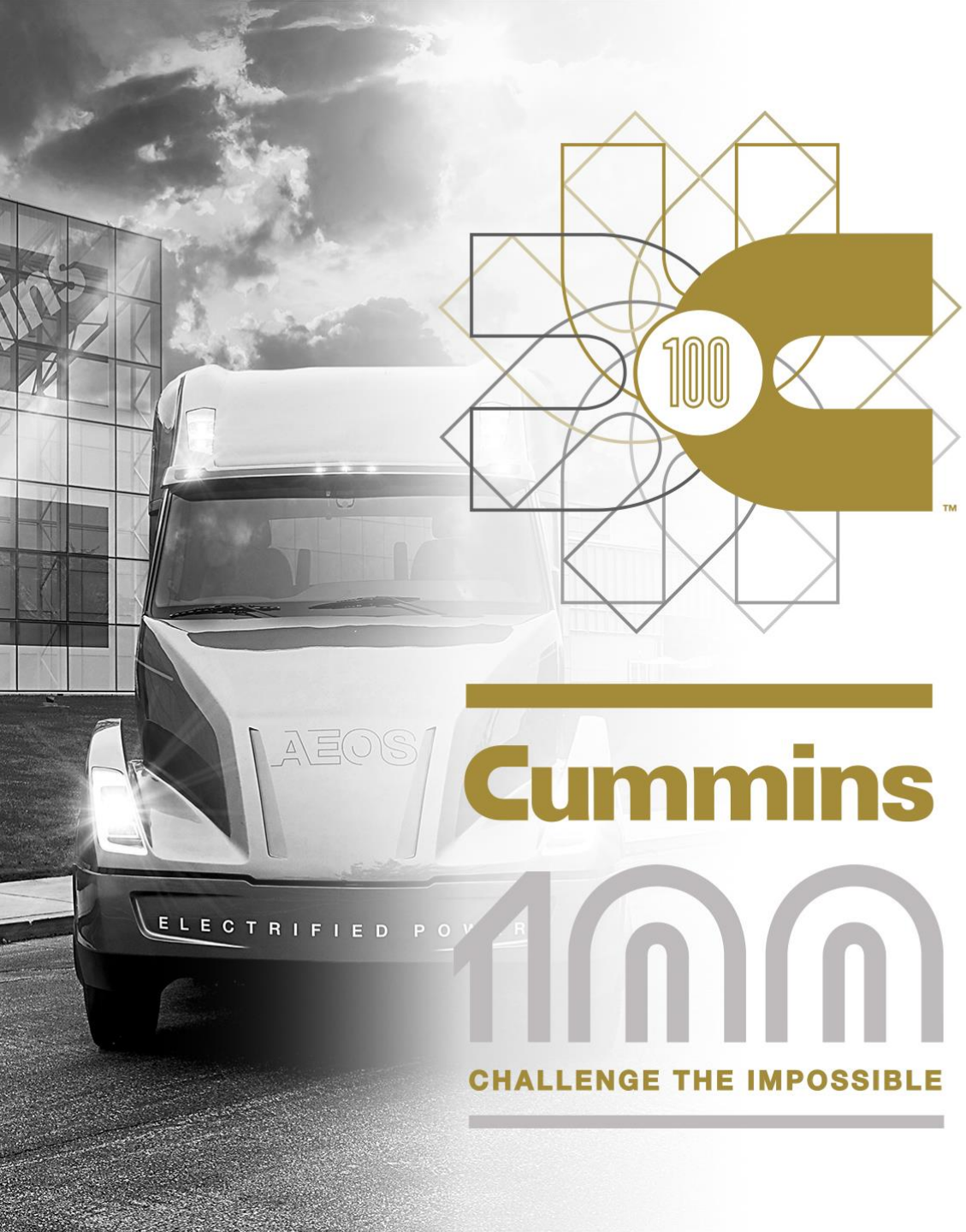


DG Set Installation Guidelines

Revised A- Check 750+ kVA DG sets

23rd -24th July 2019

Agenda

Agenda- Revised A-Check for 750 KVA & Above rating DG sets

Sr. No.	Description	Duration	Time
	Day 1: Tuesday 23-Jul-2019		
1	Programme Objective	45 min.	10.00 AM - 10.45 AM
2	Safety	30 min.	10.45 AM- 11.15 AM
	Short break	15 min.	11.15 AM- 11.30 AM
3	Understanding DG set ratings, transient performance,	30 min.	11.30 AM - 12.00
4	DG Set installation guidelines- Location, foundation	60 min.	12.00 PM - 01.00 PM
	Lunch break	60 min.	01.00 PM - 02.00 PM
5	Exhaust system flue gas piping calculations,	30 min.	02.00 PM - 02.30 PM
6	Cooling system options selection criteria's,	30 min.	02.30 PM - 03.00 PM
7	Ventilation system calculations,	30 min.	03.00 PM - 03.30 PM
	Short break	15 min.	03.30 PM - 03.45 PM
8	DG starting battery sizing estimations,	15 min.	03.45 PM - 04.00 PM
9	Earthing system requirements	15 min.	04.00 PM - 04.15 PM
10	Understanding the Noise of DG sets,	15 min.	04.15 PM - 04.30 PM
11	Understanding the vibrations of DG sets,	15 min.	04.30 PM - 04.45 PM
12	Understanding DG set derate estimations,	15 min.	04.45 PM - 05.00 PM
13	Understanding Seismic requirements,	15 min.	05.00 PM - 05.15 PM
14	Q & A	15 min.	05.15 PM - 05.30 PM

Agenda- Revised A-Check for 750 KVA & Above rating DG sets

Sr. No.	Description	Duration	Time
	Day 2: Wednesday 24-Jul-2019		
1	Understanding customer segmentation	30 min.	10.00 AM - 10.30 AM
2	Understanding revised A-Check document	45 min.	10.30 AM- 11.15 AM
	Short break	15 min.	11.15 AM- 11.30 AM
3	Understanding revised A-Check document	90 min.	11.30 AM- 01.00 PM
	Lunch break	60 min.	01.00 PM - 02.00 PM
4	Understanding revised A-Check document	90 min.	02.00 PM- 03.30 PM
	Short break	15 min.	03.30 PM - 03.45 PM
5	Q & A	45 min.	03.45 PM - 04.30 PM

1. Session Objectives

Program Objective:

- Customer expectations are changing and benchmarking with Competition,
- Change our perspective in commissioning from DG start up to back up power solution commissioning, which includes understanding of DG Set external systems, operational logic & integration requirements.
- Standardization of A-Check format across the country, with updated content to fulfill / exceed the customer expectations,
- Customers are expecting Cummins confirmation about the DG set package installation Quality,
- Revised A Check format includes below activities,
    a. Vibration.
    b. Noise
    c. DG Set systems Operational Parameters.
    d. PC 3.3 Parameters setting for synch. / load sharing & load management,
    e. Record Installation discrepancies / observations and educate customer regarding the actions to be planned.

Program Objective

- Understand the System Requirements.
- Understand the System limitations.
- Check the Site Installation.
- Identify the Installation improvements.
- Suggest to GOEM first for all improvements, after understanding the scope/responsibility of GOEM or Scope/Responsibility of Customer.
- In case of Installation which need immediate before Commissioning, agree amicably with GOEM/Customer.
- In case of any serious installation like for example safety of the customer equipment, safety of service personnel etc., the Commissioning can be delayed till correction after through assessment and use your skills of impartial judgement.

2. Safety

Before We Begin- A Check -

Safety Personal Protection Equipment

Our **personal protective equipment** (**PPE**) **is** our **last line of defence** because it means the hazard has actually made it to us—and without the **PPE**, injury may occur to us (very likely)

Let us, Start Using these PPE (Work Area)

- Use personal Protective Equipment (PPE's) at site,
- *Helmet,*
- *Safety Shoes,*
- *Hand gloves,*
- *Safety goggle,*
- *Jacket,*
- *Welding screen,*
- *Safety belt for working at height,*
- *Work permit for hot work & work at height,*
- *Proper scaffolding for working at height,*

Our **personal protective equipment** (**PPE**) **is** our **last line of defence** because it means the hazard has actually made it to us—and without the **PPE**, injury may occur to us (very likely)

Let us, Start Using these Signages. (Work Area)

DO NOT ENTER THIS AREA.

HEIGHT WORK IN PROGRESS

For Engineers doing “A” check

LOTO (Lock Out Tag Out) is the physical restraint of all hazardous energy sources that supply power to a piece of equipment, machinery or **system**. **LOTO** also includes applying a Warning Tag on the physical restraint device.

Option-1 Remove Positive Battery Terminal.

Option- 2 Better than above – Remove Battery terminal and put the lug in the Battery Box as below:

Additional Safety –

Press Emergency Stop on the Acoustic Enclosure as well as on the Engine Control Panel.

PROTECTION IS A HABIT AND IT IS FOR YOU TO FOLLOW EVERY TIME.

SAVE YOUR LIFE IT IS PRECIOUS.

For Engineers doing “A” check

LOTO (Lock Out Tag Out) is the physical restraint of all hazardous energy sources that supply power to a piece of equipment, machinery or **system**. **LOTO** also includes applying a Warning Tag on the physical restraint device.

PROTECTION IS A HABIT AND IT IS FOR YOU TO FOLLOW EVERY TIME.

SAVE YOUR LIFE IT IS PRECIOUS.

For Engineers doing “A” check

We need to first take go to the PCC panel and put DG on Manual Mode and also put a sign board - If you can also put a signage on the Breakers it is double safety. Please remember SAFETY Begins with “ME”

Safety Aspects in DG Set

Safety Aspects – External Power Cable connections between DG set and Distribution Panel.

1. Power Cables to be routed outside enclosure from the cutout provided for cable entry on enclosure as per the 4 page DG sets GA Drawing.

2. Gland plate provided on enclosure should be slit in two halves to minimize eddy current effect. It should also be provided with rubber bidding at periphery and rubber grommets at cable entry holes, as per recommended cable size diameter.

- Proper holes according to cable sizes should be drilled in the plate. (No gas cutting /weld cut is allowed) in the plate which is proved on the acoustic enclosure for power and control cabling.
- There are three options for taking out the cables from the DG set acoustic
  a. Grommet
  b. Metallic sleeve.
  c. PVC Sleeve.

Safety Aspects in DG Set

Recommendation on cable entry holes

Power Systems

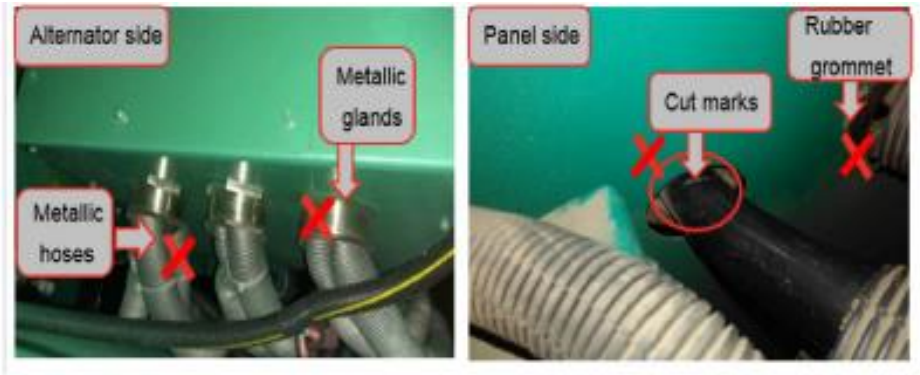
Instead of holes arrangement give rectangular cutout with rubber sheet

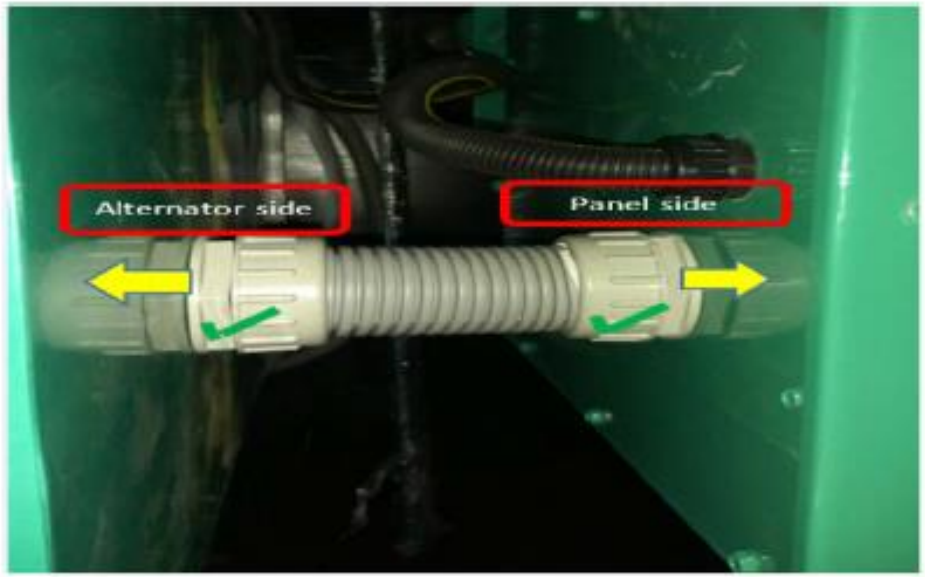
Make a rectangular plate & locate the rubber sealing/gromme t to all across rectangular cutout. It will give better sealing as well as nullify effect of eddy current

Internal control panel view on rectangular cutout with rubber sealing

Safety Aspects in DG Set

Safety Aspects – External Power Cable connections between DG set and Distribution Panel.





3. DG set Ratings, Transient Performance & Cummins Product Range

Rating Guidelines

- Rating Guidelines
  - ISO Definitions – Nomenclature
  - Understanding types of Ratings
- Transient Performance.

Part- 1 Rating Guidelines-ISO 8528 Definitions

Factors that decide the Rating

- Required Running Time (Hours per year)
- Applied load (variable or constant)
- Overload Capability

  (PS: Overload is not mentioned in Standards)

  (due to transients extra power is available)

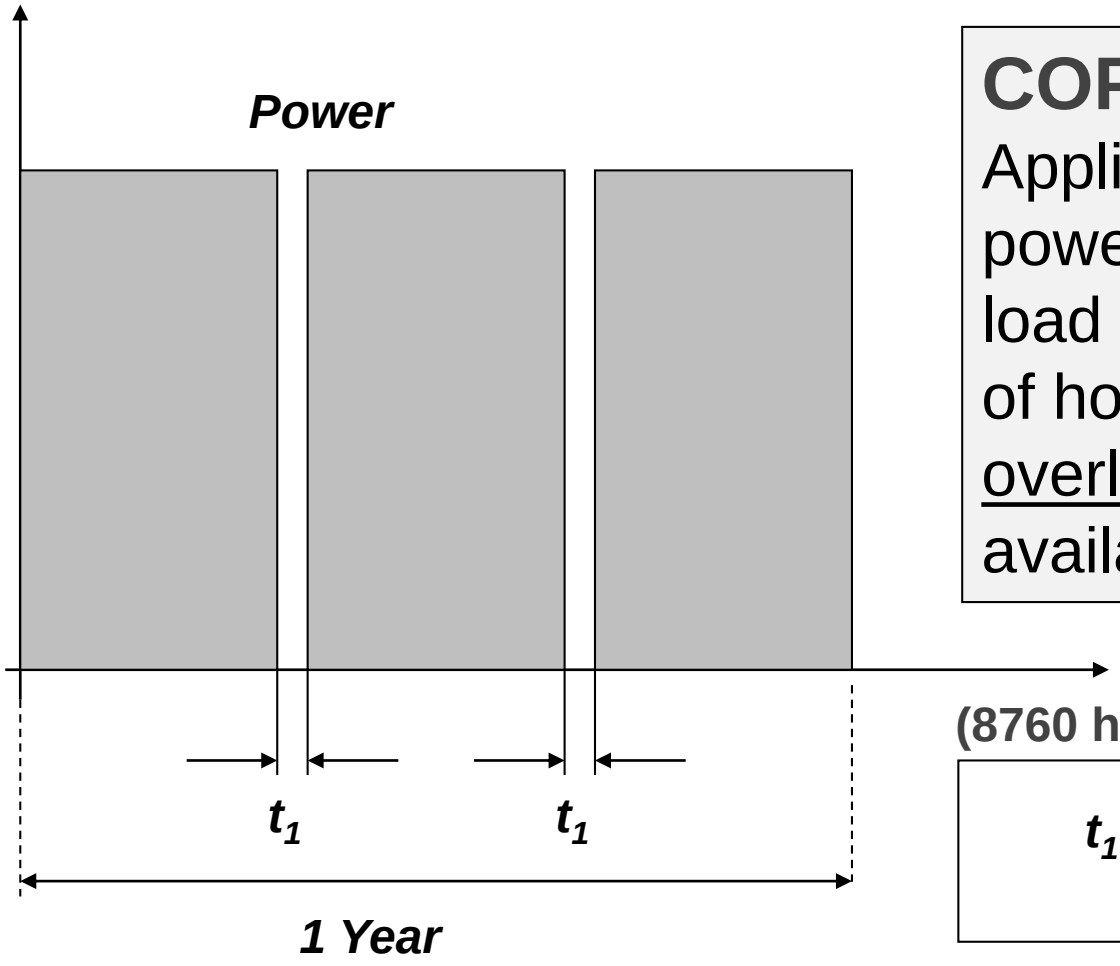
Implied changes with Rating

- Warranty

Let’s examine available ratings in detail with examples……

Rating Guidelines-ISO 8528-1 Definitions

Continuous Power - COP



COP

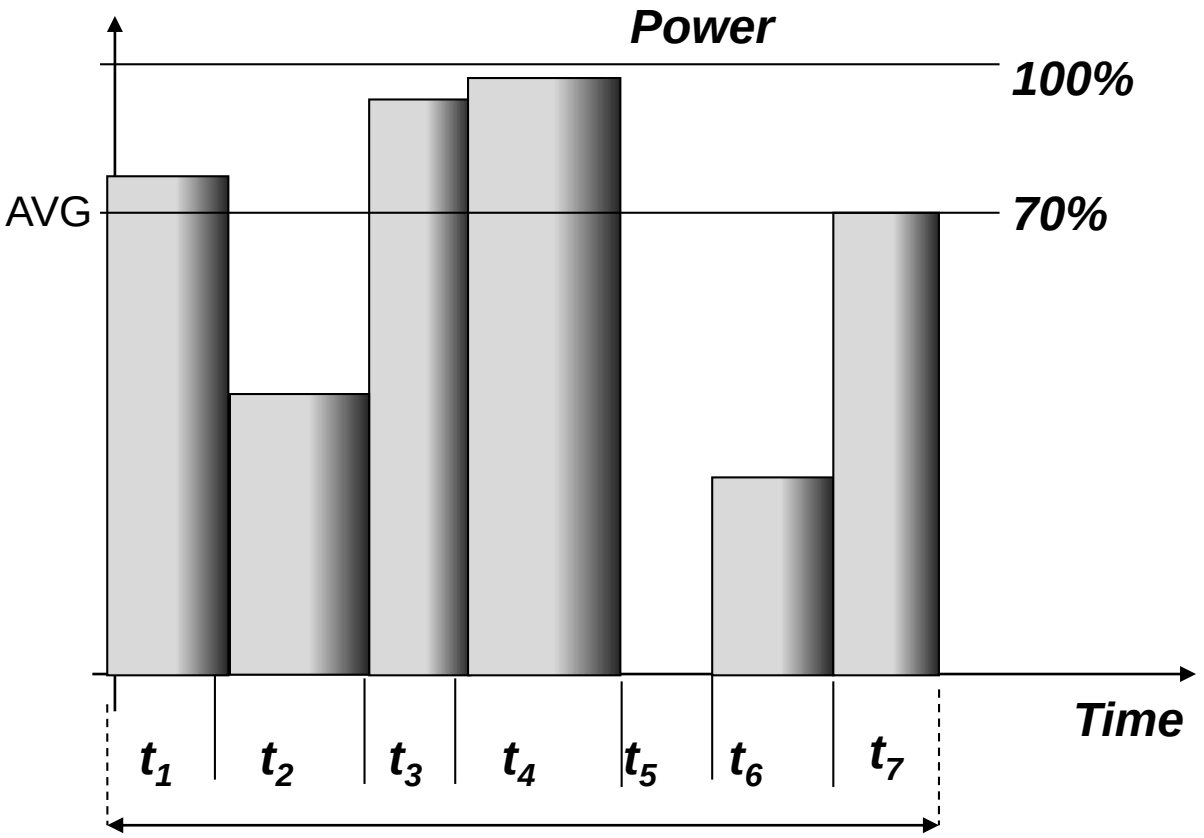
Applicable for supplying utility power at a constant 100% load for an unlimited number of hours per year. No overload capability is available for this rating.

Some may even ask for 10% Overload. *i.e* 1010 kVA COP may require us to offer KTA50G8

t_1	Shutdown for maintenance

Rating Guidelines-ISO 8528-1 Definitions

Prime Power - PRP



24 Hours/365 days a year

$$P_{pa} = \frac{P_1 t_1 + P_2 t_2 + P_3 t_3 + \cdots + P_n t_n}{t_1 + t_2 + t_3 + \cdots + t_n} = \frac{\sum_{i=1}^{n} P_i t_i}{\sum_{i=1}^{n} t_i}$$

Prime Power

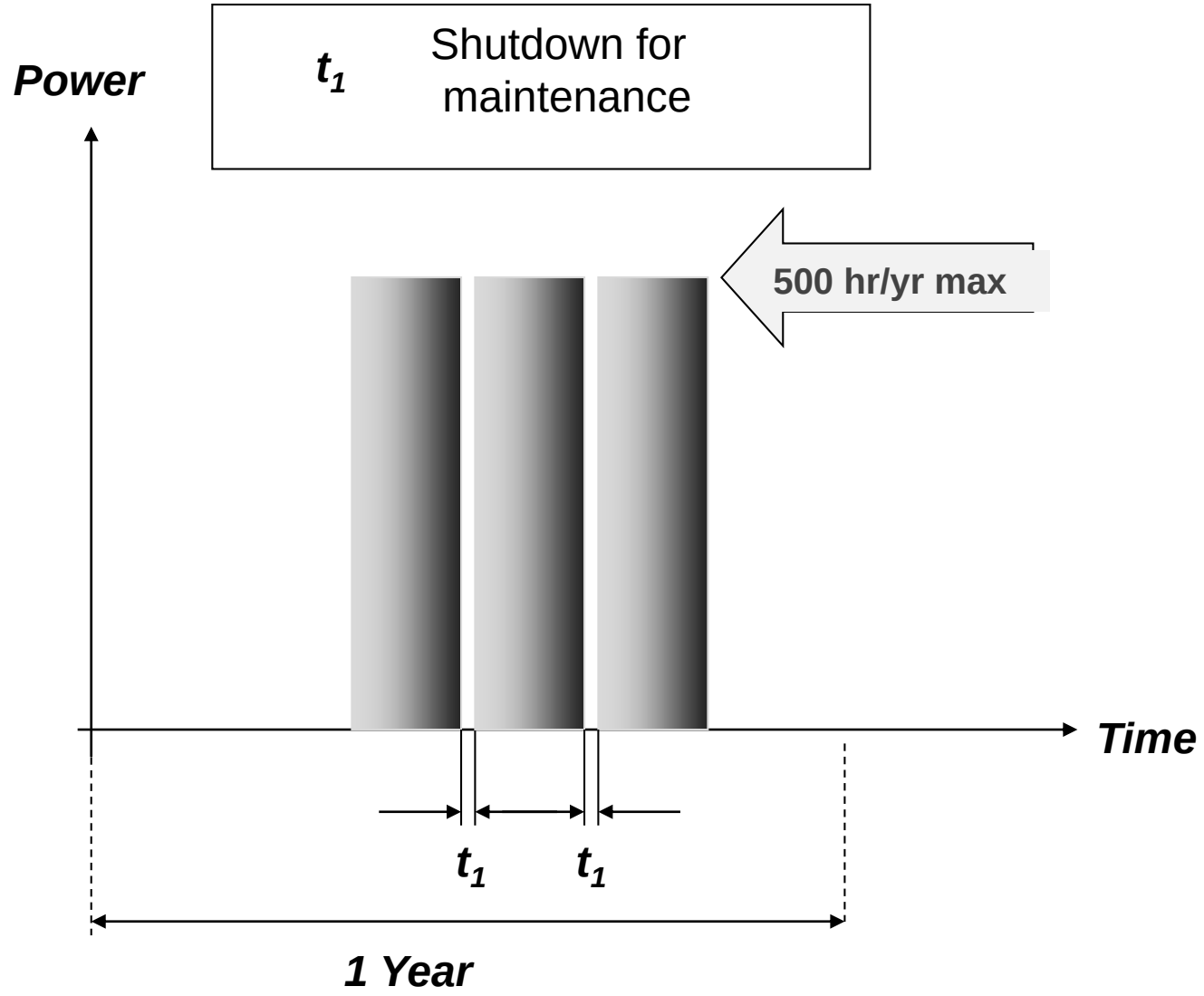
Unlimited Time PRP:
(8760 hr/yr less service)

- ❑**Unlimited number of hours per year**
- ❑**Variable load**
- ❑Not to exceed **70% average of the PP** rating during any operating **period of 24 hours**.

❑ 10 % Overload available in a **period of 12 hours**. (Not mentioned in standards but all DG Manufacturers follow)

Rating Guidelines-ISO 8528 Definitions

Limited Prime Power - LTP



Limited Time LTP:

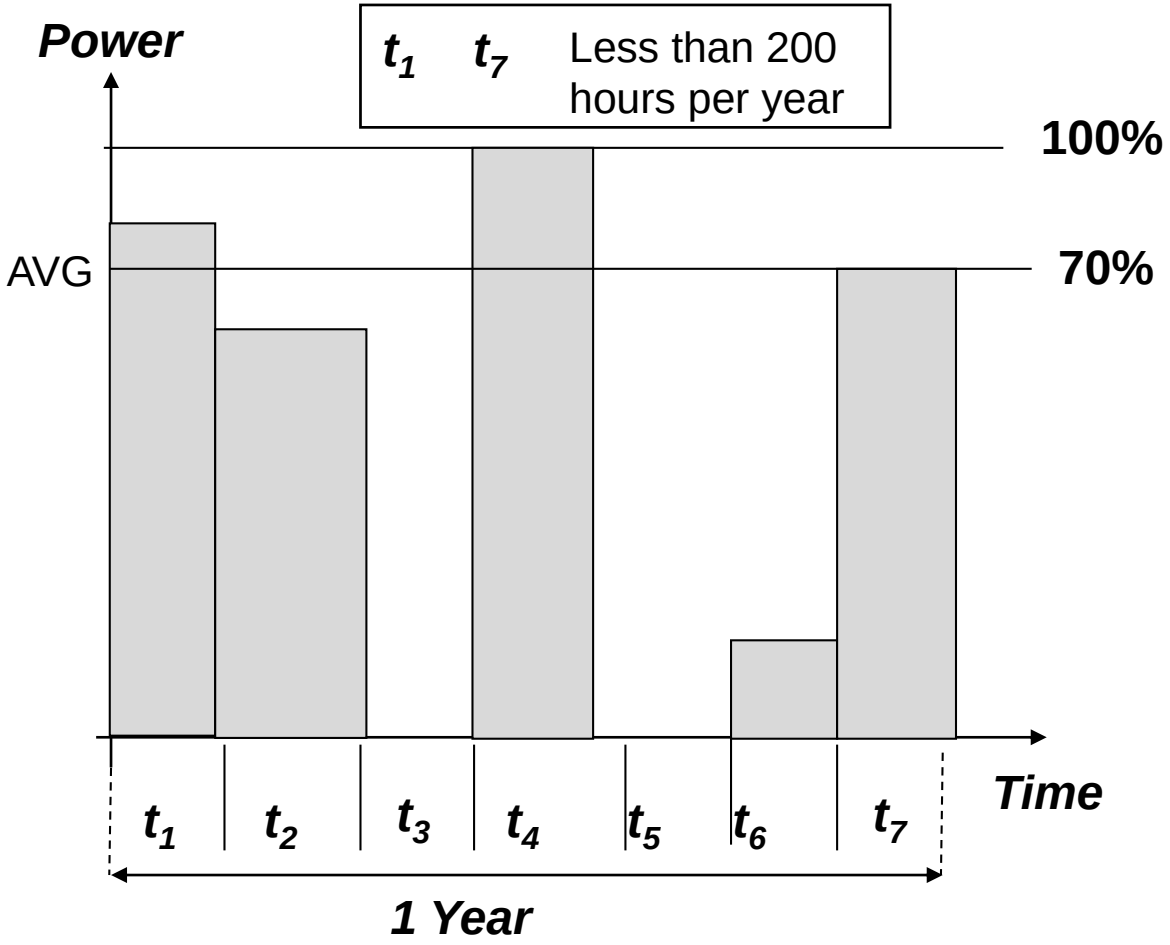
- limited number of hours **500 h/year**
- **Non-Variable Load**

applications at power levels never to exceed the Prime Power rating.

