1.0 Enclosure sound attenuation requirements.

The package noise level, including exhaust gas noise emissions shall achieve specified dB(A) noise objectives in free field conditions by one of the following Formats. Proposals detailing noise reduction performance by way of insertion loss is not permissible. Proposals are to identify method of achieving specified noise objectives.

1.1.1 Level 1 Format: Weather Proof (not acoustic insulated, however some attenuation is achieved via main enclosure panel structure and exhaust silencer shall meet 100 dB(A) @ 1mtr when measured at 1 mtr from and 1 mtr up from gas discharge point.

1.1.2 Level 2 Format: Engine noise insertion loss at 1 mtr from air inlet typically 21.5 dB(A). Air discharge and engine noise attenuated by 35dB (A) at 1 mtr from end of vertical air discharge plenum. Greater levels of insertion loss shall be achieved with the use of horizontal air discharge splitter attenuators (Splitter's). Splitter length shall meet specified noise from the point of source. Exhaust attenuation performance to meet specified noise / distance objectives.

1.1.3 Level 3 Format: Noise emissions at 1 mtr from enclosure shall be within +/-3 dB(A) of specified dB(A) levels in any direction from the generating set package using vertical air direction intake hoods and discharge plenums down to insertion loss levels of 35dB(A). Greater levels of insertion loss for specified objective shall be achieved with the use of horizontal air flow splitters at an appropriate design and length at air inlet and discharge. Exhaust attenuation performance to meet specified noise / distance objectives. Exhaust noise insertion loss shall be sized such that accumulated package noise from like noise sources shall meet specified noise objectives.

1.2 Enclosure weather Ingress protection requirements

1.2.1 Main body of the enclosure and door seal shall withstand IP56 Ingress protection.

1.2.2 Package Cooling and aspiration air intake shall, when operational, meet IP24 increasing to IP55 if motorized louvers are specified when machine is at rest.

1.2.3 Package Air discharge shall meet IP56 when operational and minimum of IP 11 when at rest, increasing to IP55 if gravity air flaps are specified.

1.2.4 Average intake face velocity shall not exceed 800 fpm and peak value at any portion of the intake face area shall not exceed 1000fpm.

1.2.5 For heavy snow areas if specified, air intake shall be of horizontal air flow format and IP24 cellular louvers shall be bolstered by aluminium high free area / low delta P intake louvers to increase resistance of ice buildup in cellular air paths. (Level 2 and or 'Level 3–Splitter' noise Format as appropriate)

1.2.6 As a minimum, package shall meet or exceed UL2200 Rainproof.

1.3 Generating set package air flow management.

Cognizant of specified acoustic performance and required ingress control system, total pressure drop (resistance to airflow) shall not exceed available cooling fan static pressure external to radiator capability (duct allowance) as determined by the generating set manufacturer, radiator manufacturer or ventilation fan manufacturer as applicable.

2.0 Enclosure Structure Design Criteria

Enclosure system shall meet specified criteria in contract documents or standard criteria in Section 2.0 whichever the greater.

2.1 Wind Loading

2.1.1 The enclosure construction method shall meet specified wind loading.

2.1.2 If specified the generating set package shall be subject to 3rd Party and certification made available prior to delivery of the completed package.

2.2 Seismic

2.2.1 If specified generating set enclosure and sub-base tank and or supporting steelwork shall meet specified conditions assuming and importance factor of (IP) 1.5 or 1.0 if specifically mentioned.

2.2.2 Package and enclosure shall be either Seismic listed with an established and reputable 3rd Party for an importance or shall be subject to 3rd party review whose compliance statement shall be provided prior to delivery of completed package.

2.3 Standard Product Criteria

Note Roof or wind loading. Flat Roof snow load Pg= 16.5 PSF

01) Snow importance factor, Is 1.1
02) Roof live load, Lr=20 PSF
03) Live Load, L = 300lb (point load)
04) Wind Importance, Iw = 1.15
05) Wind speed, V = 90 mph
06) Exposure category C

2.4 Climate Resistance

01) Enclosure construction and materials shall have been prototype tested in a high a) ambient temperature, b) saliferous environment and c) high humidity hurricane region for a period of no less than two years and exhibited zero degradation to finishes or structural integrity.
02) Enclosure construction and materials shall be capable, without degradation, in North America regions spanning a temperature range of -30^0F to $+140^0$F

