Data Center MIL03 Settimo Milanese

Studio di Impatto Ambientale

Allegato A – Modello di dispersione degli inquinanti in atmosfera

LSMIL031-DOC-G-022-4 | <00>

Dicembre 2023

MICROSOFT 4825 ITALY S.R.L.

Firmato digitalmente da: Claudio Maria Giacobbe Albano
Luogo: COLOGNO MONZESE
Data: 21/12/2023 11:04:07

Lightspeed Data Center Settimo Milanese, Italia

Project No:	LSMIL031
Document Title:	Studio di Impatto Ambientale - Allegato A – Modello di dispersione degli inquinanti in atmosfera
Document No.:	Document No. LSMIL031-DOC-G-022-4
Revision:	00
Document Status:	Finale
Date:	Dicembre 2023
Client Name:	MICROSOFT 4825 ITALY S.R.L
Client No:	P18151
Project Manager:	Stefano Piccio
Author:	CH2M HILL srl (part of Jacobs)
File Name:	MIL03_Studio_Impatto_Ambientale_Allegato A_rev00

CH2M HILL S.r.L

Via Alessandro Volta N 16
Cologno Monzese (MI)
Milan, Italy
T +39 02 250 981
F +39 02 250 98506
www.jacobs.com

Dott. Ing. LUCA SANESE ALBO INGEGNERI PROV. DI CHIETI N° 1314 ORD. CHIETI

Document history and status

Revision	Date	Description	Author	Checked	Reviewed	Approved
00	Dicembre 2023	Prima Emissione	Luca Sanese (ENGEA)-Consulente	Laura Tomasi (Ingegnere Ambientale)	Stefano Piccio (Geologo)	Claudio Albano (Ingegnere Ambientale)
			Claudio Albano iscritto all'ordine degli Ingegneri di Milano n. A 32263			

ALLEGATO A

Questo Allegato continue le seguenti relazioni:

- Modello di dispersione degli inquinanti in atmosfera

Studio Preliminare Ambientale

Data Center Settimo Milanese – Edificio ML3

ALLEGATO A

Studio delle dispersione degli inquinanti in atmosfera relativo all’ esercizio dei generatori di back-up

Indice

Indice delle figure

Indice delle tabelle

1. Introduzione

La presente relazione costituisce l'Allegato A ("Studio di dispersione degli inquinanti in atmosfera") allo Studio Preliminare Ambientale relativo all'installazione ed esercizio dei generatori di back-up a servizio del nuovo Data Center Microsoft di Settimo Milanese (MI), che verrà ospitato in un edificio di nuova costruzione denominato "MIL03".

I generatori di back-up garantiranno la continuità all'approvvigionamento energetico in mancanza di fornitura di energia dalle linee di alimentazione dell'ente distributore, in particolare, le simulazioni considerano l'installazione di 9 generatori a servizio dell'edificio MIL03[1].Il funzionamento dei generatori è previsto solo in caso di eventi incidentali che comportino l'interruzione dell'alimentazione elettrica delle unità del sito; dunque, il totale delle ore di funzionamento dei generatori e la loro distribuzione nel corso dell'anno solare non è prevedibile. Sulla base dei dati statistici medi forniti dal Gestore della Rete, si è assunto che il funzionamento dei generatori di emergenza non superi le 2 ore continuative.

È prevista inoltre l'accensione dei generatori in occasione dell'ordinaria manutenzione che prevede i seguenti test di funzionamento standard:

- un test annuale di funzionamento a pieno carico in modo alternato, un generatore alla volta, della durata compresa tra 60 e 90 minuti per generatore
- un test trimestrale di funzionamento al 70% del carico in modo alternato, un generatore alla volta della durata di 30 minuti per generatore
- un test mensile di funzionamento a carico nullo in modo alternato, un generatore alla volta, della durata di 15 minuti per generatore,

Ogni test prevede 5min di *cooldown* per l'arresto del generatore e nel corso del mese non viene effettuato più di un test per generatore. Pertanto, complessivamente, ogni generatore è previsto essere attivo per: 1*65min +1*95min + 3*35min + 8*20min = 425min = 7,1h; per un totale di circa 57 ore complessive di test di funzionamento per i 9 generatori principali di MIL03.

In aggiunta a quanto sopra sono previsti inoltre test (USS/UPM) su base quinquennale con azionamento multiplo dei generatori per 90+5 min, per un massimo di 95 min*9generatori = 855 min = circa 15 ore complessive.

Il funzionamento dei generatori in condizioni ordinarie è previsto pertanto pari a circa 72 ore complessive annuali.

L'accensione e lo spegnimento di ogni generatore in caso di assenza dell'alimentazione elettrica è automatico e la fase di entrata in regime in termine di carico è immediata.

Il presente studio si propone di valutare, attraverso l'utilizzo di una simulazione modellistica, l'impatto sulla qualità dell'aria della dispersione degli inquinanti emessi a camino dai generatori durante la normale attività di manutenzione. Con approccio cautelativo, lo scenario considerato (Scenario 1) per la simulazione è il test annuale di maggiore durata (90 minuti) ovvero quello che prevede l'accensione sequenziale di tutti i 9 generatori a pieno carico per 90 minuti ciascuno assumendo che le attività di manutenzione procedano ad un ritmo pari a due generatori al giorno, uno alla mattina ed uno il pomeriggio, per un periodo complessivo pari a 4,5 giorni consecutivi nel mese in cui è effettuato il test annuale. Nella simulazione, per coerenza modellistica, si è prevista l'accensione per 120 minuti e, tale scenario emissivo, sebbene riferito ad un test annuale, è stato ripetuto per ogni mese, allo scopo di valutare la dispersione degli inquinanti durante i normali test di funzionamento, considerando la variabilità delle condizioni meteorologiche nel corso di un anno solare.

[1] Viene trascurato il generatore a servizio del sistema di trattamento acque di potenza inferiore a 1 MWt.

Inoltre, lo studio ha preso in esame il verificarsi di una condizione di emergenza (Scenario 2), che comporti l'accensione contemporanea di tutti i generatori per 2 ore consecutive. Per valutare gli effetti sulla qualità dell'aria di tale scenario emergenziale è stato utilizzato un approccio di tipo stocastico, volto a stimare la probabilità di ricadute al suolo significative presso i recettori limitrofi all'impianto. L'evento emergenziale (durata 2h) è stato simulato con una frequenza di accadimento ogni 26 ore per un intero anno (N=337), al fine di considerare la variabilità delle diverse condizioni meteorologiche nelle diverse ore del giorno e nelle diverse stagioni dell'anno. x

Lo studio è stato condotto in accordo alle linee guida ARPA Lombardia "*Indicazioni relative all'utilizzo di tecniche modellistiche per la simulazione della dispersione di inquinanti negli studi di impatto sulla componente atmosfera*" – ottobre 2018.

I generatori sono stati selezionati al fine di funzionare sia con combustibili tradizionali (diesel), sia con biocarburanti (HVO diesel) in maniera flessibile, sulla base delle esigenze di mercato. Per questa ragione, le simulazioni sono state definite tenendo anche in considerazione lo scenario emissivo più sfavorevole tra le due tipologie di carburanti.

Gli inquinanti pertinenti considerati nel presente studio sono:

- biossido di azoto (NO_2);
- particolato atmosferico (PM_{10});
- monossido di carbonio (CO);
- ammoniaca (NH_3), in caso di utilizzo della tecnologia SCR (Selective Catalytic Reduction), e il rischio di trascinamento (slip) di ammoniaca
- acido cloridrico (HCl), in caso di utilizzo di biocarburanti HVO Diesel
- COV espressi come Carbonio Organico Totale (COT)

Lo studio è stato elaborato attraverso le seguenti fasi:

- Definizione degli Standard di Qualità dell'Aria relativi agli inquinanti considerati, con cui confrontare i risultati del modello (**Capitolo 2**)
- Definizione delle caratteristiche meteoclimatiche nell'area di studio, effettuata mediante l'analisi dei dati da centraline meteo presenti nella zona rielaborati da un preprocessore meteorologico. Allo scopo è stato acquisito ed analizzato il set di dati per l'intero anno 2021 (**Capitolo3**).
- Caratterizzazione dello stato attuale della qualità dell'aria, effettuata mediante l'analisi dei dati registrati ed elaborati da ARPA Lombardia con riferimento ai parametri considerati nel presente studio (**Capitolo 4**).
- Simulazione della dispersione degli inquinanti emessi in atmosfera, tramite la modellizzazione delle sorgenti emissive e degli effetti scia dovuti agli edifici circostanti e l'impostazione delle griglie di calcolo e dei recettori sensibili. (**Capitolo 4.4**).
  Per ciascun inquinante sono stati quindi calcolati i valori di concentrazione al livello del suolo negli opportuni termini medi e/o percentili necessari per effettuare i confronti con gli standard di qualità dell'aria.

I risultati delle simulazioni (**Capitolo 6**) sono riportati sotto forma di tabelle e mappe di ricaduta, al fine di valutare le possibili modificazioni della qualità dell'aria nell'area circostante l'impianto in oggetto. Le simulazioni modellistiche di ricaduta al suolo degli inquinanti emessi sono state prodotte utilizzando il modello CALPUFF (v. 7.2.1) in catena al preprocessore meteorologico CALMET (v. 6.5.0). Per l'elaborazione dei dati di output al modello è stato utilizzato CALPOST (v. 7.1.0).

Il **Capitolo 7** riporta delle considerazioni conclusive relative allo studio.

2. Riferimenti normativi

Il principale riferimento normativo a livello nazionale in materia di qualità dell'aria è il Decreto Legislativo n. 155 del 13/08/2010, Attuazione della direttiva 2008/50/CE relativa alla qualità dell'aria ambiente e per un'aria più pulita in Europa.

Con riferimento agli inquinanti esaminati nel presente studio, i valori limite per la tutela della qualità dell'aria stabiliti dal D.Lgs. 155/2010, Allegato XI, sono indicati in **Tabella 2-1**.

Inquinante	Livello di concentrazione	Periodo di mediazione	Valore limite
CO	**Valore limite** giornaliero per la protezione della salute umana	Massimo giornaliero della media mobile calcolata su 8 ore	10 mg/m^3
NO_2	**Valore limite** orario per la protezione della salute umana	1 ora	200 µg/m^3 da non superare più di 18 volte per anno civile
	Valore limite annuale per la protezione della salute umana	Anno civile	40 µg/m^3
PM_{10}	**Valore limite** giornaliero per la protezione della salute	24 ore	50 µg/m^3 da non superare più di 35 volte per anno civile
	Valore limite annuale per la protezione della salute umana	Anno civile	40 µg/m^3

Tabella 2-1: valori limite per la tutela della qualità dell'aria stabiliti dal D.Lgs. 155/2010

Le normative nazionali ed europee non stabiliscono valori limite o standard da rispettare per le concentrazioni in aria ambiente di **NH_3.** Le Linee Guida WHO (Air Quality Guidelines for Europe – second edition, 2000) stabiliscono il **livello critico per l'ambiente** per i composti azotati. I livelli critici sono basati su un'indagine di evidenze scientifiche pubblicate di effetti fisiologici ed ecologicamente importanti solo sulle piante, in particolare acidificazione ed eutrofizzazione. Il livello critico fissato per l'NH_3 è di 270 µg/m^3 come media giornaliera.

L'attuale normativa non prevede limiti per i parametri **COV/COT** (composti organici volatili / carbonio organico totale) e **HCl** (acido cloridrico).

3. Caratteristiche meteoclimatiche dell'area

3.1 Il modello meteorologico CALMET

I dati meteorologici relativi all'anno 2021 usati nelle simulazioni del presente studio sono stati ricostruiti mediante l'applicazione del modello CALMET, in base ai dati rilevati nelle stazioni SYNOP ICAO (International Civil Aviation Organization) di superficie e profilometriche presenti sul territorio nazionale e ai dati rilevati nelle stazioni locali sito-specifiche della rete ARPA Lombardia presenti in un dominio di 20 x 20 km centrato nell'area di progetto (Origine SW x = 493374.00 m E - y = 5026414.00 m N UTM fuso 32 – WGS84) con una risoluzione spaziale orizzontale (dimensioni griglia) di 1000 m e una risoluzione verticale (quota livelli verticali) di 0-20-50-100-200-500-1000-2000-4000 m sul livello del suolo.

CALMET è un modello meteorologico in grado di generare campi di vento variabili nel tempo e nello spazio, punto di partenza per il modello di simulazione vero e proprio. I dati richiesti come input sono dati meteo al suolo e in quota (vento, temperatura, pressione), dati geofisici per ogni cella della griglia di calcolo (altimetria, uso del suolo), e dati al di sopra di superfici d'acqua, quando queste sono presenti (differenza di temperatura aria/acqua, vento, temperatura). In output, oltre ai campi di vento tridimensionali, si ottengono altre variabili come l'altezza di rimescolamento, la classe di stabilità, l'intensità di precipitazione, il flusso di calore e altri parametri per ogni cella del dominio di calcolo.

CALMET prende in considerazione i dati provenienti da diverse stazioni meteorologiche che si possono trovare in aria, al suolo o in corrispondenza di superfici acquose e delle quali si indicano le coordinate all'interno della griglia di calcolo. Questi dati vengono utilizzati per creare un unico file meteorologico in cui le informazioni delle diverse stazioni vengono interpolate per ottenere valori che variano da cella a cella nella griglia meteorologica definita per la simulazione. Questa elaborazione delle informazioni provenienti dalle stazioni meteo avrà effetti sulla successiva fase di simulazione della dispersione degli agenti odorigeni, in particolare inciderà sul percorso seguito dal puff e quindi sulle concentrazioni percepite al suolo. Il modello diagnostico per il calcolo dei campi di vento utilizza un algoritmo in due fasi:

- nella prima fase una stima iniziale del campo di vento viene modificata in base agli effetti cinematici del terreno, dei pendii presenti, degli effetti di blocco.

- nella seconda fase, vengono introdotti i dati osservati dalle stazioni meteo all'interno del campo prodotto dalla prima, ottenendo così il campo di vento finale.

Nella **Tabella 3-1** e **Figura 3-1** sono indicate le stazioni meteo utilizzate per la ricostruzione del campo meteorologico.

Stazione meteo	Coordinate (UTM fuso 32-WGS84)	Distanza dal sito di progetto	Utilizzo in CALMET
Stazione radiosondaggi SYNOP ICAO 16064-Cameri profilo	521901.00 m E 5030755.00 m N	19 km	Dati in quota
Stazione ARPA Lombardia Corsico – v.le Italia	507619.00 m E 5031403.00 m N	6,5 km	Dati di superficie sito specifici
Stazione ARPA Lombardia Rho – Scalo Fiorenza	507155.00 m E 5040421.00 m N	6,2 km	Dati di superficie sito specifici
Stazione di superficie SYNOP ICAO LINATE - LIML 160800	521662.00 m E 5032423.00 m N	29 km	per dati sinottici di pressione, copertura nuvolosa e altezza nubi

Tabella 3-1: Coordinate stazioni meteo

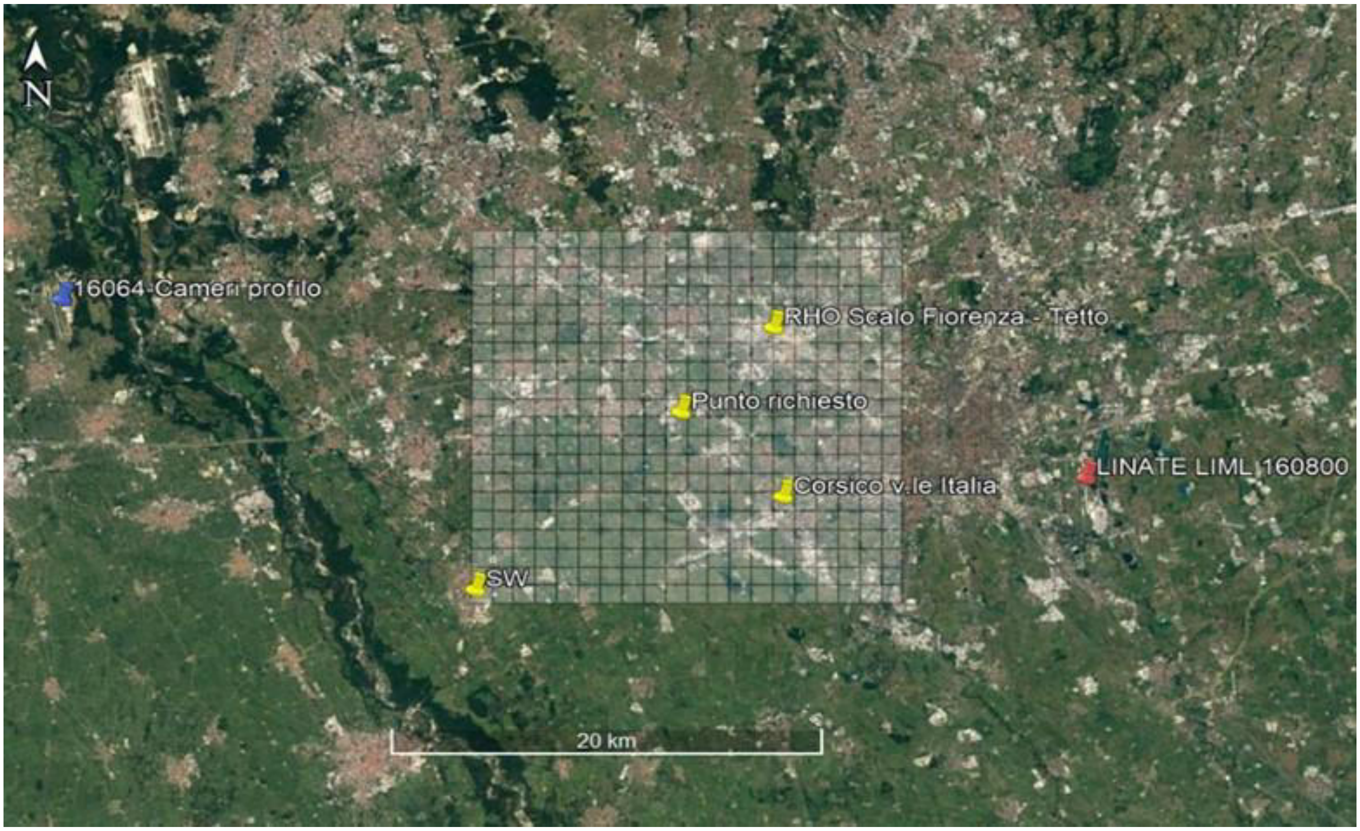


Figura 3-1: Stazioni meteo e griglia meteorologica utilizzate in CALMET (fonte: elaborazione su Google Earth)

Nei paragrafi seguenti vengono riportati i principali parametri meteorologici misurati dalle stazioni di superficie e successivamente ricostruiti presso l'area di progetto tramite il preprocessore CALMET.

3.2 Temperatura

3.2.1 Dati misurati presso le stazioni di superficie

Periodo	Minima	Media	Massima
Anno	-7.50	14.51	35.40
Primavera	-0.10	13.40	26.50
Estate	15.30	24.79	35.40
Autunno	1.50	14.90	30.10
Inverno	-7.50	4.74	20.50
gen	-3.80	3.38	11.90
feb	-3.00	7.86	20.50
mar	-0.10	10.31	24.50
apr	2.10	12.78	26.50
mag	8.60	17.10	26.10
giu	15.50	24.58	34.60
lug	15.30	24.99	33.00
ago	16.40	24.80	35.40
set	12.70	21.70	30.10
ott	5.30	13.93	22.90
nov	1.50	9.10	16.90
dic	-7.50	3.29	11.80

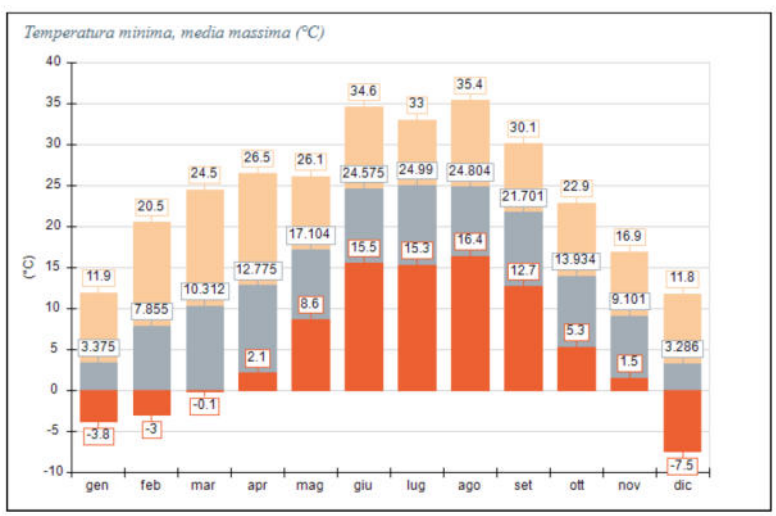


Figura 3-2: Andamento della temperatura - Stazione di Rho – anno 2021

Periodo	Minima	Media	Massima
Anno	-4.80	14.97	38.60
Primavera	-1.70	13.94	29.10
Estate	14.80	25.89	38.60
Autunno	-1.00	15.27	32.70
Inverno	-4.80	4.57	21.80
gen	-4.30	3.01	12.90
feb	-4.80	7.91	21.80
mar	-1.40	9.90	27.00
apr	-1.70	13.24	28.40
mag	9.60	18.66	29.10
giu	15.80	26.02	36.70
lug	16.10	26.33	36.40
ago	14.80	25.33	38.60
set	12.70	22.22	32.70
ott	3.50	14.14	25.20
nov	-1.00	9.51	17.00
dic	-3.50	3.11	11.10

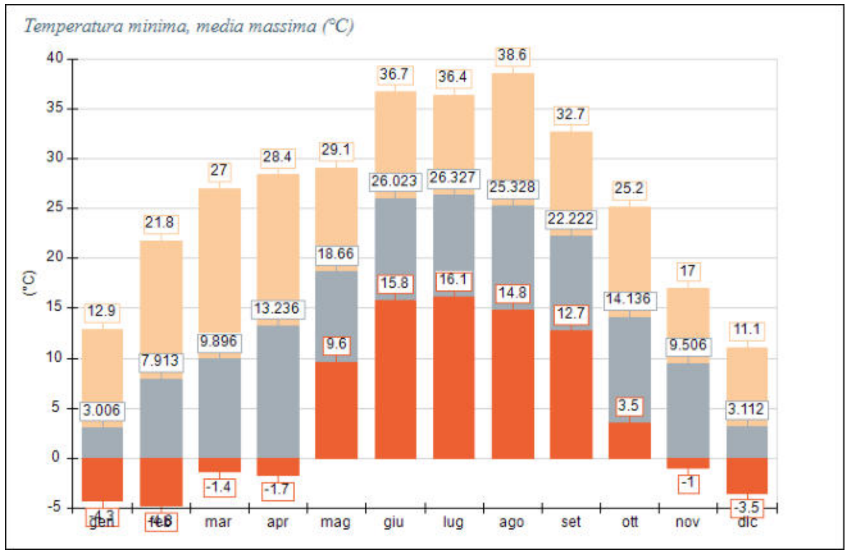


Figura 3-3: Andamento della temperatura - Stazione di Corsico – anno 2021

3.2.1 Dati ricostruiti presso l''area di progetto

In Figura 3-4è mostrato l'andamento delle temperature nell'area di studio ottenuto mediante l'applicazione del modello CALMET per l'anno 2021, come sopra descritto. La temperatura media risulta essere pari a 14,75°C; il mese con la temperatura media più elevata è luglio (temperatura media mensile pari a 25,7°C), il mese più freddo gennaio (media mensile pari a 3,2°C). Gli andamenti ricostruiti sono in linea con quanto misurato dalle stazioni di superficie.

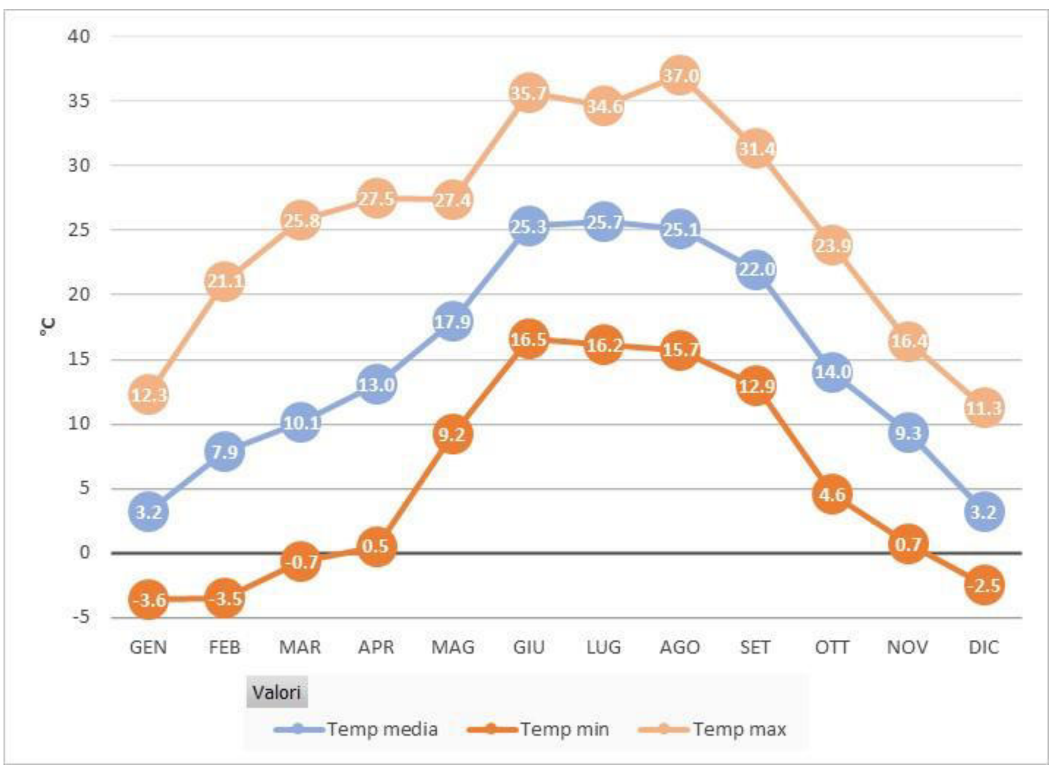


Figura 3-4: Andamento della temperatura presso l'area di progetto (fonte: elaborazione CALMET)

3.3 Precipitazioni

3.3.1 Dati misurati presso le stazioni di superficie

Periodo	Media	Massima	Cumulata
Anno	0.10	19.90	902.70
Primavera	0.07	12.00	152.20
Estate	0.08	19.90	179.10
Autunno	0.15	14.30	332.20
Inverno	0.11	5.60	239.20
gen	0.17	5.60	127.40
feb	0.13	4.80	85.40
mar	0.00	1.00	2.20
apr	0.06	5.00	46.00
mag	0.14	12.00	104.00
giu	0.08	19.90	58.30
lug	0.12	18.00	88.00
ago	0.04	7.30	32.80
set	0.11	14.30	80.40
ott	0.11	13.70	83.70
nov	0.23	9.00	168.10
dic	0.04	2.20	26.40

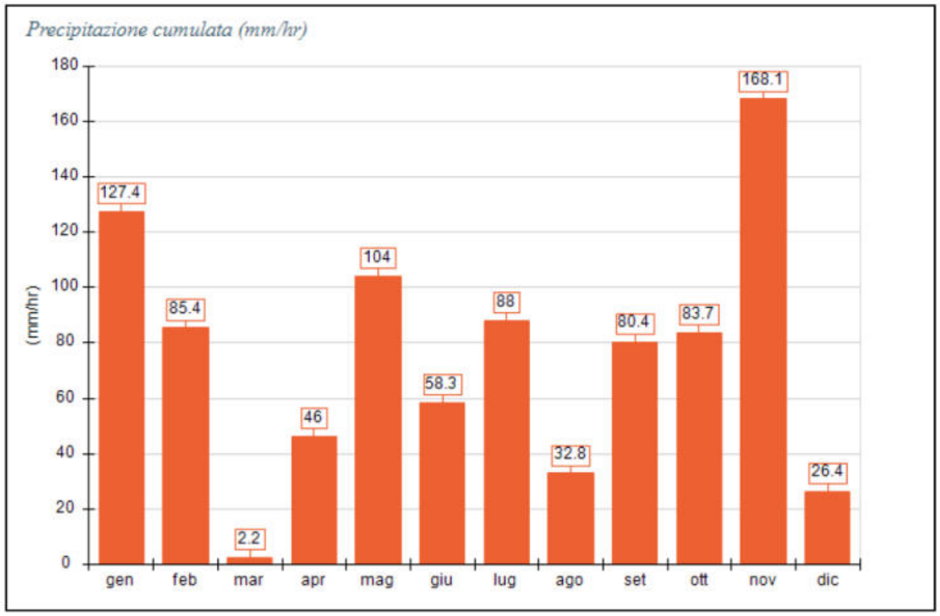


Figura 3-5: Andamento delle precipitazioni - Stazione di Rho – anno 2021

Periodo	Media	Massima	Cumulata
Anno	0.08	20.40	732.00
Primavera	0.06	11.80	140.20
Estate	0.03	20.40	73.00
Autunno	0.13	20.20	292.80
Inverno	0.10	4.20	226.00
gen	0.17	4.20	130.00
feb	0.07	2.80	50.00
mar	0.01	3.40	8.80
apr	0.10	5.60	70.60
mag	0.08	11.80	60.80
giu	0.02	9.20	15.80
lug	0.05	20.40	38.80
ago	0.02	12.20	18.40
set	0.10	20.20	75.20
ott	0.07	14.20	52.00
nov	0.23	7.00	165.60
dic	0.06	2.60	46.00

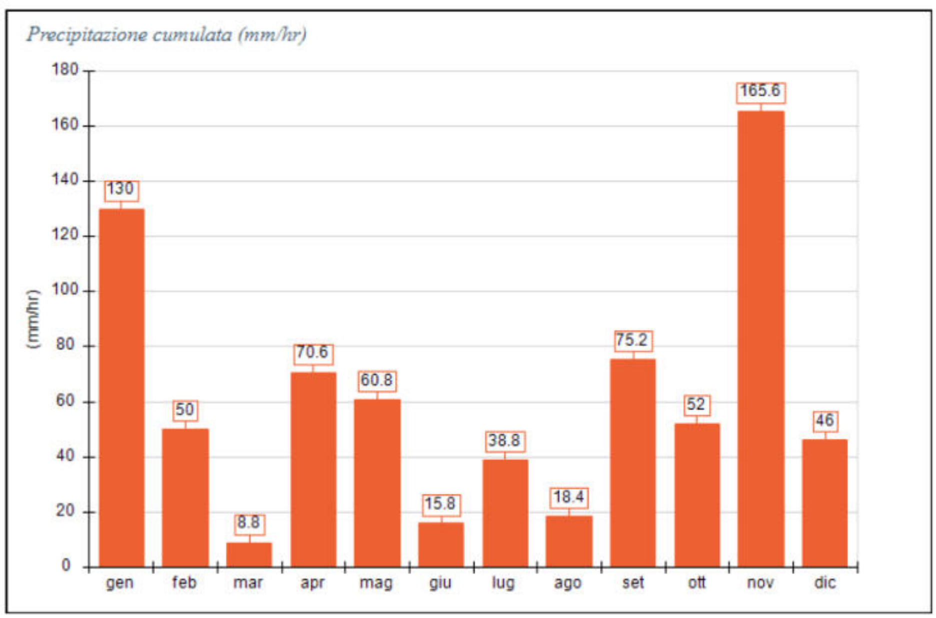


Figura 3-6: Andamento delle precipitazioni - Stazione di Corsico – anno 2021

3.3.2 Dati ricostruiti presso l''area di progetto

In Figura 3-7 è mostrato l'andamento delle precipitazioni nell'area di studio. Per l'anno 2021 risulta una precipitazione cumulata complessiva di 820 mm, con un massimo nel mese di novembre (166,8 mm) ed un minimo nel mese di marzo (5,4 mm). L'andamento ricostruito è in linea con quanto misurato dalle stazioni di superficie.

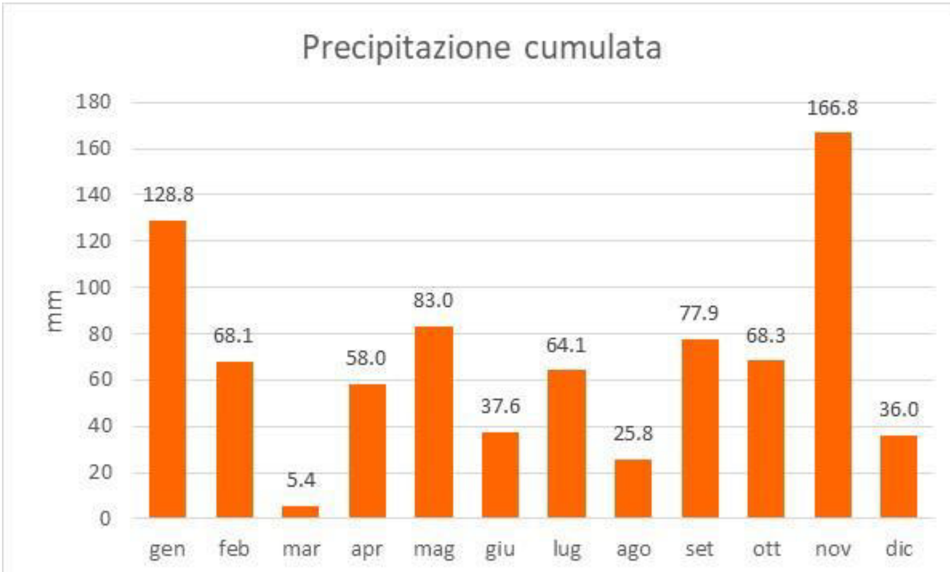


Figura 3-7: Andamento delle precipitazioni presso l'area di progetto – anno 2021 (fonte: elaborazione CALMET)

3.4 Direzione e velocità del vento

3.4.1 Dati misurati presso le stazioni di superficie

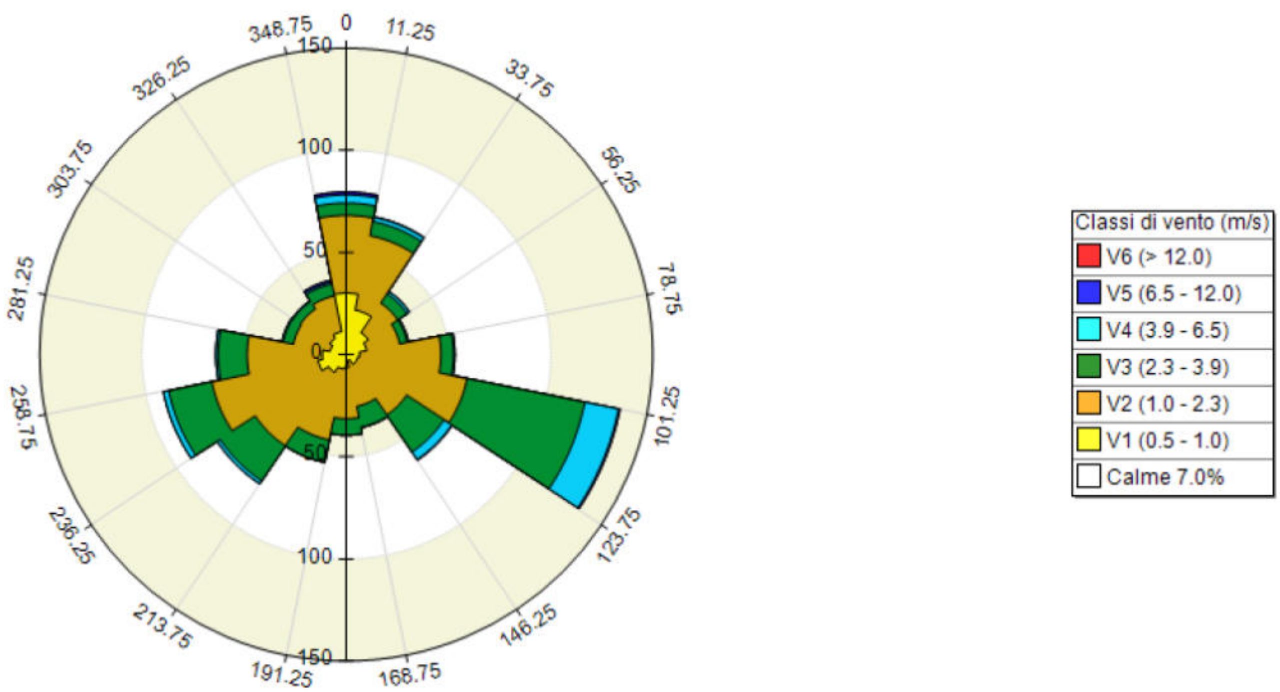


Figura 3-8: Rosa dei Venti - Stazione di Rho – anno 2021

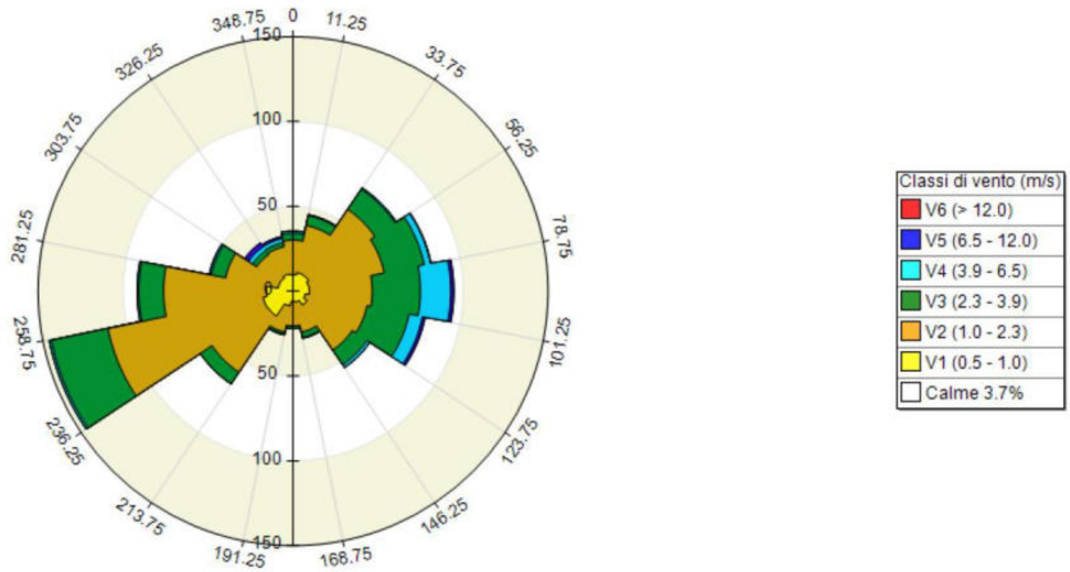


Figura 3-9: Rosa dei venti - Stazione di Corsico – anno 2021

3.4.2 Dati ricostruiti presso l''area di progetto

In Figura 3-10 è mostrata la distribuzione percentuale delle classi di velocità del vento. I valori di velocità del vento si riferiscono ad una quota di 10 metri dal p.c. La velocità media annuale del vento è di 1,59 m/s. In generale si osserva una predominanza dei venti di intensità compresa nelle classi di velocità basse: le velocità più frequenti (49,9%) sono quelle comprese nella classe V2 (1-2,3 m/s), seguite dalla classe V1 (0,5-1 m/s) con frequenza del 21,1%. Le direzioni prevalenti risultano quelle da E-ESE e O-OSO; dai quadranti orientali provengono i venti dotati di velocità maggiore (Figura 3-5). La ricostruzione modellistica è il risultato della combinazione delle rose dei venti misurate presso le stazioni limitrofe di Rho e Corsico.

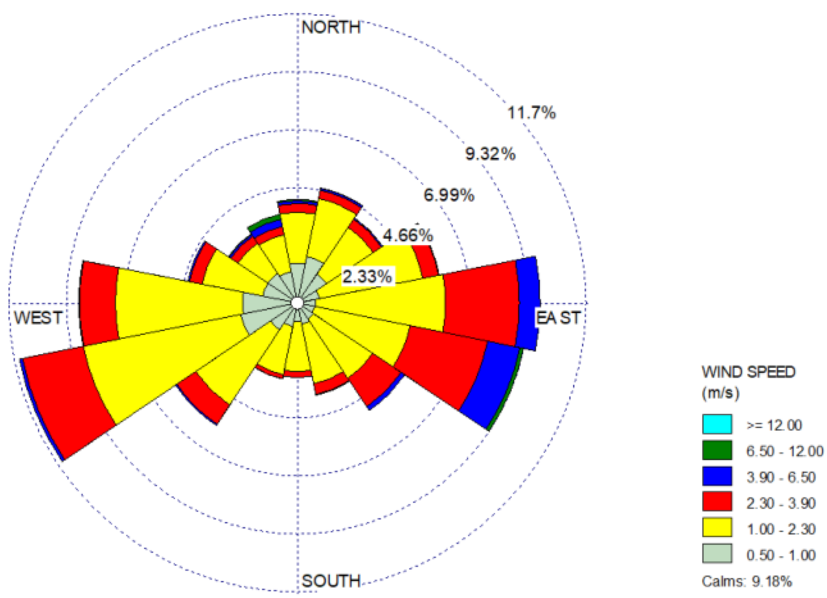


Figura 3-10: Rosa dei venti presso l'area di progetto (fonte: elaborazione CALMET)

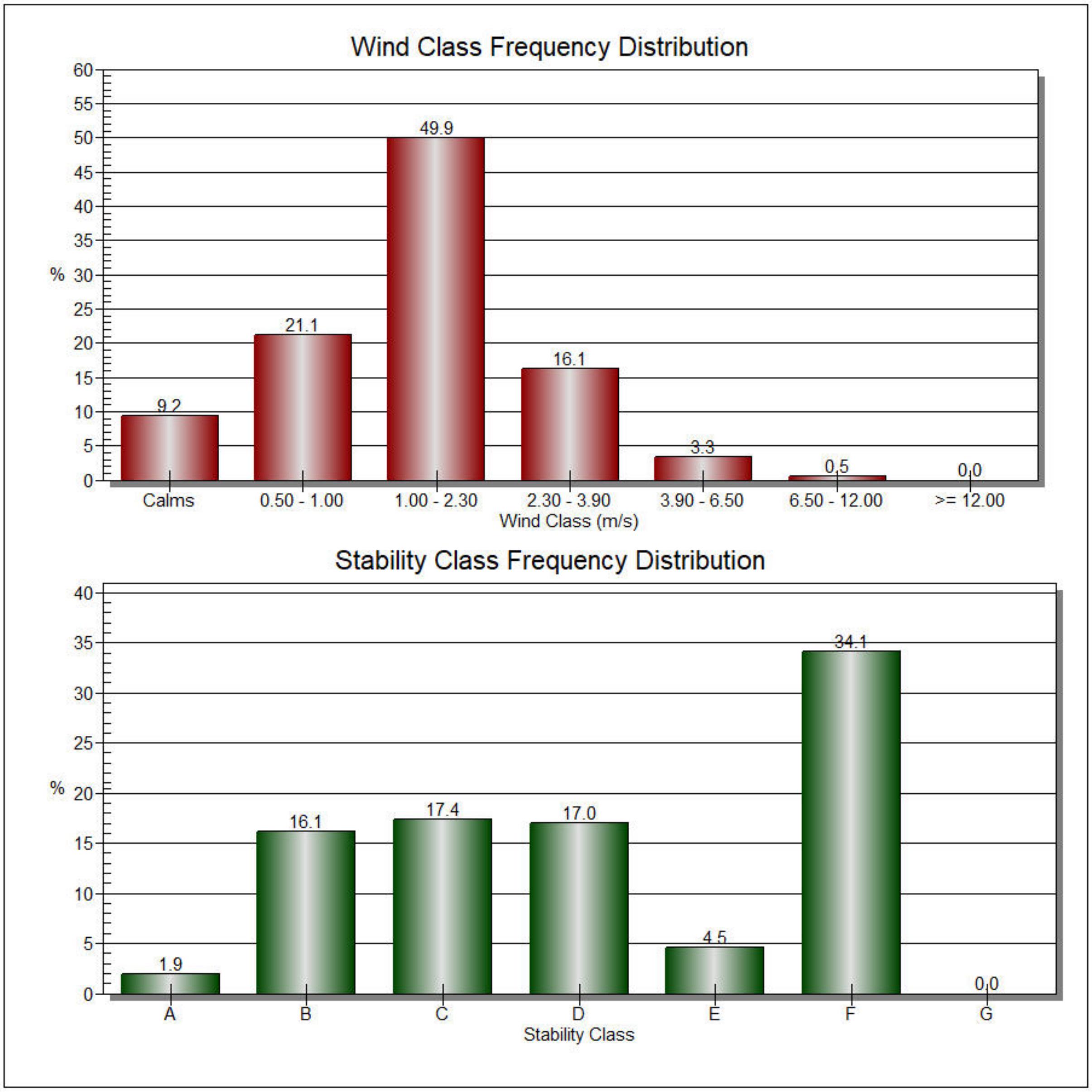


Figura 3-11: Distribuzione percentuali delle velocità dei venti e delle classi di stabilità presso l'area di progetto (fonte: elaborazione CALMET)

4. Stato della qualità dell'aria

Secondo la zonizzazione per la valutazione della qualità dell'aria ambiente approvata dalla Regione Lombardia con D.G.R. n. IX/2605 del 30/11/2011, ai sensi del D.Lgs. n. 155/2010, il territorio interessato dalle attività afferenti al nuovo Data-Center situato nel comune di Settimo Milanese è classificato all'interno dell'**Agglomerato di Milano – Fascia 1**. All'interno del buffer di 3km intorno alla nuova installazione, si trovano i comuni di Bareggio, Cornaredo e Cusago classificati in **Zona A - pianura ad elevata urbanizzazione** (Figura 4-1). Tali zone sono entrambe caratterizzata da elevate densità di emissioni di PM10 primario, NOX e COV e situazione meteorologica avversa per la dispersione degli inquinanti (velocità del vento limitata, frequenti casi di inversione termica, lunghi periodi di stabilità atmosferica caratterizzata da alta pressione), oltre ad alta densità abitativa, di attività industriali e di traffico.