- Any operation exceeding 500 hours per year should use the Continuous Power Rating

Rating Guidelines-ISO 8528 Definitions

Emergency Standby Power - ESP

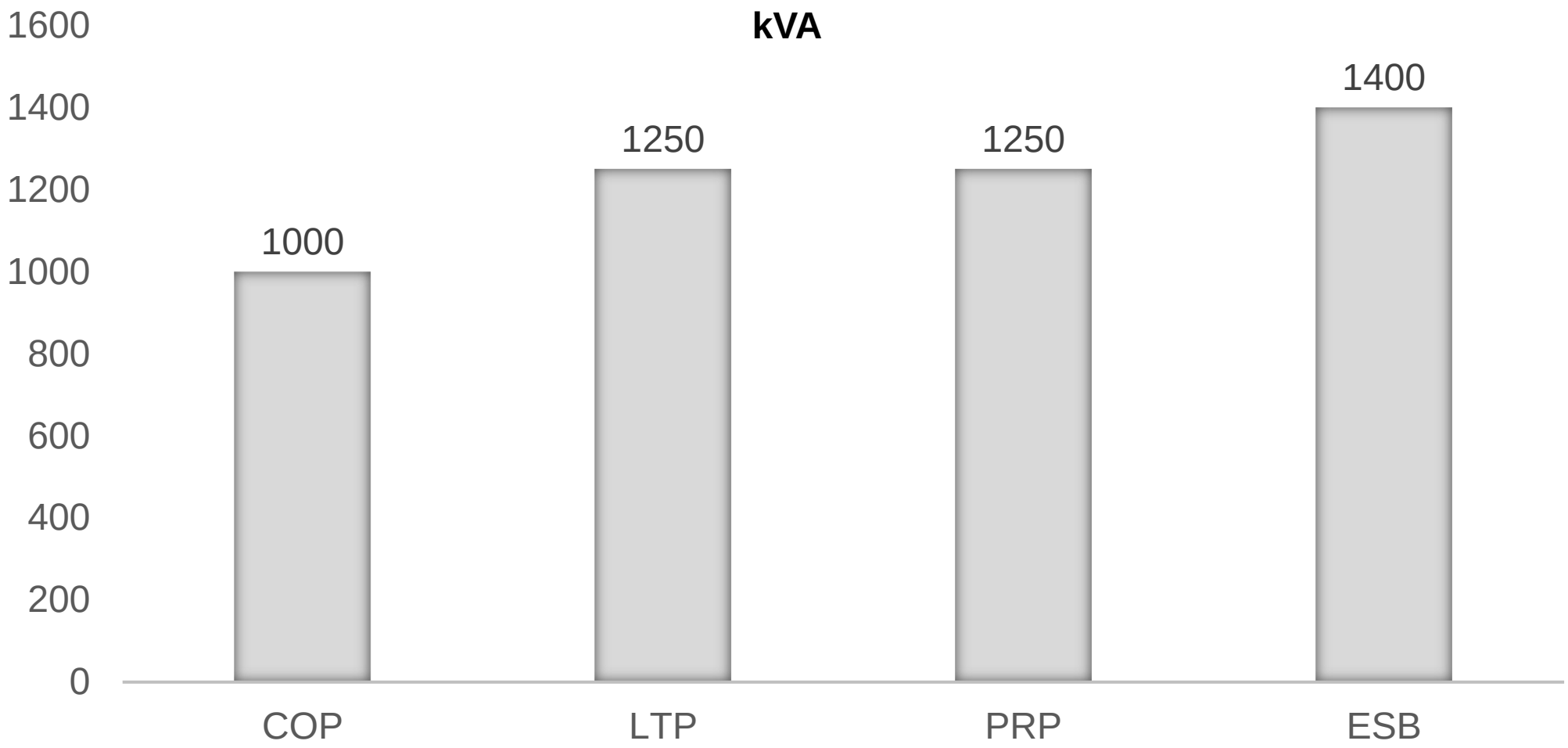


$$P_{pa} = \frac{P_1 t_1 + P_2 t_2 + P_3 t_3 + \cdots + P_n t_n}{t_1 + t_2 + t_3 + \cdots + t_n} = \frac{\sum_{i=1}^{n} P_i t_i}{\sum_{i=1}^{n} t_i}$$

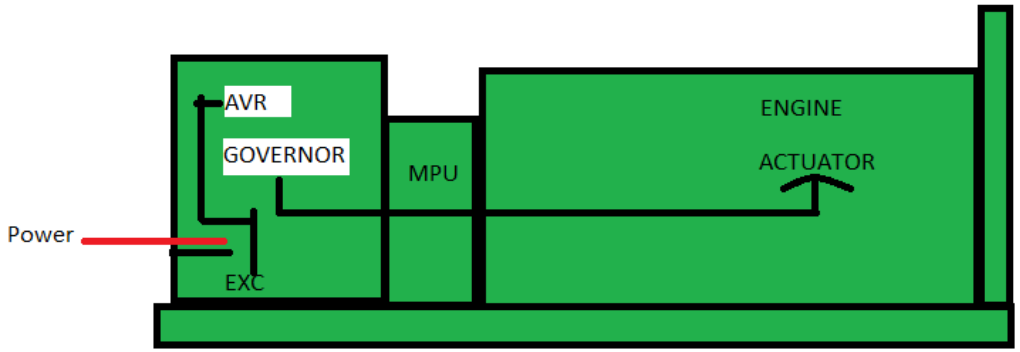
ESP

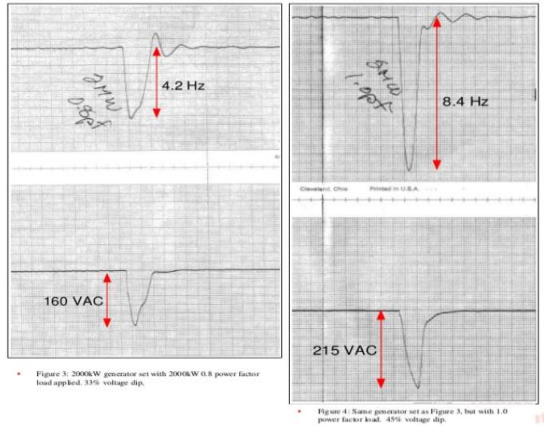
- For supplying emergency power for the duration of a utility power failure.
- Not to exceed **200 hrs/yr**
- **Average load factor of 70%** of the standby rating
- No negotiated outage operations.

Example C1250 D5- KTA50G3



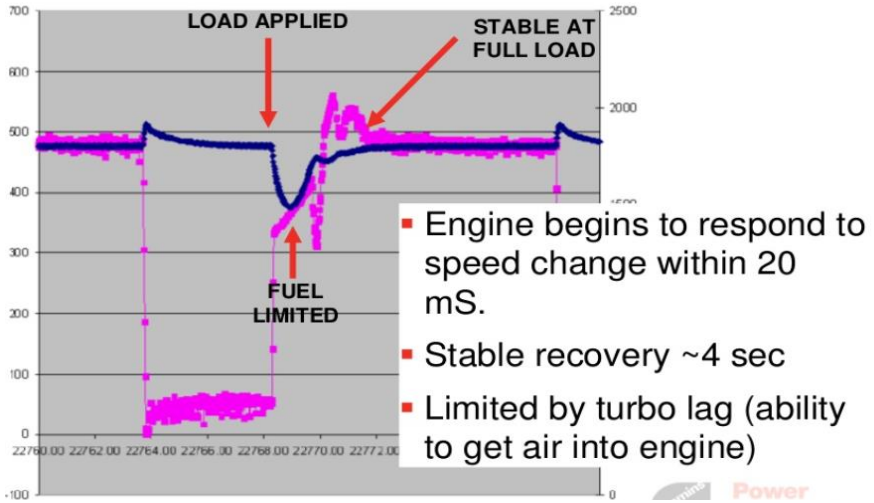
Genset Transients Performance





- Engine slows and voltage drops until fuel rate and/or excitation level increases.
  - Governor and AVR cant predict change in load. So .
  - Load change = V, Hz change
- Magnitude of the changes depends on
  - Size of the load relative to the gensets.
  - How fast fuel rate and excitation can be changed..
  - AVR v/HZ function.

Engine Fueling and Speed during Transient



Rating Guidelines

ISO3046 (BS5514) Performance Classes for Engines

FREQUENCY

Class	Droop %	Steady <25%	State at loads >25%	Transient 100% Load OFF	Recovery Secs.
A2	<8	1.5%	1%	15	15
A1	<5	1.0%	0.8%	10	8

The amount of load application for turbocharged engines is subject to a BMEP/POWER curve given in the Standard where a typical BMEP range of 15 to 20 bar shows a load application of 40/50% whilst remaining within the limits of the Classes shown above.

GENERAL NOTE:

There is a tendency (especially with some of the less modern customer specifications) to quote the Engine standard. This cannot apply as engines are always coupled to an alternator having a significant effect on the system inertia and hence governing characteristics.

ISO8528 is the only applicable governing standard for Generating Sets.

Rating Guidelines

ISO8528 (BS7698) Performance Classes for engine driven Gen Sets

ISO8528 (BS7698) Performance Classes for Engine driven Generating Sets

FREQUENCY

Class	Droop %	Steady State %	Transient 100% OFF	Recov. Secs.	Transient Max. Load ON	Recov. Secs.
G1	<8	2.5	18	10	15	10
G2	<5	1.5	12	5	10	5
G3	<3	0.5	10	3	7	3

VOLTAGE

Class	Transient Max. Load ON (%)	Recovery. Secs.
G1	25	10
G2	20	6
G3	15	4

Cummins Product range

Diesel Generator Set Product Ratings

3 Phase, 415 V, 50 Hz, 1500 RPM

Prime Power Rating

Genset Model	kVA Rating	Engine Model	BHP	Alternator Frame	Genset Controller
C7.5D5P	7.5	X1.3TAA-G1	23	PI044D	PS0600
C10D5P	10	X1.3TAA-G1	23	PI044E	PS0600
C15D5P	15	X1.3TAA-G1	23	ScL1-P1	PS0600
C20D5P	20	X1.3TAA-G7	25.2	Scl2-M1	PS0600
C25D5P	25	X2.7T-G1	32	Scl2-M1	PS0600
C30D5P	30	X2.7TAA-G2	38.5	Scl2-P1	PS0600
C35D5P	35	X2.7TAA-G7	47.5	S1L2J1	PS0600
C40D5P	40	X3.6TAA-G1	52.4	S1L2K1	PS0600
C50D5P	50	4BTAA3.3-G11	64	S1L2-R1	PS0600
C62.5D5P	62.5	4BTAA3.3-G11	84	S1L2-Y1	PS0600
C82.5D5P	82.5	4BTAA3.9-G4	110	UCI224G	PS0500
C100D5P	100	6BTAA5.9-G13	159	UCI274C	PS0500
C125D5P	125	6BTAA5.9-G13	159	UCI274V	PS0500
C140D5P	140	QSB5.9-G1	184	UCI274E	PC1.1
C160D5P	160	QSB5.9-G2	206	UCI274F	PC1.1
C180D5P	180	QSB6.7-G14	234	UCI274G	PC1.1
C200D5P	200	QSB6.7-G15	256	UCI274H	PC1.1
C225D5P	225	QSB6.7-G16	280	UCI274K	PC1.1
C250D5P	250	6L8.9TAA-G4	335	UCI274K	PC1.1
C275D5P	275	QSL9-G16	334	HCI444D	PC1.1
C300D5P	300	QSL9-G15	322	HCI444D	PC1.1
C320D5P	320	QSL9-G15	322	HCI444E	PC1.1
C365D5P	365	QSN14-G1	448	HCI444F	PC1.2
C400D5P	400	QSN14-G2	486.5	HCI544C	PC1.2
C500D5P	500	KTAA19-G10	587	HCI544D	PC1.2
C600D5P	600	KTAA19-G12	713	HCI544E	PC3.3
C625D5P	625	KTAA19-G13	739	HCI544F	PC3.3
C650D5P	650	QSK19-G7	828.5	HCI544F	PC1.2
C750D5P	750	KTA38-G12	1069	HCI634W	PC3.3
C810D5P	810	KTA38-G12	1069	HCI634V	PC3.3
C910D5P	910	KTA38-G17	1069	HCI634Y	PC3.3
C1010D5P	1010	KTA38-G5	1180	HCI634Y	PC3.3
C1250D5P	1250	KTA50-G3	1470	HCI634Z	PC3.3
C1500D5P	1500	KTA50-G8-I	1735	PI734C	PC3.3
C1750D5P	1750	QSK50-G10	2000	PI734E	PC3.3
C1825D5P#	1825	QSK50-G10	2000	PI734E	PC3.3
C2000D5P	2000	QSK60-G4	2319	PI734F	PC3.3
C2250D5P	2250	QSK60-G8	2603	PI734H	PC3.3
C3000D5	2750	QSK78-G9	3088	LVSI804T	PC3.3
C3750D5	3350	QSK95-G4	3866	LVSI804X	PC3.3

Advantage Prime Power Rating

Genset Model	kVA Rating	Engine Model	BHP	Alternator Frame	Genset Controller
C440D5AP	440	QSN14-G3	531	HCI544C	PC1.2
C660D5AP	660	QSK19-G5	781.5	HCI544F	PC1.2
C700D5AP	700	QSK19-G7	828.5	HCI544F	PC1.2
C830D5AP	830	KTA38-G12	1069	HCI634W	PC3.3
C900D5AP	900	KTA38-G12	1069	HCI634W	PC3.3
C1400D5AP	1400	KTA50-G3	1646	PI734B	PC3.3
C1925D5AP	1925	QSK50-G10	2200	PI734E	PC3.3
C2000D5AP#	2000	QSK50-G10	2200	PI734E	PC3.3
C2250D5AP	2250	QSK60-G4	2567	PI734G	PC3.3

Standby Power Rating

Genset Model	kVA Rating	Engine Model	BHP	Alternator Frame	Genset Controller
C2500D5	2500	QSK60-G8	2878	PI734H	PC3.3
C2750D5B	2750	QSK60-G22	3182	LVSI804X	PC3.3
C3000D5	3000	QSK78-G9	3404	LVSI804W	PC3.3
C3750D5	3750	QSK95-G4	4381	PI80X	PC3.3

DCC (Data Center Continuous) Power Rating

Genset Model	kVA Rating	Engine Model	BHP	Alternator Frame	Genset Controller
C750D5P	750	KTA38-G12	1069	HCI634W	PC3.3
C810D5P	810	KTA38-G12	1069	HCI634V	PC3.3
C1010D5P	1010	KTA38-G5	1180	HCI634Y	PC3.3
C1250D5P	1250	KTA50-G3	1470	HCI634Z	PC3.3
C1500D5P	1500	KTA50-G8-I	1735	PI734C	PC3.3
C2000D5P	2000	QSK60-G4	2319	PI734F	PC3.3
C2250D5P	2250	QSK60-G8	2603	PI734H	PC3.3
C2750D5B	2800	QSK60-G22	3182	LVSI804X	PC3.3
C3000D5	2750	QSK78-G9	3088	LVSI804T	PC3.3
C3750D5	3350	QSK95-G4	3866	LVSI804X	PC3.3

Note: # - With external cooling system
For single phase and other voltage combinations, please contact Cummins Marketing Team.

Gas Generator Sets Product Ratings

3 Phase, 415 V, 50 Hz, 1500 RPM

Continuous Operating Power (Producer Gas)

kWe Rating	Engine Model
70	G855-G
120	GTA855-G
240	GTA1710-G

Cummins Product Range

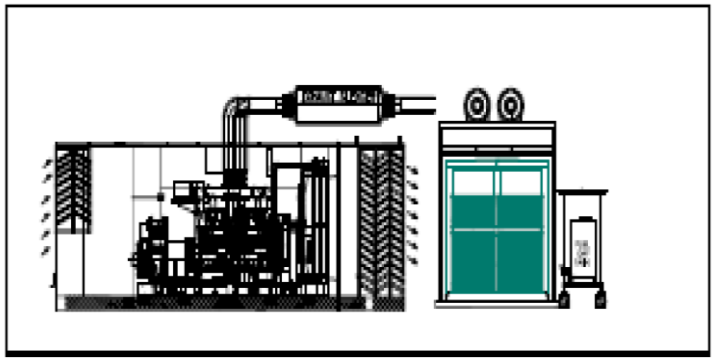
Lean Burn - Continuous Operating Power (Natural Gas)

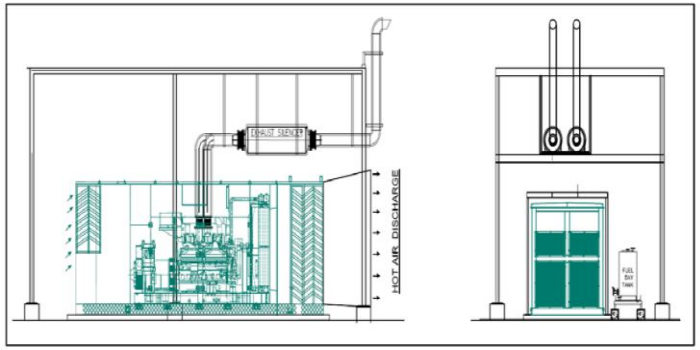
kWe Rating	Model	Genset Model	Controller
995	QSK60-G	C995N5C	PC3.3
1160	QSK60-G	C1160N5C	PC3.3
1200	QSK60-G	C1200N5C C	PC3.3
1400	QSK60-G	1400N5C	PC3.3
1540	QSV91-G	C1540N5CB	PC3.3
1750	QSV91-G	C1750N5CB	PC3.3
2000	QSV91-G	C2000N5CB, C2000N5C	PC3.3

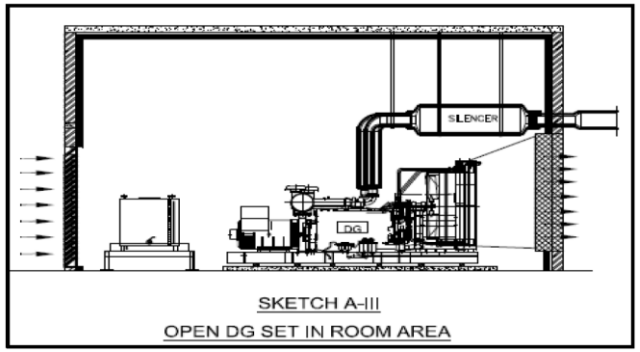
4. DG Set Installation Guidelines- Location, Foundation

DG Set location

- DG sets with Acoustic enclosure in Open area,
- CPCB II Products (up to 800KW Mechanical)- 75 dBA (CPCB Approved)
- 1010 KVA & Above- Cap in type enclosures- 25 DBA Insertion loss
- DG sets with Acoustic enclosure in Covered area,
- Open sets installation in civil room area (1010 KVA & above rating)







DG Set location- Space considerations

No.	Description	DG set with Acoustic Enclosure in Open Area.	DG set with Acoustic Enclosure in Covered Area.	Open DG set in room.
1	Free space on both sides	Min. 1m	Min. 1	Min. 2m
2	Free space at Radiator end (Radiator- - Hot air outlet front discharge)	Min. 2m	Min. 1m (No obstacle for hot air disbursement @ 2m)	Min. 1m (No obstacle for hot air disbursement @ 2m)
	Free space at Radiator end (Radiator- - Hot air outlet Top discharge)	Min. 1m	Min. 1m (Ducting to provide as applicable to avoid hot air recirculation to inlet air).	N/A
3	Free space at Alternator side.	Min. 1.5m (No obstacle for fresh air suction)	Min. 1.5m (No obstacle for fresh air suction)	Min. 2m (considering alternator hauling space requirement)
4	Fresh air inlet effective opening area	N/A	Effective open area -Min 1.5 times of the Radiator core area.	Effective open area -Min 1.5 times of the Radiator core area.
5	Hot air discharge effective opening area	N/A	Effective open area -Min 1 times of the Radiator core area.	Effective open area -Min 1 times of the Radiator core area.
6	Distance between two sets	Min 1m between two canopies.	Min 1m between two canopies.	Min1.5m between two foundations.

DG Set location- Considerations

- Cooling system option-

1. Set mounted radiator,
2. HE option (Cooling tower or remote radiator in secondary cooling circuit)
3. Remote radiator in primary cooling circuit,

- Ventilation Air flow requirement-

1. Air intake opening/ air entry provision &
2. Hot air outlet opening / hot air chamber,
3. Radiation heat load from engine, alternator in room area,
4. Wind flow direction,

DG Set location- considerations

- Exhaust silencer installation & exhaust duct routing,
- Fuel day tank location,
- Electrical cable / bus duct layout,
- Switchgear panel location,
- Maintenance space- mainly Alternator removal for maintenance,

DG Foundation-

- DG Foundation size to be considered as per equipment dimensions,

  + 100 to 150mm more at all sides, from DG set frame or 50mm more than acoustic enclosure frame.

- Foundation block depth calculations needs to worked out by civil structural engineer considering following factors,

1. DG set static & dynamic loads,
2. Site soil load bearing strength,
3. Site specific structural compliance requirements if any

DG Foundation-

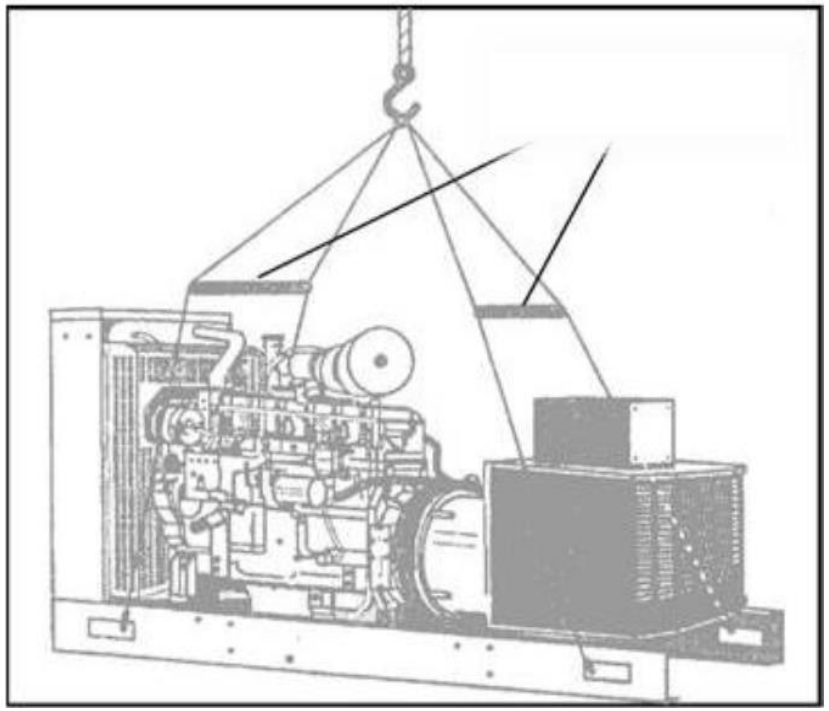
- Ensure civil foundation is properly cured before shifting of DG set on foundation.
- DG Foundation finish surface should be elevated by 150mm from site finish floor level, to avoid rain water entry to enclosure & to maintain cleanliness.
- DG Foundation finish surface should be leveled properly within 6mm variation.
- Permissible slope over foundation length-

  For rating up to 625 KVA- 1”

  For rating up above 750 KVA- 2”

DG Set receipt inspection at site

- DG set unloading & shifting to foundation route / process to be reviewed with site customer / safety team.
- Check compliance documentation for crane & crane operator involved in DG unloading at site.
- Crane and lifting ropes capacity to be verified as per weight of DG set to be unloaded / shifted.
- Check site soil condition / route for crane movement.
- Use proper slings with spreader bar for unloading of DG set as per DG set model requirements.
- Position DG set as per installation drawings as per site layout requirements.



Pre-Requisites for DG Erection-

- DG Set external system erection works needs to be started only after setting

  AVM’s properly and locating DG set on foundation,
- DG set controller (PCC), all harness connections needs be disconnected at PCC end / ECM end and all connectors to be masked properly to avoid any damage.
- While fabrication on DG set external piping / ducting connections, weld Earthing to be connected at closest point of weld area.
- Blank all the openings on DG set to avoid entry of debris, duct.
- Provide blanking plate on turbo outlet flange to avoid rain water entry to engine from exhaust duct. This blanking plate to be removed before commissioning of DG set.

AVM Installation- Soft mounted DG sets

- For soft mounted DG set, rubber AVM’s are provided between engine / alternator & base frame, which are factory set.
- We have to ensure that DG set base frame is resting properly on levelled foundation.

AVM Installation- Hard mounted DG sets

- For hard mounted DG set, rubber or spring type AVM's are provided between DG Base frame & civil foundation finished floor, as per below process,
- Check & record the finish foundation level at AVM resting locations using water level tube, all readings should be within 6mm.
- Install DG set on AVM's as per AVM locations specified in GA Drawing of particular DG set.

AVM Installation- Hard mounted DG sets

- Record AVM loaded height of all AVM's as per format.
- Lift DG Set and add metal shim plates minimum 3mm thick, below AVM to control loading on all AVM uniform as per AVM data, as per guidelines.
- Maintain AVM installed loaded height variation within guidelines.

AVM Installation- Hard mounted DG sets

ESN_ Date :

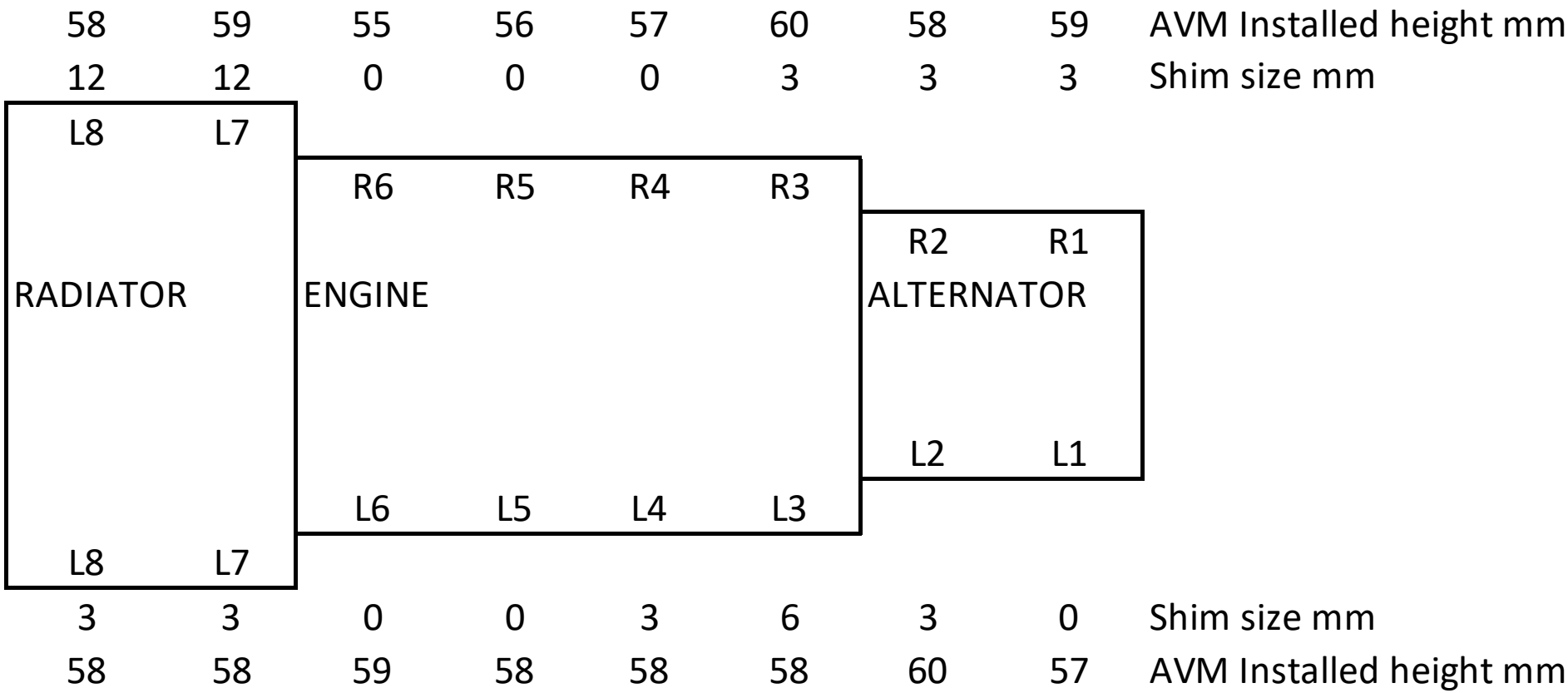
Customer :

Done By : DG#

SPRING TYPE AVM ADJUSTMENT FOR DG

					Installed height of AVM-mm
					Shims Thickness below AVM
					Civil foundation water level in mm
	AVM 5	AVM 4	AVM 3	AVM 2	AVM 1
Engine side	DG No. ___ Sr. No._____				Alternator side
	AVM 5	AVM 4	AVM 3	AVM 2	AVM 1
					Civil foundation water level in mm
					Shims Thickness below AVM
					Installed height of AVM-mm

AVM Installation- Hard mounted DG sets



AVM Installation- Hard mounted DG sets

- For example 2000 /2250 KVA- QSK60 G4/G8 DG Sets,

- Rubber pad option- Set mounted radiator

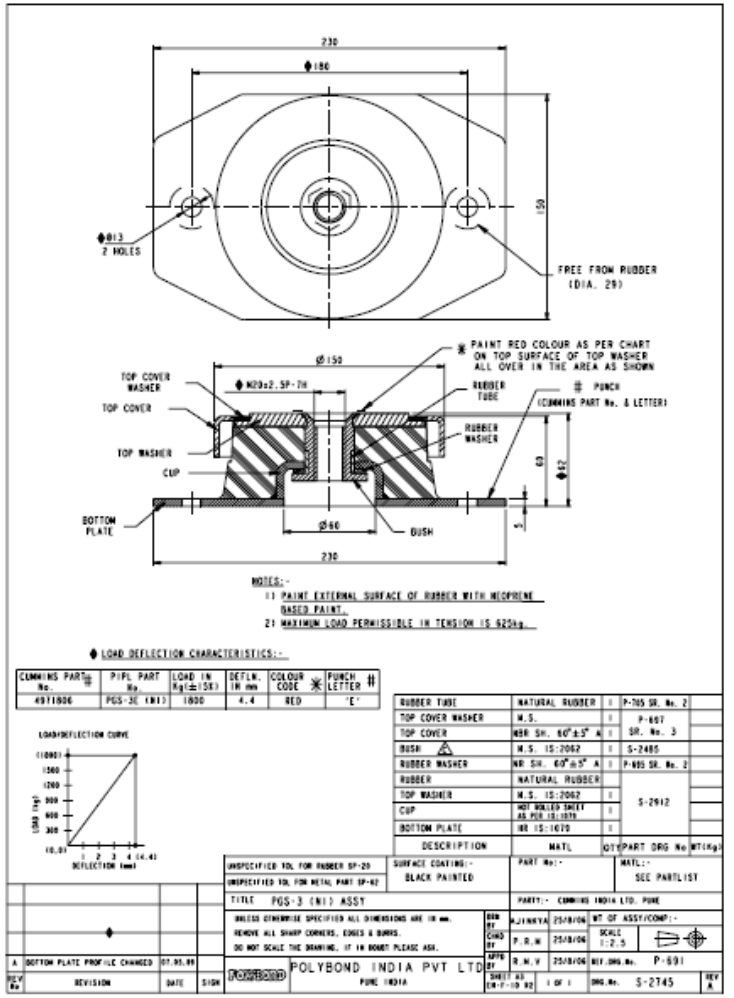
  option- 16 No. AVM’s

  AVM Free height- 62mm

  Average compression of AVM- 2.5 to 3.5mm

- All AVM’s should be uniformly loaded, within 1mm of variation.

