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# Fluence Cube™ Installation Manual

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# 1. Preface

## 1.1 Support Services

Fluence is committed to fully supporting every Cube site. Our primary point of contact is our 24/7 Operations group, which logs each issue raised into our workflow-tracking tool and progressively escalates each issue within the Fluence Support Services team, as needed.

Fluence Support Services can be contacted 24/7 at **+1 (703) 635-7631**.

## 1.2 Scope of This Document

This document is a guide for the safe **installation** of the Fluence Cube Energy Storage System (ESS), which throughout this manual will be called “the Cube.” This manual details the safe installation of a single Cube in compliance with applicable laws and regulations. Multiple Cubes can be attached to each other to make preconfigured systems called “stacks”; for more information on preconfigured stacks, see the Appendices:

- Appendix A: Gridstack™
- Appendix B: Sunstack™
- Appendix C: Edgestack™

This document is intended only for the use of **persons already trained and qualified to work on the Cube**.

This document is **not an operation and maintenance guide**. For operation and maintenance, see “Fluence Cube Operation and Maintenance Manual,” Document Control Number 06-01-0001-OAM-001.

The following **prerequisites** shall be properly completed prior to Cube placement, anchoring, and other installation activities:

- Foundations are installed as per the weight, dimensions, and other physical criteria required for installation of the Cube, including leveling to acceptable tolerances.
- Ground grid installed under the slab or beam foundations.

**NOTE:** Depending on the duration of the construction period, temporary power may be required to operate the auxiliary equipment in each Cube (HVAC/chiller, fire panel, Leaf controller, etc.).



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## 1.3 The Cube: Overview

The Cube is a discrete energy-storage unit that includes batteries, a battery management system, a data acquisition system, and other equipment and accessories necessary to maintain health and long-term operation in an outdoor environment.



**Fig. 1.** Fluence Cube..

An Energy Storage System (ESS) consists of one or more Cubes, a power conversion system, and associated auxiliary equipment, to include AC switchgear, meters, relays, and telecommunications equipment. Cubes can be, and usually are, interconnected to form larger systems. In particular, the Cube is the fundamental building block of the Gridstack, Edgestack, and Sunstack ESS configurations.

**NOTE:** The Cube may be built in either a Short Duration or Long Duration configuration. The duration of the system is set at the factory and may not be modified in-field.

## 1.4 Further Information

Further details on Cube enclosure and Cube specifications are given in “Fluence Gen 6 Cube Battery Enclosure Specification,” Document Control Number CUBE-PM-INF-001.



## 2. Safety Symbols and Instructions

The symbols shown below may appear throughout this document, or upon the Cube or its components, to highlight risks. Sources of potential hazards are described.

Please consult all safety datasheets (SDSs), including the Gen6 Fluence Cube product safety datasheet (PSDS), Document Control Number 06-01-0001-DSH-005, regarding hazardous materials, and review component-specific safety information in subsystem documentation for additional information. Adherence to health and safety codes will help protect personnel and equipment.

### 2.1 Warning Symbol

Warnings highlight DANGER to PERSONNEL of SERIOUS INJURY OR DEATH when handling, operating or maintaining equipment or systems.



### 2.2 Caution Symbol

Cautions highlight the possibility of DAMAGE to EQUIPMENT, or DEGRADATION of EQUIPMENT OPERATION when handling, operating, or maintaining equipment.



### 2.3 Electrical Hazards

The Cube carries high-voltage electrical current, which can cause shocks or severe bodily harm. Equipment, supplies, and loads must be properly installed and grounded in accordance with specifications and applicable electrical safety codes. The common voltages encountered in this system may cause electric shocks and can sustain an arc flash. Use of safe electrical work practices and suitable Personal Protective Equipment (PPE) is required to protect against injury. Adherence to electrical safety codes will help protect personnel and equipment.



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## 2.4 Fire Hazards

A damaged lithium-ion battery module may cause a fire or explosion. Review all manufacturer instructions for proper procedures for handling and storage of components. Also, improper connection or damage to an electrical line may cause a fire or arc flash. Each Cube has a fire-suppression system that uses a solid aerosol fire-suppression agent. Adherence to fire safety codes will help protect personnel and equipment.



## 2.5 Chemical Hazards

### GENERAL CHEMICAL HAZARDS

Some components contain hazardous substances and/or dangerous goods. Refer to the manufacturers' SDSs and a qualified professional for complete and correct mitigation procedures and see the Cube PSDS for full information on hazardous substances within the Cube (Document Control Number 06-01-0001-DSH-005). SDS for all chemicals and hazardous substances in the Fluence Cube are provided at each site. Personnel performing operations or maintenance on the ESS shall have access to SDSs and on-site and through Fluence Support.



In normal Cube operation all chemical components are sealed, but components can become hazards under adverse conditions. For example, fluids may be released if hoses are pierced or connections fail. Note particularly the following chemical hazards:

### BATTERIES

- The contents of lithium-ion battery cells may be water-reactive, toxic, or corrosive to skin or metal. Cells may vent hazardous or flammable gases.
- A lead-acid battery is present to power the uninterruptible power supply (UPS). Its contents are toxic and corrosive to skin.

### COOLANTS

The Cube can contain chiller coolant, chiller refrigerant, and climate-control HVAC refrigerant. For full information on these substances, including first-aid measures, see their respective SDSs.



- **Chiller Coolant.** In Cubes served by a chiller system, the coolant is a mixture of ethylene glycol and water. Ethylene glycol is toxic. See manufacturer's SDS.



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**What to Do if Exposed to Chiller Coolant.** Avoid breathing vapors: if vapors are inhaled, seek fresh air and seek medical help immediately if symptoms occur. For eye contact, rinse immediately with plenty of water, also under the eyelids, for at least 15 minutes, and get immediate medical attention. For skin contact, wash immediately with plenty of water for at least 15 minutes and get medical attention immediately if symptoms occur. If swallowed, do not induce vomiting: rinse mouth with water and call a physician or Poison Control Center immediately.

- **Chiller Refrigerant.** Where present (i.e., in Cubes containing liquid-cooled batteries), the battery chiller refrigerant, R410a, is a mixture of difluoromethane and pentafluoroethane. It is mildly toxic and can cause asphyxiation if excessively inhaled. Liquid contact could cause frostbite.

**What to Do if Exposed to Chiller Refrigerant.** Avoid breathing vapors. If vapors are inhaled, seek fresh air and seek medical help immediately if symptoms occur. For skin contact, promptly flush skin with water until all chemical is removed. If there is evidence of frostbite, bathe (do not rub) with lukewarm (not hot) water. Get medical attention if symptoms persist. For eye contact, immediately flush eyes with large amounts of water for at least 15 minutes (in case of frostbite, water should be lukewarm, not hot), lifting eyelids occasionally to facilitate irrigation, and get immediate medical attention.

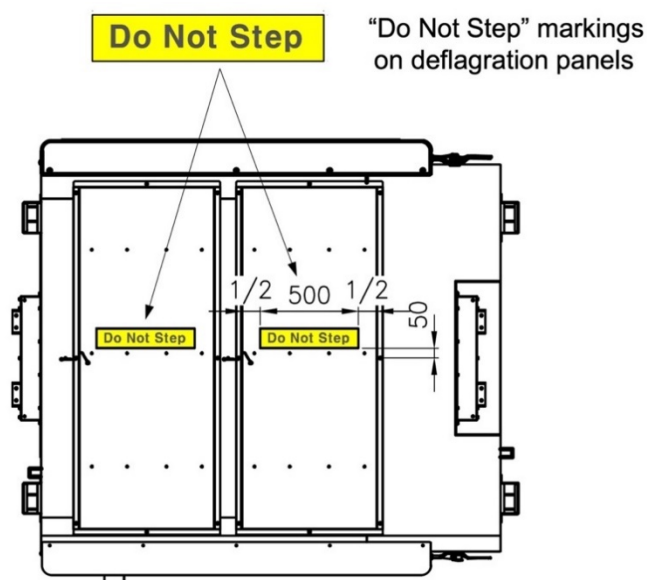
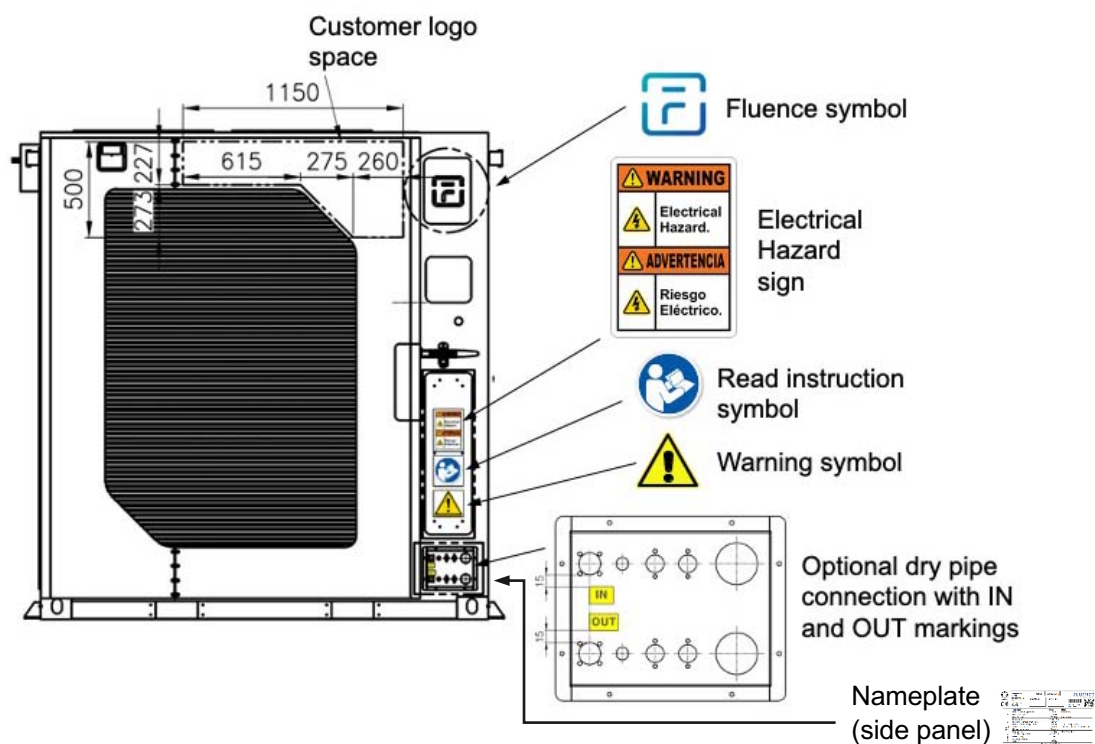
- **Climate-Control HVAC Refrigerant.** The Cube HVAC climate-control refrigerant, R134a (1,1,1,2-tetrafluoroethane), can cause asphyxiation if excessively inhaled. Liquid contact could cause frostbite.