3.0 Fire related Performance for panel materials of construction as a minimum shall be compliant as follows

3.0.1 ASTM E84 flame spread 00, smoke development 10ASTM E162 flame spread index 0
3.0.2 ASTM E108 modified –passed
3.0.3 ASTM 1929 flash 811 degrees f, ignition 837 degrees F
3.0.4 NFPA 285
3.0.5 UBC 26-9 ISMSA passed
3.0.6 ASTM E119 passed
3.0.7 UBC 29-3 corner test passed
3.0.8 Can/ULC S 134M passed

Code evaluation reports shall be available for:

- City of Los Angeles
- ICC ES
- ICBO ES
- Miami Dade NOA
- Fla Building Code approval
- New York City

3.1 Acoustic and fire control insulation for Level 2 and Level 3 noise formats shall comply with:

3.1.1 ASTM C423 Noise reduction Coefficient - 1.05
3.1.2 ASTM C612 Material specification (HH-I-558B) - Types 1-4
3.1.3 ASTM C665 Corrosivity to Steel – Passes
3.1.4 ASTM C1104 Water vapor Sorption, <1% By weight: <0.2% by volume at 120^0F (49^0C), 95% RH
3.1.5 ASTM C1338 Fung Resistant – Passes
3.1.6 ASTM E84 Flame Spread/Smoke Developed - 5/0 or less
3.1.7 ASTM E136 Noncombustible – Passes
3.1.8 NFPA 285: 1-3Hours
3.1.9 UBC 26-9: 1-3 Hours
3.1.10 UL723, CAN/ULC-S102-M - 5/0 or less
3.1.11 City Of New York – MEA-346-90
3.1.12 CBO (uniform Building code) – All Building classification types
3.1.13 BOCA (National Building code) – All Building classification types
3.1.14 SBCCI (Standard Building code) – All Building classification types
3.1.15 ICC (International Building code) – All Building classification types

- Density – Walls - ASTM C612 Nominal 8lbs/ft^3.
- Splitters – to suit noise objectives, density varies between 2,4,& 8 ft^3
- R Value/in ($hr{\cdot}ft^{2\cdot0}F$)/Btu m2·)C/W 4.2/0.74

4.0 **General enclosure structure construction requirements**

4.1 The enclosure walls, roof, bulkheads and anti-racking beams shall be constructed from purpose designed anodized natural color Aluminum 6061 alloy and T6 Temper extruded exoskeletal framework designed to receive and bond to 4mm aluminum composite material (CM) meeting design criteria as detailed in Section 2.
4.2 CM finish shall be fluorpolymer resin atop a primer base externally and primer only internally applied by way of a proprietary extrusion process meeting AAMA2605. Certain colors have a Solar reflective index (SRI) of 29 and shall have been defined by Cool Roof Rating Council (CRRC) as 'cool'
4.3 Bonding of CM to extrusions shall have been subject to process optimization and prototype strength testing resulting in a bond capable of withstanding greater than an applied force of 300lbs per linear inch.
4.4 Deflection resistance shall be <0.45lb/inch: CM shall exceed that of 14 ga steel by a factor of >3. Deflection test: Test strip 3" wide material under flat sheet conditions on 24 inch support centers.

4.5 Insulation is to be retained to exoskeletal framework using 0.050" 5052 (0.125" ID holes on 0.1875" centers) perforated sheet.

4.6 Rivets used in retaining perforated sheet shall be Aluminum steel pin and a minimum of 0.1875" diameter of appropriate grip range.

4.7 Corner guards at lower and upper extrusions fabricated from 0.1875 minimum 5052 aluminum shall be held in place with 3/16 Stainless Steel countersunk rivets and composite material to extrusion bonding agent.

4.8 Access doors shall be fabricated similarly as detailed above and shall be sufficiently rigid to allow the use of single point door locking hardware.

4.9 Minimum of (2) access doors shall be provided. Door quantity shall increase if safe access/egress is compromised by position of internally mounted equipment demands.

4.10 Door seals shall be of wiper silicon seal construction, purpose designed to fit exoskeletal extruded material door frame.

4.11 Exoskeletal framework shall be designed with integral water drain facilities to drain by example, water passing defective door seals without water entering remainder of enclosure.