Il Comune di Settimo Milanese è presente nell'elenco dei comuni interessati dalle procedure di infrazione comunitaria N.2014/2147 e Procedura n. 2015/2043 per le quali la Repubblica Italiana è stata condannata per 'Superamento sistematico e continuato dei valori limite applicabili alle PM10 e NO2 in determinate zone e agglomerati italiani' da parte della Corte di Giustizia Europea (sentenza pronunciata il 10 novembre 2020), tuttavia i dati della qualità dell'aria raccolti durante la valutazione della baseline, non hanno registrato situazioni di criticità negli ultimi tre anni.

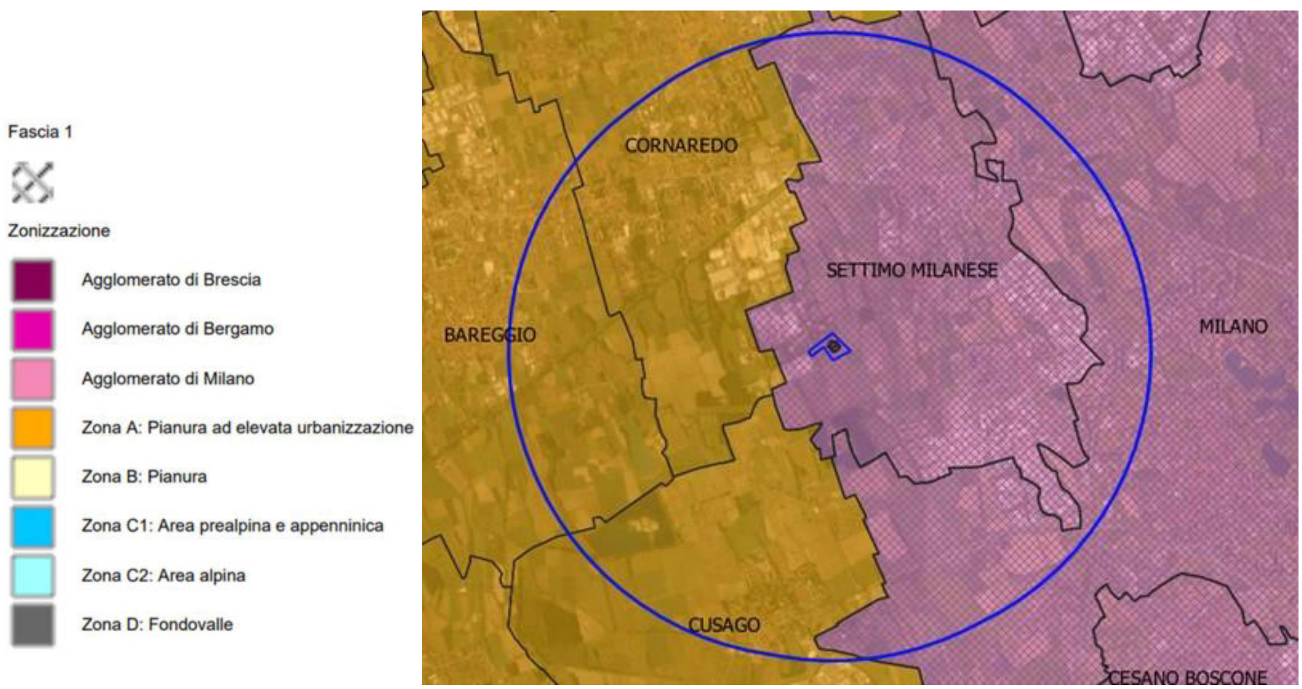


Figura 4-1: Zonizzazione per la valutazione della qualità dell'aria ambiente nell'area di studio

Con riferimento agli inquinanti di interesse, Biossido di Azoto (NO_2), particolato atmosferico aerodisperso (PM_{10}), Monossido di Carbonio (CO), vengono di seguito riassunte le principali informazioni circa il contesto emissivo e di qualità dell'aria ante operam nell'area di interesse. Per il primo aspetto si è fatto riferimento al database INEMAR (INventario EMissioni Aria Regionale), con particolare riferimento all'ultimo inventario 2019, confrontando il quadro comunale (Settimo Milanese) con il contesto provinciale (Provincia di Milano).

Per quanto riguarda la qualità dell'aria attuale, la centralina ARPAL di Settimo Milanese è stata dismessa nel corso del 2018. Le stazioni di monitoraggio più vicine all'area di progetto sono quelle di Rho, Milano Liguria, Cormano e Magenta rappresentate nella seguente Tabella 4-1 e Figura 4-2.

Ai fini del presente studio, per definire i livelli ante-operam dei parametri NO_2 e PM_{10} si è fatto riferimento alle stime modellistiche effettuate da ARPA Lombardia per l'anno 2021 per i comuni di Settimo Milanese, Cornaredo, Bareggio e Cusago; per il parametro CO, in mancanza di stime modellistiche sito-specifiche, si è fatto riferimento ai valori misurati presso la centralina di Rho nell'ultimo quinquennio.

Tabella 4-1: Stazioni di monitoraggio ARPAL limitrofe all'area di progetto

Zona	Prov	Stazione	UTM Nord	UTM Est	Quota	Tip.	Inquinanti	Distanza del sito
Agglom. di Milano	MI	Cormano	5044180.2	512693.1	153	UB	**NO2** O3 SO2	5,1 km
Agglom. di Milano	MI	Milano Liguria	5032273.2	513134	115	UT	**CO NO2**	12,2 km
Agglom. di Milano	MI	Rho	5041100.3	503483.1	152	UB	**CO NO2**	10,8 km
Zona A	MI	Magenta	5034328.6	490635.3	137	UB	**CO NO2** O3 **PM10** SO2	12,7 km

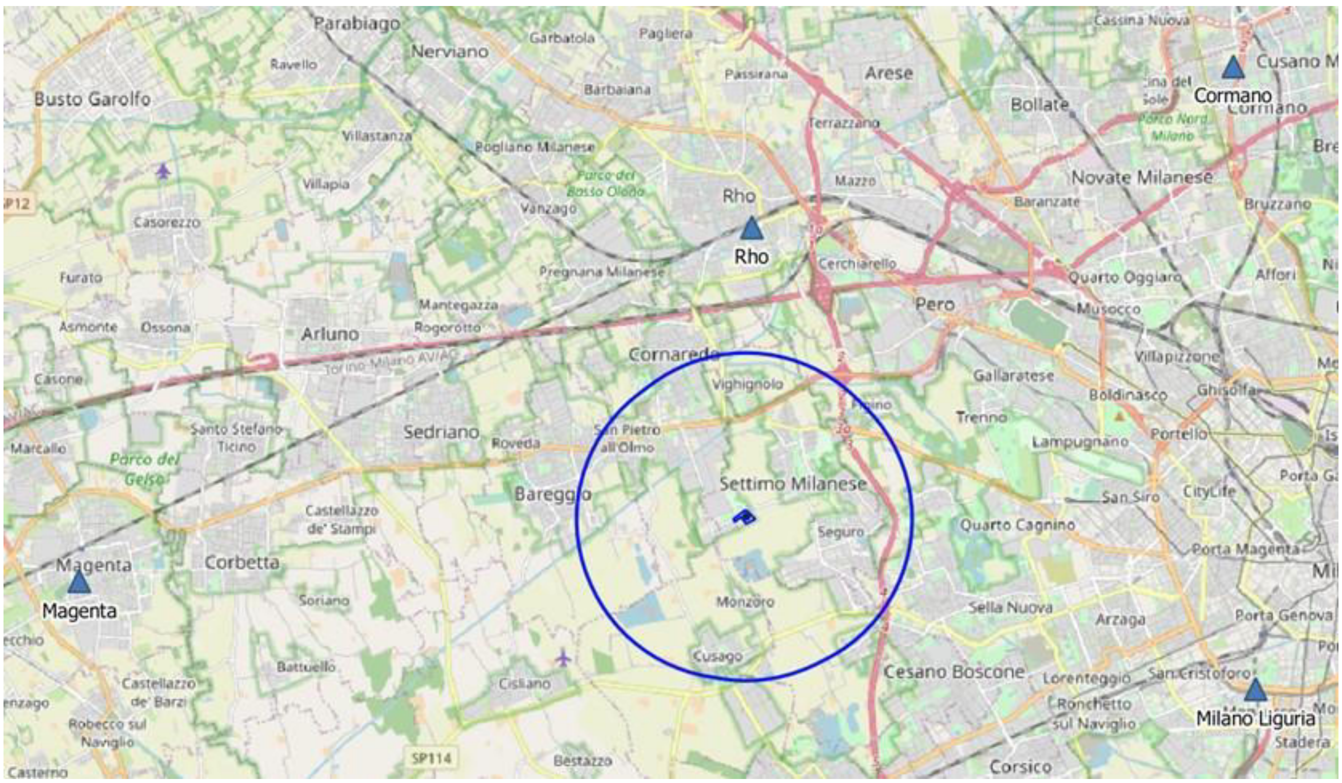


Figura 4-2: Localizzazione delle stazioni di monitoraggio ARPAL limitrofe all'area di progetto

4.1 Ossidi di Azoto (NOx)

Gli ossidi di azoto (nel complesso indicati anche come NO_X) sono emessi direttamente in atmosfera dai processi di combustione ad alta temperatura (impianti di riscaldamento, motori dei veicoli, combustioni industriali, centrali di potenza, etc.), per ossidazione dell'azoto atmosferico e, solo in piccola parte, per l'ossidazione dei composti dell'azoto contenuti nei combustibili utilizzati. All'emissione, gran parte degli NO_X è in forma di monossido di azoto (NO), con un rapporto NO/NO_2 notevolmente a favore del primo. Si stima che il contenuto di biossido di azoto (NO_2) nelle emissioni sia tra il 5% e il 10% del totale degli ossidi di azoto. L'NO, una volta diffusosi in atmosfera può ossidarsi e portare alla formazione di NO_2. L'NO è quindi un inquinante primario mentre l'NO_2 ha caratteristiche prevalentemente di inquinante secondario.

Il territorio di Settimo Milanese, interessato dalle attività afferenti alla realizzazione ed esercizio del Data Center in progetto, è caratterizzato da livelli di emissioni di ossidi di azoto è pari a circa 6,5 t/Km^2, a fronte di una media provinciale (MI) pari a circa 50 t/Km^2 (cfr. Figura 4-3).

Dalla consultazione del database INEMAR (Inventario Emissioni Aria Regione Lombardia), risulta che nel 2019 le emissioni totali di NOx nel comune di Settimo Milanese sono state di 70,4 t, pari a circa lo 0,35% delle emissioni provinciali (30’393 t/anno). Le emissioni sono attribuibili prevalentemente al trasporto su strada (57%) e a processi di combustione non industriali (19%) e industriali (13%) che coprono complessivamente l’89% delle emissioni. La Figura 4-4 mostra la ripartizione delle emissioni nel territorio comunale di Settimo Milanese per macrosettore.

Gli standard di qualità dell’aria (SQA) per la protezione della salute umana relativamente al NO_2 sono definiti dal D.Lgs. 155/2010, e sono di seguito riportati:

- valore limite delle medie annuali: 40 µg/m^3
- valore limite delle medie orarie: 200 µg/m^3 (18 superamenti annui consentiti)

Il grafico in Figura 4-5 mostra le medie annuali e mensili di concentrazione di NO_2 per i territori comunali interessati, sulla base delle concentrazioni giornaliere di NO_2 modellate da ARPA Lombardia per l’anno 2021. Le medie annuali sono comprese tra circa 31 µg/m^3 a Settimo Milanese e Cornaredo e circa 27 µg/m^3 a Cusago e Bareggio, con valori medi mensili che vanno dai 50 µg/m^3 del mese di dicembre ai 15 µg/m^3 del mese di agosto. Non si rilevano superamenti del limite di 200 µg/m^3, il massimo rilevato risulta pari a 132,1 µg/m^3 stimato a Cornaredo nel mese di Settembre.

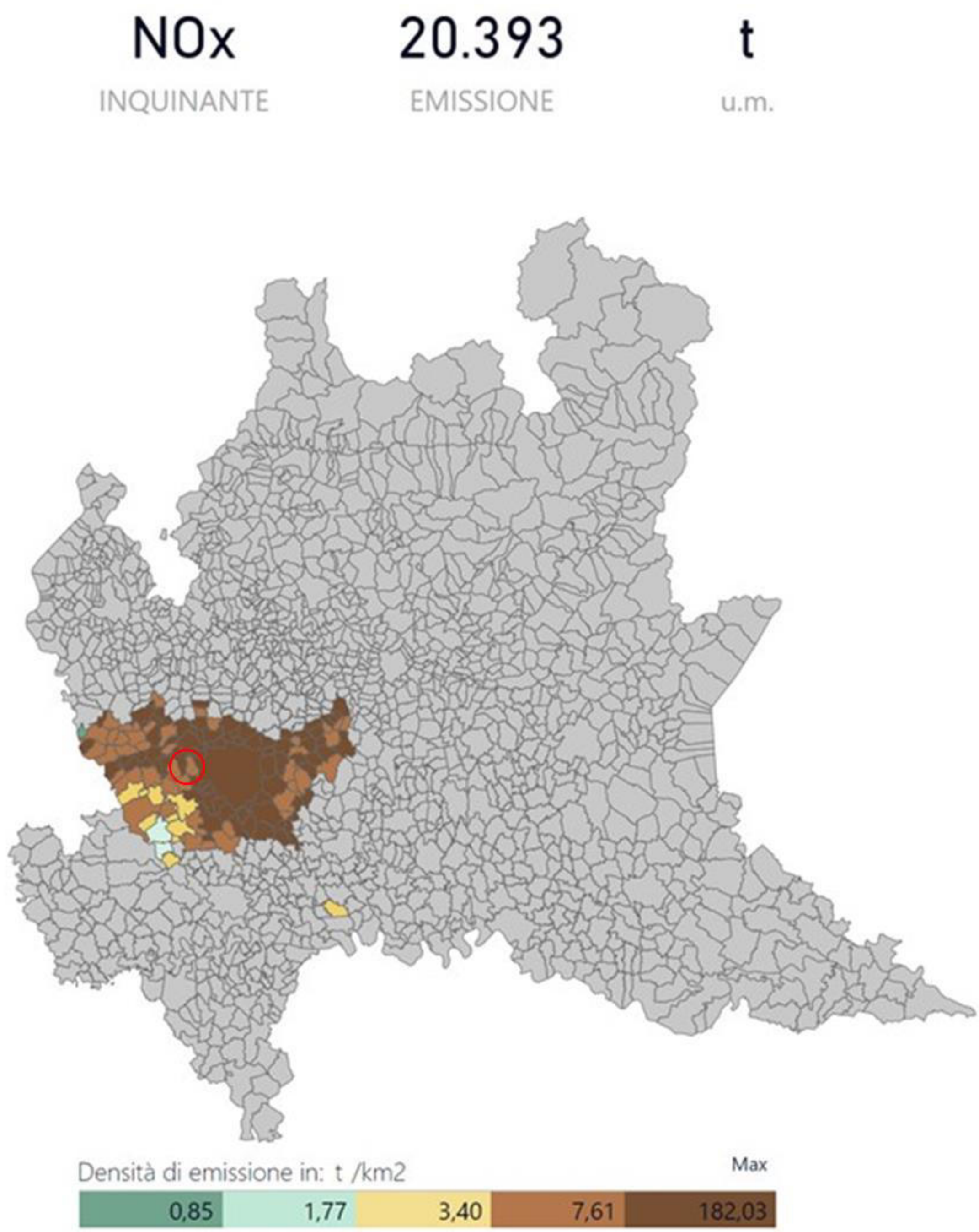


Figura 4-3: Mappa delle emissioni annue (t/Km2) NO_2 (Fonte: INEMAR - ARPA Lombardia (2022), INEMAR, Inventario Emissioni in Atmosfera: emissioni in regione Lombardia nell'anno 2019 – in revisione pubblica. ARPA Lombardia Settore Monitoraggi Ambientali)

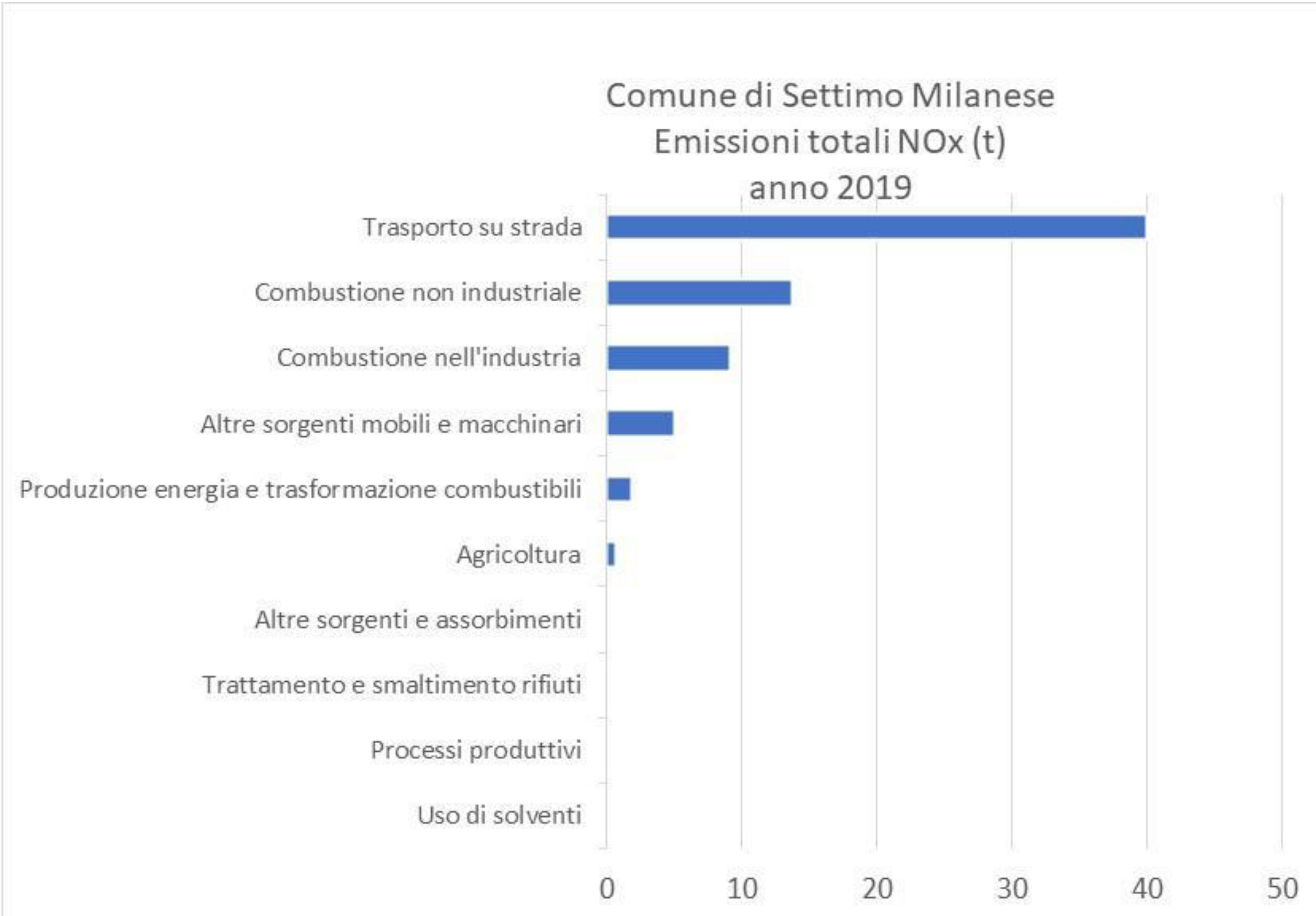
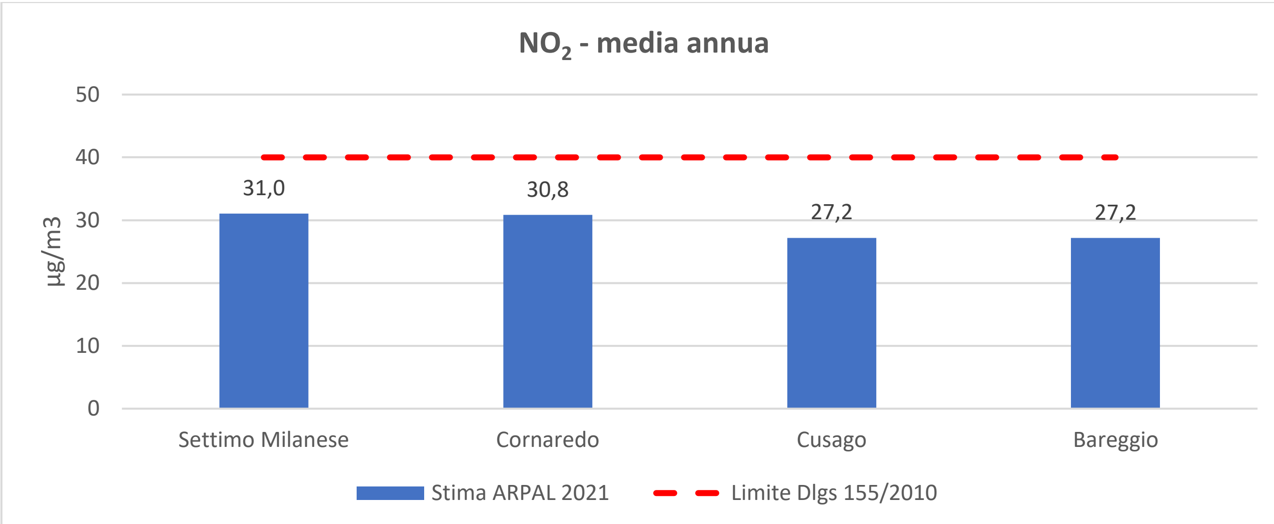
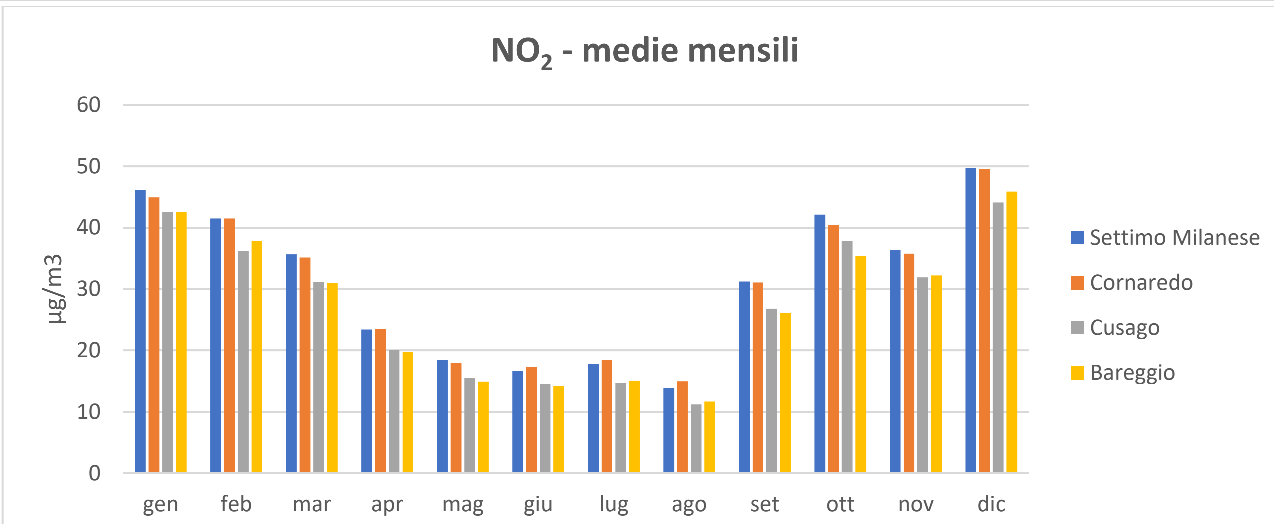


Figura 4-4: Emissioni annue totali (t) di NO2 nel comune di Settimo Milanese (Elaborazione da dati: INEMAR - ARPA Lombardia (2022), INEMAR, Inventario Emissioni in Atmosfera: emissioni in regione Lombardia nell'anno 2019 – in revisione pubblica. ARPA Lombardia Settore Monitoraggi Ambientali





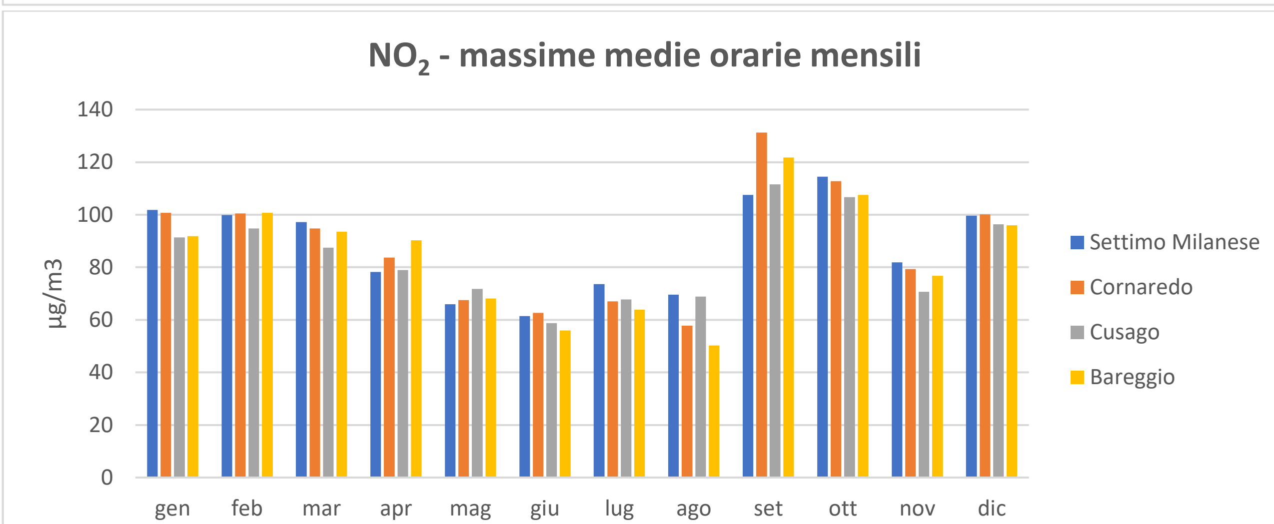


Figura 4-5: Medie annuali, medie mensili e massime medie orarie mensili di NO2 per l'anno 2021 (Elaborazione da dati modellati da ARPA Lombardia)

4.2 Particolato atmosferico (PM_{10})

Le sorgenti di particolato atmosferico possono essere di tipo naturale (erosione del suolo, spray marino, vulcani, incendi boschivi, dispersione di pollini, etc.) o antropiche (industrie, riscaldamento, traffico veicolare e processi di combustione in generale). Può essere di tipo primario se immesso in atmosfera direttamente dalla sorgente o secondario se si forma successivamente, in seguito a trasformazioni chimico-fisiche di altre sostanze. I maggiori componenti del particolato atmosferico sono il solfato, il nitrato, l'ammoniaca, il cloruro di sodio, il carbonio e le polveri minerali. Si tratta, dunque, di un inquinante molto diverso da tutti gli altri, presentandosi non come una specifica entità chimica ma come una miscela di particelle dalle diverse proprietà.

Il territorio comunale di Settimo Milanese interessato dalle attività afferenti alla realizzazione ed esercizio del data-center in progetto è caratterizzato da livelli di Polveri pari a 1,1 t/Km^2, a fronte di una media provinciale (MI) pari a circa 7 t/Km^2 (cfr. Figura 4-6).

Dalla consultazione del database INEMAR (Inventario Emissioni Aria Regione Lombardia), risulta che nel 2019 le emissioni totali di PM_{10} nel comune di Settimo Milanese sono state 11.4 t, pari a circa lo 0,4% delle emissioni provinciali (2862 t), attribuibili prevalentemente al trasporto su strada, all'uso di solventi e a processi di combustione non industriali. La Figura 4-7 mostra la ripartizione delle emissioni nel territorio comunale di Settimo Milanese per macrosettore.

Gli standard di qualità dell'aria (SQA) per la protezione della salute umana relativamente al PM_{10} sono definiti dal D.Lgs. 155/2010, e sono di seguito riportati:

- valore limite delle medie annuali: 40 µg/m^3
- valore limite delle medie giornaliere: 50 µg/m^3 (35 superamenti annui consentiti)

Il grafico in Figura 4-8 mostra le medie annuali e mensili di concentrazione di PM_{10} per i territori comunali in esame, sulla base delle concentrazioni giornaliere di PM_{10} modellate da ARPA Lombardia per l'anno 2021. Le medie annuali risultano essere pari a 28-29 µg/m^3 con valori medi mensili che vanno dai 48 µg/m^3 del mese di febbraio ai 14 µg/m^3 del mese di maggio. Il numero di superamenti del limite giornaliero risulta superiore al limite normativo (35), con una stima compresa tra 39 e 41 eventi annuali sopra soglia.

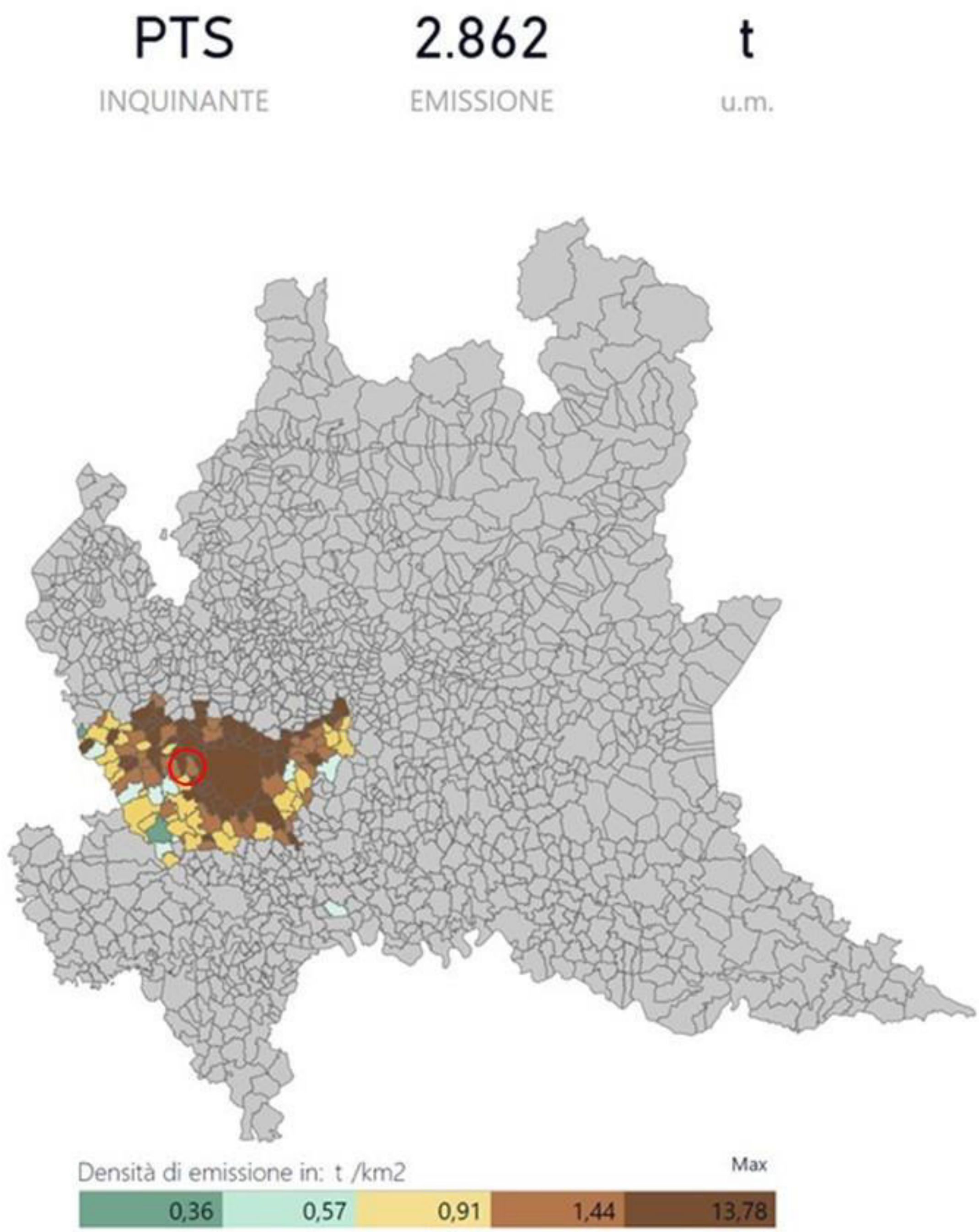


Figura 4-6: Mappa delle emissioni annue (t/Km2) PM10 (Fonte: INEMAR - ARPA Lombardia (2022), INEMAR, Inventario Emissioni in Atmosfera: emissioni in regione Lombardia nell'anno 2019 – in revisione pubblica. ARPA Lombardia Settore Monitoraggi Ambientali)

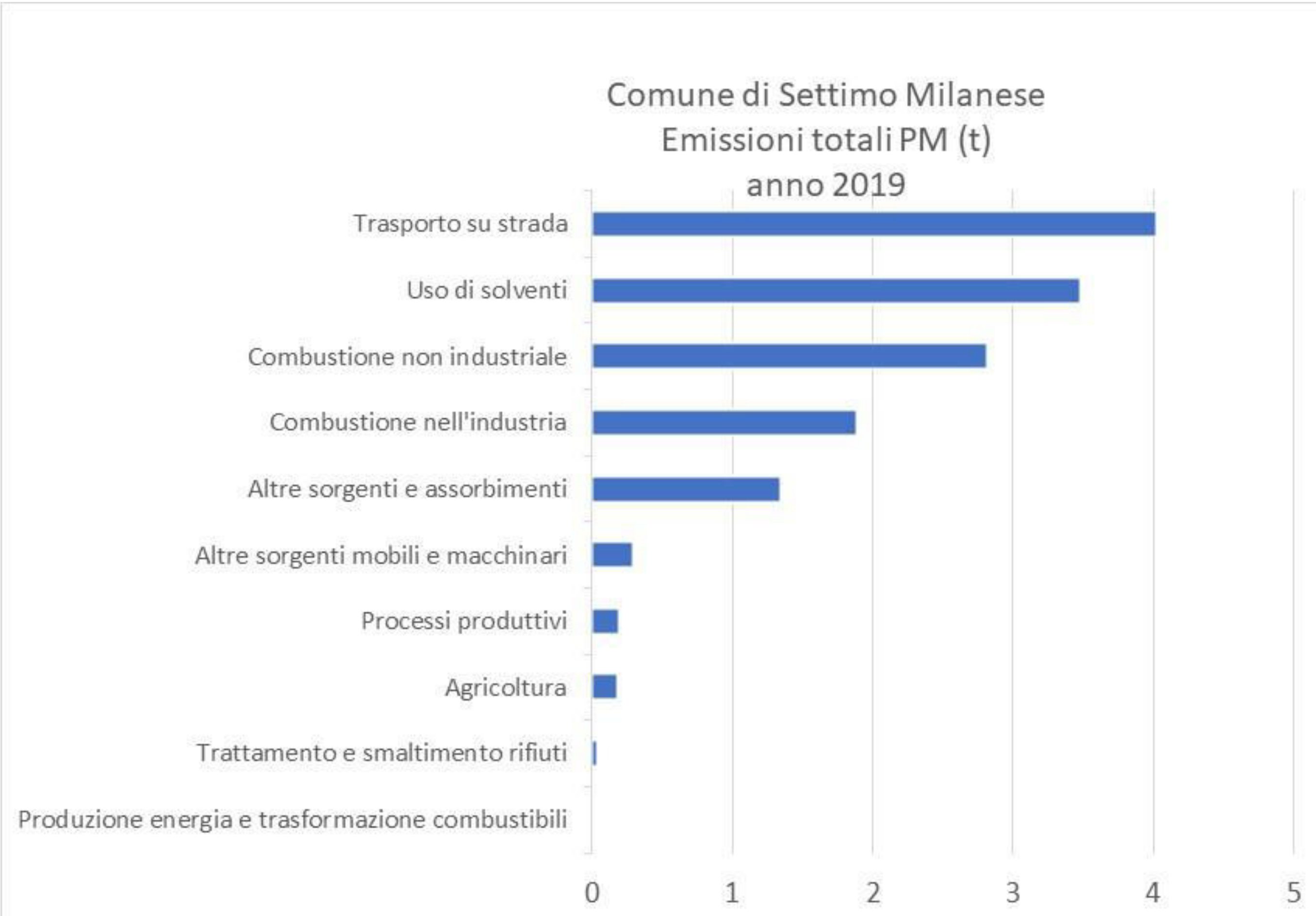


Figura 4-7: Emissioni annue totali (t) di PM10 nel comune di Settimo Milanese (Elaborazione da dati: INEMAR - ARPA Lombardia (2022), INEMAR, Inventario Emissioni in Atmosfera: emissioni in regione Lombardia nell'anno 2019 – in revisione pubblica. ARPA Lombardia Settore Monitoraggi Ambientali)

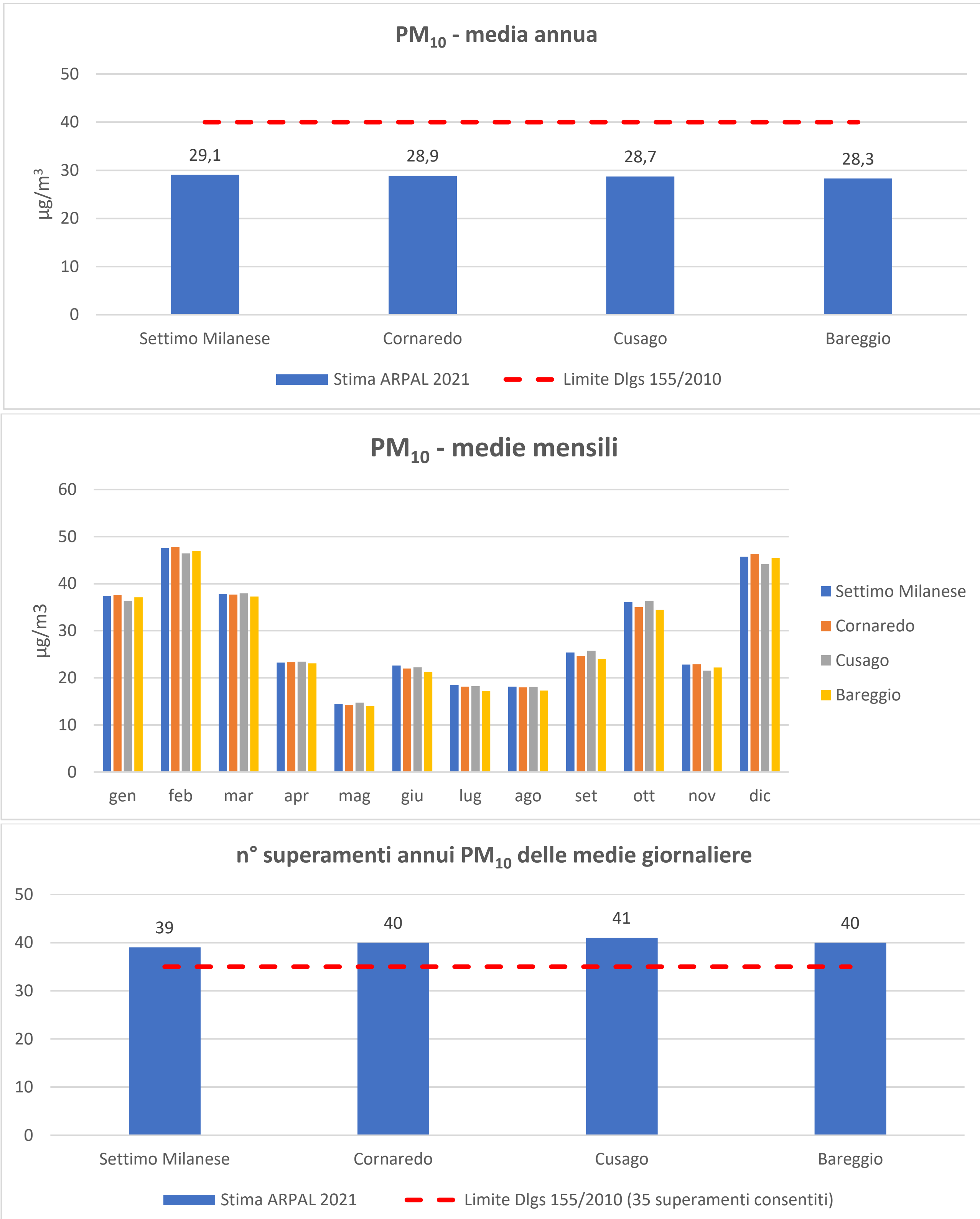


Figura 4-8: Medie annuali, medie mensili e numero di superamenti annui di PM10 per l'anno 2019 (Elaborazione da dati modellati da ARPA Lombardia)

4.3 Monossido di carbonio (CO)

Il monossido di carbonio (CO) è un gas inodore, incolore, infiammabile e molto tossico. È prodotto da reazioni di combustione in difetto di aria.

Il monossido di carbonio si miscela bene con l'aria, formando miscele esplosive. Può reagire vigorosamente con ossigeno, acetilene, cloro, fluoro, ossidi di azoto. È un inquinante prevalentemente primario, emesso direttamente da tutti i processi di combustione incompleta dei composti carboniosi. Le sorgenti possono essere di tipo naturale (incendi, vulcani, emissioni da oceani, etc.) o di tipo antropico (traffico veicolare, riscaldamento, attività industriali come la produzione di ghisa e acciaio, raffinazione del petrolio, lavorazione del legno e della carta, etc.).

Il territorio comunale di Settimo Milanese interessato dalle attività afferenti alla realizzazione ed esercizio del data-center in progetto è caratterizzato da livelli di CO pari a 9,2 t/Km^2, a fronte di una media provinciale (MI) pari a circa 59 t/Km^2 (cfr. Figura 4-9).

Dalla consultazione del database INEMAR (Inventario Emissioni Aria Regione Lombardia), risulta che nel 2019 le emissioni totali di CO nel Comune di Settimo Milanese sono state 99 t, pari a circa lo 0,4% delle emissioni provinciali (23832 t), attribuibili prevalentemente al trasporto su strada, all'uso di solventi e a processi di combustione non industriali. La Figura 4-10 mostra la ripartizione delle emissioni nel territorio comunale di Settimo Milanese per macrosettore.

Gli standard di qualità dell'aria (SQA) per la protezione della salute umana relativamente al CO sono definiti dal D.Lgs. 155/2010, e sono di seguito riportati:

- valore limite delle medie giornaliere (max media mobile su 8h): 10 mg/m^3

Il monossido di carbonio non è incluso tra gli inquinanti per i quali ARPA Lombardia effettua stime modellistiche, dunque, non è possibile avere un'indicazione dello stato della qualità dell'aria del comune di Settimo Milanese relativamente a tale inquinante. Come dato di confronto è possibile utilizzare le misure effettuate dalla stazione di monitoraggio della rete di rilevamento ARPA di Rho più prossima al sito di progetto che dista circa 5 km.

Il grafico in Figura 4-11 mostra i massimi annuali calcolati sulla media mobile di 8 ore di CO dalla stazione più prossima al sito di progetto (Rho) nell'ultimo quinquennio (2017-2021). I dati rilevati mostrano valori abbondantemente sotto i limiti di norma per tutti i giorni dell'anno con un valore massimo pari a 3 mg/m^3.