- Top screw to be tightened properly.



AVM Installation- Hard mounted DG sets

- For example 2000 /2250 KVA- QSK60 G4/G8 DG Sets,

- Spring type AVM's- Set mounted radiator

  option- 10 No. AVM's

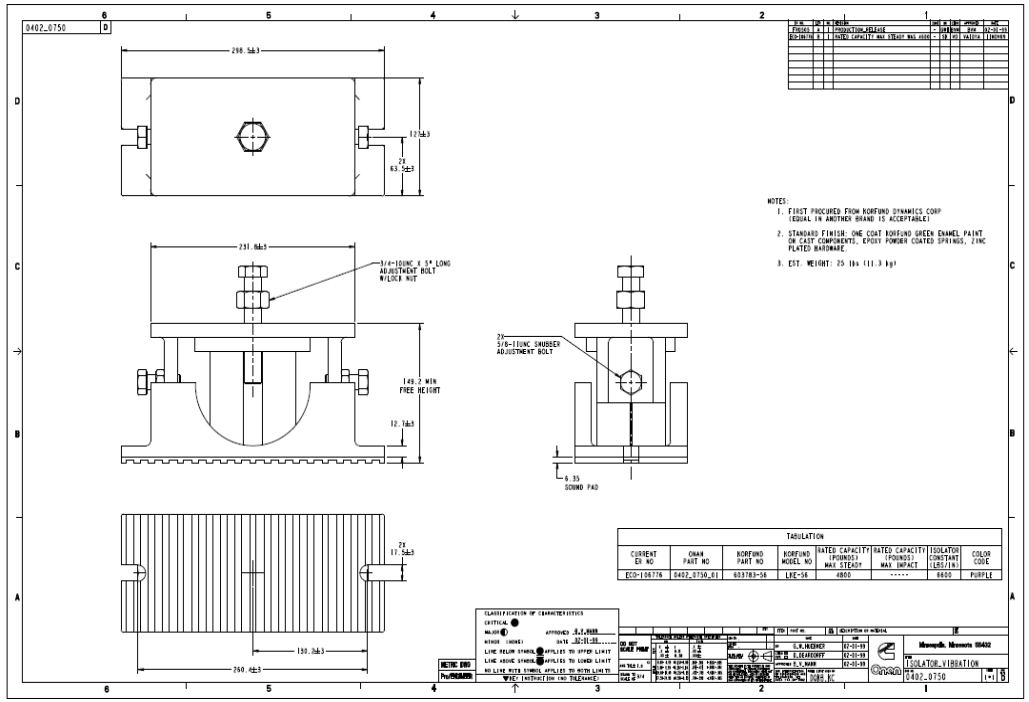
  AVM Free height- 150mm

  Average compression of AVM- 14mm

- All AVM's should be uniformly loaded, within

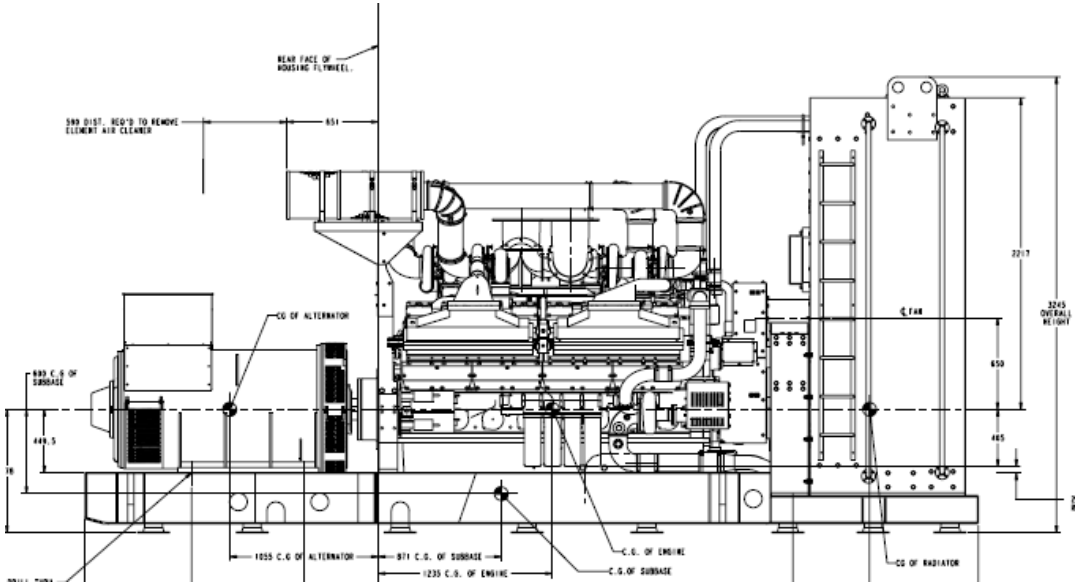
  +/-3mm.

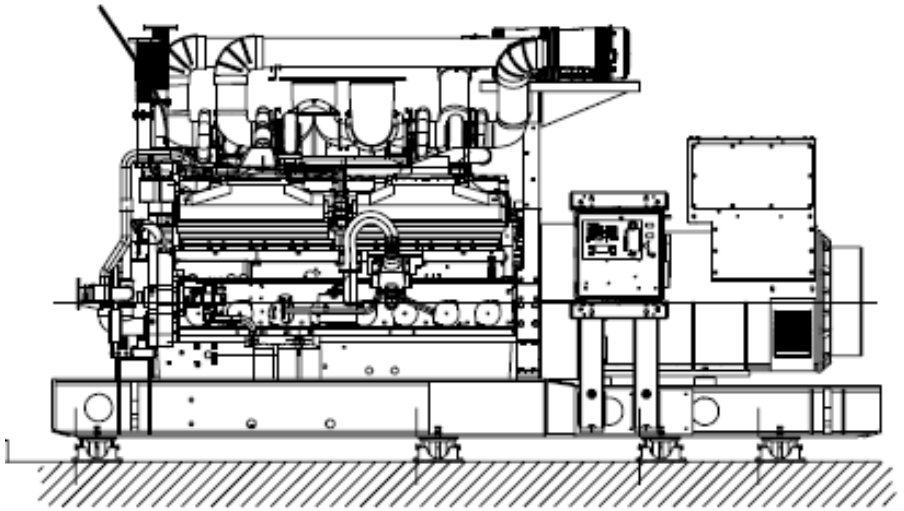
- AVM pad tensioning bolt to be tightened by 1-2 revolution incase fine tuning of AVM compression envisaged. Lock nut to be locked properly.



QSK60- G4 & G8 Options available

Sr	Combinations	SO No.	Engine Sub base Design	Radiator Supplier	Alternator	AVM PN x Qty
1	Combination 1		PL / Kent	Enginemate	LV & HV	Rubber AVM - 4971806 x 16 No.
4	Combination 2		PL / Kent	Bearward	LV & HV	Spring AVMs X 10 No.
5	Combination 3		PL / Kent	PHE option	LV & HV	Spring AVMs X 10 No.
6	Combination 4		PL / Kent	NO COOL Option	LV & HV	Spring AVMs X 8 No.





5. Exhaust System

Exhaust System Considerations

- Exhaust System ducting Installation,
  - Engine exhaust gas flow & back pressure limits,
  - Exhaust duct length and stack location,
  - Thermal insulation requirement,
- Exhaust Noise
  - Sound from Tail Pipe,
  - Sound transmitted to structure,
- Exhaust After Treatment if applicable

Exhaust Duct size selection

- Exhaust System duct size calculations based on following,
  - Engine exhaust gas flow rate,
  - Engine back pressure limit,

Model	mm (inches) of Hg	kPa
X1.3	30.98 (1.22)	4.13
X2.7/ X3.6	29.97 (1.18)	4
6B5.9	38.1 (1.5)	5
4B3.3/ 4B3.9/ QSB5.9/ QSB6.7/ L8.9/QSL9/ QSN14/ KTAA19 /KTA38	76.2 (3)	10.15
QSK 19/ K50/ QSK50/ QSK60/ QSK78/QSK95	50.8 (2)	6.77
Gas Engines	50.8 (2)	6.77

Exhaust Duct size selection-

Sr. No.	Engine Model	DG Set Rating	Exhaust gas flow per DG.	Exhaust silencers /DG Set	Pipe Dia before "Y" piece	Common Pipe Dia after "Y" piece	Estimated Exhaust Gas Velocity (Single Pipe)	Double Pipes Dia after Turbocharger	Estimated Exhaust Gas Velocity (Double Pipe)
		kVA	m3/s	Nos.	inch NB	inch NB	m/sec	inch NB	m/sec
1	KTA38G5	1010	3.31	2	10	12	45	10	32
2	KTA50G3	1250	4.00	1	10	14	40	10	39
3	KTA50G8I	1500	4.35	2	10	14	44	10	43
4	QSK50G10	1790	5.14	2	12	16	39	12	35
5	QSK-60-G3	1875	5.27	2	12	16	42	12	37
6	QSK-60-G4	2000	5.61	2	12	16	43	12	38
7	QSK-60-G8	2250	6.31	2	12	18	38	12	43
8	QSK-78-G9	2750	7.21	2	14	18	43	14	36
9	QSK-95-G4	3350	9.05	2	14	20	44	14	43

Exhaust Duct size selection

- Following site inputs are critical in duct diameter sizing calculation,
  - Engine exhaust gas flow rate,
  - Engine back pressure limit,
  - Length of ducting,
  - No. of flexible bellows,
  - No. of 90 Deg. long radius Bends,
  - No. of 45 Deg. long radius Bends,

Exhaust System Back Pressure Calculations

Generating Set Rating - kVA	2750 P 3000 S
Engine Model	QSK78-G9
Alternator Frame	HV804S

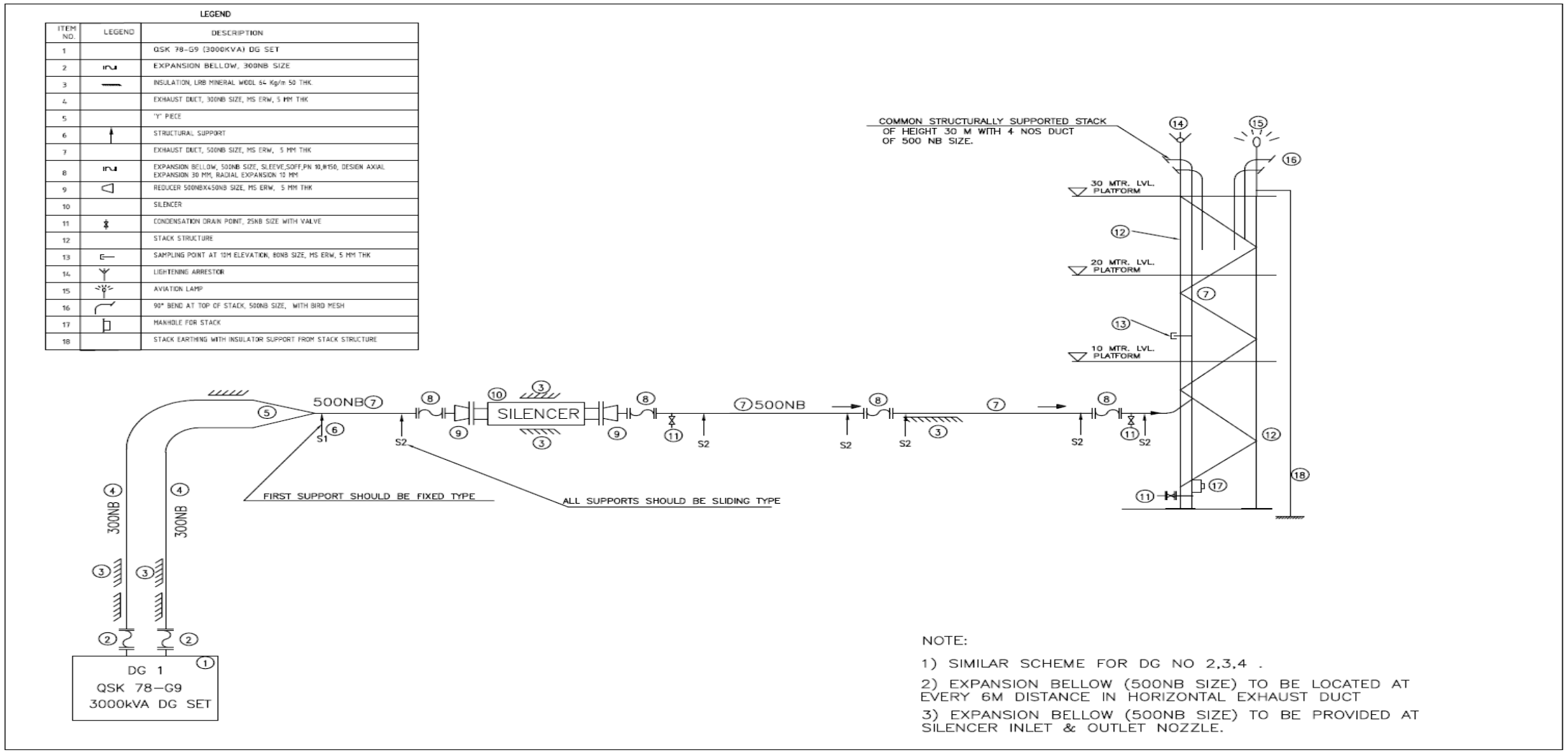
Calculations for Equivalent Pipe Length	Total nos.	Equivalent length for one number in metre	Total length
Straight pipe - feet			50
90 deg. standard elbow	0	10.5	0
90 deg. medium radious elbow	0	8.9	0
90 deg. long radious elbow	3	7.2	21.6
45 deg. Elbow	1	3.1	3.1
Tee, side inlet or outlet	0	24.1	0
Expansion Bellows	3	1.2	3.6576
18 inch. Flexible tube	0	0.9	0
Total Pipe Length - Mtr			78

$P = L \times S \times Q^2 / 5184 \times D^5$
L = Total pipe length in feet
Q = Exhaust flow in CFM
D = Inside diameter of pipe in inch
S = Specific weight of exhaust gas in lb / cu.ft. and will vary with the absolute temperature of exhaust gas. S = 41 / (460 + exhaust temperature in 0F)
P = Back pressure in psi. Must not exceed max.allowable back pressure

L - feet	257
Q - CFM	15272.90
D - inch	**20.0**
Exhaust Temperature - ^0F	801
S - lb per cu.ft.	0.033
P - psi	0.118

Pipes, flexibles and bends back pressure - kPa	0.81
Silencer back pressure (Considered)	3.4
Y piece portion back pressure	0.6
Total Back Pressure - kPa	**4.8**
Max.Permissible Back Pressure - kPa	6.8
Cushion for back pressure - kPa	**2.0**
Velocity Through Exhaust pipe	**35.6**
Permissible velocity = 40 m/s (Max)	

Exhaust System P&ID Scheme

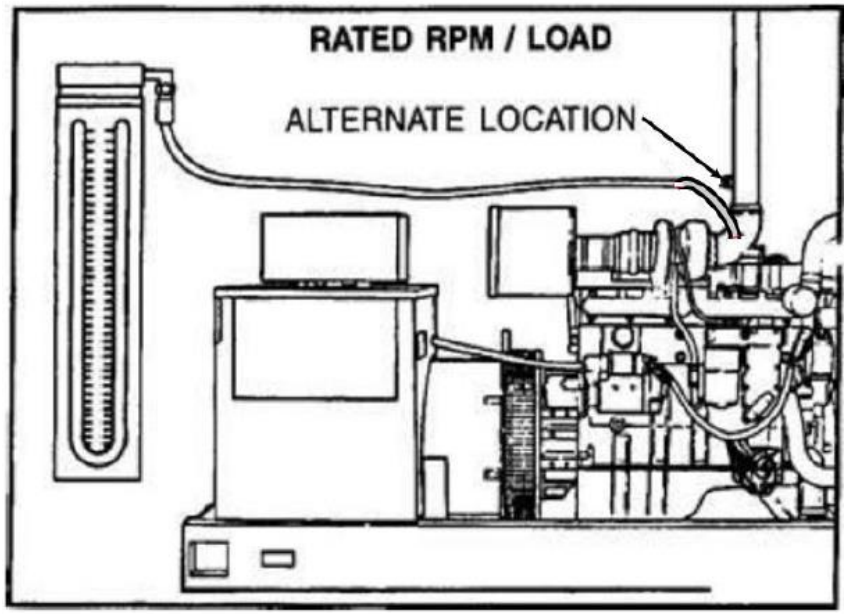


Affects of Exhaust System High back pressure

High exhaust system back pressure may lead to,

- Lower fuel economy,
- High exhaust gas temperature & higher thermal loading of engine combustion chamber related components,
- Poor performance of engine- engine derate,
- Less durability,

Exhaust gas backpressure measurement Scheme



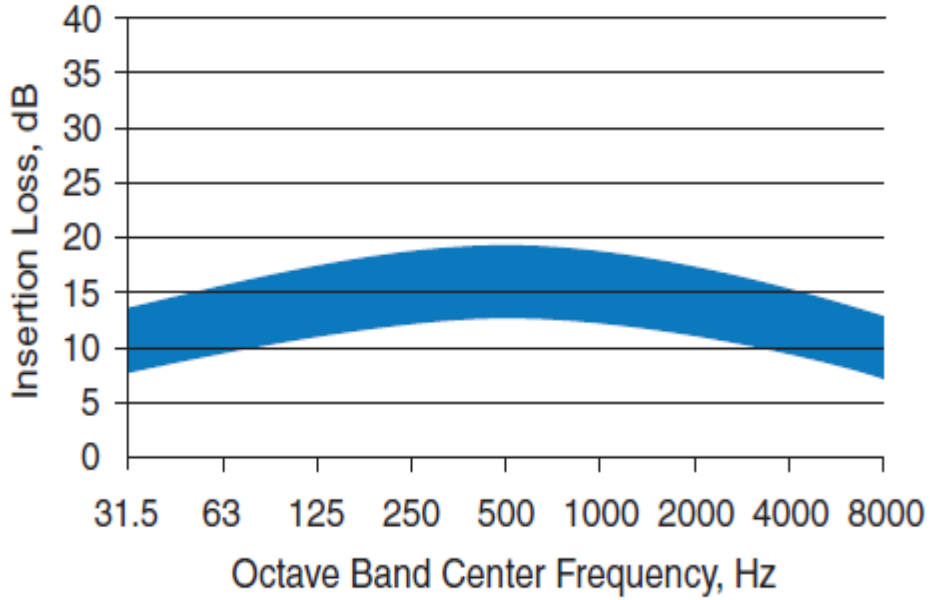
Exhaust gas silencers

- Exhaust gas silencers can be used single module per DG set or two no. per set (one for each bank),
- Considering the estimated attenuation, following type of silencers can be worked out,

  - Industrial Grade (12-18 DBA),
  - Residential Grade (18-25 DBA),
  - Critical Grade (25-35 DBA),
  - Hospital Grade (35-42 DBA)

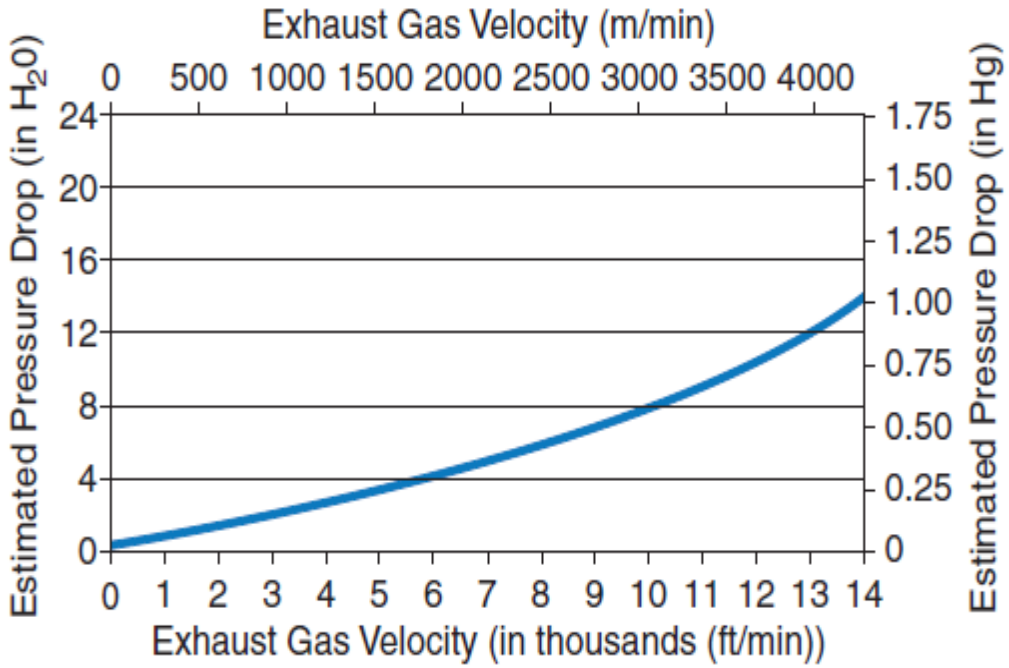
Industrial Grade silencer

Typical Attenuation Curves

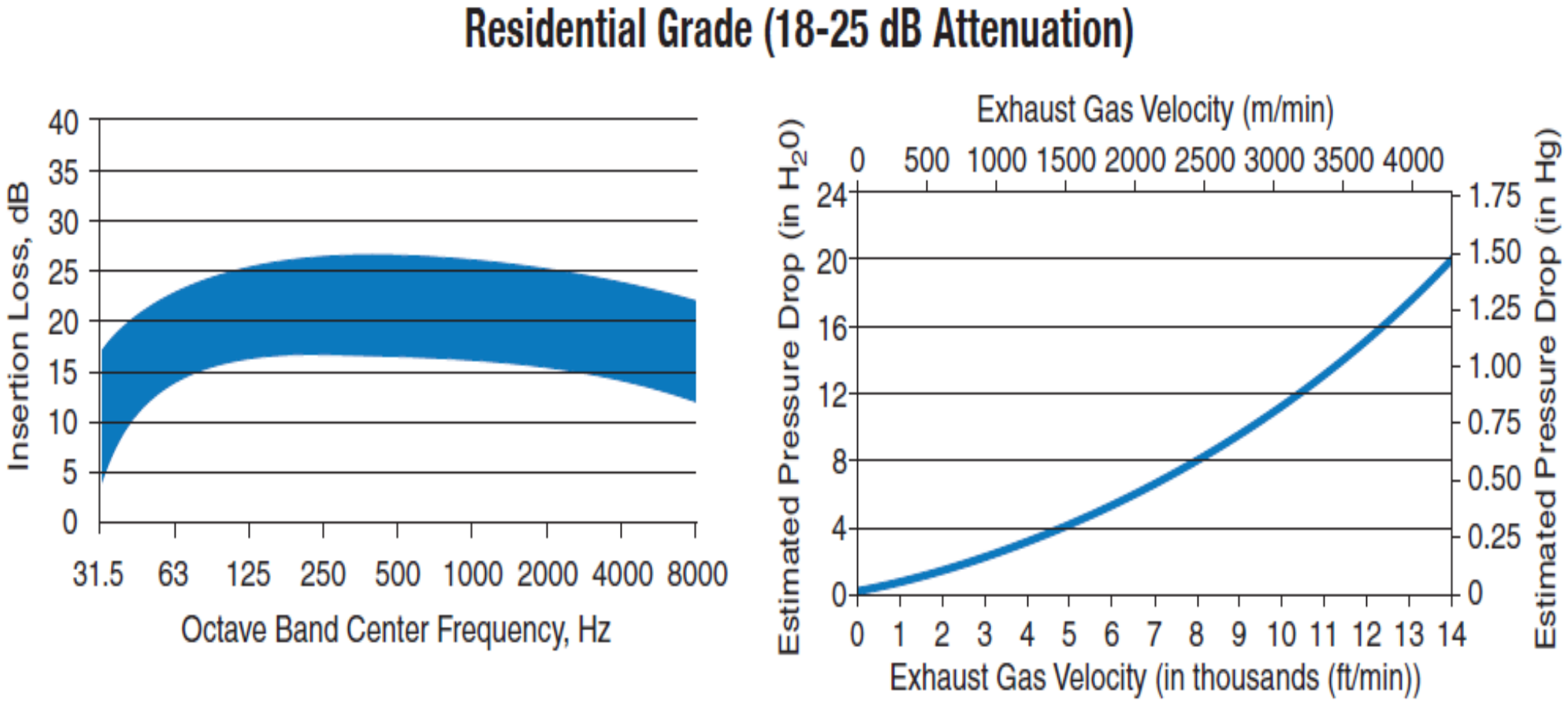


Typical Pressure Drop Curves

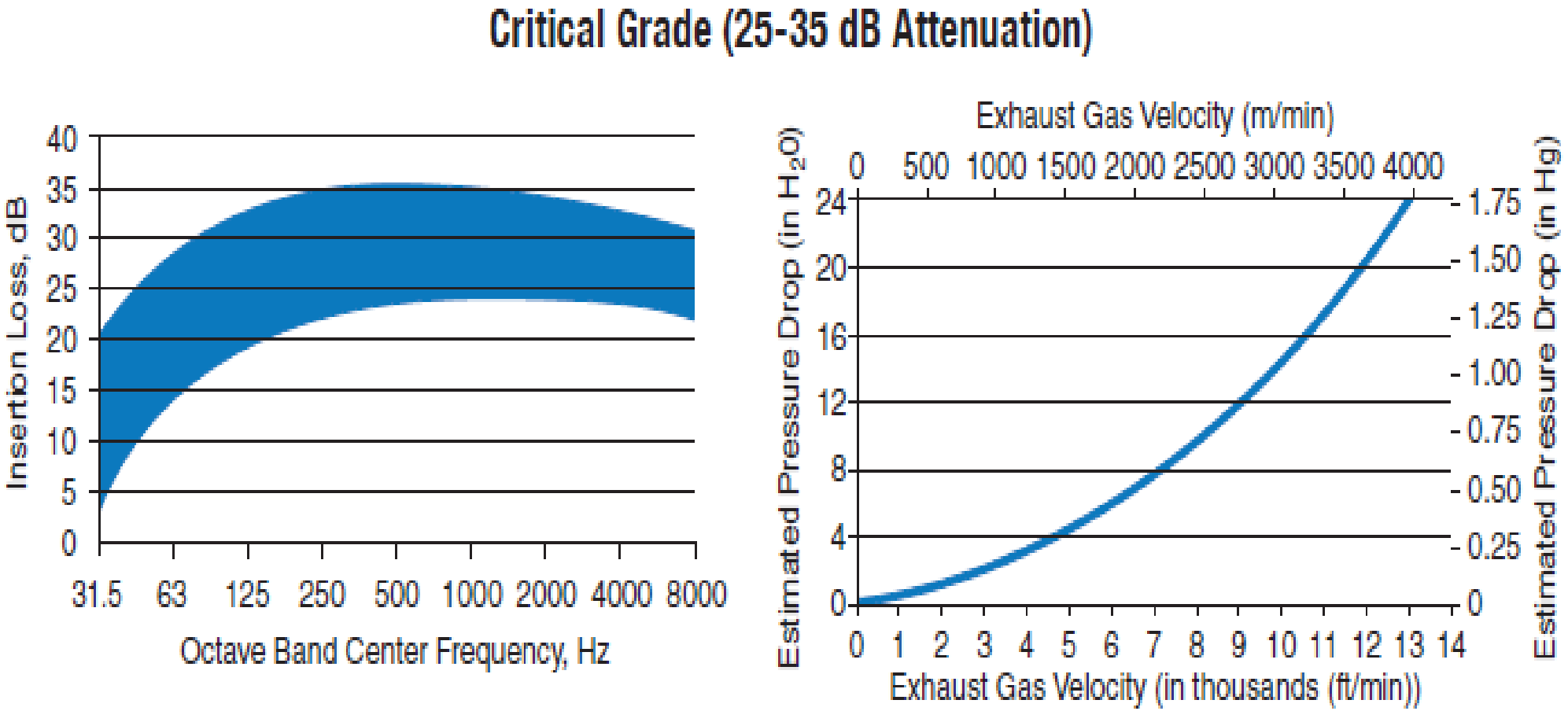
Industrial Grade (12-18 dB Attenuation)