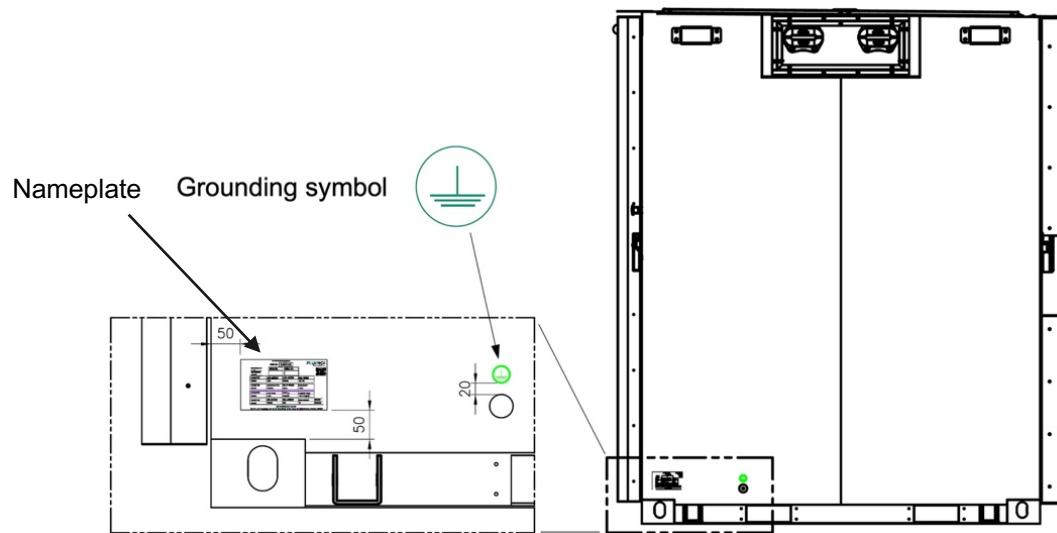
**What to Do if Exposed to HVAC Refrigerant.** Avoid breathing vapors: if vapors are inhaled, seek fresh air and seek medical help immediately if symptoms occur. For skin contact, promptly flush skin with water until all chemical is removed. If there is evidence of frostbite, bathe (do not rub) with lukewarm (not hot) water. Get medical attention if symptoms persist. For eye contact, immediately flush eyes with large amounts of water for at least 15 minutes (in case of frostbite, water should be lukewarm, not hot), lifting eyelids occasionally to facilitate irrigation, and get immediate medical attention.



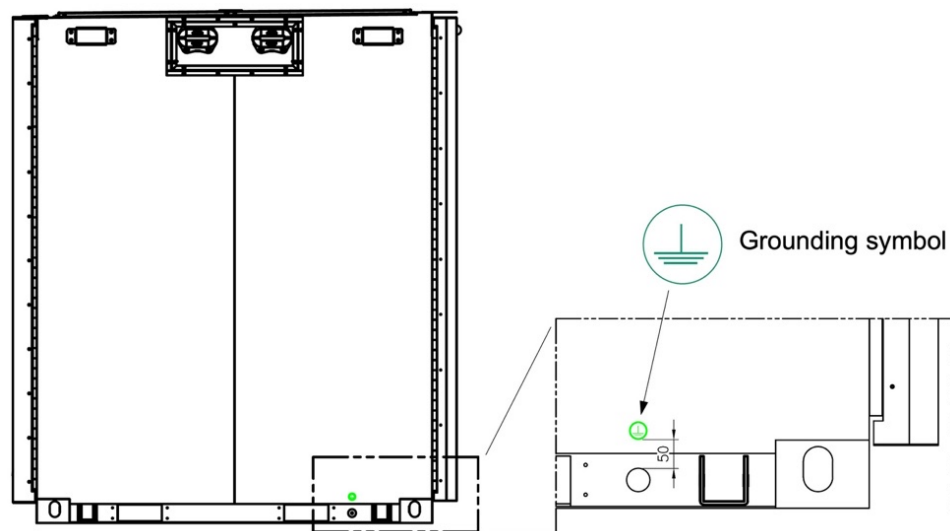
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## 2.6 Cube Markings





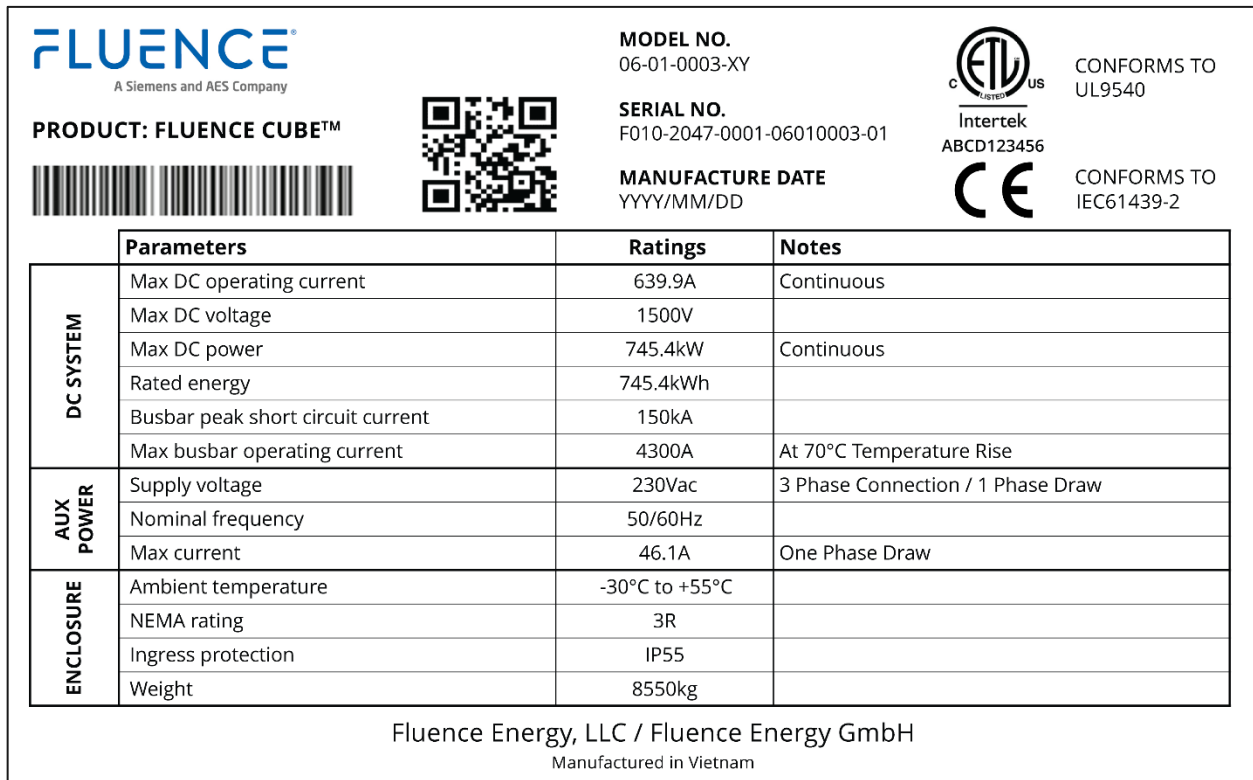
**Fig. 4.** Cube, side view 1.



**Fig. 5.** Cube, side view 2.



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**Fig. 6.** Cube nameplate. Long duration configuration shown as example. Numerical values will vary with Cube configuration.



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## 3. System Description

### 3.1 Basic Specifications

The Fluence Cube is the building block for all Fluence advanced energy storage solutions and fleets tailored to customers' needs. These include single- or multiple-Cube solutions to provide AC storage for commercial or industrial applications (Edgestack) and multiple-Cube solutions providing grid-scale storage for utilities (Gridstack) or DC-coupled storage with solar photovoltaics (Sunstack). Refer to the Appendices for more information on the Edgestack, Gridstack, and Sunstack solutions.

All Fluence ESS solutions utilize the Fluence Operating System (Fluence OS™) and Fluence IQ™, an intelligence engine to enhance all levels of system hardware, software, monitoring, and services.

#### Fluence Cube Basic Specifications

**Cube Dimensions (H x W x D):**

Long Duration: 2,549 x 2,578 x 2,160 mm (100.4 x 101.5 x 85.0 in)

Short Duration: 2,549 x 2,578 x 2,257 mm (100.4 x 101.5 x 88.9 in)

**Cube Weight (without coolant) kg/lb:**

Long Duration: 8,200 kg / 18,078 lb ± 2%

Short Duration: 8,550 kg / 18,850 lb ± 2%

**Coolant Weight kg/lb:**

Long Duration: 40.4 kg / 89 lb

Short Duration: 68.9 kg / 152 lb

**Enclosure Rating:** NEMA Type 3R

**IP Rating:** IP55

**Battery Chemistry:** Advanced lithium-ion sealed cells

**Battery Cooling:** Liquid cooled

**Installation:** Forklift compatible from all four sides. Crane compatible and includes vertical stabilization.



## 3.2 Major Components

Below are listed first the Cube's safety-specific components, then a number of its other components. These lists name only prominent components and are therefore not complete. Refer to **Fig. 7** and **Fig. 8** to visualize selected components.

### SAFETY COMPONENTS

- Smoke/CO detector.
- Fire suppression system.
- Fire alarm (horn/strobe).
- Two deflagration panels.
- Incipient gas detection: carbon monoxide (CO) sensor.
- Lockable DC disconnect switch.
- F-Stop (fast stop) button.
- Open door sensor.
- Sliding door lock.
- Gas spring damper on door.
- Liquid leak detection.

### OTHER COMPONENTS

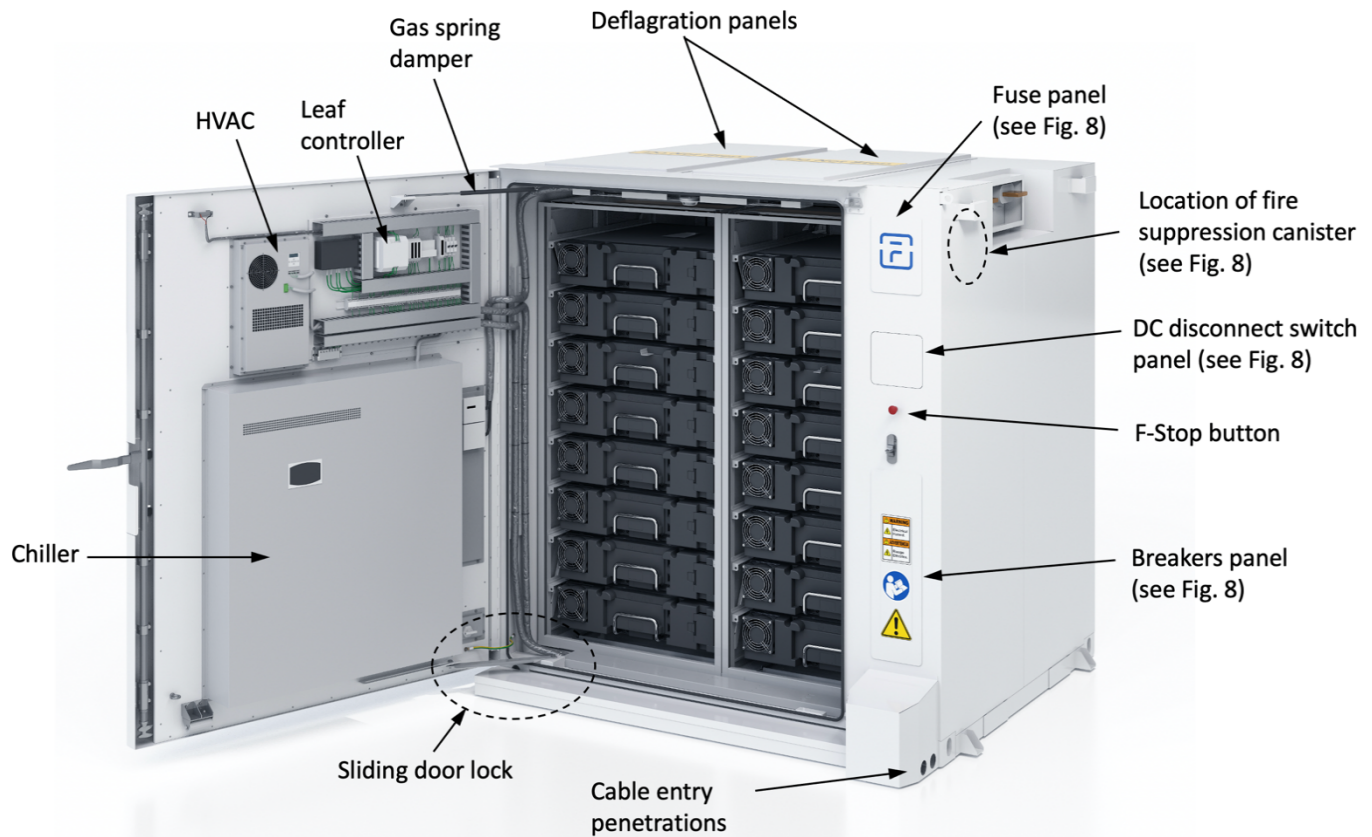
- One or two climate-control HVAC units, depending on configuration.
- One or two chiller units, depending on configuration
- An aerosol-based FSS comprising one canister.
- One pair of DC busbars rated for 1,500 VDC, 4,000 A with appropriate mountings and connectors, depending on Cube configuration. The Long Duration configuration may individually contribute a maximum continuous current of 320 A. The Short Duration configuration may individually contribute a maximum continuous current of 640 A.
- One or two main fuses rated for 1,500 VDC. Long Duration configuration contains one 400 A main fuse. Short Duration configuration contains two 450 A main fuses.
- One non-load break disconnect switch rated for 1,500 VDC. Long Duration configuration contains a DC disconnect switch rated for 400 A. Short Duration configuration contains a DC disconnect switch rated for 1250 A.
- One Leaf controller.