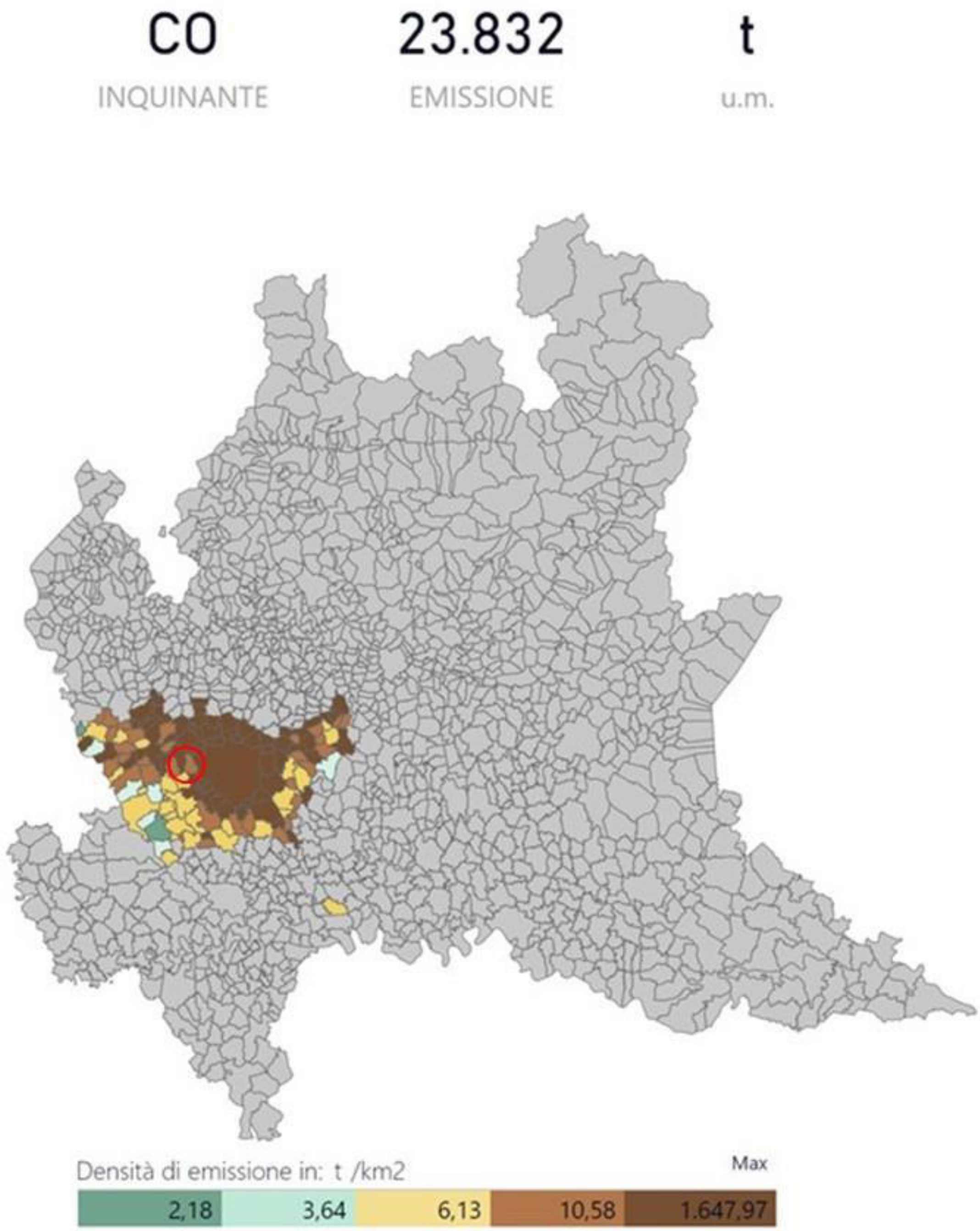


Figura 4-9: Mappa delle emissioni annue (t/Km2) CO (Fonte: INEMAR - ARPA Lombardia (2022), INEMAR, Inventario Emissioni in Atmosfera: emissioni in regione Lombardia nell'anno 2019 – in revisione pubblica. ARPA Lombardia Settore Monitoraggi Ambientali)

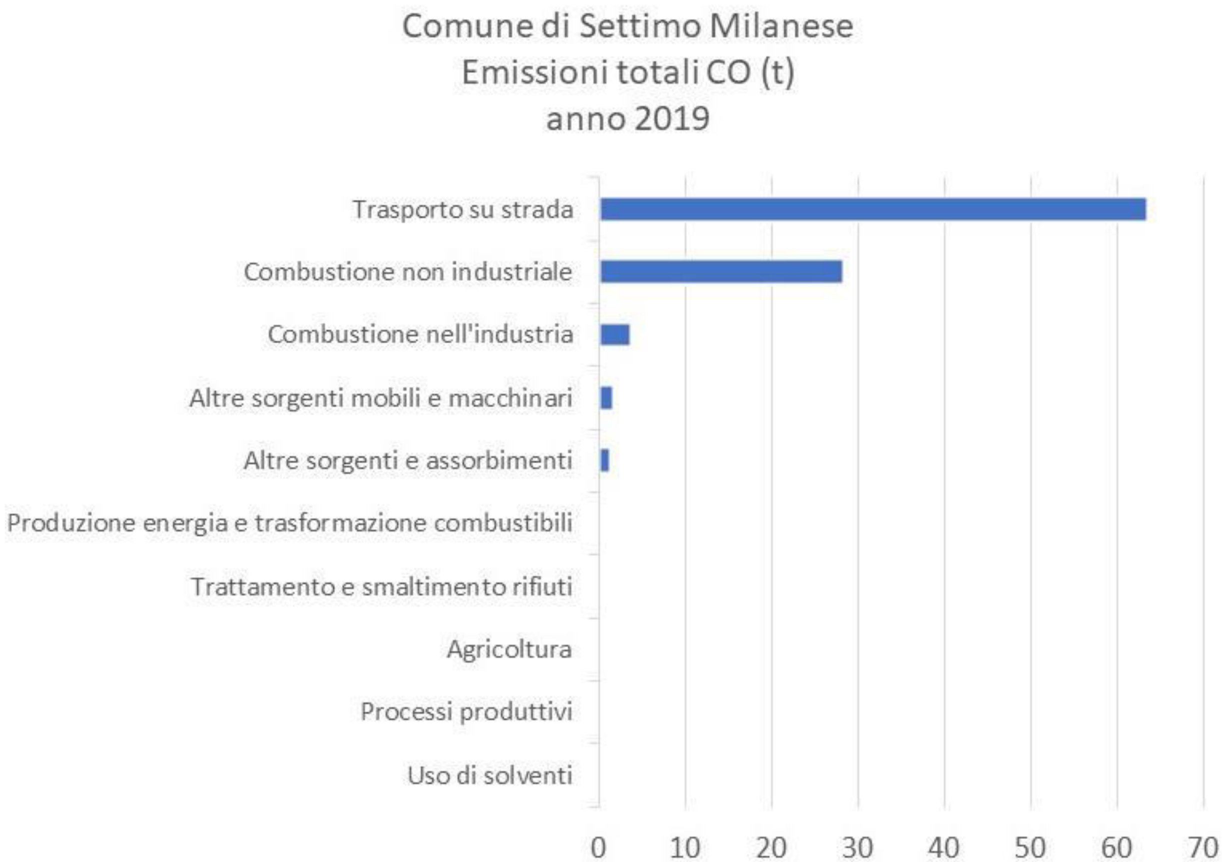


Figura 4-10: Emissioni annue totali (t) di CO nel comune di Settimo Milanese (Elaborazione da dati: INEMAR - ARPA Lombardia (2022), INEMAR, Inventario Emissioni in Atmosfera: emissioni in regione Lombardia nell'anno 2019 – in revisione pubblica. ARPA Lombardia Settore Monitoraggi Ambientali)

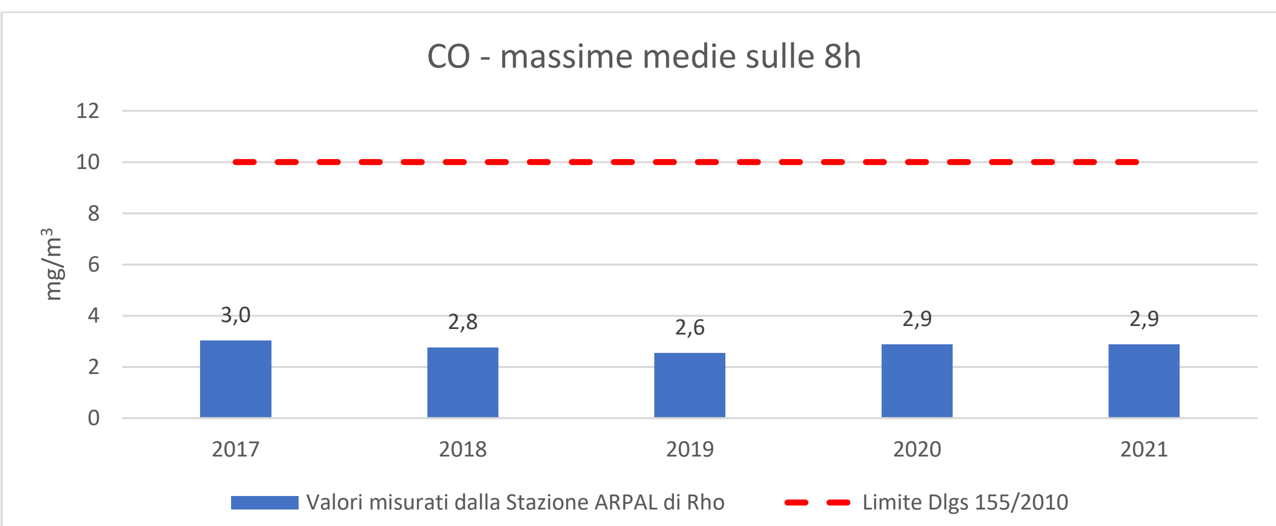


Figura 4-11: Massime medie sulle 8 ore di CO nel periodo 2017-2021 (Elaborazione da misure stazione di rilevamento ARPA Lombardia di Rho)

4.4 Ammoniaca (NH_3)

La normativa nazionale ed europea non stabiliscono valori limite o standard da rispettare per le concentrazioni in aria ambiente di NH_3. Le Linee Guida WHO (Air Quality Guidelines for Europe – second edition, 2000) stabiliscono il livello critico per l'ambiente per i composti azotati. I livelli critici sono basati su un'indagine di evidenze scientifiche pubblicate di effetti fisiologici ed ecologicamente importanti solo sulle piante, in particolare acidificazione ed eutrofizzazione. Il livello critico fissato per l'NH_3 è di 270 µg/m^3 come media giornaliera. Non ci sono invece riferimenti a valori limite per la protezione della salute umana per l'NH3, mentre sono fissate le soglie di esposizione professionale (TLV-TWA: 25 ppm pari a 17 mg/m^3 e TLV-STEL: 35 ppm pari 24 mg/m^3) che risultano di almeno tre ordini di grandezza superiori rispetto alle concentrazioni usualmente registrate in campagne di monitoraggio di NH3 in aria ambiente. Per quanto riguarda le emissioni è in vigore il DLgs 171 del 2004 e s.m.i. che fissa i tetti emissivi nazionali di SO2, NOx, COV e NH_3 in recepimento della Direttiva 2001/81/Ce del Parlamento Europeo e del Consiglio del 23/10/2001. E' attualmente all'esame della Commissione la revisione di tale direttiva che prevede un ulteriore abbassamento dei tetti emissivi (proposta di direttiva 2013/0443 (COD)).

Il territorio comunale di Settimo Milanese interessato dalle attività afferenti alla realizzazione ed esercizio del data-center in progetto è caratterizzato da livelli di NH_3 pari a 3,7 t/Km^2, a fronte di una media provinciale (MI) pari a circa 14 t/Km^2 (cfr. Figura 4-9).

Dalla consultazione del database INEMAR (Inventario Emissioni Aria Regione Lombardia), risulta che nel 2019 le emissioni totali di NH_3 nel Comune di Settimo Milanese sono state circa 40 t, pari a circa lo 0,7% delle emissioni provinciali (5674 t), attribuibili quasi esclusivamente all'agricoltura (97.5%). La Figura 4-10 mostra la ripartizione delle emissioni nel territorio comunale di Settimo Milanese per macrosettore.

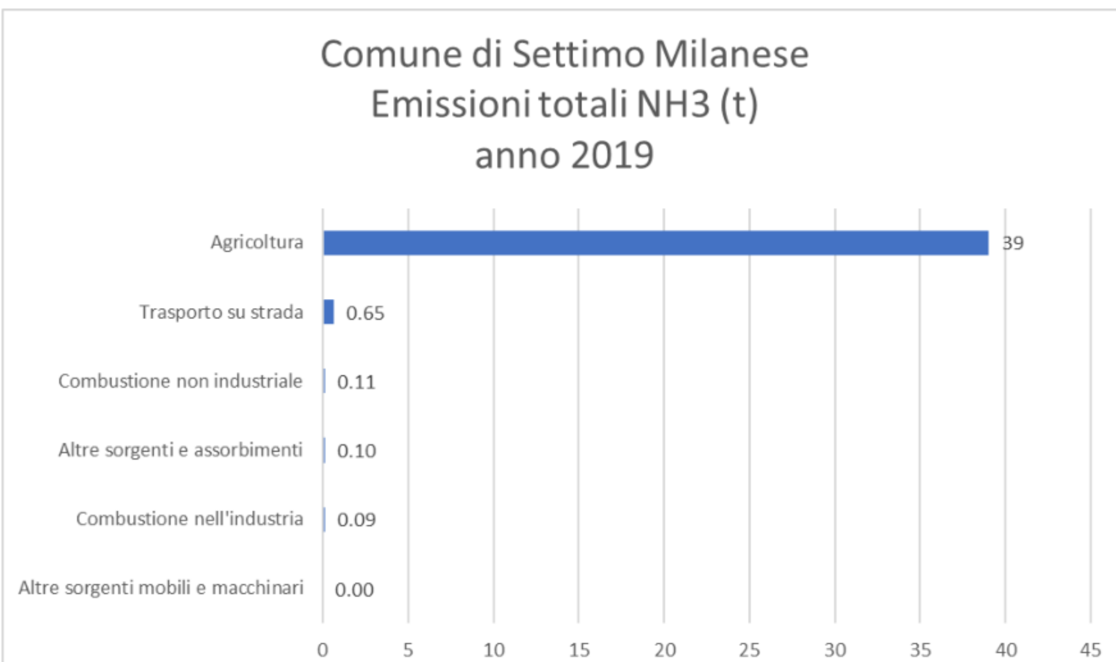


Figura 4-12: Emissioni annue totali (t) di NH3 nel comune di Settimo Milanese (Elaborazione da dati: INEMAR - ARPA Lombardia (2022), INEMAR, Inventario Emissioni in Atmosfera: emissioni in regione Lombardia nell'anno 2019 – in revisione pubblica. ARPA Lombardia Settore Monitoraggi Ambientali)

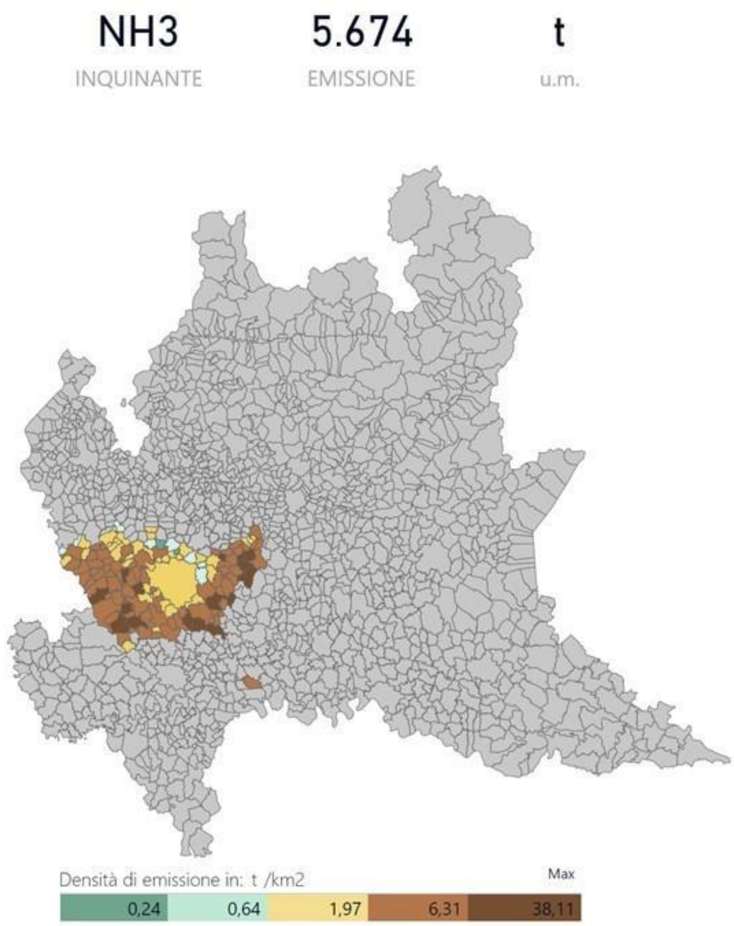


Figura 4-13: Mappa delle emissioni annue (t/Km2) CO (Fonte: INEMAR - ARPA Lombardia (2022), INEMAR, Inventario Emissioni in Atmosfera: emissioni in regione Lombardia nell'anno 2019 – in revisione pubblica. ARPA Lombardia Settore Monitoraggi Ambientali)

Per quanto concerne i valori di fondo rappresentativi dell'area in esame, si è fatto riferimento alle concentrazioni misurate presso la stazione urbana di Milano Pascal, la più vicina al sito in esame tra quelle riportate nel documento ARPAL "*Progetto Ammoniaca: relazione finale triennio 2017-2019*".

Concentrazioni di NH_3 misurate dalla RRQA [μg/m³]	Bertonico	Colico	Corte de Cortesi	Cremona - Via Fatebenefratelli	Cremona - via Gerre Borghi	Milano - Pascal	Moggio	Monza Parco	Pavia	Sannazzaro de' Burgondi	Schivenoglia
Media	30.2	4.2	56.3	7.5	14.3	9.9	2.7	8.5	8.9	8.5	16.0
Deviazione standard	22.1	3.3	55.6	6.3	17.0	6.1	2.7	8.0	6.3	5.9	19.0
98° percentile	94.6	12.7	222.4	25.7	51.5	25.9	9.3	28.6	25.3	23.0	45.4
Massimo rilevato	433.9	58.7	710.0	84.2	463.8	99.2	21.5	238.9	61.7	66.2	741.8
Ore dati [h]	75272	36733	96899	61070	57876	79378	82685	31495	26833	26533	42403

4.5 Composti Organici Volatili (COV)

Il territorio comunale di Settimo Milanese interessato dalle attività afferenti alla realizzazione ed esercizio del data-center in progetto è caratterizzato da livelli di emissione di COV pari a 32 t/Km^2, a fronte di una media provinciale (MI) pari a circa 98 t/Km^2.

Dalla consultazione del database INEMAR (Inventario Emissioni Aria Regione Lombardia), risulta che nel 2019 le emissioni totali di CO nel Comune di Settimo Milanese sono state 348 t, pari a circa lo 0,9% delle emissioni provinciali (39'870 t), attribuibili prevalentemente all'uso di solventi. La seguente figura mostra la ripartizione delle emissioni nel territorio comunale di Settimo Milanese per macrosettore.

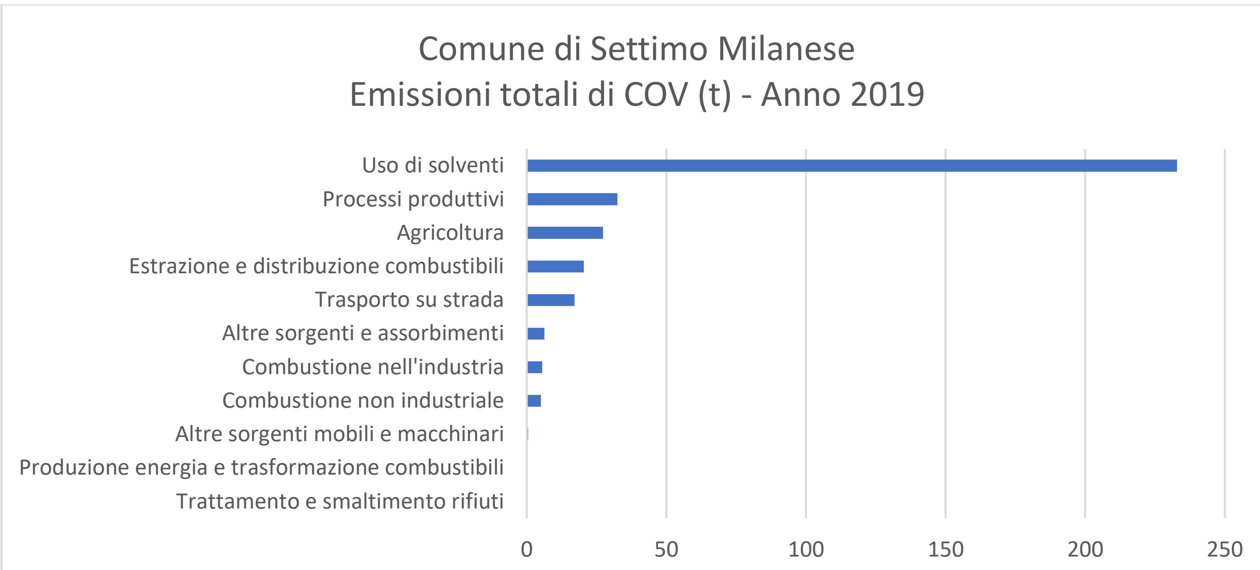


Figura 4-14: Emissioni annue totali (t) di COV nel comune di Settimo Milanese (Elaborazione da dati: INEMAR - ARPA Lombardia (2022), INEMAR, Inventario Emissioni in Atmosfera: emissioni in regione Lombardia nell'anno)

4.6 Acido Cloridrico (HCl)

Il parametro HCl non rientra tra gli inquinanti monitorati da ARPA Lombardia, né tra quelli per cui vengono stimate emissioni dal sistema INEMAR. Ai fini del presente studio si è fatto riferimento al livello tipico in aria ambiente indicati da IARC[1] (<10 µg/m^3), ed alle concentrazioni di riferimento in aria (RAC - Reference Air Concentrations) indicate quali livelli ambientali accettabili nella regolamentazione statunitense [2] (7 µg/m^3).

[1] Hydrochloric Acid (IARC Summary & Evaluation, Volume 54, 1992) (inchem.org)

[2] eCFR :: 40 CFR 266.107 -- Standards to control hydrogen chloride (HCl) and chlorine gas (Cl2) emissions.

5. Simulazione della dispersione degli inquinanti

5.1 Descrizione del modello CALPUFF

La dispersione degli inquinanti in atmosfera è stata eseguita tramite il modello CALPUFF.

CALPUFF è un modello a "puff" multistrato non stazionario in grado di simulare il trasporto, la trasformazione e la deposizione atmosferica di inquinanti in condizioni meteo variabili non omogenee e non stazionarie. CALPUFF, realizzato da Atmospheric Studies Group Earth Tech, è associato ad un modello meteorologico diagnostico CALMET (cfr. **paragrafo 3.1**) e ad un post-processore CALPOST per l'analisi dei dati calcolati.

Il modello CALPUFF è stato adottato da U.S. Environmental Protection Agency (U.S. EPA) nelle proprie linee guida sulla modellistica per la qualità dell'aria come uno dei modelli preferiti in condizioni di simulazione long-range, oppure per condizioni locali caratterizzate da condizioni meteorologiche complesse, ad esempio orografia complessa e calme di vento. Il modello CALPUFF è inserito nell'elenco dei modelli consigliati da APAT ora ISPRA per la valutazione e gestione della qualità dell'aria ("*Guida interattiva alla scelta dei modelli di dispersione nella valutazione della qualità dell'aria"*- 2001) e rientra nelle tipologie di modelli consigliati nelle linee guida ARPA Lombardia ("*Indicazioni relative all'utilizzo di tecniche modellistiche per la simulazione della dispersione di inquinanti negli studi di impatto sulla componente atmosfera*" *– 2018)*

I modelli a segmenti o a "puff" sono modelli in grado di simulare situazioni non stazionarie e sono generalmente associati a modelli di campo di vento. Di complessità intermedia tra i modelli stazionari (gaussiani) e quelli 3D (modelli euleriani e lagrangiani a particelle), consentono di descrivere la traiettoria delle emissioni e quindi di seguire l'evoluzione temporale della dispersione, perché possono tenere in conto le variazioni spaziali e temporali. Sono quindi da preferirsi, rispetto ai modelli gaussiani, per studiare situazioni complesse, sia dal punto di vista dell'orografia, sia delle emissioni, sia del campo di moto turbolento. I modelli a puff, in particolare, consentono di trattare anche le situazioni di calma di vento.

I modelli a "segmenti" considerano il pennacchio suddiviso in un certo numero di porzioni (o segmenti) tra loro indipendenti, il cui baricentro si muove in accordo alle condizioni meteorologiche incontrate lungo il percorso. Ogni segmento produce un campo di concentrazioni al suolo calcolato col modello gaussiano e solo il segmento più prossimo al punto recettore contribuisce a stimare la concentrazione nel recettore stesso.

La Figura 5-1 illustra la procedura descritta. La concentrazione totale ad un certo istante viene calcolata sommando i contributi di ogni singolo puff. Nei modelli a puff, il moto del baricentro di ogni puff in cui è suddiviso il pennacchio si muove in accordo alle condizioni meteorologiche incontrate lungo il percorso. Ogni puff si espande, nelle tre direzioni cartesiane, in modo gaussiano.

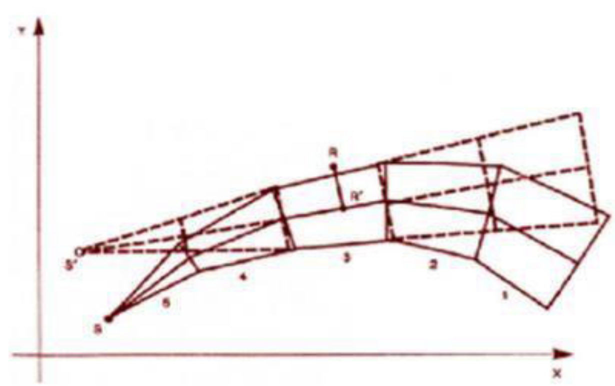


Figura 5-1: Segmentazione del pennacchio nei modelli a puff

A differenza di quanto avviene nel modello gaussiano standard, non si fa l'ipotesi che la diffusione lungo la direzione di moto del pennacchio sia trascurabile rispetto allo spostamento. Questo fa sì, da un lato, che nell'equazione che descrive questo modello la velocità del vento non compaia più esplicitamente; dall'altro lato, che il modello possa essere usato anche per le situazioni di vento debole o di calma. La concentrazione al suolo nel punto recettore è la somma dei contributi di tutti i puff. L'espressione del modello a puff è la seguente (Zannetti, 1990):

$$\Delta c = \frac{\Delta M}{(2\pi)^{3/2}\sigma_h^2\sigma_z^2} exp\left[-\frac{1}{2}\frac{(x_p - x_r)^2}{\sigma_h^2}\right] exp\left[-\frac{1}{2}\frac{(y_p - y_r)^2}{\sigma_h^2}\right] exp\left[-\frac{1}{2}\frac{(z_p - z_r)^2}{\sigma_z^2}\right]$$

dove:

$\Delta M = Q\,\Delta t$	massa emessa nell'intervallo di tempo $t\ [Kg]$
x_p, y_p, z_p	coordinate del baricentro dell'i-esimo puff $[m]$
x_r, y_r, z_r	coordinate del punto recettore $[m]$
σ_h, σ_z	coefficienti di dispersione orizzontale e verticale $[m]$

Figura 5-2: Equazione del modello a puff (Zanetti 1990)

Gli algoritmi di CALPUFF consentono inoltre di considerare l'effetto scia generato dagli edifici prossimi alla sorgente (effetto downwash), della fase transizionale del pennacchio, della orografia complessa del terreno, della deposizione secca ed umida. Il modello può simulare sia sorgenti puntiformi, sia areali. Inoltre, specifici algoritmi sono in grado di trattare gli effetti legati alla vicinanza con la costa marina, oppure alla presenza di strati limite di inversione termica in atmosfera.

Sui puff rilasciati in atmosfera durante le ore di calma di vento, CALPUFF attua i seguenti accorgimenti:

- l'intera massa di inquinante da rilasciare nel corso dell'ora è posta in un unico puff;
- il puff è posto istantaneamente alla quota finale di innalzamento (non è calcolato l'innalzamento graduale);
- non sono calcolati gli effetti scia degli edifici.

Sui puff che sono già stati rilasciati prima dell'ora di calma di vento, CALPUFF attua i seguenti accorgimenti, durante le ore di calma di vento:

- la posizione del centro del puff rimane immutata;
- la crescita dei parametri σ_y e σ_z (che rendono conto della dimensione dei puff) è calcolata esclusivamente in funzione del tempo;
- i parametri σ_v e σ_w (velocità turbolente) sono eventualmente modificati affinché non siano inferiori ad un minimo prefissato.

Le simulazioni modellistiche sono state condotte sulla base delle seguenti ipotesi:

- area di studio con orografia semplice;
- calcolo dei coefficienti dispersivi attraverso l'utilizzo dei parametri continui di turbolenza e variabili micrometeorologiche;
- considerazione dell'effetto scia degli edifici (building downwash);
- assenza di fenomeni di deposizione secca e umida.

5.2 Caratteristiche delle sorgenti emissive

Le emissioni associate al sito oggetto di studio sono quelle generate dalla combustione di diesel/HVO diesel nei motori dei 9 generatori d'emergenza il cui funzionamento è previsto solo in caso di eventi incidentali che comportino l'interruzione dell'alimentazione elettrica a servizio dell'unità "MIL03". È prevista inoltre l'accensione dei generatori in occasione dell'ordinaria manutenzione degli stessi che prevede test mensili ed annuali di funzionamento fuori e sotto carico. Ogni generatore è dotato di proprio camino per il convogliamento in atmosfera dei fumi di scarico provenienti dalla combustione.

Come premesso al capitolo 1, nel presente studio è stato considerato il seguente scenario:

- Scenario 1 di manutenzione: la simulazione dell'accensione sequenziale di tutti i 9 generatori per 120 minuti ciascuno (maggiore della massima durata dei test di funzionamento), assumendo che le attività di manutenzione procedano ad un ritmo pari a due generatori al giorno, uno alla mattina (h 10-12) ed uno il pomeriggio (h 16-18), per un periodo complessivo pari a 4,5 giorni/mese, ripetuto per 12 mesi.

- Scenario 2 di emergenza: la simulazione dell'accensione contemporanea di tutti i generatori per 2 ore consecutive. Per valutare gli effetti sulla qualità dell'aria di tale scenario emergenziale è stato utilizzato un approccio di tipo stocastico, volto a stimare la probabilità di ricadute al suolo significative presso i recettori limitrofi all'impianto. L'evento emergenziale (durata 2h) è stato simulato con una frequenza di accadimento ogni 26 ore per un intero anno (N=337), al fine di considerare la variabilità delle diverse condizioni meteorologiche nelle diverse ore del giorno e nelle diverse stagioni dell'anno.

I generatori di emergenza supereranno le 500 ore di funzionamento annue e dunque le emissioni generate sono sottoposte a limiti normativi ai sensi della DGR Lombardia n.IX/3934; per questa ragione come valori di input al modello relativamente alle concentrazioni di ogni singolo inquinante sono stati considerati i valori limite di concentrazione riportati nella seguente tabella tratta dal suddetto decreto, prevedendo l'adozione di un sistema di abbattimento *end-of-pipe* specifico per NOx tramite tecnologia SCR e dosaggio di AdBlue.

Tabella 5-1: concentrazioni degli inquinanti emessi alle sorgenti (rif. D.g.r. 6 agosto 2012 – n. IX/3934)

7.3 MOTORI

7.3.1 Valori limite

I valori limite sono riferiti ad una percentuale di ossigeno libero nell'effluente gassoso **pari al 5%** in volume.

Inquinanti	Combustibili liquidi		Gas naturale	Biogas e syngas (solo nei luoghi di produzione)
	Fossili	biocombustibili		
NOx (espressi come NO2)	100	100 (in Fascia 1) 200 (in Fascia 2) (4)	75 (in Fascia 1) 150 (in Fascia 2) (5)	400
NH3 (3)	5	5	5	5
CO	100	100	100	250
SO2 (1)	150	50	-	150
COT	150	50	-	100 (2)
Polveri	10	20	-	-
HCl (1)	-	5	-	5

NOTE

1. I valori limite s'intendono rispettati se i combustibili liquidi presentano un tenore di zolfo ridotto (come H2S) < 0,1 % v/v e se il biogas/syngas al momento dell'alimentazione risponde ai seguenti requisiti chimico fisici:
   - Zolfo ridotto (come H2S) < 0.1% v/v
   - Cloro < 50 mg/Nmc
2. esclusi i metanici
3. nel caso di utilizzo di sistemi di abbattimento ad urea/ammoniaca
4. a partire dal 1/1/2021 il valore limite dovrà essere pari a 100 mg/Nmc su tutto il territorio regionale
5. a partire dal 1/1/2021 il valore limite dovrà essere pari a 75 mg/Nmc su tutto il territorio regionale

Per quanto concerne le emissioni di NOx, ciascuno scenario è stato valutato nell'ipotesi di assenza (a) e presenza (b) di un sistema di abbattimento SCR degli NOx al fine di valutarne il beneficio in termini ambientali. In caso di presenza, le simulazioni hanno previsto anche un flusso emissivo di NH_3 al fine di considerare l'effetto di trascinamento (*slip*) dovuto all'iniezione di AdBlue nel dispositivo di SCR. I flussi emissivi assumono un tenore di O_2 reale nei fumi pari al 10%.

La seguente Figura 5-3 mostra la localizzazione delle sorgenti considerate sul layout di impianto, la successiva Tabella 5-4 riporta le caratteristiche geometriche ed emissive come inserite nel modello di dispersione. La

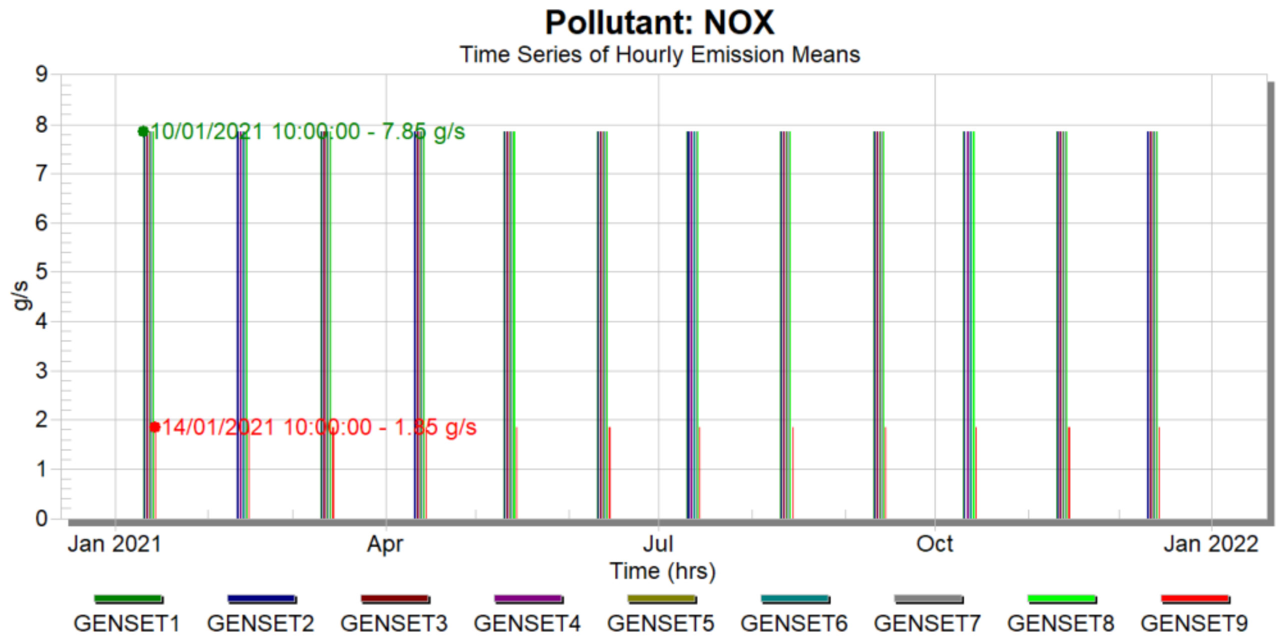


Figura 5-4 e la Figura 5-5 riportano infine in forma grafica i cicli di funzionamento simulati su base mensile e annuale.

Figura 5-3: Localizzazione punti di emissione

Tabella 5-2: caratteristiche dei punti di emissione

Unità	Sorgente	Coordinate UTM WGS84 (km)		H (m)	D (m)	Velocità di uscita (m/s)	Temp. fumi (K)	NOX (g/s)		CO (g/s)	PM (g/s)	NH3 (g/s)	HCl (g/s)	COT (g/s)
		X	Y					(a)	(b)			(b)	(c)	
ML3	GENSET1	503364,8	5035518,6	24	0,6	30,1	659,15	7,85	0,242	0,242	0,048	0,012	0,012	0,121
ML3	GENSET2	503339,8	5035551,7	24	0,6	30,1	659,15	7,85	0,242	0,242	0,048	0,012	0,012	0,121
ML3	GENSET3	503447,8	5035577,8	24	0,6	30,1	659,15	7,85	0,242	0,242	0,048	0,012	0,012	0,121
ML3	GENSET4	503419,9	5035614,9	24	0,6	30,1	659,15	7,85	0,242	0,242	0,048	0,012	0,012	0,121
ML3	GENSET5	503366,4	5035516,5	24	0,6	30,1	659,15	7,85	0,242	0,242	0,048	0,012	0,012	0,121
ML3	GENSET6	503446,2	5035579,9	24	0,6	30,1	659,15	7,85	0,242	0,242	0,048	0,012	0,012	0,121
ML3	GENSET7	503421,4	5035612,8	24	0,6	30,1	659,15	7,85	0,242	0,242	0,048	0,012	0,012	0,121
ML3	GENSET8	503338,3	5035553,8	24	0,6	30,1	659,15	7,85	0,242	0,242	0,048	0,012	0,012	0,121
ML3	GENSET9	503339,1	5035552,8	24	0,4	29,8	748,15	1,85	0,094	0,094	0,019	0,005	0,005	0,047
							Totale	64,65	2,03	2,03	0,40	0,101	0,101	1,015

(a) Senza sistema di abbattimento SCR (NOx da datasheet dei generatori)
(b) Con sistema di abbattimento SCR (NOx pari al limite D.g.r. 6 agosto 2012 – n. IX/3934, raggiungibile con sistema SCR)
(c) Parametro pertinente in caso di utilizzo di HVO diesel

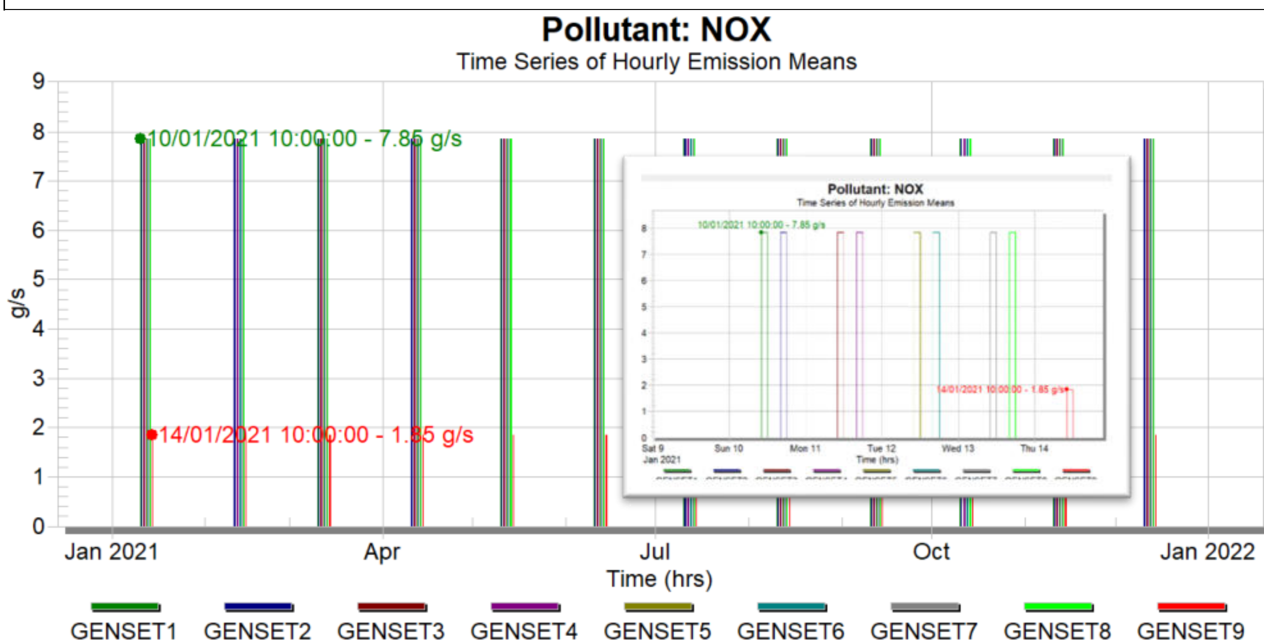


Figura 5-4: ciclo di funzionamento mensile simulato e relative emissioni di NOx associate a ciascun generatore – Scenario 1a di manutenzione senza sistema SCR attivo

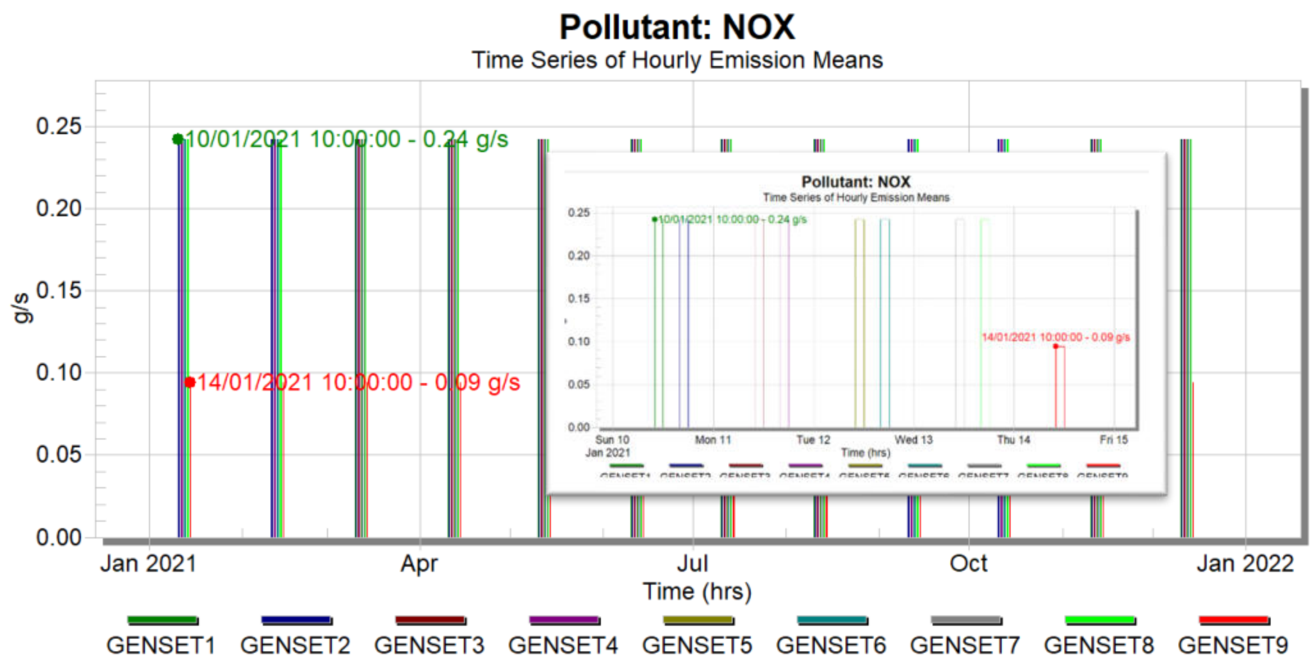


Figura 5-5: ciclo di funzionamento mensile simulato e relative emissioni di NOx associate a ciascun generatore - – Scenario 1b di manutenzione con sistema SCR attivo

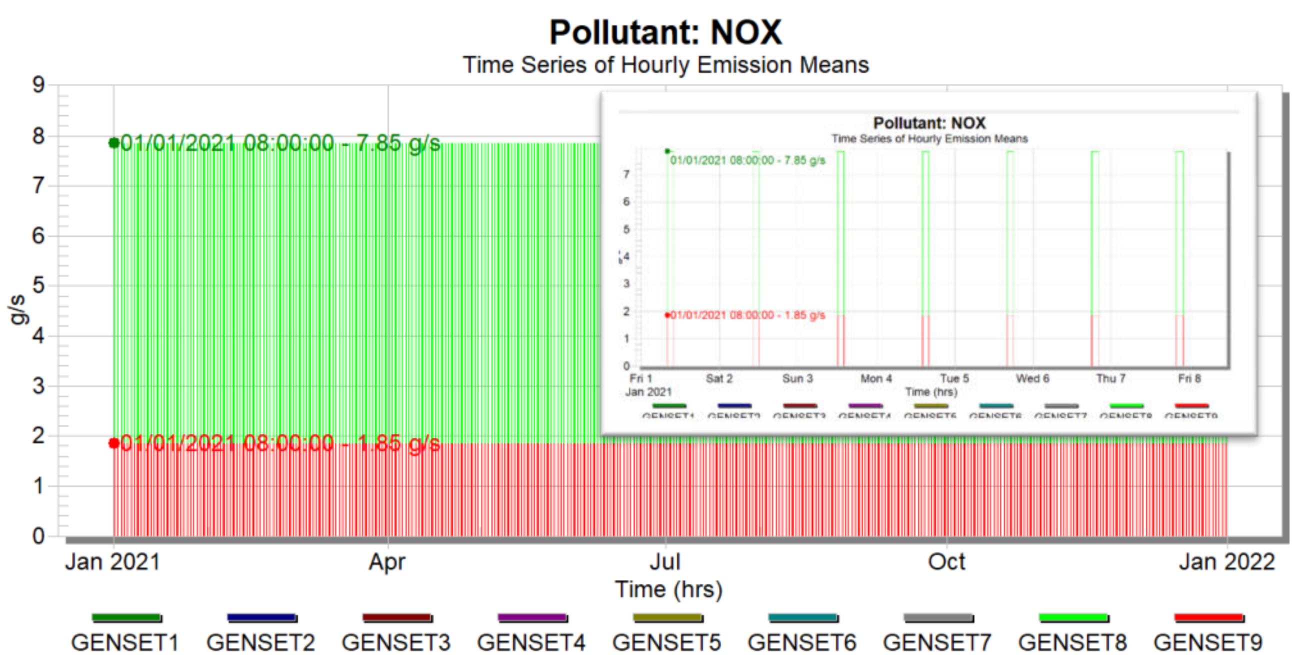


Figura 5-6: valutazione dello scenario emergenziale con approccio stocastico: simulazione ripetuta (n=337) dello scenario 2a (emergenza in assenza di sistema SCR)

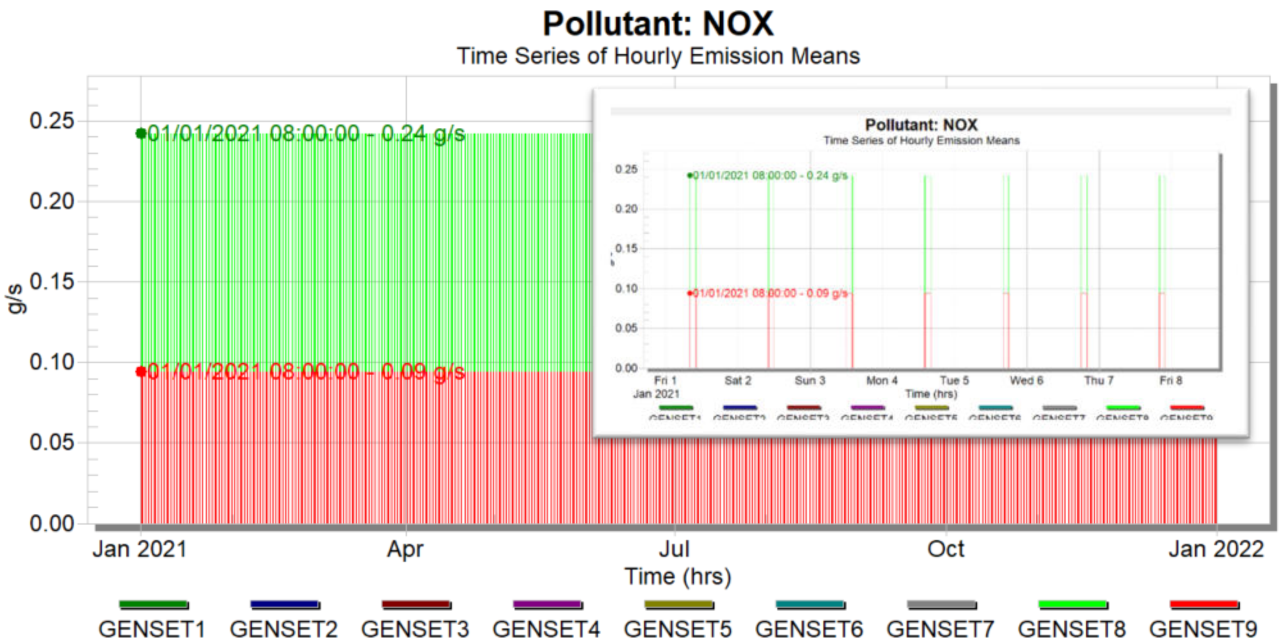


Figura 5-7: valutazione dello scenario emergenziale con approccio stocastico: simulazione ripetuta (n=337) dello scenario 2b (emergenza in presenza di sistema SCR)

5.2.1 Confronto con stime emissive a livello comunale

La seguente tabella mette a confronto:

- le emissioni stimate a livello comunale dall'applicativo INEMAR per il Comune di Settimo Milanese con riferimento all'anno 2019
- le emissioni previste complessive calcolate considerando il programma di manutenzione annuale richiamato in introduzione al presente documento (max 72 h complessive)
- le emissioni previste simulate per lo scenario di manutenzione
- le emissioni stimate a seguito di un evento di emergenza della durata di 2h

Parametro	Stima emissiva anno 2019 Comune di Settimo Milanese (Fonte: INEMAR)	Stime emissive (t) e confronto % con stime annuali comunali			
			MANUTENZIONE		EMERGENZA
		Note	Piano di manutenzione (72h/anno)	Scenario 1 simulato (216h/anno)	Scenario 2 simulato (singolo evento, 2h)
NOx	70,4 t	senza SCR	1,862 (2,645%)	5,59 (7,9%)	0,47 (0,7%)
		con SCR	0,058 (0,083%)	0,18 (0,2%)	0,01 (0,02%)
NH3	40 t	con SCR	0,003 (0,007%)	0,01 (0,02%)	0,001 (0,002%)
PM	11,4 t		0,012 (0,102%)	0,03 (0,3%)	0,003 (0,025%)
CO	99 t		0,058 (0,059%)	0,18 (0,2%)	0,015 (0,015%)
COV/COT	348 t		0,029 (0,008%)	0,09 (0,03%)	0,007 (0,002%)
HCl	-		0,003	0,01	0,001

La tabella evidenzia come le emissioni complessive di NOx stimate per l'implementazione del programma di manutenzione dell'impianto (72h) rappresenterebbero circa il 2,6% delle emissioni comunali riferite all'anno 2019, nel caso il sistema SCR non venisse implementato. Tale contributo è ridotto a circa lo 0,08% in caso di abbattimento delle emissioni di NOx tramite dispositivo SCR. Le emissioni annuali di PM, CO, NH3 e COV previste dal programma di manutenzione risultano invece sempre in inferiori o uguali allo 0,3% delle rispettive emissioni comunali.