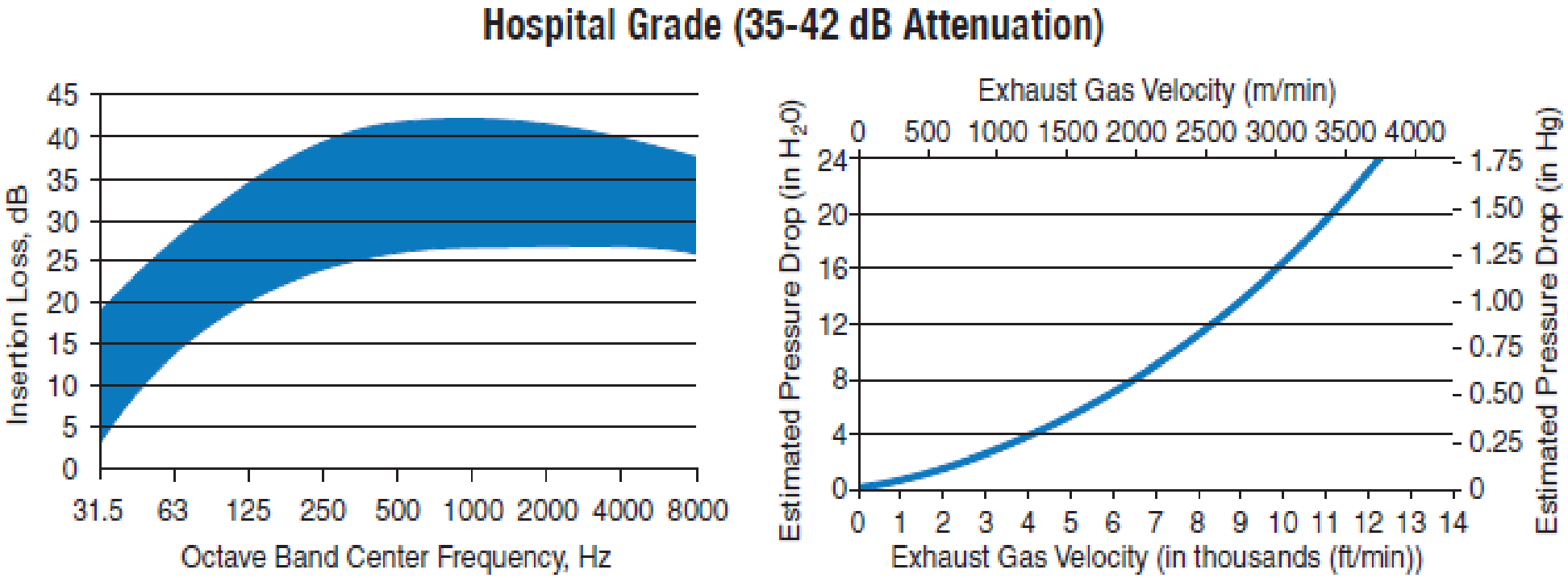
Residential Grade silencer



Critical Grade Silencer



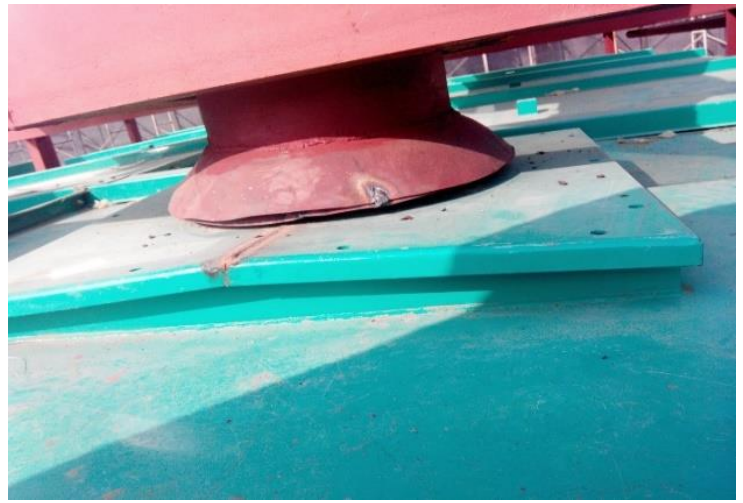
Hospital Grade Silencer



Rain Water Entry Protection

Following care to be taken during assembly of acoustic enclosure at site,

- Proper sealing at doors and foundation level.
- Rain protection cover for exhaust ducts terminated from enclosure,
- Condensate drain point of 1” diameter pipe needs to be provided in exhaust horizontal ducting, after silencer location, at lowest point to drain condensate water.
- Exhaust ducting should have downward slope away from engine at 1:200,



Flexible Bellow Alignment Check after Turbocharger

- Exhaust bellow after turbochargers alignment to be checked after installation, should be within 3mm in both axis.
- Blanking plate need to be removed before DG set start up.
- Check exhaust port after turbo for entry of any foreign material like welding rods, steel pieces etc. entered during site fabrication work.
- Check for installation of suitable gasket for bellow fitment (Metallic type, 3mm thick- ring gasket),

Flexible bellow selection in exhaust system

- Exhaust duct is subjected to thermal expansion when operating temperature rises from ambient to +400 Deg.C. About 3.7mm thermal expansion is estimated per meter of duct.
- Metallic flexible bellow needs to be provided in horizontal duct laid as per thermal expansion estimation & bellow design parameters.
- Exhaust bellow needs to be selected on the basis of following parameters,

- Design temperature (about 550 to 600 Deg.C)

- Design pressure (about 1 bar)

- Axial expansion (30 to 50mm)

- Radial expansion (10mm)

Thermal Insulation for Exhaust duct

- Exhaust duct thermal insulation details are given below,

- Rockwool slab of thickness- 50mm,

- Rockwool density- 64 to 100 Kg/m3,

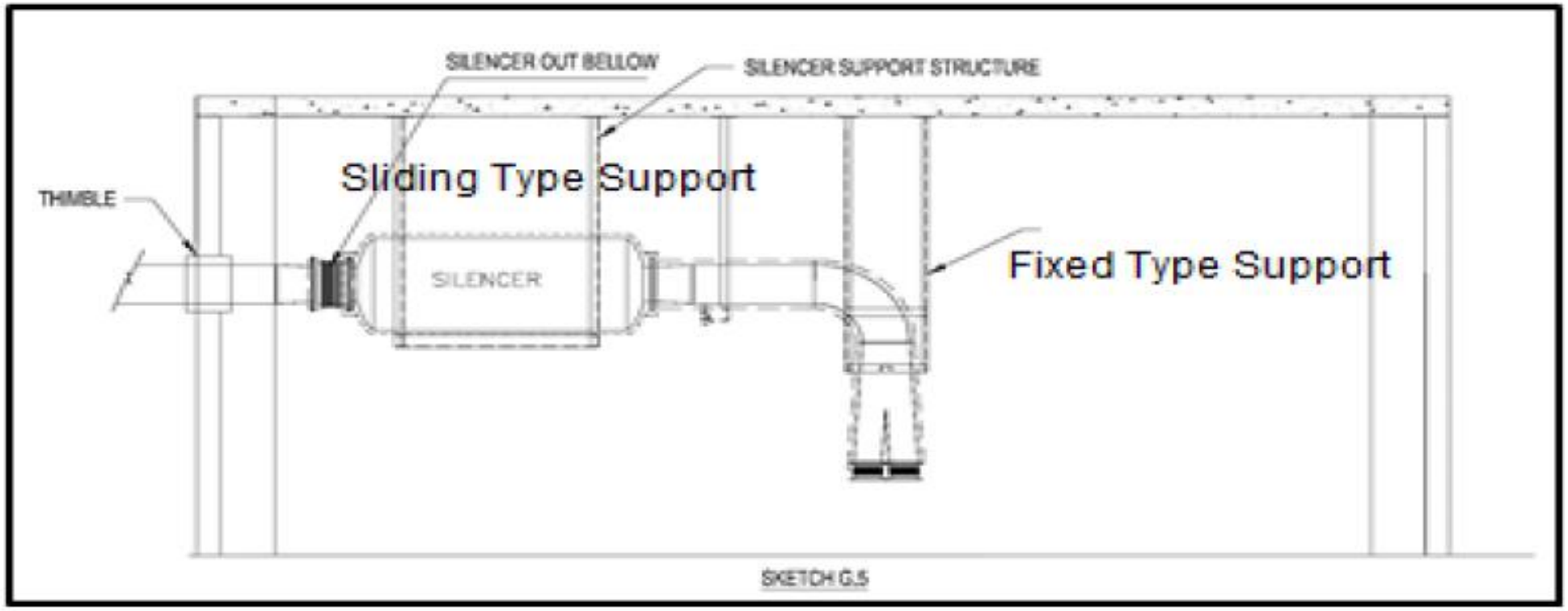
- Aluminium cladding- 24 to 26 SWG,

Estimated surface temperature with above thermal insulation will be about 70 to 80 Deg.C depending upon room ventilation effectiveness.

Estimated heat dissipation from thermally insulated duct will be about 1KW per meter length.

Supports for Exhaust ducts

- First support for exhaust ducting after turbocharger outlet should be fixed type.
- All other supports in exhaust ducting should be sliding type (Shoe support),



Exhaust Stack

- Exhaust stack diameter needs to be worked out on back pressure & gas exit velocity considerations.
- Exhaust stack types-
  - Self supported type,
  - Structurally supported type,
- Individual exhaust stack pipe is recommended for each DG set.
- Lighting protection & twin type aviation lamp needs to be provided at stack top most elevation,
- Two earthing pits with two earthing strips connections to be provided for stack.

Exhaust Stack Height considerations

- For CPCB-II DG Set products, stack height guidelines is as follows,

  $H = h + 0.2 \times \sqrt{kVA}$

  Where H = height of exhaust stack h = height of building.

- For 800 KW + DG Sets,

  $H = h + 0.2 \times \sqrt{kVA}$

  Where H = height of exhaust stack h = height of building.

Or 30m

Note- Stack height to be considered which is maximum of above aspects.

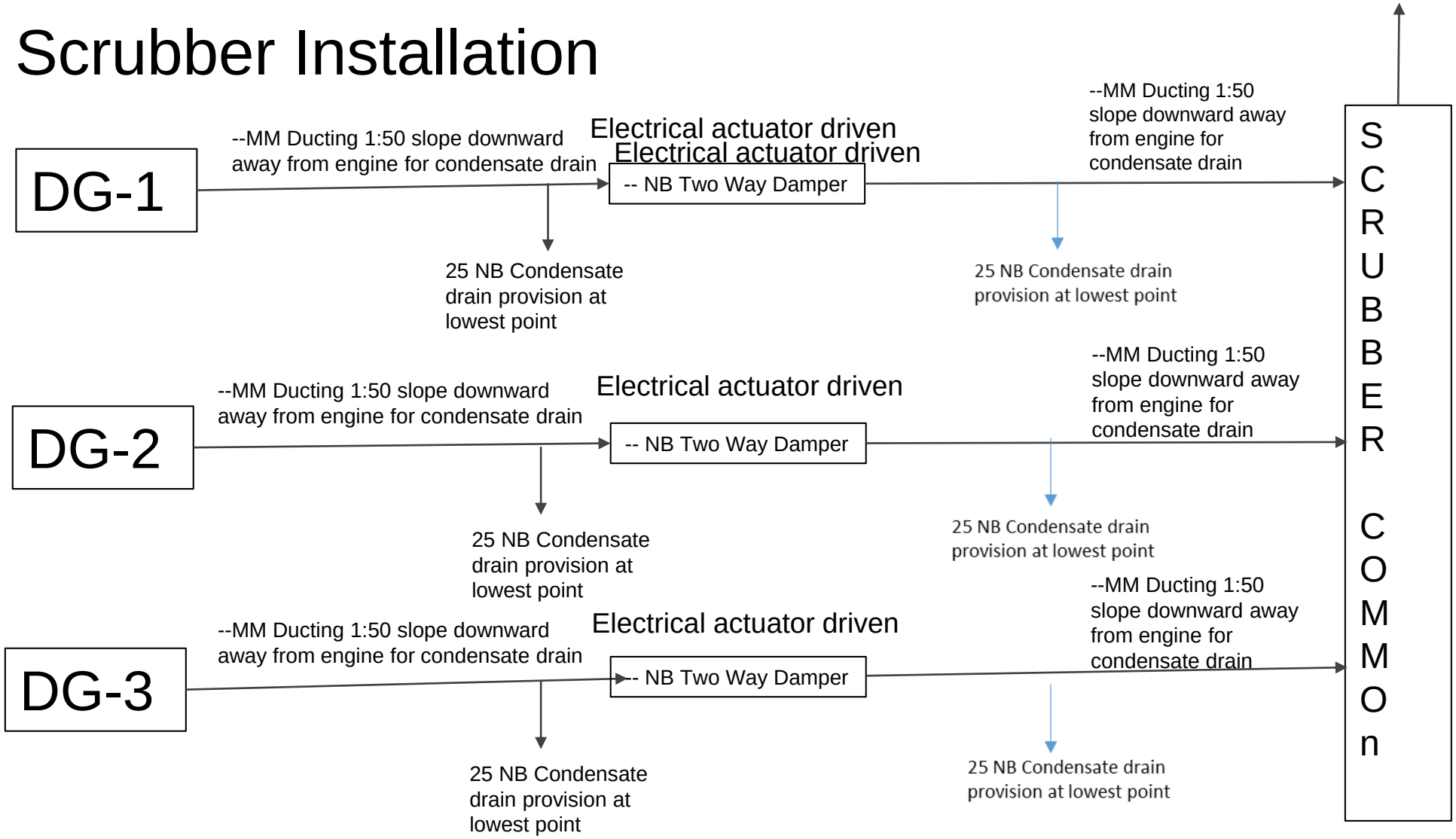
Common stack for two DG sets- Case specific

i. Individual DG set exhaust duct diameter to be selected as per back pressure and exhaust velocity criteria.
ii. DG set duct entry to stack should be at an angle of 45 deg. max (w.r.t. vertical stack pipe)
iii. There should be about 1.5 meter space between two duct nozzles connected to vertical stack.
iv. DG Set duct should be protruded in the vertical stack by about 25mm.
v. Condensate drain point should be provided for each DG set horizontal duct laid at bottom most point before stack entry.
vi. Stack pipe diameter to be selected as per back pressure and exhaust gas velocity considering all connected DG sets in operation.
vii. The exhaust pipe laid horizontally from engine outlet to stack inlet should be with downward slope away from engine at the ratio of 1:50

Common Wet Scrubber Installation- Case specific

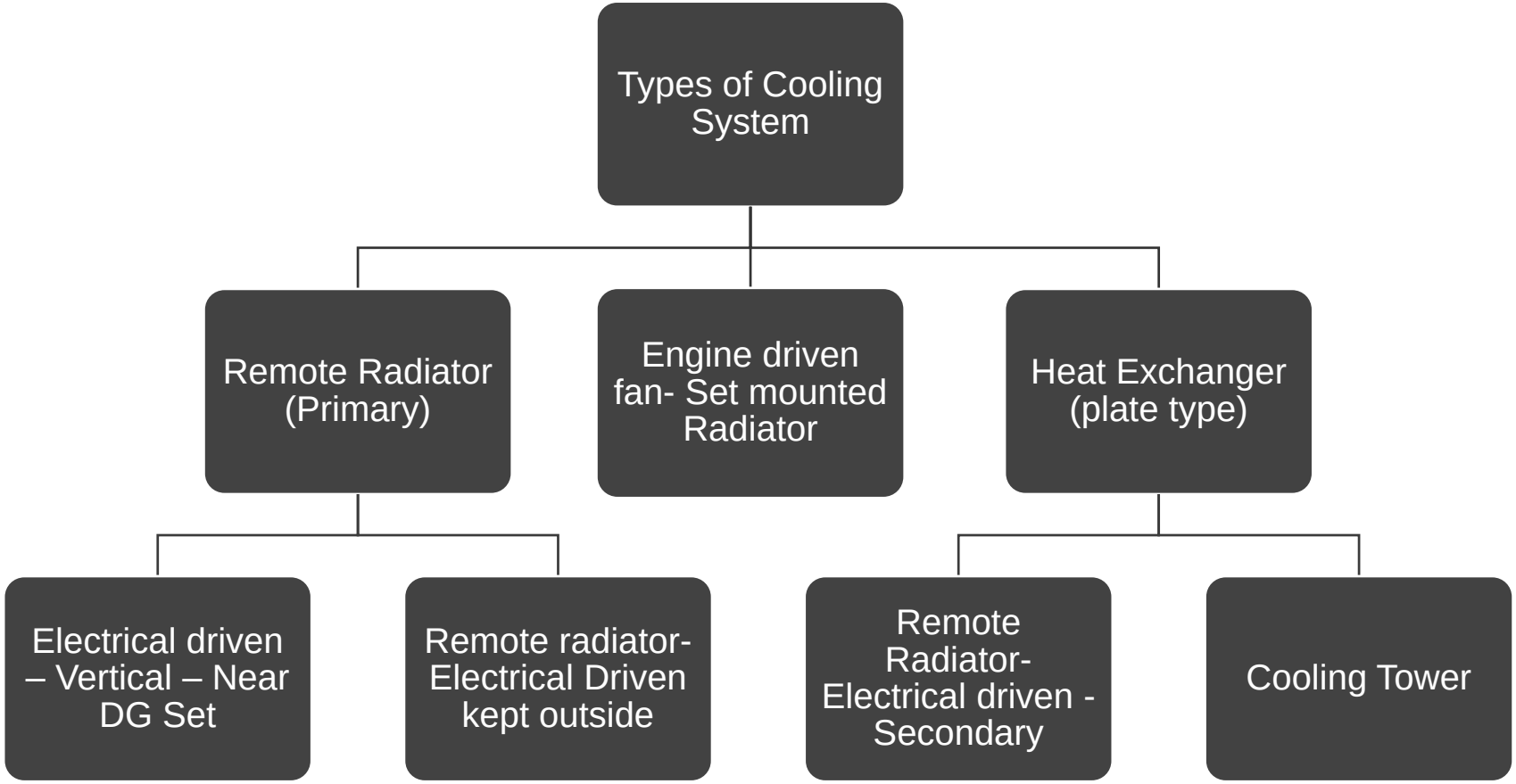
I. Exhaust back pressure is within the engine prescribed limits including the scrubber back pressure design data.
II. Individual DG set exhaust duct diameter to be selected as per back pressure and exhaust velocity criteria.
III. Motorized two way diverter damper to be provided for each DG set duct, before entry to scrubber with flexible joint at scrubber inlet nozzle. Necessary interlock to be provided for diverter damper closing in case of particular engine/DG set is idle & other sets are in operation.
IV. The exhaust pipe laid horizontally at scrubber inlet should be with downward slope towards scrubber inlet at ratio 1:50
V. Condensate drain point should be provided for each DG set horizontal duct laid at scrubber inlet to drain condensate formed in the duct.
VI. The maintenance of the scrubber needs to be carried as per the recommendations of the manufacturer.
VII. Necessary water treatment plant to be provided as per scrubber manufacturer or statutory requirement before disposal.

Scrubber Installation



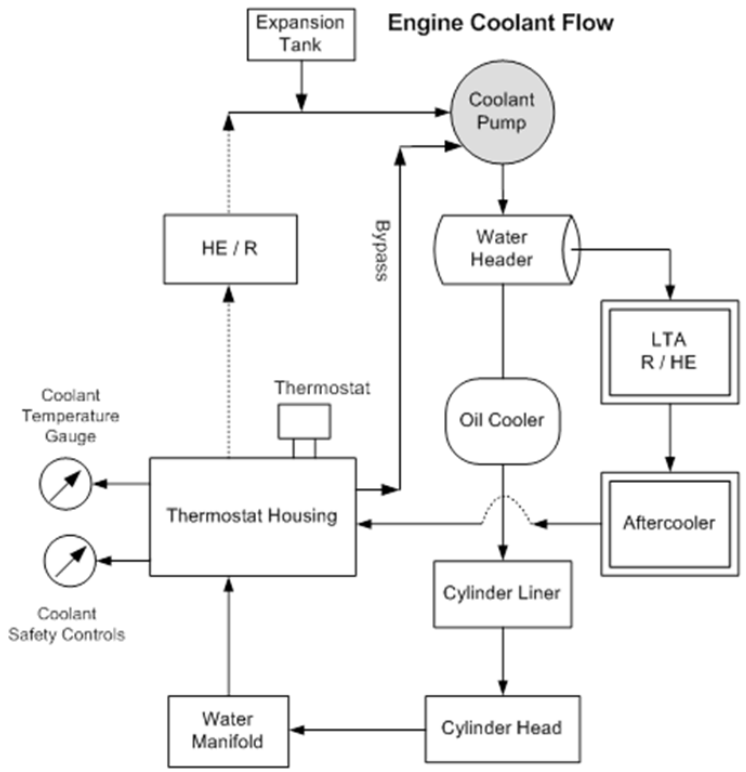
6. Cooling System

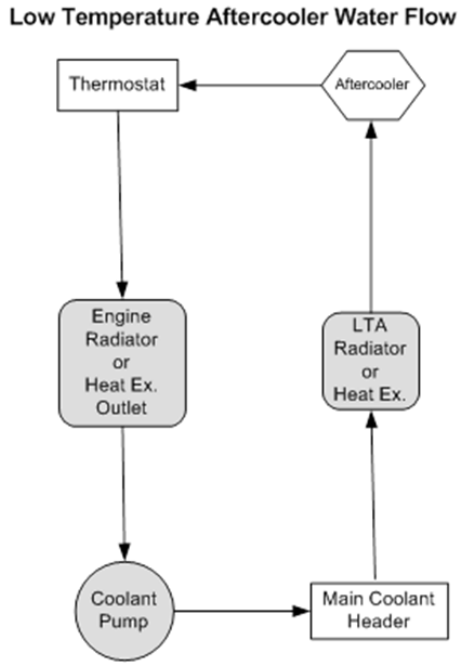
Different Types of Cooling System



One Pump Two Loop Cooling Systems (1P2L)

- Two cooling circuits within the engine, two radiator cores but only **one coolant pump**.

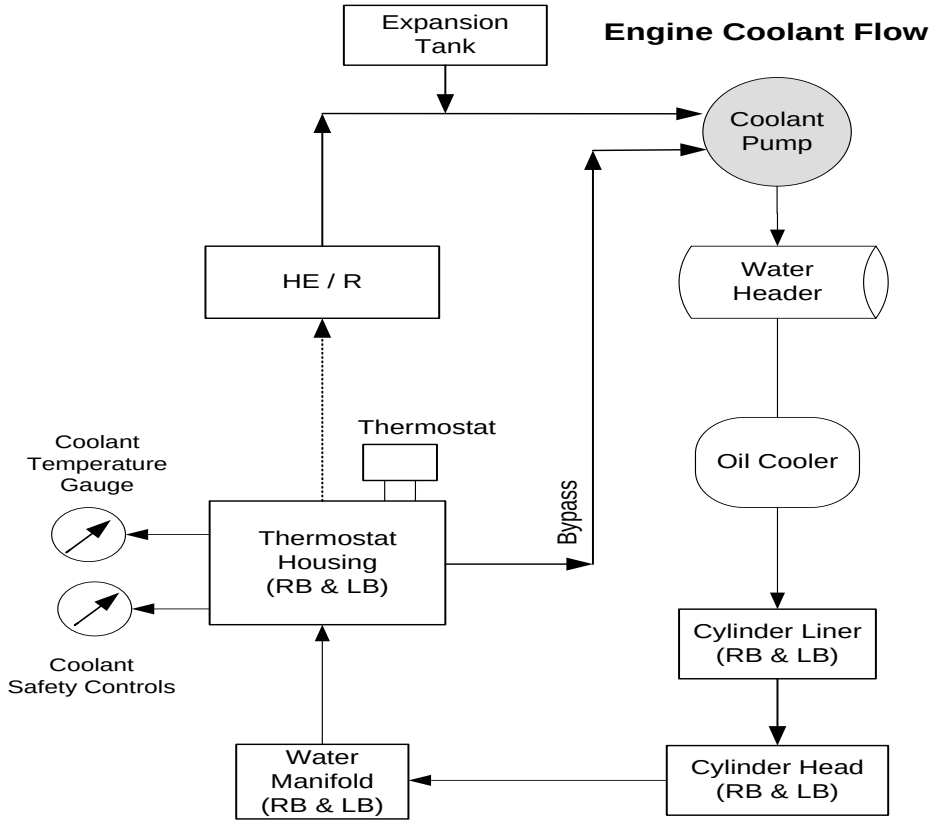


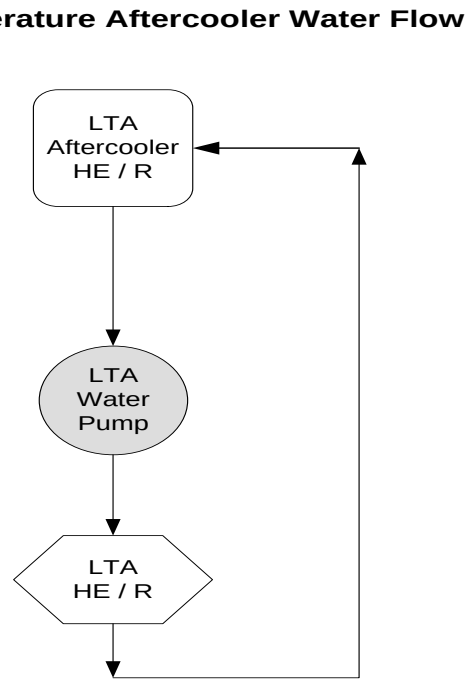


Cummins India Limited Marketing Department	KTA19-G9 - Coolant Flow Diagram
	Revision : 00- August 2004

Two Pump Two Loop Cooling Systems (2P2L)

QSK60 - G3 / G4 - Coolant Flow Diagrams





Cummins India Limited Marketing Department	**QSK60 - G3 / G4 - Coolant Flow Diagram** Revision : 00- August 2004

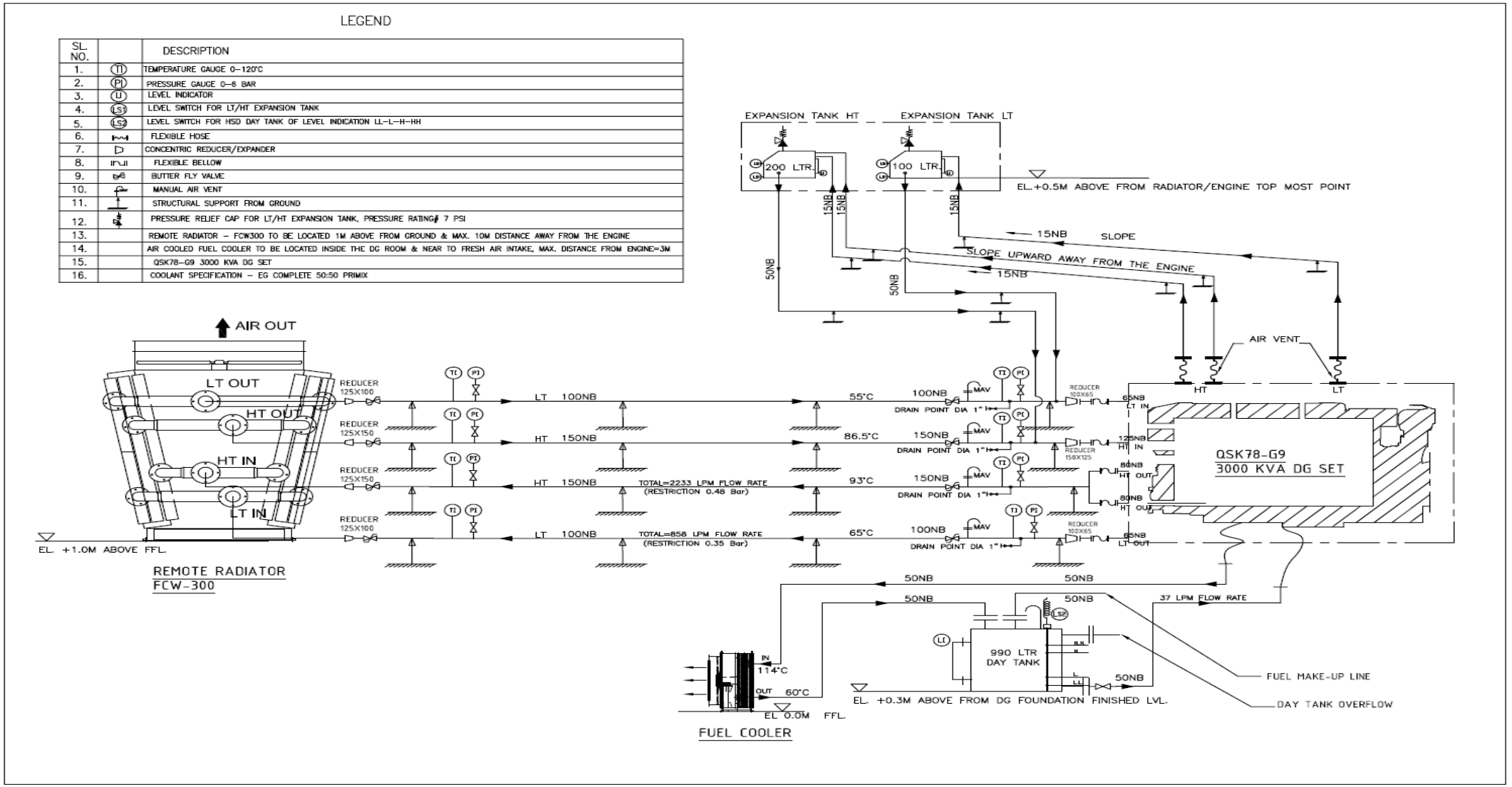
Engine coolant composition

X1.3/X2.7/X3.6/4B3.3/4B3.9/6B5.9/QSB5.9/QSB6.7/L8.9/ QSL9/ QSN14/KTAA19/QSK19/K38-G12&17/QSK50/ QSK60/QSK78/QSK95	Premix Ethylene Glycol (EG compleat 50:50)
KTA38-G5/KTA50-G3/KTA50-G8I	CAC Premixed (DCA2)

Considerations for Remote radiator in primary circuit

- Maximum permissible elevation from DG foundation- 5m.
- Maximum distance of radiator from DG set – 10m,
- Permissible pressure drop in engine external cooling circuit,
- Cooling system pipe diameter to be calculated considering flow rate & pressure drop limit,
- Radiator to be installed at 1m elevation from finish floor level to minimize duct carry over on radiator core,
- Expansion tank to be installed at 0.5 m minimum above cooling system topmost area,
- Isolation valves, gauges, venting provision, drain valve to be provided as per system P&ID scheme.