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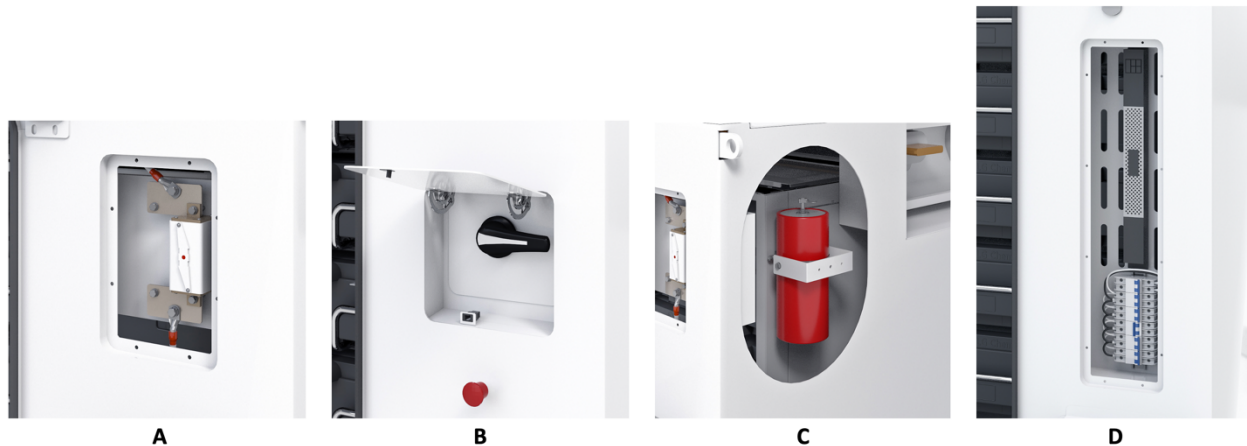
- One power distribution block.
- One 24 VDC power supply for Leaf controller and F-Stop button.
- One 230 VDC 600 W UPS.
- One or two battery racks. Each rack has a BPU, and each BPU has a disconnect switch, fuse, and contactor.



**Fig. 7.** Selected Cube components. There is a second door at back of Short Duration configuration, not shown. Horn/strobe unit is on outside of door, upper left corner (not visible in this image). BPUs not depicted: are installed at top of each battery rack. Smoke/CO detector is located in front of the battery racks (1 per Cube), not shown.



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**Fig. 8.** Cube components normally hidden by access panels or Cube structure.

- A: Cube fuse.** Screws must be removed to open panel.
- B: DC disconnect.** Panel opens manually.
- C: Fire suppression canister.** Cutaway view (no external access to canister).
- D: Breakers and UPS.** Screws must be removed to open panel.

### 3.3 Heating and Cooling Systems

Every Cube contains an HVAC system to climate-control the Cube interior. The Long Duration configuration contains one HVAC system, which is mounted on the inside of the front door. The Short Duration configuration contains two identical HVAC systems, one mounted on the inside of the front door and the other on the inside of the back door.

Chillers (additional cooling subsystems) are devoted to controlling battery operating temperature. Depending on configuration, each Cube may have either one or two chillers to control battery temperatures.

Cooling units must be well maintained to ensure maximum system life and component warranty compliance. Actively managed environmental conditions are required for successful operation.

See OEM manuals for further details on HVAC and chiller units. Note that visual inspection is required prior to maintenance, that the maintenance area must be protected to avoid unwanted spills or leakages to the exterior, and that all safety procedures must be followed during maintenance work, including use of PPE.



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## 4. Safety

### 4.1 General

Each Fluence system is specially designed and configured to meet individual site needs as safely as possible. However, as with any utility-scale generator or complex electrical system, risks are present. **It is critical that only trained and qualified persons install the ESS** and do so in accordance with original design parameters and criteria. Improper installation or failure to follow safe operating procedures of the ESS can result in property damage, personal injury, or death.

Some solutions will require battery models to be electrically connected to each other on-site in series to form individual electrical strings. Electrical connection of battery modules to form a string requires working with energized systems (i.e., live voltage). Working with live voltage requires special training and PPE and, in some countries, specific certification may be required for this kind of work.

Prior to commencing installation, Fluence strongly recommends that all ESS owners conduct orientation meetings with local first responders to ensure mutual understanding of Fluence component composition and necessary emergency actions prior to commencement of the installation process.

Assess and satisfy PPE needs before undertaking installation. Use of suitable PPE and electrically safe work practices are required to protect against injury.

Each site must perform individual risk assessments to identify site-specific hazards and develop mitigating strategies, which will include on-site availability of necessary PPE. Sites managed by Fluence Energy LLC will also determine and implement applicable Fluence safety standards.

### 4.2 Wind Hazards

Wind can swing an unsecured Cube door hard enough to cause severe injury. Also, in high-wind conditions, personnel who have mounted ladders or scaffolding to work on upper portions of the Cube are at increased risk of falling. (The US Occupational Safety and Health Administration considers winds over 30 mph [48 kph] to be “high winds” if the work involves material handling, otherwise over 40 mph [64 kph].)

Note the following **important safety points**:

- Do not work on the Cube in high winds without taking special precautions appropriate for such conditions.



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- Even when high winds are not expected, take the following precautions:
  - 1) Upon opening a Cube door, secure the door. At minimum, ensure that the sliding door lock is properly engaged. A chain may additionally be used to connect the hook at the bottom of the door to an external part and hold the door in an open position.
  - 2) Upon mounting a ladder or scaffolding to work on the Cube, immediately secure a safety line to the safety loop at the Cube's upper corner.

## 4.3 Key Safety Points

- Only trained and qualified persons shall install the Cube.
- Fluence recommends a site orientation be conducted with local first responders prior to system use.

## 4.4 Personal Protective Equipment (PPE)

Use of suitable Personal Protective Equipment (PPE) is required to protect against injury. Each site shall perform individual risk assessments to identify site-specific hazards and develop mitigating strategies, which shall include availability and use of PPE. Sites managed by Fluence Energy LLC will also determine and implement applicable Fluence safety standards.

Below are minimum PPE requirements by type of work performed. The specific PPE required for installation shall be determined on-site through an assessment by a qualified Occupational Safety and Health Administration officer.

### VISITOR

A visitor may approach an ESS for the sole purpose of visual observation in situ. Visitors shall only open a de-energized ESS enclosure under the supervision of a qualified person.

- Hard hat
- Fire resistant (FR) smock
- Safety glasses
- Safety gloves



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## WORKER/OPERATOR

Depending on the work and the location of the work, the following PPE is recommended. Items to which FR rating is applicable shall be FR CAT 2.

- **Safety glasses** meeting ANSI/ISEA Z87.1. Where arc flash potential exists, additional PPE, such as face shield and balaclava shall be used.
- **Hearing protection.** Nonconductive hearing protection equipment is required to protect against unexpected noises that may occur
- **Hard hat** (i.e., a non-conductive Class E low-voltage hard hat or Class G high-voltage hard hat that meets the requirements of ANSI/ISEA Z89.1). Where arc flash potential exists, additional PPE, such as a face shield and balaclava, shall be used.
- **Arc-rated face shield.**
- **Clothing** must be made of natural fiber or fire-resistant material; long sleeves and long pants are to be worn for utmost protection. When working in areas with potential for arc flashes, clothing labeled with a specified Arc Thermal Performance Value or Energy Break Through Value (in cal/cm<sup>2</sup> or kJ/cm<sup>2</sup>) shall be worn, since these fire-resistant, arc-rated materials can reduce burn injuries during an arc flash.
- Cotton or natural fiber **undergarments**.
- Suitable work **gloves** shall be worn when handling all materials and equipment. When working with high-voltage, insulated gloves meeting the requirements of ASTM D 120 shall be worn.
- **Leather shoes**, certified to pass inspection with ASTM F2412. Where non-conductive shoes are required, no metal parts shall be present in the sole or heel of the shoes. Electrical overshoes shall be worn where step potential exists. Refer to subsystem documentation prior to servicing to determine possible locations of step potential hazards.

## KEY PPE POINTS

- Appropriate PPE shall always be worn while working in and around a Cube or preconfigured stack configuration.
- The level of PPE required is risk-dependent and shall be determined on a site-by-site basis with help of qualified persons.



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## 4.5 Heavy Equipment

All operators of heavy equipment shall be trained and qualified for the specific equipment they are operating.



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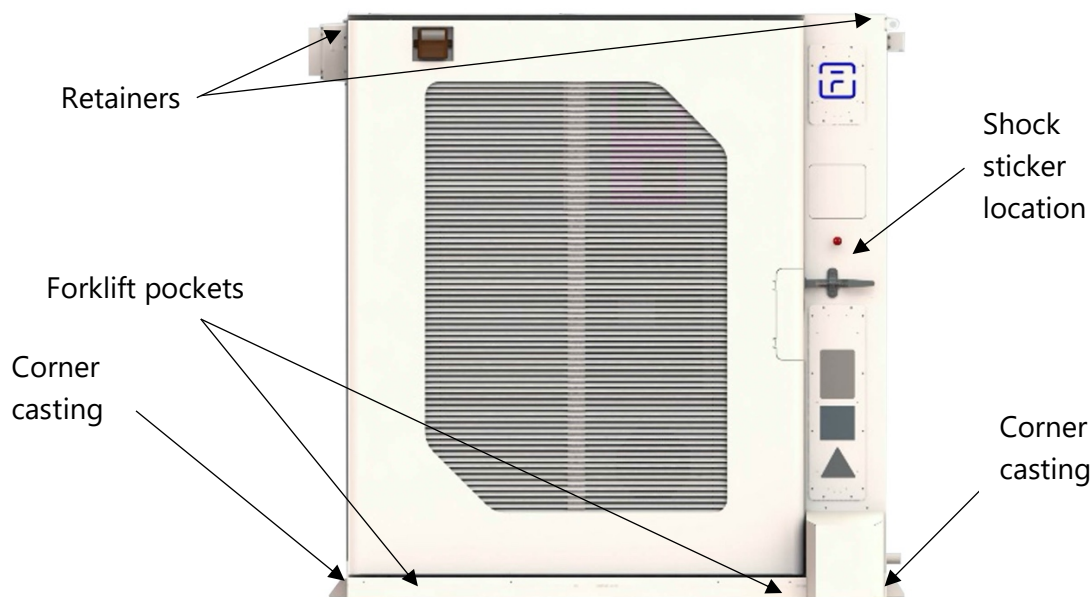
## 5. Installation

### 5.1 Transporting, Delivery, and Storage

**NOTE:** Handling and safety instructions for transportation personnel – including dimensions, weight, and loading/unloading procedures – are detailed in the document *Fluence Cube Transportation and Handling Guidelines* (DCN 06-01-0001-INF-001).