Un singolo evento di emergenza, di durata pari a circa 2h, emetterebbe una quantità di NOx compresa tra 0,7% (caso non mitigato) e 0,02% (caso mitigato) delle emissioni comunali annuali. Le emissioni dei rimanenti inquinanti rappresenterebbero contributi inferiori allo 0,025% delle emissioni comunali annuali.

5.3 Dominio di calcolo e recettori sensibili considerati

Il dominio di calcolo di CALPUFF utilizzato per il calcolo delle concentrazioni di inquinanti al suolo emessi dall'impianto in progetto ha dimensioni pari a 11x12 km. I valori delle concentrazioni sono stati simulati tramite la sovrapposizione di più griglie di calcolo (*Sampling Grid*) a risoluzione crescente in prossimità delle sorgenti emissive (Figura 5-4):

- Griglia 10x11 Km passo: 500 m
- Griglia 4x4 Km passo: 200 m
- Griglia 2x2 Km passo: 100 m
- Griglia 1x1 Km passo: 50 m

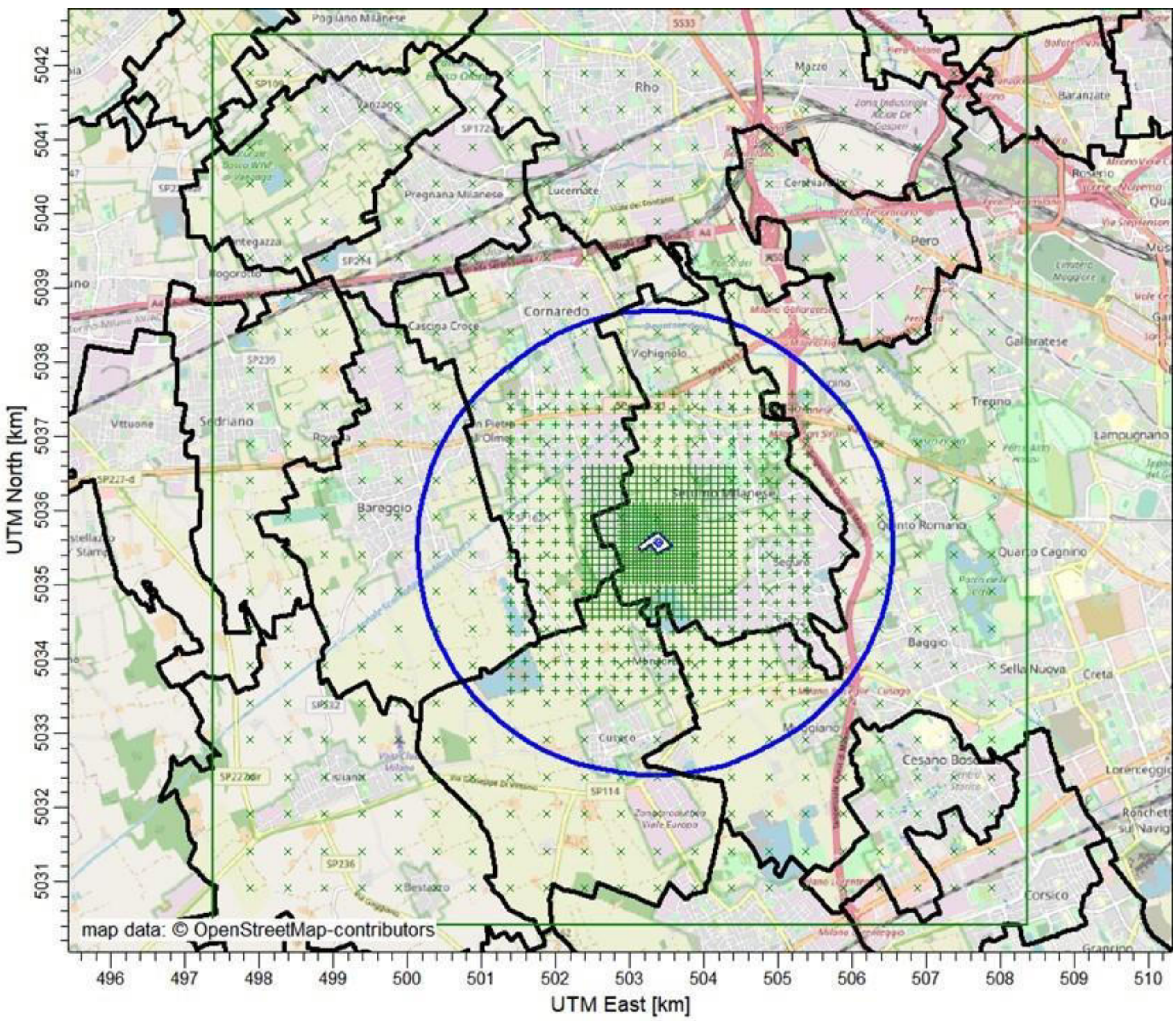


Figura 5-8: Griglie di calcolo utilizzate nelle simulazioni

Alle griglie regolari dei punti recettori sono stati aggiunti ulteriori recettori discreti in corrispondenza:

- delle abitazioni isolate prossime all'impianto;
- degli edifici più vicini appartenenti ai centri abitati ubicati nell'arco di 3 km dall'impianto.
- delle aree destinate al pubblico (parchi, giardini, centri sportivi).
- dei recettori sensibili quali istituti scolastici e strutture sanitarie.
- Dei recettori aggiuntivi considerati nella relazione di impatto acustico

I recettori sensibili sono riportati nella seguente tabella; nelle immagini seguenti si riporta la loro posizione rispetto all'area di progetto.

Tabella 5-3: recettori discreti selezionati

ID	X	Y	Descrizioni
	[m]	[m]	
R_1	504097	5036065	Settimo Milanese - Via Rilé
R_2	504598	5035234	Settimo Milanese - Via Edison
R_3	503107	5034292	Monzoro - Via Marconi
R_4	502917	5034619	Cascina Molinello - Via Marconi
R_5	501876	5034870	Cascina Carla - SP162
R_6	501340	5035200	Cascina Molino Catena - Via Cusago
R_7	501159	5035028	Cascina Bergamina - Via Cusago
R_8	501042	5035376	Cascina Figina - Via Figina
R_9	500654	5035599	Bareggio - Via Pasteur
R_10	501394	5036121	Cornaredo - Via Rossini
R_11	502038	5036565	Cornaredo - Via Vespucci
R_12	502306	5036786	Cornaredo - Via Monzoro
R_13	503430	5037613	Vighignolo - Via Minzoni
R_14	505225	5035535	Scuola Infanzia - Don Milani - Settimo Milanese
R_15	504240	5036755	Scuola Primaria via Buozzi - Settimo Milanese
R_16	501937	5036852	Scuola Infanzia via Colombo - Cornaredo
R_17	503457	5037925	Scuola Primaria Vighignolo - Via Matteotti
R_18	502101	5037123	Scuola Secondaria Muratori - Cornaredo
R_19	502366	5037533	Scuola Primaria via Don Sturzo - Cornaredo
R_20	Areale (mesh 50m)		Centro Sportivo ex Italtel
R1-R13: Residenziali			
R14-R19 istituti scolastici			
R20_1-47 Centro Sportivo ex Italtel (adiacente all'installazione)			

RA	502801	5035491	edificio privato di rappresentanza e/o produttivo
RB	502976	5035546	Villa Litta Modigliani
RC	503061	5035652	edificio privato di rappresentanza e/o produttivo
RD	503231	5035663	Bar Centro Sportivo ex Italtel
RE	503714	5035732	Cascina con zona agricola

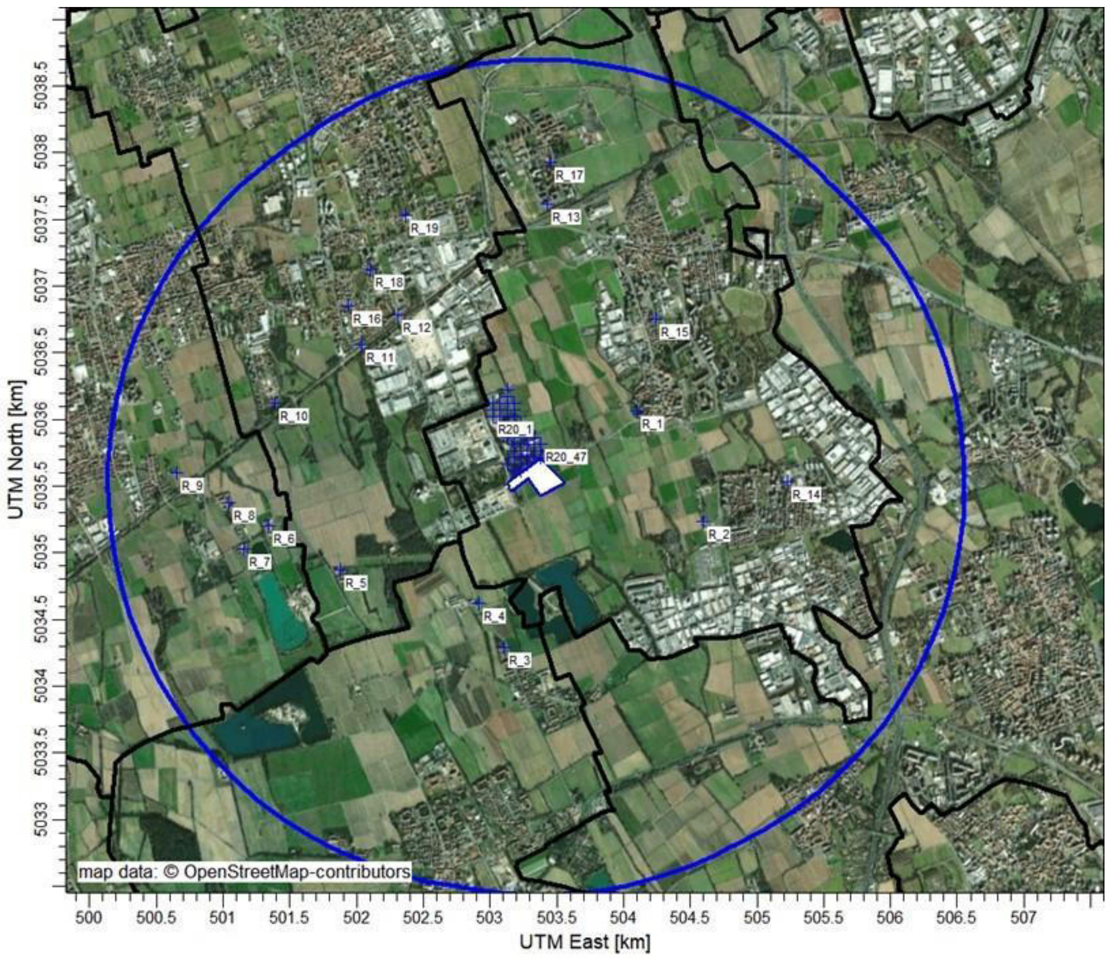


Figura 5-9: Posizione dei recettori nel raggio di 3 Km dall'area di progetto.

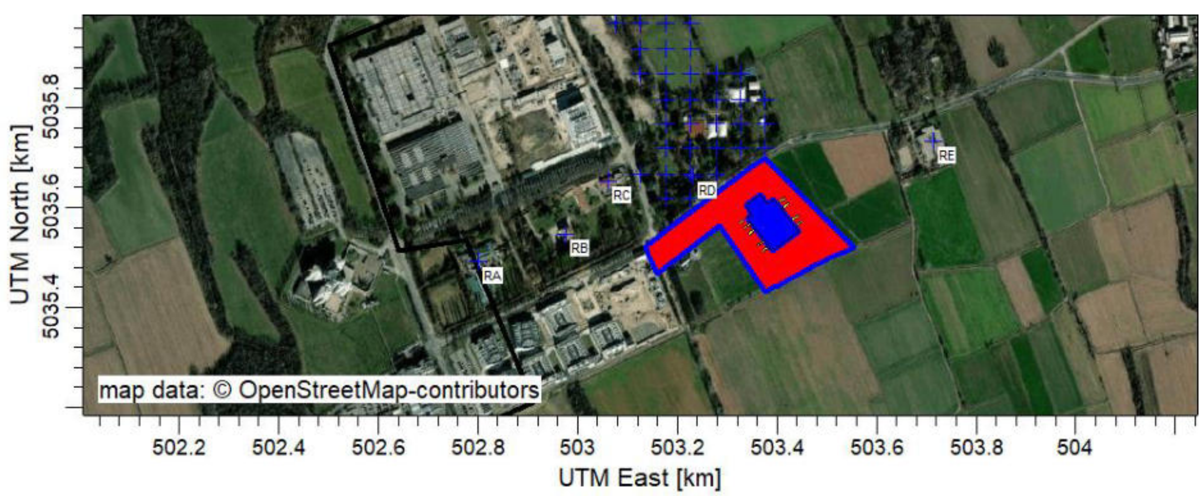


Figura 5-10: Posizione dei recettori nel raggio di 500 m dall'area di progetto.

5.4 Effetto downwash

Per una rappresentazione maggiormente completa della situazione emissiva e del corrispondente stato di diffusione in atmosfera, nel modello di calcolo è stata applicata l'opzione downwash, ovvero si è tenuto conto della presenza degli edifici posti nelle immediate vicinanze delle sorgenti emissive che possono interferire sulla traiettoria dei pennacchi emessi ("effetto scia"), con la possibilità, per turbolenza indotta dall'azione del vento, di osservare un incremento delle concentrazioni a terra nelle adiacenze dell'impianto.

Nella figura seguente è rappresentata una ricostruzione 3D delle volumetrie considerate nel modello di calcolo per considerare tale effetto.

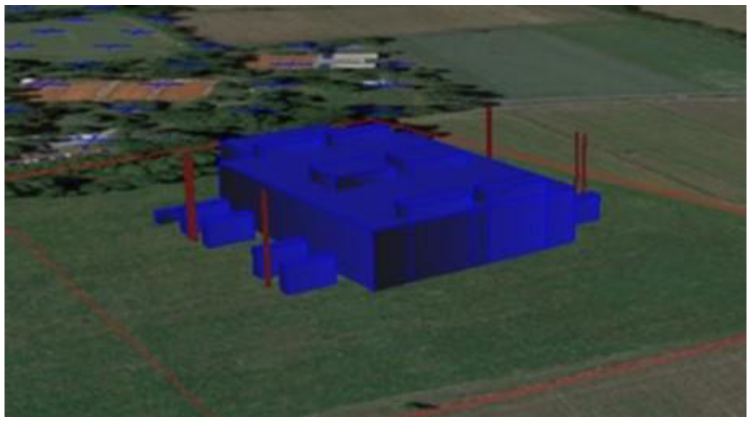


Figura 5-11: Ricostruzione tridimensionale dell'area di impianto con ubicazione delle sorgenti simulate (in rosso) e degli edifici considerati per l'effetto building downwash (in blu)

La seguente tabella riporta le caratteristiche geometriche degli edifici considerati nelle simulazioni al fine di calcolare l'effetto building downwash.

Tabella 5-4: caratteristiche geometriche degli edifici considerati nelle simulazioni al fine di calcolare l'effetto building downwash

ID	Descr	livello	altezza livello [m]	Num Vertici	X1 [m]	Y1 [m]	X2 [m]	Y2 [m]	X3 [m]	Y3 [m]	X4 [m]	Y4 [m]
BLD_1	MIL03	1	15.6	8	503341.5	5035578.9	503350.9	5035586.0	503336.9	5035604.6	503366.5	5035626.9
					X5 [m]	Y5 [m]	X6 [m]	Y6 [m]	X7 [m]	Y7 [m]	X8 [m]	Y8 [m]
					503380.5	5035608.3	503393.4	5035618.0	503443.6	5035551.5	503392.2	5035512.7
ID	Descr	livello	altezza livello	Num Vertici	X1 [m]	Y1 [m]	X2 [m]	Y2 [m]	X3 [m]	Y3 [m]	X4 [m]	Y4 [m]
BLD_1	screen wall1	2	19.5	4	503370.9	5035558.6	503386.4	5035570.3	503394.7	5035559.3	503379.2	5035547.6
BLD_1	screen wall2	2	19.5	4	503354.4	5035580.5	503350.5	5035585.7	503366.0	5035597.4	503369.9	5035592.2
BLD_1	screen wall3	2	19.5	4	503374.1	5035595.4	503370.2	5035600.5	503385.7	5035612.2	503389.6	5035607.0
BLD_1	screen wall4	2	19.5	4	503398.9	5035562.5	503390.6	5035573.5	503406.1	5035585.1	503414.4	5035574.1
BLD_1	screen wall5	2	19.5	4	503420.4	5035534.0	503416.5	5035539.2	503431.9	5035550.8	503435.8	5035545.6
BLD_1	screen wall6	2	19.5	4	503400.7	5035519.1	503396.8	5035524.3	503412.2	5035536.0	503416.2	5035530.8
GEN_1	genset	1	7.5	4	503355.7	5035553.9	503344.9	5035545.8	503342.6	5035548.8	503353.4	5035557.0
GEN_2	genset	1	7.5	4	503347.1	5035565.3	503336.3	5035557.2	503334.0	5035560.3	503344.8	5035568.4
GEN_3	genset	1	7.5	4	503417.1	5035618.1	503406.3	5035610.0	503404.0	5035613.0	503414.8	5035621.1
GEN_4	genset	1	7.5	4	503382.2	5035518.7	503371.4	5035510.6	503369.1	5035513.6	503379.9	5035521.7
GEN_5	genset	1	7.5	4	503373.6	5035530.1	503362.8	5035522.0	503360.5	5035525.0	503371.3	5035533.2
GEN_6	genset	1	7.5	4	503443.5	5035582.8	503432.8	5035574.7	503430.5	5035577.7	503441.3	5035585.9
GEN_7	genset	1	7.5	4	503452.2	5035571.4	503441.4	5035563.3	503439.1	5035566.3	503449.9	5035574.4
GEN_8	genset	1	7.5	4	503425.7	5035606.7	503414.9	5035598.6	503412.6	5035601.6	503423.4	5035609.7
GEN_9	genset adm	1	3.5	4	503324.2	5035569.6	503331.6	5035575.1	503333.3	5035572.9	503325.9	5035567.3

5.5 Calcolo delle concentrazioni di NO_2

I gas esausti derivanti dalla combustione nei motori dei generatori di emergenza sono costituiti da Ossidi di Azoto (NOx) principalmente sotto forma di monossido di Azoto (NO) parte del quale, reagendo per permanenza in atmosfera con Ozono e altri agenti ossidanti, si trasforma in biossido di Azoto (NO_2).

Le simulazioni modellistiche sono condotte stimando le concentrazioni di NO_x e successivamente, attraverso la definizione del rapporto NO2/NOx, sono state calcolate le concentrazioni di NO_2 per il corretto confronto con gli standard di qualità dell'aria ambiente stabiliti dal Dlgs 155/2010.

Il metodo utilizzato per la conversione è l'***Ambient Ratio Method Version 2 (ARM2)***[1] sviluppato dalla United States Environment Protection Agency (USEPA) elaborata attraverso l'analisi delle serie decennali (2001 – 2010) dei dati misurati di NO ed NO_2 in tutte le stazioni del territorio nazionale americano. Il metodo ARM2 permette di definire il rapporto NO_2/NO_x utilizzando la seguente funzione polinomiale:

$$\mathbf{Y} = -1.1723E\text{-}17\mathbf{X}^6 + 4.2795E\text{-}14\mathbf{X}^5 - 5.8345E\text{-}11\mathbf{X}^4 + 3.4555E\text{-}08\mathbf{X}^3 - 5.6062E\text{-}06\mathbf{X}^2 - 2.7383E\text{-}03\mathbf{X} + 1.2441E\text{+}00$$

dove:
Y= rapporto NO_2/NO_x
X= concentrazione di NO_x calcolata dal modello

Come consigliato dalle linee guida ARPA Lombardia "*Indicazioni relative all'utilizzo di tecniche modellistiche per la simulazione della dispersione di inquinanti negli studi di impatto sulla componente atmosfera*", al fine di valutarne l'efficacia per l'area in esame, i risultati ottenuti tramite il metodo ARM2 sono stati confrontati con le concentrazioni misurate nel periodo 2017-2021 dalle centralina di monitoraggio ARPA di Settimo Milanese e Rho, le più prossime al sito di progetto.

La Figura seguente mostra come, il rapporto NO_2/NO_x stimato con il metodo ARM2 sia confrontabile e cautelativo rispetto a quello ottenuto tramite le concentrazioni misurate dalla centralina di rilevamento di Settimo Milanese e Rho.

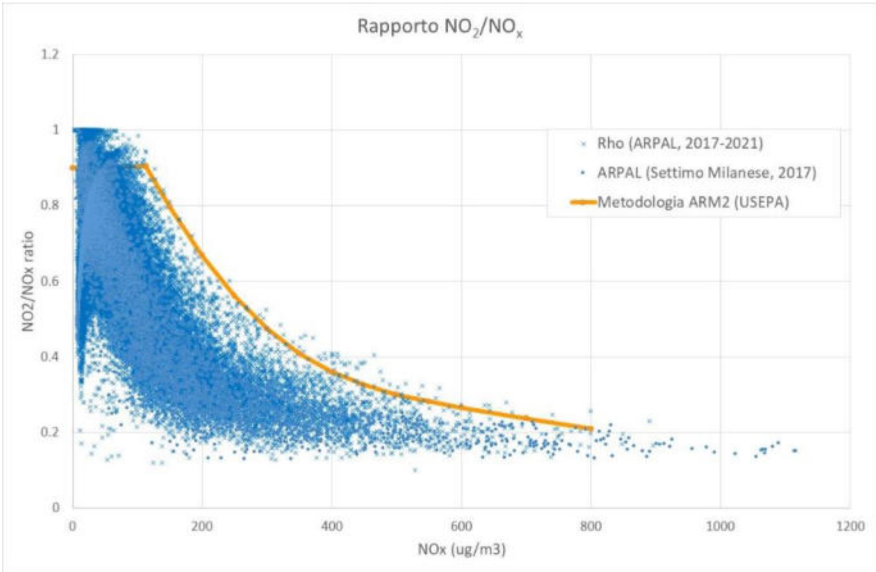


Figura 5-12: Confronto del rapporto NO2/NOx in funzione degli NOx ottenuto con il metodo ARM2 e le concentrazioni misurate presso la centralina ARPA di Settimo Milanese (2017) e Rho (2017-2021)

[1] Maggiori informazioni sul Metodo ARM2 al seguente link:
https://gaftp.epa.gov/Air/aqmg/SCRAM/models/preferred/aermod/ARM2_Development_and_Evaluation_Report-September_20_2013.pdf

6. Risultati delle simulazioni

6.1 Scenario di manutenzione

6.1.1 Biossido di Azoto (NO2)

La Figura 6-1 rappresenta la mappa di impatto che mostra i valori di concentrazione orari di NO_2 così come ottenuti dalla simulazione dello scenario di manutenzione in assenza di misure di mitigazione. La mappa mostra l'assenza di superamenti del limite orario 200 $\mu g/m^3$ in tutto il dominio di indagine, con valori inferiori a 100 $\mu g/m^3$ a distanze superiori a 250m dal sito di progetto. Presso tutti i recettori residenziali i massimi orari risultano inferiori a 40 $\mu g/m^3$, mentre i 19[i] valori massimi orari (Figura 6-3) si attestano su valori di oltre un ordine di grandezza sotto il limite orario di 200 $\mu g/m^3$, risultando inferiori a 20 $\mu g/m^3$.

La Figura 6-2 rappresenta la mappa di impatto che mostra i valori di concentrazione orari di NO_2 così come ottenuti simulando l'attivazione del sistema SCR di abbattimento degli ossidi di azoto. La mappa mostra concentrazioni massime orarie ben al di sotto i 10 $\mu g/m^3$ già al perimetro dell'area di progetto. I 19[i] valori massimi orari (Figura 6-4) si attestano su valori di 2 $\mu g/m^3$ al perimetro dell'area di progetto e ≤1 $\mu g/m^3$ nei pressi dei recettori sensibili distali. Considerando cautelativamente la ripetizione delle attività di manutenzione per ciascun mese dell'anno, le massime medie annuali (Figura 6-5 e Figura 6-6) risultano inferiori di oltre 3 ordini di grandezza (Scenario non mitigato) e di oltre 4 ordini di grandezza (Scenario con mitigazione) rispetto al limite normativo (40 $\mu g/m^3$).

La tabella seguente riporta le elaborazioni statistiche, risultanti dalla simulazione, inerenti ai recettori sensibili considerati ed il confronto con i limiti previsti dal Dlgs 155/2010. Non si evidenziano superamenti delle soglie relative alla distribuzione percentile della concentrazione oraria e della media annuale. In riferimento al potenziale effetto cumulativo, considerando un valore di fondo per l'area in esame (cfr. paragrafo 4.1), non sono ravvisabili criticità.

Tabella 6-1: concentrazioni di NO2 ai recettori sensibili e massimi di dominio – scenario di manutenzione

ID	Descrizione	Valori massimi orari µg/m³		19° valore massimo orario µg/m³		Media Annua µg/m³	
		(a)	(b)	(a)	(b)	(a)	(b)
1	Settimo Milanese - Via Rilé	38.6	1.2	15.43	0.51	9.9E-02	3.1E-03
2	Settimo Milanese - Via Edison	15.4	0.5	1.93	0.06	1.7E-02	5.3E-04
3	Monzoro - Via Marconi	26.9	0.8	0.22	0.01	1.2E-02	3.6E-04
4	Cascina Molinello - Via Marconi	39.5	1.2	0.38	0.01	1.3E-02	4.1E-04
5	Cascina Carla - SP162	26.4	0.8	0.50	0.02	9.8E-03	3.1E-04
6	Cascina Molino Catena - Via Cusago	9.6	0.3	0.50	0.02	5.7E-03	1.8E-04
7	Cascina Bergamina - Via Cusago	7.4	0.2	0.36	0.01	4.7E-03	1.5E-04
8	Cascina Figina - Via Figina	9.1	0.3	0.61	0.02	6.8E-03	2.1E-04
9	Bareggio - Via Pasteur	7.3	0.2	0.88	0.03	8.7E-03	2.7E-04
10	Cornaredo - Via Rossini	26.5	0.8	4.01	0.12	2.3E-02	7.3E-04
11	Cornaredo - Via Vespucci	16.5	0.5	2.81	0.09	1.9E-02	6.1E-04
12	Cornaredo - Via Monzoro	11.4	0.4	1.87	0.06	1.7E-02	5.4E-04
13	Vighignolo - Via Minzoni	11.9	0.4	1.70	0.05	1.0E-02	3.2E-04
14	Scuola Infanzia - Don Milani - Settimo Milanese	13.0	0.4	2.02	0.06	1.5E-02	4.7E-04
15	Scuola Primaria via Buozzi - Settimo Milanese	20.6	0.6	5.20	0.16	3.2E-02	1.0E-03
16	Scuola Infanzia via Colombo - Cornaredo	9.7	0.3	1.80	0.07	1.3E-02	4.3E-04
17	Scuola Primaria Vighignolo - Via Matteotti	9.8	0.3	1.32	0.04	8.3E-03	2.6E-04
18	Scuola Secondaria Muratori - Cornaredo	8.9	0.3	1.36	0.04	1.3E-02	4.0E-04
19	Scuola Primaria via Don Sturzo - Cornaredo	11.4	0.4	2.12	0.07	1.3E-02	4.1E-04
20	Centro Sportivo ex Italtel	133.2	5.4	48.74	1.58	2.1E-01	7.3E-03
A	Edificio privato di rappresentanza e/o produttivo	49.8	1.5	3.88	0.14	3.6E-02	1.2E-03
B	Villa Litta Modigliani	54.1	1.7	9.06	0.34	6.5E-02	2.1E-03
C	Edificio privato di rappresentanza e/o produttivo	68.4	2.1	30.00	0.97	1.4E-01	4.6E-03
D	Bar Centro Sportivo	128.9	4.9	36.24	1.23	2.1E-01	7.0E-03
E	Cascina con zona agricola	58.0	1.8	37.80	1.17	1.9E-01	6.2E-03
	Massimo di dominio	152.0	14.5	55.80	1.84	2.9E-01	1.2E-02
	SQA (D.Lgs. 155/2010)	**-**	**-**	**200**	**200**	**40**	**40**

(a) Senza sistema di abbattimento SCR
(b) Con sistema di abbattimento SCR

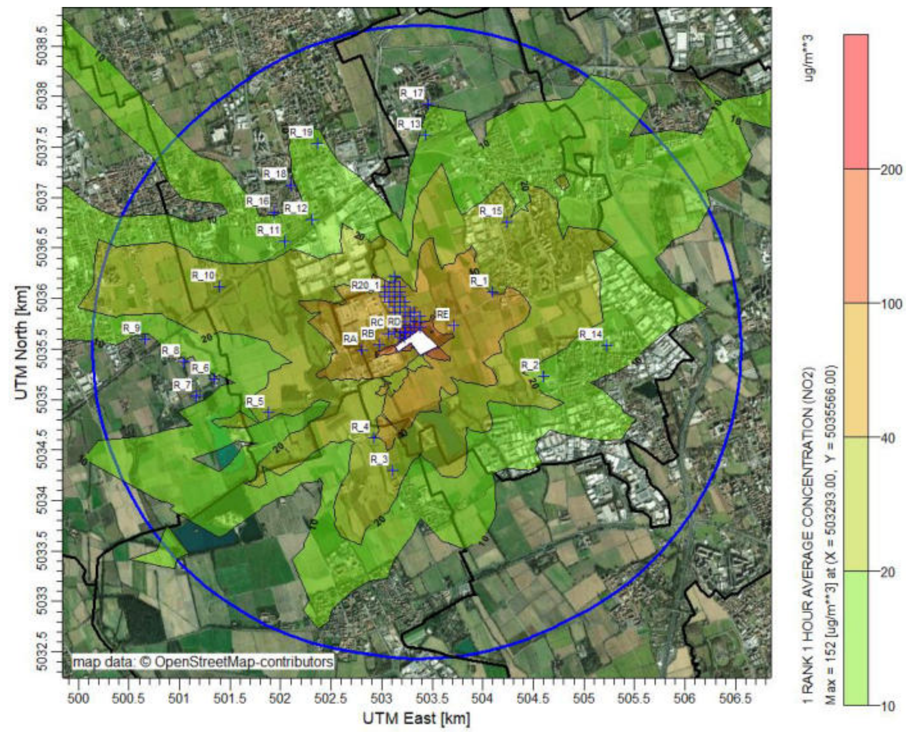


Figura 6-1: Mappa delle concentrazioni di picco orarie di NO2 nello scenario 1a di manutenzione (non mitigato)

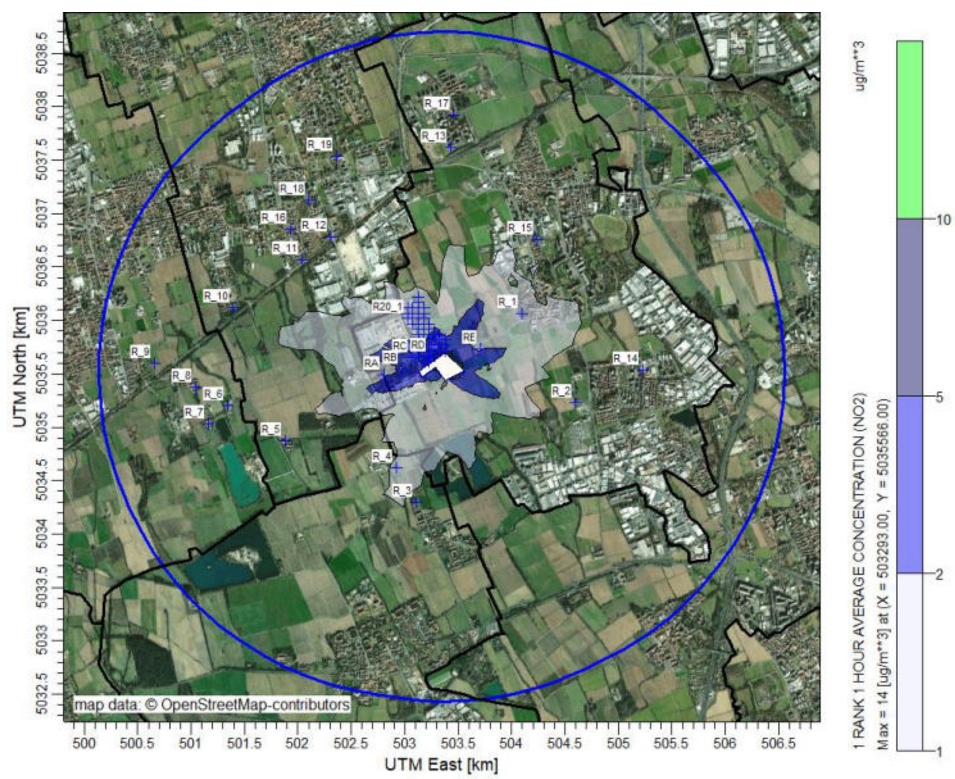


Figura 6-2: Mappa delle concentrazioni di picco orarie di NO2 nello scenario 1b di manutenzione (mitigato con SCR)

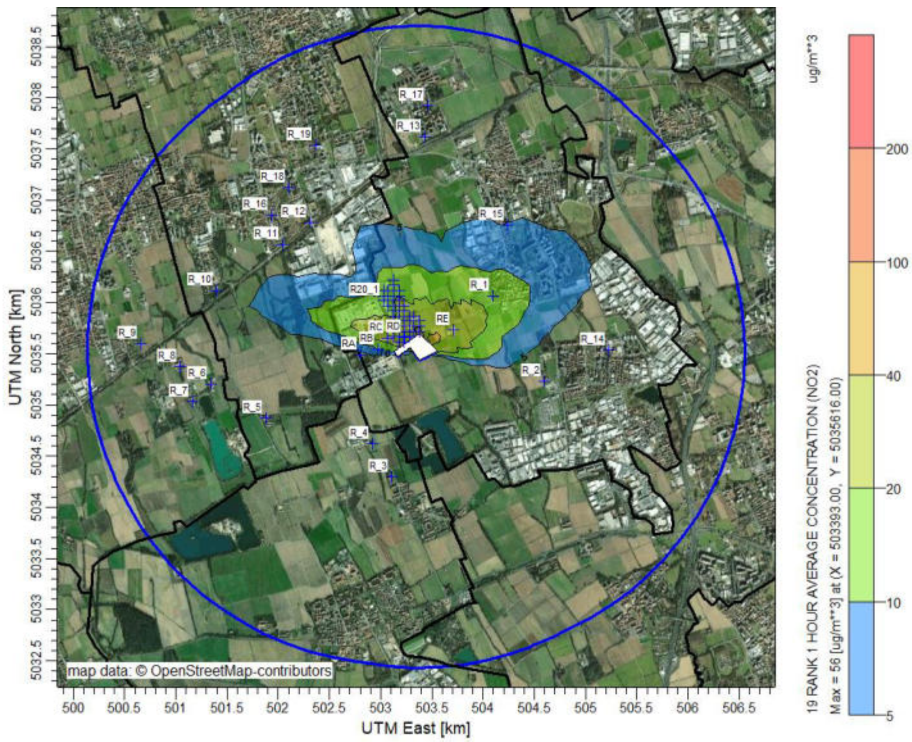


Figura 6-3: Mappa dei 19i valori massimi orari di NO2 nello scenario 1a di manutenzione (non mitigato)

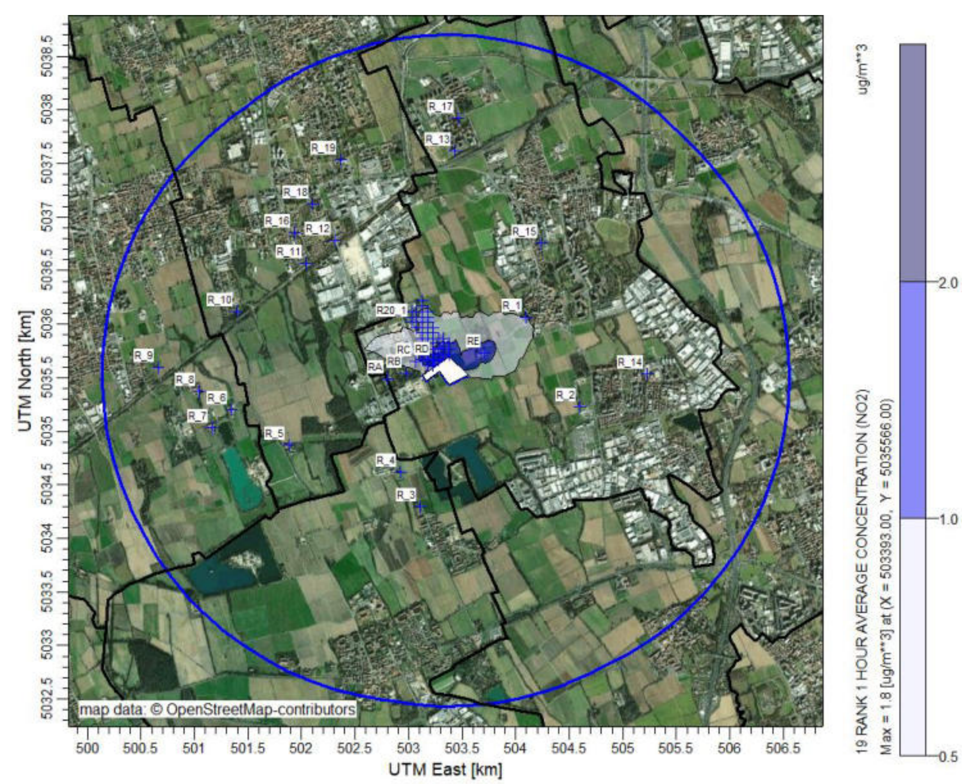


Figura 6-4: Mappa dei 19i valori massimi orari di NO2 nello scenario 1b di manutenzione (mitigato con SCR)

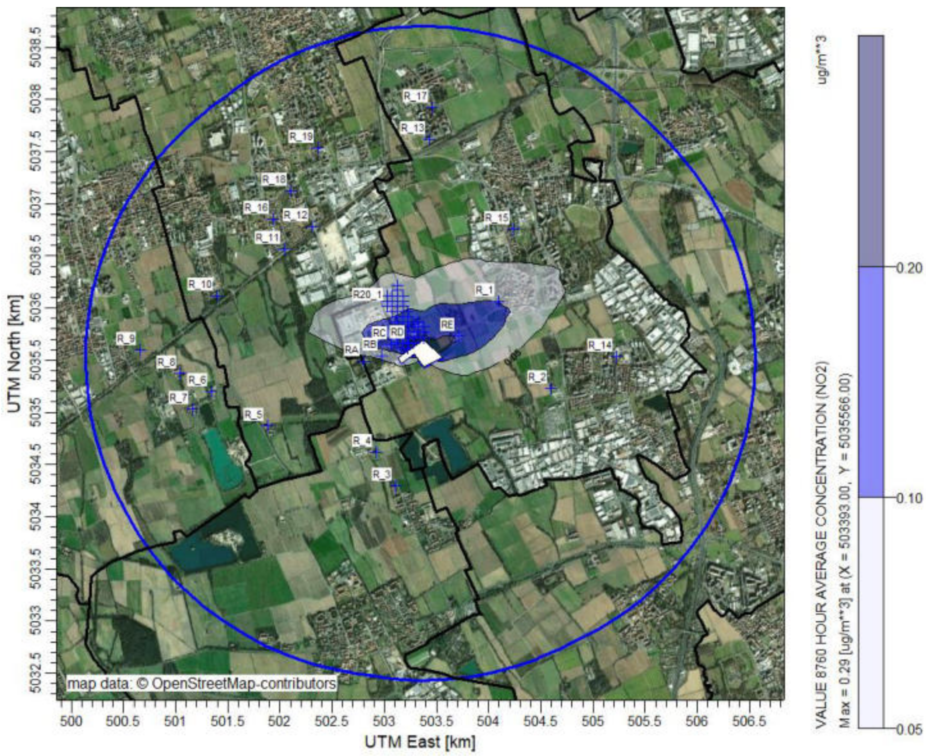


Figura 6-5: Mappa delle concentrazioni medie annuali di NO2 nello scenario 1a di manutenzione (non mitigato)

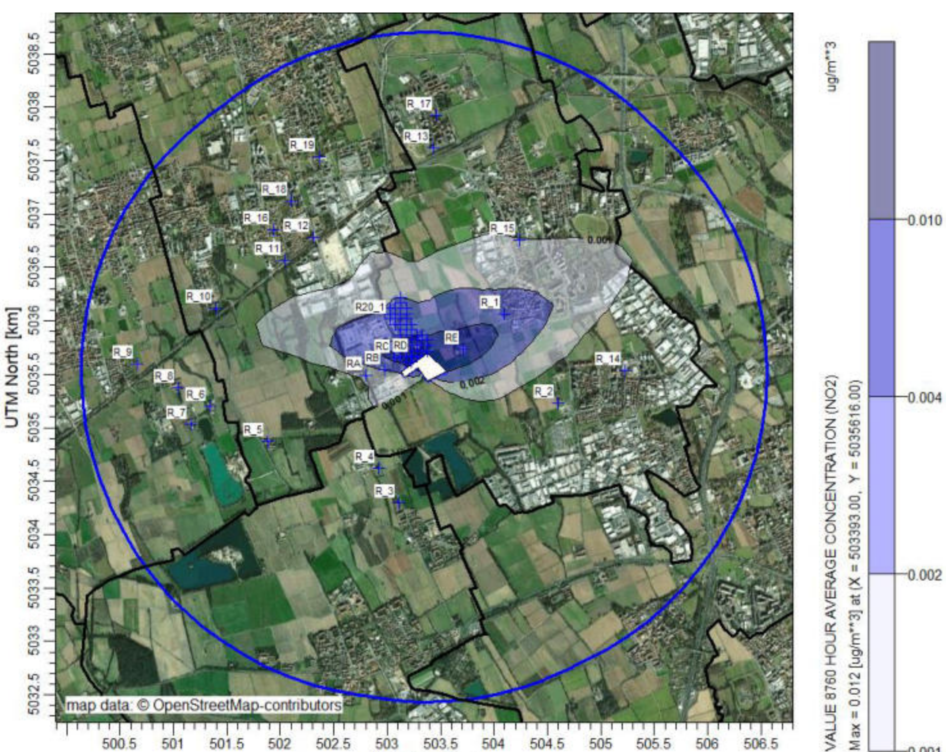


Figura 6-6: Mappa delle concentrazioni medie annuali di NO2 nello scenario 1b di manutenzione (mitigato con SCR)

6.1.2 Particolato atmosferico (PM10)

La Figura 6-7 rappresenta la mappa di impatto che mostra i valori di concentrazione massimi giornalieri di PM10 così come ottenuti dalla simulazione dello scenario di manutenzione. La mappa mostra valori trascurabili in relazione standard di qualità dell'aria ambiente indicati dal Dlgs 155/2010.

