Failure mode #	Potential Hazard	Description	Assembly
1	Thermal Runaway condition	propagating cell failure leading to off-gassing or fire	Megapack Battery Module Battery Tray/Cell

2	Failure of Energy Management System	inoperable site controller	Tesla Site Controller

3	Cell/Module combustion	Combustion leading to fire spread beyond containment	Megapack Battery Module Battery Tray/Cell

4	Cell/Module off-gassing leading to an explosion	explosion or deflagration caused by an accumulation of flammable gases	Megapack Battery Module Battery Tray/Cell

5	Battery cell failure leading to external fire	battery cells cause the balance of system to catch on fire	Megapack Battery Module Battery Tray/Cell BOS

6	Environmental hazard	nearby exposures are subject to a hazard scenario	Megapack Battery Module Battery Tray/Cell BOS Entire site

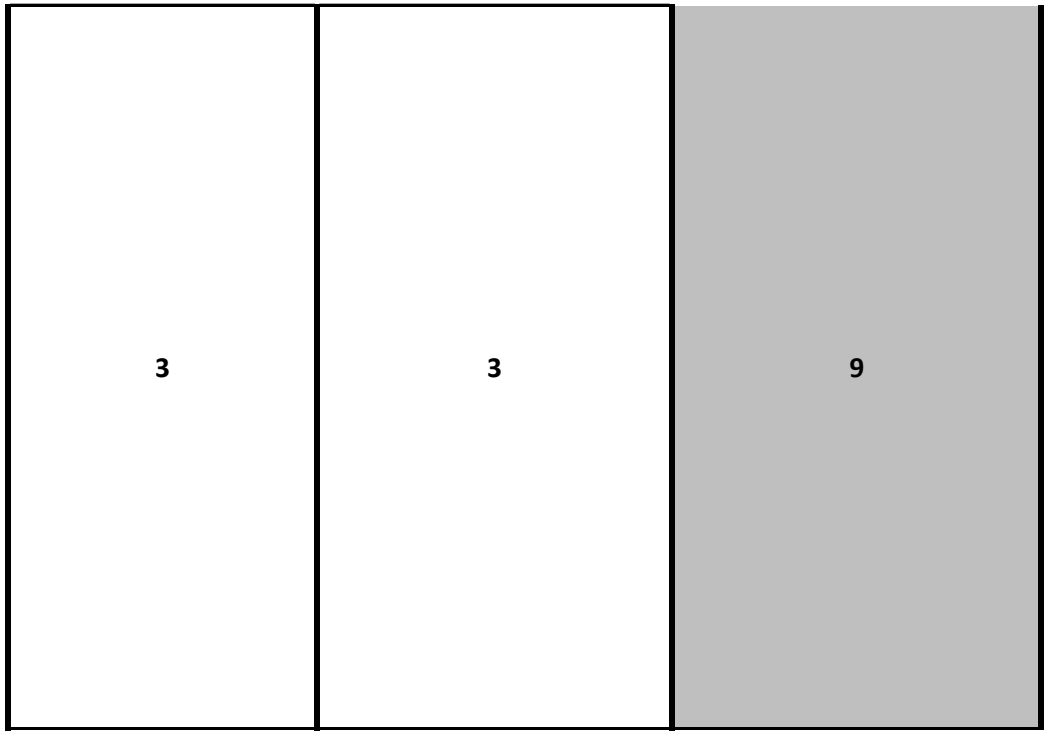
7	Battery module BMS Failure	Battery module communication loss that prevents monitoring and control of the BESS	Megapack Battery Module Battery Tray/Cell
8	Megapack 2XL BMS failure	Megapack 2XL communication loss that prevents monitoring and control of the BESS	Megapack Battery Module Battery Tray/Cell

9	Site Controller/BoP/ PLC Failure	Site controller communication loss or failure preventing the BMS from working with the EMS	Site controller BOS

10	Failure of ventilation or exhaust system	Failure of explosion/deflagration control	Thermal roof Overpressure vents Sparkers
11	Mechanical Failure Condition	Impact to BESS by external force (i.e. vehicle)	Megapack Site wall boundary

12	Mechanical Failure Condition	Cooling system failure (i.e., pump/fan breakdown, coolant leakage, etc.)	Megapack Thermal management system
13	Mechanical Failure Condition	Structural failure (i.e. seismic events)	Megapack Concrete equipment pads
14	Mechanical Failure Condition	Handling and maintenance errors	Megapack BESS area
15	PV Array	Fire or electrical fault originating in the PV array spreads toward the BESS area, causing external heat exposure and/or access obstruction	PV Array (steel foundation) DC collection Inverters
16	Vegetative / Brush Fire	Vegetation or brush fire spreads into the project area, increasing radiant heat exposure and potentially impeding responder access	Site perimter BESS area
17	BESS Noise (Operational / Abnormal Event)	Operational or abnormal equipment noise (HVAC/fans, inverters, alarms, sparker activation) causing nuisance complaints or misinterpretation as an emergency	BESS area Site boundary

Without safeguards: Severity [1 = Very low, 5 = Very high]	Without safeguards: Likelihood of Occurrence [1 = Remote, 5 = Very high]	Without safeguards: Risk Ranking
4	4	16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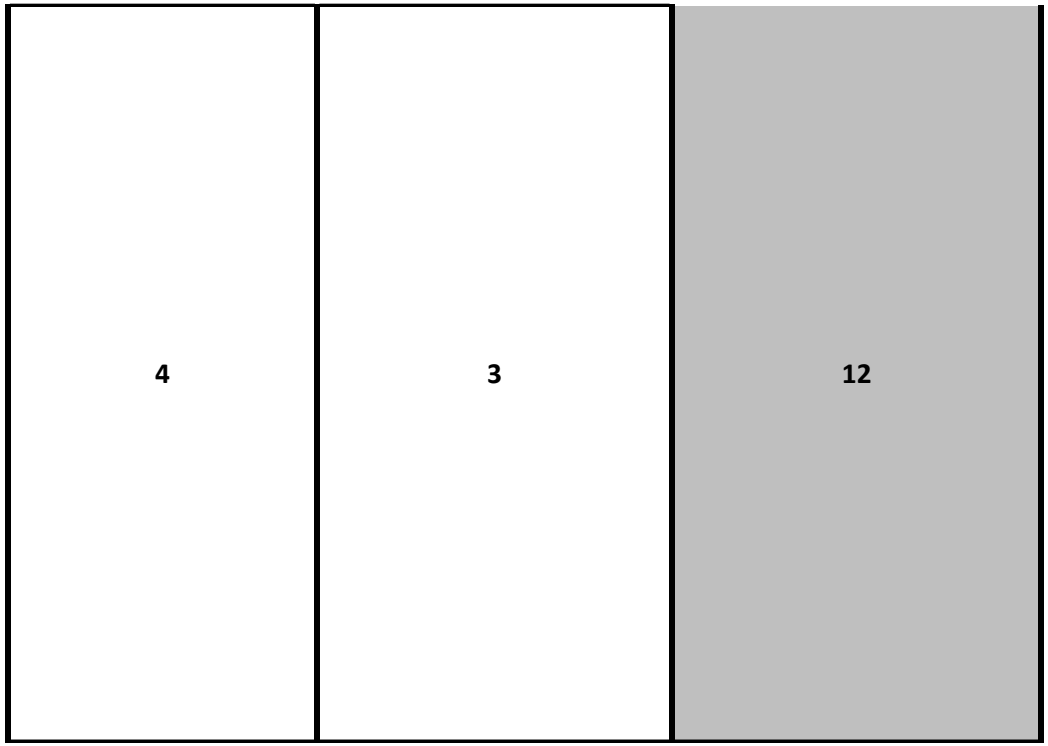
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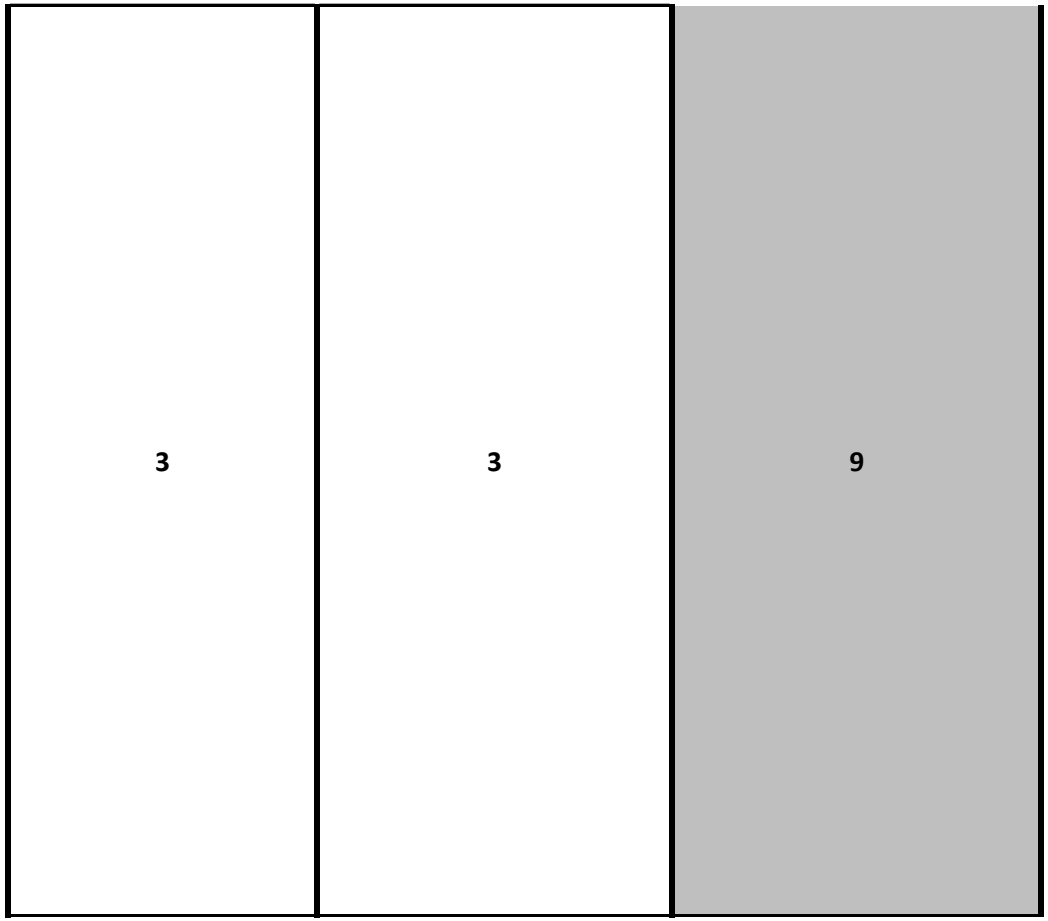
5	**3**	**15**

4	**3**	**12**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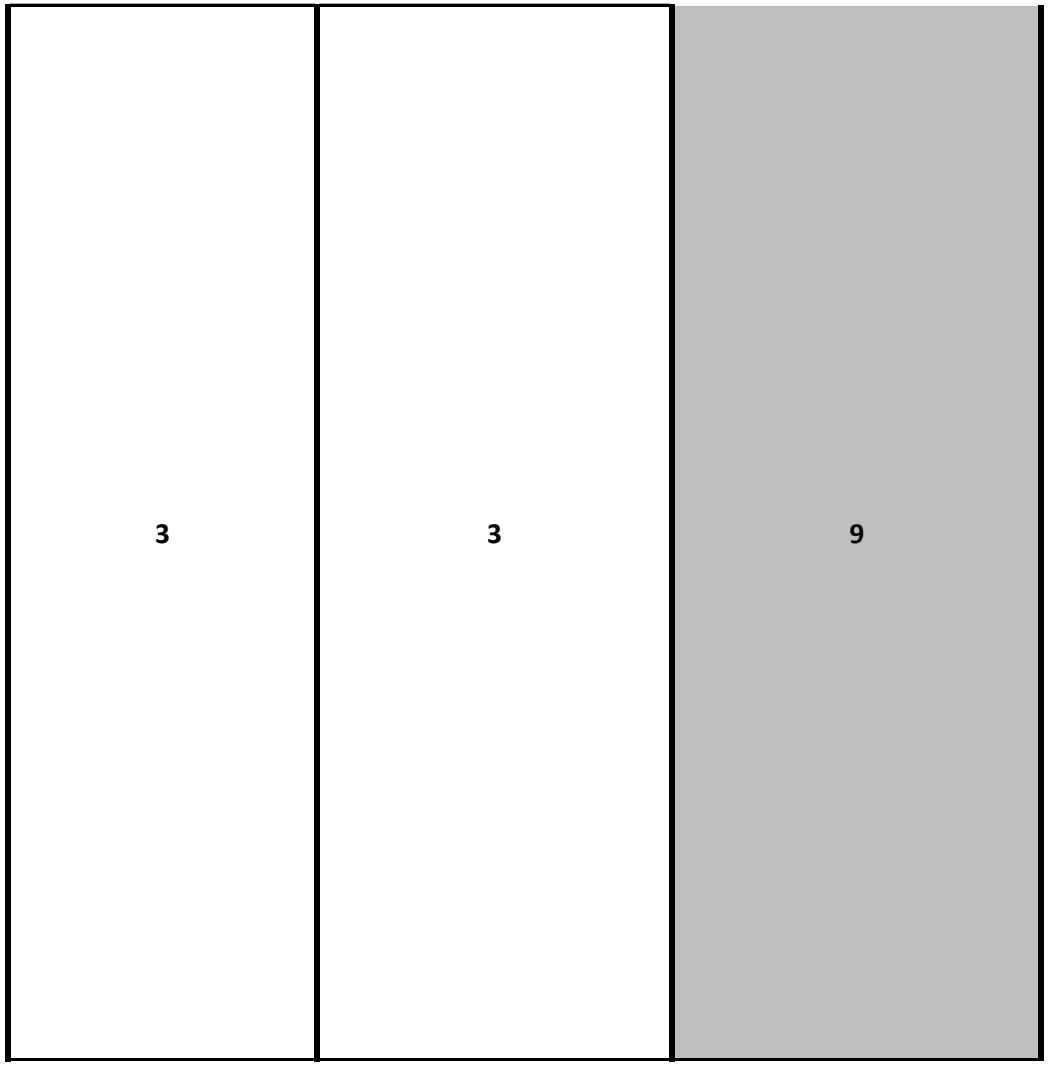
2	3	6
3	3	9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4	**3**	**12**
5	**3**	**15**

4	**3**	**12**
3	**2**	**6**
4	**3**	**12**
4	**3**	**12**
4	**2**	**8**
1	**5**	**5**

Prevention (Layer 1)
(Firmware / Resettable Hardware / Design prevention)

1. Battery Management System: The Tesla BMS for The MP2XL actively monitors the battery cells, modules, and unit to provide protective actions against a full-spectrum of failures and ultimately reduce the likelihood and severity of a thermal runaway condition.