Forklift pockets, with removable covers, are located near the bottom on all four sides of the Fluence Cube enclosure for safe handling with a forklift.

Four corner castings, one in each bottom corner, and four retainers located on the sides near the top, provide for safe handling of the Cube with a crane (**Fig. 9**).



**Fig. 9.** Forklift pockets, corner castings, and retainers on the Cube. (In this image, covers are on forklift pockets.)

After manufacture, each Cube is shipped overseas in a high cube container. During shipping, plastic vinyl wrapping covers each Cube and vertical fiberboard edge protectors protect the corners. In addition, the external busbar sections are covered with rigid metal covers. Humidity is controlled inside the Cube by desiccant bags.



Instructions for unloading cubes from the shipping container are provided in the document *Fluence Cube Unloading/Loading Procedure* (DCN 06-01-0001-PRO-007).

## 5.2 Unpacking and Preparation

When the Cube is delivered to the ESS site, it should be thoroughly inspected for damage that may have occurred during transport. The shock sticker attached to the outside, near the F-Stop button, can indicate potential damage to the Cube. A temperature and humidity datalogger, installed internally and connected to the USB port of the Leaf controller, is used to ensure the batteries were not subject to inappropriate conditions during Cube shipping and onsite storage.

Prolonged high temperatures will damage the batteries. In the event of a delay in aux power connection to the Cube, increased calendar degradation may occur if higher average daily battery temperatures are reached as a result. For calendar degradation impacts, refer to the *Fluence Cube Cooling System Design Document* (DCN 06-01-0001-INF-008). Indoor storage is the most ideal while waiting for Cube installation and HVAC commissioning (after which the Cube's own HVAC system will maintain correct climatization). However, outdoor storage is permissible for short periods. Minimize the amount of time each Cube is stored outdoors prior to commissioning of the cooling system. If long-term outdoor storage is unavoidable, a tent or other means of protecting equipment-containing batteries from the sun should be considered.

The temperature and humidity datalogger should not be removed until auxiliary power has been connected to the Cube and the Cube's internal climate-control system is activated, so the datalogger can record both transport conditions and on-site conditions.

Prepare each Cube for placement in the final location:

- Note whether the shock sticker on the exterior of the Cube, near the F-Stop button, has exceeded its preset threshold. If so, halt installation and contact Fluence. If not, remove the shock sticker and proceed with installation.
- Remove packing material and desiccant bags located inside the cabinet.
- Temperature and humidity data from the datalogger device will transfer automatically to Fluence upon connection of auxiliary power and communications to the Cube.

## 5.3 Placement on Foundation

It is the responsibility of the engineer of record to design the foundation. The Balance of Plant Provider is responsible to provide the Construction Work Plan, which includes the site layout. The foundation must have the minimum strength required to support the system in accordance



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with applicable regulations. A geotechnical study of the location must be carried out in order to determine the characteristics to design the most suitable foundation. Provisions must be made to accommodate the ventilated precast cable trenches. Cable openings in the appropriate locations allow for electrical hookups.

The location should have the following characteristics:

- Not prone to flooding.
- Have provisions for proper drainage.
- Soil should be dry, compacted, stable, and homogeneous.
- Surrounding area must be gravel, ballast, or pebble.
- Maximum slope is 0% from front to back of Cube and 0.5% from side to side .

Place transformer and inverter in the appropriate positions on the foundation. Place each Cube in the appropriate position in turn. The distance between Cubes (wall to wall) is 7 to 12 inches (178 to 305 mm) to accommodate the DC bus connections.

For proper operation of the door, it is important that the Cube is leveled. Once the Cube is placed in its final location, the door must be operated to verify smooth opening and closing. If it is difficult to operate, then a leveling ruler must be used to identify where the leveling shims are to be added. When needed, the shims must be placed under the corner castings.

## 5.4 Securing to Foundation and Anchoring

Attach each Cube to the foundation through three anchors using M20 anchor bolts (to be defined and provided by customer). Qualified millwrights should install the anchor bolts.

## 5.5 Ground/Earth Connections

Bond each Cube to the ground/earth bus or terminal. Bond the ground/earth bus or terminal to the site Electrical Grounding Electrode System. The design should follow electrical code as required by the entity having jurisdiction.

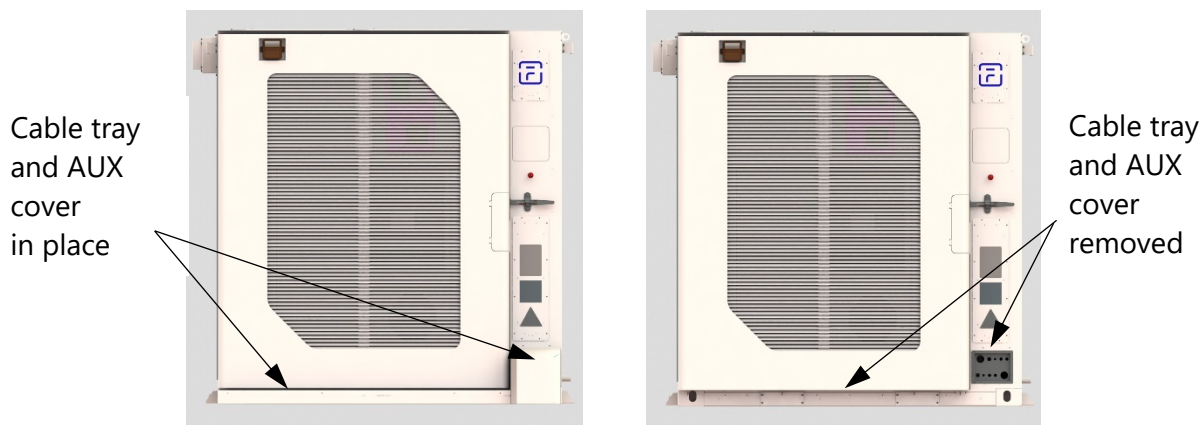
## 5.6 Auxiliary Power

Each Cube is supplied with 400/230V 3Ø auxiliary power, which supplies the cooling system and other loads. The customer supplies the proper five-conductor cable to connect the 400 V breakers to the first Cube in each line.



**NOTE:** When the Cubes first arrive on-site, prior to the Cubes being commissioned, the 600W HVAC (mounted on the door panel) should be used to control the Cube internal temperature. If the Cube has been commissioned, and the batteries are non-operational, under most circumstances the Cube can be kept cool with the 600W HVACs alone.

Auxiliary power is connected to each Cube in series. Fluence provides the cable assembly to connect auxiliary power from one Cube to the next in the **Cube-to-Cube Connection Kit**. The cable assembly should be routed through the cable tray and AUX cover, located along the front base of the Cube (**Fig. 10**). The Cable Tray is secured with fourteen (14) Hex M6 x 20 mm stainless steel screws (6 mounting to the Cube and 8 mounting the top cover to the trough), each with a spring washer and flat washer. The AUX cover is secured to the Cube with four (4) Torx M4 stainless steel screws. Torque M4 screws to 2.3 Nm and M6 screws to 8 Nm. For assembly detail, refer to APPENDIX D: Assembly of the Flexible Busbar, Cable Tray, and Fuse/AUX Panel Covers.

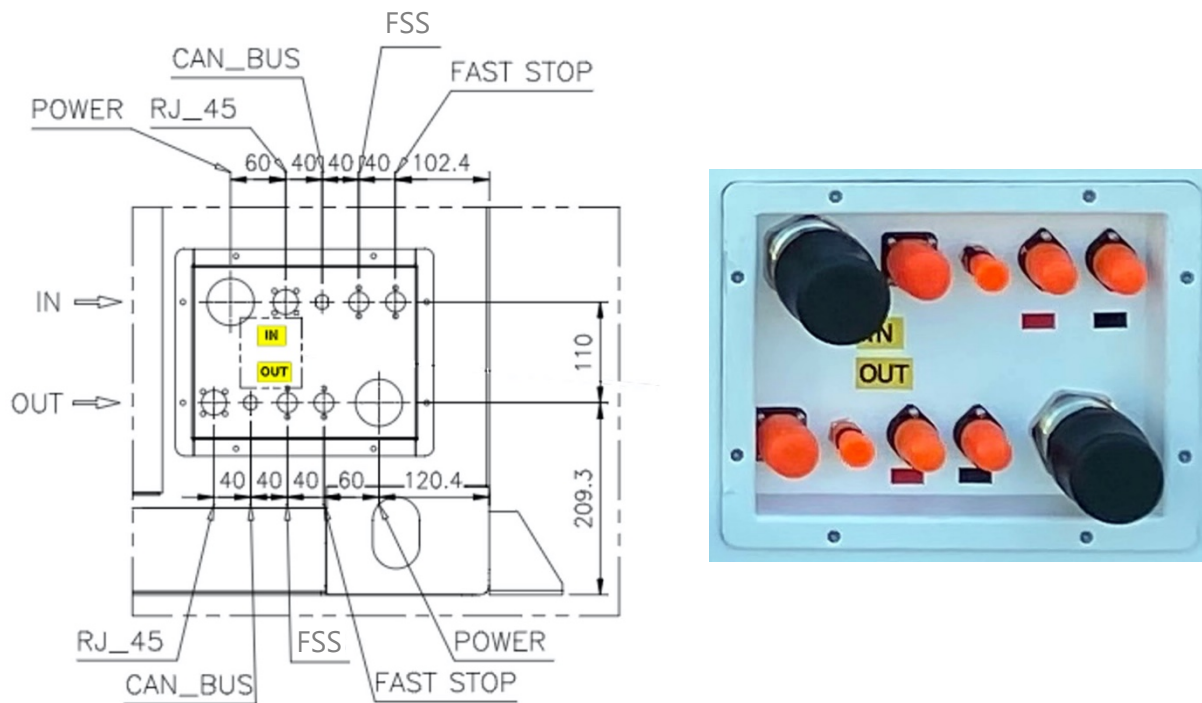


**Fig. 10.** Cube with cable tray and AUX cover in place (left) and removed (right).

The three-phase supply will go into every Cube but only one phase will be connected (refer to Fluence engineering drawings for the installation). Three phases are used for daisy chaining so that different Cubes can be powered by different phases. After entering the Cube, these wires are connected to a power distribution block. The power distribution block is configured such that one of the three phases, the neutral, and the ground are taken off to feed the auxiliary power circuit within the cube. All three phases, neutral, and ground are jumpered and configured on the power distribution block such that they can exit the Cube and proceed to the adjacent Cube (if present). Refer to Fluence engineering drawings for details of the distribution block connections: *3-Line Drawing* and *Cube-to-Cube Connection*.



The AUX power cable assembly connects to the Cube at the cable connection interface underneath the AUX cover (**Fig. 11**). There are holes for the auxiliary power wire. The one on top is input and below is output. The ports are labeled. To attach the cables, remove the protective caps, then open and secure each connection using an 8 mm Allen™ wrench. The cable tray is divided into two sections using a vertical metal barrier; the outer section (away from Cube) is used for the aux power cables, while the inner section (close to the Cube) is used for the communications cables.