4.12 Door latch hardware shall be of single point latch, like keyed, stainless steel or, cast aluminum Panic release type for Walk in enclosures and of non-metallic type for non-walk in (skin tight) enclosures.

4.13 Door hinge hardware shall be anti-theft (concealed bolting), stainless steel and purpose designed to suit exoskeletal framework comprising and off center hinge pin to permit full door opening access when door is at 90^0 open position or beyond.

4.14 Stainless steel door hold back devices shall be fitted along with door not metallic bump stops.

4.15 Hinges shall be purpose designed to fit to exoskeletal framework with the use of stainless steel bolting hardware.

4.16 All stainless steel bolting is to be assembled with the use of anti-seize.

4.17 When using Level 2 or 3 vertical discharge plenums, plenum maintenance access shall be provided by way a crawl through access door complying with door construction as above with like key access without panic release door hardware.

4.18 Level 2 or 3 vertical discharge plenums shall incorporate (as part of supporting structure – see supporting structure section) a steel base plate with a fall of at least 1" over plenum length toward the end of the structure, away from the radiator. A gap shall span the majority of plenum width permitting rainwater to drain from the plenum area.

4.19 Splitters as part of Level 2 or 3 attenuation methods shall be constructed in continuous lengths appropriate to specified noise reduction objectives and shall meet airflow management and material of construction objectives as detailed within this specification.

4.20 Anti-racking cross beams shall exist between side walls to suit specified wind loading and seismic criteria whichever the greater, and to support internally mounted heavy equipment such that weight is transferred to sidewalls and supporting structure.

4.21 Insulated exhaust silencers shall be designed for 200^0F surface temp and be internally mounted unless noise objectives or EPA Tier 4 exhaust gas after treatment of applicable determine otherwise.

4.22 Exhaust tailpipe shall pass through the enclosure roof and shall incorporate 'touch-less' pipe to enclosure design features so not to heat damage enclosure structure and surface finish.

4.23 'Touch-less' air gaps surrounding exhaust tailpipe shall be packed with insulation rope when motorized louvers at the air intake are required to prevent water ingress by vacuum when louvers are opening during generator starting.

4.24 Enclosure roof shall be demountable following appropriate disassembly procedures.

4.25 Enclosure roof shall feature a minimum of a 1" crown from longitudinal center line and from within approx. 36" of each end.

4.26 Level 2 and 3 Vertical discharge plenums shall incorporate a 0.125" aluminum wire mesh bird screen at point of air egress.

4.27 Level 2 and 3 horizontal air flow splitter installations shall incorporate low delta P fixed blade weather louver at point of air egress.

4.28 Enclosure shall incorporate facilities for lift eye attachment by bolting into pre threaded holes. Lift eye arrangement shall be rated for weight of enclosure and components internally secured to enclosure.

4.29 Enclosure shall be bolted to supporting structure via zinc plated 5/16th bolts on approx. 24" centers

4.30 Ventilation fans, where specified, shall be mounted in enclosure walls and ingress protected to IP24

5.0 **Supporting structure**

The following specification controls interface between the supporting sub-structure and applies to a structural steel base and sub-base tanks of specified capacity (or generating set run time) meeting UL142 and UL2085.

5.0.1 The structure with or without the enclosure mounted shall be road transportable or transportation meeting trailer specification at Section 6.0.

5.0.2 Structural Steel - Sub structure shall be finish painted in black enamel following comprehensive cleaning and abrasion.

5.0.3 Sheet Metal (UL142/2085 tanks) shall be finished in black enamel following phosphate wash or equivalent by spray or powder coating techniques.

5.0.4 Structural Steel and Ul142 tanks for Saliferous environments If specified shall be painted with a 8-16DFT 3 coat paint system per specification EDIP1S

5.0.5 Supporting strictures when used with Level 2 or 3 discharge plenums shall include a rainwater run off base plate with a minimum of a 1" fall away from the radiator bulkhead.

5.0.6 Supporting structures when used with Level 2 or 3 air intake or discharge splitters shall be such that splitter area floor level is lower than generating set floor area such that water ingress into splitter area does not drain into the generating set area.

5.0.7 The supporting structure shall incorporate a minimum of a 1" rain-guard up stand that surrounds the generating set area nominally inward of the enclosure inner wall preventing water ingress by capillary action between enclosures to supporting structure joint.