Remote Radiator in Primary circuit- P&ID



Cooling Pipe Diameter Selection

Cooling system piping selection for QSK78 G9 DG set - NMDC Project

Date : 15.03.17

1 LT Circuit (Pipe Size 100 NB)

Sr No	Pressure loss description	Quantity	Unit	Unit Pressure drop Bar	Total Pressure drop Bar	Remark
1	Remote Radiator LT Circuit	1	No	0.1	0.1	Kindly confirm radiator pressure drop whithin 0.1 bar (1mWC)
2	Straigh Piping Pressure Loss-with pipe size 100NB	14	M	0.004285714	0.060	
3	90 Deg Bends	10	No	0.01	0.1	
4	B/F Valve	4	No	0.008	0.032	
5	Flexible Bellows	2	No	0.002	0.004	
6	Vertical Head	1	M	0	0	
7	Design margin		M		0.0444	
Total Estimated Pressure drop		**Bar**	**Bar**		**0.3404**	**Engine permissible limit as per as per engine data sheet is 0.35 Bar**

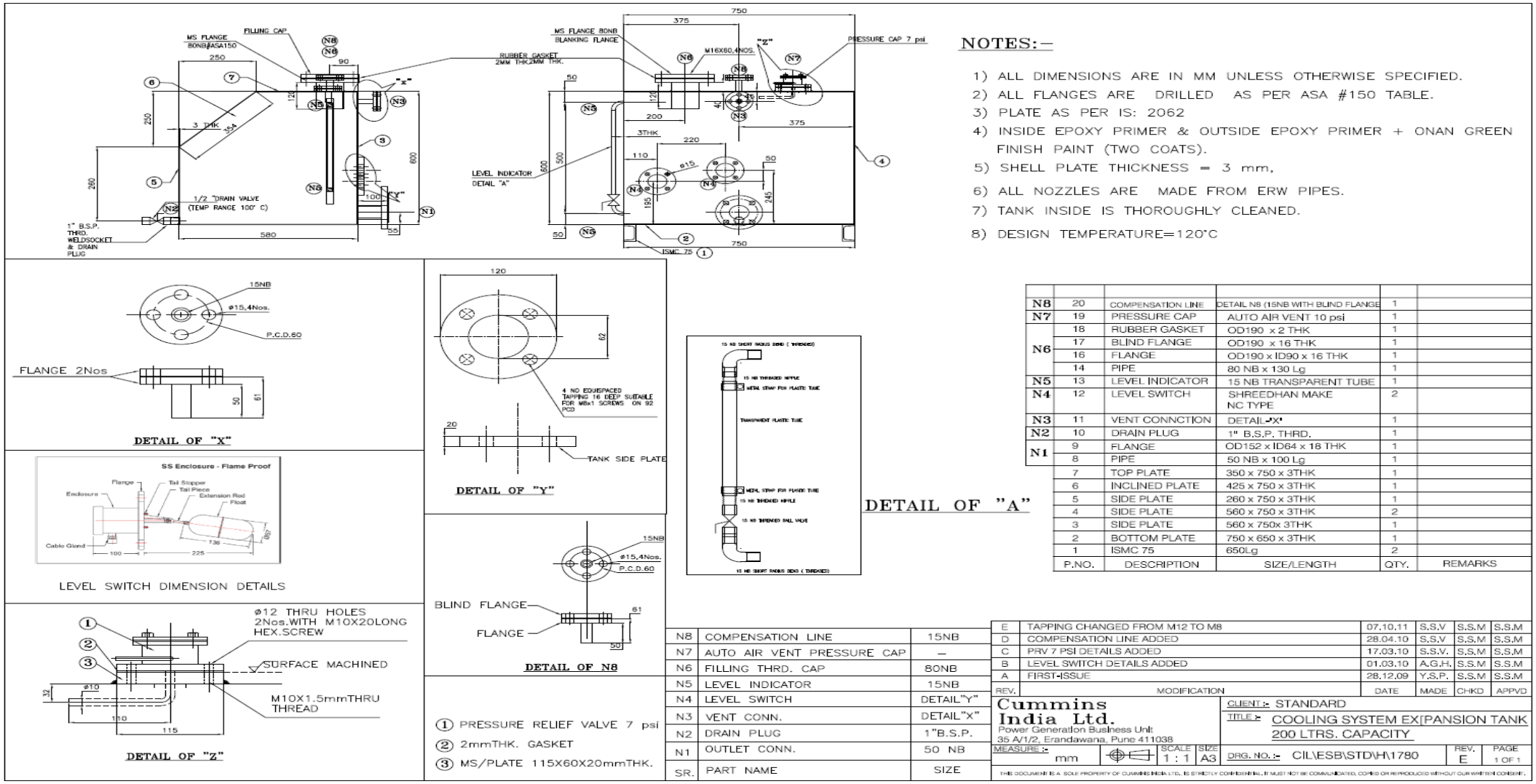
Cooling System Expansion Tank Capacity Calculations

HT-Total Tank Volume For different Types of Tanks		HT-Total Volume
Vtotal= K Vsystem (Den. Cold Temp./ Dens.High Temp.) - 1]		
Total volume of the HT-open tank of 50%water& Glycol		192.1
Vtotal= KVsystem[(Den. Cold Temp./ Dens.High Temp.) - 1] / [1 - (Pinitial/Pmax]		
Total volume of the HT- Diaphragm tank of 50%water& Glycol		252.5
Vtotal= K Vsystem (Den. Cold Temp./ Dens.High Temp.) - 1] / [(Patmo / Pinitial) - (Patmo/ Pmax)]		
Total volume of the HT-closed tank of 50%water& Glycol		261.0

LT-Total Tank Volume For different Types of Tanks		LT-Total Volume
Vtotal= K Vsystem (Den. Cold Temp./ Dens.High Temp.) - 1]		
Total volume of the open tank of 50%water& Glycol		70.2
Vtotal= KVsystem[(Den. Cold Temp./ Dens.High Temp.) - 1] / [1 - (Pinitial/Pmax]		
Total volume of the Diaphragm tank of 50%water& Glycol		92.3
Vtotal= K Vsystem (Den. Cold Temp./ Dens.High Temp.) - 1] / [(Patmo / Pinitial) - (Patmo/ Pmax)]		
Total volume of the closed tank of 50%water& Glycol		95.4

Tank selection table		
Tank Capacity by System Expansion Volume Calculation (Lit)	**Circuit**	**Selected Capacity of tanks (Lit)**
192.1	HT Circuit Tank	200
70.2	LT Circuit Tank	100

Cooling System Expansion Tank-



NOTES:—

1) ALL DIMENSIONS ARE IN MM UNLESS OTHERWISE SPECIFIED.
2) ALL FLANGES ARE DRILLED AS PER ASA #150 TABLE.
3) PLATE AS PER IS: 2062
4) INSIDE EPOXY PRIMER & OUTSIDE EPOXY PRIMER + ONAN GREEN FINISH PAINT (TWO COATS).
5) SHELL PLATE THICKNESS = 3 mm.
6) ALL NOZZLES ARE MADE FROM ERW PIPES.
7) TANK INSIDE IS THOROUGHLY CLEANED.
8) DESIGN TEMPERATURE=120°C

P.NO.		DESCRIPTION	SIZE/LENGTH	QTY.	REMARKS
N8	20	COMPENSATION LINE	DETAIL N8 (15NB WITH BLIND FLANGE	1	
N7	19	PRESSURE CAP	AUTO AIR VENT 10 psi	1	
N6	18	RUBBER GASKET	OD190 x 2 THK	1	
	17	BLIND FLANGE	OD190 x 16 THK	1	
	16	FLANGE	OD190 x ID90 x 16 THK	1	
	14	PIPE	80 NB x 130 Lg	1	
N5	13	LEVEL INDICATOR	15 NB TRANSPARENT TUBE	1	
N4	12	LEVEL SWITCH	SHREEDHAN MAKE NC TYPE	2	
N3	11	VENT CONNCTION	DETAIL-"X"	1	
N2	10	DRAIN PLUG	1" B.S.P. THRD.	1	
N1	9	FLANGE	OD152 x ID64 x 18 THK	1	
	8	PIPE	50 NB x 100 Lg	1	
	7	TOP PLATE	350 x 750 x 3THK	1	
	6	INCLINED PLATE	425 x 750 x 3THK	1	
	5	SIDE PLATE	260 x 750 x 3THK	1	
	4	SIDE PLATE	560 x 750 x 3THK	2	
	3	SIDE PLATE	560 x 750x 3THK	1	
	2	BOTTOM PLATE	750 x 650 x 3THK	1	
	1	ISMC 75	650Lg	2	

SR.	PART NAME	SIZE
N8	COMPENSATION LINE	15NB
N7	AUTO AIR VENT PRESSURE CAP	—
N6	FILLING THRD. CAP	80NB
N5	LEVEL INDICATOR	15NB
N4	LEVEL SWITCH	DETAIL"Y"
N3	VENT CONN.	DETAIL"X"
N2	DRAIN PLUG	1"B.S.P.
N1	OUTLET CONN.	50 NB

① PRESSURE RELIEF VALVE 7 psi
② 2mmTHK. GASKET
③ MS/PLATE 115X60X20mmTHK.

REV.	MODIFICATION	DATE	MADE	CHKD	APPVD
E	TAPPING CHANGED FROM M12 TO M8	07.10.11	S.S.V	S.S.M	S.S.M
D	COMPENSATION LINE ADDED	28.04.10	S.S.V	S.S.M	S.S.M
C	PRV 7 PSI DETAILS ADDED	17.03.10	S.S.V.	S.S.M	S.S.M
B	LEVEL SWITCH DETAILS ADDED	01.03.10	A.G.H.	S.S.M	S.S.M
A	FIRST-ISSUE	28.12.09	Y.S.P.	S.S.M	S.S.M

Cummins India Ltd.
Power Generation Business Unit
35 A/1/2, Erandawana, Pune 411038

CLIENT :- STANDARD
TITLE :- COOLING SYSTEM EXPANSION TANK 200 LTRS. CAPACITY
MEASURE :- mm | SCALE 1 : 1 | SIZE A3
DRG. NO. :- CIL\ESB\STD\H\1780 | REV. E | PAGE 1 OF 1

Radiator Selection Guide- Primary circuit

Design Ambient Temp deg Cent		45	45	45	45	45	45
Engine Model		KTA-38	KTA-50-G3	KTA-50G8-I	QSK50G10	QSK60G4	QSK60G8
Genset Rating in kVA	Details	1010 (PRP)	1250 (PRP)	1500 (PRP)	1800 (HE) (PRP)	2000(PRP)	2500 (ESP)
Radiator Selection Parameters- Primary							
LTA	Coolant spcification	CAC (DCA2) (Mixing ratio of 1:15 with recommend quality water)			EG Compleat 50:50		
	Primary Circuit Permissible Pressure Drop- KPa	20	1P2L System, 775 KW heat load is common for LTA & HTA	20	20	20	20
	Design Temp- Deg Cent.	120		120	120	120	120
	Make-up /Expansion Tank Capacity in lits	100		100	125	125	125
	LTA OUT from Engine Temp Deg C	69.3		77.1	73.38	77.75	81
	LTA IN to Engine Temp Deg C	62		62	62	61.8	62
	LTA Coolant flow rate (lps)	6		6	7.6	6.9	6.9
	Heat Load - KW	170		378	394	455	545
	Noise @ 10 m distance -dBA	75		75	75	75	75
HTA	Coolant specification	CAC (DCA2) (Mixing ratio of 1:15 with recommended quality water)			EG Compleat 50:50		
	Primary Circuit Permissible Pressure Drop- KPa	30	30	30	30	30	30
	Design Temp- Deg Cent.	120	120	120	120	120	120
	Make-up /Expansion Tank Capacity in lits	100	100	100	125	125	125
	HT Outlet from Engine Temp Deg C.	93	77.34	93	93	93	93
	HT IN to Engine Temp Deg C.	88.41	70	87.9	87.61	88	86.80
	HT Coolant Flow Rate (lps)	17.7	25.2	25.2	26.25	24	24
	Heat Load - in KW	340	775	536	592	500	620
Remote Radiator - Design Pressure-	Bar (g)	6	6	6	6	6	6
Remote Radiator - Test Pressure-	Bar (g)	21	21	21	21	21	21
Selected Remote Radiator Model (Coil Company make) in Primary Cooling Circuit.		FCW100	FCW120	FCW140	FCW180	FCW200	FCW220
Configuration		LT+HT	Common	LT+HT	LT+HT	LT+HT	LT+HT
Selected Fuel Cooler Model (Coil Company make)in Primary Cooling circuit		N/A	N/A	N/A	FCS36H48	FCS36H48	FCS36H48
Fuel cooler Heat Load	KW	N/A	N/A	N/A	9	35	35
Fuel Flow Rate	LPM	N/A	N/A	N/A	15	32	25

Considerations for Remote Radiator in Secondary Circuit

- Maximum permissible elevation from DG foundation- As per site requirement,
- Maximum distance of radiator from DG set – As per site requirement,
- Permissible pressure drop in engine external cooling circuit- Water circulation Pump head to be selected as per site requirement,
- Cooling system pipe diameter to be calculated considering flow rate & pressure drop limit,
- Radiator to be installed at 1m elevation from finish floor level to minimize duct carry over on radiator core,
- Make up tank of capacity 500 litre to be installed at 0.5 m minimum above radiator,
- Isolation valves, gauges, venting provision, drain valve to be provided as per system P&ID scheme.
- Radiator selected with @ 8-10 Deg. C approach temperature & @10 Deg. C delta T.

Radiator Selection Guide- Secondary circuit

Design Ambient Temp deg Cent		45	45	45	45	45	45
Engine Model		KTA-38	KTA-50-G3	KTA-50G8-I	QSK50G10	QSK60G4	QSK60G8
Genset Rating in kVA	Details	1010 (PRP)	1250 (PRP)	1500 (PRP)	1800 (HE) (PRP)	2000(PRP)	2500 (ESP)
Delta T		8.2	12.5	14.8	8.3	8.11	9.89
	PHE Model LTA	GX04X39	GX04X39	GX04X39	GC-26X44	GC-26X44	GC-26X44
	PHE Model- HT	GC26X26	GC26X26	GC26X26	GC26X26	GC26X26	GC26X26
	PHE Model- Fuel	N/A	N/A	N/A	GC-008X32	GC-008X32	GC-008X32
Delta P Cold side (kPA)- LTA+HT	kPA	109	109	109	125	125	125
Delta P HOT side (kPA) LTA	kPA	15	15	15	6	6	6
Delta P HOT side (kPA) HT	kPA	50	50	50	50	50	50
Radiator Selection Parameters- Secondary							
Design Ambient Temp deg Cent		45	45	45	45	45	45
Secondary Circuit	Coolant specification	Potable water					
	Secondary Circuit Permissible Pressure Drop- KPa	50	Not applicable	Not applicable	50	50	50
	Design Temp- Deg Cent.	120			120	120	120
	Make-up Tank Capacity in lits for top-up	500			500	500	500
	Raw Water In Temp deg C	66.12			66.23	65.97	67.72
	Raw Water out Temp deg C	58			58	58	58
	Cooling water flow rate (lps)	15			28.6	28.63	28.63
	Heat Load - KW	510			986	955	1165
Remote Radiator - Design Pressure-	Bar (g)	6			6	6	6
Remote Radiator - Test Pressure-	Bar (g)	21			21	21	21
Selected Remote Radiator Model (Coil company Make)		FCW120			FCW240	FCW240	FCW260
Estimated Cooling water pump head selection	m (to be calculated as per site layout scheme requirement)	24			24	24	24

Considerations for Cooling tower in Secondary Circuit

- Cooling water consumption at cooling tower will be about 1.6% to 2.0% of water circulation flow rate across cooling tower.
- Make up water quality parameters to be maintained as

  per guideline,
- If cooling water properties are beyond limits, it may result in,

  - Scale formation in PHE,
  - Overheating of engine may lead to tripping,
  - Corrosion

Water Properties	
Hardness as CaCO3	170 ppm max
pH - Raw water-Engine water	8.5-7.5 5.0-9.0
Chlorides	40 ppm max
TDS	400 ppm max
Sulphates	100 ppm max

Cooling Tower Selection Guide- Secondary circuit

Design Ambient Temp deg Cent		45	45	45	45	45	45
Engine Model		KTA-38	KTA-50-G3	KTA-50G8-I	QSK50G10	QSK60G4	QSK60G8
Genset Rating in kVA	Details	1010 (PRP)	1250 (PRP)	1500 (PRP)	1800 (HE) (PRP)	2000(PRP)	2500 (ESP)
Delta T		8.2	12.5	14.8	8.3	8.11	9.89
PHE Selection Parameters							
PHE - Operating Pressure-	Bar (g)	10	10	10	10	10	10
PHE - Design Pressure-	Bar (g)	13	13	13	13	13	13
PHE - Test Pressure-	Bar (g)	16	16	16	16	16	16
	PHE Model LTA	GX04X39	GX04X39	GX04X39	GC-26X44	GC-26X44	GC-26X44
	PHE Model- HT	GC26X26	GC26X26	GC26X26	GC26X26	GC26X26	GC26X26
	PHE Model- Fuel	N/A	N/A	N/A	GC-008X32	GC-008X32	GC-008X32
Cooling Tower Selection Parameters- Secondary							
Design Temp deg Cent (WBT)		28	28	28	28	28	28
Secondary Circuit	Coolant specification	Potable water					
	Secondary Circuit Permissible Pressure Drop- Kpa (LTA+HT PHEs)	109	109	109	125	125	125
	Raw Water In Temp deg C.	32	32	32	32	32	32
	Raw Water out Temp deg C.	40.2	44.5	46.8	40.3	40.11	41.89
	Cooling water Flow Rate (lps)	15	15	15	28.61	28.61	28.61
	Heat Load - KW	510	775	914	986	955	1165
Estimated Cooling water pump head selection	m (to be calculated as per site layout scheme requirement)	24	24	24	24	24	24
Equivalent TR - estimated		145	221	260	281	272	332

Cooling Tower Selection Guide- Secondary circuit

Secondary cooling circuit:

b) **For CPCB-II Product Range.**

Remote Radiator in Secondary cooling circuit. (Design ambient 45 Deg C)

Model	KVA rating	JW Heat Load (KW)	LTA/CAC Heat Load (KW)	Fuel HR (KW)	Total Heat Load (KW)	Raw Water flow (LPM)	Raw water in Temp	Raw water Out temp	New Revised model Secondary Circuit
KTA38G12	750/810	Current PHE is designed for Cooling Tower Only.							No Applicable.
KTAA19 G10/G11	500	210	120	N/A	330	505	55	64.34	FCW 90
QSK19 G6/G7	600/640/ 650	203	172	N/A	375	505	55	65.6	FCW 100
QSN14 G3	365/380	226.3	128	3.4	357.7	555	55	64.24	FCW 100

Note: Remote Radiator for KTTA19, QSK19 and QSN14 in Primary circuit are not applicable due to charge air coolers (CAC) option.

Low Noise Option- Site Specific Requirement

To comply site specific requirement for low noise option – remote radiator cooling, following aspects to be considered,

- Exhaust silencer to be selected as per noise attenuation requirement,
- Radiator fans to be selected with low noise option to achieve overall 75 DBA at @1m & 65 DBA at @10m (+/- 3 DBA),
- Radiator of standard option- 85 DBA at @1m & 75 DBA at @10m (+/- 3 DBA),
- DG Set acoustic enclosure to be worked out for 30 to 35 DBA insertion loss at @1m outside enclosure (CPCB Guideline is 25 DBA), Intake air louvers & hot air outlet louvers needs to be designed suitably.
- Ventilation fans used in acoustic enclosure needs to be selected for low noise option and required flow rate / static head.

Remote Radiator in Primary and in Secondary are different

Remote radiator for Primary circuit

Remote radiator for Secondary circuit

7. Ventilation System

Ventilation System- Considerations

Ventilation system is required for,

- To take out heat dissipated from DG Set (Engine & alternator),
- For 2000 KVA (QSK60-G4) dissipation heat load is,
  Engine- 175 KW + Alternator- 72= 247 KW
- To provide intake air for combustion,
- To maintain temperature rise in acoustic enclosure over ambient temperature,
- Electronic components on DG set are subjected to inside air temperature,

Ventilation System- Considerations

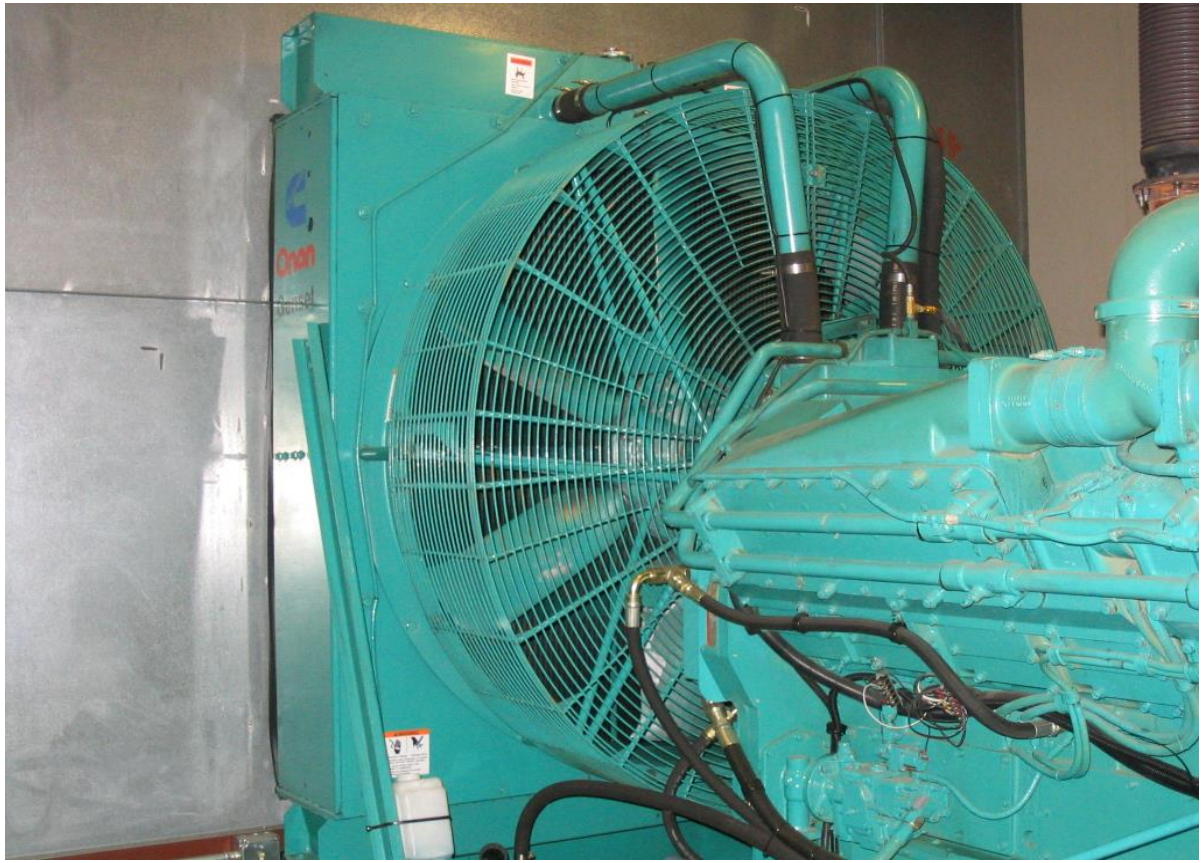
Improper ventilation leads to,

- Poor performance and reliability of genset
- Poor fuel efficiency
- Premature failures of engine, alternator and electrical components.
- Unbearable working conditions due to higher room temperatures.

Ventilation System- Considerations

DG Set mounted radiator option-

- Takes care of engine cooling & ventilation,
- Average temperature rise is about 7 to 8 Deg.C,
- For cooling system performance, air on radiator core is critical aspect,
- Intake air travels from alternator to engine & to radiator core,
- Acoustic enclosure pressure drop to be maintained within permissible limit (0.5 Inch of water column) including intake louvers & hot air outlet louvers.
- Ventilation air flow is critical to get optimum cooling system performance



Ventilation System- Considerations

DG Set with HE or remote radiator option or room installation-

- Ventilation fans need to be provided at hot air outlet area inside enclosure.
- Cooling system is independent of ventilation system,
- Ventilation fan selection aspects are,
- Radiation Heat load of DG set,
- Air flow capacity to be calculated as per permissible temperature rise over ambient (7 to 10 Deg.C),
- Fan delivery static head as per estimated pressure drop across acoustic enclosure,
- Noise level requirements,

Ventilation Air flow requirement

Engine room ventilation can be estimated by the foll owing formulas :

$$V\ (cfm) = \frac{H}{0.070 \times 0.24 \times \Delta T} + \text{Engine Combustion Air}$$

or

$$V\ (m^3/min) = \frac{H}{1.099 \times 0.017 \times \Delta T} + \text{Engine Combustion Air}$$

V = Ventilating air (cfm) (m^3/min).

H = Heat radiation (Btu/min) (kW).

ΔT = Permissible temperature rise in engine room (F) (C).

Density of air at 100F = 0.070 lb/cu ft (1.099 kg/m^3).

Specific heat of air = 0.24 btu/F(0.017 kW/C).

Assuming 38C (100F) ambient air temperture.