**Fig. 11.** Cable connection interface underneath the AUX cover: schematic (left), photo (right), with caps on connections.

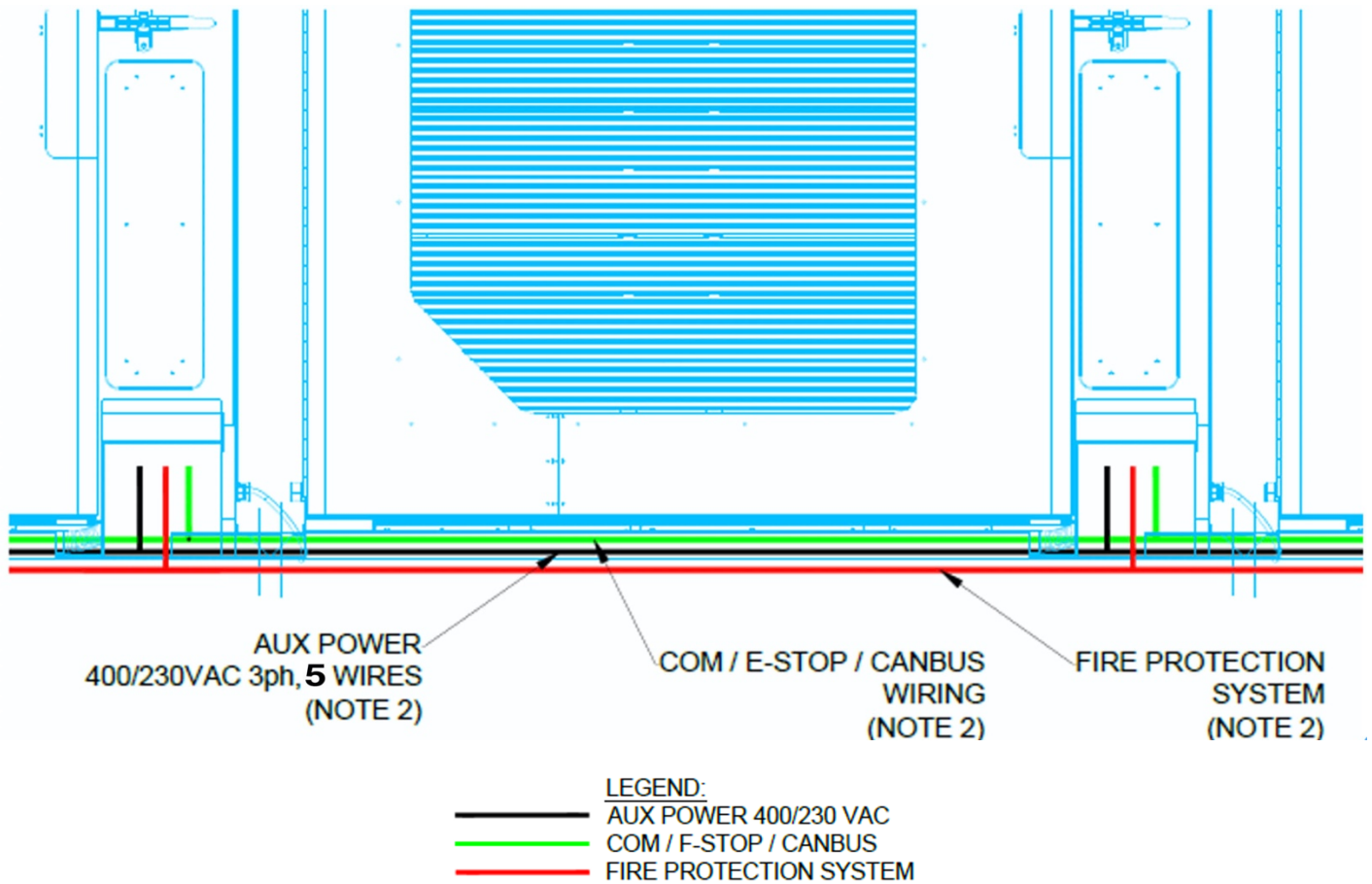
## 5.7 Communication Connections

Communications for the system include an Ethernet connection, a Controller Area Network (CAN) bus connection, a Fire Protection System connection, and the Fast Stop (F-Stop) connection. Communications cable assemblies are connected to each Cube in series (**Fig. 12**). Fluence provides these cable assemblies connecting one Cube to the next in the Cube-to-Cube Connection Kit. The wiring should be routed through the Cable Tray and AUX Cover, located along the front base of the Cube (**Fig. 10**). The communications cable assemblies connect to the



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Cube at the cable connection interface underneath the AUX Cover (**Fig. 11**). Each Cube has 2 terminal blocks for each connection. All ports are labeled. To attach the cables, remove the protective caps, then open and secure each connection using an 8 mm Allen wrench.



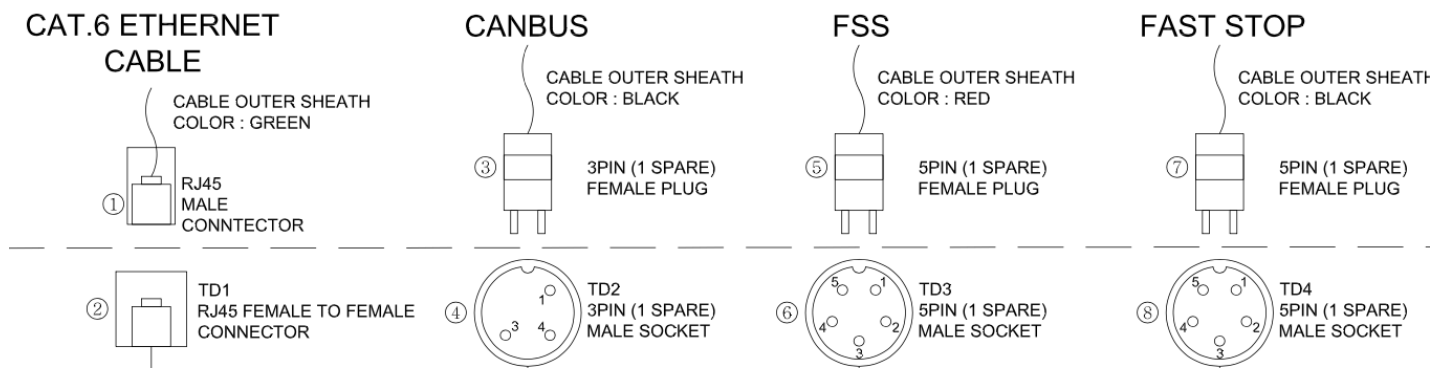
**Fig. 12.** Cube to Cube aux power, fire protection, and Com/F-Stop/CANbus wiring. **Notes:** (1) Supplied by contractor (see conduit schedule in interconnection section). (2) Supplied by Fluence.

The Ethernet connection consists of CAT 6 cable with an RJ45 male connector that connects to an RJ45 female connector inside the cabinet (**Fig. 13**). The wire pinout for the Ethernet cables is shown in **Fig. 14**. The CAN bus connection consists of a 3-pin female socket that connects to a 3-pin male plug. The FSS connection consists of a 5-pin female socket that connects to a 5-pin male plug. The F-Stop connection consists of a 5-pin female socket that connects to a 5-pin male plug.

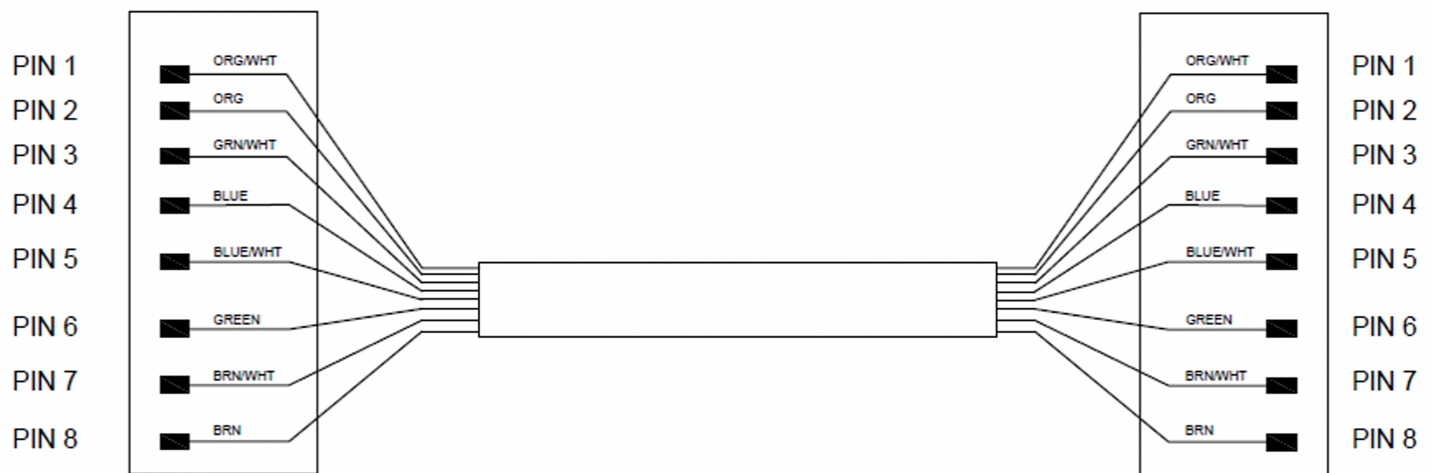


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**Fig. 13.** Communication connections.



**Fig. 14.** Ethernet wire connections.

## 5.8 Busbars, Mountings and Connectors

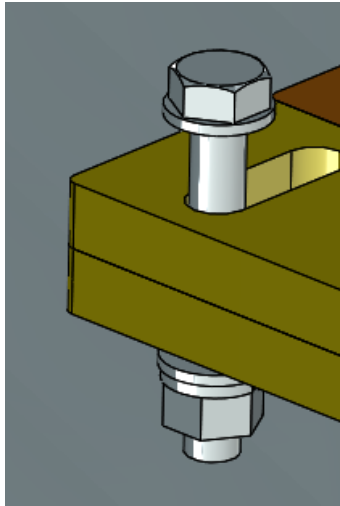
**NOTE:** For easier access to work on the upper portions of the Cube, it may be necessary to mount a ladder or scaffolding. Alternatively, personnel may also stand or sit on the top surface of the Cube. To prevent damage to form and/or function avoid contact with the deflagration panels. When located on the top surface or upon mounting a ladder or scaffolding to work on the Cube, immediately secure a safety line to the safety loop at the Cube's upper corner. Reference the safety guidelines specified in **Section 4**.

To protect the internal busbars during shipping, all Cubes include disposable busbar covers mounted to the exterior enclosure (Error! Reference source not found.). Remove the disposable



cover to expose the internal busbars and prepare for connection to the neighboring Cube. Labeling exists on the cube in proximity to the busbars to clearly identify electrical polarity.

The Cubes are interconnected by means of 2 x 15mm thick flexible, external busbars per pole. The busbars are rated at 1,500 VDC, 4,000 A, 150 kA. The busbars of each Cube are joined with a busbar extension that is attached with four (4) M12 x 80 mm 10.9 bolts, with matching nut, spring washer and two flat washers for each bolt (**Fig. 15**). Torque to 135 Nm. For the busbar connection, a split lock washer is required to keep constant pressure between busbar when the bolt loosens.

