise on all possible situations, therefore, your specific use of this product should be evaluated to determine if additional precautions are required.

The data/information contained herein has been reviewed and approved for general release on the basis that this document contains no export controlled information.

END OF MSDS