Ref.C.7

Power Generation

CIL/PGBU/ Air ventilation calculation/2500 kVA DG set
22nd June 2016

VENTILATION AIR QUANTITY CALCULATION FOR 2500 KVA DG SET

DG set rating-	2500 KVA, Standby
Engine Model-	QSK60-G8
Genset controller-	PCC 3201
Cooling system-	Remote radiator in primary cooling citcuit,
Enclosure-	With acoustic enclosure
Alternator frame-	LVSI804R
Customer-	M/s. Tata Communication Limited
Site-	Mumbai, India

Radiation heat load to ambient-
As per engine data sheet,

- From engine- 205.0 KW,
- From alternator- 85.0 KW
- Total (engine & alternator) - 290.0 KW

Combustion intake air flow- 5515 CFM / 2.605 m3/s

Temperature rise consideration in acoustic enclosure-
Permissible temperature rise in acoustic enclosure over ambient temperature- 7 Deg. C

Formula for ventilation air quantity calculation in m3/minute-

$$V\ m^3/min = \frac{H}{1.099 \times 0.017 \times \Delta T} + \text{Engine Combustion Air}$$

Where,

V-	Air volume in m3/min.
H-	Radiation heat load to ambient from DG set
Delta T-	Permissible temperature rise in Deg. C,

V = ((290/ (1.099 X 0.017 X 7)) + (2.605 X60)
= 2373 M3/Min.
= 39.56 m3/Sec = 83745 CFM

Conclusion-
Ventilation air quantity requirement for each 2500 KVA DG set- 83745 CFM

Ventilation system- Considerations

DG Set in room area-

- Effective opening at air intake side should be minimum 1.5 times of radiator core area,
- Effective opening at hot air outlet side should be minimum equal to radiator core area,
- Auxiliary ventilation fan to be provided to take out heat from room area when DG set stops, to maintain ambient temperature in room area.

Ventilation system- Considerations

Hot air outlet duct extension on enclosure-
When DG Sets are installed in room area and hot air to be terminated outside to avoid short circuit of hot air to suction side, following critical aspect to be considered,

- Size of the extension duct to be worked out considering overall pressure drop of max. 2mm.
- In case of increased back pressure, radiator fan flow will reduce and impacts cooling efficiency of radiator.

Ventilation System- Considerations

DG Set installation in building Basement-

For DG set mounted radiator specified air flow is required with proper air inlet and hot air outlet scheme, which is the concern area at most of the sites.

Following option can be worked out to suit basement installation,

- DG set with HE option- remote radiator or cooling tower in secondary cooling circuit,
- Product cooler to maintain DG room temperature, with cooling tower in secondary cooling circuit,
- Fresh air supply mechanism (@2 times of combustion area requirement),
- Better noise attenuation option,

DG Spacing

A.6 **Spacing Guidance**

No.	Description	DG set with Acoustic Enclosure in Open Area.	DG set with Acoustic Enclosure in Covered Area.	Open DG set in room.
1	Free space on both sides	Min. 1m	Min. 1	Min. 2m
2	Free space at Radiator end (Radiator- - Hot air outlet front discharge)	Min. 2m	Min. 1m (No obstacle for hot air disbursement @ 2m)	Min. 1m (No obstacle for hot air disbursement @ 2m)
	Free space at Radiator end (Radiator- - Hot air outlet Top discharge)	Min. 1m	Min. 1m (Ducting to provide as applicable to avoid hot air recirculation to inlet air).	N/A
3	Free space at Alternator side.	Min. 1.5m (No obstacle for fresh air suction)	Min. 1.5m (No obstacle for fresh air suction)	Min. 2m (considering alternator hauling space requirement)
4	Fresh air inlet effective opening area	N/A	Effective open area -Min 1.5 times of the Radiator core area.	Effective open area -Min 1.5 times of the Radiator core area.
5	Hot air discharge effective opening area	N/A	Effective open area -Min 1 times of the Radiator core area.	Effective open area -Min 1 times of the Radiator core area.
6	Distance between two sets	Min 1m between two canopies.	Min 1m between two canopies.	Min1.5m between two foundations.

Ventilation system- Considerations

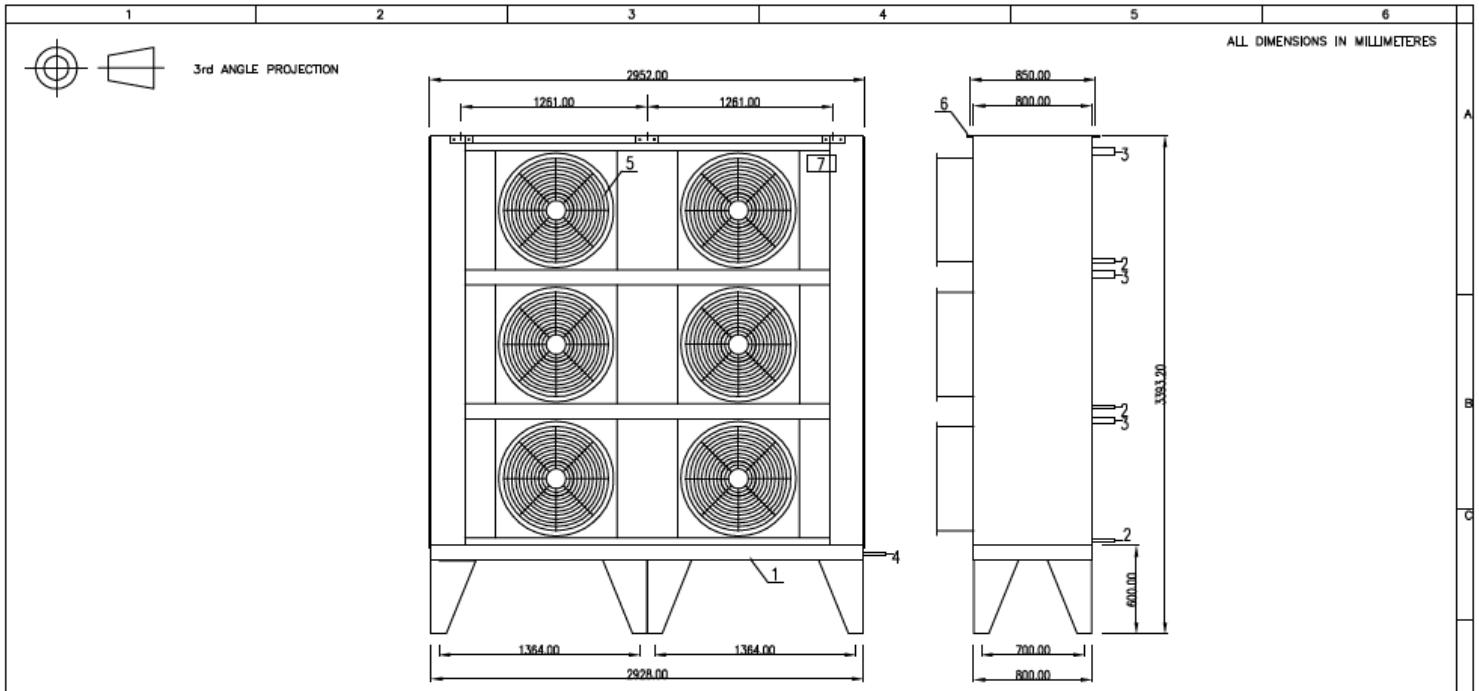
DG Set installation in building Basement-





Ventilation system- Considerations

DG Set installation in building Basement-



Coil Details: Cu.Tubes/Alu.Fins,Face Area: 108"x97.3"

7	Elect.Conn Box	1	Elect.Conn Box
6	Fixing	8	MS Angle-5/8" Hole
5	Fan Gaurd	6	Welded Plastic Coated
4	Drain Conn.	1	2 1/2"
3	Outlet Conn.	3	2 1/8" Copper Pipe with MS Ext.
2	Inlet Conn.	3	2 1/8" Copper Pipe with MS Ext.
1	Casing	1	GI Powder Coated

Star Coolers & Condensers Pvt. Ltd.

H-13 (Unit-1) M.I.D.C Jalgaon-425003
Maharashtra (India)
Tel:-(0257) 2272779 Fax:- (0257) 2272778
email:- starcooler_jal@dataone.in

Motor		Fan		Defrost	
KW	1.5	Dia.	710	Coil	None
Pole	4P	Type	Axial	Tray	None
RPM	1440	Make	Wing	Fan	None
Make: Marathon/CG					

Technical Details

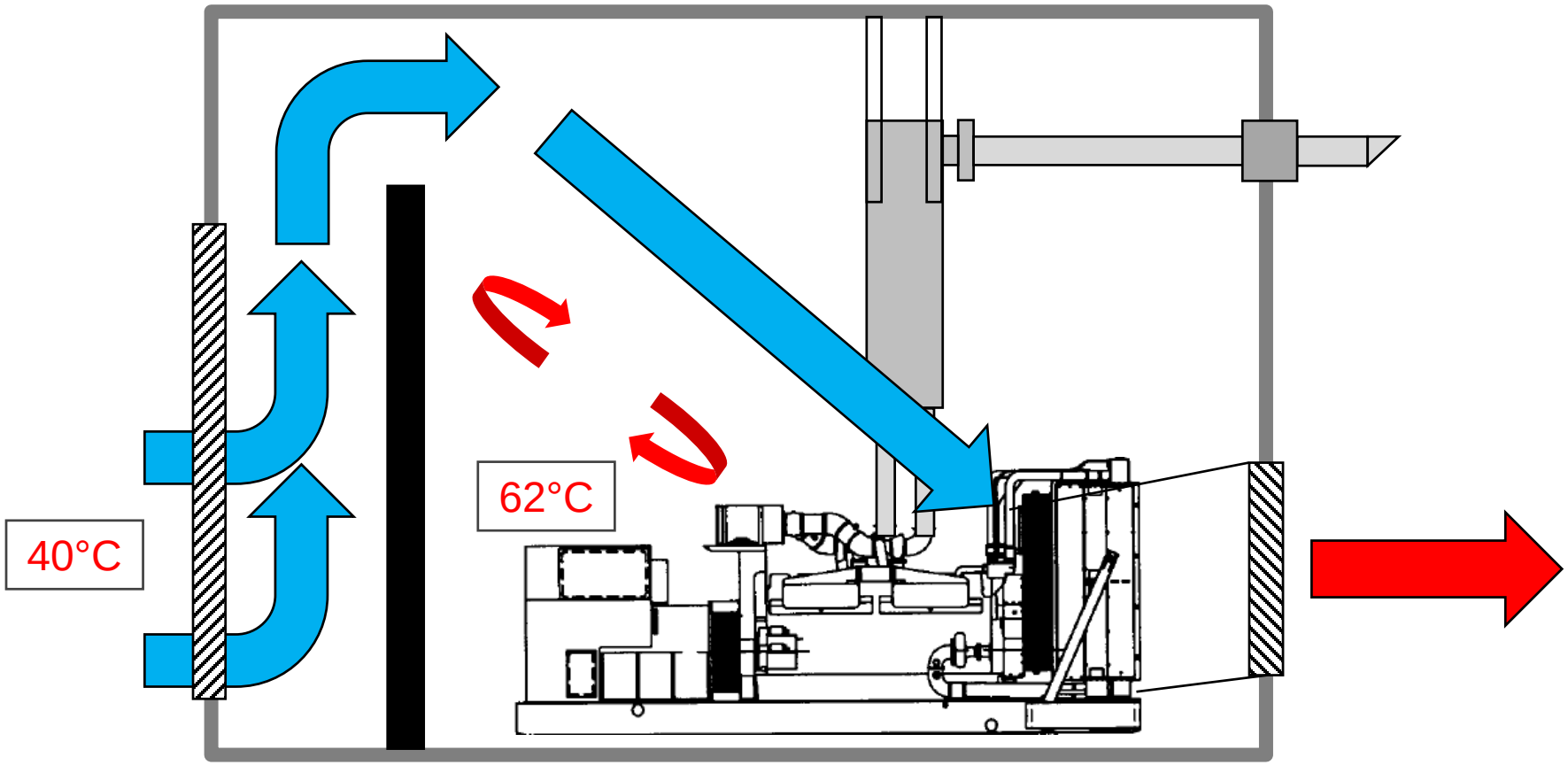
Duty KW	Room Temp.°C	Inlet Temp.°C	Outlet Temp.°C	Flow Rate	Medium	Supply
190	42	32	36	5.71L/Sec	CW	380/420V 3PH 50HZ

Model:- CIC 61612

Customer:- Wipro Project

Scale:- 1:1 | Job No:- Quoted | Customer Po. No
Drawn:- SARIKA | Drg.No:- GA CIC 61612
Date:- 13.08.2015 | No Of Unit:- 01Nos. | REV 0

Installation Review: Ventilation



Ventilation Calculation

In all cases care should be taken to avoid re circulation of hot air.

Note: Refer Table 1 for Ventilation air quantity requirement. Fan flow rate should be selected according to the engine breathing air and radiation heat dissipation with permissible temp rise in DG room/Enclosure.
Static head of the fan should be selected according to the restriction at air suction area and hot air outlet area, also consider the attenuation requirement.

Maximum temperature allowed to rise in DG Set room /Enclosure is

Option	**Allowable temperature rise**	
Radiator Cooled	7-8 degree C	(Air inlet temp to Radiator Core)
HE cooled or “No Cool”	10 degree C	

Ventilation Calculation

Formula for Ventilation Air Quantity Calculation

Option-1 - Air flow quantity requirement in CFM

$$V\,(cfm) = \frac{H}{0.070 \times 0.24 \times \Delta T} + \text{Engine Combustion Air}$$

Where H is heat load in btu / minute and Δ T in Degree Fahrenheit. Engine combustion in CFM.

Option- 2 - Air flow quantity requirement in m3/ Minute

$$V\,m^3/min = \frac{H}{1.099 \times 0.017 \times \Delta T} + \text{Engine Combustion Air}$$

Where H is heat load in kW and Δ T in Degree Centigrade. Engine combustion in m3/min

Ventilation Calculation- Table 1 in DG Inst Guide

Model	Rating (0.8 pf) In kVA	Exh. Gas flow (No. of bank X flow per bank)	Exhaust Silencer nominal bore	Fuel piping diameter ID for @ 10 M length.	Lube oil system capacity (Including filters)	Cooling system - Radiator fan flow	DG set Heat dissipation (Radiation Engine +Alternator)	Combustion Air requirement	Ventilation air capacity required at 10 Deg ΔT
	P - Prime, S - Standby	No. x m^3/sec	Inch / No. of banks	mm	L	m^3/sec	KW	m3/sec	m3/sec
QSK95-G4	3350 (P)	2 X 4.58	14/2	50	647.3	96.38	407	4.15	40.5
QSK78-G9	2750 (P)	2 X 3.60	14/2	50	466	58.75	325	3.22	32.2
QSK78-G9	2750 (P) - 40˚C	2 X 3.60	14/2	50	466	33.20	325	3.22	32.2
QSK60-G8	2250 (P) - 40˚C	2 X 3.16	14/2	50	400	46.70	290	2.6	28.5
QSK60-G4	2000 (P) - 50˚C	2 x 2.8	14/2	50	280/400	30.03	247	2.4	24.4
QSK50-G10	1790 (P) (HE)	2 X 2.56	12X2	50	235	RTF	223	2.01	21.9
KTA-50-G8-I	1500 (P)	2 X 2.22	10/2	25	177	28.40	202.8	1.74	19.8
KTA-50-G3	1250 (P)	2 X 2	10/2	25	177	27.35	194.8	1.74	19.1
KTA-38-G5	1010 (P)	2 X 1.53	10/2	25	145	19.99	172.52	1.21	16.6
KTA38-G12	810 (P)	2 x 1.24	8/2	25	155	27.07	107.8	1.069	10.7
KTA38-G12	750 (P)	2 x 1.17	8/2	25	155	27.07	105.56	1.024	10.4
QSK19-G7	640 (P)	1 x 1.96	10/1	N/A	84.4	12.93	101.4	0.775	9.8
QSK19-G6	600 (P)	1 x 1.86	10/1	N/A	84.4	12.93	100.12	0.742	9.7
KTAA19-G10	500 (P)	1 x 1.45	10/1	N/A	50	6.76	60	0.603	6.0
QSN14-G2	400 (P)	1 x 1.17	6/1	N/A	38.6	8.87	45.08	0.483	4.5
QSN14-G1	365 (P)	1 x 1.08	6/1	N/A	38.6	8.87	36.3	0.45	3.7

N/A - Not available

TABLE No. 1

8. DG Starting Battery Sizing

Battery Sizing Estimation

- Earlier CCA Calculations were done as per engine design parameters,
- Now CCA values at various operating temperature are defined in engine data sheets released by Cummins factory.
- DG Starting battery capacity to be selected by battery manufacturer/ supplier on the basis of following aspects,

- Engine CCA value,
- Cranking time as 10 Sec per start,
- 3 or 6 starts capability as per site requirement,
- Minimum ambient operating conditions at site and
- Redundancy requirement if any.

Battery Selection

Generally DG Set starting batteries are supplied along with DG sets, Cummins Pulse lite type specially designed for cranking application. The batteries are dry charged and this pre-charge of the batteries will remain for around 3 months maximum. If DG commissioning is delayed beyond this period, these batteries need to be trickle charged again to be able to start the DG.

In case of batteries other than Cummins supply Batteries, they are also generally supplied in charged condition.

Batteries should be placed on wooden stands and preferably near the starting motor. A wooden/acrylic top cover with proper venting can also help protect the battery leads/terminals. Refer Sketch on right.

Please refer Table K.4 for battery capacity and cable sizes for various engine models. Cable sizes are for maximum length of 2 meter. If a length is more, size the cable to be increased to minimize overheating of the cable and minimum voltage drop.

- For AMF applications, an external battery charger should keep the batteries fully charged at all times.

.

Battery Selection

Engine CCA Value for Starting Battery sizing and selection

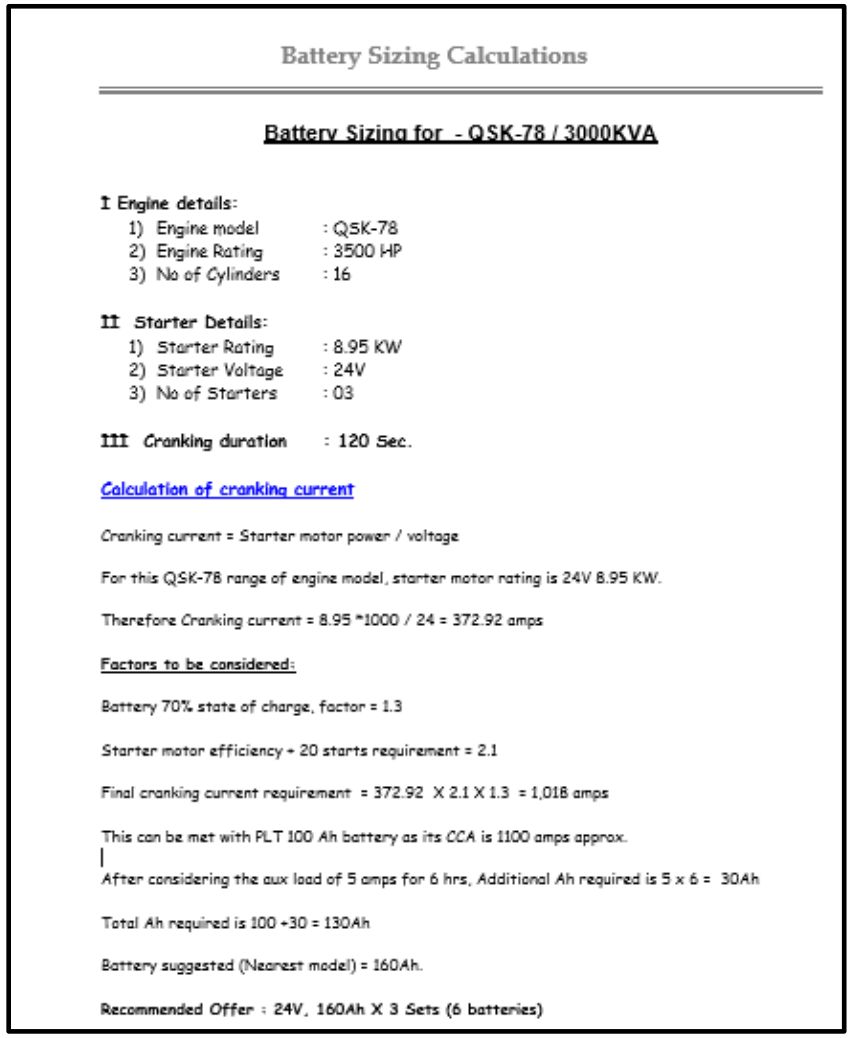
Sr. No.	Engine Model	DG set KVA Rating	Engine Starter motor rating		No of Starters	Cold soak temp @	CCA Requirement:
			Voltage	kW			
1	X1.3TAAG1	7.5	12	1.2	1	N/A	638
2	X1.3TAAG1	10	12	1.2	1	N/A	638
3	X1.3TAAG1	15	12	1.2	1	N/A	638
4	X2.7TG1	20	12	2	1	10 to 32 Deg.F (-12 to 0 Deg.C)	638
5	X2.7TG1	25	12	2	1	10 to 32 Deg.F (-12 to 0 Deg.C)	638
6	X2.7TAA-G2	30	12	2	1	10 to 32 Deg.F (-12 to 0 Deg.C)	638
7	X3.6TAA-G1	35	12	2	1	10 to 32 Deg.F (-12 to 0 Deg.C)	650
8	X3.6TAA-G1	40	12	2	1	11 to 32 Deg.F (-12 to 0 Deg.C)	650
9	4B3.3TAA-G11	50	12	2.2	1	10 to 32 Deg.F (-12 to 0 Deg.C)	550
10	4B3.3TAA-G11	62.5	12	2.2	1	10 to 32 Deg.F (-12 to 0 Deg.C)	550
11	4B3.9TAA-G3	70	12	2.9	1	10 to 32 Deg.F (-12 to 0 Deg.C)	700
12	4B3.9TAA-G4	82.5	12	2.9	1	10 to 32 Deg.F (-12 to 0 Deg.C)	700
13	6BTAA5.9-G13	100	12	2.9	1	10 to 32 Deg.F (-12 to 0 Deg.C)	950
14	6BTAA5.9-G13	125	12	2.9	1	10 to 32 Deg.F (-12 to 0 Deg.C)	950
15	QSB5.9-G1	140	24	2.5	1	10 to 32 Deg.F (-12 to 0 Deg.C)	750
16	QSB5.9-G2	160	24	2.5	1	10 to 32 Deg.F (-12 to 0 Deg.C)	750
17	QSB6.7-G11	180	24	3.7	1	10 to 32 Deg.F (-12 to 0 Deg.C)	750
18	QSB6.7-G12	200	24	3.7	1	10 to 32 Deg.F (-12 to 0 Deg.C)	750
19	QSB6.7-G13	225	24	3.7	1	10 to 32 Deg.F (-12 to 0 Deg.C)	550
20	QSL9-G16	250/275	24	9	1	10 to 32 Deg.F (-12 to 0 Deg.C)	750
21	QSL9-G15	300/320	24	9	1	10 to 32 Deg.F (-12 to 0 Deg.C)	750
22	QSN14-G1	365	24	8	1	10 to 32 Deg.F (-12 to 0 Deg.C)	900
23	QSN14-G2	400	24	7.5	1	10 to 32 Deg.F (-12 to 0 Deg.C)	900
24	QSN14-G3	440	24	7.5	1	10 to 32 Deg.F (-12 to 0 Deg.C)	900
25	KTAA19-G10	500	24	9	1	10 to 32 Deg.F (-12 to 0 Deg.C)	900
26	KTAA19-G11	520	24	9	1	10 to 32 Deg.F (-12 to 0 Deg.C)	900
27	QSK19-G6	600/660	24	9	1	10 to 32 Deg.F (-12 to 0 Deg.C)	900
28	QSK19-G6	625	24	9	1	10 to 32 Deg.F (-12 to 0 Deg.C)	900
29	QSK19-G7	650/700	24	9	1	10 to 32 Deg.F (-12 to 0 Deg.C)	900
30	KTA38-G10	750/830	24	9	2	10 to 32 Deg.F (-12 to 0 Deg.C)	1280
31	KTA38-G11	810/900	24	9	2	10 to 32 Deg.F (-12 to 0 Deg.C)	1280

Engine CCA Value for Starting Battery sizing and selection (Cont'd)

Sr. No.	Engine Model	DG set KVA Rating	Engine Starter motor rating		No of Starters	Cold soak temp @	CCA Requirement:
			Voltage	kW			
32	KTA38-G5	1010	24	9	2	0 to 32 Deg.F (-18 to 0 Deg.C)	1800
						32 to 50 Deg.F (0 to 10 Deg.C)	1280
						50 Deg.F & Above (10 Deg.C & above)	1200
33	KTA50-G3	1250/1400	24	9	2	0 to 32 Deg.F (-18 to 0 Deg.C)	1800
						32 to 50 Deg.F (0 to 10 Deg.C)	1800
						50 Deg.F & Above (10 Deg.C & above)	1280
34	KTA50-G8I	1500	24	9	2	0 to 32 Deg.F (-18 to 0 Deg.C)	1800
						32 to 50 Deg.F (0 to 10 Deg.C)	1800
						50 Deg.F & Above (10 Deg.C & above)	1280
35	QSK50-G10	1800/2000	24		2	10 to 32 Deg.F (-12 to 0 Deg.C)	1800
36	QSK60-G4	2000/2250	24	9	2	0 to 32 Deg.F (-18 to 0 Deg.C)	2200
						32 to 50 Deg.F (0 to 10 Deg.C)	1800
						50 Deg.F & Above (10 Deg.C & above)	1800
37	QSK60-G8	2250	24	8.95	2	0 to 32 Deg.F (-18 to 0 Deg.C)	2200
						32 to 50 Deg.F (0 to 10 Deg.C)	1800
						50 Deg.F & Above (10 Deg.C & above)	1800
38	QSK78-G9	2750/3000	24		3	0 to 32 Deg.F (-18 to 0 Deg.C)	2200
39	QSK95 G4	3350/3750	24		2	0 to 32 Deg.F (-18 to 0 Deg.C)	1400

Battery selection is done by DBU and suggest please get in touch with the following for all batteries selection
Lakshmi N Pacha- cell- 7722094573
<Lakshmi.Pacha@cummins.com>

Battery Sizing



Battery Sizing Calculations

Battery Sizing for - QSK-78 / 3000KVA

I Engine details:

1) Engine model : QSK-78
2) Engine Rating : 3500 HP
3) No of Cylinders : 16

II Starter Details:

1) Starter Rating : 8.95 KW
2) Starter Voltage : 24V
3) No of Starters : 03

III Cranking duration : 120 Sec.

Calculation of cranking current

Cranking current = Starter motor power / voltage

For this QSK-78 range of engine model, starter motor rating is 24V 8.95 KW.

Therefore Cranking current = 8.95 *1000 / 24 = 372.92 amps

Factors to be considered:

Battery 70% state of charge, factor = 1.3

Starter motor efficiency + 20 starts requirement = 2.1

Final cranking current requirement = 372.92 X 2.1 X 1.3 = 1,018 amps

This can be met with PLT 100 Ah battery as its CCA is 1100 amps approx.

After considering the aux load of 5 amps for 6 hrs, Additional Ah required is 5 x 6 = 30Ah

Total Ah required is 100 +30 = 130Ah

Battery suggested (Nearest model) = 160Ah.

Recommended Offer : 24V, 160Ah X 3 Sets (6 batteries)

Battery Sizing for QSK 60

Flywheel Ring gear teeth	142	nos
No. of pinion on starter	11	nos
Breakaway torque of engine @ 30°F	1500	Lb-ft
Breakaway torque of alternator	1050	Lb-ft
Total breakaway torque	2500	Lb-ft
Breakaway torque to be overcome by starter (A)	198	Lb-ft
Cranking torque of engine @ 30°F	900	Lb-ft
Cranking torque of alternator	630	Lb-ft
Total cranking torque	1530	Lb-ft
Cranking torque to be overcome by starter (B)	**119**	Lb-ft
Average torque = (2*B+A) / 3	**145**	Lb-ft
From the starter curve required CCA (I)	**2200**	**Amps**

The battery selected shall have a CCA equivalent to the cranking current requirement plus cater to the auxiliary load of 12Ah (3amps x 4 hrs)

Hence, the battery selected is Pulse Ultralite -12V 160Ah -4 nos with a cranking current of 1650 amps each.

In case of higher auxiliary load, 2 additional batteries are recommended.