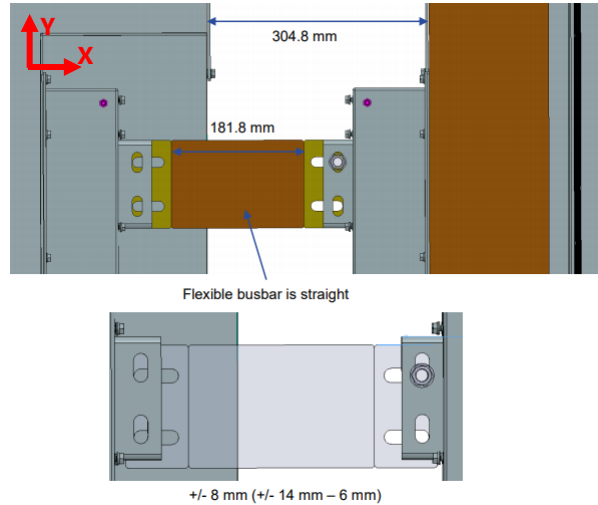
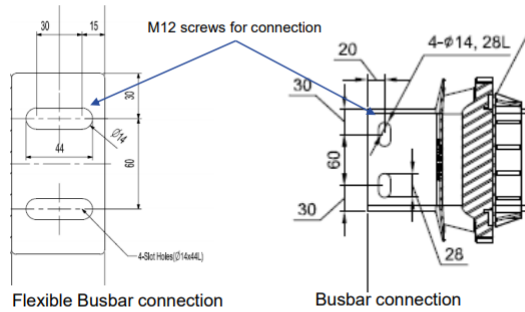


**Fig. 15.** M12 bolt securing the flexible busbar. Bolt is shown untightened: to secure, tighten nut on threaded (lower) portion of bolt.

To prevent inadvertent exposure, install the cover and bellows cover over the busbars and secure to the exterior Cube enclosure. For assembly detail, refer to APPENDIX D: Assembly of the Flexible Busbar, Cable Tray, and Fuse/AUX Panel Covers.

The Flexible Busbar can accommodate limited linear misalignment of Cubes in the Y-axis direction (**Fig. 16**) and limited torsional misalignment. Additionally, the sheetmetal cover is less than 1 mm larger than the connection point on the Cube; large misalignments will prevent the cover from being properly mounted. Over the range of acceptable spacing between Cubes of 7 to 12 inches (178 to 305 mm) in the X-axis, a tolerance of  $\pm 0.3$  inches ( $\pm 8$  mm) in the Y-axis is permitted. This tolerance is limited by the maximum distance in the X-axis direction, busbar slot dimensions and the clearance from the busbar to the sheetmetal cover.





**Fig. 16.** Flexible busbar alignment. Shown clockwise from left to right: Flexible busbar connection, Busbar connection, Nominal alignment with 12" (304.8mm cube-to-cube spacing, Maximum misalignment

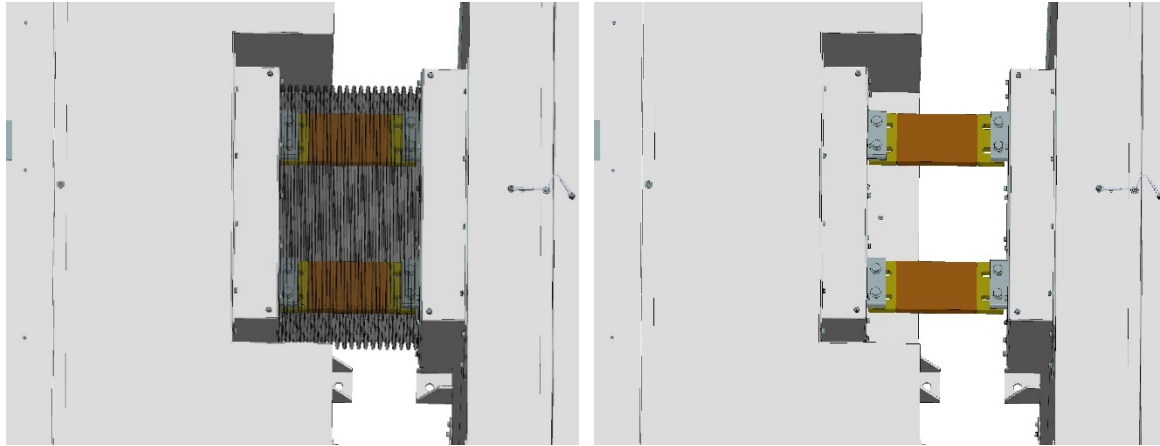
Fluence provides the external busbars, busbar cover, busbar bellows cover, and mounting hardware in the Cube-to-Cube Connection Kit.



**Fig. 17.** Exploded view of busbar connection, including adjustable protective outer covering but not bellows covering (**Fig. 18**).

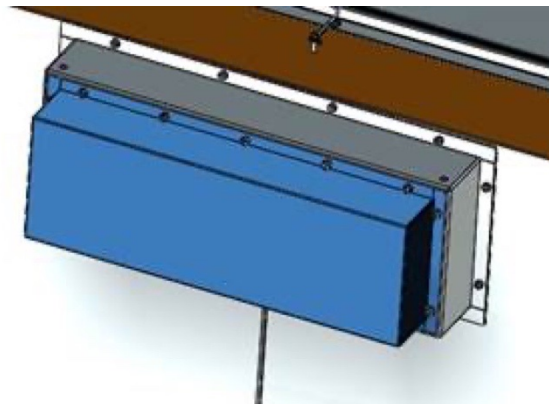


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**Fig. 18.** Top-down view of busbar bellows covering in place (left: covering is opaque but is depicted here as see-through for clarity) and removed (right).

At the start of a row of Cubes, no connection is made to the outermost set of busbars. Install the Operational End-Row Cover over these busbars (**Fig. 19.** Operational End-Row Cover). This cover is secured to the Cube using fourteen (14) Hex M6 x 20 mm stainless steel screws, each with a spring washer and a flat washer. Torque screws to 8 Nm.



**Fig. 19.** Operational End-Row Cover.

On the opposite end of the row of Cubes, the Cube Row Termination (CRT) is a busbar interconnect between the Cube and the PCS. For more information about the CRT, see "Cube Row Termination Manual," Document Control Number 06-04-0003-OAM-006.

## 5.9 Cooling System for Liquid-Cooled Batteries

For liquid-cooled systems, first commission the circulating water system, then start up the chiller.



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For liquid-cooled systems, it is first necessary to fill the coolant system with fluid. Cubes are shipped without coolant (check with Fluence for complete specifications). The cooling system capacity of the energy Cube (long duration) and power Cube (short duration) are 35 L and 60 L, respectively.

Follow the coolant fill procedure, *Fluence Cube Chiller Coolant Fill Instructions* (DCN: 06-01-0001-PRO-008). A coolant fill kit is available (Fluence PN A004-0020) and includes fluid pump, valves, and hoses. Using the kit, approximately 20 minutes are required to fill the cooling system in the energy Cube, and about twice as long for the power Cube. The procedure can be completed by one person; however, an additional person (2 total) can improve efficiency.

## 5.10 Battery Module Service Disconnect

Cubes that contain liquid-cooled Contemporary Amperex Technology (CATL) battery modules require installation of a low-voltage disconnect, also referred to as a Manual Service Disconnect (MSD), on each battery module in order to complete and enable the electrical circuit. Fluence provides the MSDs to the installation site in the CATL Accessories Assembly. The MSDs should not be applied to the battery module by the installation team. The MSDs must be set aside until commissioning. The Fluence commissioning team will install these devices.

## 5.11 Energizing the Cube

When the Cube is first energized, all UPS-backed loads will remain initially de-energized because the UPS will still be off. To turn the UPS on, open the aux panel cover and press and hold the UPS button for 4–5 seconds. Ensure that all circuit breakers are closed. Once the UPS turns on, the Leaf controller assembly on the door should light. The Cube will start in F-Stop condition because the fire panel located on the Fluence Outdoor Core Telco Enclosure (OCTE) will not be commissioned yet and will signal an open (faulted) condition. In this state, the Cube HVAC and chiller will not function. Once the OCTE fire panel is successfully commissioned, the system will start functioning in normal mode.

Self-configuration of the system occurs once the Cube is energized and the OCTE is powered up and connected to the Cube. For the Cube to fully start functioning, the fire panel and the F-Stop circuit in the OCTE should be in normal condition.

**NOTE:** For UL-certified versions of the Cube, the Modbus gateways of the fire panel located in the OCTE must be programmed by certified personnel and may not be auto-configured. Refer to the *OCTE Installation and Commissioning Manual* (DCN 06-05-00XX-PRO-001).

For the Cube to function properly, the power-up sequence must follow these steps:



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- 1) Energize the Array Telco Enclosure
- 2) Configure and Install the Array Telco Enclosure
- 3) Energize the OCTE
- 4) Configure and Install the OCTE
- 5) Energize the Cube
- 6) Turn the Cube UPS on
- 7) Self-Configuration of the Cube Leaf Controller

## 5.12 Final Inspection and Certification

Following installation, the construction team, contractors, and commissioning engineers shall perform inspections and tests of the fire system and mechanical, electrical, and controls subsystems to ensure:

- All balance of plant equipment configured to communicate properly over DNP3/TCP and/or Modbus/TCP as appropriate.
- Relays and meters are properly configured.
- Relays and meters are properly calibrated.
- Ground fault detection systems are properly configured.
- Fire alarm and control systems are active and functioning properly.
- Balance of plant indication systems (DC aux power battery charger alarms, transformer I/O, etc.) are operating properly.
- Switchboard and switchgear testing is complete.
- Auxiliary power systems are functioning properly.
- Full utility connection capacity is available.
- HVAC systems are operating properly.
- Protection systems (including F-Stop buttons and ground fault detector) function properly to trip the core main breaker.
- Battery systems are properly installed.
- Inverter systems are properly installed.
- Inverter configuration checks are completed.
- Power cables and network cables are properly installed



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## 5.13 Testing and Commissioning

The Commissioning Plan shall be completed during system commissioning and shall include the following acceptance criteria:

- Demonstrate proper Modbus functionality of Cube controller, inverter, and battery system.
- Demonstrate proper F-Stop functionality of inverter and battery.
- Demonstrate proper operation of the inverter at system power ratings.
- Demonstrate rated capacity of the battery system with acceptable battery cell temperatures.

## 5.14 Repair Activity & Parts Under Warranty

Refer to the Fluence-provided SOPs for performing component replacements (PCS, UPS, PLC Controller, etc.).

Components under warranty are identified by the Computerized Maintenance Management System (CMMS). For components under warranty, the failed component shall be removed and returned to the OEM using the Return Material Authorization process (see Fluence SOP document "Fluence—RMA Process," Document Control Number 0000-PRO-FLN-90-7018). Any unauthorized component repair activity may result in voiding part warranty.

## 5.15 Critical Spares

Fluence provides critical spares lists to support optimal maintenance activities. The CMMS provides an overview of the minimum critical spares.



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## 6. Installation Help and Advice

Fluence is committed to fully supporting each Cube site. Our primary point of contact is our 24/7 Operations group who log each issue raised into our workflow-tracking tool and progressively escalate the issue within the Fluence Support Services team.

Fluence Support Services may be contacted 24/7 at **+1 (703) 635-7631**.



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## 7. Training

With each site commissioning, Fluence Support Services offers three training courses:

- Orientation
- Operations
- Maintenance

Additional refresher training is available upon request. Refer to the training program summary documents.