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2. Network Operations Center (NOC): The Tesla BMS and Site Controller communicate via network operations center for both Tesla and Nexamp to provide 24/7 data on the BESS.

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1. Megapack 2XL BMS: The Site Controller and EMS that monitors and supervises all module-level BMS functions . It will provide an isolation condition in the event of BMS failure as to prevent a potential failure mode from cascading.
1. Module-level BMS: The module level BMS will trigger an isolation in the event of an EMS failure as to prevent a potential failure mode from cascading.

1. Megapack 2XL BMS: The MP2XL BMS monitors and supervises all the modules at the AC side and will provide an isolation in the event site controller failure.

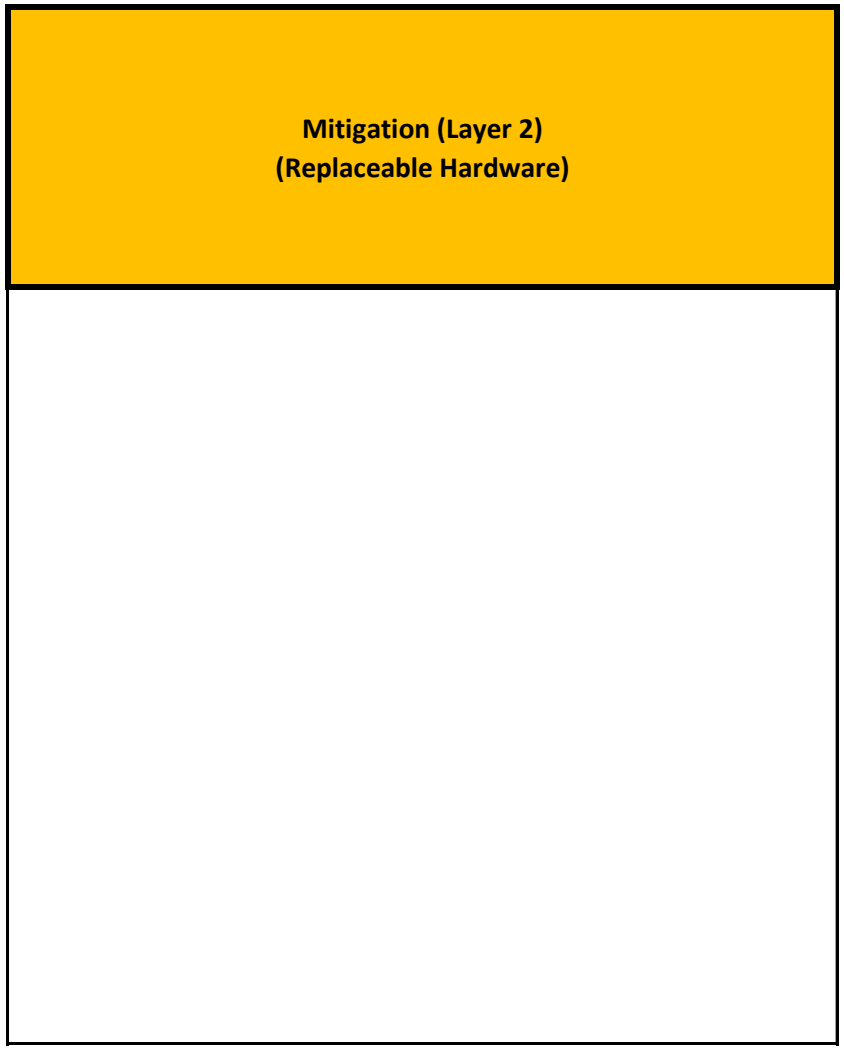
2. Module BMS: The MP2XL module-level BMS will enact an isolation measure upon the failure of the EMS/Site controller

1. Battery Management System: The Tesla BMS for The MP2XL actively monitors the battery cells, modules, and unit to provide protective actions against a full-spectrum of failures and ultimately reduce the likelihood and severity of a thermal runaway condition.

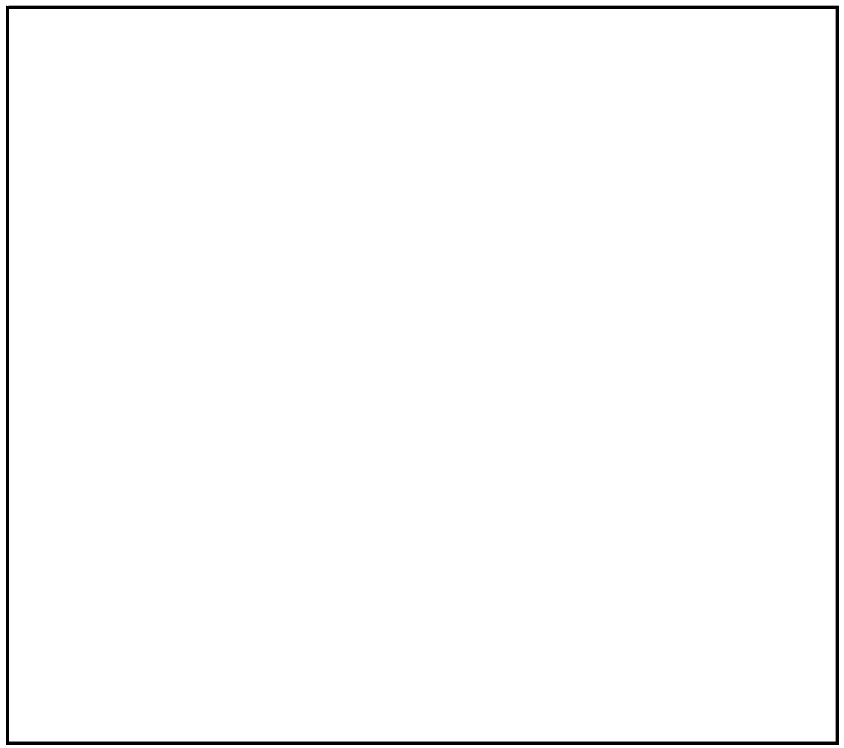
2. Network Operations Center (NOC): The Tesla BMS and Site Controller communicate via network operations center for both Tesla and Nexamp to provide 24/7 data on the BESS.

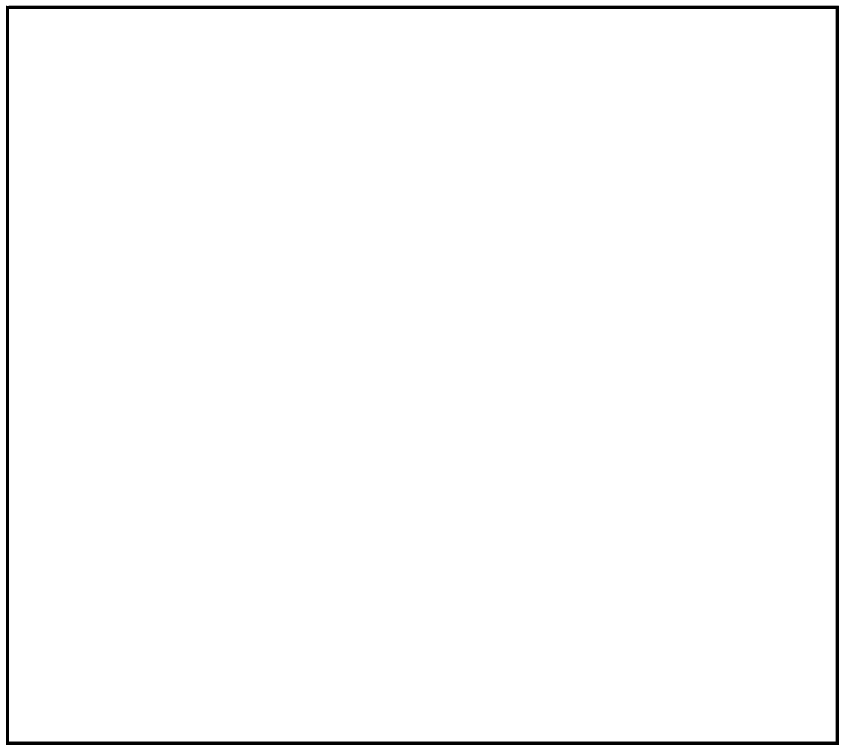
Site boundary wall (sound barrier)
Bollards

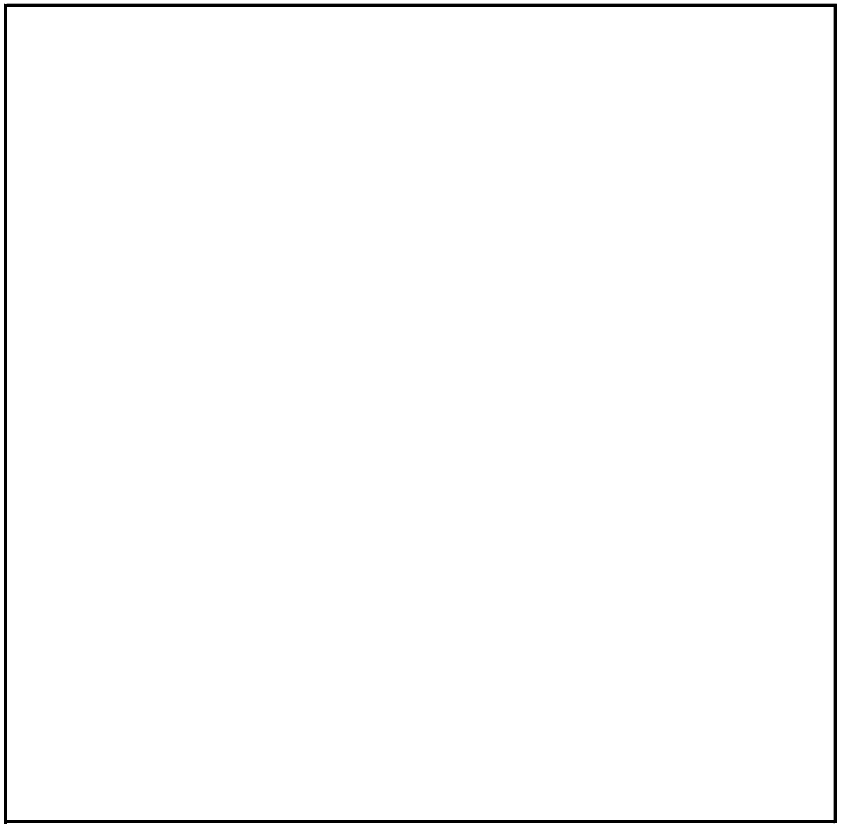
- Firmware detection of low coolant
IBC seismic rating for civil engineering
O&M Manual Training Certified personnel
PV system designed to NEC requirements including rapid shutdown and arc fault protection
Routine vegetation management and defensible space maintenance Code compliant setbacks and gravel covered areas
Noise Study Site distance O&M Manual Training Certified personnel