Now, these battery calculations are to be taken from either DBU or from the battery supplier. CCA values are given

9. Earthing System

Earthing Guideline

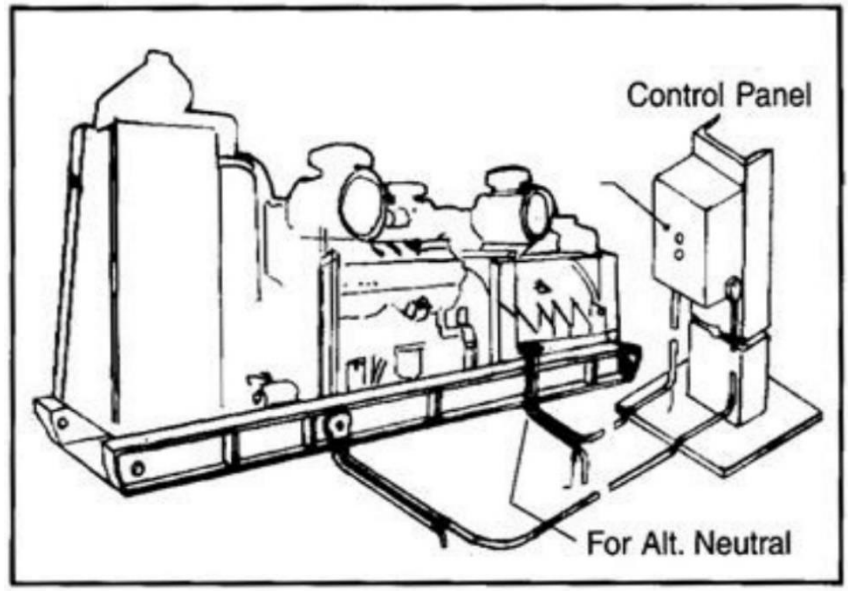
EARTHING (As Per IS 3043/IEC)

1. The generating set and all associated equipment control and switch gear panels must be earthed before the set is put into operation. PCC panel should have separate earthing strip connection of suitable size connected to DG Set body earthing.

2. Four numbers earth pits are required as per Indian Electricity rules or local electricity board.

- 2 earthing pits for DG Set/ control panel body
- 2 earthing pits for neutral.

Minimum distance between the two earth pits should be @800 mm, numbers of earth pits are to be determined by fault level calculation.

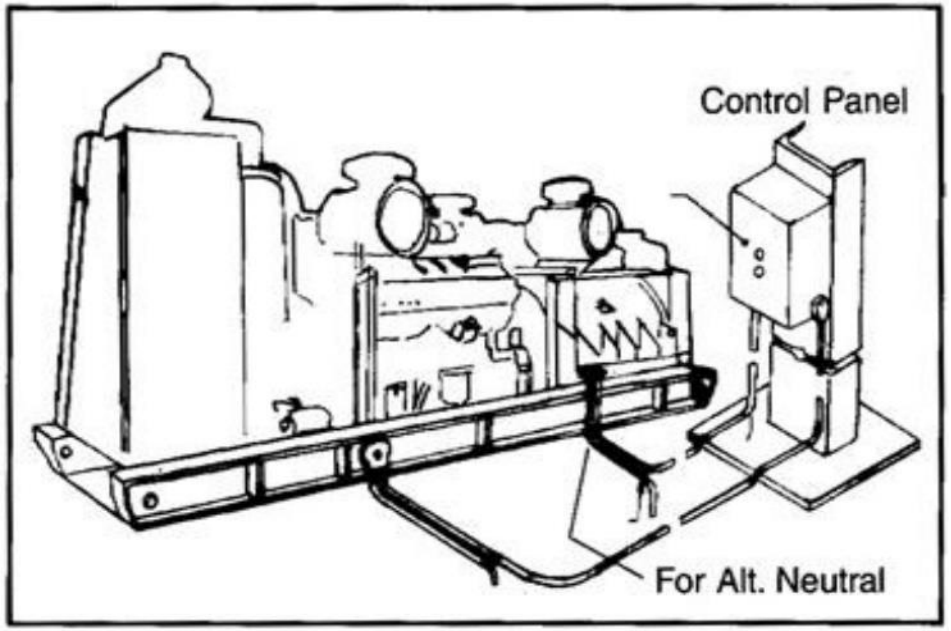


Earthing Guideline

EARTHING (As Per IS 3043/IEC)

3.Practice earth resistance should not exceed one ohm. Earthing should be checked at earth pit location and resistance should be maintained within 1 ohm.

For DG Sets with AVM's between engine/ alternator and base rail, the earthling MUST be done at the engine/ alternator and NOT at base rail.



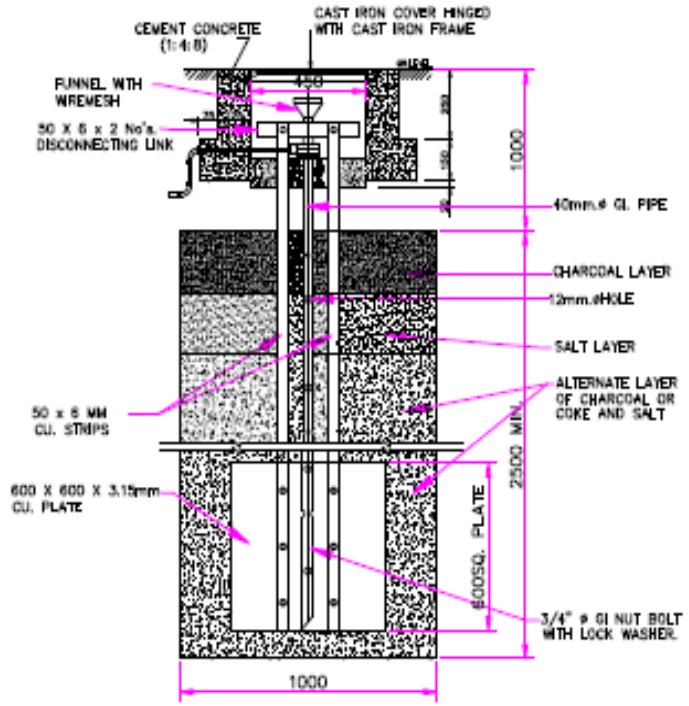
N.4 DG Set should be earthed at two distinct points through a GI/ Copper Strips/ conductor heavy enough to carry the short circuit current without burning. (Sketch N.4)

Note: In case of multiple DG sets check with GOEM project team on earthing pits design and earthing grids/rings

Earthing Guideline

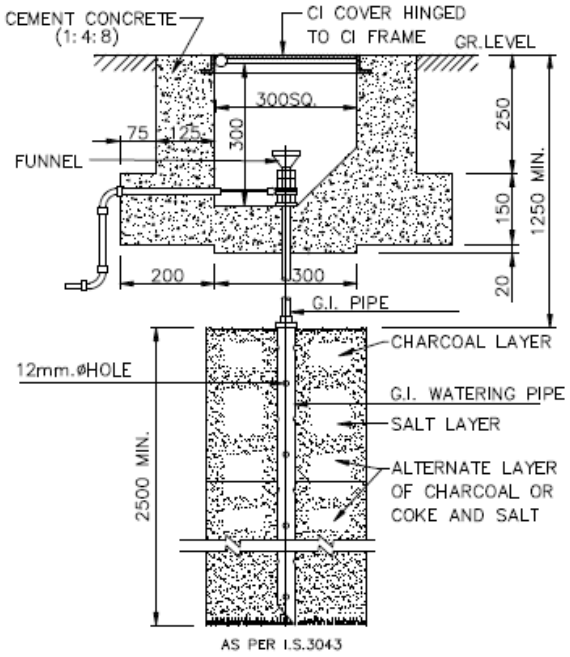
TYPES OF EARTHING

Different type of earthing stations
A. Plate Type Earthing station



EARTHING PIT DETAILS
COPPER PLATE EARTHING

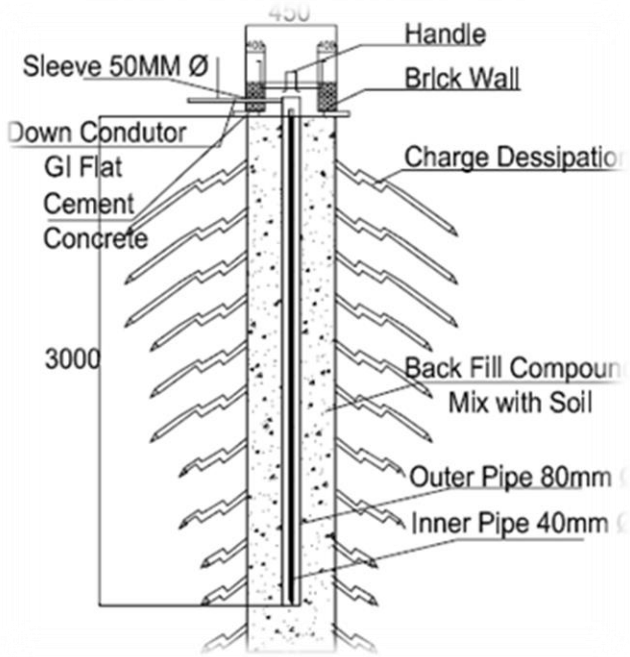
Different type of earthing stations
B. Pipe Type Earthing station



Earthing Guideline

TYPES OF EARTHING

Different type of earthing stations
C. Chemical Earthing Section



Mobile Generator Earthing

Annexure 1

Guideline for Earthing of Portable/Mobile Generator – (Ref : IS: 3043 – 1987)

Where a supply is taken from **a mobile generator**, the following recommendations shall apply:

- The generator neutral should be connected to the vehicle chassis.
- The earth terminal at each outlet on the generator vehicle should be connected separately to the alternator neutral where the latter is bonded to the vehicle chassis.

c) If Mobile DG set is **in Stationary location**, the earthing of the local control panel available at site should be used. Where an electricity board protective earth terminal or exposed structural metalwork is present, it should be connected to the earthing conductor on the mobile generator. In case there is no such provision then alternatively gel/spike earthing can be done in the ground.

Recommendations

- All equipment that can be energized must be grounded
- Ground fault current must have a defined path to return to the sources
- Remember the two big rules for ground fault sensing:
  - There can be only one neutral-to-ground bond in the system
  - The sensor for the ground-fault signal devices shall be located downstream of the neutral bonding point
- Specify 4-Pole ATS if:
  - GFP on Normal/GF Indication on Emergency is required
  - Any 3-phase 4-wire with line-to-ground voltage above150V when future expansion to the facility is expected.
- Paralleled sources add complexity but key principle still applies
  - Fault current needs a defined path to return to the source
- Specify or Show Neutral Bonding Jumper on Generator When Separately-Derived (Some manufactures don’t bond the neutral-to-ground on the generator).

Impediments to effective equipment grounding

- Painted surfaces
- Corroded ground connections
- Corroded ground wires/cables
- Damaged connections or conductors
- Loose ground connections
- Missing “star” type washers where they are meant to establish ground connection

10. Understanding Noise of DG sets

Brief

- Noise is unwanted sound.
- Noise is defined in dBA,
- For CPCB-II Products, 75 dBA noise level at 1m is statutory compliance requirement at manufacturer end,
- For DG Ratings more than1010 KVA, 25 dBA insertion loss to source noise level at 1m from reference point is statutory requirement and compliance is in end client scope.
- In case of complain logged by neighbors for noise issue, DG owner / operator to take all possible steps to curtail issue reported as per site regulatory requirements.
- Most of the projects are coming up in commercial zone, which calls for lower noise level requisites.
- Noise measurement reference standard in IS8528-10,

What are the Noise Norms?

Table 1.1: Standards of Noise Levels under EPA (1986): Noise Pollution (Regulation & Control) Rules, 2000

Area Code	Category of Area	Limits in dB(A) L_{eq}	
		Day time	Night time
A	Industrial area	75	70
B	Commercial area	65	55
C	Residential Area	55	45
D	Silence Zone	50	40

Note:

1. Day time is reckoned in between 6 A.M and 10 P.M.
2. Night time is reckoned in between 10 P.M and 6 A.M.
3. Silence zone is referred as areas up to 100 meters around such premises as hospitals, courts, educational institutions and courts. The Silence zones are to be declared by the Competent Authority.
4. Use of vehicular horns, loudspeakers and bursting of crackers shall be banned in these zones.
5. Mixed categories of areas should be declared as one of the four above mentioned categories by the Competent Authority and the corresponding standards shall apply.

MAHARASHTRA POLLUTION CONTROL BOARD
Kalpataru Point, 3rd Floor, Sion (East), Mumbai-400011
Website: www.mpcb.gov.in

Noise - Source

What are the noises which we need to be aware of

1. Engine Mechanical Noise – Pressure
2. Exhaust Sound- Octave Band

Sound data
C3000 D5e
50 Hz

Sound pressure level, dB(A)

See Notes 1-6 listed below

Configuration	Exhaust	Measurement location number average as per ISO 3744 @ 1m		
		Sound pressure dB(A) @ 75% load EN ISO 3744	Sound pressure dB(A) @ 100% load (Prime) EN ISO 3744	Sound pressure dB(A) @ 110% load (Standby) EN ISO 3744
Standard –unhoused	Infinite	100.0	100.9	101.3

Sound power level, dB(A)

See Notes 2-4, 7 and 8 listed below

Configuration	Exhaust	Octave Band Center Frequency (Hz)		
		Sound power level achieved, 75% dB(A)	Sound power level achieved, 100% dB(A)	Sound power level achieved, 110% dB(A)
Standard –unhoused	Infinite	121.2	122.1	122.5

Exhaust sound power level, dB(A)
open set at operating point - 1m @ 110% load (ISO 8528-10)

See Notes 2 and 9 listed below

Open exhaust (no muffler rated load	Octave band center frequency (Hz)										Overall sound power level
	32	63	125	250	500	1000	2000	4000	8000	16000	
	45.6	77.3	85.5	90.5	98.7	100.5	98.7	92.3	89.5	75	104.8

Note:

1. Sound levels are subject to instrumentation, measurement, installation and manufacturing variability.
2. Data based on full rated load. Sound data with remote-cooled generator sets are based on rated loads without cooling fan noise
3. Sound data for generator set with infinite exhaust do not include exhaust noise.
4. Sound pressure levels are measured per ANSI S1.13 and ANSI S12.18, as applicable.
5. Reference sound pressure is 20 µPa.
6. Sound power levels per ISO 3744 and ISO 8528-10, as applicable.
7. Reference power = 1 pw (10-12W)
8. Exhaust sound power levels are per ISO 6798, as applicable.

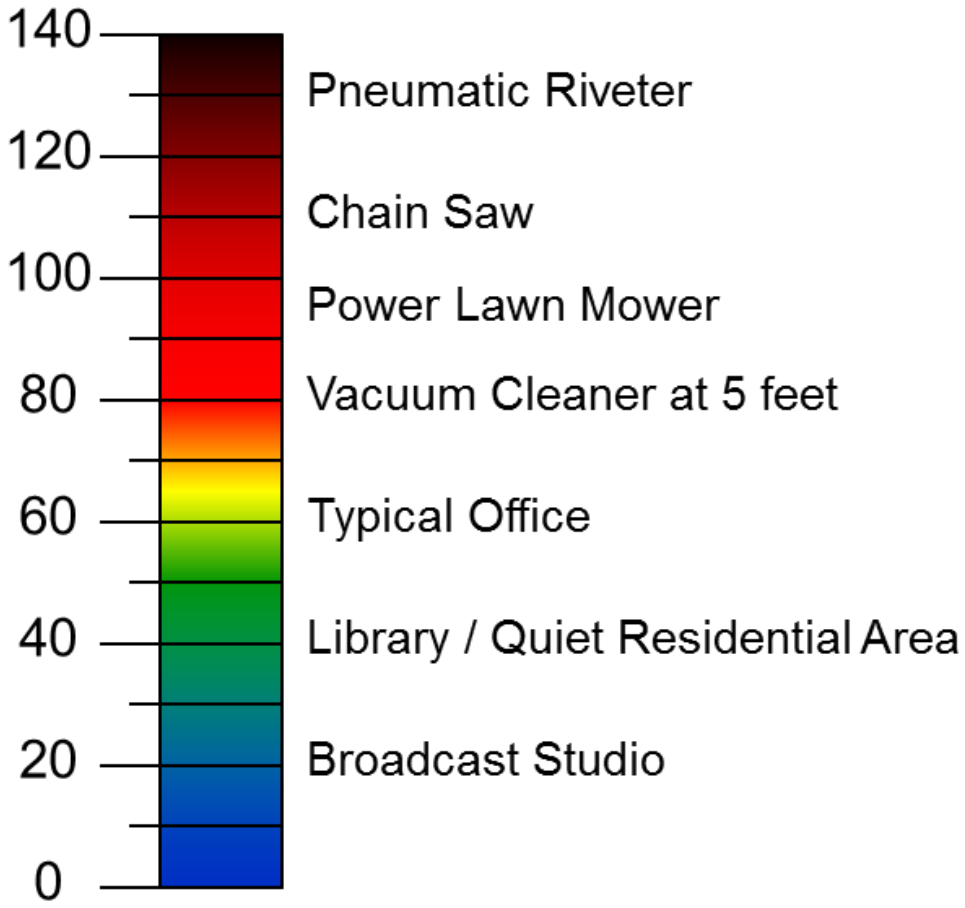
Sound Attenuation

1. Engine Mechanical Noise – Pressure

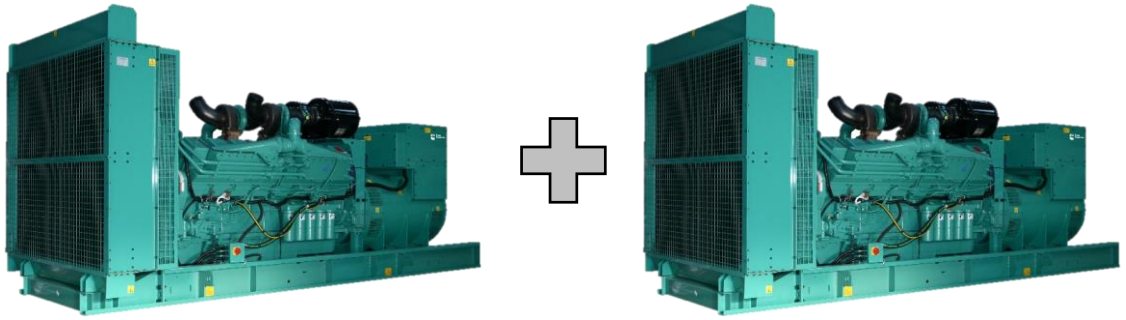
2. Exhaust Sound- Octave Band

Generator Set Sound Contributors

- Un-silenced engine exhaust
  - 120-130 dB(A) @ 1m
- Radiator cooling fan
  - 100-110 dB(A) @ 1m
- Engine
  - 100 -105 dB(A) @ 1m
- Alternator
  - 80 – 90 dB(A) @ 1m



The Sum of Sound Sources



100 dB(A) + 100 dB(A)

= 103 dB(A)

Adding decibels	
When the numerical difference in dB(A) between two noise levels is:	Add this dB(A) to the **higher** of the two noise levels for a total:
0	3.0
0.1 – 0.9	2.5
1.0 – 2.4	2.0
2.4 – 4.0	1.5
4.1 – 6.0	1.0
6.1 – 10	0.5
>10	0

Installation Considerations

- Limits are almost always based on sound pressure at the property line.
- Location is the single greatest ally or enemy
- Increase distance from source to receiver
  - Sound pressure drops ~6 dB(A) at 2x distance
- High mass, absorptive barriers
- Avoid reflective surfaces
  - Perceived sound pressure increases:
    - 3dBA due to a reflective surface
    - 5dBA for two reflective surfaces
- Direct noise away from sensitive locations
  - Radiator discharge turning vanes
  - Exhaust discharge elbows

Common Specification Pitfalls

Generator set shall include critical grade muffler.

- Grades are not standardized.
- Advertised sound attenuation is dependent on application.

Generator set shall include [critical grade / level X] housing.

- Does not mandate compliance with the limit imposed on the owner.
- Enclosure/housing grades are not standardized.

Generator set shall include housing/muffler with X dB(A) reduction.

- Does not mandate compliance with the limit imposed on the owner.
- Magnitude of reduction is not relative to the raw or resulting sound levels.

Specification Pitfalls: Muffler Grades

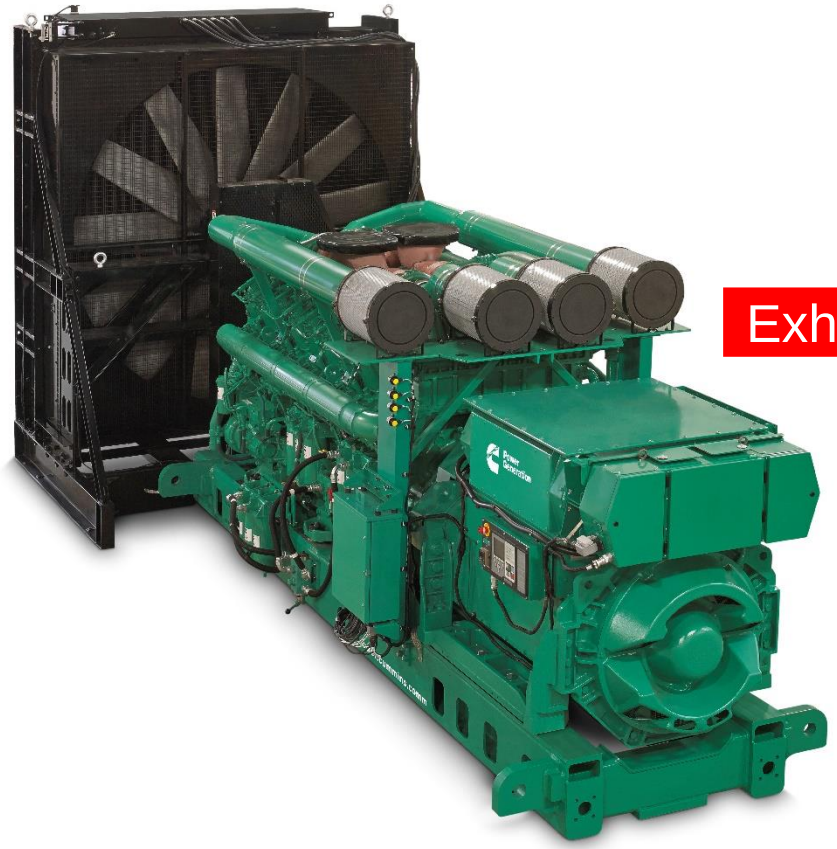
Fan: 86 dB(A)

Exhaust: 94 dB(A)

Engine/Alternator: 80 dB(A)

95 dB(A)

Specification Pitfalls: Muffler Grades



Fan: 86 dB(A)

Exhaust: 94 dB(A)

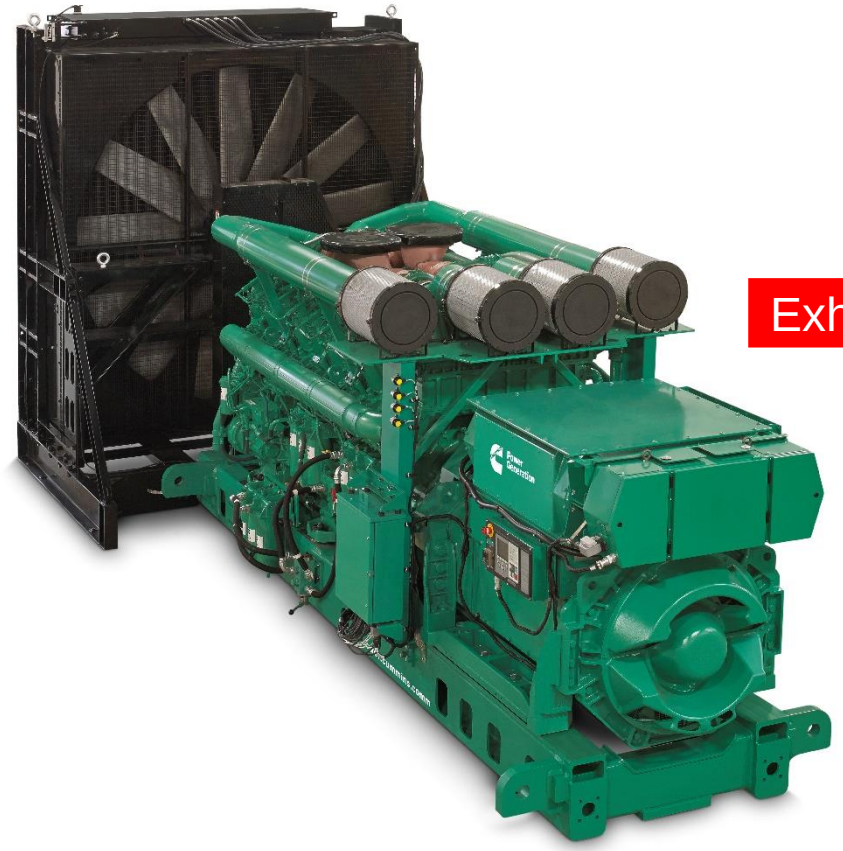
"Industrial-Grade" Muffler [15 dB(A)]

Exhaust: 79 dB(A)

Engine/Alternator: 80 dB(A)

88 dB(A)

Specification Pitfalls: Muffler Grades



Fan: 86 dB(A)

Exhaust: 94 dB(A)

"Critical-Grade" Muffler [30 dB(A)]

Exhaust: 64 dB(A)

87 dB(A)

Engine/Alternator: 80 dB(A)

Testing Considerations

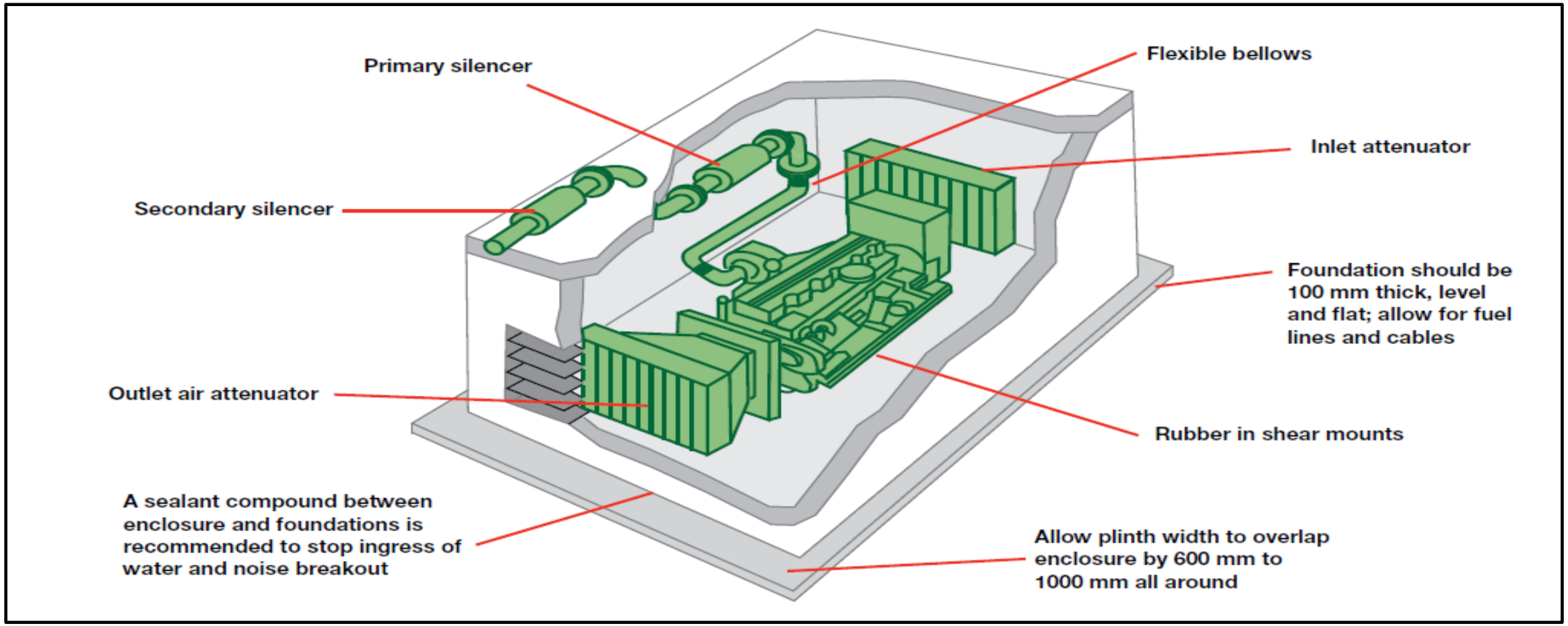
- At what load can the generator set be tested?
- Are there any other contributors to sound at the site? (load bank, ambient noise)
- Who is performing the measurements?
- When are the measurements being performed?
- What type of measurement equipment will be used to perform the validation testing?

Testing with Ambient Noise

Adding decibels	
When the numerical difference in dB(A) between two noise levels is:	Add this dB(A) to the higher of the two noise levels for a total:
0	3.0
0.1 – 0.9	2.5
1.0 – 2.4	2.0
2.4 – 4.0	1.5
4.1 – 6.0	1.0
6.1 – 10	0.5
>10	0

If the ambient noise at the site is more than 10 dB(A) greater than the generator set, validating sound performance on site will present a challenge.