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## 8. References

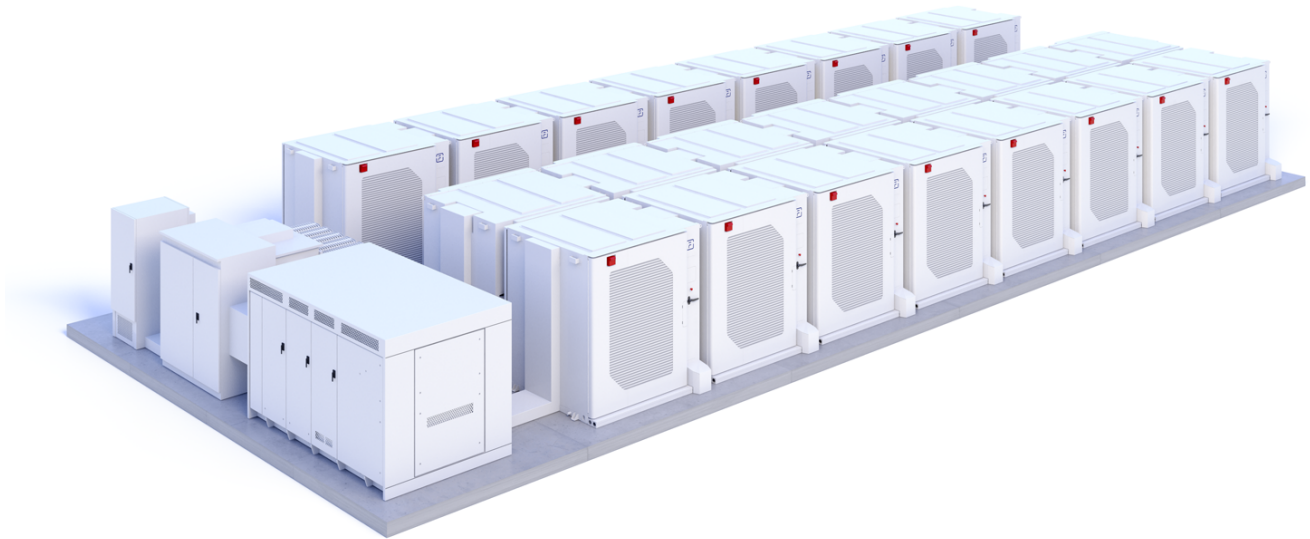
06-01-0001-INF-001	Fluence Cube Transportation and Handling Guidelines
06-01-0001-PRO-007	Cube Unloading/Loading Procedure
06-01-0001-PRO-008	Fluence Cube Chiller Coolant Fill Instructions
06-01-0001-INF-008	Fluence Cube Cooling System Design Document
06-05-00XX-PRO-001	OCTE Installation and Commissioning Manual
0052-DRW-FLN-90-001	Fluence Cube Nameplate, Long Duration System
0053-DRW-FLN-90-001	Fluence Cube Nameplate, Short Duration System
0052-DRW-FLN-GEN6-17-1040	Fluence Cube Lifting Plan, Short Duration System
0053-DRW-FLN-GEN6-17-1040	Fluence Cube Lifting Plan, Long Duration System
0052-DRW-FLN-GEN6-17-1042	Packing Concept and Dimensions, Long Duration System
0053-DRW-FLN-GEN6-17-1042	Packing Concept and Dimensions, Short Duration System
0052-DRW-FLN-GEN6-17-5022	3-Line Drawing, Long Duration System
0053-DRW-FLN-GEN6-17-5022	3-Line Drawing, Short Duration System
0052-DRW-FLN-GEN6-17-5024	Cube to Cube Connection, Long Duration System
0053-DRW-FLN-GEN6-17-5024	Cube to Cube Connection, Short Duration System



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# APPENDIX A: Gridstack

The Fluence Gridstack is an AC-coupled ESS designed as a grid-scale energy storage solution.



**Fig 25.** Gridstack (single-Core example).

**Table 1.** Fluence Gridstack system configurations. See Fluence document SS-006-03-EN for complete Gridstack specs.

<b>Related AC Power Per System</b>	2 MW to 100+ MW
<b>Discharge Duration</b>	30 minutes to 4+ hours
<b>Power Conversion</b>	2 MW modular inverters
<b>Battery Chemistry</b>	Advanced lithium-ion sealed cells
<b>Air Conditioning</b>	Air or liquid
<b>Fire Suppression</b>	Solid aerosol fire suppression agent
<b>Ambient Operating Temperature</b>	-30 °C to 50 °C
<b>Digital Intelligence</b>	Fluence IQ
<b>System Controls and Market Dispatch</b>	Fluence OS



## APPENDIX B: Sunstack

The Fluence Sunstack is a DC-coupled ESS designed as a solar-energy storage solution.



**Fig. 20.** Sunstack example.

**Table 2.** Sunstack system configurations. See Fluence document TS-009-03-EN for complete Sunstack specs.

<b>Related AC Power Per System</b>	1 MW to 100+ MW
<b>Discharge Duration</b>	1 to 4+ Hours
<b>Power Conversion</b>	500 kW DC/DC converters
<b>Battery Chemistry</b>	Advanced lithium-ion sealed cells
<b>Air Conditioning</b>	Air or liquid
<b>Fire Suppression</b>	Solid aerosol fire suppression agent
<b>Ambient Operating Temperature</b>	–30 °C to 50 °C
<b>Digital Intelligence</b>	Fluence IQ
<b>System Controls and Market Dispatch</b>	Fluence OS



# APPENDIX C: Edgestack

The Fluence Edgestack is an AC-coupled ESS. It is designed as a commercial or industrial power storage solution.



**Fig. 21.** Edgestack (two-Cube example).

**Table 3.** Edgestack system configurations. See Fluence document TS-008-03-EN for complete Edgestack specs.

<b>AC Max Power Per System</b>	500 kW	1 MW	1.5 MW	2 MW
<b>Discharge Duration</b>	30 minutes to 4+ hours			
<b>Connection Voltage</b>	480 VAC			
<b>Sidecar Dimensions</b>	2,600 × 1,921 × 1,626 mm			
<b>Battery Chemistry</b>	Advanced lithium-ion sealed cells			
<b>Air Conditioning</b>	Air or liquid			
<b>Fire Suppression</b>	Solid aerosol fire suppression agent			
<b>Ambient Operating Temperature</b>	–30 °C to 50 °C			
<b>Digital Intelligence</b>	Fluence IQ			
<b>System Controls and Market Dispatch</b>	Fluence OS			

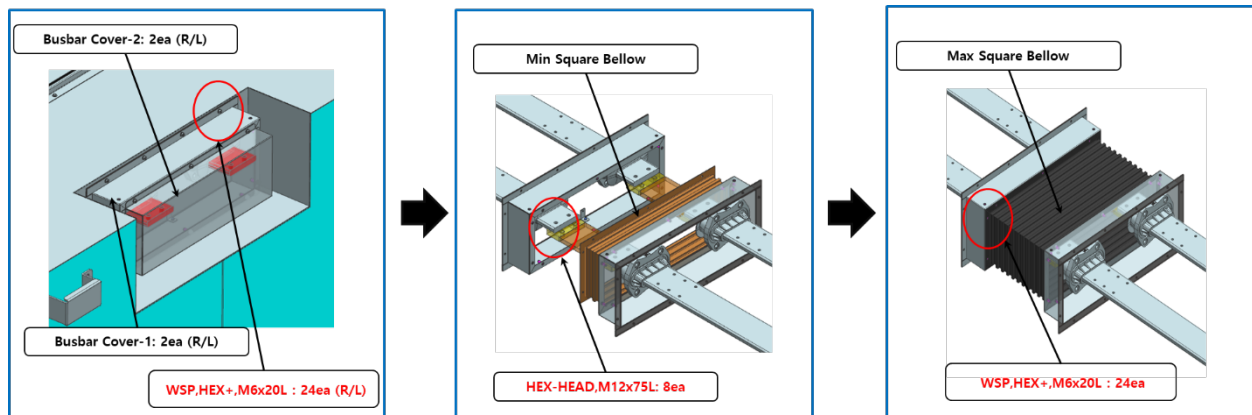


# APPENDIX D: Assembly of the Flexible Busbar, Cable Tray, and Fuse/AUX Panel Covers

## FLEXIBLE BUSBAR AND BELLOWS COVER

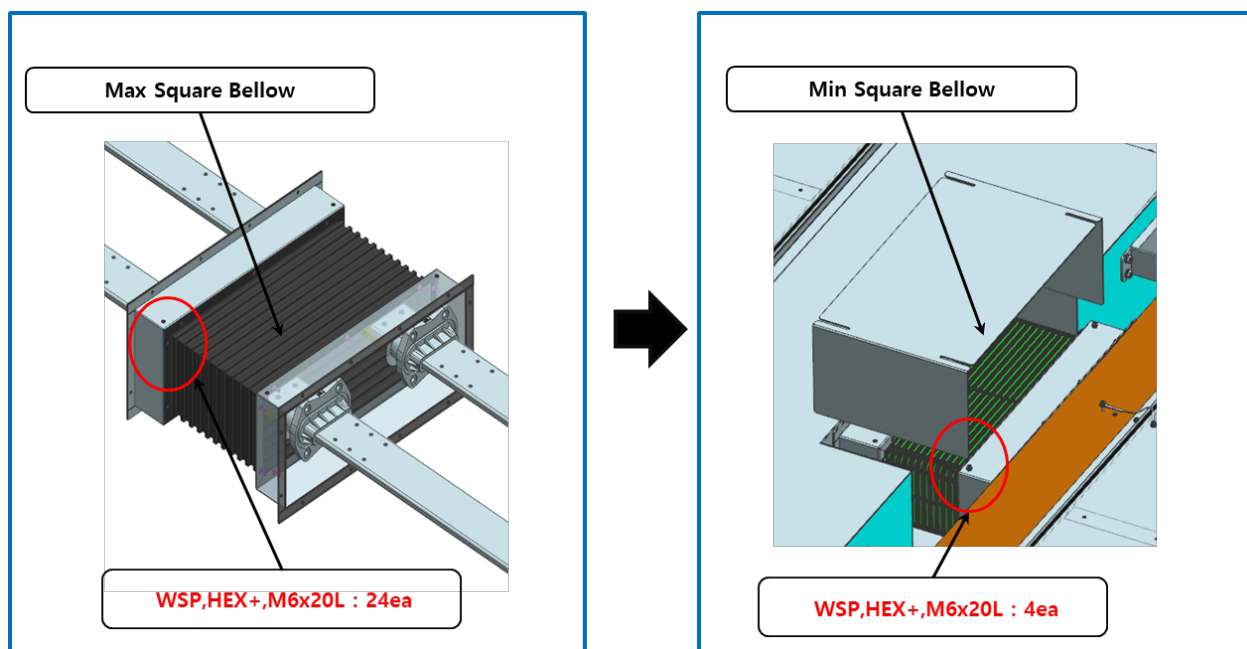
For protection, the Cube is shipped with a disposable cover installed over each set of busbars.

1. Remove the disposable busbar covers and discard/recycle. Save the M6 x 20L hex screws (qty 24) for reuse.
2. Attach the bellows cover on one side with M6 x 20L hex screws (qty 12). Torque screws to 8 Nm.
3. Assemble each busbar with a M12 x 75L hex bolt, matching nut, split lock washer and two flat washers for each bolt. Torque to 135 Nm (qty 4 per busbar)
4. Stretch the bellows cover and attach the other side with M6 x 20L hex screws (qty 12). Torque screws to 8 Nm.