La tabella seguente riporta le elaborazioni statistiche, risultanti dalla simulazione, inerenti ai recettori sensibili considerati ed il confronto con i limiti previsti dal Dlgs 155/2010. I valori risultano essere trascurabili sia rispetto ai limiti previsti dal Dlgs 155/2010 che in riferimento ad un potenziale effetto cumulativo con il valore di fondo per l'area in esame, con valori simulati inferiori di oltre 5 ordini di grandezza rispetto ai valori di riferimento.

Tabella 6-2: concentrazioni di PM10 ai recettori sensibili e massimi di dominio – scenario di manutenzione

ID	Descrizione	Valori massimi giornalieri µg/m³	Media Annua µg/m³
1	Settimo Milanese - Via Rilé	2.4E-02	7.0E-04
2	Settimo Milanese - Via Edison	8.4E-03	1.2E-04
3	Monzoro - Via Marconi	9.6E-03	7.9E-05
4	Cascina Molinello - Via Marconi	1.4E-02	9.0E-05
5	Cascina Carla - SP162	7.8E-03	6.7E-05
6	Cascina Molino Catena - Via Cusago	3.8E-03	3.9E-05
7	Cascina Bergamina - Via Cusago	2.5E-03	3.3E-05
8	Cascina Figina - Via Figina	4.3E-03	4.7E-05
9	Bareggio - Via Pasteur	4.7E-03	6.0E-05
10	Cornaredo - Via Rossini	9.8E-03	1.6E-04
11	Cornaredo - Via Vespucci	6.7E-03	1.3E-04
12	Cornaredo - Via Monzoro	6.9E-03	1.2E-04
13	Vighignolo - Via Minzoni	4.2E-03	7.1E-05
14	Scuola Infanzia - Don Milani - Settimo Milanese	6.1E-03	1.0E-04
15	Scuola Primaria via Buozzi - Settimo Milanese	7.6E-03	2.2E-04
16	Scuola Infanzia via Colombo - Cornaredo	5.7E-03	9.4E-05
17	Scuola Primaria Vighignolo - Via Matteotti	3.6E-03	5.7E-05
18	Scuola Secondaria Muratori - Cornaredo	4.8E-03	8.9E-05
19	Scuola Primaria via Don Sturzo - Cornaredo	5.0E-03	9.0E-05
20	Centro Sportivo ex Italtel	8.0E-02	1.6E-03
A	Edificio privato di rappresentanza e/o produttivo	2.1E-02	2.6E-04
B	Villa Litta Modigliani	2.7E-02	4.6E-04
C	Edificio privato di rappresentanza e/o produttivo	3.7E-02	1.0E-03
D	Bar Centro Sportivo	6.4E-02	1.5E-03
E	Cascina con zona agricola	4.4E-02	1.4E-03
	Massimo di dominio	1.9E-01	2.6E-03
	SQA (D.Lgs. 155/2010)	**50**	**40**

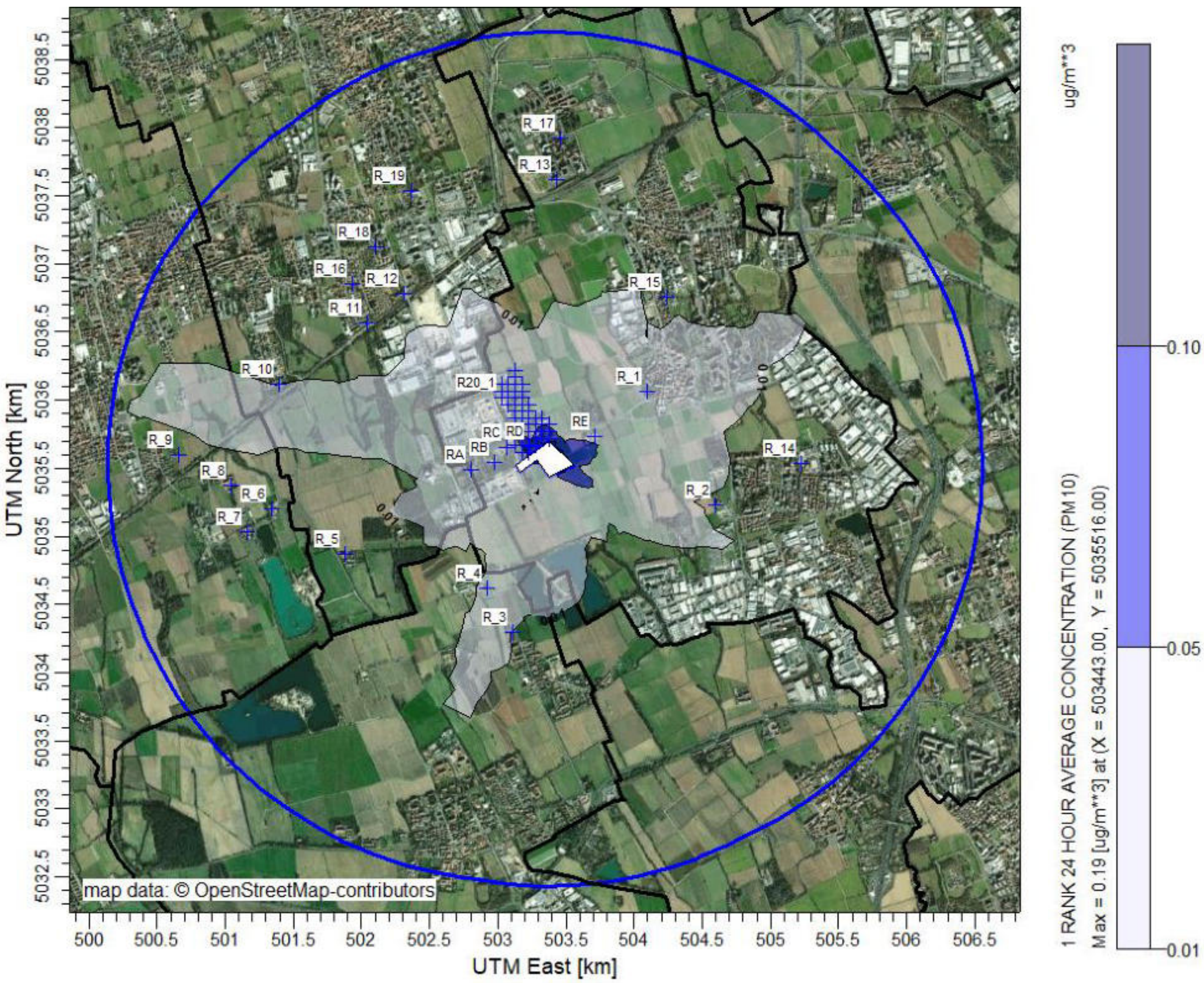


Figura 6-7: Mappa di impatto delle concentrazioni massime giornaliere (24 ore) di PM10 nello scenario di manutenzione

6.1.3 Monossido di Carbonio (CO)

La Figura 6-8 rappresenta la mappa di impatto che mostra i valori di concentrazione giornalieri di CO calcolati sulla media mobile di 8 ore così come ottenuti dalla simulazione dello scenario di manutenzione. La mappa mostra valori trascurabili in relazione standard di qualità dell'aria ambiente indicati dal Dlgs 155/2010.

La tabella seguente riporta le elaborazioni statistiche, risultanti dalla simulazione, inerenti ai recettori sensibili considerati ed il confronto con i limiti previsti dal Dlgs 155/2010. I valori risultano essere trascurabili sia rispetto ai limiti previsti dal Dlgs 155/2010 che in riferimento ad un potenziale effetto cumulativo con il valore di fondo per l'area in esame (3 mg/m^3 = 3'000 µg/m^3), con valori simulati inferiori di oltre 4 ordini di grandezza rispetto ai valori di riferimento.

Tabella 6-3: concentrazioni di CO ai recettori sensibili e massimi di dominio – scenario di manutenzione

ID	Descrizione	Massimo valore giornaliero calcolato sulla media mobile di 8 ore µg/m^3
1	Settimo Milanese - Via Rilé	0.28
2	Settimo Milanese - Via Edison	0.09
3	Monzoro - Via Marconi	0.15
4	Cascina Molinello - Via Marconi	0.22
5	Cascina Carla - SP162	0.12
6	Cascina Molino Catena - Via Cusago	0.06
7	Cascina Bergamina - Via Cusago	0.04
8	Cascina Figina - Via Figina	0.07
9	Bareggio - Via Pasteur	0.07
10	Cornaredo - Via Rossini	0.13
11	Cornaredo - Via Vespucci	0.08
12	Cornaredo - Via Monzoro	0.07
13	Vighignolo - Via Minzoni	0.06
14	Scuola Infanzia - Don Milani - Settimo Milanese	0.07
15	Scuola Primaria via Buozzi - Settimo Milanese	0.09
16	Scuola Infanzia via Colombo - Cornaredo	0.07
17	Scuola Primaria Vighignolo - Via Matteotti	0.05
18	Scuola Secondaria Muratori - Cornaredo	0.05
19	Scuola Primaria via Don Sturzo - Cornaredo	0.06
20	Centro Sportivo ex Italtel	0.94
A	Edificio privato di rappresentanza e/o produttivo	0.31
B	Villa Litta Modigliani	0.40
C	Edificio privato di rappresentanza e/o produttivo	0.57
D	Bar Centro Sportivo	0.68
E	Cascina con zona agricola	0.46
	Massimo di dominio	2.85
	SQA (D.Lgs. 155/2010)	**10'000 µg/m^3 (10 mg/m^3)**

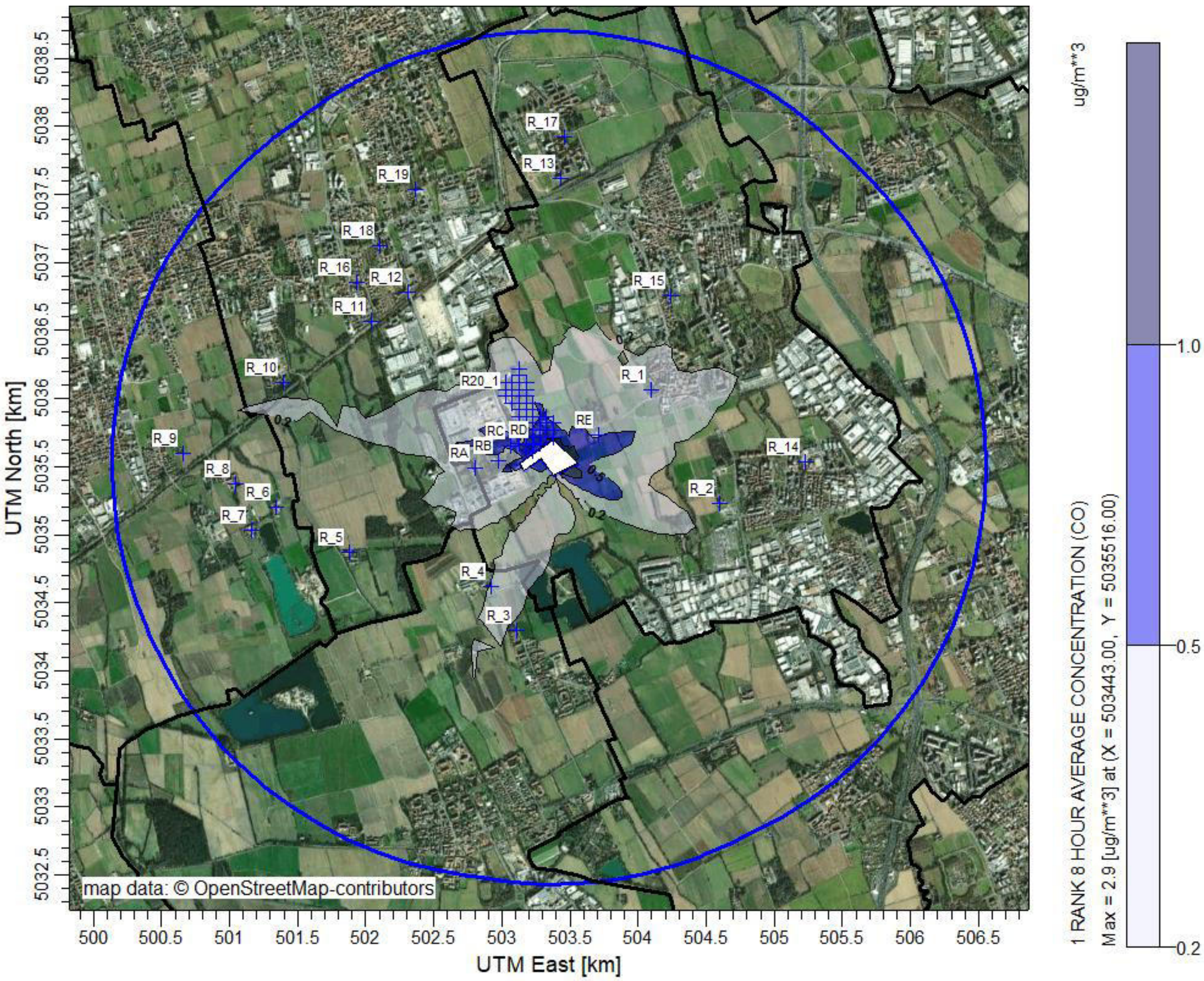


Figura 6-8: Mappa di impatto delle concentrazioni medie giornaliere (media mobile su 8 ore) di CO nello scenario di manutenzione

6.1.4 Ammoniaca (NH3)

La figura seguente rappresenta la mappa di impatto che mostra i valori di concentrazione giornalieri di NH_3 così come ottenuti dalla simulazione dello scenario di manutenzione. La mappa mostra valori trascurabili in relazione al valore di riferimento raccomandato da WHO (270 µg/m³).

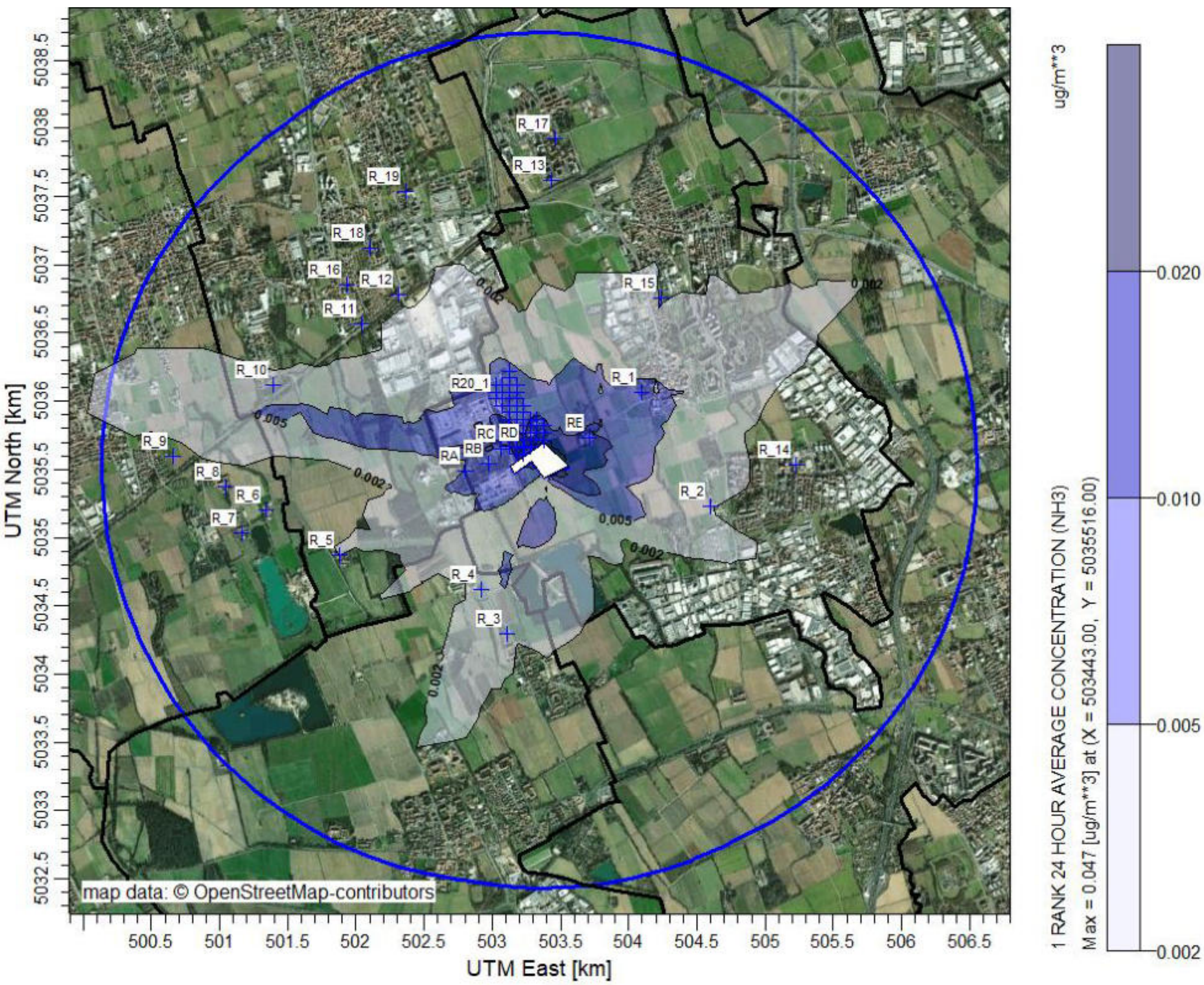


Figura 6-9: Mappa di impatto delle concentrazioni massime giornaliere (24 ore) di PM10 nello scenario 1b di manutenzione

6.1.5 Acido Cloridrico (HCl)

Anche le ricadute di acido cloridrico, in caso di utilizzo di carburanti HVO, risultano prive di criticità, anche nel peggiore dei casi simulati (1 RANK). Le ricadute massime orarie previste si mantengono ovunque inferiori di circa 1 ordine di grandezza rispetto al livello tipico in aria ambiente indicati da IARC[1] (<10 µg/m³), ed alle concentrazioni di riferimento in aria (RAC - Reference Air Concentrations) indicate quali livelli ambientali accettabili nella regolamentazione statunitense [2] (7 µg/m³).

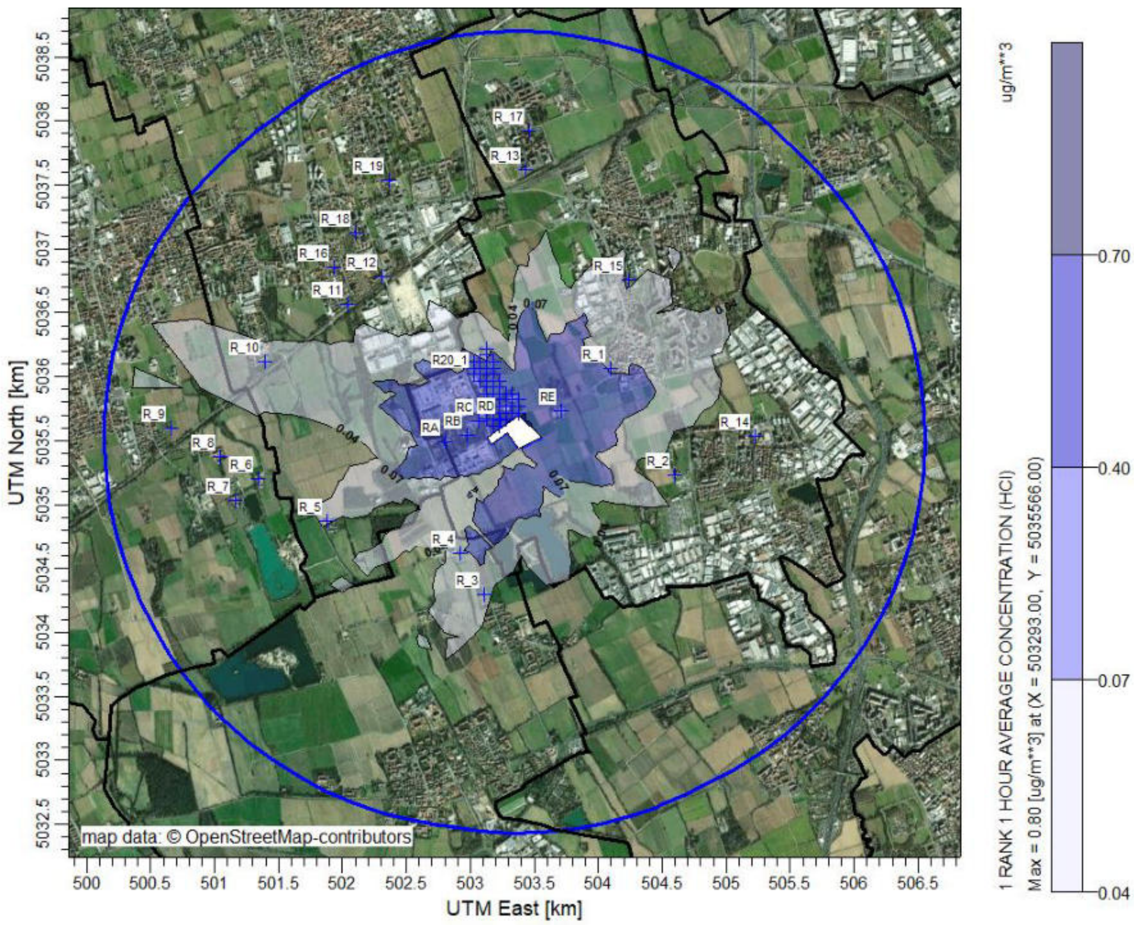


Figura 6-10: Mappa delle concentrazioni massime assolute orarie di HCl per lo Scenario 1 di Manutenzione

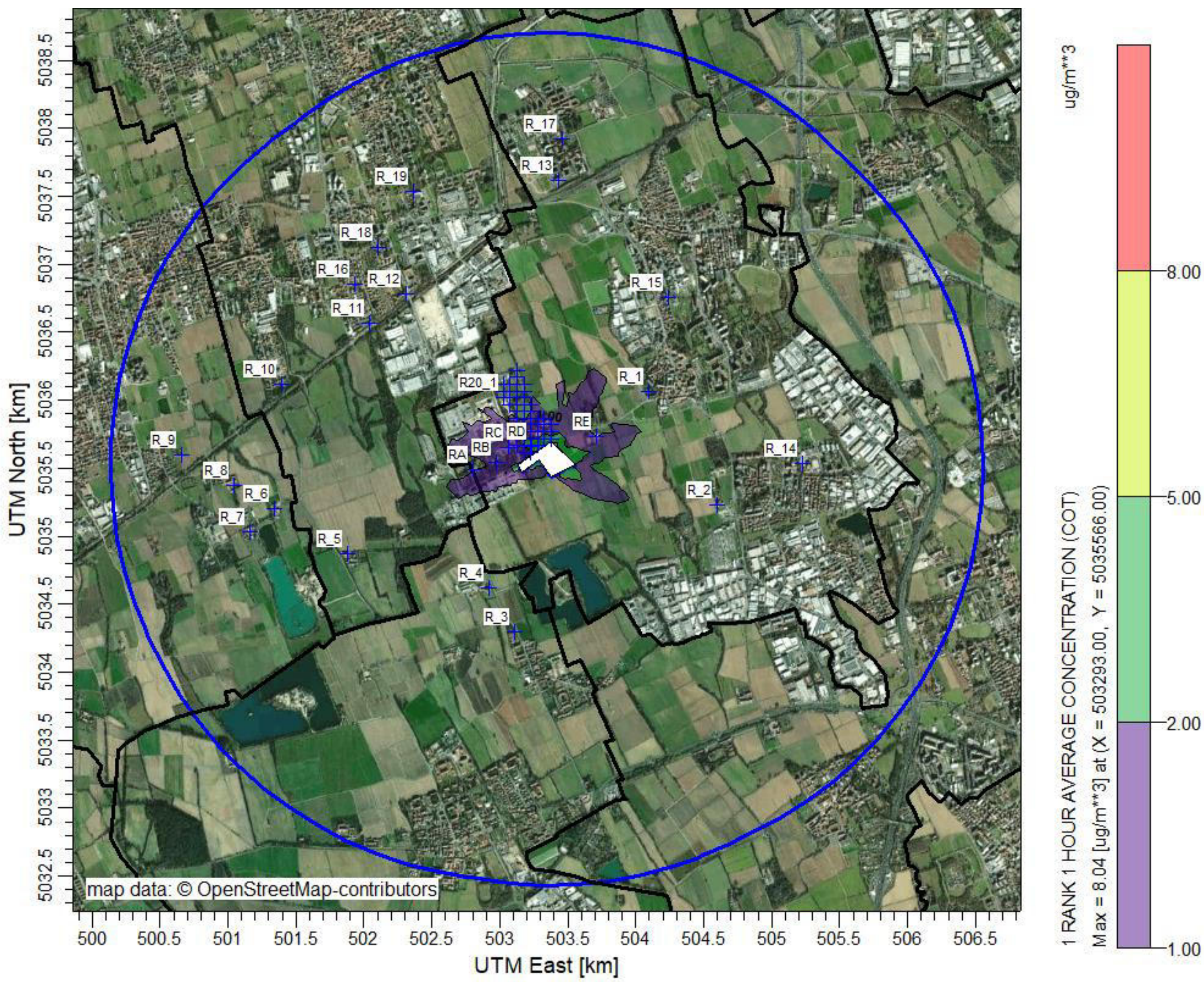
[1] Hydrochloric Acid (IARC Summary & Evaluation, Volume 54, 1992) (inchem.org)

[2] eCFR :: 40 CFR 266.107 -- Standards to control hydrogen chloride (HCl) and chlorine gas (Cl2) emissions.

6.1.6 Carbonio Organico Totale (COT)

Le ricadute massime di COT sono previste sempre inferiori a 10 µg/m^3 già in prossimità delle sorgenti emissive.

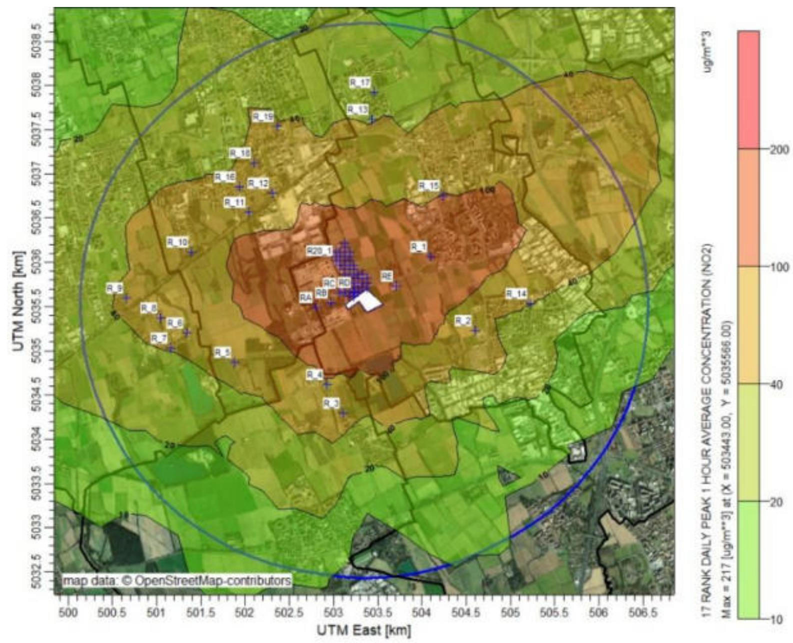
L'attuale normativa non prevede limiti per il parametro COT; le emissioni possono comunque essere considerate trascurabili dato che rappresentano, per lo scenario di manutenzione simulato (attivazione dei generatori per 216 h/anno cumulative), lo 0,02% delle stime emissive comunali calcolate su base annuale (cfr. par. 5.2.1).



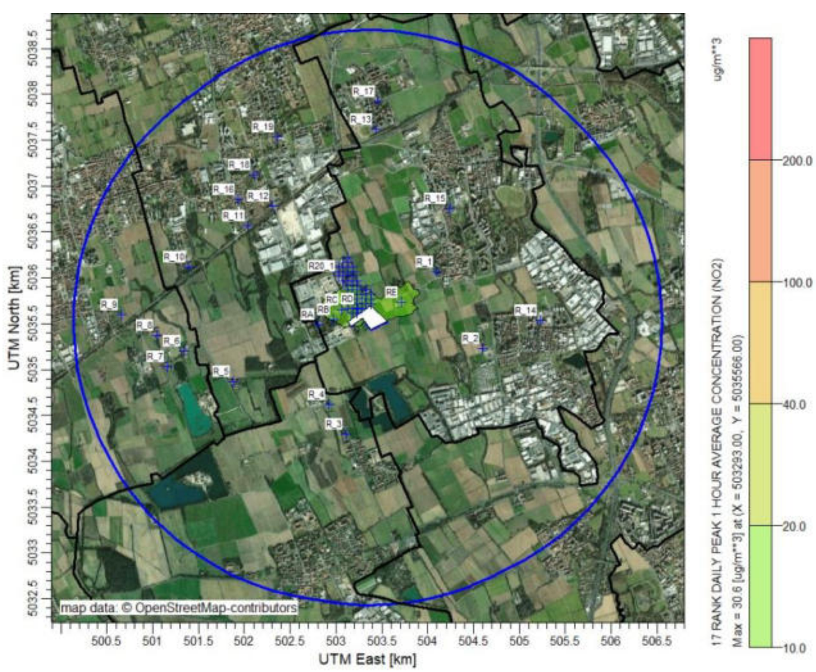
6.2 Scenario di emergenza

6.2.1 Biossido di Azoto (NO2)

Le seguenti figure mostrano le mappe dei picchi orari di NO_2 previsti per ciascun recettore, nelle peggiori simulazioni effettuate (95° percentile, n=337), senza e con l'abbattimento SCR. In altre parole, per ciascun punto della mappa, è visualizzato il valore di NO_2 orario che è stimato poter essere superato con una probabilità del 5%. Ovvero: in caso di attivazione contemporanea di tutti i generatori di emergenza per 2h consecutive, le ricadute orarie di NO2 avrebbero il 95% di probabilità di essere pari o inferiori a quelle visualizzate nella mappa.



(a)



(b)

Figura 6-11: Mappa delle concentrazioni di picco orarie di NO2 (95° percentile) nello scenario 2 di emergenza: (a) non mitigato (b) mitigato con SCR

In assenza di abbattimento SCR, lo scenario emergenziale mostra potenziali superamenti della concentrazione di riferimento (200 ug/m^3), possibili ma poco probabili, nelle immediate vicinanze delle installazioni verso sud-est e sud-ovest; presso i recettori sensibili i valori di NO_2 risultano sempre inferiori a 200 ug/m^3. Con l'attivazione dell'abbattimento SCR, le ricadute di NO_2 risultano sempre inferiori al limite normativo, di almeno 1 ordine di grandezza presso i recettori.

I seguenti grafici e tabelle mostrano, per i recettori sensibili potenzialmente più impattati posti in prossimità del sito in esame, la distribuzione di probabilità delle massime concentrazioni orarie di NO2 (picco giornaliero) previste in caso di emergenza.

Anche in assenza di abbattimento SCR l'analisi mostra probabilità pressoché nulle di ricadute superiori alla soglia di riferimento (200 µg/m^3). L'abbattimento degli ossidi di azoto a valle dei sistemi SCR permette di ridurre notevolmente le ricadute previste di NO2 che in tutte le simulazioni effettuate non raggiungono mai valori superiori al limite di riferimento.

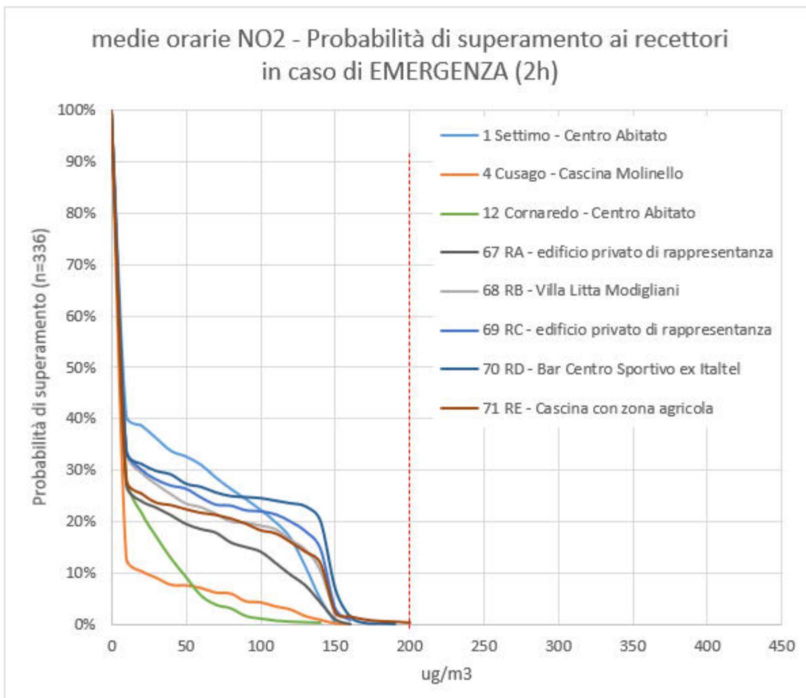


Figura 6-12: Medie orarie NO2 - Probabilità di superamento del limite orario ai recettori in caso di emergenza senza abbattimento SCR

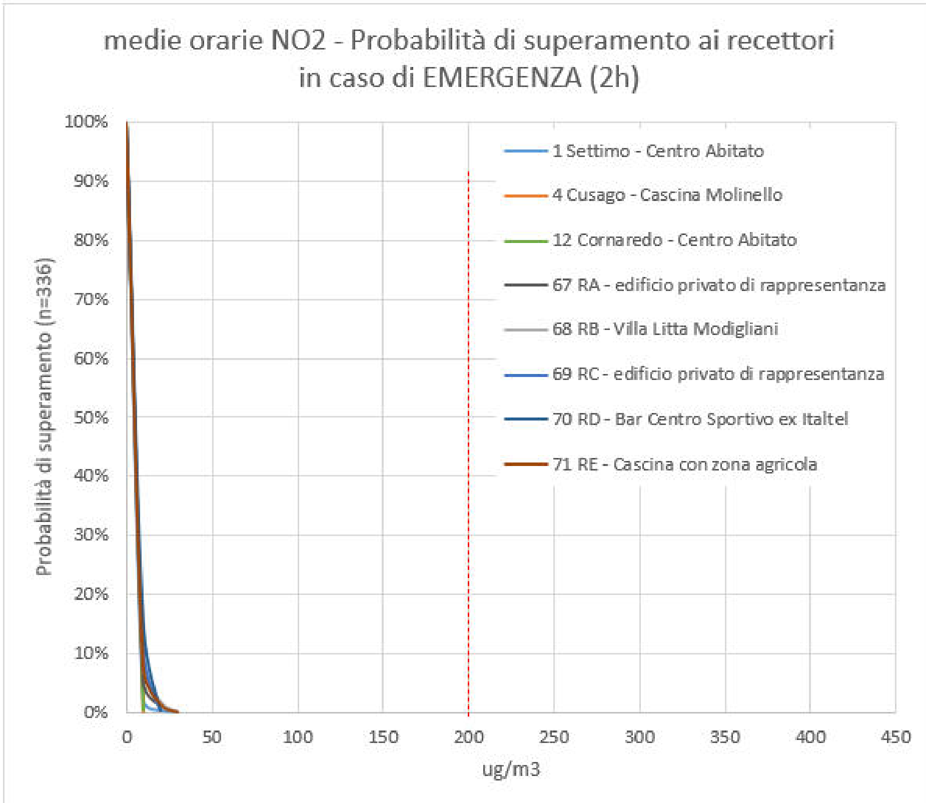


Figura 6-13: Medie orarie NO2 - Probabilità di superamento del limite orario ai recettori in caso di emergenza con abbattimento SCR

Tabella 6-4: Sintesi statistica delle simulazioni relative allo scenario 2a di emergenza. Ricadute massime orarie di NO_2 previste in caso di abbattimento NOx senza SCR (picchi giornalieri)

REC	Scenario 2a di emergenza (senza mitigazione SCR) numero di simulazioni n=337							
	media	ennesimo percentile delle ricadute massime orarie (µg/m^3)						max
		75° perc.	80 ° perc.	90° perc.	95° perc.	98° perc.	99° perc.	
1 Settimo - Centro Abitato	39.0	88.1	109.4	132.1	140.0	143.4	144.3	155.0
4 Cusago - Cascina Molinello	9.5	0.3	0.9	22.9	83.9	127.4	138.8	164.5
12 Cornaredo - Centro Abitato	12.8	14.6	25.2	46.8	64.3	87.7	103.0	144.1
67 RA - edificio privato di rappresentanza	24.9	15.6	44.5	118.1	139.8	146.2	150.0	156.0
68 RB - Villa Litta Modigliani	32.2	42.7	77.2	140.3	144.1	149.8	152.8	156.0
69 RC - edificio privato di rappresentanza	35.8	56.3	118.3	143.7	149.0	152.9	157.3	167.0
70 RD - Bar Centro Sportivo ex Italtel	39.7	79.3	140.7	146.0	153.0	159.1	162.6	191.0
71 RE - Cascina con zona agricola	30.8	21.8	87.7	141.5	144.6	151.1	168.4	208.9

Tabella 6-5: Sintesi statistica delle simulazioni relative allo scenario 2b di emergenza. Ricadute massime orarie di NO_2 previste in caso di abbattimento NOx con SCR (picchi giornalieri)

REC	Scenario 2b di emergenza (con mitigazione SCR) numero di simulazioni n=337							
	media	ennesimo percentile delle ricadute massime orarie (µg/m^3)						max
		75° perc.	80 ° perc.	90° perc.	95° perc.	98° perc.	99° perc.	
1 Settimo - Centro Abitato	1.3	0.6	1.7	5.1	6.8	10.0	13.8	31.0
4 Cusago - Cascina Molinello	0.2	0.0	0.0	0.3	1.6	3.3	3.5	10.1
12 Cornaredo - Centro Abitato	0.3	0.0	0.1	1.1	1.6	2.4	2.9	13.7
67 RA - edificio privato di rappresentanza	1.6	0.7	1.7	4.8	9.7	16.0	21.1	23.5
68 RB - Villa Litta Modigliani	2.3	1.5	3.5	8.0	14.0	18.6	22.8	30.3
69 RC - edificio privato di rappresentanza	2.3	1.7	4.2	10.1	13.1	15.3	16.3	22.2
70 RD - Bar Centro Sportivo ex Italtel	2.9	2.4	7.3	12.1	14.9	16.6	18.2	27.0
71 RE - Cascina con zona agricola	2.0	0.8	2.7	8.0	11.5	14.6	23.0	29.9

6.2.2 Particolato atmosferico (PM10)

La seguente figura mostra il peggiore (1 RANK) tra tutti i casi di emergenza simulati con riferimento alle massime ricadute di polveri (PM10). I risultati mostrano l'assenza di criticità con valori massimali inferiori di 2 ordini di grandezza rispetto ai limiti di riferimento (50 µg/m³).

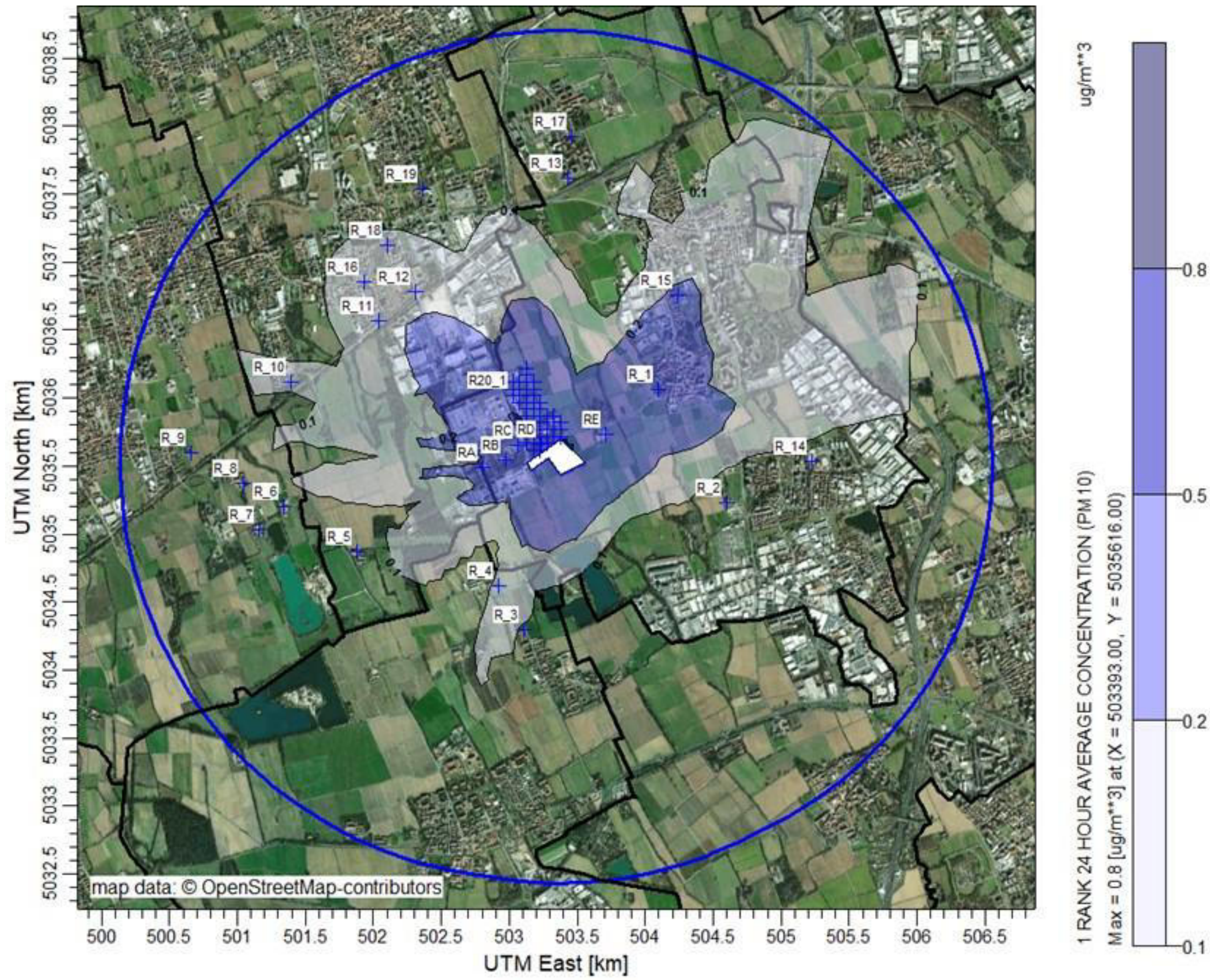


Figura 6-14: Mappa delle concentrazioni massime assolute giornaliere di PM10 per lo Scenario 2

6.2.3 Monossido di Carbonio (CO)

Analogamente a quanto riportato per il parametro polveri, la seguente figura mostra il peggiore (1 RANK) tra tutti i casi di emergenza simulati con riferimento alle massime ricadute di monossido di carbonio (CO). Anche in questo caso i risultati mostrano l'assenza di criticità con valori massimali inferiori di oltre 3 ordini di grandezza rispetto ai limiti di riferimento (10 mg/m^3 = 10'000 µg/m^3).