To meet the CPCB Norms Noise limits we have to now look at attenuators :Caution–Single/Multiple DG sets(diff 7-8dBA)



Reduction in Sound over Distance-

Typical 9 meters Boundary- 10 dBA

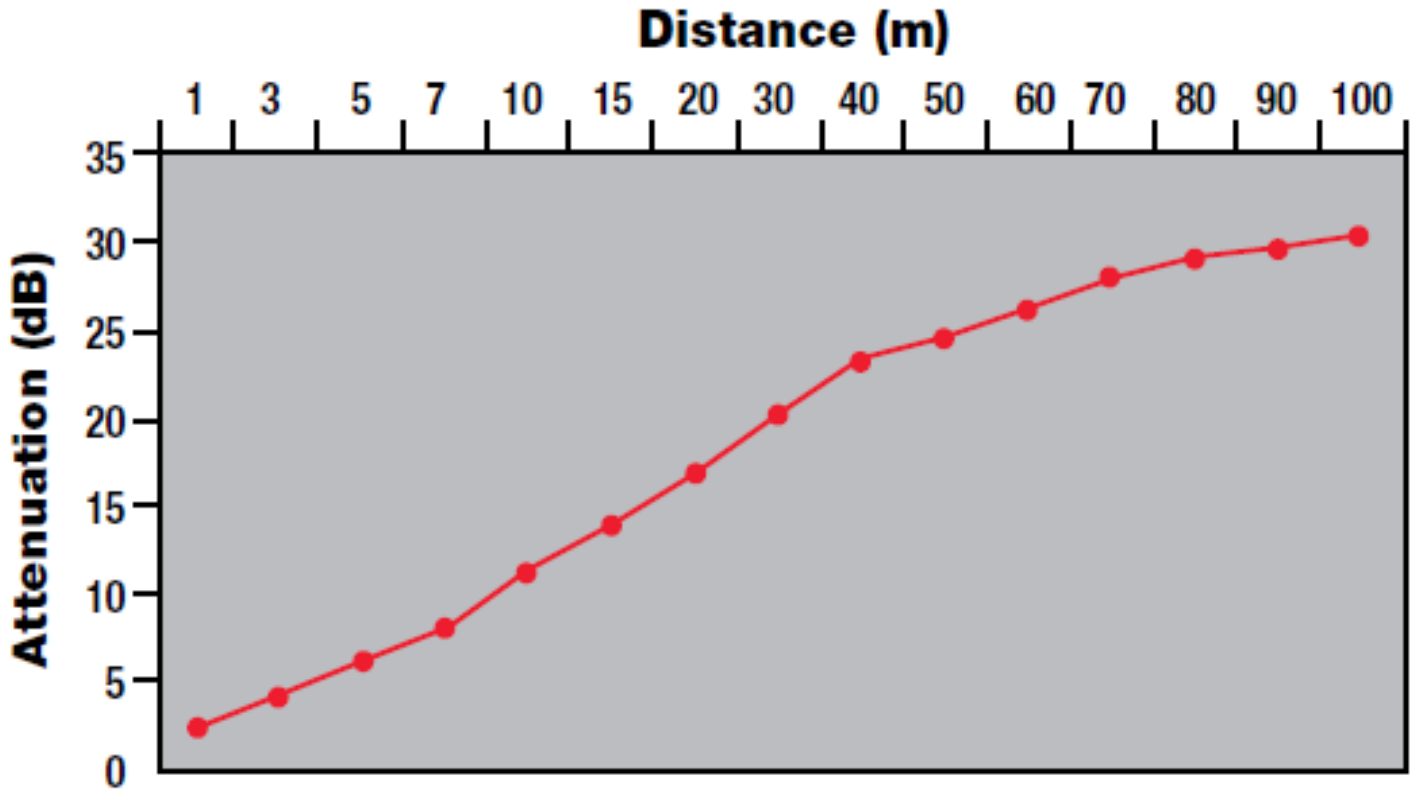


Figure 7: Reduction of sound over distance

Single DG –
75 DBA

Multiple
- – 82 to 83 dBA

Summary

With every day –

- Customers are now demanding low Noise.
- Industrial area not so stringent.
- Residential area – very stringent.
- 75 dBA or 65 dBA is not the norm- No neighbor complaint is the requirement.
- Even humming/irritation noise in not acceptable.
- We need to work with Noise Experts/Consultants
- New Silencer Manufacturers- for Impulsive/Reactive Silencers

11. Understanding Vibrations of DG sets

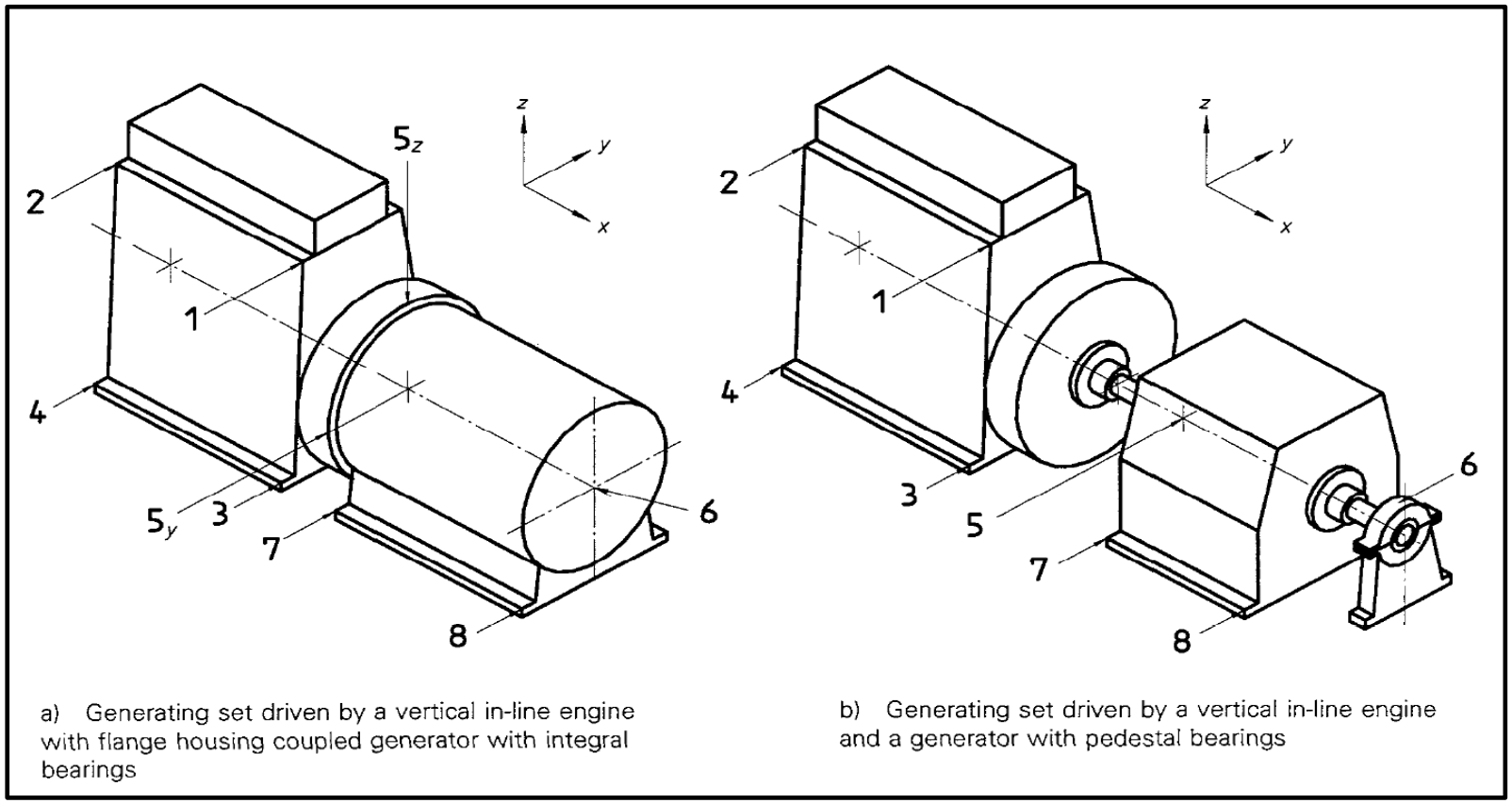
Understand Vibrations

Content

1. Where to measure the vibrations.
2. Measurement values as per standards
3. Format for measurement.

Vibrations

- Cummins DG sets have built in anti – vibration. These AVMs isolates engine vibrations transferred to foundation. Vibration limits and measurement should Meet ISO8528 part 9.
- **R.1 Measurement locations-** refer sketch below **Vibration Limits as per IS 8528-9** refer table below



a) Generating set driven by a vertical in-line engine with flange housing coupled generator with integral bearings

b) Generating set driven by a vertical in-line engine and a generator with pedestal bearings

Vibrations

- Cummins DG sets have built in anti – vibration pads. These AVMs isolates engine vibrations transferred to foundation. Vibration limits and measurement should Meet ISO8528 part 9.
- **Measurement locations-** refer sketch below (above page)

Vibration Limits as per IS 8528-9 refer table below

Table C.1 — Rms values for vibration velocity, displacement and acceleration of RIC engine driven AC generating sets (see clause 10)

Declared engine speed	Rated power output of the generating set		Vibration displacement[1], s_{rms}			Vibration velocity, v_{rms}			Vibration acceleration[1], a_{rms}		
	(cos φ = 0,8)		RIC engine [2] [3]	Generator [2]		RIC engine [2] [3]	Generator [2]		RIC engine [2] [3]	Generator [2]	
				value 1	value 2		value 1	value 2		value 1	value 2
min⁻¹	kV·A	kW	mm	mm	mm	mm/s	mm/s	mm/s	m/s²	m/s²	m/s²
⩾ 2 000 but ⩽ 3 600	⩽ 15 (1-cylinder engine)	⩽ 12 (1-cylinder engine)	—	1,11	1,27	—	70	80	—	44	50
	⩽ 50	⩽ 40	—	0,8	0,95	—	50	60	—	31	38
	> 50	> 40	—	0,64 [4]	0,8 [4]	—	40 [4]	50 [4]	—	25 [4]	31 [4]
⩾ 1 300 but < 2 000	⩽ 10	⩽ 8	—	—	—	—	—	—	—	—	—
	> 10 but ⩽ 50	> 8 but ⩽ 40	—	0,64	—	—	40	—	—	25	—
	> 50 but ⩽ 125	> 40 but ⩽ 100	—	0,4	0,48	—	25	30	—	16	19
	> 125 but ⩽ 250	> 100 but ⩽ 200	0,72	0,4	0,48	45	25	30	28	16	19
	> 250	> 200	0,72	0,32	0,45	45	20	28	28	13	18
> 720 but < 1 300	⩾ 250 but ⩽ 1 250	⩾ 200 but ⩽ 1 000	0,72	0,32	0,39	45	20	24	28	13	15
	> 1 250	> 1 000		0,29	0,35		18	22		11	14
⩽ 720	> 1 250	> 1 000	0,72	0,24 (0,16) [5]	0,32 (0,24) [5]	45	15 (10) [5]	20 (15) [5]	28	9,5 (6,5) [5]	13 (9,5) [5]

NOTE — The relationship between vibration velocity and vibration frequency is shown in figure C.1

1) The values of s_{rms} and a_{rms} are determined from the following equations by using the values given in the table for v_{rms}.

$s_{rms} = 0.0159 \times v_{rms}$
$a_{rms} = 0,628 \times v_{rms}$

2) In the case of flange housing coupled generating sets the values measured at point 5 [see figure 1 a)] shall meet the values for generators.

3) The stated values for RIC engines are applicable for engines with power outputs of more than 100 kW. For smaller engines with power outputs below 100 kW, no typical values exist.

4) These values are subject to agreement between the manufacturer and customer.

5) The values given in parentheses are applied to generators mounted on solid concrete foundations. In these cases the axial measurement for points 7 and 8 in figure 1 a) and b) shall be 50 % of the values given in parentheses.

Vibration Data Record Format

Annexure - 1

Vibration Measurement Report

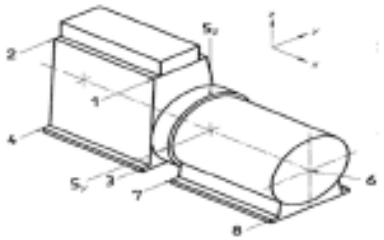
Engine Sr. No. _____ Genset Sr. No. _____

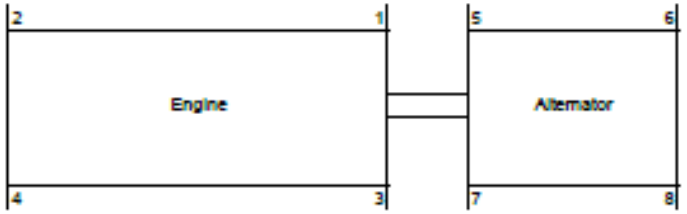
Engine Model _____ Genset Model _____

Alternator Sr. No. _____ Alternator Frame _____

Genset Rating _____ Date of Testing _____

Electrical load in % to rated output - _____





Sr. No.	X- Longitudinal	Z- Vertical	Y- Transverse
1			
2			
3			
4			
5			
6			
7			
8			

Note :
L- Direction- Longitudinal to crankshaft axis
V- Direction- Vertical
T- Direction- Transverse to crankshaft axis

13. Understanding DG Power derate estimation

Program Objective

- Understanding of deration
- Engine
- Alternator
- Combined effect on DG Set.

Point to discuss

1. Why Derate calculations are important?
2. What are the derate inputs required from GOEM/customer to give the proper recommendations?
3. How to read the derate calculations ?
4. What is the process flow if the standard product not fits customer requirement
5. What is DG sizing?
6. What are the sizing inputs required from GOEM/customer for the proper recommendations?
7. How to read the sizing Output ?

Why Derate calculations are important

Derating the technique employed in power electrical and electronic devices wherein the devices are operated at less than their rated maximum power dissipation".
The factors matters for this are altitude, Ambient temperature, Class of Insulation in case of alternators.

Altitude: In areas of high altitude, air pressure drops reducing the air density. This can create problems with generator start up. air is crucial for ignition in any type of generator. Another factor that gets affected is availability of ambient air to facilitate heat dissipation from the generator. A lot of heat is created during the combustion process and needs to be dissipated into the environment to reduce engine temperature. At high altitudes, due to the low air density, heat dissipation occurs at a much slower rate than it would at sea levels, resulting in high engine temperatures for a sustained period of time. The engine remains hot and overheating is a common problem in such cases.

Temperature: High temperatures are also associated with lower air density and can cause similar ignition problems due to inadequate air supply. This can burden the engine which pushes itself to deliver the power it is designed to. However, due to inadequate oxygen levels available for combustion, it fails to do so. In many such instances, the engine gets overheated and sometimes collapses altogether.

Temperature Rise details

Class B temperature rise: For example, an 80°C **rise** is often referred to as a '**Class B**' **temperature rise**, since 80°C is the maximum allowable **temperature rise** (by resistance) for a 1.0 S.F. motor insulated with **Class B** insulation based on a 40°C ambient.

Class F: For example, an 105°C **rise** is often referred to as a '**Class F**' **temperature rise**, since 105°C is the maximum allowable **temperature rise** (by resistance) for a 1.0 S.F. motor insulated with **Class F** insulation based on a 40°C ambient.

Class H: For example, an 125°C **rise** is often referred to as a '**Class F**' **temperature rise**, since 105°C is the maximum allowable **temperature rise** (by resistance) for a 1.0 S.F. motor insulated with **Class F** insulation based on a 40°C ambient.

Winding 311 **0.8 Power Factor**

RATINGS

	Class - Temp Rise	Cont. F - 105/40°C				Cont. H - 125/40°C				Standby - 150/40°C				Standby - 163/27°C			
50 Hz	Series Star (V)	380	400	415	440	380	400	415	440	380	400	415	440	380	400	415	440
	Parallel Star (V)	190	200	208	220	190	200	208	220	190	200	208	220	190	200	208	220
	Series Delta (V)	220	230	240	254	220	230	240	254	220	230	240	254	220	230	240	254
	kVA	450	495	450	450	500	550	500	500	515	575	515	515	550	590	550	530
	kW	360	396	360	360	400	440	400	400	412	460	412	412	440	472	440	424
	Efficiency (%)	94.8	94.7	95.0	95.1	94.5	94.3	94.8	94.9	94.4	94.1	94.7	94.9	94.1	94.0	94.5	94.8
	kW Input	380	418	379	379	423	467	422	421	436	489	435	434	468	502	466	447

What are the derate inputs required from GOEM/customer to give the proper recommendations?

To know to whom we are serving

What is Power Output & Qty. tender requirement

Rating Application

For proper Alternator selection

									Alternator				
Sr. No.	Name of Customer	Name of OEM	DG kVA rating Requirement at Site as per tender	No. of sets required at site	Prime/Standby/Continuous /DCC Rating	Site Ambient Temp. as per tender		Site Altitude as per tender	1ph/3ph	50Hz/60Hz	Insulation class requirement	Temprature Rise requirement	Any spacific requirement as per tender
						Minimum	Maximum						

Tender requirement for temp. & altitude.
Always mention min. & max. temp (if mentioned on tender) to check whether the genset validation done on it or not.

Incase any tender requirement of PMG/HT frames /Paralleling

CGT standard Guideline for Temperature Rise

Alternator General Rating Chart for Industrial Application

Rating :- 415V , 3 phase, 50 Hz, 4-pole, 1500 rpm, 0.8 p.f. lag , Altitude up to 1000 mtr above m.s.l, IP-23 protection, S1 duty, IC01 cooling.

FRAME	Class H to H , Ambient 40 degree C	Class H to H , Ambient 45 degree C	Class H to H , Ambient 50 degree C	Class H to F , Ambient 40 degree C	Class H to F , Ambient 45 degree C	Class H to F , Ambient 50 degree C	Class H to B , Ambient 40 degree C	Class H to B , Ambient 45 degree C	Class H to B , Ambient 50 degree C
PI04D	7.5	7.2	7	6.8	6.5	6.3	6	5.7	5.5
PI04E	10	9.7	9.4	9.1	8.8	8.5	8	7.7	7.4
PI04F	12.5	12.1	11.7	11.4	11	10.6	10	9.6	9.2
PI04G	15	14.5	14.1	13.7	13.2	12.8	12	11.5	11.1
PI04H	17.5	16.9	16.4	16	15.4	14.9	14	13.4	12.9
PI14D	20	19.4	18.8	18.2	17.6	17	16	15.4	14.8
PI14E	25	24.2	23.5	22.8	22	21.3	20	19.2	18.5
PI14F	27.5	26.6	25.8	25	24.1	23.3	22	21.1	20.3
PI14G	30	29.1	28.2	27.5	26.6	25.7	24	23.1	22.2
PI14H	35	33.9	32.9	32	30.9	29.9	28	26.9	25.9
PI14J	40	38.8	37.6	36.5	35.3	34.1	32	30.8	29.6
PI14K	42.5	41.2	39.9	37.5	36.2	34.9	32.9	31.6	30.3
UCI224C	40	38.8	37.6	35.2	34	32.8	31	29.8	28.6
UCI224D	50	48.5	47	45	43.5	42	40	38.5	37
UCI224E	60	58.2	56.4	53	51.2	49.4	47	45.2	43.4
UCI224V	63	61.1	59.2	56.7	54.8	52.9	49.1	47.2	45.3
UCI224F	70	67.9	65.8	61.6	59.7	57.9	53	51.9	49.8
UCI224G	82.5	80	77.5	72.6	70.3	67.8	66	63.5	61
UCI274C	100	97	94	84	81	78	75	72	69
UCI274D	110	106.7	103.4	96.4	93.1	89.8	86	83.4	80.2
UCI274V	125	121.2	117.5	110	106.2	102.5	96	93.1	90
UCI274E	140	135.8	131.6	125	120.8	116.6	112.5	108.3	104.1
UCI274F	160	155.2	150.4	145	140.2	135.4	126	121.2	116.4
UCI274G	180	174.6	169.2	162	157.3	151.9	140	135.8	130.6
UCI274H	200	194	188	182	176	170	158	152	146
UCD274J	230	223.1	216.2	210	203.1	196.2	180	173.1	166.2
UCD274K	250	242.5	235	229	221.5	214	200	192.5	185
HCI44C	250	242.5	235	230	222.5	215	200	192.5	185
HCI44D	300	291	282	280	271	262	240	231	222

FRAME	Class H to H , Ambient 40 degree C	Class H to H , Ambient 45 degree C	Class H to H , Ambient 50 degree C	Class H to F , Ambient 40 degree C	Class H to F , Ambient 45 degree C	Class H to F , Ambient 50 degree C	Class H to B , Ambient 40 degree C	Class H to B , Ambient 45 degree C	Class H to B , Ambient 50 degree C
HCI44E	350	339.5	329	320	309.5	299	275	264.5	254
HCI44F	380	368.6	357.2	349.6	339	328.6	300	291	281.2
HCI54C	455	441.3	427.7	400	386.3	372.7	350	336.3	322.7
HCI54D	500	485	470	450	435	420	390	375	360
HCI54E	600	582	564	550	532	514	480	462	444
HCI54F	670	649.9	629.8	620	599.9	579.8	540	519.9	499.8

FRAME	Class H to H , Ambient 40 degree C	Class H to H , Ambient 45 degree C	Class H to H , Ambient 50 degree C	Class H to F , Ambient 40 degree C	Class H to F , Ambient 45 degree C	Class H to F , Ambient 50 degree C	Class H to B , Ambient 40 degree C	Class H to B , Ambient 45 degree C	Class H to B , Ambient 50 degree C
HCI64W	750	727.5	705	683	660.5	638	575	557.6	540
HCI64V	800	776	752	750	726	702	640	616	592
HCI64Y	1050	1018.5	987	956	924.5	893	805	780.8	756
HCI64Z	1250	1212.5	1175	1138	1100.5	1063	962	933	900
PI74B	1400	1358	1316	1305	1263	1221	1205	1163	1121
PI74C	1550	1503.5	1457	1445	1398.5	1352	1335	1288.5	1242
PI74E	1900	1843	1786	1770	1713	1656	1635	1578	1521
PI74F	2080	2017.6	1955.2	1935	1872.6	1810.2	1790	1727.6	1665.2
PI74G	2200	2134	2068	2050	1984	1918	1895	1829	1763

Additional CGT guideline for derate factor as per Site condition :-

1. Additional 3% deration is applicable for every 5 degree C more ambient above 40 degree C, up to 60 degree C ambient.
2. Additional 3% deration is applicable for every 500mtr above 1000mtr msl, up to 4000mtr.
3. Always Deration factor to be apply cumulative for applicable conditions.

Sample Derate Calculations

Recommended engine model & kVA rating
as per final power output

As per given inputs
rating Application

Power & %derate
(as per site conditions)
for mentioned
engine model as per
engine datasheet.

Engine power in kWm
considering fan power,
battery charger power &
net power

Check slide 6-7 for
H to F temp. rise derate.
Recommended Alternator frame

Additional derate as per
general CGT guideline. See
slide 7

Alternator Power Output

Out of engine & alternator, whichever power is lower will be consider as Genset Power output in kVA

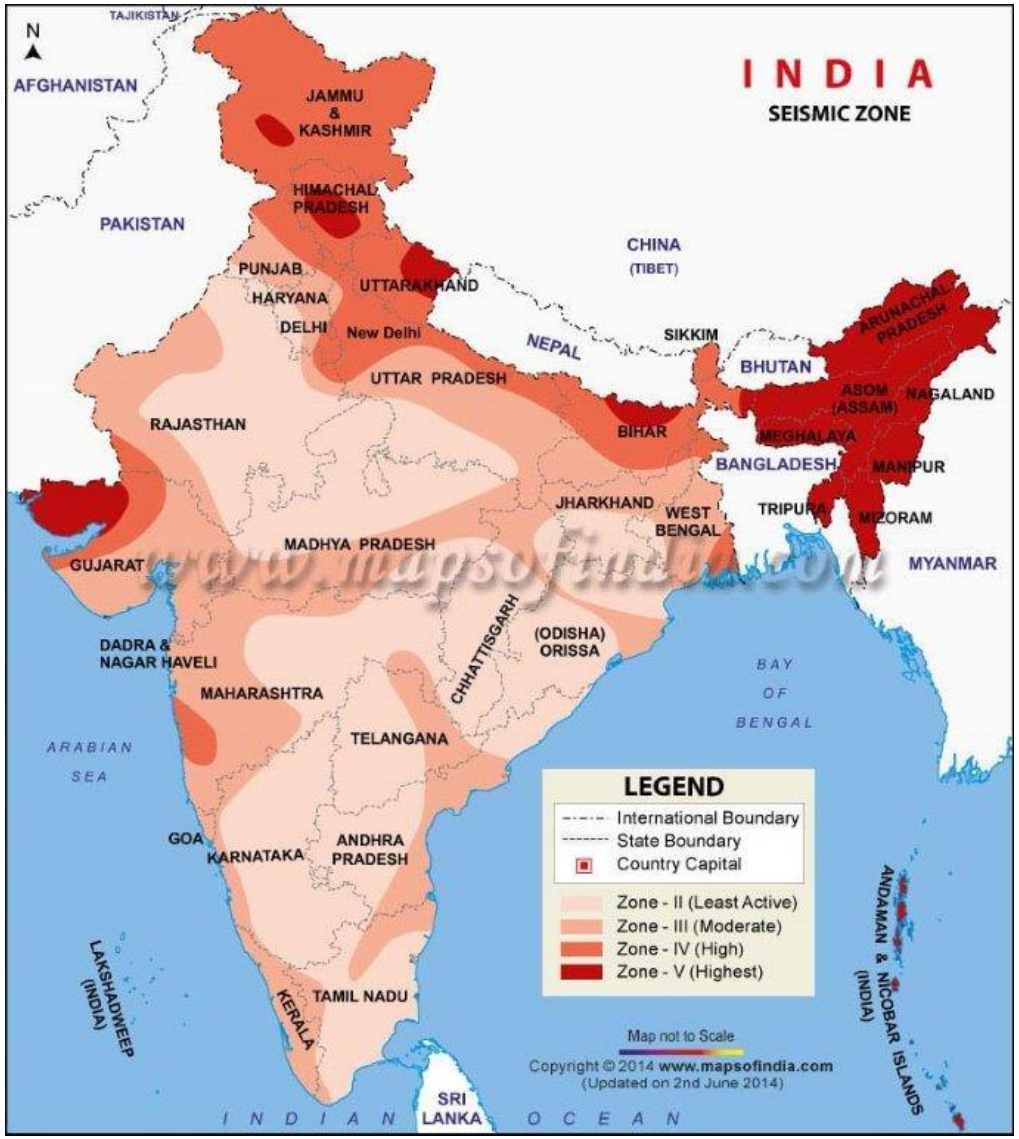
Temp. rise requirement as per tender

DG set power output calculation			
Engine Model :		QSB5.9-G1	
Genset Model :		C140D5P	
Cooling system :			
Dated		05.02.2019	
		Prime Rating	
Description	UOM		Remarks
A. Engine derate calculation.			
Prime (Prime Power BHP)	BHP	184.0	
Deration for Engine - AT 1000m/ MSL, ambient temp 50Deg C	%	0.7%	
Net Power after deration	BHP	183	
Fan	BHP	10.05	
Charging Alternator	BHP	1.47	
Nett power at fly wheel	BHP	171	
Conversion factor (1 BHP = 0.746 kW)		0.746	
Engine power after deration	kW(m)	128	
B. Alternator derate calculation			
Alternator rating at 50degC ,1000m altitude, Class H temp. rise	kVA	140.0	Alternator Frame Stamford UCI274E
Alternator Rating for Winding temp. Rise requirement class (~~105~~/125/~~150~~)	kVA	140.0	H to H
Derate factor for altitude	%	0.00%	
Deration for ambient temp.	%	6.00%	
Total derate applicable	%	6.00%	
Site derated Power for alternator	kVA	132	
C. DG Set Power Derate calculation- site specific rating			
DG corrected output	kWe	117	
P.F.		0.80	
Estiimated Alternator efficiency	%	92.00%	
Site Specific rating output (Lowest from engine & alternator derated power)	kVA	132	
	kWe	105	

13. Understanding Seismic compliance requirements

Seismic Map of India-

India falls under either
Zone 2
Zone 3
Zone 4
Zone 5



14. Alternator RTD & BTD Thresholds

Alternator- RTD & BTD Thresholds

TABLE . ALARM AND SHUTDOWN TEMPERATURE SETTINGS FOR WINDINGS

Windings insulation	Max. Continuous temperature (°C)	Alarm temperature (°C)	Shutdown temperature (°C)
Class B	130	120	140
Class F	155	145	165
Class H	180	170	190

To detect overheating of bearings, control signals should be set according to the following table.

TABLE 13. ALARM AND SHUTDOWN TEMPERATURE SETTINGS FOR BEARINGS

Bearings	Alarm temperature (°C)	Shutdown temperature (°C)
Drive end bearing	45 + maximum ambient	50 + maximum ambient
Non-drive end bearing	40 + maximum ambient	45 + maximum ambient

Table L 9

Q+A


Cummins