5. Install the busbar cover with M6 x 20L hex screws (qty 4). Torque screws to 8 Nm.





## CABLE TRAY AND AUX COVER

1. Using a PVC cutter, trim conduit (CPS-48B) to slightly longer than the length from Cube to Cube.
2. Assemble the AUX Cover (Cover-Power-Right), CPS-48B conduit and PNC-M6348B fitting with nut (qty 2). Specifications for the PNC-M6348B fitting are as follows:
  - Manufacturer: CP System Co., LTD
  - Color: Black
  - Thread: M63 x 1.5 metric (EN 60423)

Conduit size	Thread Dia.	Thread length	Total length	Inner Dia.	Outer Dia.	Wrench size
48	62.7	21.7	81.7	57	71.5	64

Note: All dimensions in millimeters





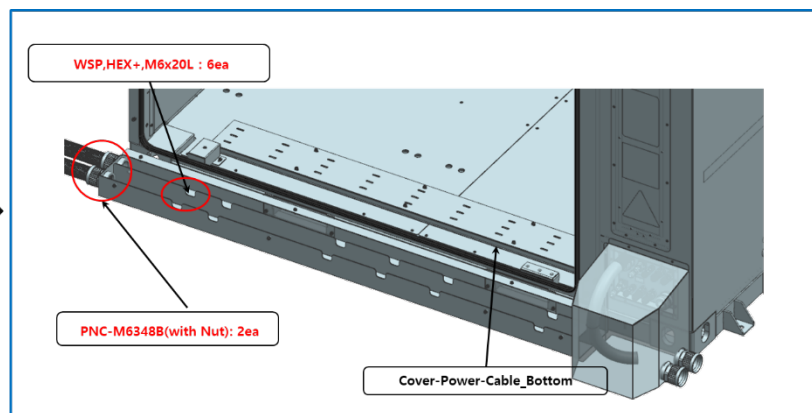
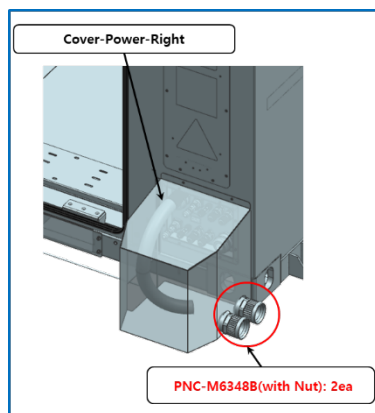


3. Install the Cover Power Cable\_Bottom to the Cube with M6 x 20L hex screws (qty 6). Torque screws to 8 Nm.
4. Install PNC-M6348B fitting with nut (qty 2) to the Cover Power Cable\_Bottom.

Assemble PNC-M6348B Fitting



5. Assemble the frame with M6 x 25L hex screws (qty 4). Torque screws to 8 Nm.



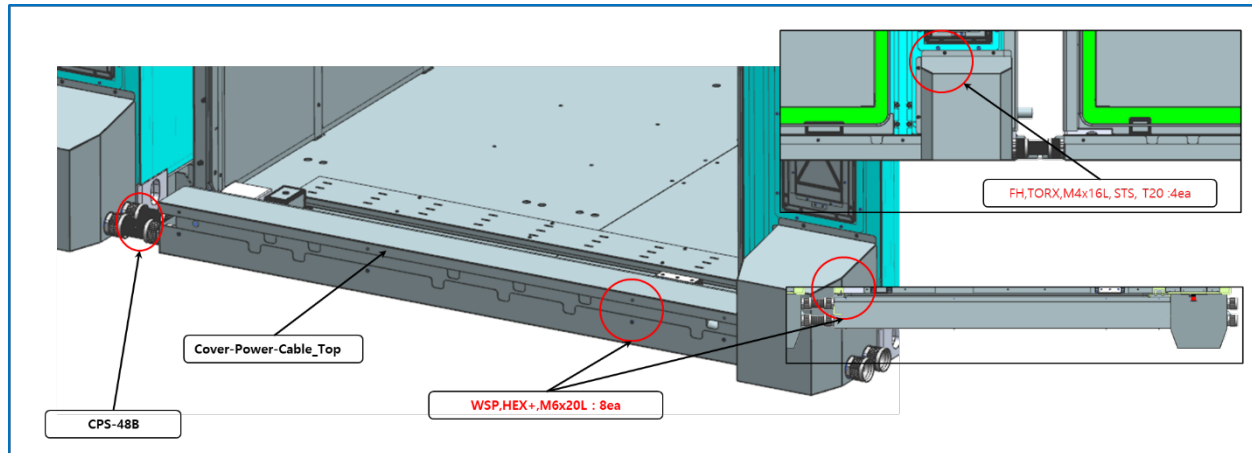
6. Assemble the Cover Power Cable\_Bottom and Cover Power Cable\_Top with M6 x 20L hex screws (qty 8). Torque screws to 8 Nm.



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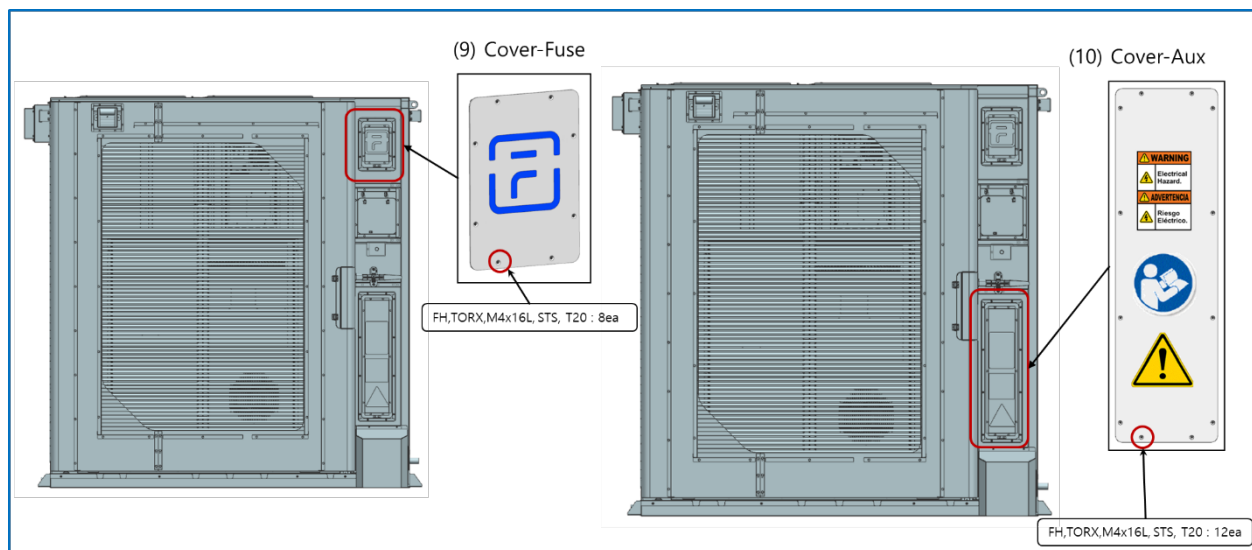


- Attach the AUX Cover to the Cube with M4 x 16L torx T20 screws (qty 4). Torque screws to 2.3 Nm.



## FRONT FUSE COVER AND AUX PANEL COVER

- Attach the Fuse Cover to the Cube using M4 x 16L torx T20 screws (qty 8). Torque screws to 2.3 Nm.
- Attach the AUX Panel Cover to the Cube using M4 x 16L torx T20 screws (qty 12). Torque screws to 2.3 Nm.



# APPENDIX E: Abbreviations and Definitions

<b>AGC</b>	Automatic Generation Control. A system that adjusts the power output of multiple generators at different power plants in response to changes in system load.
<b>ARC</b>	Automatic Resource Control. A mode of operation for Fluence's Gridstack and Edgestack, in which the system automatically responds to an external dispatch signal.
<b>Array</b>	An Array is several individually controllable Cores, which together comprise a ESS.
<b>AWG</b>	American Wire Gauge. A standardized wire gauge system used predominantly in North America, for diameters of round, solid, nonferrous conducting wires.
<b>BMS</b>	Battery Management System. An electronic system that ensures the safe operating condition of a battery pack, monitors its state, and reports all cell-level data.
<b>BPU</b>	Battery Protection Unit. The BPU protects a battery string from faults. When a fault is detected, the BPU automatically opens the relevant contactor to isolate the fault.
<b>CAN</b>	Controller Area Network
<b>Chiller</b>	The type of cooling system used for a liquid-cooled Fluence Cube.
<b>CMMS</b>	Computerized Maintenance Management System. Created by Fluence for site-specific maintenance.
<b>CO</b>	Carbon monoxide. An odorless, colorless, tasteless flammable gas that is slightly dense than air. CO is toxic.
<b>Core</b>	A core is a set of Cubes connected to a central inverter unit and to a transformer. One Core may comprise one or more Nodes.
<b>Cube</b>	A complete functional energy-storage unit. The fundamental building block of a Fluence Gridstack, Edgestack, or Sunstack ESS.
<b>DAS</b>	Data acquisition system. A software program that gathers, analyzes, and monitors data processes.



<b>DCPM</b>	Direct Current Protection Module (DCPM).
<b>DCS</b>	Distributed Control System. Consists of a hierarchy of controllers connected by a communications network that operate in a closed-loop system to control an industrial process.
<b>EAF</b>	Equivalent Availability Factor. Measures the percentage of time that a generation unit is available to generate electricity if called upon in the marketplace.
<b>ESS</b>	Energy Storage System
<b>Fluence IQ</b>	A digital intelligence system that continually monitors safety and performance data.
<b>Fluence OS</b>	The interface through which a human operator controls a ESS, and which presents process data to a human operator.
<b>FSS</b>	Fire Suppression System. Monitors the Cube for a fire condition and initiates an aerosol-extinguishing agent.
<b>FR</b>	Fire resistant. An item or material that can withstand heat and resist burning.
<b>HVAC</b>	Heating, ventilation, and air conditioning. Type of cooling system used for an air-cooled Fluence Cube.
<b>JSA</b>	Job Safety Analysis.
<b>Leaf controller</b>	An industrial computer used to control automated processes.
<b>MDU</b>	Market Dispatch Unit. A software layer that makes real-time changes in system operation based on market conditions.
<b>Node</b>	A Node is the smallest controllable entity within a Core. Generally, a Node will be associated with one individual DC bus pertaining to one inverter. One inverter may contain one or more DC buses and consequentially one or more nodes. Each Node will contain one or more rows of Cubes.
<b>OEM</b>	Original Equipment Manufacturer. The manufacturer of any discrete subsystem (e.g., HVAC, fire suppression) that is incorporated into a Fluence ESS but is not built by Fluence.
<b>PCS</b>	Power Conversion System. An inverter that changes direct current to alternating current or vice-versa and is used to charge or discharge batteries.



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<b>PLC</b>	Programmable Logic Controller. An industrial computer used to control automated processes.
<b>PPE</b>	Personal Protective Equipment. Items of safety equipment to protect against hazards.
<b>PSDS</b>	Product Safety Data Sheet. The Cube PSDS is a document issued by Fluence (Document Control Number 06-01-0001-DSH-005) with information relating to occupational safety and health for use of the Cube.
<b>RMA</b>	Return Material Authorization. The procedure adopted by Fluence for return of goods.
<b>RTU</b>	Remote Terminal Unit. An RTU (sometimes called RTAC) serves as an interface between Fluence OS and external systems, including energy management systems of customers and interface points for grid operators
<b>SDS</b>	Safety Data Sheet. Document issued by manufacturer with information relating to occupational safety and health for use of a product.
<b>SOP</b>	Standard Operating Procedure.
<b>TBD</b>	To be determined.
<b>Stack</b>	Multiple Cubes connected in parallel to form a larger ESS.
<b>UPS</b>	Uninterruptible power supply.



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