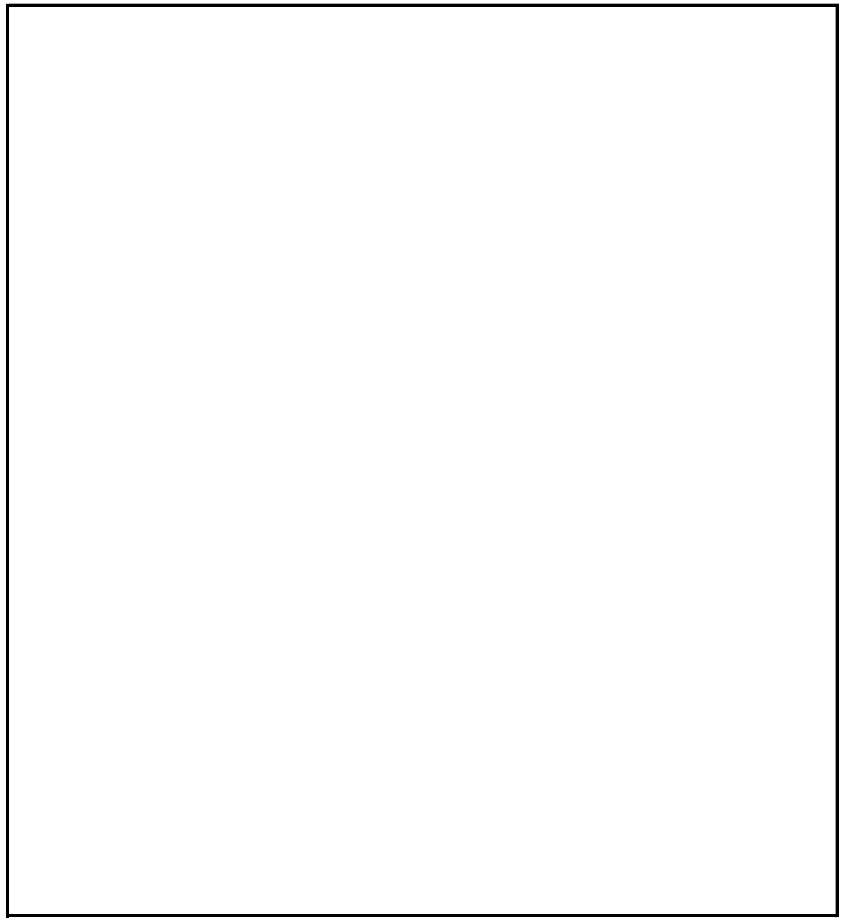

Mitigation (Layer 2)
(Replaceable Hardware)

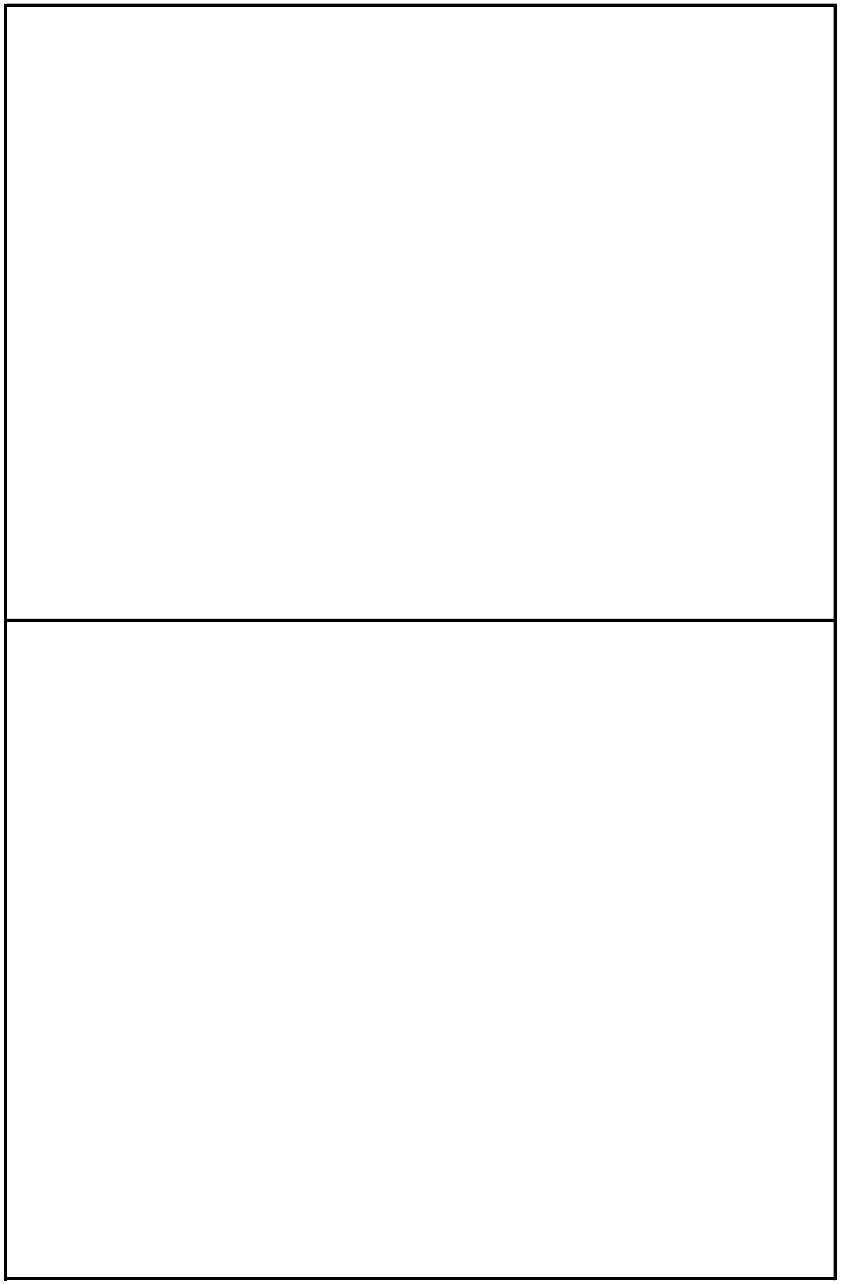
1. If the Tesla Site Controller is unable to be fixed, Tesla will replace the Site Controller under warranty. However, the Site Controller and the data around availability of the system has demonstrated it's great reliability.

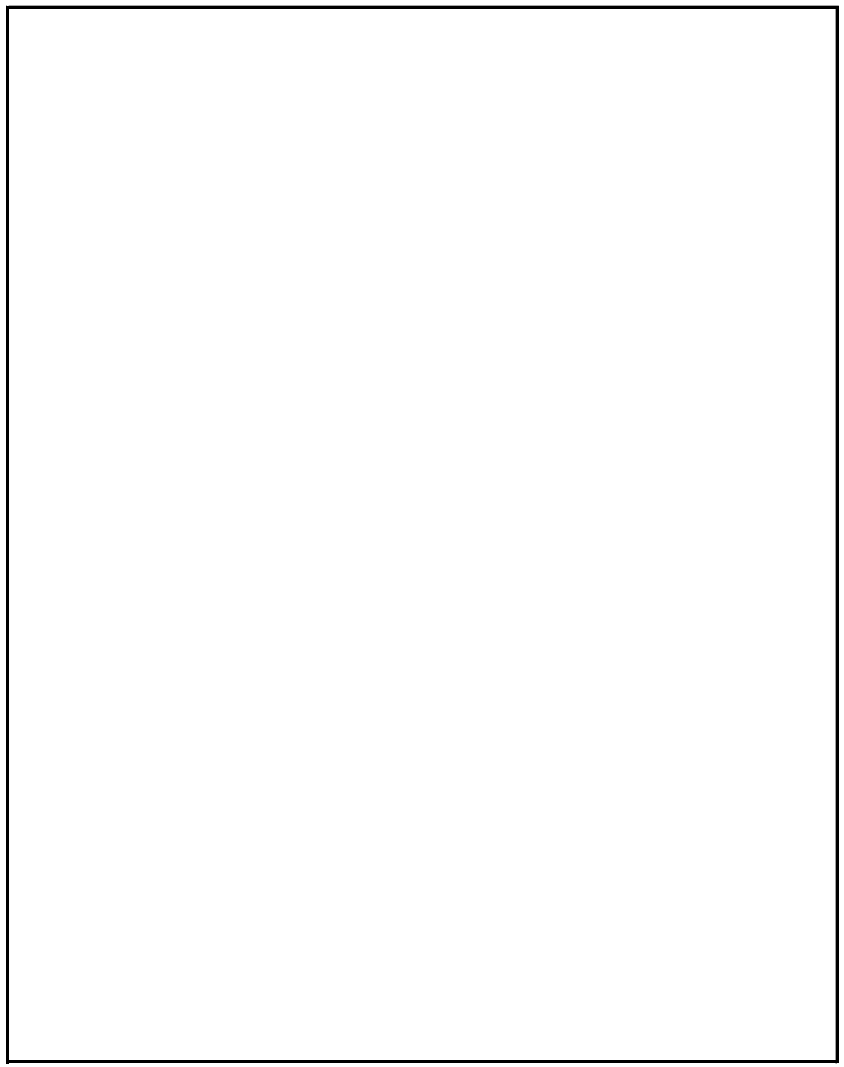


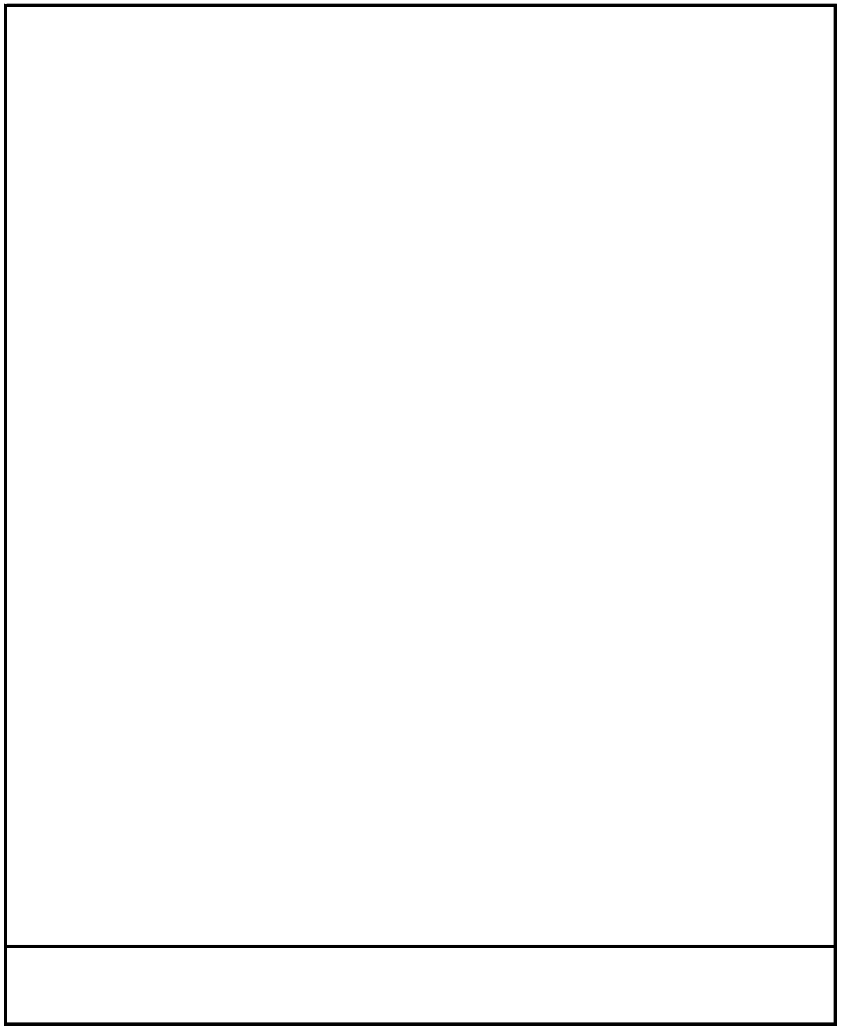












Maintenance determines any required HVAC/equipment replacements

Mitigation 2 (Layer 3) (Hardware Design Mitigation)	With safeguards: Severity [1 = Very low, 5 = Very high]
1. Active cell protection: The battery cells are actively and uniformly cooled through a 50/50 ethylene glycol and water mix in a closed loop system. The thermal management system provides heating and cooling as necessary, which is monitored and controlled through the BMS and Site Controller . 2. Cell thermal abuse tolerance: Battery Cells are tested and listed to UL 1642. The certification requires testing for thermal abuse tolerances. In addition, UL 9540A testing was done at the cell, module and unit level, displaying the systems ability to resist thermal runaway propagation. 3. Module thermal abuse tolerance: Battery Modules are tested and listed to UL 1973. The certification requires testing for thermal abuse tolerances. In addition, UL 9540A testing was done at the cell, module and unit level, displaying the systems ability to resist thermal runaway propagation.	**3**

1. System shutdown/disconnect: The MP2XL is capable of overcurrent and over voltage protection via a fixable link on the DC side of the AC and DC inverters and modules, and ground found protection. 2. Passive circuit protection and design: In addition to ground fault detection and over voltage protection, there are fused disconnects and DC connect switches for isolation mechanisms. 3. Cell thermal abuse tolerance: Battery Cells are tested and listed to UL 1642. The certification requires testing for thermal abuse tolerances. In addition, UL 9540A testing was done at the cell, module and unit level, displaying the systems ability to resist thermal runaway propagation.	**1**