5.0.8 Decking (Top) of the supporting structure shall be fully welded and leak proof

5.0.9 The 1" rain guard shall also surround any through deck stub up locations and shall double as leak containment from gen set fluids.

5.0.10 A closed cell foam (neoprene) gasket of a minimum of 0.250" thickness shall be installed between enclosure joint and supporting structure. The one side self-adhesive gasket shall be installed to supporting structure prior to installation of the enclosure.

6.0 **Transportation specification**

The following specification determines minimum requirements for road transportation in respect of sub structure design and use of supporting trailers during transit.

6.0.1 Low boy trailers shall be rated greater than 1.5 times of load weight.

6.0.2 Trailer to have adjustable crowning. Crowning to be adjusted to zero crown under static load weight at point of loading.

6.0.3 Trailers, for loads in excess of 10ft wide, shall have outriggers and correct height planking, to extend deck width to 10ft.

6.0.4 Extended trailers to suit load length shall be fitted with a drop in deck suitable for load.

6.0.5 Package shall be secured to transportation using supporting structure lifting locations

6.0.6 Where enclosures are shipped separately from supporting structure, enclosure manufactures shall provide suitable Dunnage rated for load weight or special purpose shipping skids to permit safe transportation. Special purpose shipping skids shall be returned to enclosure manufacturer in good order.

6.0.7 Package shall be shipped with air inlet and or discharge protection to minimize vacuum and consequent debris fouling within enclosure during transit.

6.0.8 Generating sets fitted with unrestrained spring vibration isolators shall be installed with demountable blocking devices between generating set skid base and supporting structure.

6.0.9 Transportation Company shall be responsible for safe securing, road permits and or police escorts as applicable and transportation of equipment free of damage.

7.0 **Enclosure / Package Electrical Up-fit**

Enclosure shall be pre- installed with Electrical equipment to suit project specifics in accordance with the NEC code revision applicable to US State of installation.

General requirements.

7.01 Fittings, Conduit, Distribution boards, lights etc. where practicable will be secure to enclosure walls using galvanized steel unistrut spanning exoskeletal framing.

7.02 All operable devices, AC distribution boards and control panels, disconnects etc. shall be installed with 48" front clearance.

7.03 All non-flexible conduit shall be Electrical mechanical tubing (EMT)

7.04 EMT shall be bend optimized, straight, secured to enclosure and shall incorporate junction boxes at appropriate wire pull station locations.

7.05 Liquid tight flexible conduit shall be used between enclosure mounted EMT and vibrating equipment. Max unsupported length of flexible conduit shall be 4 ft.

7.06 Flexible conduit to vibrating equipment mounted devices such as Jacket Water heaters, battery chargers, unit mounted local control panels etc. shall drop from underside of enclosure roof above the AC main alternator to avoid engine heat and cluttering of walkways. Adequate clearance shall be provided between such drops and exhaust silencer.

7.07 Conduits, cabling etc. passing on walkway's shall be avoided, however if unavoidable walkover non slip covers shall be securely installed over same.

7.08 NEMA1 Distribution boards shall be of plug in breaker type.

7.09 120 Vac small power receptacles shall be GFI type and shall be integrated with light 3 way light switch locations

7.10 Fluorescent lighting if AC lighting specified shall be of 8' high output vapor proof type and installed away from adverse heat sources with generator maintenance and operation in mind and shall include 3 way light switches at (2) personnel access doors.

7.11 24 VDC Lighting if specified shall be LED (incandescent replacement LED) bulb in Vapor proof fittings complete with 1 hour mechanical timer wired to generator starter battery connections. A DC 10A MCB will be installed in generator local control panel serving as overcurrent protection.

7.12 On engine additional wiring will be undertaken with appropriate conductor size of high strand count heat oil and fuel resistant wiring located in spilt loom flexible conduit and cable tied / clipped as deemed appropriate per industry practice.

7.13 Cabling / wiring as necessary shall pass through enclosure structure with an minimum ingress rating of IP56 .

7.14 Enclosure structure will be bonded to supporting structure and generating set ground bar using 1/0 DLO Flex cable with single hole crimp lugs.

7.15 DLO cable as a minimum shall be 90^0C, 1000vac rated and shall crimp lug terminated. Terminating DLO cable in screw down fittings is not permissible.