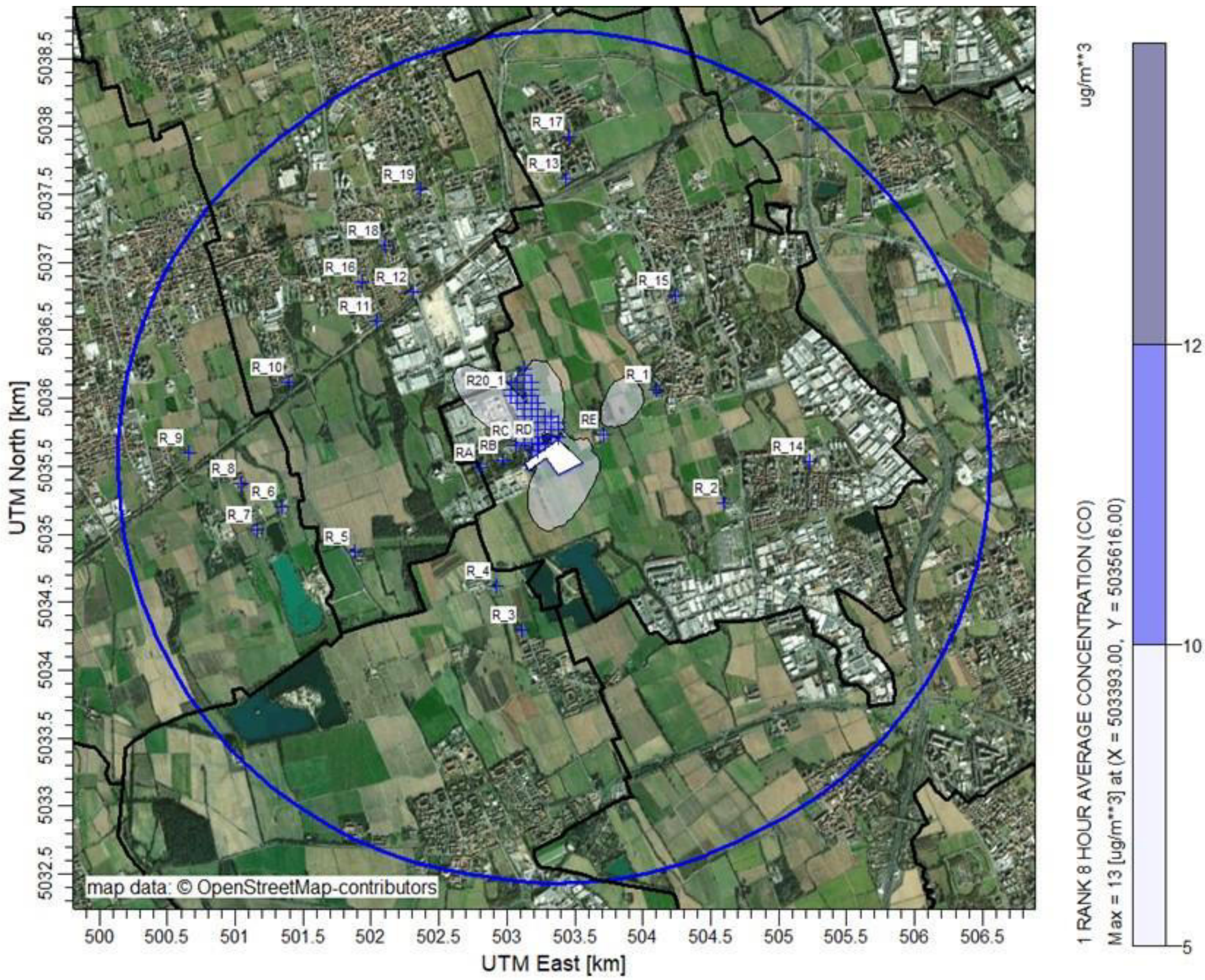


Figura 6-15: Mappa delle concentrazioni massime assolute giornaliere di CO per lo Scenario 2

6.2.4 Ammoniaca (NH3)

Anche le ricadute di ammoniaca, in caso di attivazione del sistema SCR, risultano prive di criticità, anche nel peggiore dei casi simulati (1 RANK). Assumendo un trascinamento (*slip*) di 10 ppmv di NH_3, le ricadute previste si mantengono ovunque inferiori di oltre 3 ordini di grandezza rispetto al valore di riferimento (270 µg/m^3).

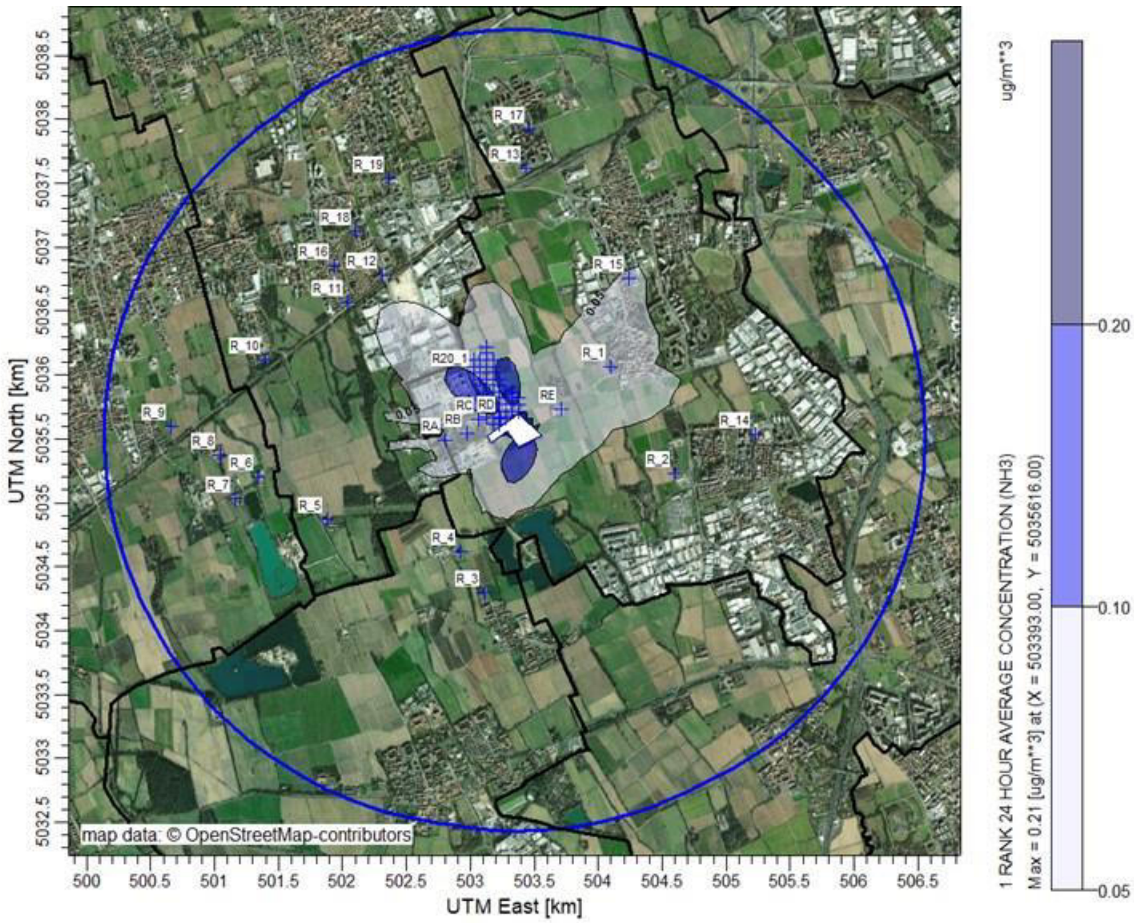


Figura 6-16: Mappa delle concentrazioni massime assolute giornaliere di NH_3 per lo Scenario 2 di Emergenza

6.2.5 Acido Cloridrico (HCl)

Anche le ricadute di acido cloridrico, in caso di utilizzo di carburanti HVO, risultano prive di criticità, anche nel peggiore dei casi simulati (1 RANK). Le ricadute massime orarie previste si mantengono ovunque inferiori di circa 1 ordine di grandezza rispetto al livello tipico in aria ambiente indicati da IARC[1] (<10 µg/m^3), ed alle concentrazioni di riferimento in aria (RAC - Reference Air Concentrations) indicate quali livelli ambientali accettabili nella regolamentazione statunitense [2] (7 µg/m^3).

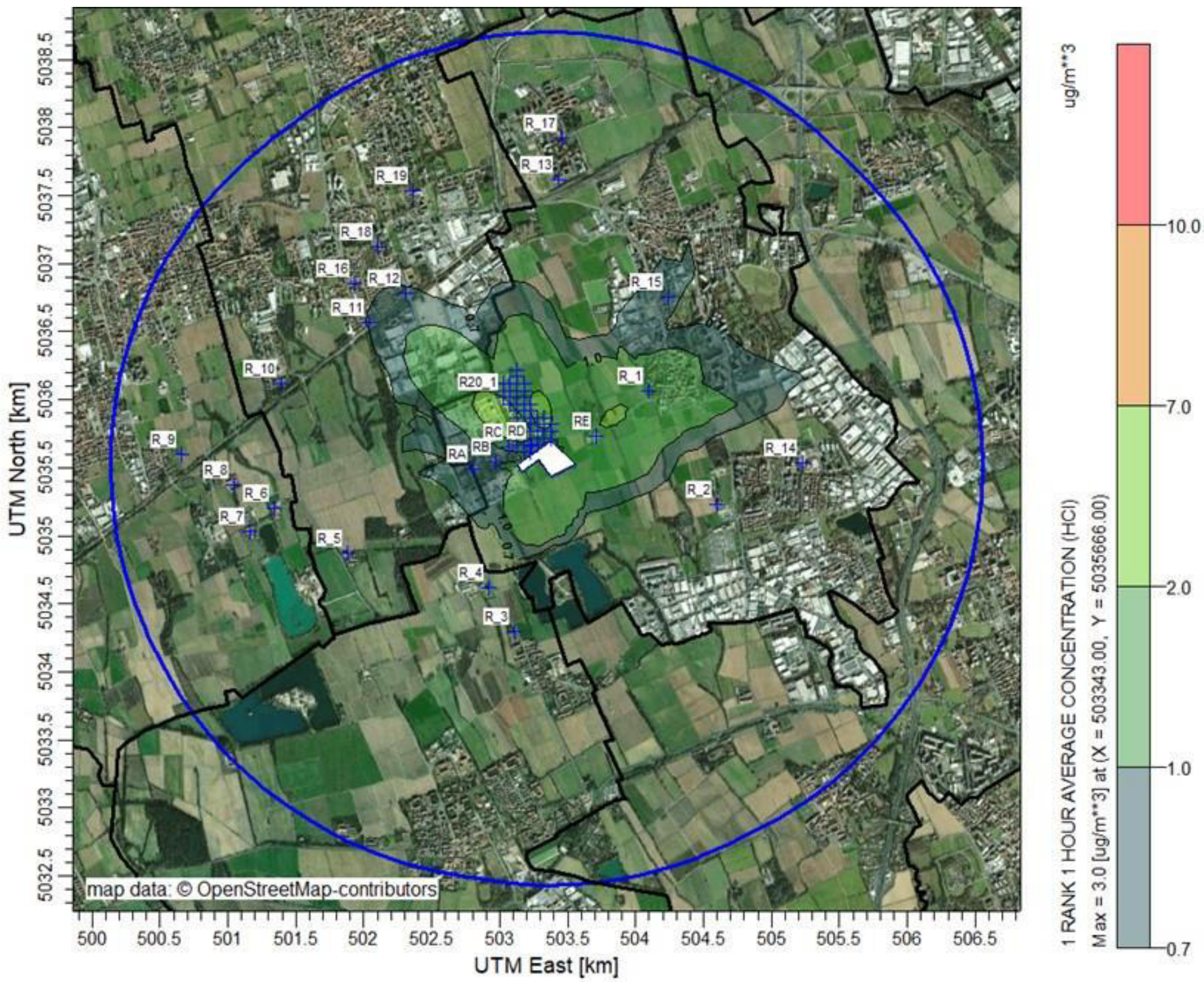


Figura 6-17: Mappa delle concentrazioni massime assolute orarie di HCl per lo Scenario 2 di Emergenza

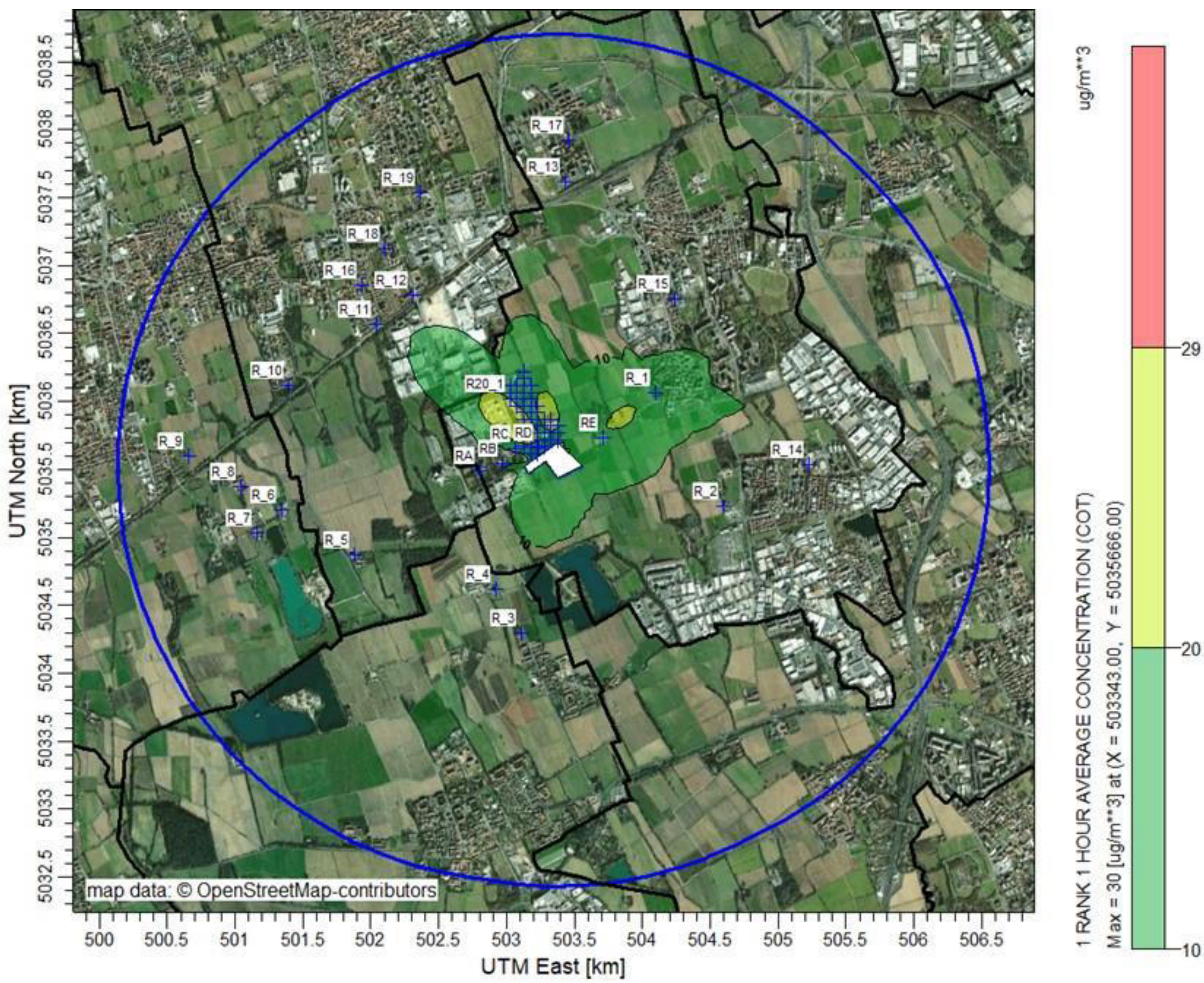
[1] Hydrochloric Acid (IARC Summary & Evaluation, Volume 54, 1992) (inchem.org)

[2] eCFR :: 40 CFR 266.107 -- Standards to control hydrogen chloride (HCl) and chlorine gas (Cl2) emissions.

6.2.6 Carbonio Organico Totale (COT)

Le ricadute massime orarie di COT sono previste sempre inferiori a 30 µg/m^3 già in prossimità delle sorgenti emissive; il 95° percentile delle medie orarie presenta concentrazioni sempre inferiori a 10 µg/m^3 all'esterno del perimetro di impianto.

L'attuale normativa non prevede limiti per il parametro COT; le emissioni possono comunque essere considerate trascurabili dato che rappresentano, per un ipotetico scenario di emergenza della durata di 2 ore, lo 0,002% delle stime emissive comunali calcolate su base annuale (cfr. par. 5.2.1).



7. Considerazioni conclusive

Il presente studio si è proposto di valutare, attraverso simulazione modellistica, gli effetti della dispersione di inquinanti in atmosfera derivanti dal funzionamento di 9 generatori di emergenza a servizio del nuovo Data Center di Settimo Milanese (MI), che verrà ospitato in un edificio di nuova costruzione denominato “MIL03”.

Il funzionamento dei generatori è previsto solo in caso di eventi incidentali che comportino l’interruzione dell’alimentazione elettrica delle unità del sito, dunque, il totale delle ore di funzionamento dei generatori e la loro distribuzione nel corso dell’anno solare non è prevedibile.

È prevista inoltre l’accensione dei generatori in occasione dell’ordinaria manutenzione, per un totale annuo di funzionamento dei generatori in condizioni ordinarie pari a massime 72 ore cumulative.

I generatori di emergenza supereranno le 500 ore di funzionamento annue e dunque le emissioni generate sono sottoposte a limiti normativi ai sensi della DGR Lombardia n.IX/3934; per questa ragione, sulla base delle informazioni fornite dal fornitore, come valori di input al modello sono state considerate concentrazioni pari ai valori limite di concentrazione riportati nella tabella di cui al par. 7.3 della DGR n.IX/3934, relativa alla tipologia di impianti “motori”.

La simulazione modellistica, nello scenario definito di “manutenzione” (Scenario 1), ha considerato l’accensione sequenziale di tutti i 9 generatori per 120 minuti ciascuno (maggiore rispetto alla durata massima effettiva prevista dai test di funzionamento, pari a 90 minuti), assumendo che le attività di manutenzione procedano ad un ritmo pari a due generatori al giorno, uno alla mattina ed uno il pomeriggio, per un periodo complessivo pari a 4,5 giorni/mese. Tale scenario emissivo, ripetuto per ogni mese dell’anno, è finalizzato a valutare la dispersione degli inquinanti durante i normali test di funzionamento, considerando la variabilità delle condizioni meteorologiche nel corso di un anno solare.

Per valutare gli effetti sulla qualità dell’aria nello scenario emergenziale (Scenario 2) è stato utilizzato un approccio di tipo stocastico, volto a stimare la probabilità di ricadute al suolo significative presso i recettori limitrofi all’impianto. L’evento emergenziale (accensione contemporanea di tutti i generatori per una durata pari a 2h) è stato simulato con una frequenza di accadimento ogni 26 ore per un intero anno (N=337), al fine di considerare la variabilità delle diverse condizioni meteorologiche nelle diverse ore del giorno e nelle diverse stagioni dell’anno.

Ciascuno scenario è stato inoltre valutato nell’ipotesi di assenza (a) e presenza (b) di un sistema di abbattimento specifico per NOx tramite tecnologia SCR e dosaggio di AdBlue.

Gli inquinanti oggetto della simulazione modellistica sono stati: biossido di azoto (NO_2), particolato atmosferico (PM_{10}), monossido di carbonio (CO), ammoniaca (NH_3, potenzialmente emesso in presenza di sistema SCR), acido cloridrico (HCl, potenzialmente emesso in caso di utilizzo di biocarburanti HVO diesel) e Carbonio Organico Totale (COT). Le emissioni di SO_2 sono considerate trascurabili considerando l’utilizzo di combustibili a bassissimo contenuto di zolfo.

Per quanto concerne le emissioni previste in fase di manutenzione, gli esiti delle simulazioni modellistiche portano a prevedere per tutti gli inquinanti l’assenza di criticità in tutto il dominio di calcolo compresi i recettori sensibili individuati in un raggio di 3 Km dal sito di progetto e considerando i livelli di fondo rappresentativi per l’area in esame. L’adozione di un sistema SCR riduce ulteriormente le ricadute di NO_2 fino a valori trascurabili.

Con riferimento allo scenario di emergenza, l’attivazione contemporanea di tutti i generatori per una durata simulata di 2h non risulta critica per quanto riguarda le possibili ricadute di PM_{10}, CO, NH_3, HCl e COT, mentre in assenza di un sistema di abbattimento degli ossidi di azoto, sussiste per il parametro NO_2 la possibilità di temporanei superamenti delle concentrazioni di riferimento orarie (200 ug/m^3) in prossimità delle sorgenti emissive, con probabilità pressoché nulle di interessare un recettore sensibile. Tale eventualità risulta molto improbabile ($p<1\%$) e nulla in caso di adozione di un sistema SCR. Risultano infine non critici i possibili trascinamenti di ammoniaca connessi alla iniezione di AdBlue nei sistemi di riduzione catalitica SCR.

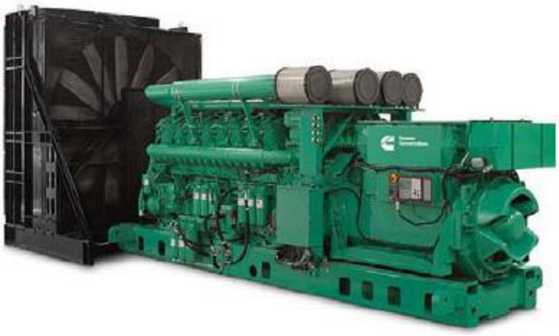
ALLEGATO 1: Scheda dati delle emissioni dei generatori

Specification Sheet

Diesel Generator Set QSK95 Series Engine

2600 kVA-3750 kVA 50 Hz

Emissions Regulated



Description

Cummins® commercial generator sets are fully integrated power generation systems providing optimum performance, fuel economy, reliability and versatility for stationary Standby, Prime and Continuous power applications.

Features

Cummins Heavy-Duty Engine - Rugged 4-cycle, industrial diesel delivers reliable power, low emissions and fast response to load changes.

Alternator - Several alternator sizes offer selectable motor starting capability with low reactance windings, low waveform distortion with non-linear loads and fault clearing short-circuit capability.

Control System - The PowerCommand® digital control is standard equipment and provides total genset system integration including automatic remote starting/stopping, precise frequency and voltage regulation, alarm and status message display, AmpSentry™ protective relay, output metering and auto-shutdown.

Cooling System - Standard and enhanced integral set-mounted radiator systems, designed and tested for rated ambient temperatures, simplifies facility design requirements for rejected heat. Also optional remote cooled configuration for non-factory supplied cooling systems.

Warranty and Service - Backed by a comprehensive warranty and worldwide distributor network.

NFPA - The generator set accepts full rated load in a single step in accordance with NFPA 110 for Level 1 systems.

ISO8528-5 G3 Capable - refer to factory for site and configuration specific transient performance classification

	Standby Rating	Prime Rating	Continuous Rating	Emissions Compliance	Data Sheets
Model	50 Hz kVA (kW)	50 Hz kVA (kW)	50 Hz kVA (kW)	EPA and TA Luft	50 Hz
C3500 D5e	3500 (2800)	3125 (2500)	2600 (2080)	2g TA Luft	NAD-5830-EN
C3500 D5e	3500 (2800)	3125 (2500)	2750 (2200)	Tier 2	NAD-5938-EN
C3750 D5e	3750 (3000)	3350 (2680)	3000 (2400)	Tier 2	NAD-5986-EN

Note: All ratings include radiator fan losses.

Generator Set Specifications

Governor regulation	ISO 8528 Part 1
Voltage regulation, no load to full load	± 0.5%
Random voltage variation	± 0.5%
Frequency regulation	Isochronous
Random frequency variation	± 0.25%
EMC compatibility	Emissions to EN61000-6-4 Immunity to EN61000-6-2

Engine Specifications

Bore	190 mm (7.48 in.)
Stroke	210 mm (8.27 in.)
Displacement	95.3 litres (5816 in^3)
Configuration	Cast iron, V 16 cylinder
Battery capacity	~~6 x 1400 amps~~ minimum at ambient temperature of -18 °C (0 °F)
Battery charging alternator	140 amps
Starting voltage	24 volt, negative ground
Fuel system	Cummins modular common rail system
Fuel filter	On engine triple element, 5 micron primary filtration with water separators, 3 micron/2 micron (filter in filter design) secondary filtration.
Fuel transfer pump	Electronic variable speed priming and lift pump
Breather	Cummins impactor breather system
Air cleaner type	Unhoused dry replaceable element
Lube oil filter type(s)	Spin-on combination full flow filter and bypass filters
Standard cooling system	High ambient compact cooling system (ship loose) High ambient cooling system (ship loose)

Alternator Specifications

Design	Brushless, 4 pole, drip proof, revolving field
Stator	Optimal
Rotor	Two bearing, flexible coupling
Insulation system	Class H on low and medium voltage, Class F on high voltage
Standard temperature rise	125 ºC Standby/105 ºC Prime
Exciter type	Optimal
Phase rotation	A (U), B (V), C (W)
Alternator cooling	Direct drive centrifugal blower fan
AC waveform Total Harmonic Distortion (THDV)	< 5% no load to full linear load, < 3% for any single harmonic
Telephone Influence Factor (TIF)	< 50 per NEMA MG1-22.43
Telephone Harmonic Factor (THF)	< 3
Anti-condensation heater	1400 watt

Available Voltages

50 Hz Line – Neutral/Line – Line

• 220/380	• 254/440	• 3464/6000	• 5775/10000
• 230/400	• 400/690	• 3637/6300	• 6060/10500
• 240/415	• 1905/3300	• 3810/6600	• 6350/11000

Note: Consult factory for other voltages.

Generator Set Options and Accessories

Engine

- 480 V thermostatically controlled coolant heater for ambient above 4.5 °C (40 °F)
- Heavy duty air cleaner
- Redundant fuel filter
- Air starter
- Redundant electric starting
- Lube oil make up
- Coalescing breather filter

Alternator

- 80 °C rise
- 105 °C rise
- 125 °C rise
- 150 °C rise
- Differential current transformers

Cooling system

- Enhanced high ambient cooling system (ship loose)
- Remote cooled configuration
- High ambient compact cooling system (ship loose)
- High ambient cooling system (ship loose)

Generator Set Options and Accessories (continued)

Control Panel

- Multiple language support
- Ground fault indication
- Remote annunciator panel
- Paralleling and shutdown alarm relay package
- Floor mounted pedestal installed control panel

Generator Set

- Battery Redundant
- Battery charger Redundant
- LV and MV entrance box
- Spring isolators
- Factory witness tests
- IBC, OSHPD, IEEE seismic certification

Warranty

- 3, 5, or 10 years for Standby including parts (labor and travel optional)
- 2 or 3 years for Prime including parts, labor and travel

Note: Some options may not be available on all models - consult factory for availability.

PowerCommand 3.3 – Control System

An integrated microprocessor based generator set control system providing voltage regulation, engine protection, alternator protection, operator interface and isochronous governing. Refer to document S-1570 for more detailed information on the control.

AmpSentry – Includes integral AmpSentry protection, which provides a full range of alternator protection functions that are matched to the alternator provided.

Power Management – Control function provides battery monitoring and testing features and smart starting control system.

Advanced Control Methodology – Three phase sensing, full wave rectified voltage regulation, with a PWM output for stable operation with all load types.

Communications Interface – Control comes standard with PCCNet and Modbus interface.

Regulation Compliant – Prototype tested: UL, CSA, UKCA and CE compliant.

Service - InPower™ PC-based service tool available for detailed diagnostics, setup, data logging and fault simulation.

Easily Upgradeable – PowerCommand controls are designed with common control interfaces.

Reliable design – The control system is designed for reliable operation in harsh environment.

Multi-language Support

Operator Panel Features

Operator/Display Functions

- Displays paralleling breaker status
- Provides direct control of the paralleling breaker
- 320 x 240 pixels graphic LED backlight LCD
- Auto, manual, start, stop, fault reset and lamp test/panel lamp switches
- Alpha-numeric display with pushbuttons
- LED lamps indicating genset running, remote start, not in auto, common shutdown, common warning, manual run mode, auto mode and stop

Paralleling Control Functions

- First Start Sensor™ system selects first genset to close to bus
- Phase lock loop synchronizer with voltage matching
- Sync check relay
- Isochronous kW and kVar load sharing
- Load govern control for utility paralleling
- Extended paralleling (Base Load/Peak Shave) mode
- Digital power transfer control, for use with a breaker pair to provide open transition, closed transition, ramping closed transition, Peaking and Base Load functions.

Other Control Features

- 150 watt anti-condensation heater
- DC distribution panel
- AC auxiliary distribution panel

Alternator Data

- Line-to-Neutral and Line-to-Line AC volts
- 3-phase AC current
- Frequency
- kW, kVar, power factor kVA (three phase and total)
- Winding temperature
- Bearing temperature

Engine Data

- DC voltage
- Engine speed
- Lube oil pressure and temperature
- Coolant temperature
- Comprehensive FAE data (where applicable)

Other Data

- Genset model data
- Start attempts, starts, running hours, kW hours
- Load profile (operating hours at % load in 5% increments)
- Fault history
- Data logging and fault simulation (requires InPower)
- Air cleaner restriction indication
- Exhaust temperature in each cylinder

Standard Control Functions

Digital Governing

- Integrated digital electronic isochronous governor
- Temperature dynamic governing

Standard Control Functions (continued)

Digital Voltage Regulation

- Integrated digital electronic voltage regulator
- 3-phase, 4-wire Line-to-Line sensing
- Configurable torque matching

AmpSentry AC Protection

- AmpSentry protective relay
- Over current and short circuit shutdown
- Over current warning
- Single and three phase fault regulation
- Over and under voltage shutdown
- Over and under frequency shutdown
- Overload warning with alarm contact
- Reverse power and reverse Var shutdown
- Field overload shutdown

Engine Protection

- Battery voltage monitoring, protection and testing
- Overspeed shutdown
- Low oil pressure warning and shutdown
- High coolant temperature warning and shutdown
- Low coolant level warning or shutdown
- Low coolant temperature warning
- Fail to start (overcrank) shutdown
- Fail to crank shutdown
- Cranking lockout
- Sensor failure indication
- Low fuel level warning or shutdown
- Fuel-in-rupture-basin warning or shutdown
- Full authority electronic engine protection

Control Functions

- Time delay start and cool down
- Real time clock for fault and event time stamping
- Exerciser clock and time of day start/stop
- Data logging
- Cycle cranking
- Load shed
- Configurable inputs and outputs (20)
- Remote emergency stop

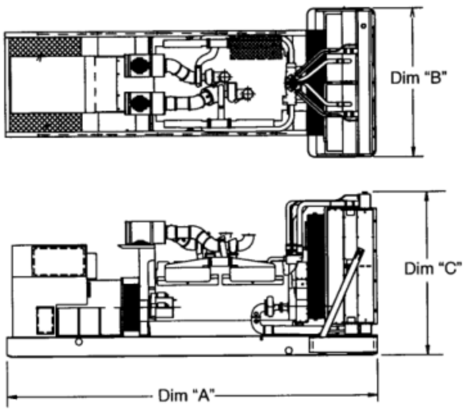
Ratings Definitions

Emergency Standby Power (ESP):
Applicable for supplying power to varying electrical loads for the duration of power interruption of a reliable utility source. Emergency Standby Power (ESP) is in accordance with ISO 8528. Fuel Stop power in accordance with ISO 3046, AS 2789, DIN 6271 and BS 5514.

Limited-Time Running Power (LTP):
Applicable for supplying power to a constant electrical load for limited hours. Limited-Time Running Power (LTP) is in accordance with ISO 8528.

Prime Power (PRP):
Applicable for supplying power to varying electrical loads for unlimited hours. Prime Power (PRP) is in accordance with ISO 8528. Ten percent overload capability is available in accordance with ISO 3046, AS 2789, DIN 6271 and BS 5514.

Base Load (Continuous) Power (COP):
Applicable for supplying power continuously to a constant electrical load for unlimited hours. Continuous Power (COP) in accordance with ISO 8528, ISO 3046, AS 2789, DIN 6271 and BS 5514.



This outline drawing is for reference only. See PowerSuite library for specific model outline drawing number.

Do not use for installation design

Model	Dim "A"* mm (in.)	Dim "B"* mm (in.)	Dim "C"* mm (in.)	Set weight* dry kg (lbs)	Set weight* wet kg (lbs)
C3500 D5e	7902 (311)	3028 (119)	3663 (144)	29526 (65092)	31194 (68771)
C3750 D5e	7902 (311)	3028 (119)	3663 (144)	29526 (65092)	31194 (68771)

* Weights and dimensions represent a set with standard features and alternator frame P80X.
See outline drawing for weights and dimensions of other configurations.

Codes and Standards

Codes or standards compliance may not be available with all model configurations – consult factory for availability.

ISO 9001	This generator set is designed in facilities certified to ISO 9001 and manufactured in facilities certified to ISO 9001 or ISO 9002.	CE	The CE marking is only valid when equipment is used in a fixed installation application. Material compliance declaration is available upon request.
CSA	All models are CSA certified to product class 4215-01.	UK CA	The UKCA marking is only valid when equipment is used in a fixed installation application. Material compliance declaration is available upon request.
		ISO8528	This generator set has been designed to comply with ISO8528 standards.
U.S. EPA	Engine certified to Stationary Emergency U.S. EPA New Source Performance Standards, 40 CFR 60 subpart IIII Tier 2 exhaust emission levels.	TÜV TA-Luft	The engine used in this generator set complies with TA Luft Standards of $2g/nm^3$ NO_x at Prime rating corrected to 5% oxygen content and measured in accordance with ISO 8178.

Warning: Back feed to a utility system can cause electrocution and/or property damage. Do not connect to any building's electrical system except through an approved device or after building main switch is open.

For more information contact your local Cummins distributor or visit power.cummins.com

Our energy working for you.™

NAS-5829-EN PDA056G725 (02/22)

Specification sheet

All features listed are included and available apart of the ones crossed though some not used ie. paralleling functions) .

PowerCommand®
3.3 control system

Control system description

The PowerCommand control system is a microprocessor-based genset monitoring, metering and control system designed to meet the demands of today's engine driven gensets. The integration of all control functions into a single control system provides enhanced reliability and performance, compared to conventional genset control systems. These control systems have been designed and tested to meet the harsh environment in which gensets are typically applied.

Features

- 320 x 240 pixels graphic LED backlight LCD.
- Multiple language support.
- AmpSentry™ protection - for true alternator overcurrent protection.
- Digital power transfer control (AMF) provides load transfer operation in open transition, closed transition, or soft (ramping) transfer modes.
- Extended paralleling (peak shave/base load) regulates the genset real and reactive power output while paralleled to the utility. Power can be regulated at either the genset or utility Bus monitoring point.
- Digital frequency synchronization and voltage matching.
- Isochronous load share
- Droop kW and kVAr control
- Real time clock for fault and event time stamping.
- Exerciser clock and time of day start/stop initiate a test with or without load, or a base load or peak shave session.
- Digital voltage regulation. Three phase full wave FET type regulator compatible with either shunt or PMG systems.
- Digital engine speed governing (where applicable)
- Generator set monitoring and protection.
- Utility/AC Bus metering and protection
- 12 and 24 V DC battery operation.
- ModBus® interface for interconnecting to customer equipment.
- Warranty and service. Backed by a comprehensive warranty and worldwide distributor service network.
- Certifications - Suitable for use on gensets that are designed, manufactured, tested and certified to relevant UL, NFPA, ISO, IEC, Mil Std. and CE standards.

PowerCommand digital genset control PCC 3300

Description

The PowerCommand genset control is suitable for use on a wide range of diesel and lean burn natural gas gensets in paralleling applications. The PowerCommand control is compatible with shunt or PMG excitation style. It is suitable for use with reconnectable or non-reconnectable generators, and it can be configured for any frequency, voltage and power connection from 120-600 VAC line-toline, 601-45,000 VAC with external PT.

Power for this control system is derived from the genset starting batteries. The control functions over a voltage range from 8 VDC to 30 VDC.

Features

- 12 and 24 VDC battery operation.
- Digital voltage regulation - Three phase full wave FET type regulator compatible with either shunt or PMG systems. Sensing is three phase.
- Digital engine speed governing (where applicable) - Provides isochronous frequency regulation.
- Full authority engine communications (where applicable) - Provides communication and control with the Engine Control Module (ECM).
- AmpSentry protection - for true alternator overcurrent protection.
- Genset monitoring - Monitors status of all critical engine and alternator functions.
- Digital genset metering (AC and DC).
- Genset battery monitoring system to sense and warn against a weak battery condition.
- Configurable for single or three phase AC metering.
- Engine starting - Includes relay drivers for starter, Fuel Shut Off (FSO), glow plug/spark ignition power and switch B+ applications.
- Genset protection – Protects engine and alternator.
- Real time clock for fault and event time stamping.
- Exerciser clock and time of day start/stop initiate a test with or without load, or a base load or peak shave session.
- Digital power transfer control (AMF) provides load transfer operation in open transition, closed transition, or soft (ramping) transfer modes.
- Extended paralleling (peak shave/base load) regulates the genset real and reactive power output while paralleled to the utility. Power can be regulated at either the genset or utility bus monitoring point.
- Digital frequency synchronization and voltage matching.
- Isochronous load share
- Droop kW and KVAr control
- Sync cCheck – The sync check function has adjustments for phase angle window, voltage window, frequency window and time delay.
- Utility/AC Bus metering and protection
- Advanced serviceability – using InPower™, a PC-based software service tool.
- Environmental protection – The control system is designed for reliable operation in harsh environments.
- The main control board is a fully encapsulated module that is protected from the elements.
- ModBus interface for interconnecting to customer equipment.
- Configurable inputs and outputs – Four discrete inputs and four dry contact relay outputs.
- Warranty and service – Backed by a comprehensive warranty and worldwide distributor service network.
- Certifications – Suitable for use on gensets that are designed, manufactured, tested and certified to relevant UL, NFPA, ISO, IEC, Mil Std. and CE standards.

Base control functions

HMI capability

Options – Local and remote HMI options.

Operator adjustments – The HMI includes provisions for many set up and adjustment functions.

Genset hardware data – Access to the control and software part number, genset rating in kVA and genset model number is provided from the HMI or InPower.

Data logs – Includes engine run time, controller on time, number of start attempts, total kilowatt hours, and load profile. (Control logs data indicating the operating hours at percent of rated kW load, in 5% increments. The data is presented on the operation panel based on total operating hours on the generator).

Fault history – Provides a record of the most recent fault conditions with control date and time stamp. Up to 32 events are stored in the control non-volatile memory.

Alternator data

- Voltage (single or three phase line-to-line and line-to-neutral)
- Current (single or three phase)
- kW, kVAr, power factor, kVA (three phase and total)
- Frequency

For Lean burn natural gas engine applications:

- Alternator heater status
- Alternator winding temperature (per phase)
- Alternator drive end bearing temperature
- Alternator non-drive end bearing temperature

Utility/AC Bus data

- Voltage (three phase line-to-line and line-to-neutral)
- Current (three phase and total)
- kW, kVAr, power factor, kVA (three phase and total)
- Frequency

Engine data

- Starting battery voltage
- Engine speed
- Engine temperature
- Engine oil pressure
- Engine oil temperature
- Intake manifold temperature
- Coolant temperature
- Comprehensive Full Authority Engine (FAE) data (where applicable)

For lean burn natural gas engine applications:

- Safety shutoff valve status
- Valve proving status
- Downstream gas pressure
- Gas inlet pressure
- Gas mass flow rate
- Control valve position
- Gas outlet pressure
- Manifold pressure
- Manifold temperature
- Throttle position
- Compressor outlet pressure
- Turbo speed
- Compressor bypass position
- Cylinder configuration (e.g., drive end and non-drive end configurations
- Coolant pressure 1 and 2 (e.g., HT and LT)
- Coolant temperature 1 and 2 (e.g., HT and LT)
- Exhaust port temperature (up to 18 cylinders)
- Pre-filter oil pressure
- Exhaust back pressure
- CM700 internal temperature
- CM700 isolated battery voltage
- Speed bias
- CM558 internal temperature
- CM558 isolated battery voltage
- Knock level (up to 18 cylinders)
- Spark advance (up to 18 cylinders)
- Knock count (up to 18 cylinders)
- Auxiliary supply disconnector status
- Engine heater status
- Coolant circulating pump status
- Lube oil priming pump status
- Lube oil status
- Oil heater status
- Derate authorization status
- Start system status
- Ventilator fan status
- Ventilation louvre status
- Radiator fan status
- DC PSU status
- Start inhibit/enable status and setup

Service adjustments – The HMI includes provisions for adjustment and calibration of genset control functions. Adjustments are protected by a password. Functions include:

- Engine speed governor adjustments
- Voltage regulation adjustments
- Cycle cranking
- Configurable fault set up
- Configurable input and output set up
- Meter calibration
- Paralleling setup
- Display language and units of measurement

Engine control

SAE-J1939 CAN interface to full authority ECMs (where applicable). Provides data transfer between genset and engine controller for control, metering and diagnostics. 12 VDC/24 VDC battery operations - PowerCommand will operate either on 12 VDC or 24 VDC batteries.

Temperature dependent governing dynamics (with electronic governing) - modifies the engine governing control parameters as a function of engine temperature. This allows the engine to be more responsive when warm and more stable when operating at lower temperature levels.

Isochronous governing - (where applicable) Capable of controlling engine speed within +/-0.25% for any steady state load from no load to full load. Frequency drift will not exceed +/-0.5% for a 33 °C (60 °F) change in ambient temperature over an 8 hour period.

Droop electronic speed governing - Control can be adjusted to droop from 0 to 10% from no load to full load.

Remote start mode - It accepts a ground signal from remote devices to automatically start the genset and immediately accelerates to rated speed and voltage or run at idle until engine temperature is adequate. The remote start signal will also wake up the control from sleep mode. The control can incorporate a time delay start and stop.

Remote and local emergency stop - The control accepts a ground signal from a local (genset mounted) or remote (facility mounted) emergency stop switch to cause the genset to immediately shut down. The genset is prevented from running or cranking with the switch engaged. If in sleep mode, activation of either emergency stop switch will wake up the control.

Sleep mode - The control includes a configurable low current draw state to minimize starting battery current draw when the genset is not operating. The control can also be configured to go into a low current state while in auto for prime applications or applications without a battery charger.

Engine starting - The control system supports automatic engine starting. Primary and backup start disconnects are achieved by one of two methods: magnetic pickup or main alternator output frequency. The control also supports configurable glow plug control when applicable.

Cycle cranking - Is configurable for the number of starting cycles (1 to 7) and duration of crank and rest periods. Control includes starter protection algorithms to prevent the operator from specifying a starting sequence that might be damaging.

Time delay start and stop (cooldown) - Configurable for time delay of 0-300 seconds prior to starting after receiving a remote start signal and for time delay of 0-600 seconds prior to shut down after signal to stop in normal operation modes. Default for both time delay periods is 0 seconds.

For lean burn natural gas engine applications:

Engine start inhibit/enable – The function will allow application-specific processes to be started prior to the genset/engine start (e.g., pumps, boosters, etc.).

Alternator control

The control includes an integrated three phase line-to-line sensing voltage regulation system that is compatible with shunt or PMG excitation systems. The voltage regulation system is a three phase full wave rectified and has an FET output for good motor starting capability. Major system features include:

Digital output voltage regulation - Capable of regulating output voltage to within +/-1.0% for any loads between no load and full load. Voltage drift will not exceed +/-1.5% for a 40 ºC
(104 ºF) change in temperature in an eight hour period. On engine starting or sudden load acceptance, voltage is controlled to a maximum of 5% overshoot over nominal level.

The automatic voltage regulator feature can be disabled to allow the use of an external voltage regulator.

Droop voltage regulation - Control can be adjusted to droop from 0-10% from no load to full load.

Torque-matched V/Hz overload control - The voltage roll-off set point and rate of decay (i.e. the slope of the V/Hz curve) is adjustable in the control.

Fault current regulation - PowerCommand will regulate the output current on any phase to a maximum of three times rated current under fault conditions for both single phase and three phase faults. In conjunction with a permanent magnet generator, it will provide three times rated current on all phases for motor starting and short circuit coordination purpose.