1. Deflagration protection: MP2XL is equipped with an explosion control system that consists of 12 sparkers and 26 overpressure vents to ignite and vent any combustible/flammable gases as they are released. This prevents the accumulation of flammable gases. 2. Thermal isolation/cascading protection: The UL 9540A test demonstrated that thermal isolation limited heat transfer between the MP2XL and external walls, BESS units, and structures. 3. Facility design and siting: Design and siting were developed in line with MA fire code (NFPA 1) and Tesla's requirements. The BESS area will be cleared of vegetation and any combustible materials to prevent the spread of a fire. The non-combustible, ballistic rated noise barrier provides a barrier between the BESS and nearby exposures. 4. Emergency response plan: Tesla provides a MP2XL product specific emergency response guide and the system owner has developed a site-specific emergency response plan in line with NFPA 855. 5. Fire service response: Response of the fire department including staging fire fighters and securing adequate water to cool down nearby exposures (via fire hydrant) is paramount.	**2**

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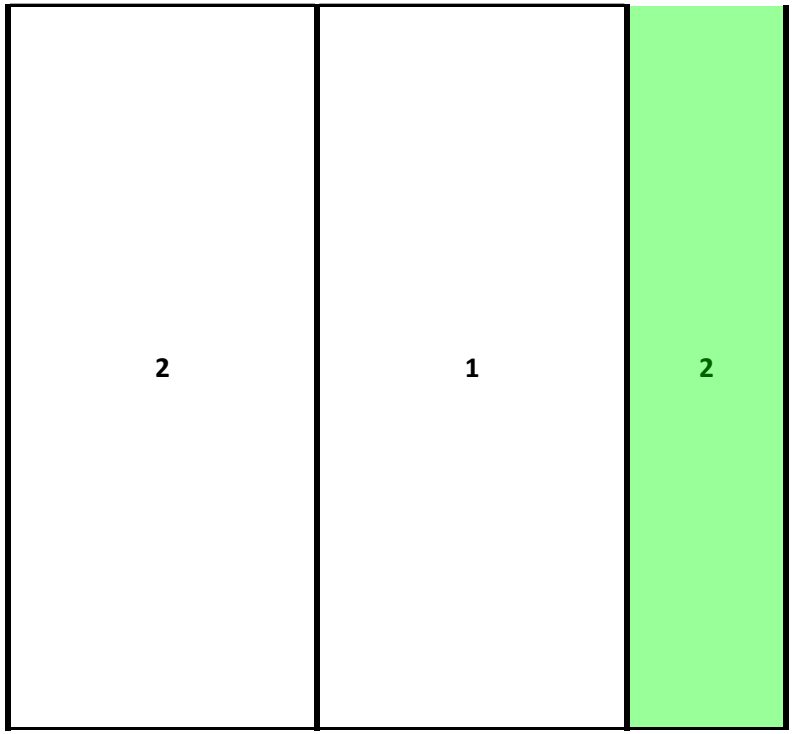
1. Deflagration redundancy: MP2XL is equipped with an explosion control system that consists of 12 sparkers and 26 overpressure vents to ignite and vent any combustible/flammable gases as they are released. This prevents the accumulation of flammable gases. In the event some of the sparkers and/or overpressure vents fail, the system is overdesigned and can successfully remove the potential hazard even with all of the sparkers/overpressure vents not operating. This is demonstrated in modeling and testing. If all sparkers/overpressure vents fail, the other mitigations in this section will be at play. 2. Thermal isolation/cascading protection: The UL 9540A test demonstrated that thermal isolation limited heat transfer between the MP2XL and external walls, BESS units, and structures. 3. Facility design and siting: Design and siting were developed in line with FCNYS and Tesla's requirements. The BESS area will be cleared of vegetation and any combustible materials to prevent the spread of a fire. The non-combustible, ballistic rated noise barrier provides a barrier between the BESS and nearby exposures. 4. Emergency response plan: Tesla provides a MP2XL product specific emergency response guide and the system owner has developed a site-specific emergency response plan in line with NFPA 855. 5. Fire service response: Response of the fire department including staging fire fighters and securing adequate water to cool down nearby exposures (via fire hydrant) is paramount.	**2**
MP2XL IK09 rated	**1**

- Two drains in the floor at opposite ends of the enclosure lead to drain ports that open when in contact with water. These prevent flooding inside the enclosure in case of a coolant leak or if there is a roof penetration. - Every cooling system is positive pressure leak tested at a pressure above the maximum pump output pressure at end of life - Temperature sensor with feedback to the BMS - BMS derates battery output power and therefor heat generation - Since the coolant is conductive it will likely caused either discharging to ground or shorts which will trigger firmware trips, blown fuses, triggered pyros or wire bond/busbar fusing	**2**
	2
	2
Site design - PV array's distance from BESS is a crucial mitigation layer from failure	**3**
	3
Containerized system Varying fan duty cycles depending on operational needs to reduce overall noise	**1**

With safeguards: Likelihood of Occurrence [1 = Remote, 5 = Very high]	With safeguards: Detectability [1 = Certain, 5 = Impossible]	RPN
2	2	12

- Low risk if RPN <1
- Medium risk if 12
- High risk if RPN ≥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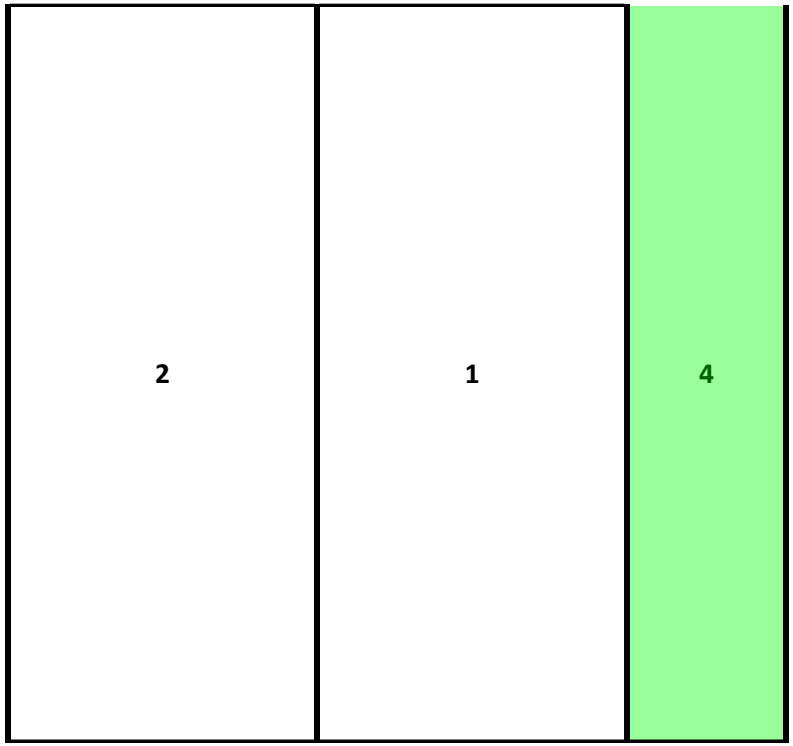
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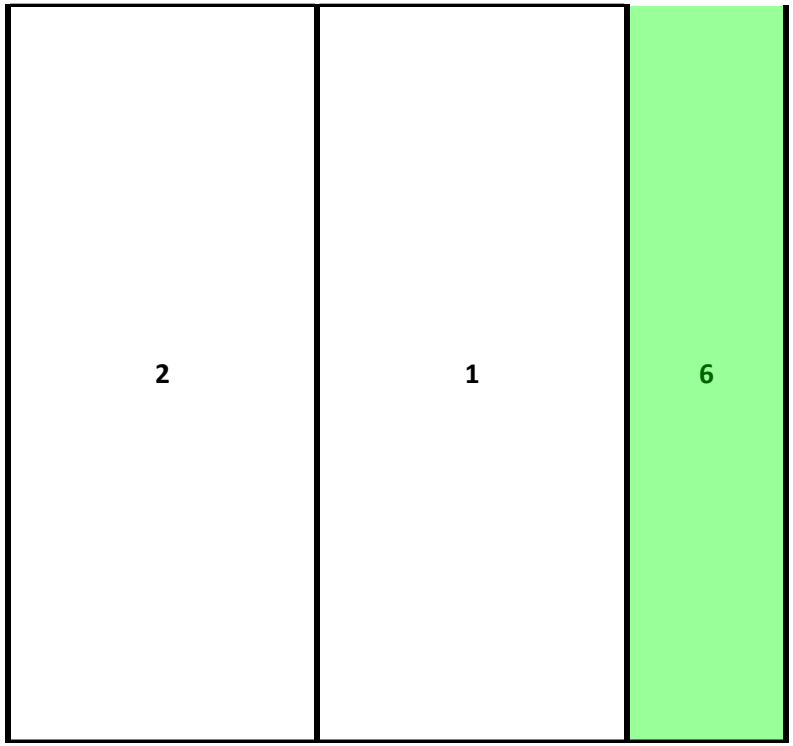
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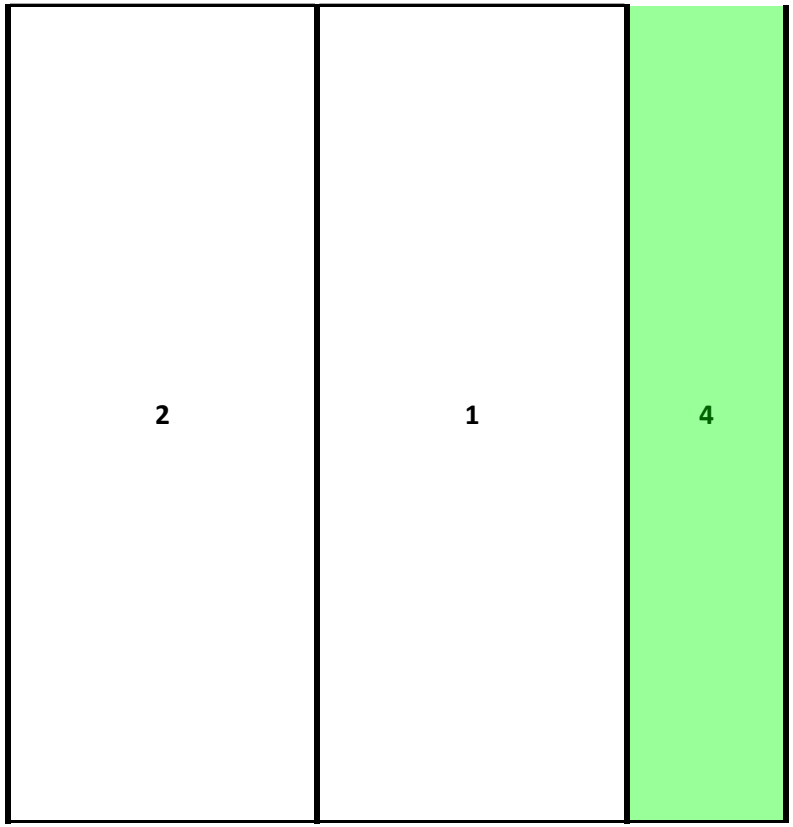
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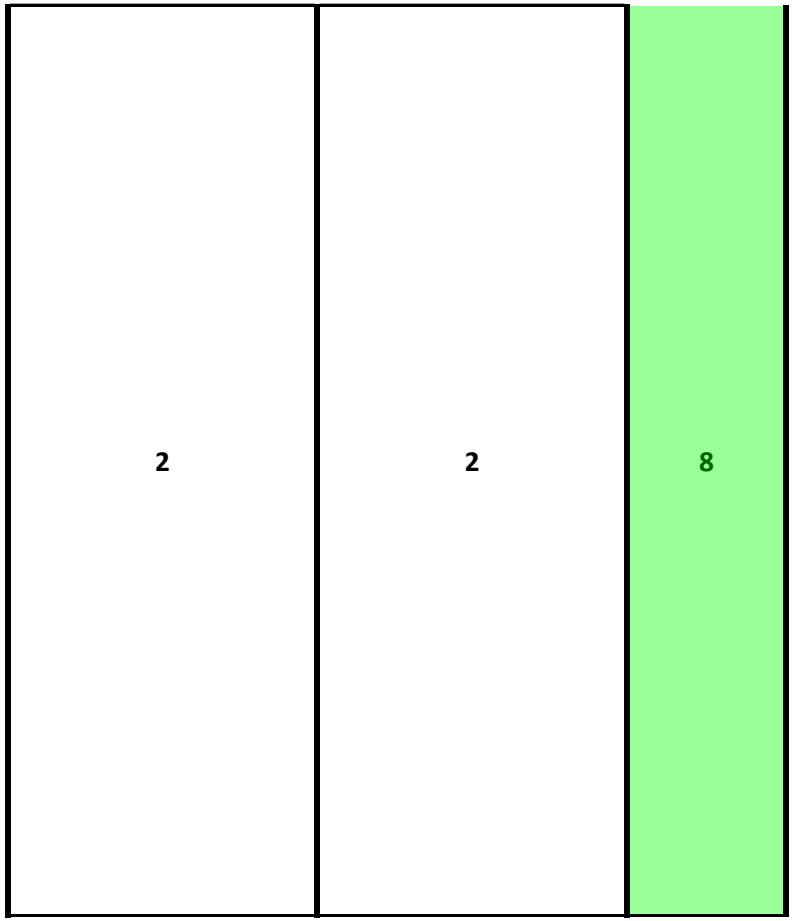
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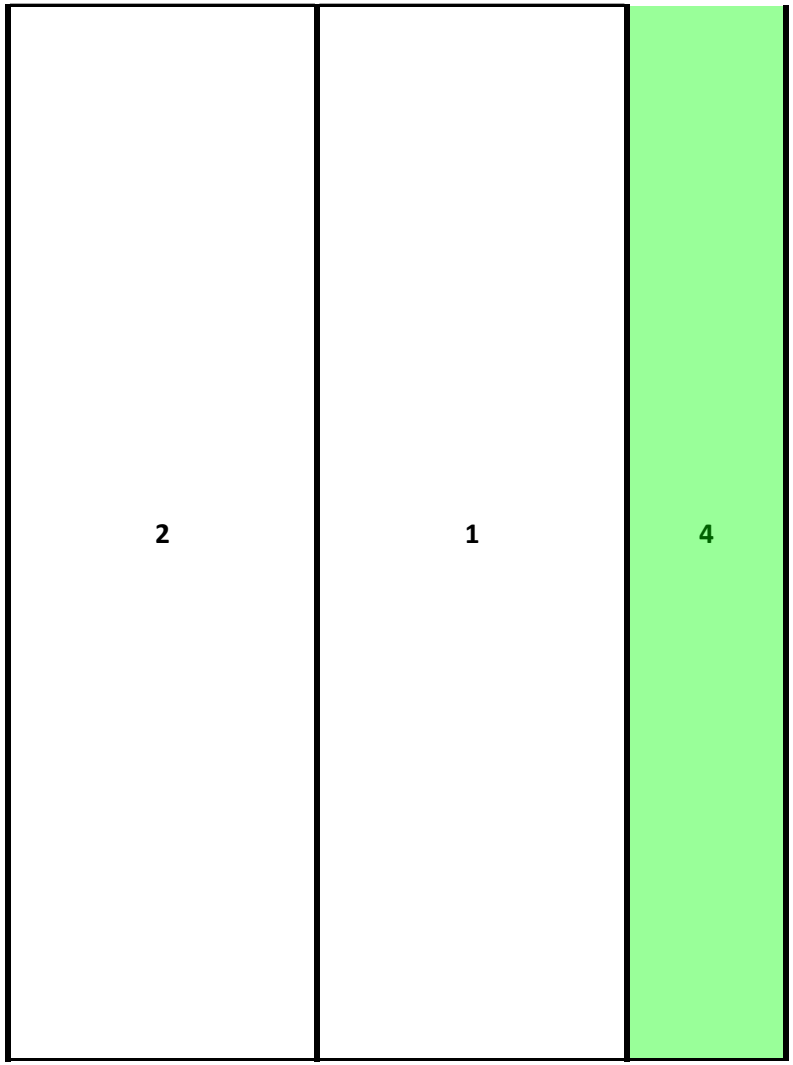
2	1	4
2	1	4