7.16 Where ventilation fans and motorized intake and gravity flap louvers all coexist, failsafe motorized louvers shall be utilized and arranged to open when ventilation fan thermostat reached start set point of typically 85^0F.

In aide memoir check list for electrical up-fit for specifying authority

Device	*Helpful notes*
AC Lighing	*Necessary for walk in*
DC Lighting	*As desired – frequency of install not that high – see DC lighting in Section 7 above*
JW heaters	*Essential for standby machines, 480 0r 208 3 phase keeps installed cost lower and current manageable and within 208/120 100A typical distribution boards*
Alternator space heaters	*Typically 1000/2000watt. Essential in damp or high humidity regions*
Space heating	*Jacket water heater rating (of typ 9kw), will most often maintain internal enclosure temp at a practicable level. If level 1 enclosure it shall be specified*

	as insulated. Level 2 and 3 are insulated by virtue. Gravity flap and motorized louvers should be specified. *Standard (cost effective) space heater rating c/w thermostat if supplemental or independent heating is required is 4.9kW.*
Shore power transformer	*Required if shore power is 480 vac or higher Typically 25KVA, aluminum wound / 208/120 output*
480 Disconnect	*If Shore power transformer is required.*
480 distribution board	*JW heaters more cost effective and higher kWt rated at 480 volt. We recommend use of same if shore power is 480*
208 / 120 Distribution board	*Required where battery chargers as a minimum exist and of course for additional devices such as lighting etc*
240/208 Disconnect	*Required if shore-power is 240/ 208 and shore power feed disconnect position dictates. Maybe required if the shore power requires to be maintained while 240/208 distribution board is powered down*
Emergency exit lighting / exit sign	*Frequency of install low*
Heat / smoke detectors	*Frequency of install is low , smoke can be problematic due to paint oil deposit on hot surfaces smoke on generator start*
Ventilation fans and control thermostat	*Frequency of install is low – see comments in section 7.0 ref fan and louver coexistence. Combination of CM and popular colors Mica Platinum and Mica champagne (and others) have a CRRC roof rating of Cool, of Course Level 2 and 3 acoustic styles are insulated. In our experience these factors avoid the need for a vent fan.*
Fuel polishing power supply	*Often required to cater for later install of this system. Typ 30A, 208 3 phase, power taken to anticipated position of polishing system*
Fuel transfer control system	*Fuelogic FCM (with return pump) or FCM- RF (without return pump) is installed along with FCM-F08 level sensing on internal enclosure wall. Rupture basin switch wired to FCM(-RF). FCM(-RF) System Form C status Outputs wired to gen local control panel (LCP) and available in Modbus format from LCM to client BMS system. AC power for pump supply derived directly from generator. DC control power from gen start batteries. Fuelogic DPCM is also available to manage duty and standby dual pump arrangements also available. DPCM can handle multi FCM fuel request signals where remote pumps have the ability to supply multiple day tanks from 1 or more bulk storage tanks.*

8.0 Package Mechanical Up-fit

Mechanical interfaces shall be undertaken with good practices with an emphasis on ergonomic positioning of ancillary devices in promotion of a safe working environment, ease of maintenance and reliable operation of installed equipment.

General requirements

8.0.1 Fuel transfer pumps (supply or return) shall be positioned in environments not to exceed 15^0F above ambient when the generating is set is operational and shall be protected from the weather. Ventilation of TEFC motors shall not be compromised.

8.0.2 Where practicable fuel transfer pumps should be installed in a containment area fitted with a leak detection switch wired back to Fuelogic FCM(-RF) system so to alarm.

8.0.3 Level control for fuel transfer into sub-base or day tanks shall be Fuelogic FCM-F08 fitted with UL stainless steel stem / Buna N floats and installed within a stainless steel Stillwell.

8.0.4 Dip- tubes for supply and return connections for engine and fuel transfer systems shall be sized along with connecting pipework within max permissible system head capability.

8.0.5 Engine fuel supply and return transfer pump dip-tubes shall terminate 1" above tank bottom and be 45^0 mitered at fuel inlet.

8.0.6 Engine return and transfer supply pump dip-tubes shall terminate at 20% of tank height above tank bottom.

8.0.7 Engine fuel supply and return positions within the tank shall be either spaced apart by a minimum of 4ft and or either side of a tank internal baffle.