Paralleling functions

First Start Sensor™ system – PowerCommand provides a unique control function that positively prevents multiple gensets from simultaneously closing to an isolated bus under black start conditions. The First Start Sensor system is a communication system between the gensets that allows the gensets to work together to determine which genset is a system should be the first to close to the bus. The system includes an independent backup function, so that if the primary system is disabled the required functions are still performed.

Synchronizing – Control incorporates a digital synchronizing function to force the genset to match the frequency, phase and voltage of another source such as a utility grid. The synchronizer includes provisions to provide proper operation even with highly distorted bus voltage waveforms. The synchronizer can match other sources over a range of 60-110% of nominal voltage and -24 to +6 Hz. The synchronizer function is configurable for slip frequency synchronizing for applications requiring a known direction of power flow at instant of breaker closure or for applications where phase synchronization performance is otherwise inadequate.

Load sharing control – The genset control includes an integrated load sharing control system for both real (kW) and reactive (kVar) loads when the genset(s) are operating on an isolated bus. The control system determines kW load on the engine and kVar load on the alternator as a percent of genset capacity, and then regulates fuel and excitation systems to maintain system and genset at the same percent of load without impacting voltage or frequency regulation. The control can also be configured for operation in droop mode for kW or Kvar load sharing.

Load govern control – When PowerCommand receives a signal indicating that the genset is paralleled with an infinite source such as a utility (mains) service, the genset will operate in load govern mode. In this mode the genset will synchronize and close to the bus, ramp to a pre-programmed kW and kVar load level, and then operate at that point. Control is adjustable for kW values from 0- 100% of Standby rating, and 0.7-1.0 power factor (lagging). Default setting is 80% of Standby and 1.0 power factor. The control includes inputs to allow independent control of kW and kVar load level by a remote device while in the load govern mode. The rate of load increase and decrease is also adjustable in the control. In addition, the control can be configured for operation in kW or kVAr load govern droop.

Load demand control – The control system includes the ability to respond to an external signal to initiate load demand operation. On command, the genset will ramp to no load, open its paralleling breaker, cool down, and shut down. On removal of the command, the genset will immediately start, synchronize, connect, and ramp to its share of the total load on the system.

Sync check – The sync check function decides when permissive conditions have been met to allow breaker closure. Adjustable criteria are: phase difference from 0.1-20 deg, frequency difference from 0.001-1.0 Hz, voltage difference from 0.5-10%, and a dwell time from 0.5-5.0 sec. Internally the sync check is used to perform closed transition operations. An external sync check output is also available.

Genset and utility/AC Bus source AC metering – The control provides comprehensive three phase AC metering functions for both monitored sources, including:

3-phase voltage (L-L and L-N) and current, frequency, phase rotation, individual phase and totalized values of kW, kVAr, kVA and Power Factor; totalized positive and negative kW-hours, kVAr-hours, and kVA-hours. Three wire or four wire voltage connection with direct sensing of voltages to 600V, and up to 45kV with external transformers. Current sensing is accomplished with either 5 amp or 1 CT secondaries and with up to 10,000 amp primary. Maximum power readings are 32,000kW/kVAR/kVA.

Power transfer control – provides integrated automatic power transfer functions including source availability sensing, genset start/stop and transfer pair monitoring and control. The transfer/retransfer is configurable for open transition, fast closed transition (less than 100msec interconnect time), or soft closed transition (load ramping) sequences of operation. Utility source failure will automatically start genset and transfer load, retransferring when utility source returns. Test will start gensets and transfer load if test with load is enabled. Sensors and timers include:

Under voltage sensor: 3-phase L-N or L-L under voltage sensing adjustable for pickup from 85-100% of nominal. Dropout adjustable from 75-98% of pickup. Dropout delay adjustable from 0.1-30 sec.

Over voltage sensor: 3-phase L-N or L-L over voltage sensing adjustable for pickup from 95-99% of dropout. Dropout adjustable from 105-135% of nominal. Dropout delay adjustable from 0.5-120 sec. Standard configuration is disabled, and is configurable to enabled in the field using the HMI or InPower service tools.

Over/Under frequency sensor: Center frequency adjustable from 45-65 Hz. Dropout bandwidth adjustable from 0.3-5% of center frequency beyond pickup bandwidth. Pickup bandwidth adjustable from 0.3-20% of center frequency. Field configurable to enable.

Loss of phase sensor: Detects out of range voltage phase angle relationship. Field configurable to enable.

Phase rotation sensor: Checks for valid phase rotation of source. Field configurable to enable.

Breaker tripped: If the breaker tripped input is active, the associated source will be considered as unavailable.

Timers: Control provides adjustable start delay from 0- 300 sec, stop delay from 0-800 sec, transfer delay from
0- 120 sec, retransfer delay from 0-1800 sec, programmed transition delay from 0-60sec, and maximum parallel time from 0-1800 sec.

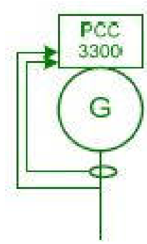
Breaker control – Utility and genset breaker interfaces include separate relays for opening and closing breaker, as well as inputs for both 'a' and 'b' breaker position contacts and tripped status. Breaker diagnostics include contact failure, fail to close, fail to open, fail to disconnect, and tripped. Upon breaker failure, appropriate control action is taken to maintain system integrity.

Extended paralleling – In extended paralleling mode (when enabled) the controller will start the genset and parallel to a utility source and then govern the real and reactive power output of the genset based on the desired control point. The control point for the real power (kW) can be configured for either the genset metering point ("base load") or the utility metering point ("peak shave"). The control point for the reactive power (kVAr or Power Factor) can also be independently configured for either the genset metering point or the utility metering point. This flexibility would allow base kW load from the genset while maintaining the utility power factor at a reasonable value to avoid penalties due to low power factor. The System always operates within genset ratings. The control point can be changed while the system is in operation. Set points can be adjusted via hardwired analog input or adjusted through an operator panel display or service tool.

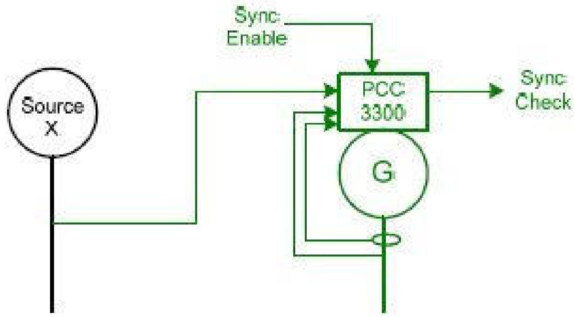
Exerciser clock –The exerciser clock (when enabled) allows the system to be operated at preset times in either test without load, test with load, or extended parallel mode. A real time clock is built in. Up to 12 different programs can be set for day of week, time of day, duration, repeat interval, and mode. For example, a test with load for 1 hour every Tuesday at 2AM can be programmed. Up to 6 different exceptions can also be set up to block a program from running during a specific date and time period.

Application types – Controller is configured to operating in one of six possible application types. These topologies are often used in combinations in larger systems, with coordination of the controllers in the system either by external device or by interlocks provided in the control. Topologies that may be selected in the control include:

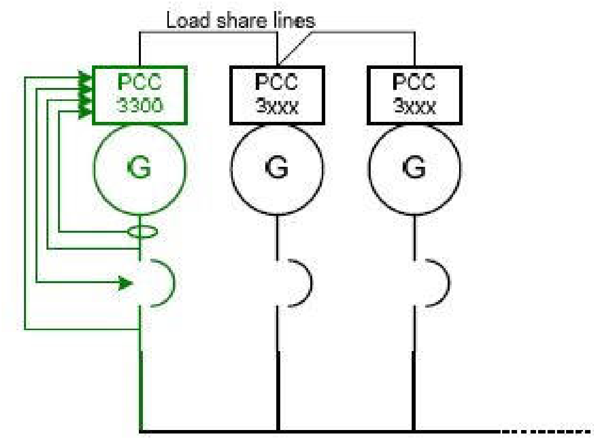
Standalone: Control provides monitoring, protection and control in a non-paralleling application.



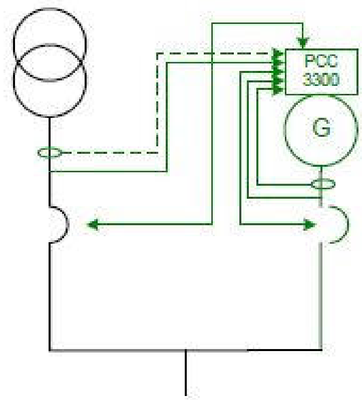
Synchronizer only: control will synchronize the genset to other source when commanded to either via a hardwired or Modbus driven input.



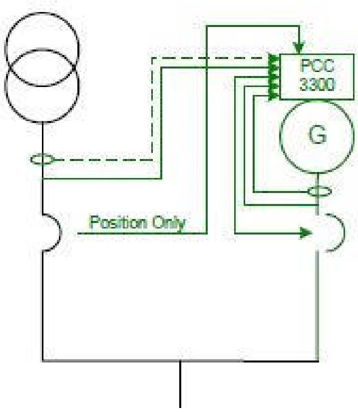
Isolated Bus: allows the genset to perform a dead bus closure or synchronize to the bus and isochronously share kW and kVAR loads with other gensets.



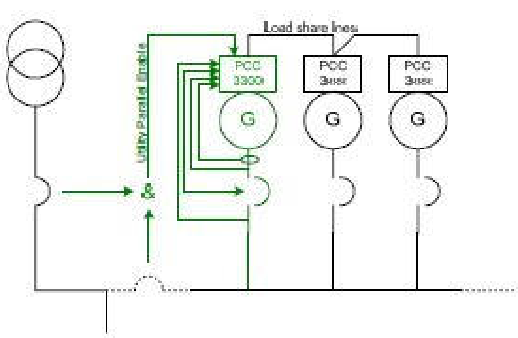
Power transfer control: control operates a single genset/single utility transfer pair in open transition, fast closed transition, or soft closed transition. Extended paralleling functionality also provides base load and peak shave options.



Utility single: Control monitors one genset and utility. The control will automatically start and provide power to a load if the utility fails. The control will also resynchronize the genset back to the utility and provides extended paralleling capabilities.



Utility multiple: Supports all functionality of Isolated Bus and provides extended paralleling to the utility. Extended paralleling load set points follow a constant setting; dynamically follow an analog input, ModBus register or HMI.



Protective functions

On operation of a protective function the control will indicate a fault by illuminating the appropriate status LED on the HMI, as well as display the fault code and fault description on the LCD. The nature of the fault and time of occurrence are logged in the control. The service manual and InPower service tool provide service keys and procedures based on the service codes provided.

Protective functions include:

Battle short mode

When enabled and the battle short switch is active, the control will allow some shutdown faults to be bypassed. If a bypassed shutdown fault occurs, the fault code and description will still be annunciated, but the genset will not shutdown. This will be followed by a fail to shutdown fault. Emergency stop shutdowns and others that are critical for proper operation (or are handled by the engine ECM) are not bypassed. Please refer to the control application guide or manual for list of these faults.

Derate

The derate function reduces output power of the genset in response to a fault condition. If a derate command occurs while operating on an isolated bus, the control will issue commands to reduce the load on the genset via contact closures or ModBus. If a derate command occurs while in utility parallel mode, the control will actively reduce power by lowering the base load kW to the derated target kW.

Configurable alarm and status inputs

The control accepts up to four alarm or status inputs (configurable contact closed to ground or open) to indicate a configurable (customer-specified) condition. The control is programmable for warning, derate, shutdown, shutdown with cooldown or status indication and for labeling the input.

Emergency stop

Annunciated whenever either emergency stop signal is received from external switch.

General engine protection

Low and high battery voltage warning - Indicates status of battery charging system (failure) by continuously monitoring battery voltage.

Weak battery warning - The control system will test the battery each time the genset is signaled to start and indicate a warning if the battery indicates impending failure.

Fail to start (overcrank) shutdown - The control system will indicate a fault if the genset fails to start by the completion of the engine crack sequence.

Fail to crank shutdown - Control has signaled starter to crank engine but engine does not rotate.

Cranking lockout - The control will not allow the starter to attempt to engage or to crank the engine when the engine is rotating.

Fault simulation –The control in conjunction with InPower software, will accept commands to allow a technician to verify the proper operation of the control and its interface by simulating failure modes or by forcing the control to operate outside of its normal operating ranges. InPower also provides a complete list of faults and settings for the protective functions provided by the controller.

For lean burn natural gas engine applications:

Off load running (protection) – This feature protects the engine in the event the genset is being called to go off load for too long.

Hydro mechanical fuel system engine protection

Overspeed shutdown – Default setting is 115% of nominal Low lube oil pressure warning/shutdown – Level is preset (configurable with InPower or HMI) to match the capabilities of the engine used. Control includes time delays to prevent nuisance alarms.

High lube oil temperature warning/shutdown – Level is preset (configurable with InPower or HMI) to match the capabilities of the engine used. Control includes time delays to prevent nuisance alarms.

High engine temperature warning/shutdown – Level is preset (configurable with InPower or HMI) to match the capabilities of the engine used. Control includes time delays to prevent nuisance alarms.

Low coolant temperature warning – Indicates that engine temperature may not be high enough for a 10 second start or proper load acceptance.

Low coolant temperature warning – Can be set up to be a warning or shutdown.

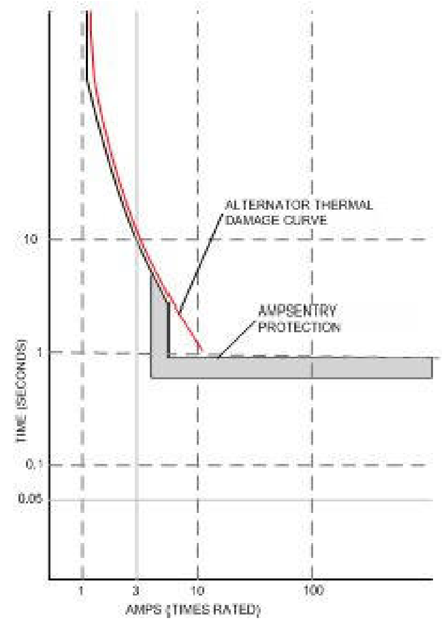
High intake manifold temperature shutdown – Level is preset (configurable with InPower or HMI) to match the capabilities of the engine used. Control includes time delays to prevent nuisance alarms.

Full authority electronic engine protection

Engine fault detection is handled inside the engine ECM. Fault information is communicated via the SAE-J1939 data link for annunciation in the HMI.

Alternator protection

AmpSentry protective relay - A comprehensive monitoring and control system integral to the PowerCommand Control System that guards the electrical integrity of the alternator and power system by providing protection against a wide array of fault conditions in the genset or in the load. It also provides single and three phase fault current regulation so that downstream protective devices have the maximum current available to quickly clear fault conditions without subjecting the alternator to potentially catastrophic failure conditions. See document R1053 for a full size time over current curve. The control does not included protection required for interconnection to a utility (mains) service.



High AC voltage shutdown (59) - Output voltage on any phase exceeds preset values. Time to trip is inversely proportional to amount above threshold. Values adjustable from 105-125% of nominal voltage, with time delay adjustable from 0.1-10 seconds. Default value is 110% for 10 seconds.

Low AC voltage shutdown (27) - Voltage on any phase has dropped below a preset value. Adjustable over a range of 50-95% of reference voltage, time delay 2-20 seconds. Default value is 85% for 10 seconds. Function tracks reference voltage. Control does not nuisance trip when voltage varies due to the control directing voltage to drop, such as during a V/Hz roll-off or synchronizing.

Under frequency shutdown (81 u) - Genset output frequency cannot be maintained. Settings are adjustable from 2-10 Hz below reference governor set point, for a 5-20 second time delay. Default: 6 Hz, 10 seconds. Under frequency protection is disabled when excitation is switched off, such as when engine is operating in idle speed mode.

Over frequency shutdown/warning (81o) - Genset is operating at a potentially damaging frequency level. Settings are adjustable from 2-10 Hz above nominal governor set point for a 1-20 second time delay. Default: 6 Hz, 20 seconds, disabled.

Overcurrent warning/shutdown (51) - Implementation of the thermal damage curve with instantaneous trip level calculated based on current transformer ratio and application power rating.

Loss of sensing voltage shutdown - Shutdown of genset will occur on loss of voltage sensing inputs to the control.

Field overload shutdown - Monitors field voltage to shutdown genset when a field overload condition occurs.

Over load (kW) warning - Provides a warning indication when engine is operating at a load level over a set point. Adjustment range: 80-140% of application rated kW, 0-120 second delay. Defaults: 105%, 60 seconds.

Reverse power shutdown (32) - Adjustment range: 5-20% of Standby kW rating, delay 1-15 seconds. Default: 10%, 3 seconds.

Reverse Var shutdown - Shutdown level is adjustable: 15- 50% of rated Var output, delay 10-60 seconds. Default: 20%, 10 seconds.

Short circuit protection - Output current on any phase is more than 175% of rating and approaching the thermal damage point of the alternator. Control includes algorithms to protect alternator from repeated over current conditions over a short period of time.

Negative sequence overcurrent warning (46) – Control protects the generator from damage due to excessive imbalances in the three phase load currents and/or power factors.

Custom overcurrent warning/shutdown (51) – Control provides the ability to have a custom time overcurrent protection curve in addition to the AmpSentry protective relay function.

Ground fault overcurrent (51G) – Control detects a ground fault either by an external ground fault relay via a contact input or the control can measure the ground current from an external current transformer. Associated time delays and thresholds are adjustable via InPower or HMI.

~~Paralleling protection~~

Breaker fail to close warning: When the control signals a circuit breaker to close, it will monitor the breaker auxiliary contacts and verify that the breaker has closed. If the control does not sense a breaker closure within an adjustable time period after the close signal, the fail to close warning will be initiated.

Breaker fail to open warning: The control system monitors the operation of breakers that have been signalled to open. If the breaker does not open within and adjustable time delay, a Breaker Fail to Open warning is initiated.

Breaker position contact warning: The controller will monitor both 'a' and 'b' position contacts from the breaker. If the contacts disagree as to the breaker position, the breaker position contact warning will be initiated.

Breaker tripped warning: The control accepts inputs to monitor breaker trip / bell alarm contact and will initiate a breaker tripped warning if it should activate.

Fail to disconnect warning: In the controller is unable to open either breaker, a fail to disconnect warning is initiated. Typically this would be mapped to a configurable output, allowing an external device to trip a breaker.

Fail to synchronize warning: Indicates that the genset could not be brought to synchronization with the bus. Configurable for adjustable time delay of 10 -900 seconds, 120 default.

Phase sequence sensing warning: Verifies that the genset phase sequence matches the bus prior to allowing the paralleling breaker to close.

Maximum parallel time warning (power transfer control mode only): During closed transition load transfers, control independently monitors paralleled time. If time is exceeded, warning is initiated and genset is disconnected.

Bus or genset PT input calibration warning: The control system monitors the sensed voltage from the bus and genset output voltage potential transformers. When the paralleling breaker is closed, it will indicate a warning condition if the read values are different.

Field control interface

Input signals to the PowerCommand control include:

- Coolant level (where applicable)
- Fuel level (where applicable)
- Remote emergency stop
- Remote fault reset
- Remote start
- Rupture basin
- Start type signal
- ~~Battle short~~
- Load demand stop
- ~~Synchronize enable~~
- Genset circuit breaker inhibit
- Utility circuit breaker inhibit
- ~~Single mode verify~~
- ~~Transfer inhibit – prevent transfer to utility (in power transfer control mode)~~
- ~~Retransfer inhibit – prevent retransfer to genset (in power transfer control mode)~~
- kW and kVAr load setpoints
- Configurable inputs - Control includes (4) input signals from customer discrete devices that are configurable for warning, shutdown or status indication, as well as message displayed

For lean burn natural gas engine applications:

- Gearbox oil pressure/temperature protection
- Fire fault
- Earth fault
- Differential fault
- DC power supply fault
- Genset Interface Box (GIB) isolator open fault
- Start inhibit/enable (x3)
- Radiator fan trip

- Ventilator fan trip
- Ventilation louvers closed
- Start system trip
- Alternator heater trip
- Alternator heater status
- Alternator winding temperature (PT100 RTDx3)
- Alternator drive end bearing temperature (PT100 RTD)
- Alternator non-drive end bearing temperature (PT100 RTD)

Output signals from the PowerCommand control include:

- Load dump signal: Operates when the genset is in an overload condition.
- Delayed off signal: Time delay based output which will continue to remain active after the control has removed the run command. Adjustment range: 0 - 120 seconds.
  Default: 0 seconds.
- Configurable relay outputs: Control includes (4) relay output contacts (3 A, 30 VDC). These outputs can be configured to activate on any control warning or shutdown fault as well as ready to load, not in auto, common alarm, common warning and common shutdown.
- Ready to load (genset running) signal: Operates when the genset has reached 90% of rated speed and voltage and latches until genset is switched to off or idle mode.
- Paralleling circuit breaker relays outputs: Control includes (4) relay output contacts (3.5 A, 30 VDC) for opening and closing of the genset and utility breakers.

For lean burn natural gas engine applications:

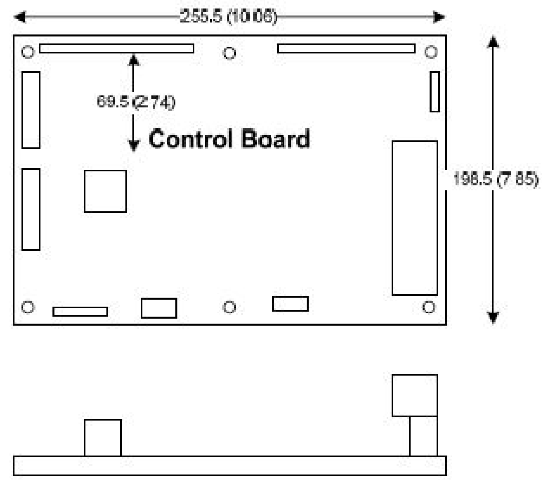
- Start inhibit/enable event
- Emergency stop event
- Ventilator fan run control
- Louvre control
- Radiator fan control
- Alternator heater control
- Engine at idle speed event

Communications connections include:

- PC tool interface: This RS-485 communication port allows the control to communicate with a personal computer running InPower software.
- ModBus RS-485 port: Allows the control to communicate with external devices such as PLCs using ModBus protocol.

  Note - An RS-232 or USB to RS-485 converter is required for communication between PC and control.
- Networking: This RS-485 communication port allows connection from the control to the other Cummins products.

Mechanical drawing



PowerCommand Human Machine Interface HMI320

Description

This control system includes an intuitive operator interface panel that allows for complete genset control as well as system metering, fault annunciation, configuration and diagnostics. The interface includes five genset status LED lamps with both internationally accepted symbols and English text to comply with customer's needs. The interface also includes an LED backlit LCD display with tactile feel soft-switches for easy operation and screen navigation. It is configurable for units of measurement and has adjustable screen contrast and brightness.

The run/off/auto switch function is integrated into the interface panel.

All data on the control can be viewed by scrolling through screens with the navigation keys. The control displays the current active fault and a time-ordered history of the five previous faults.

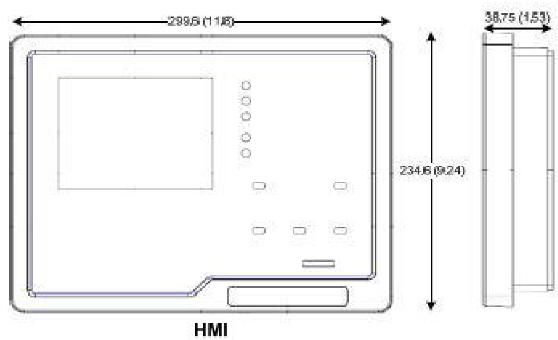
Features

- LED indicating lamps:
- Genset running
- Remote start
- Not in auto
- Shutdown
- Warning
- Auto
- Manual and stop
- Circuit breaker open (if equipped)
- Circuit breaker closed (if equipped)
- 320 x 240 pixels graphic LED backlight LCD.
- Four tactile feel membrane switches for LCD defined operation. The functions of these switches are defined dynamically on the LCD.
- Seven tactile feel membrane switches dedicated screen navigation buttons for up, down, left, right, ok, home and cancel.
- Six tactile feel membrane switches dedicated to control for auto, stop, manual, manual start, fault reset and lamp test/panel lamps.
- Two tactile feel membrane switches dedicated to control of circuit breaker (where applicable).
- Allows for complete genset control setup.
- Certifications: Suitable for use on gensets that are designed, manufactured, tested and certified to relevant UL, NFPA, ISO, IEC, Mil Std. and CE standards.
- LCD languages supported: English, Spanish, French, German, Italian, Greek, Dutch, Portuguese, Finnish, Norwegian, Danish, Russian and Chinese characters.

Communications connections include:

- PC tool interface - This RS-485 communication port allows the HMI to communicate with a personal computer running InPower.
- This RS-485 communication port allows the HMI to communicate with the main control board.

Mechanical drawing



Software

InPower (beyond 6.5 version) is a PC-based software service tool that is designed to directly communicate to PowerCommand gensets and transfer switches, to facilitate service and monitoring of these products.

Environment

The control is designed for proper operation without recalibration in ambient temperatures from -40 ºC (-40 ºF) to +70 ºC (158 ºF), and for storage from -55 ºC (-67 ºF) to +80 ºC (176 ºF). Control will operate with humidity up to 95%, non-condensing.

The HMI is designed for proper operation in ambient temperatures from -20 ºC (-4 ºF) to +70 ºC (158 ºF), and for storage from -30 ºC (-22 ºF) to +80 ºC (176 ºF).

The control board is fully encapsulated to provide superior resistance to dust and moisture. Display panel has a single membrane surface, which is impervious to effects of dust, moisture, oil and exhaust fumes. This panel uses a sealed membrane to provide long reliable service life in harsh environments.

The control system is specifically designed and tested for resistance to RFI/EMI and to resist effects of vibration to provide a long reliable life when mounted on a genset. The control includes transient voltage surge suppression to provide compliance to referenced standards.

Certifications

PowerCommand meets or exceeds the requirements of the following codes and standards:

- NFPA 110 for level 1 and 2 systems.
- ISO 8528-4: 1993 compliance, controls and switchgear.
- CE marking: The control system is suitable for use on generator sets to be CE-marked.
- EN 50081-1,2 residential/light industrial emissions or industrial emissions.
- EN 50082-1,2 residential/light industrial or industrial susceptibility.
- ISO 7637-2, level 2; DC supply surge voltage test.
- Mil Std 202C, Method 101 and ASTM B117: Salt fog test.
- UL 508 recognized or Listed and suitable for use on UL 2200 Listed generator sets.
- CSA C282-M1999 compliance
- CSA 22.2 No. 14 M91 industrial controls.
- PowerCommand control systems and generator sets are designed and manufactured in ISO 9001 certified facilities.

Warranty

All components and subsystems are covered by an express limited one year warranty. Other optional and extended factory warranties and local distributor maintenance agreements are available.

PCCNet COMPATIBLE

For more information contact your local Cummins distributor or visit power.cummins.com

Our energy working for you.™

S-1570 (08/18)

Generator set data sheet

Model:	**C3750 D5e**	Thermal Power Input = 7.9880MW
Frequency:	**50 Hz**	
Fuel type:	**Diesel**	
kVA rating:	**3750 Standby** **3350 Prime** **3000 Continuous**	
Emissions level:	**EPA Tier 2**	

Fuel consumption

	Standby				Prime				Continuous			
	kVA (kW)				**kVA (kW)**				**kVA (kW)**			
Ratings	3750 (3000)				3350 (2680)				3000 (2400)			
Ratings without fan[1]	3844 (3075)				3445 (2756)				3095 (2476)			
Load	**1/4**	**1/2**	**3/4**	**Full**	**1/4**	**1/2**	**3/4**	**Full**	**1/4**	**1/2**	**3/4**	**Full**
US gph	59	107	150	197	53	96	136	176	49	88	124	159
L/hr	222	406	569	745	202	364	514	664	202	331	471	603

[1]Ratings for reference with the optional remote radiator cooling configuration. See note 1 under "Alternator data" section.

Engine

	Standby rating	Prime rating	Continuous rating
Engine model	QSK95-G10		
Configuration	Cast iron, Vee, 16 cylinder		
Aspiration	Turbocharged and after-cooled		
Gross engine power output, kW_m (bhp)	3264 (4377)	2902 (3892)	2612 (3503)
BMEP at set rated load, kPa (psi)	2745 (398)	2434 (353)	2193 (318)
Bore, mm (in.)	190.0 (7.48)		
Stroke, mm (in.)	210.1 (8.27)		
Rated speed, rpm	1500		
Piston speed, m/s (ft/min)	10.5 (2067)		
Compression ratio	15.5:1		
Lube oil capacity, L (qt)	647 (684)		
Overspeed limit, rpm	1725		
Regenerative power, kW	430		

Fuel flow

Maximum fuel flow, L/hr (US gph)	1427 (377)
Maximum fuel inlet restriction with clean filter, kPa (in Hg)	16.9 (5)
Maximum fuel return line restriction, kPa (in Hg)	34 (10)
Maximum fuel inlet temperature, °C (°F)	71.1 (160)
Maximum fuel outlet temperature, °C (°F)	92.2 (198)

Air	Standby rating	Prime rating	Continuous rating
Combustion air, m³/min (scfm)	255 (8984)	245 (8634)	234 (8263)
Maximum air cleaner restriction with clean filter, mm H_2O (in H_2O)	457 (18)		
Alternator cooling air, m³/min (scfm)	240 (8476)		

Exhaust	Standby rating	Prime rating	Continuous rating
Exhaust flow at set rated load, m³/min (cfm)	619 (21853)	569 (20064)	531 (18722)
Exhaust temperature at set rated load, °C (°F)	433 (810)	406 (762)	392 (736)
Maximum back pressure, kPa (in H_2O)	7 (28)		

Set-mounted radiator cooling	High Ambient	High Ambient Compact
Ambient design, °C (°F)	43 (109)	44 (111)
Fan load, kWm (HP)	78 (105)	130 (175)
Coolant capacity (with radiator), L (US gal)	1155 (305)	1238 (327)
Cooling system air flow, m³/min (scfm)	3135 (110700)	2352 (83054)
Maximum cooling air flow static restriction, kPa (in H_2O)	0.12 (0.5)	0.12 (0.5)

Set-mounted radiator cooling	Enhanced High Ambient
Ambient design, °C (°F)	52 (126)
Fan load, kWm (HP)	78 (105)
Coolant capacity (with radiator), L (US gal)	1155 (305)
Cooling system air flow, m³/min (scfm)	3135 (110700)
Maximum cooling air flow static restriction, kPa (in H_2O)	0.12 (0.5)

Optional remote radiator cooling			
Engine coolant capacity, L (US gal)	379 (100)		
Max flow rate at max friction head, jacket water circuit, L/min (US gal/min)	2419 (639)		
Max flow rate at max friction head, after-cooler circuit, L/min (US gal/min)	579 (153)		
Heat rejected, jacket water circuit, MJ/min (Btu/min)	85.6 (81059)	76.8 (72706)	70.0 (66294)
Heat rejected, after-cooler circuit, MJ/min (Btu/min)	22.3 (21117)	19.5 (18444)	17.4 (16416)
Heat rejected, fuel circuit, MJ/min (Btu/min)	0.33 (310)	0.33 (310)	0.33 (310)
Total heat radiated to room, MJ/min (Btu/min)	25.2 (23853)	22.6 (21334)	20.4 (19244)
Maximum friction head, jacket water circuit, kPa (psi)	59 (8.5)		
Maximum friction head, after-cooler circuit, kPa (psi)	59 (8.5)		
Maximum static head above engine crank centerline, jacket water circuit, m (ft)	18 (60)		
Maximum static head above engine crank centerline, after-cooler circuit, m (ft)	18 (60)		
Maximum jacket water outlet temp, °C (°F)	110 (230)	100 (212)	100 (212)
Maximum after-cooler inlet temp, °C (°F)	71.1 (160)	68 (155)	68 (155)
Maximum after-cooler inlet temp at 25 °C (77 °F) ambient, °C (°F)	46.1 (115)		

Note: For non-standard remote installations contact your local Cummins representative.

Weights

Unit dry weight kg (lb)	29630 (65186)
Unit wet weight kg (lb)	31494 (69287)

Note: Weights represent a set with standard features and alternator frame P80X. See outline drawing for weights of other configurations.

Derating factors

Standby	**High Ambient Cooling System:** Full genset power available up to 897 m (2942 ft) at ambient temperatures up to 40 °C (104 °F). Above these conditions, derate at 4% per 305 m (1000 ft) and 9.6% per 10 °C (18 °F). **High Ambient Compact Cooling System:** Full genset power available up to 407 m (1335 ft) at ambient temperatures up to 40 °C (104 °F). Above these conditions, derate at 7% per 305 m (1000 ft) and 18.7% per 10 °C (18 °F). **Enhanced High Ambient Cooling System:** Full genset power available up to 920 m (3020 ft) at ambient temperatures up to 40 °C (104 °F) and 550 m (1805 ft) at ambient temperatures up to 50 °C (122 °F). Above these conditions, derate at 4% per 305 m (1000 ft) and 9.2% per 10 °C (18 °F).
Prime	**High Ambient Cooling System:** Full genset power available up to 1351 m (4432 ft) at ambient temperatures up to 40 °C (104 °F). Above these conditions, derate at 4.4% per 305 m (1000 ft) and 10.9% per 10 °C (18 °F). **Enhanced High Ambient Cooling System:** Full genset power available up to 1450 m (4758 ft) at ambient temperatures up to 40 °C (104 °F) and 691 m (2267 ft) at ambient temperatures up to 50 °C (122 °F). Above these conditions, derate at 4.4% per 305 m (1000 ft) and 10% per 10 °C (18 °F).
Continuous	**High Ambient Cooling System:** Full genset power available up to 1809 m (5935 ft) at ambient temperatures up to 40 °C (104 °F). Above these conditions, derate at 4.1% per 305 m (1000 ft) and 12.1% per 10 °C (18 °F). **Enhanced High Ambient Cooling System:** Full genset power available up to 2077 m (6815 ft) at ambient temperatures up to 40 °C (104 °F) and 1399 m (4591 ft) at ambient temperatures up to 50 °C (122 °F). Above these conditions, derate at 6.8% per 305 m (1000 ft) and 15.4% per 10 °C (18 °F).

Ratings definitions

Emergency Standby Power (ESP):	**Limited-Time Running Power (LTP):**	**Prime Power (PRP):**	**Base Load (Continuous) Power (COP):**
Applicable for supplying power to varying electrical load for the duration of power interruption of a reliable utility source. Emergency Standby Power (ESP) is in accordance with ISO 8528. Fuel stop power in accordance with ISO 3046, AS 2789, DIN 6271 and BS 5514.	Applicable for supplying power to a constant electrical load for limited hours. Limited-Time Running Power (LTP) is in accordance with ISO 8528.	Applicable for supplying power to varying electrical load for unlimited hours. Prime Power (PRP) is in accordance with ISO 8528. Ten percent overload capability is available in accordance with ISO 3046, AS 2789, DIN 6271 and BS 5514.	Applicable for supplying power continuously to a constant electrical load for unlimited hours. Continuous Power (COP) is in accordance with ISO 8528, ISO 3046, AS 2789, DIN 6271 and BS 5514.

Alternator data[1]

Voltage	Connection	Temperature rise °C	Duty[2]	Max surge kVA	Winding number	Alternator data sheet	Feature code
380	Wye, 3-phase	150/125/105	S/P/C	11145	12	ADS-532	B595-2
380-440	Wye, 3-phase	150/125	S/P	11146	12	ADS-532	B667-2
380	Wye, 3-phase	105	P	11145	12	ADS-532	B630-2
400	Wye, 3-phase	125	S	11146	12	ADS-532	BA63-2
400	Wye, 3-phase	105	P	11146	12	ADS-532	BA62-2
400-415	Wye, 3-phase	125	P	10132	12	ADS-531	B635-2
400	Wye, 3-phase	105	C	11146	12	ADS-532	BA61-2
415	Wye, 3-phase	125	S	11146	12	ADS-532	BA68-2
415	Wye, 3-phase	105	P	11146	12	ADS-532	BA66-2
415	Wye, 3-phase	105	C	11146	12	ADS-532	BA65-2
440	Wye, 3-phase	105	C	11025	12	ADS-532	BA71-2
440	Wye, 3-phase	105	P	11025	12	ADS-532	B658-2
690	Wye, 3-phase	125	S	11970	65	ADS-586	BA77-2
690	Wye, 3-phase	150	S	11970	65	ADS-586	BA78-2
690	Wye, 3-phase	105	P	11970	65	ADS-586	BA74-2
690	Wye, 3-phase	125	P	9960	65	ADS-531	BA76-2
690	Wye, 3-phase	80	C	11970	65	ADS-586	BA72-2
690	Wye, 3-phase	105	C	11970	65	ADS-586	BA73-2
3300	Wye, 3-phase	80	S	14880	8003	ADS-592	B620-2
3300	Wye, 3-phase	105	S	10845	51	ADS-587	BA80-2
3300	Wye, 3-phase	125/105/80	S/P/C	10845	51	ADS-587	B470-2
3300	Wye, 3-phase	150	S	9481	51	ADS-545	BB78-2
3300	Wye, 3-phase	80	P	10845	51	ADS-587	BA79-2
3300	Wye, 3-phase	105	P	9481	51	ADS-545	B372-2
3300	Wye, 3-phase	125	P	9481	51	ADS-545	BB79-2
3300	Wye, 3-phase	105	C	10845	51	ADS-587	B471-2
6000	Wye, 3-phase	80	S	14170	8010	ADS-591	BA83-2
6000	Wye, 3-phase	105	S	12728	8008	ADS-589	BA86-2

Notes:

[1]Alternator data is configured for a set with ratings including engine cooling fan losses and standard features at 40 °C ambient temperature. For non-standard configurations, including remote radiator applications, check appropriate alternator data sheets or contact your local Cummins representative.

[2]Standby (S), Prime (P) and Continuous ratings (C).

[3]Maximum rated starting kVA that results in a minimum of 90% of rated sustained voltage during starting.

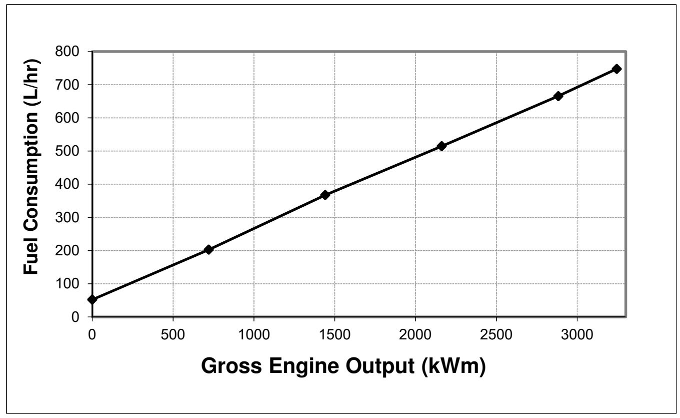
Engine Performance Data	G-Drive	Date		
Cummins Inc.	QSK95-G10	5-May-16		
Columbus, Indiana 47202-3005		Configuration	CPL	Revision
http://www.cummins.com	FR7369	D0M3001GX03	4245	-

Compression Ratio	15.5:1	**Displacement**	95 L (5816 in³)
Fuel System	Cummins MCRS	**Aspiration**	Turbocharged and Low Temperature Aftercooled
Aftertreatment	None	**Emission Certification**	EPA Tier2 (NSPS)

Engine Speed	Standby Power		Prime Power		Continuous Power	
rpm	kWm	bhp	kWm	bhp	kWm	bhp
1500	3245	4351	2883	3866	2593	3477

Engine Fuel Consumption @ 1500 rpm

Output Power			Fuel Consumption			
%	kWm	bhp	kg/kWm-hr	lb/bhp-hr	L/hr	US gal/hr
Standby Power						
100	3245	4351	0.196	0.322	748	197.3
Prime Power						
100	2883	3866	0.196	0.323	666	175.7
75	2162	2899	0.202	0.333	515	135.9
50	1441	1933	0.217	0.356	367	97.0
25	721	966	0.239	0.393	203	53.5
Continuous Power						
100	2593	3477	0.197	0.325	602	159.0



Fuel consumption @ 3000kWe output is 731L/hr - please see the genset data sheet, the consumption here is given at max engine power

Data Subject to Change Without Notice

These guidelines have been formulated to ensure proper application of generator drive engines in A.C. generator set installations. **STANDBY POWER RATING:** Applicable for supplying emergency power for the duration of the utility power outage. No overload capability is available for this rating. Under no condition is an engine allowed to operate in parallel with the public utility at the Standby Power rating. This rating should be applied where reliable utility power is available. A Standby rated engine should be sized for a Max of an 80% average load factor and 200 hours of operation per year. This includes less than 25 hours per year at the Standby Power rating. Standby ratings should never be applied except in true emergency power outages. Negotiated power outages contracted with a utility company are not considered an emergency. **PRIME POWER RATING:** Applicable for supplying electric power in lieu of commercially purchased power. Prime Power applications must be in the form of one of the following two categories: **UNLIMITED TIME RUNNING PRIME POWER:** Prime Power is available for an unlimited number of hours per year in a variable load application. Variable load should not exceed a 70% average of the Prime Power rating during any operating period of 250 hours. The total operating time at 100% Prime Power shall not exceed 500 hours per year. A 10% overload capability is available for a period of 1 hour within a 12-hour period of operation. Total operating time at the 10% overload power shall not exceed 25 hours per year. **LIMITED TIME RUNNING PRIME POWER:** Limited Time Prime Power is available for a limited number of hours in a non-variable load application. It is intended for use in situations where power outages are contracted, such as in utility power curtailment. Engines may be operated in parallel to the public utility up to 750 hours per year at power levels never to exceed the Prime Power rating. The customer should be aware, however, that the life of any engine will be reduced by this constant high load operation. Any operation exceeding 750 hours per year at the Prime Power rating should use the Continuous Power rating. **CONTINUOUS POWER RATING:** 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.

Reference AEB 10.47 for determining Electrical Output.

Data shown above represent gross engine performance capabilities obtained and corrected in accordance with ISO-3046 conditions of 100 kPa (29.53 in Hg) barometric pressure [110 m (361 ft) altitude], 25 °C (77 °F) air inlet temperature, and relative humidity of 30% with No. 2 diesel or a fuel corresponding to ASTM D2.

Derates shown are based on 18 in H_2O air intake restriction and 1.5 in Hg exhaust back pressure.

The fuel consumption data is based on No. 2 diesel fuel weight at 0.85 kg/L (7.1 lbs/US gal). Power output curves are based on the engine operating with fuel system, water pump and lubricating oil pump; not included are battery charging alternator, fan, optional equipment and driven components.

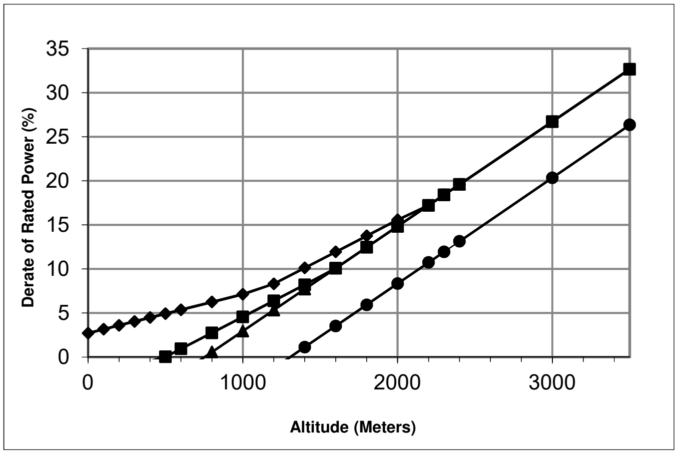
Data Status : Limited Production

Tolerance : +/- 5%

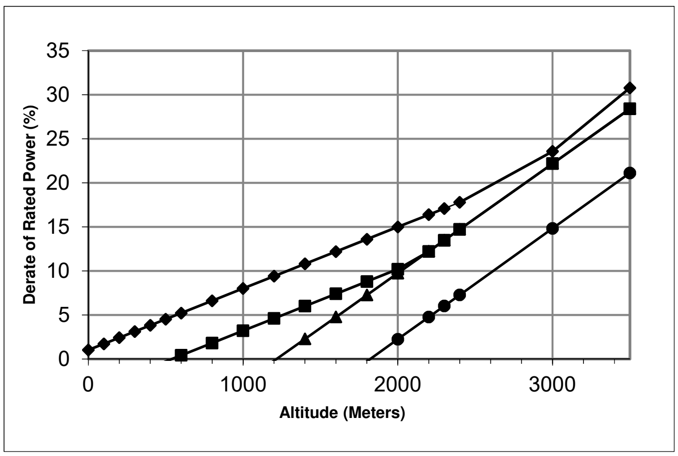
Chief Engineer

1,500 rpm Power Derate Curves

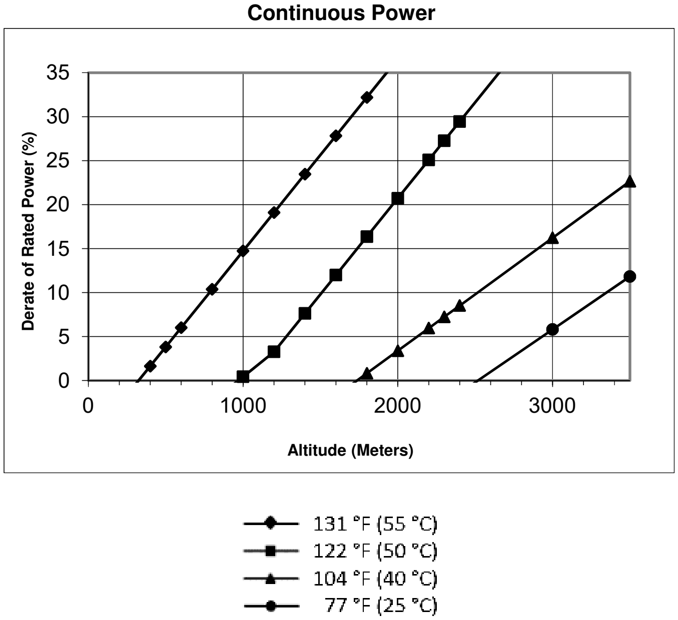
Standby Power



Prime Power



Continuous Power



Operation At Elevated Temperature And Altitude:

For **Standby Operation** above these conditions, derate by an additional 3.6% per 300m (1000 ft), and 9.9% per 10 °C (18 °F).
For **Prime Operation** above these conditions, derate by an additional 4.3% per 300m (1000 ft), and 9.6% per 10 °C (18 °F).
For **Continuous Operation** above these conditions, derate by an additional 6.5% per 300m (1000 ft), and 31.7% per 10 °C (18 °F).