2
1
4

2	2	8
1	4	4

2	2	8
2	1	4
2	1	4
2	2	12
2	1	6
3	1	3

2

≤ RPN < 25

25

Failure mode #	Potential Hazard	Description
1	External Hard Short Circuit	Defined as 5mOhm short between the outputs of the assembly/subassembly
2	Internal Hard Short Circuit	A short circuit that occurs internally in a subassembly or between subassemblies. Could be triggered by loose debris, tools, piercings, conductive fluids, etc.

3	Isolation loss	The impedance to ground for any of the measured components is less than the worst case expected value during normal operations
4	Over Current Charge	Over current overcharge is defined as charging with a higher current than what the battery cell can withstand for the specific temperature and SOC
5	Over Voltage Charge	Over voltage overcharge is defined as charging with a higher voltage than what the cell can withstand for the specific temperature and SOC
6	Over discharge	One or multiple cell (s) are discharged to a state where permanent damage occurs
7	Loss of low voltage power supply	

8	Under Temperature	Temperature low enough to significantly impact functionality and performance
9	Over Temperature	Temperature rises above the maximum allowed temperature for the actual SOC, either limiting functionality, causing damage to the cells or hardware or increase the risk of a thermal runaway or thermal event

10	Thermal Runaway	An increase in temperature changes within the battery cell that leads to conditions that causes further temperature increase (Positive temperature coefficient). Causes irreversible and catastrophic failures to the cells.
11	Externa/Internal Fire Exposure	A substantial heat source in the proximity of the Megapack
12	Inoperable Cooling System	Derated or completely non-functional cooling system
13	Coolant Leak	Partial or complete loss of coolant

14	Impact/shock	
15	Vibration during shipping	
16	Conductive fluid ingress (external flooding)	
17	Lightning (direct)	
18	Lightning (indirect)	
19	Animal caused damage	

20	Dust	
21	Vandalism	
22	Gunfire/ Penetration	
23	Electric Shock/ Arc flash	

Assembly	Without safeguards: Severity [1 = Very low, 5 = Very high]	Without safeguards: Likelihood of Occurrence [1 = Remote, 5 = Very high]
Megapack Battery Module Battery Tray/Cell	**3**	**3**
Megapack Battery Module Battery Tray/Cell	**4**	**3**

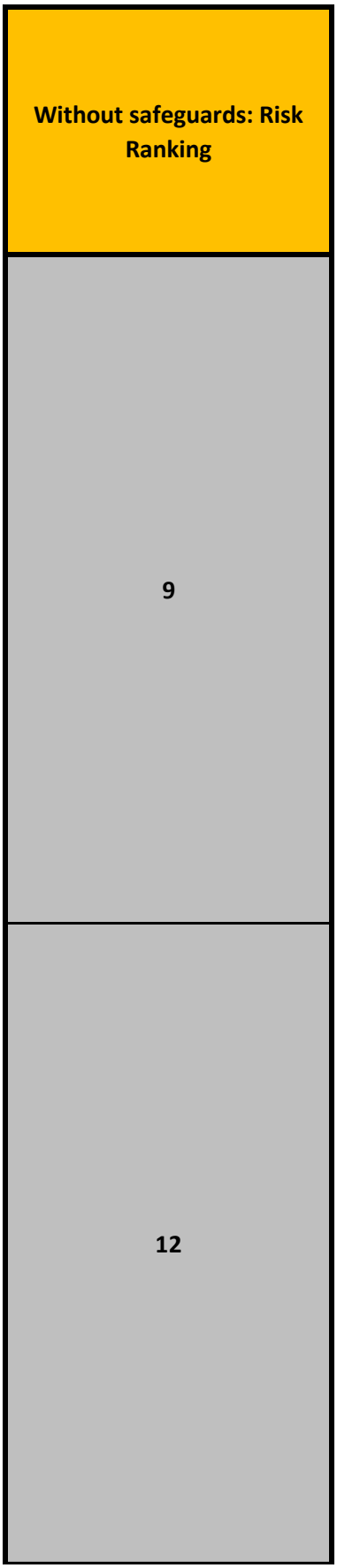
Megapack	**3**	**2**
Megapack Battery Module Battery Tray/Cell	**3**	**3**
Megapack Battery Module Battery Tray/Cell	**4**	**3**
Megapack Battery Module Cell assembly/cell	**3**	**2**
Megapack	**3**	**3**

Megapack Battery Module Cell assembly/cell	**3**	**3**
Megapack Battery Module Cell assembly/cell	**3**	**3**

Megapack Battery Module Cell assembly/cell	**4**	**3**
Megapack	**5**	**2**
Megapack	**4**	**3**
Megapack	**4**	**3**

Megapack Battery Module Cell assembly/cell	**4**	**2**
Megapack	**3**	**3**
Megapack Battery Module Cell assembly/cell	**4**	**3**
Megapack	**4**	**2**
Megapack	**4**	**2**
Megapack	**3**	**3**

Megapack	**2**	**3**
Megapack	**4**	**2**
Megapack	**4**	**2**
Megapack Battery Module	**4**	**3**


Without safeguards: Risk Ranking
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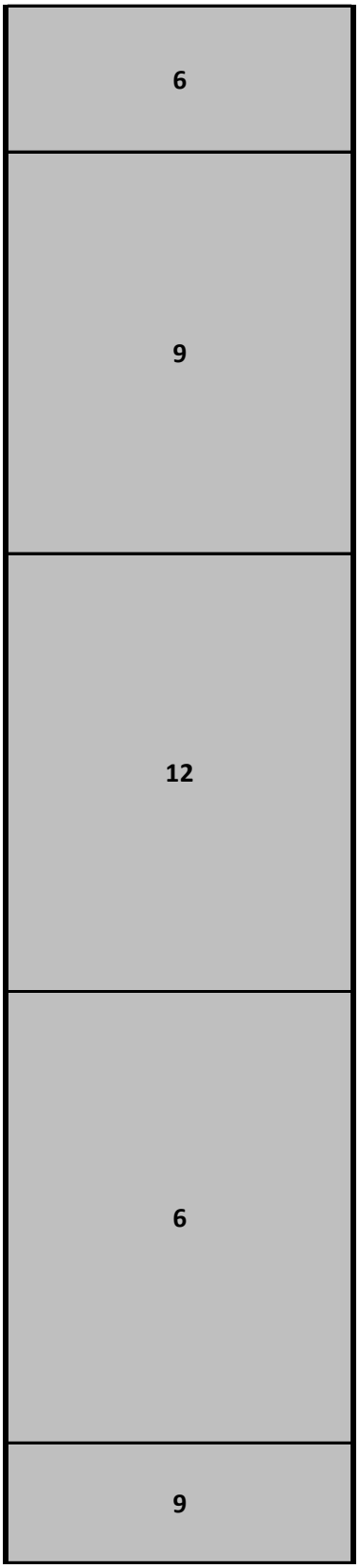
12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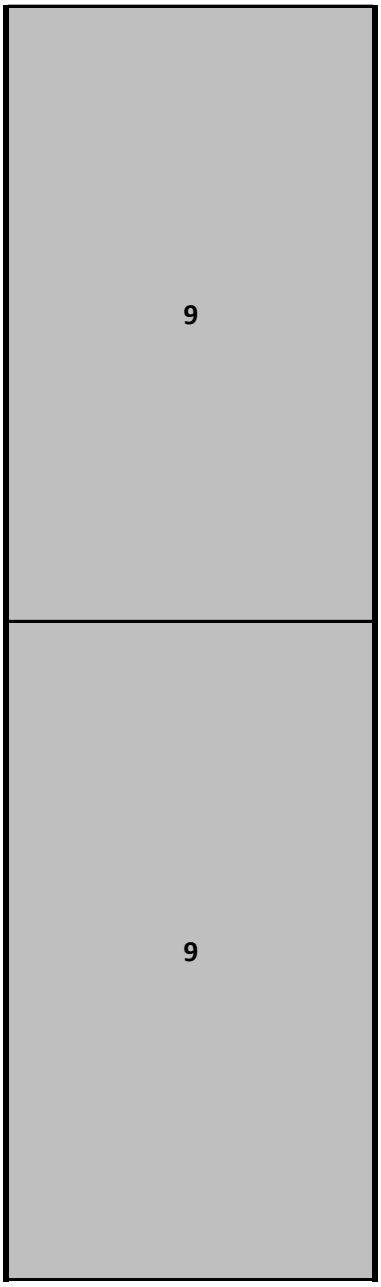
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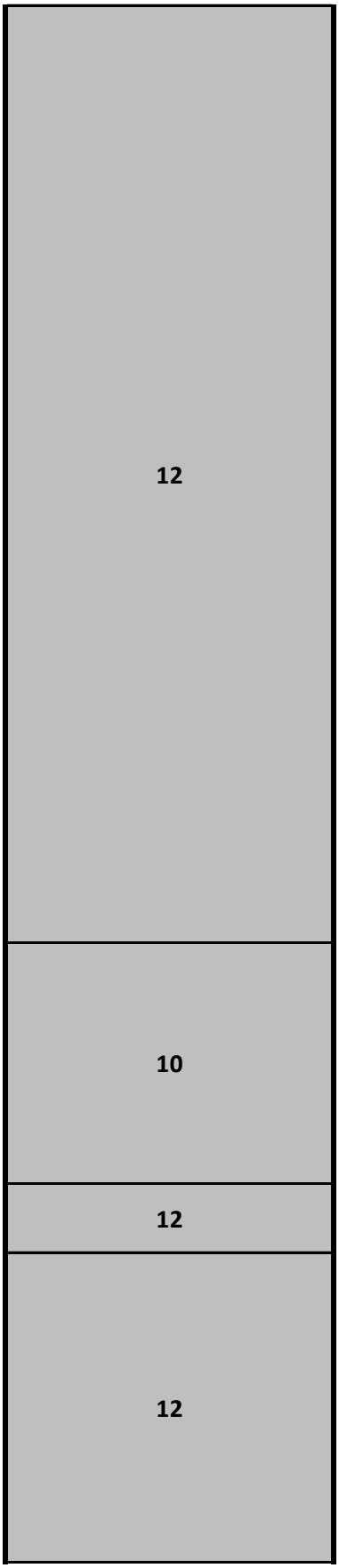
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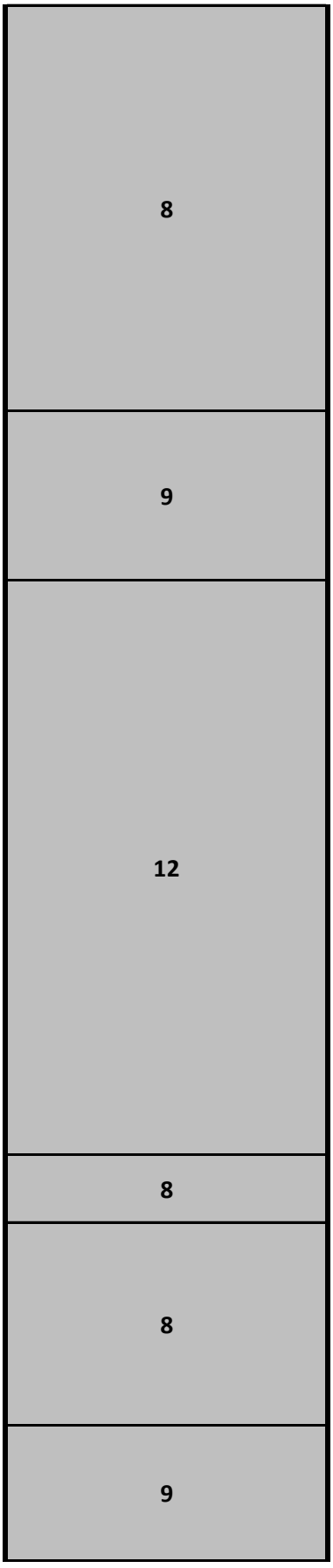
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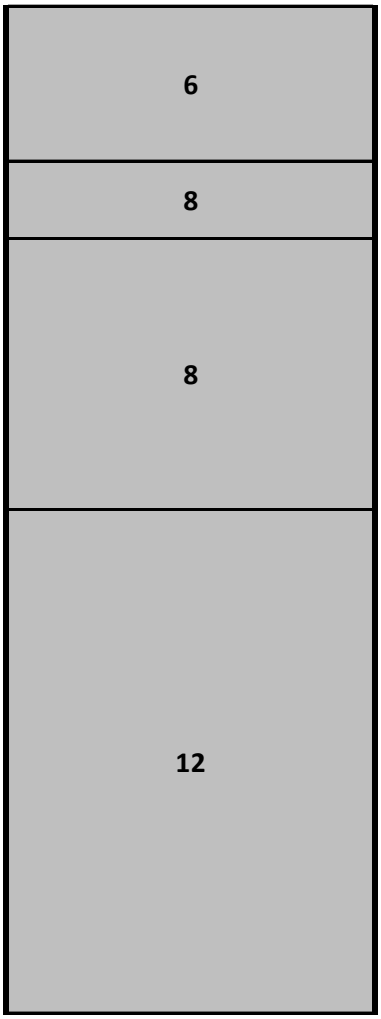
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Prevention (Layer 1) **(Firmware / Resettable Hardware / Design prevention)**
Megapack - Megapack AC breaker - Firmware trip in Powerstage - Powerstage AC contactors (480VAC) Battery Module - Firmware trip in DC/DC
Megapack - Megapack AC breaker - Firmware trip in Powerstage - Powerstage AC contactors (480VAC) Battery Module - Firmware trip in DC/DC