8.0.8 Fuel connections to sub-base tanks shall be as close to engine skid fuel connections as practicable with an emphasis on an unobstructed walkway.

8.0.9 Should additional fittings to the sub-base tank be required post manufacture use of a Fuelogic Re-port is permissible with Class II fuels to avoid fuel drain down and de gassing.

8.0.10 Sub-base tank connections shall be properly sized during design phase to limit use of pipework size adaptor fittings to (1), preferably (0).

8.0.11 HOFR Flexible fuel connections shall be used between engine and supporting structure. Fuel connections shall be of crimped end fittings hydraulic stainless steel reinforced type of a pressure rating at fuel temperature of at least 1000psi.

8.0.12 Flexible exhaust connection (Bellows) between engine and exhaust silencer (ES) shall be 316 Stainless Steel of convoluted multi ply construction. Lateral and axial spring rates shall be within allowable nozzles load of both ES and the engine connection. If specified the bellows shall incorporate a flow liner to avoid spring rate resonance and carbon build up within convolutions.

8.0.13 Floor mounted battery racks shall be secured to sub-structure decking.

8.0.14 Floor mounted battery boxes shall be located in a perimeter restraint.

8.0.15 Engines using open crankcase ventilation (CV). CV hoses shall be piped into radiator air discharge utilizing a non-ferrous appropriate weather / rodent termination device so to avoid oil mist build up on radiator core, or an alternate location as agreed during design phase. CV hoses shall have a continuous fall and be neatly clipped as practicably permissible.

8.0.16 Installation of Closed Crankcase ventilation systems shall be undertaken cognizant of associated manufacturer's installation guidelines and cognizant of vibration.

8.0.17 Piping passing on walkway's shall be avoided, however if unavoidable walkover non slip covers shall be securely installed over same.

In aide memoir - check list for mechanical upfit , weather ingress enhancements acoustic for specifying authority

Subject	*Helpful commentary*
Exhaust bellows	*See above specification with 8.0 exhaust bellows ref flow liner – Flow liner not commonly installed in standby applications however is recomended. Bellows operating cycles are limited and failure causes significant fouling of package interior with high cost of repair*
Level 1 system noise approach.	*Level 1 is generally considered as a weather protection device however CM material does have superior sound insertion loss characteristics above steel or aluminum sheet metal so in certain case this level of attenuation where noise levels distant from the source may be sufficient.*
Level 2 system noise approach	*Is a good solution where noise control can be directed i.e. machine positioned In such a way that this intake (highest emitting zone) can be pointed away from the required quiet zone.*
Level 3 Plenum chamber / hood system approach	*Cost effective solution where noise close to the package is required to be moderately low or moderate at mid and long range. Intake hoods can attract ground moisture which can be negative in cold climes and resistance to snow drifts is not optimal. Likewise vertical air discharge plenums allows heavy low angle rain to get to radiator core which limits IP rating to IP11. Addition of gravity or fixed blade lovers can attain IP24 and improve ingress volume.*
Level 3 Splitter system approach	*Noise reduction and weather resistance both optimal and cost efficient if noise objectives enforce this system.*
Fuel Transfer – Reverse Pumps	*Good protection against overfill. Reverse pump should be mounted atop sub-base tank / local to tank to be evacuated*
Fuel Transfer Supply pumps	*Can be mounted at day tank particularly if flooded*

	suction head or low total pressure head on suction side. Otherwise best mounted at bulk fuel installation under flooded suction head conditions. Use of foot valve in bulk tanks ideal to prevent drain back if conditions allow.
Dual pumps	*Fuelogic DPCM provides for an economic ultra-simple hence reliable yet comprehensive dual pump control. DPCM can manage multi gen fuel supply requests and delivery.*
Fuel polishing / Sub-base tank size	*Ultra low sulfur diesel has a reduced ability l to resist algae catalyzed by water within fuel or condensed with the tank sub-base tank. Algae if entered into the engine fuel injection system will render the engine inoperable and or potentially at root cause of catastrophic damage. Suggest consider use of smaller capacity sub-base tanks and or day tanks bulk storage and fuel transfer where fuel can be more easily and universally managed. In any event fuel polishing in high condensing environments or generally should be considered for critical high capacity systems.*