- Isolation loss detection on DCDC
- Detection on HV to ground and MV to ground
- Low isolation warning
- Firmware trip in DCDC

Megapack
- Megapack AC breaker
- Firmware trip in Powerstage
- Powerstage AC contactors (480VAC)

Battery Module
- The DCDC includes hardware monitored and triggered Over Voltage protection

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Megapack
- Powerstage firmware over voltage protection
- Product should clamp a 5kV surge (1.2 by 50 microsecond full-wave impulse to a value not exceeding 300% of the peak working voltage, 300V whichever is greater

Battery module
- Voltage rationality check
- DCDC firmware over voltage protection

Battery Tray/cell
- Cell assembly voltage measurement

Battery module
- Voltage rationality check
- The BMB (Battery Monitoring Board) shall operate down to a minimum brick voltage of 1.5V to enable non-standard battery recovery through manually triggered software override
- End of discharge algorithm
- CCV (closed circuit voltage) regulator (trickle charge batteries to prevent further discharge)
- Battery off mode (limits quiescent currents)

Cell assembly/cell
- Cell assembly voltage measurement

- Thermal system derating if one of the power supplied fails

Megapack
-Thermal system will always keep the system at optimal temperature using pumps, fans, radiators, and compressor loops.
- Heaters in coolant loop can heat the coolant to condition the cells to operating temperature conditions

Battery Module
- Dual thermistors with sanity check in each cell assembly, for a total of 24+ thermistors per a battery module
- Thermal system (normal heating, heat mode)
- Firmware trips for under temperature

Cell assembly/cell
- 2 thermistors at cell assembly level

Megapack
-Thermal system will always keep the system at optimal temperature using pumps, fans, radiators, and compressor loops.
- Powerstage firmware detects power electronics over temperature and derates current accordingly
- Firmware trips for over temperature

Battery Module
- Dual thermistors with sanity check in each cell assembly, for a total of 24+ thermistors per a battery module
- Firmware trips for over temperature. Limits are compliant with UL 1998
- BMS reads over temperature from thermistors, derates the power in the battery module accordingly. If the temperature rises further, the High Voltage Processor disables power to the Battery Module DCDC

Cell assembly/cell
- 2 thermistors at cell assembly level

Megapack
- Thermal system will operate independently from over temperature alerts, ensuring battery modules can remain cool as long as possible.

Battery Module
- Dual thermistors with sanity check in each cell assembly, for a total of 24+ thermistors per a battery module
- Firmware trips for over temperature. Limits are compliant with UL 1998
- BMS reads over temperature from thermistors, derates the power in the battery module accordingly. If the temperature rises further, the High Voltage Processor disables power to the Battery Module DCDC

Cell assembly/cell
- 2 thermistors at cell assembly level
- Each cell goes through manufacturing diagnostics to ensure the highest quality at end of life
- Cell usage parameters and operational boundaries acquired through years of testing and billions of operational hours through an industry unique variety of products
- UL 1973 and UL 9540 certifications
- UL 9540A testing

- Tesla site installation requirements and new codes and standards prevent placing the megapack in the proximity to flammable materials

- Firmware detection of low coolant

Megapack - The Megapack should not be installed in an area where flooding is likely - Firmware trips will prevent short circuits - Steel grounded enclosures will prevent shock hazards Battery Module -IP21 protection /(<12.5mm, dripping water) to enable service and replacement in outdoor environments
- No design protection except for grounding together with the faraday's cage principal for the cabinets
- Low voltage ride through -Reactive current injection - Powerstage trip - DCDC trip
- Cabinets designed to IP66 and should prevent most animals/rodents from accessing the enclosure and damaging the system components - O&M and Asset Management will do routine checks for animals and prevent animals from entering the site/BESS area

- Cabinets designed to IP66
- Thermal roof open to the environment, and dust accumulations can be cleaned out during annual preventative maintenance or more frequently in dusty locations (e.g., desert)

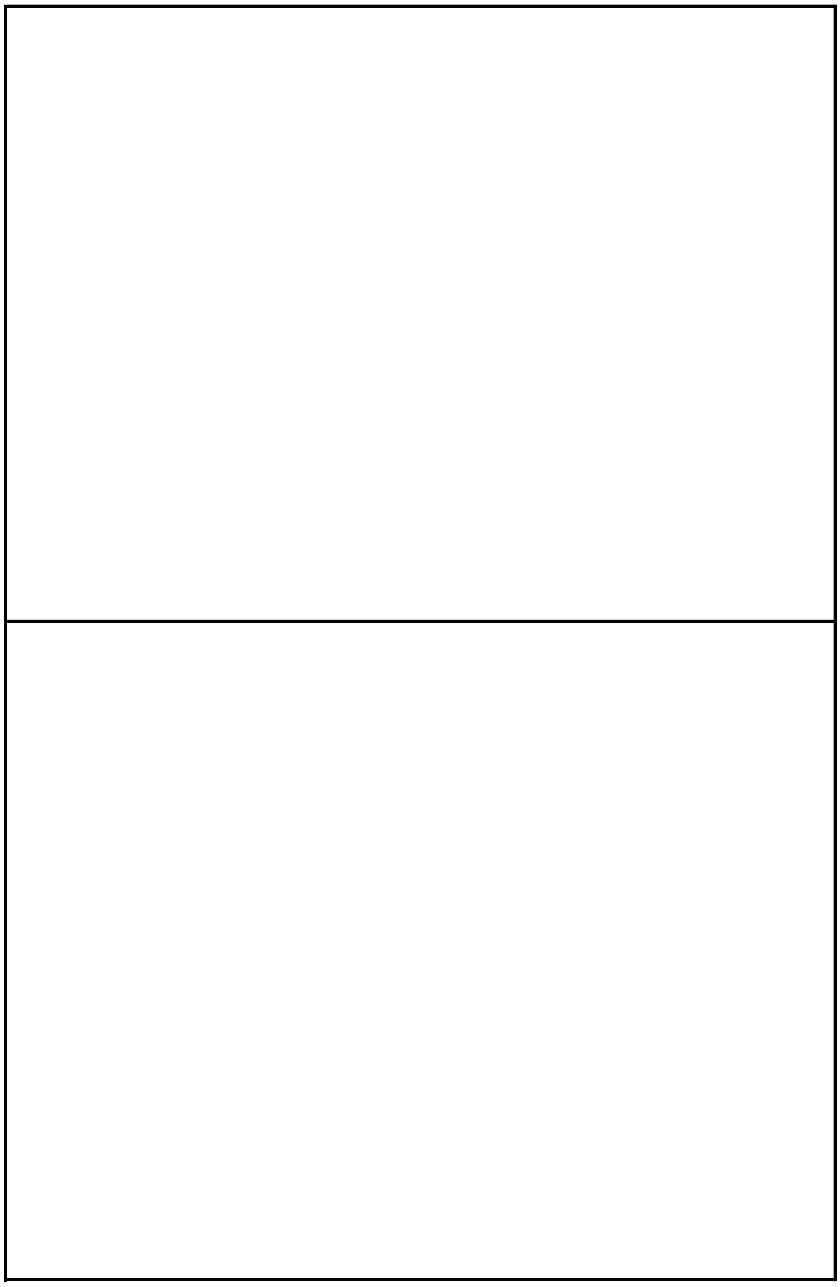
- Gated fence to be installed around the BESS site
- Megapack ships within 8 combination locks for customers to use on doors

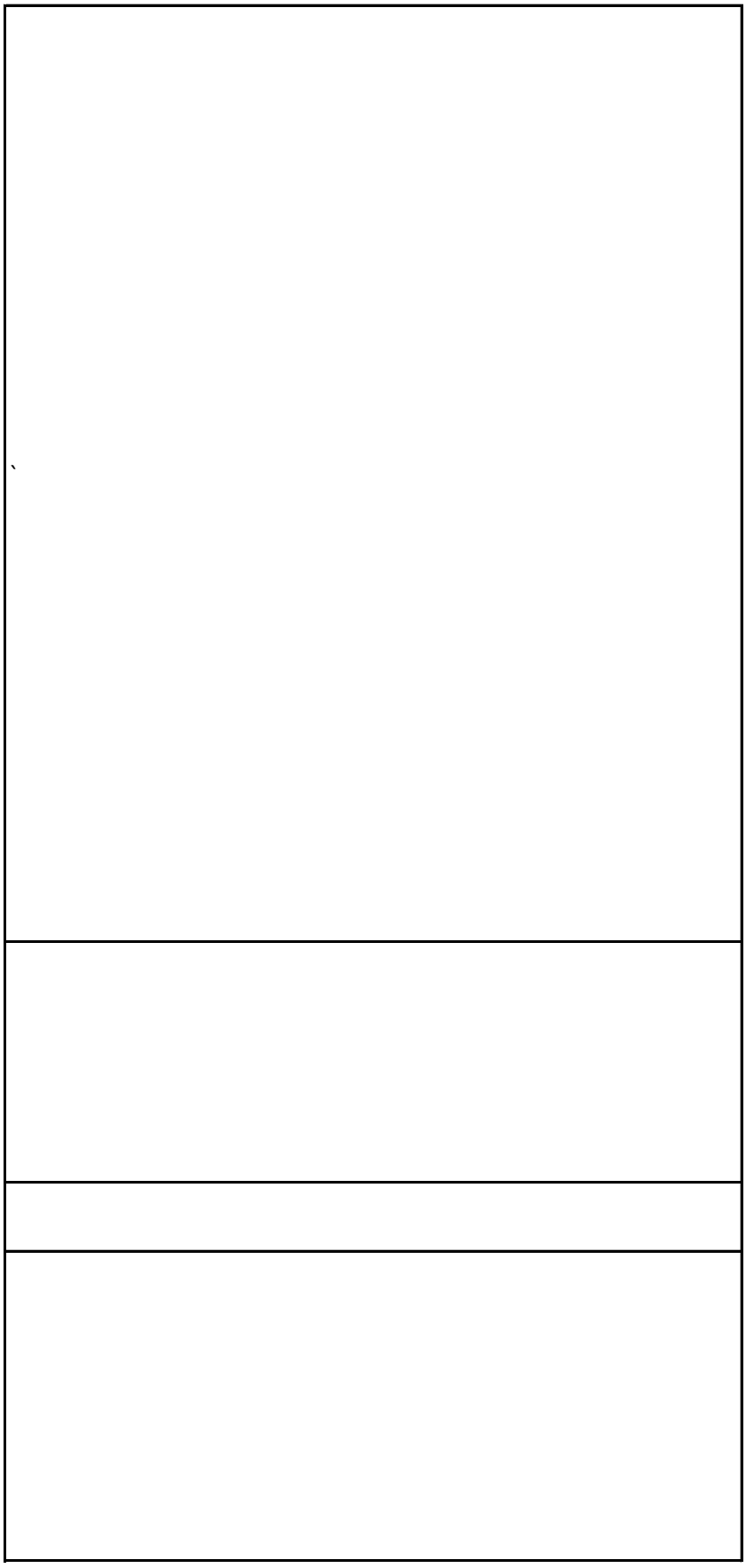
Megapack
- Covered by service procedure
- Lockable enclosure and breaker
- The HVIL circuit is opened before any high voltage connection can be made
- Touch-safe customer interface bay

Battery Module
- Panel coverings to prevent touch access to the trays and cells
- Sealed DCDCs with a top panel cover
- Comm-enabled DCDC architecture: Power can only flow in/out if a comm signal is sent, which cannot occur until the battery module is plugged into the megapack and the door is closed (HVIL enable line is not tripped)

Mitigation (Layer 2) **(Replaceable Hardware)**
Megapack - Powerstage AC fuses (480VAC) - Powerstage DC fuses (900V) -DC/DC output fuses (900V) - DC/DC input fuses (450V) - Mid-pack shunt controlled pyro disconnect in all battery modules Battery module - DC/DC output fuses (900V) -DC/DC input fuses (450V) -Mid-pack shunt controlled by pyro disconnect in all battery modules
Megapack - Powerstage AC fuses (480VAC) - Powerstage DC fuses (900V) -DC/DC output fuses (900V) - DC/DC input fuses (450V) - Mid-pack shunt controlled pyro disconnect in all battery modules Battery module - DC/DC output fuses (900V) -DC/DC input fuses (450V) -Mid-pack shunt controlled by pyro disconnect in all battery modules

- DC/DCs are fused on both sides, so if any failure occurs on either side of the circuit, it will not propagate
Battery Module - DCDC PCBAs are individually fused on the high voltage (common DC bus) side, as well as the low voltage (battery) side.
Megapack - Mid-pack shunt controlled pyro disconnect in all battery modules Battery Module - Mid-pack shunt controlled pyro disconnect in all battery modules Battery Tray/Cell - Mid-pack shunt controlled pyro disconnect in all battery modules
- Dual DCDC converter for redundancy





Megapack - The Megapack can withstand up to 6inches of standing water Battery Module - Pyro disconnect is triggered upon detection of flooding conditions as characterized by a 1-hour of continuous period battery module isolation below 100 kOhm - Conformal coating meeting UL 746C and CSA 107.1
- Electrical components are protect with surge protection circuitry in the event of an indirect lightning strike.
- Powerstage AC fuses (480VAC) - Powerstage DC fuses (900V) - DCDC output fuses (900V) -DCDC input fuses (450V) - Mid-pack shunt controlled pyro disconnect in all battery modules

Megapack - Mid-pack shunt controlled pyro disconnect in all battery modules

Mitigation 2 (Layer 3) **(Hardware Design Mitigation)**
Megapack -Battery Tray series connection fuses - Wire bond fusing on each cell - Cell current interrupt device (physically and irreversibly disconnects the cell when activated to an unsafe pressure build up) Battery module -Battery Tray series connection fuses - Wire bond fusing on each cell - Cell current interrupt device (physically and irreversibly disconnects the cell when activated to an unsafe pressure build up) Battery tray/cell -Battery Tray series connection fuses - Wire bond fusing on each cell - Cell current interrupt device (physically and irreversibly disconnects the cell when activated to an unsafe pressure build up)
Megapack -Battery Tray series connection fuses - Wire bond fusing on each cell - Cell current interrupt device (physically and irreversibly disconnects the cell when activated to an unsafe pressure build up) - Cascading failure mitigation (e.g., bus bar wrapping) Battery module -Battery Tray series connection fuses - Wire bond fusing on each cell - Cell current interrupt device (physically and irreversibly disconnects the cell when activated to an unsafe pressure build up) Battery tray/cell -Battery Tray series connection fuses - Wire bond fusing on each cell - Cell current interrupt device (physically and irreversibly disconnects the cell when activated to an unsafe pressure build up)

- Designed in accordance with UL 1741, CSA22.2 No.107.1 & IEC 62109-1

Megapack
- Cell current interrupt device (physically and irreversibly disconnects the cell when activated to an unsafe pressure build up)

Battery Module
- Cell current interrupt device (physically and irreversibly disconnects the cell when activated to an unsafe pressure build up)

Battery tray/ cell
- Cell current interrupt device (physically and irreversibly disconnects the cell when activated to an unsafe pressure build up)

Megapack
- Transient Voltage Surge Suppressive (TVSS) devices are selected in accordance with UL 1449
-Cell current interrupt device (physically and irreversibly disconnects the cell when activated to an unsafe pressure build up)

Battery module
-Cell current interrupt device (physically and irreversibly disconnects the cell when activated to an unsafe pressure build up)

Battery tray/cell
-Cell current interrupt device (physically and irreversibly disconnects the cell when activated to an unsafe pressure build up)

Battery module
- The BMB set an alert when one of its bricks' resting voltage is below the minimum recovery voltage
- Isolated DCDC converter galvanically and electrically isolates isolated batteries from the common DC bus

Megapack - Operating temperature is -30C to 50C. Can support short-term temperature extrusions beyond these operating values
Megapack - If thermal runaway conditions occur, see the thermal runaway failure mode (#10) for prevention and mitigation measures

Megapack
- one- way umbrella valves are built into the roof to release accumulation of gases or pressure to mitigate the risk of deflagration
- 33+ passive overpressure vents are built into the roof of the Megapack to mitigate the impact of thermal runaway to nearby people or enclosures/buildings. These "flaps" only open when pressure builds up as a result of thermal runaway and sparker ignition, directing all hot gases, smoke, and flame out of the top of the Megapack, keeping the front doors shut and users safe.
- A proprietary sparker system located at the top of the battery bays will ignite any localized concentrations of off-gassing from cells in thermal runaway.
- The cabinets are designed to withstand thermal runaway propagation between Megapacks at normal designed site spacing of 6in (15cm)

Battery module
- Cell assembly and potting to minimize the risk for thermal runaway propagation between battery modules, cell assemblies, and cells.

Cell Assembly/cell
- Steel battery cell assemblies have an engineered exhaust pathway to direct therm runaway gases out the top of the ESS. Exhaust pathways also prevents build up of internal pressure that could result in an ESS rupture
- Cell assembly and potting to minimize the risk for thermal runaway propagation between battery module , cell assemblies, and cells
- Propagation tested to IEC 62619 and UL 9540A
- Conducted passive propagation resistance testing, in accordance with UL 1973 and internal test standards to ensure single cell thermal runaway does not spread to neighboring cells
- Tesla Energy battery cells are listed to UL 1642 to ensure that cell thermal runaway will not result in projectiles

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- Battery modules has met and passed the criteria of UL 1973 external fire test
- Megapack has been tested to the Unit Level of UL 9540A
- Fire protection engineers have reviewed and opined the UL 9540A unit level test with favorably opinions
- The cabinets are designed to withstand severe fire impingement, as demonstrated through thermal runaway propagation testing (UL 9540A) between Megapack at normal design site spacing of 6in

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- BMS derates the battery output power, and therefore heat generation, if cell temperatures get above 55C

- Two drains in the floor at opposite ends of the enclosure lead to drain ports that open when in contact with water. These prevent flooding inside the enclosure in case of a coolant leak or if there is a roof penetration.
- Every cooling system is positive pressure leak tested at a pressure above the maximum pump output pressure at end of life
- Temperature sensor with feedback to the BMS
- BMS derates battery output power and therefor heat generation
- Since the coolant is conductive it will likely caused either discharging to ground or shorts which will trigger firmware trips, blown fuses, triggered pyros or wire bond/busbar fusing

Megapack - The enclosure has an IK rating of IK09 for impact protection Battery module - IK09 impact rating: Product must remain functioning and safe after impact, otherwise damage must be visible - Designed to survive 1.9m drop from CG without resulting in explosion, fire, or exposed electrical safety hazard Cell assembly/cells - Battery cells are enclosed in a steel pod to resist mechanical intrusion. Pod tested to UL 1973 impact and shock tests
- Battery cells are securely mounted to endure mechanical loading of cells and limit mechanical deflection of module - A fully populated Megapack passes the ASTM D4169-2016 Table 2 truck unit level shipping and vibration test
Megapack - Battery tray series connection fuses - Wire bond fusing on each cell - Cell current interrupt device (physically and irreversibly disconnects the battery cell when activated to an unsafe pressure build up) Battery Module - Battery tray series connection fuses - Wire bond fusing on each cell - Cell current interrupt device (physically and irreversibly disconnects the battery cell when activated to an unsafe pressure build up) Cell Assembly/ cell - Battery tray series connection fuses - Wire bond fusing on each cell - Cell current interrupt device (physically and irreversibly disconnects the battery cell when activated to an unsafe pressure build up)
- Battery tray series connection fuses - Wire bond fusing on each cell - Cell current interrupt device (physically and irreversibly disconnects the cell when activated to an unsafe pressure build up) - cascading failure mitigations (inquire with system test, like bus bar wrapping)

-Special tools and a key is required to access locations with High Voltage Present - Multiple levels of redundancy on High Voltage area - Door, cover, touch-safe, key-lock
- Enclosure exterior walls are 14 GA (2mm or 0.0075 '' thick) - UL 1642 physical tests subject the battery cells to nail puncture and projectile without exploding - Propagation tested according to IEC 62619 - Conduct passive propagation resistance testing, in accordance with UL 1973 and internal test standards to ensure single cell thermal runaway does not spread to neighboring cells . UL 9540A testing also supports this protection scheme.
Megapack - The Megapack is designed with an Arc flash rating of 85kAIC

With safeguards: Severity [1 = Very low, 5 = Very high]	With safeguards: Likelihood of Occurrence [1 = Remote, 5 = Very high]	With safeguards: Detectability [1 = Certain, 5 = Impossible]	RPN
2	2	2	8
3	2	2	12

3	2	2	12
2	2	1	4
3	2	1	6
2	2	1	4
2	2	1	4

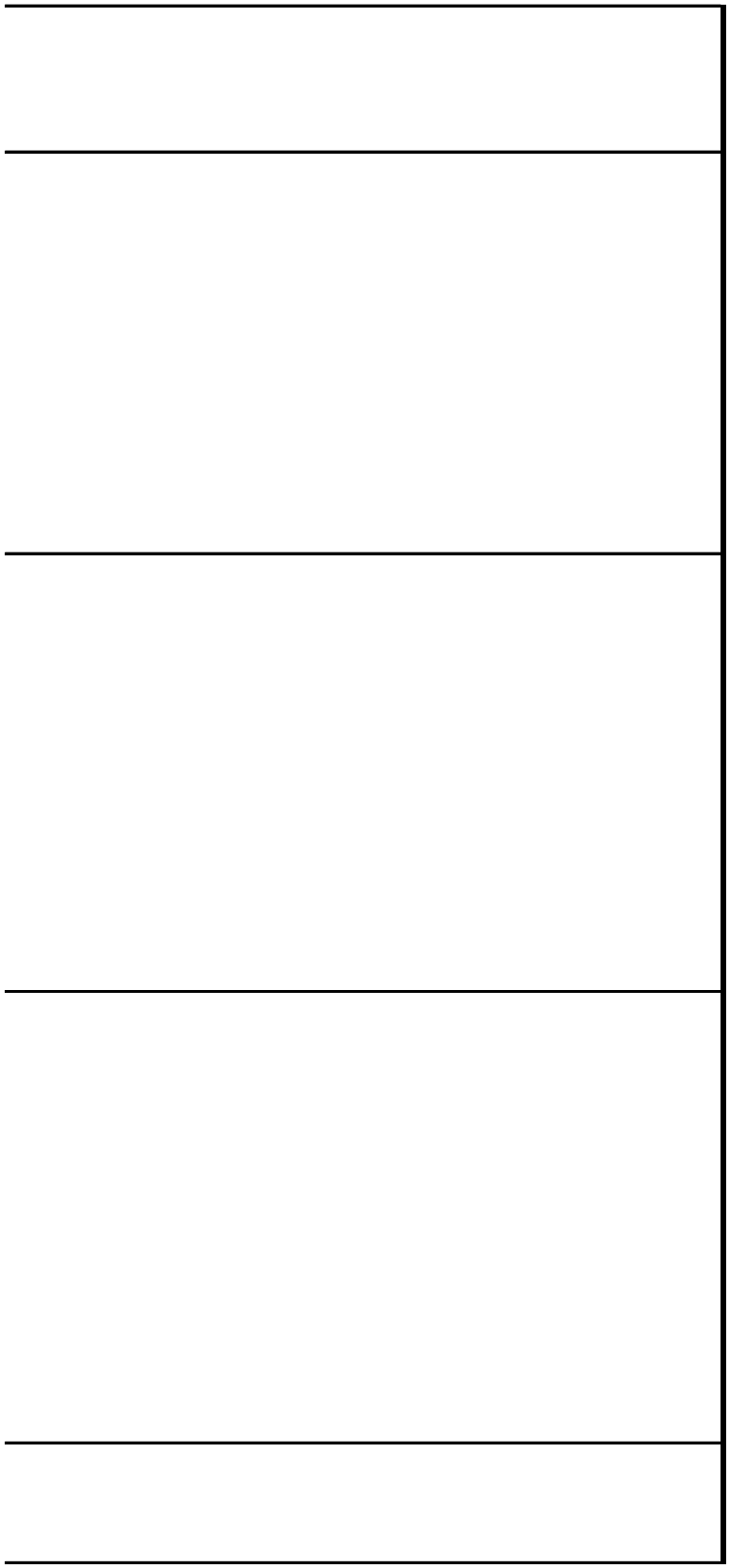
2	2	2	8
2	2	2	8

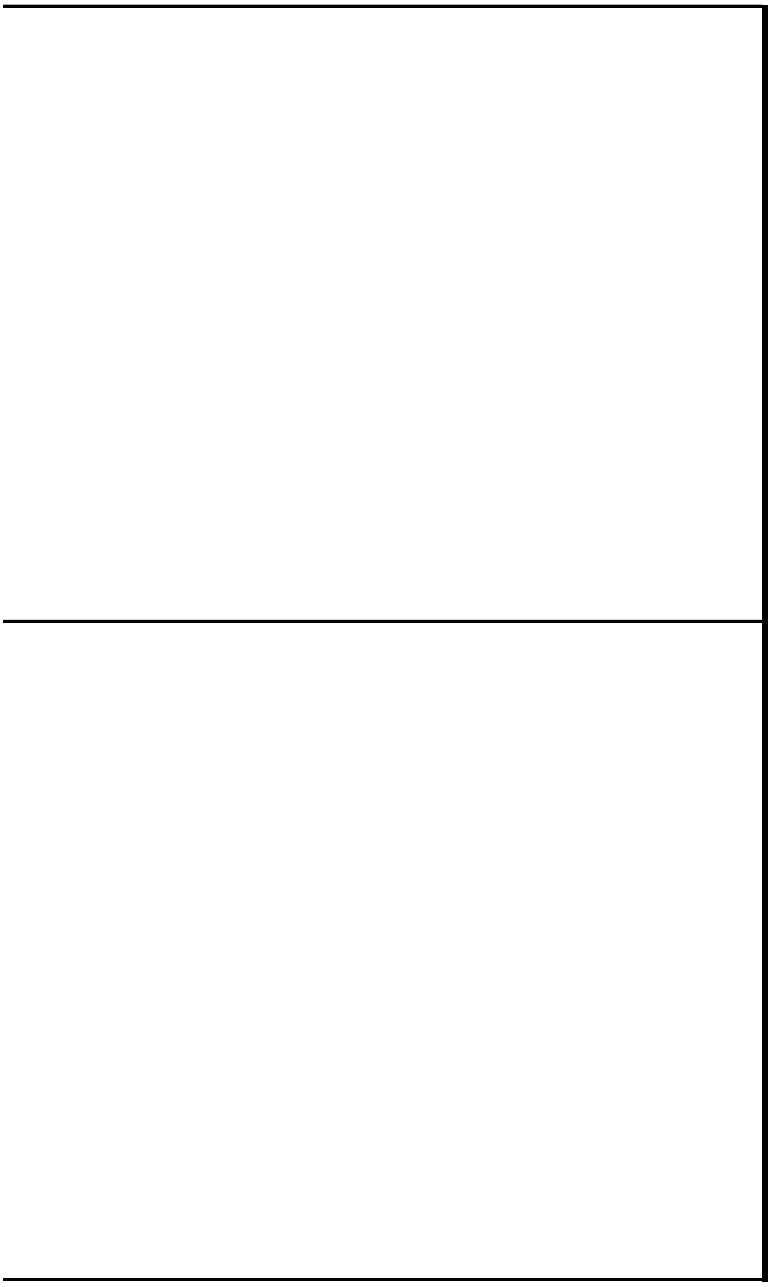
3	2	2	12
4	1	2	8
3	2	2	12
2	2	2	8

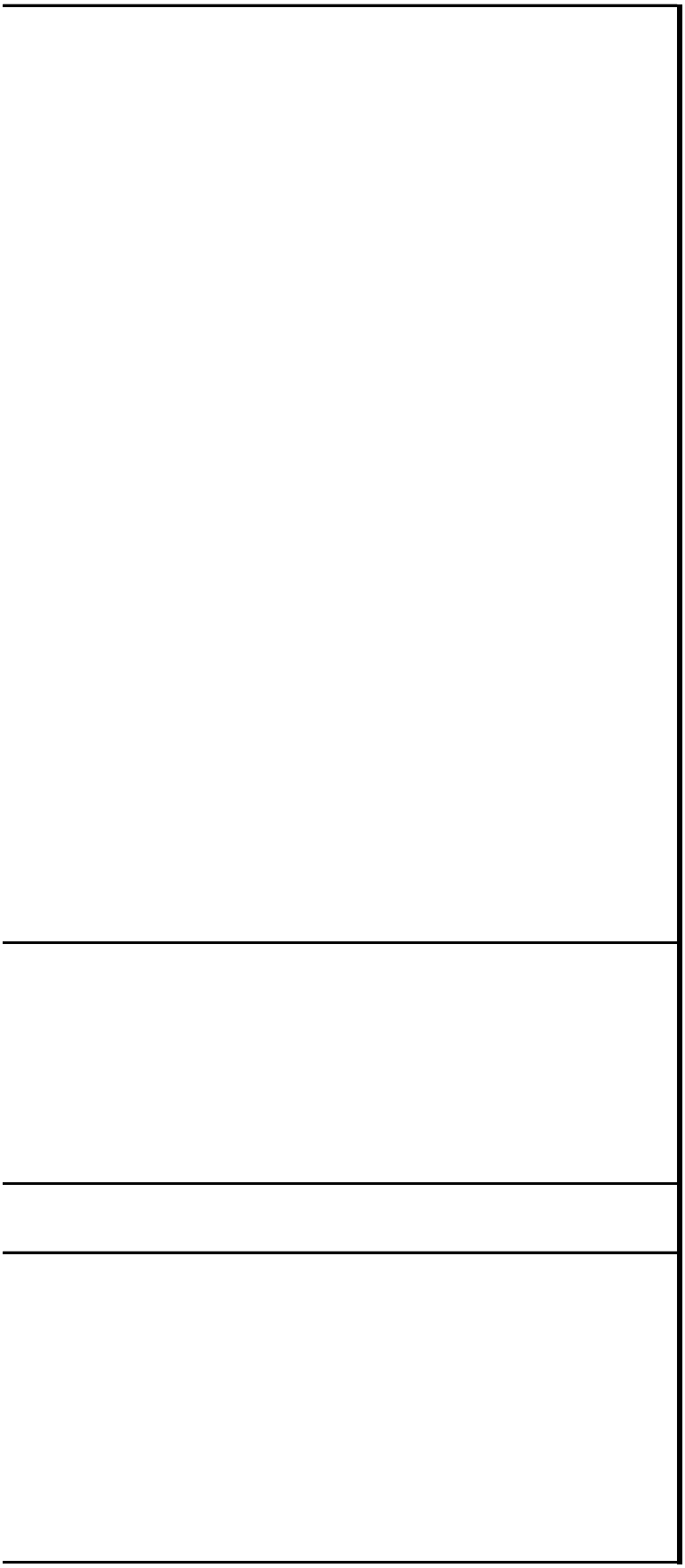
2	2	4	16
2	2	3	12
3	2	3	18
4	2	3	24
3	2	3	18
2	2	3	12

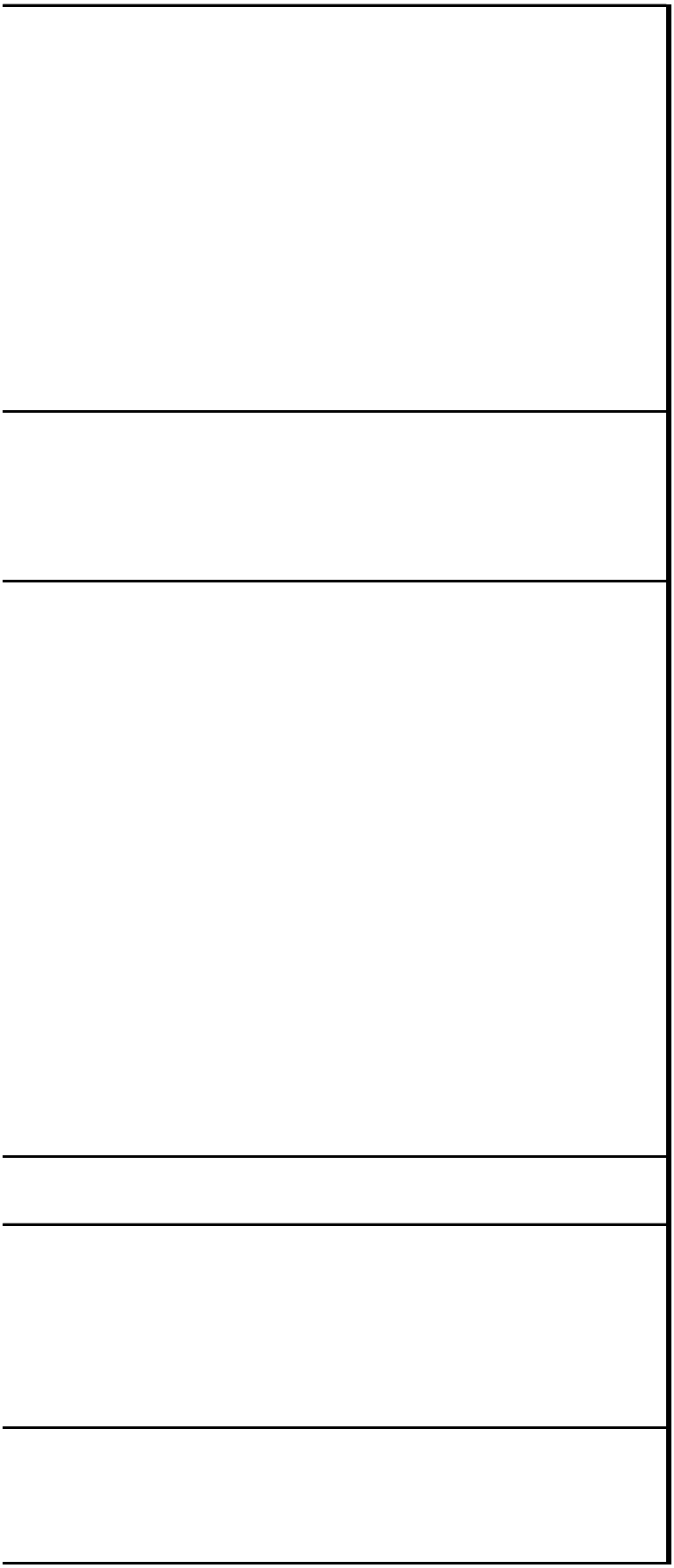
2	2	2	8
2	2	2	8
3	2	3	18
3	2	2	12

- Low risk if RPN
- Medium risk if









N <12

: 12 ≤ RPN < 25

Severity of effect (SEV)	Description
Very high	Extensive damage including loss of entire battery pack, severe injury possible, death possible
High	System inoperable due to major damage to battery pack, severe injury possible
Moderate	Loss of entire module or localized damage to battery pack, minor injury likely
Low	System operable with minimal damage to isolated section of battery pack, injury possible with improper use
Very low	No effect (no injury or damage to battery pack) or superficial damage to battery pack

Ranking
5
4
3
2
1

Probability of occurrence (OCC)	Description
Very high	Incident is inevitable
High	Incident assured with improper use
Moderate	Incident possible with improper use
Low	Incident is unlikely
Remote	Incident is nearly impossible

Ranking
5
4
3
2
1

Likelihood of detection by design control (DET)	Description
Impossible	Design control cannot detect potential cause and subsequent failure mode
Low	Low chance of design control detecting potential cause and subsequent failure mode
Medium	Moderate chance of design control detecting potential cause and subsequent failure mode
High	High chance of design control detecting potential cause and subsequent failure mode
Certain	Design control will detect potential cause and subsequent failure mode

Ranking
5
4
3
2
1