General Engine Data

Installation Drawing Number		4954034	
Type		Four Cycle; Vee; 16 Cylinder	
Aspiration		Turbocharged and Low Temperature Aftercooled	
Bore x Stroke	in x in (mm x mm)	7.48 x 8.27	(190 x 210)
Displacement	in^3 (L)	5816	(95)
Compression Ratio		15.5:1	
Dry Weight (Approximate)	lbm (kg)	28184	(12784)
Wet Weight (Approximate)	lbm (kg)	30396	(13787)
Aftertreatment Weight (Approximate)	lbm (kg)	N/A	(N/A)
Moment of Inertia of Rotating Components			
with FW 7057 Flywheel, SAE 00	lbm • ft^2 (kg • m^2)	1334	(56)
Center of Gravity from Rear Face of Block	in (mm)	53	(1359)
Center of Gravity Above Crankshaft Centerline	in (mm)	12	(300)

Engine Mounting

Max Bending Moment at Rear Face of Block	lb • ft (N • m)	9669	(13110)

Exhaust System

Max Allowable Static Bending Moment @ Exhaust Outlet Flange	lb • ft (N • m)	N/A	(N/A)
Max Back Pressure at Standby Power (Turbo Outlet)	in Hg (kPa)	2	(6.8)
Pressure Drop Across Aftertreatment	in H_2O (kPa)	N/A	(N/A)
Minimum Unaided Operating Temperature	°F (°C)	N/A	(N/A)
Max Ambient Operating Temperature (Warning)	°F (°C)	N/A	(N/A)
Max DEF Supply Flow	US gph (L/hr)	N/A	(N/A)
Max DEF Return Flow	US gph (L/hr)	N/A	(N/A)
Max Static Head (From Pump to Injector)	ft (m)	N/A	(N/A)

Air Induction System

Max Intake Air Restriction			
With Normal Duty Air Cleaner and Clean Filter Element	in H_2O (kPa)	18	(4)
With Heavy Duty Air Cleaner and Clean Filter Element	in H_2O (kPa)	N/A	(N/A)
With Dirty Filter Element	in H_2O (kPa)	28	(7)

Cooling System

Jacket Water/ High Temperature Circuit Requirements			
Max Coolant Friction Head External to Engine (1500 rpm)	psi (kPa)	8.5	(59)
Engine Water Flow at Stated Friction Head External to Engine:			
5 psi Friction Head (1500 rpm)	US gpm (L/m)	704	(2665)
Maximum Friction Head (1500 rpm)	US gpm (L/m)	677	(2563)
Coolant Capacity - Engine	US gal (L)	85	(323)
Minimum Pressure Cap Rating at Sea Level	psi (kPa)	11	(76)
Max Static Head of Coolant Above Crankshaft Centerline	ft (m)	60	(18)
Max Coolant (Top Tank) Temperature for Standby/Prime Power	°F (°C)	220 / 212	(104 / 100)
Thermostat (Modulating) Range	°F (°C)	180 - 202	(82 - 94)
Max Intake Manifold Temp Warning/Shutdown	°F (°C)	190 / 200	(88 / 93)
Low Temperature Circuit (LTC) Requirements			
Max Coolant Friction Head External to Engine (1500 rpm)	psi (kPa)	8.5	(59)
Engine Water Flow at Stated Friction Head External to Engine:			
5 psi Friction Head (1500 rpm)	US gpm (L/m)	152	(575)
Maximum Friction Head (1500 rpm)	US gpm (L/m)	143	(541)
Max Coolant Temp into LTC @ 77°F (25°C) Ambient	°F (°C)	115	(46)
Max Coolant Temperature into LTC @			
Limiting Ambient Conditions for Standby/Prime Power	°F (°C)	160 / 155	(71 / 68)
Thermostat (Modulating) Range	°F (°C)	115 - 130	(46 - 54)
Coolant Capacity - Aftercooler	US gal (L)	15	(57)
Charge Air Cooler Requirements			
Max Allowable Pressure Drop Across Charge Air Cooler and OEM CAC piping (1500 rpm)	in Hg (kPa)	N/A	(N/A)
Max Charge Air Cooler Outlet to Ambient at 77°F (25°C)(CAC dT)	Δ°F (Δ°C)	N/A	(N/A)

Lubrication System

Oil Pressure at Minimum Idle Speed	psi (kPa)	40	(276)
Oil Pressure at Governed Speed	psi (kPa)	65 - 80	(448 - 552)
Max Oil Temperature	°F (°C)	250	(121)
Oil Capacity with OP 7028: Low - High	US gal (L)	147 - 164	(556 - 621)
Total System Capacity (with Spin-On Filters)	US gal (L)	171	(647)

Fuel System

Max Fuel Supply Restriction at Fuel Pump Inlet (clean/dirty filter)	in Hg (kPa)	5 / N/A	(17 / N/A)
Max Allowable Head on Injector Return Line			
(Consisting of Friction Head and Static Head)	in Hg (kPa)	10	(34)
Max Fuel Inlet Temperature	°F (°C)	158	(70)
Max Supply Fuel Flow (Standby/Prime Power)	US gph (L/hr)	377 / 368	(1428) / (1392)
Max Return Fuel Flow (Standby/Prime Power)	US gph (L/hr)	149 / 168	(564) / (636)
Max Fuel Supply Restriction at Max Fuel Flow (from Customer Plumbing)			
Measured at Customer Fuel Inlet Connection	in Hg (kPa)	4	(14)

Electrical System

System Voltage	volts	24	N/A
Minimum Recommended Battery Capacity			
Cold Soak @ 0 °F (-18 °C)	CCA	1400	N/A
Max Starting Circuit Resistance	ohm	0.002	N/A
Max Current Draw of the System	Amps	67	N/A

Cold Start Capability

Unaided Cold Start			
Minimum Cranking Speed	rpm	110	N/A
Minimum Ambient Temp for Unaided Cold Start	°F (°C)	10	(-12)

Performance Data

		STANDBY	PRIME	CONTINUOUS
		50 Hz	50 Hz	50 Hz
Governed Engine Speed	rpm	1500	1500	1500
Engine Idle Speed	rpm	750 - 900	750 - 900	750 - 900
Gross Engine Power Output	bhp (kWm)	4351 (3245)	3866 (2883)	3477 (2593)
Brake Mean Effective Pressure	psi (kPa)	395 (2724)	351 (2421)	316 (2179)
Friction Power	hp (kWm)	N/A (N/A)	N/A (N/A)	N/A (N/A)
Intake Air Flow	ft^3/min (L/sec)	8951 (4225)	8586 (4053)	8184 (3863)
Exhaust Gas Temp	°F (°C)	803 (429)	756 (403)	729 (388)
Exhaust Gas Flow	ft^3/min (L/sec)	20661 (9751)	19127 (9027)	17891 (8444)
Air:Fuel Ratio		27.4:1	29.5:1	31.1:1
Radiated Heat to Ambient	BTU/min (kWm)	17092 (301)	15215 (268)	13770 (242)
Heat to JW Radiator	BTU/min (kWm)	82287 (1446)	73365 (1289)	66120 (1162)
Heat to Exhaust	BTU/min (kWm)	122572 (2154)	109386 (1922)	100103 (1759)
* Heat to Fuel	BTU/min (kWm)	493 (8.7)	493 (8.7)	493 (8.7)
Heat to Aftercooler Radiator	BTU/min (kWm)	20263 (356)	17926 (315)	16242 (286)
Charge Air Flow	lb/min (kg/min)	640 (291)	614 (279)	585 (266)
Turbo Comp Outlet Pressure	psi (kPa)	46 (318)	43 (297)	40 (276)
Turbo Comp Outlet Temp	°F (°C)	450 (233)	424 (218)	401 (205)

* This is the maximum heat rejection to fuel.

Noise Emissions

Frequency (Hz) Sound Power dB(A)[123]		31.5	63	125	250	500	1000	2000	4000	8000	16000	Overall
1500 rpm 50 Hz	Engine[4]	66.6	85.2	104.2	106.6	113.4	116.3	117.6	116.6	123.7	100.8	126.1
	Exhaust[5]	55.3	85.3	90.4	109.7	106.8	107.5	109.3	108.4	104.0	89.1	115.8

1. The test figures quoted are from a single gen-set test and do not constitute a guarantee of performance for any particular engine. The data is subject to instrumentation, measurement, and engine to engine variability.
2. Test reference procedures ISO 3744 and ANSI S12.34-1998 as applicable.
3. All data are "A" weighted and are rounded to the nearest dB.
4. Engine only "Without Radiator and fan", Sound Power (dB).
5. Engine Exhaust at 1 Meter from open stack, Sound Pressure (dB).

A-weighted Sound Pressure Level @ 7 meters, dB(A)

See notes 2, 5 and 7-11 listed below

Configuration	Exhaust	Applied Load	Position (Note 2)								8 Position Average
			1	2	3	4	5	6	7	8	
Standard – Unhoused (Remote Cooling)	Infinite Exhaust	0% Standby	87.0	91.5	90.0	90.7	87.4	91.6	91.4	90.0	90.2
		50% Standby	89.8	94.3	92.1	93.2	90.7	94.5	94.7	93.7	93.2
		75% Standby	92.2	97.9	93.7	95.2	92.4	96.1	96.5	96.8	95.5
		100% Standby	92.4	97.4	94.6	95.5	92.6	96.5	96.9	96.3	95.6
Standard – Unhoused (High Ambient)	Infinite Exhaust	0% Standby	90.5	95.1	95.7	95.5	96.9	95.9	95.4	97.8	95.7
		50% Standby	91.5	96.1	96.5	96.1	96.5	97.0	96.3	98.6	96.4
		75% Standby	92.3	96.8	97.1	96.7	96.5	97.8	97.0	99.3	97.0
		100% Standby	92.6	97.6	97.9	97.1	96.4	98.2	97.6	99.8	97.5
Standard – Unhoused (Enhanced High Ambient)	Infinite Exhaust	0% Standby	90.5	95.1	95.7	95.5	96.9	95.9	95.4	97.8	95.7
		50% Standby	91.5	96.1	96.5	96.1	96.5	97.0	96.3	98.6	96.4
		75% Standby	92.3	96.8	97.1	96.7	96.5	97.8	97.0	99.3	97.0
		100% Standby	92.6	97.6	97.9	97.1	96.4	98.2	97.6	99.8	97.5
Standard – Unhoused (Compact High Ambient)	Infinite Exhaust	0% Standby	89.3	95.2	95.3	96.0	96.7	96.1	95.7	93.5	95.2
		50% Standby	90.7	96.0	96.4	96.7	96.3	96.8	97.2	94.9	96.0
		75% Standby	91.4	96.8	97.2	97.4	96.1	97.5	97.9	96.0	96.6
		100% Standby	92.2	98.2	98.6	98.6	96.6	98.6	98.8	96.9	97.7

Sound Data
C3750 D5e
QSK95-G10 50Hz Diesel

Average A-weighted Sound Pressure Level @ 1 meter, dB(A)

See notes 1, 5 and 7-14 listed below

Configuration	Exhaust	Applied Load	Octave Band Center Frequency (Hz)											Overall Sound Pressure Level
			16	31.5	63	125	250	500	1000	2000	4000	8000	16000	
Standard – Unhoused (Remote Cooling)	Infinite Exhaust	0% Standby	N/A	46.3	64.7	78.2	87.7	91.5	93.2	92.4	88.3	79.6	67.1	98.3
		50% Standby	N/A	48.3	65.2	79.0	86.0	92.7	95.4	95.8	93.4	94.3	77.4	101.6
		75% Standby	N/A	48.7	65.9	82.0	87.3	93.2	96.3	97.3	94.4	100.7	79.1	104.3
		100% Standby	N/A	47.0	66.4	83.8	87.3	93.5	96.5	97.6	95.5	102.0	79.0	105.2
Standard – Unhoused (High Ambient)	Infinite Exhaust	0% Standby	N/A	51.1	66.0	91.5	95.2	97.1	96.2	93.5	88.3	78.8	65.0	102.3
		50% Standby	N/A	52.6	66.1	91.2	95.3	96.8	96.7	95.3	90.4	89.5	70.3	102.9
		75% Standby	N/A	51.8	66.2	91.2	95.3	97.0	97.1	96.2	91.6	92.3	72.1	103.5
		100% Standby	N/A	49.6	66.4	91.4	95.3	96.9	97.4	96.4	92.9	94.8	74.0	103.9
Standard – Unhoused (Enhanced High Ambient)	Infinite Exhaust	0% Standby	N/A	51.1	66.0	91.5	95.2	97.1	96.2	93.5	88.3	78.8	65.0	102.3
		50% Standby	N/A	52.6	66.1	91.2	95.3	96.8	96.7	95.3	90.4	89.5	70.3	102.9
		75% Standby	N/A	51.8	66.2	91.2	95.3	97.0	97.1	96.2	91.6	92.3	72.1	103.5
		100% Standby	N/A	49.6	66.4	91.4	95.3	96.9	97.4	96.4	92.9	94.8	74.0	103.9
Standard – Unhoused (Compact High Ambient)	Infinite Exhaust	0% Standby	N/A	48.0	67.8	84.8	92.9	96.3	97.2	94.6	91.6	84.0	70.2	102.1
		50% Standby	N/A	48.8	68.0	85.1	93.0	96.3	97.5	96.0	93.2	92.9	75.1	103.1
		75% Standby	N/A	48.8	68.1	85.6	93.1	96.3	97.8	96.7	93.9	95.7	75.6	103.7
		100% Standby	N/A	48.7	67.8	86.1	93.2	96.8	98.2	97.6	95.4	99.2	78.0	105.0

A-weighted Sound Pressure Level @ Operator Location, dB(A)

See notes 1, 5 and 7-15 listed below

Configuration	Exhaust	Applied Load	Octave Band Center Frequency (Hz)											Overall Sound Pressure Level
			16	31.5	63	125	250	500	1000	2000	4000	8000	16000	
Standard – Unhoused (Remote Cooling)	Infinite Exhaust	75% Standby	N/A	47.4	65.6	83.8	86.2	91.7	95.2	95.3	92.1	97.4	76.4	102.1
		100% Standby	N/A	45.7	68.5	86.3	86.4	93.0	94.9	95.4	92.9	97.9	75.9	102.5
Standard – Unhoused (High Ambient)	Infinite Exhaust	75% Standby	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
		100% Standby	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Standard – Unhoused (Enhanced High Ambient)	Infinite Exhaust	75% Standby	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
		100% Standby	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Standard – Unhoused (Compact High Ambient)	Infinite Exhaust	75% Standby	N/A	48.6	72.4	81.3	91.3	94.9	98.0	96.4	91.4	93.4	72.8	102.7
		100% Standby	N/A	48.4	70.7	82.8	90.8	95.6	97.4	96.0	92.1	96.6	74.2	103.1

Sound Data

C3750 D5e

QSK95-G10 50Hz Diesel

A-weighted Sound Power Level, dB(A)

See notes 1, 3 and 6-14 listed below

Configuration	Exhaust	Applied Load	Octave Band Center Frequency (Hz)											Overall Sound Power Level
			16	31.5	63	125	250	500	1000	2000	4000	8000	16000	
Standard – Unhoused (Remote Cooling)	Infinite Exhaust	0% Standby	N/A	66.9	85.2	98.8	108.3	112.1	113.8	113.0	108.9	100.1	87.7	118.9
		50% Standby	N/A	68.9	85.8	99.6	106.6	113.3	116.0	116.4	113.9	114.9	98.0	122.2
		75% Standby	N/A	69.2	86.5	102.6	107.9	113.8	116.9	117.9	115.0	121.3	99.7	124.9
		100% Standby	N/A	67.6	87.0	104.4	107.9	114.1	117.1	118.2	116.1	122.6	99.6	125.7
Standard – Unhoused (High Ambient)	Infinite Exhaust	0% Standby	N/A	73.8	88.8	114.3	118.0	119.8	119.0	116.3	111.1	101.6	87.8	125.1
		50% Standby	N/A	75.4	88.8	114.0	118.0	119.5	119.5	118.1	113.2	112.3	93.1	125.7
		75% Standby	N/A	74.6	89.0	113.9	118.1	119.8	119.9	119.0	114.4	115.1	94.9	126.3
		100% Standby	N/A	72.3	89.2	114.2	118.1	119.7	120.2	119.2	115.7	117.6	96.8	126.7
Standard – Unhoused (Enhanced High Ambient)	Infinite Exhaust	0% Standby	N/A	73.8	88.8	114.3	118.0	119.8	119.0	116.3	111.1	101.6	87.8	125.1
		50% Standby	N/A	75.4	88.8	114.0	118.0	119.5	119.5	118.1	113.2	112.3	93.1	125.7
		75% Standby	N/A	74.6	89.0	113.9	118.1	119.8	119.9	119.0	114.4	115.1	94.9	126.3
		100% Standby	N/A	72.3	89.2	114.2	118.1	119.7	120.2	119.2	115.7	117.6	96.8	126.7
Standard – Unhoused (Compact High Ambient)	Infinite Exhaust	0% Standby	N/A	70.4	90.2	107.2	115.3	118.7	119.6	117.1	114.1	106.4	92.6	124.6
		50% Standby	N/A	71.2	90.4	107.6	115.4	118.8	119.9	118.4	115.6	115.4	97.6	125.5
		75% Standby	N/A	71.3	90.6	108.0	115.5	118.7	120.3	119.1	116.3	118.1	98.1	126.2
		100% Standby	N/A	71.1	90.3	108.5	115.6	119.2	120.6	120.0	117.9	121.6	100.4	127.4

Exhaust Sound Power Level, dB(A)

See notes 4 and 6-14 listed below

Configuration	Applied Load	Octave Band Center Frequency (Hz)											Overall Sound Power Level
		16	31.5	63	125	250	500	1000	2000	4000	8000	16000	
Open Exhaust (With Tailpipe)	0% Standby	N/A	63.3	83.1	92.0	105.0	106.4	106.4	104.7	101.5	92.0	79.6	112.2
	50% Standby	N/A	58.9	92.2	96.5	116.8	114.8	115.3	116.9	114.7	107.2	94.2	122.9
	75% Standby	N/A	61.2	94.1	98.0	118.4	115.1	117.0	119.1	117.0	111.5	97.9	124.7
	100% Standby	N/A	66.3	96.3	101.4	120.7	117.8	118.5	120.3	119.4	115.0	100.1	126.8

PROTOTYPE TEST SUPPORT (PTS)
50 HZ TEST SUMMARY

Cummins Power Generation

GENERATOR SET MODELS	REPRESENTATIVE PROTOTYPE	
C3750 D5e	Model:	C3750 D5
C3500 D5e	Alternator:	MVSI804X2
C3500 D5		winding 51
C3750 D5	Engine:	QSK95-G4

The following summarizes prototype testing conducted on the designated representative prototype of the specified models. This testing is conducted to verify the complete generator set electrical and mechanical design integrity. Prototype testing is conducted only on generator sets not sold as new equipment.

Maximum Surge Power: 3000 KW

The generator set was evaluated to determine the stated maximum surge power.

Maximum Motor Starting: 30163 kVA

The generator set was tested to simulate motor starting by applying the specified kVA load at low lagging power factor (0.4 or lower). With this load applied, the generator set recovered to a minimum of 90% rated voltage.

Torsional Analysis and Testing:

The generator set was tested to verify that the design is not subjected to harmful torsional stresses. A spectrum analysis of the transducer output was conducted over the speed range of 1350 to 1950 RPM.

Cooling System: 50 ºC Ambient
0.5 in. H_2O restriction

The cooling system was tested to determine ambient temperature and static restriction capabilities. The test was performed at full rated load in elevated ambient temperature under stated static restriction conditions.

Durability:

The generator set was subjected to endurance testing replicating field duty cycles operating at variable load up to the standby rating based upon MIL-STD-705 to verify structural soundness and durability of the design.

Electrical and Mechanical Strength:

The generator set was tested to several single phase and three phase faults to verify that the generator can safely withstand the forces associated with short circuit conditions. The generator set was capable of producing full rated output at the conclusion of the testing.

Steady State Performance:

The generator set was tested to verify steady state operating performance. It was within the specified maximum limits.

Voltage Regulation:	±0.5%
Random Voltage Variation:	±0.5%
Frequency Regulation:	Isochronous
Random Frequency Variation:	±0.25%

Transient Performance:

The generator set was tested with the listed alternator to verify single step loading capability as required by NFPA 110. Voltage and frequency response on load addition or rejection were evaluated. The following results were recorded at 0.8 Power Factor:

Full Load Acceptance:

Voltage Dip:	36.6	%
Recovery Time:	7.5	Second
Frequency Dip:	16.0	%
Recovery Time:	7.3	Second

Full Load Rejection:

Voltage Rise:	19.9	%
Recovery Time:	2.2	Second
Frequency Rise:	6.5	%
Recovery Time:	2.4	Second

All Data Based on 0.8 Power Factor:

Harmonic Analysis:
(per MIL-STD-705B, Method 601.4)

	Line to Line		Line to Neutral	
Harmonic	No Load	Full Load	No Load	Full Load
3	0	0.08074	0.1399	0.1417
5	0.08097	0.8881	0.1399	0.9916
7	0.5667	0.08074	0.5597	0.1417
9	0	0	0	0
11	0.5668	0.3229	0.5597	0.2833
13	0.2429	0.3229	0.2798	0.2833
15	0	0	0	0.0000

High Ambient Air Temperature Radiator Cooling System

	Fuel Type	Duty	Rating (kW)	Max cooling @ air flow static restriction, unhoused (inches water/mm water)					Housed in free air, no air discharge restriction		
				0.0/0.0	0.25/6.4	0.5/12.7	0.75/19.1	1.0/25.4	Weather	Sound level 1	Sound level 2
				Maximum allowable ambient temperature, degree C							
50 Hz	Diesel	Standby	3000	43	43	43	42	40	N/A	N/A	N/A
		Prime	2680	44	44	44	43	42	N/A	N/A	N/A
		Continuous	2400	45	45	45	44	43	N/A	N/A	N/A
		DCC	2680	47	47	47	46	45	N/A	N/A	N/A
				Airflow (m^3/s) – Actual @ Fan							
				61.3	58.2	55	53	51	N/A	N/A	N/A

High Ambient Air Temperature Radiator Cooling System - Compact

	Fuel Type	Duty	Rating (kW)	Max cooling @ air flow static restriction, unhoused (inches water/mm water)					Housed in free air, no air discharge restriction		
				0.0/0.0	0.25/6.4	0.5/12.7	0.75/19.1	1.0/25.4	Weather	Sound level 1	Sound level 2
				Maximum allowable ambient temperature, degree C							
50 Hz	Diesel	Standby	3000	45	45	44	43	41	N/A	N/A	N/A
		Prime	2680	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
		Continuous	2400	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
		DCC	2680	52	51	50	49	48	N/A	N/A	N/A
				Airflow (m^3/s) – Actual @ Fan							
				45	44	42.8	41.6	40.9	N/A	N/A	N/A

Enhanced High Ambient Air Temperature Radiator Cooling System											
	Fuel Type	Duty	Rating (kW)	Max cooling @ air flow static restriction, unhoused (inches water/mm water)					Housed in free air, no air discharge restriction		
				0.0/0.0	0.25/6.4	0.5/12.7	0.75/19.1	1.0/25.4	Weather	Sound level 1	Sound level 2
				Maximum allowable ambient temperature, degree C							
50 Hz	Diesel	Standby	3000	52	52	52	51	49	N/A	N/A	N/A
		Prime	2680	53	53	53	52	51	N/A	N/A	N/A
		Continuous	2400	54	54	54	53	52	N/A	N/A	N/A
		DCC	2680	56	56	56	55	54	N/A	N/A	N/A
				Airflow (m^3/s) – Actual @ Fan							
				61.3	58.2	55	53	51	N/A	N/A	N/A

Notes:

1. Data shown are anticipated cooling performance for typical generator set.
2. Cooling data is based on 1000 ft (305 m) site test location.
3. Generator set power output may need to be reduced at high ambient conditions. Consult generator set data sheet for derate schedules.
4. Cooling performance may be reduced due to several factors including but not limited to: Incorrect installation, improper operation, fouling of the cooling system, and other site installation variables.

Exhaust Emission Data Sheet
C3750 D5e
50 Hz Diesel Generator Set
EPA Tier 2

Engine Information:

Model:	Cummins Inc. QSK95-G10	Bore:	7.48 in. (190 mm)
Type:	4 Cycle, VEE, 16 cylinder diesel	Stroke:	8.27 in. (210 mm)
Aspiration:	Turbocharged and Aftercooled	Displacement:	5816 cu. in. (95.3 liters)
Compression Ratio:	15.5:1		
Emission Control Device:	Turbocharged and Aftercooled		
Emission Level:	Stationary Emergency		

Performance Data	**1/4 Standby**	**1/2 Standby**	**3/4 Standby**	**Full Standby**	**Full Prime**	**Full Continuous**
Engine BHP @ 1500 RPM (50 Hz)	1094	2189	3283	4377	3892	3503
Fuel Consumption L/Hr (US Gal/Hr)	222 (59)	406 (107)	569 (150)	745 (197)	664 (176)	603 (159)
Exhaust Gas Flow m^3/min (CFM)	247 (8724)	405 (14291)	510 (17994)	619 (21853)	568 (20064)	530 (18722)
Exhaust Gas Temperature °C (°F)	366 (690)	382 (719)	386 (727)	432 (810)	406 (762)	391 (736)
Exhaust Emission Data						
HC (Total Unburned Hydrocarbons)	0.33 (132)	0.17 (74)	0.09 (44)	0.06 (28)	0.07 (35)	0.08 (40)
NOx (Oxides of Nitrogen as NO_2)	3.25 (1304)	3.53 (1550)	4.91 (2360)	6.46 (3152)	5.75 (2789)	5.19 (2499)
CO (Carbon Monoxide)	0.44 (179)	0.20 (90)	0.12 (57)	0.14 (71)	0.12 (59)	0.11 (56)
PM (Particulate Matter)	0.14 (48)	0.05 (20)	0.02 (6)	0.01 (4)	0.01 (5)	0.01 (6)
SO_2 (Sulfur Dioxide)	0.005 (1.8)	0.005 (1.8)	0.005 (1.8)	0.004 (1.7)	0.004 (1.8)	0.004 (1.8)
Smoke (FSN)	0.75	0.41	0.16	0.13	0.13	0.14

All values (except smoke) are cited: g/BHP-hr (mg/Nm³ @ 5% O2)

Test Conditions

Steady-state emissions recorded per ISO8178-1 during operation at rated engine speed (+/-2%) and stated constant load (+/-2%) with engine temperatures, pressures and emission rates stabilized.

Fuel Specification:	40-48 Cetane Number, 0.0015 Wt.% Sulfur; Reference ISO8178-5, 40 CFR 86, 1313—98 Type 2-D and ASTM D975 No. 2-D. Fuel Density at 0.85 Kg/L (7.1 lbs/US Gal)
Air Inlet Temperature	25 °C (77 °F)
Fuel Inlet Temperature:	40 °C (104 °F)
Barometric Pressure:	100 kPa (29.53 in Hg)
Humidity:	NOx measurement corrected to 10.7 g/kg (75 grains H_2O/lb) of dry air
Intake Restriction:	Set to 18 in of H_2O as measured from compressor inlet
Exhaust Back Pressure:	Set to 1.5 in Hg
Note:	mg/m³ values are measured dry, corrected to 5% O_2 and normalized to standard temperature and pressure (0°C, 101.325 kPa)

The NOx, HC, CO and PM emission data tabulated here are representative of test data taken from a single engine under the test conditions shown above. Data for the other components are estimated. These data are subjected to instrumentation and engine-to-engine variability. Field emission test data are not guaranteed to these levels. Actual field test results may vary due to test site conditions, installation, fuel specification, test procedures and instrumentation. Engine operation with excessive air intake or exhaust restriction beyond published maximum limits, or with improper maintenance, may results in elevated emission levels.

2022 EPA Tier 2 Exhaust Emission Compliance Statement C3750 D5e

Stationary Emergency

50 Hz Diesel Generator Set

Compliance Information:

The engine used in this generator set complies with Tier 2 emissions limit of U.S. EPA New Source Performance Standards for stationary emergency engines under the provisions of 40 CFR 60 Subpart IIII when tested per ISO8178 D2.

Engine Manufacturer:	Cummins Inc.
EPA Certificate Number:	NCEXL95.0AAA-044
Effective Date:	08/19/2021
Date Issued:	08/19/2021
EPA Engine Family (Cummins Emissions Family):	NCEXL95.0AAA

Engine Information:

Model:	QSK95-G10	Bore:	7.48 in. (190 mm)
Engine Nameplate HP:	4351	Stroke:	8.27 in. (210 mm)
Type:	4 cycle, Vee, 16 Cylinder Diesel	Displacement:	5816 cu. in. (95.3 liters)
Aspiration:	Turbocharged and Aftercooled	Compression Ratio:	15.5:1
Emission Control Device:	Turbocharged and Aftercooled	Exhaust Stack Diameter:	14 in.

Diesel Fuel Emissions Limits

D2 Cycle Exhaust Emissions	Grams per BHP-hr			Grams per kW_m-hr		
	NO_x + NMHC	CO	PM	NO_x + NMHC	CO	PM
Test Results	4.6	0.5	0.11	6.2	0.7	0.15
EPA Emissions Limit	4.8	2.6	0.15	6.4	3.5	0.20

Test methods: EPA emissions recorded per 40 CFR Part 60, 89, 1039, 1065 and weighted at load points prescribed in the regulations for constant speed engines.

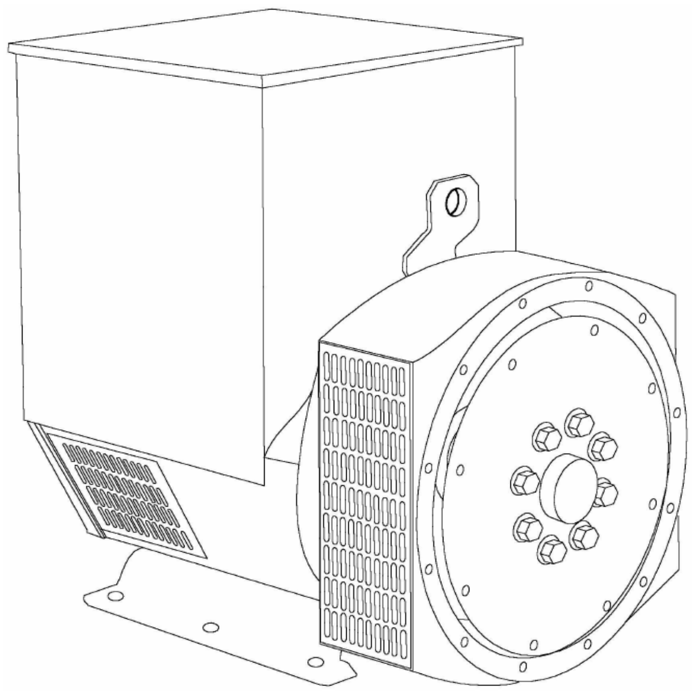
Diesel fuel specifications: Cetane number: 40-50. Reference: ASTM D975 No. 2-D, 7-15 ppm Sulfur

Reference conditions: Air inlet temperature: 25°C (77°F), Fuel inlet temperature: 40°C (104°F). Barometric pressure: 100 kPa (29.53 in Hg), Humidity: 10.7 g/kg (75 grains H2O/lb) of dry air; required for NOx correction, Restrictions: Intake restriction set to a maximum allowable limit for clean filter; Exhaust back pressure set to a maximum allowable limit.

Tests conducted using alternate test methods, instrumentation, fuel or reference conditions can yield different results. Engine operation with excessive air intake or exhaust restriction beyond published maximum limits, or with improper maintenance, may result in elevated emission levels.

STAMFORD®

UCI274F - Technical Data Sheet



UCI274F

SPECIFICATIONS & OPTIONS

STANDARDS

Newage Stamford industrial generators meet the requirements of BS EN 60034 and the relevant section of other international standards such as BS5000, VDE 0530, NEMA MG1-32, IEC34, CSA C22.2-100, AS1359. Other standards and certifications can be considered on request.

VOLTAGE REGULATORS

SX460 AVR - STANDARD

With this self excited control system the main stator supplies power via the Automatic Voltage Regulator (AVR) to the exciter stator. The high efficiency semiconductors of the AVR ensure positive build-up from initial low levels of residual voltage.
The exciter rotor output is fed to the main rotor through a three phase full wave bridge rectifier. This rectifier is protected by a surge suppressor against surges caused, for example, by short circuit.

AS440 AVR

With this self-excited system the main stator provides power via the AVR to the exciter stator. The high efficiency semi-conductors of the AVR ensure positive build-up from initial low levels of residual voltage.
The exciter rotor output is fed to the main rotor through a three-phase full-wave bridge rectifier. The rectifier is protected by a surge suppressor against surges caused, for example, by short circuit or out-of-phase paralleling.
The AS440 will support a range of electronic accessories, including a 'droop' Current Transformer (CT) to permit parallel operation with other ac generators.

MX341 AVR

This sophisticated AVR is incorporated into the Stamford Permanent Magnet Generator (PMG) control system.
The PMG provides power via the AVR to the main exciter, giving a source of constant excitation power independent of generator output. The main exciter output is then fed to the main rotor, through a full wave bridge, protected by a surge suppressor. The AVR has in-built protection against sustained over-excitation, caused by internal or external faults. This de-excites the machine after a minimum of 5 seconds.
An engine relief load acceptance feature can enable full load to be applied to the generator in a single step.
If three-phase sensing is required with the PMG system the MX321 AVR must be used.
We recommend three-phase sensing for applications with greatly unbalanced or highly non-linear loads.

MX321 AVR

The most sophisticated of all our AVRs combines all the features of the MX341 with, additionally, three-phase rms sensing, for improved regulation and performance.
Over voltage protection is built-in and short circuit current level adjustments is an optional facility.

WINDINGS & ELECTRICAL PERFORMANCE

All generator stators are wound to 2/3 pitch. This eliminates triplen (3rd, 9th, 15th …) harmonics on the voltage waveform and is found to be the optimum design for trouble-free supply of non-linear loads. The 2/3 pitch design avoids excessive neutral currents sometimes seen with higher winding pitches, when in parallel with the mains. A fully connected damper winding reduces oscillations during paralleling. This winding, with the 2/3 pitch and carefully selected pole and tooth designs, ensures very low waveform distortion.

TERMINALS & TERMINAL BOX

Standard generators are 3-phase reconnectable with 12 ends brought out to the terminals, which are mounted on a cover at the non-drive end of the generator. A sheet steel terminal box contains the AVR and provides ample space for the customers' wiring and gland arrangements. It has removable panels for easy access.

SHAFT & KEYS

All generator rotors are dynamically balanced to better than BS6861:Part 1 Grade 2.5 for minimum vibration in operation. Two bearing generators are balanced with a half key.

INSULATION/IMPREGNATION

The insulation system is class 'H'.
All wound components are impregnated with materials and processes designed specifically to provide the high build required for static windings and the high mechanical strength required for rotating components.

QUALITY ASSURANCE

Generators are manufactured using production procedures having a quality assurance level to BS EN ISO 9001.

The stated voltage regulation may not be maintained in the presence of certain radio transmitted signals. Any change in performance will fall within the limits of Criteria 'B' of EN 61000-6-2:2001. At no time will the steady-state voltage regulation exceed 2%.

NB Continuous development of our products entitles us to change specification details without notice, therefore they must not be regarded as binding.

Front cover drawing typical of product range.

STAMFORD

UCI274F

WINDING 311

CONTROL SYSTEM	SEPARATELY EXCITED BY P.M.G.		
A.V.R.	MX321	MX341	
VOLTAGE REGULATION	± 0.5 %	± 1.0 %	With 4% ENGINE GOVERNING
SUSTAINED SHORT CIRCUIT	REFER TO SHORT CIRCUIT DECREMENT CURVES (page 7)		

CONTROL SYSTEM	SELF EXCITED		
A.V.R.	SX460	AS440	
VOLTAGE REGULATION	± 1.0 %	± 1.0 %	With 4% ENGINE GOVERNING
SUSTAINED SHORT CIRCUIT	SERIES 4 CONTROL DOES NOT SUSTAIN A SHORT CIRCUIT CURRENT		

INSULATION SYSTEM	CLASS H
PROTECTION	IP23
RATED POWER FACTOR	0.8
STATOR WINDING	DOUBLE LAYER CONCENTRIC
WINDING PITCH	TWO THIRDS
WINDING LEADS	12
STATOR WDG. RESISTANCE	0.024 Ohms PER PHASE AT 22°C SERIES STAR CONNECTED
ROTOR WDG. RESISTANCE	1.52 Ohms at 22°C
EXCITER STATOR RESISTANCE	20 Ohms at 22°C
EXCITER ROTOR RESISTANCE	0.091 Ohms PER PHASE AT 22°C
R.F.I. SUPPRESSION	BS EN 61000-6-2 & BS EN 61000-6-4,VDE 0875G, VDE 0875N. refer to factory for others
WAVEFORM DISTORTION	NO LOAD < 1.5% NON-DISTORTING BALANCED LINEAR LOAD < 5.0%
MAXIMUM OVERSPEED	2250 Rev/Min
BEARING DRIVE END	BALL. 6315-2RS (ISO)
BEARING NON-DRIVE END	BALL. 6310-2RS (ISO)

	1 BEARING	2 BEARING
WEIGHT COMP. GENERATOR	530 kg	545 kg
WEIGHT WOUND STATOR	200 kg	200 kg
WEIGHT WOUND ROTOR	188.67 kg	177.71 kg
WR^2 INERTIA	1.555 kgm^2	1.5044 kgm^2
SHIPPING WEIGHTS in a crate	563 kg	577 kg
PACKING CRATE SIZE	123 x 67 x 103(cm)	123 x 67 x 103(cm)

	50 Hz				60 Hz			
TELEPHONE INTERFERENCE	THF<2%				TIF<50			
COOLING AIR	0.514 m^3/sec 1090 cfm				0.617 m^3/sec 1308 cfm			
VOLTAGE SERIES STAR	380/220	400/231	415/240	440/254	416/240	440/254	460/266	480/277
VOLTAGE PARALLEL STAR	190/110	200/115	208/120	220/127	208/120	220/127	230/133	240/138
VOLTAGE SERIES DELTA	220/110	230/115	240/120	254/127	240/120	254/127	266/133	277/138
kVA BASE RATING FOR REACTANCE VALUES	160	160	160	N/A	181.3	190	190	206.3
Xd DIR. AXIS SYNCHRONOUS	2.24	2.02	1.88	-	2.53	2.37	2.17	2.16
X'd DIR. AXIS TRANSIENT	0.19	0.17	0.16	-	0.21	0.20	0.18	0.18
X''d DIR. AXIS SUBTRANSIENT	0.13	0.12	0.11	-	0.14	0.13	0.12	0.12
Xq QUAD. AXIS REACTANCE	1.38	1.25	1.16	-	1.53	1.43	1.31	1.31
X''q QUAD. AXIS SUBTRANSIENT	0.17	0.15	0.14	-	0.20	0.19	0.17	0.17
X_L LEAKAGE REACTANCE	0.07	0.06	0.06	-	0.09	0.08	0.08	0.08
X_2 NEGATIVE SEQUENCE	0.14	0.13	0.12	-	0.16	0.15	0.14	0.14
X_0 ZERO SEQUENCE	0.08	0.08	0.07	-	0.10	0.09	0.09	0.09
REACTANCES ARE SATURATED		VALUES ARE PER UNIT AT RATING AND VOLTAGE INDICATED						

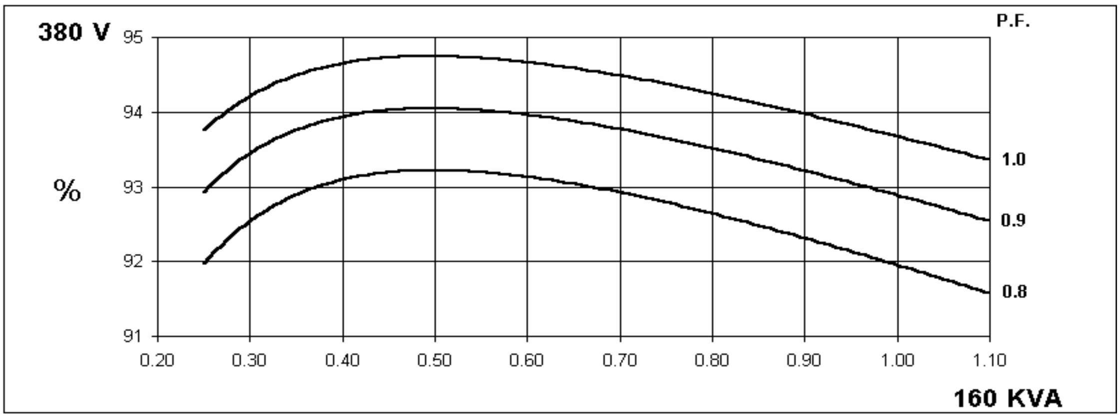
T'd TRANSIENT TIME CONST.	0.035 s
T''d SUB-TRANSTIME CONST.	0.011 s
T'do O.C. FIELD TIME CONST.	0.9 s
Ta ARMATURE TIME CONST.	0.009 s
SHORT CIRCUIT RATIO	1/Xd

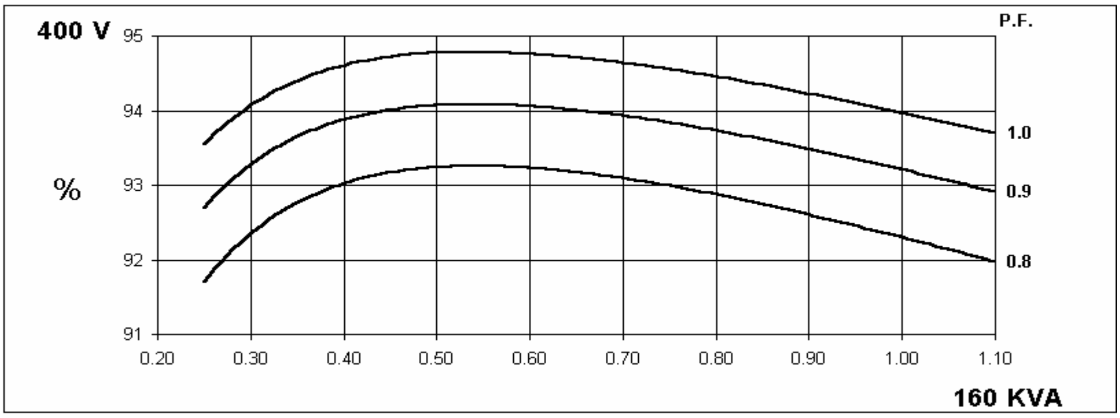
UCI274F

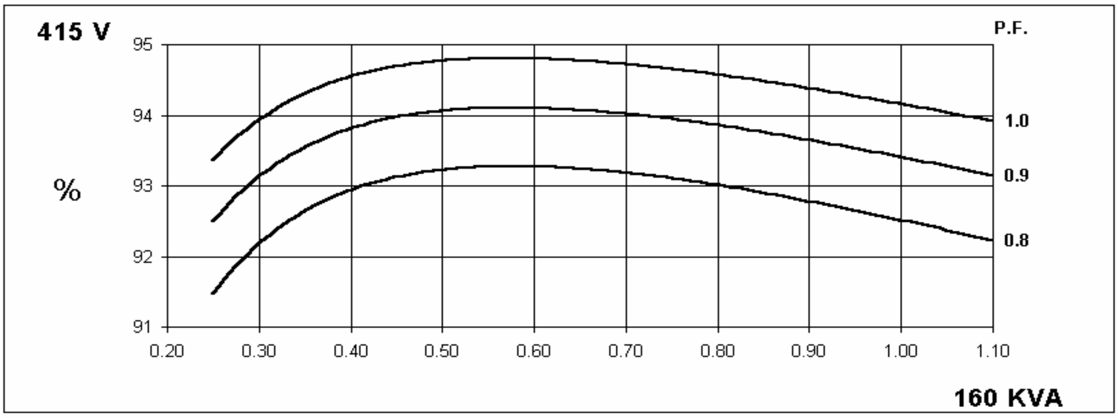
Winding 311

STAMFORD

THREE PHASE EFFICIENCY CURVES







STAMFORD

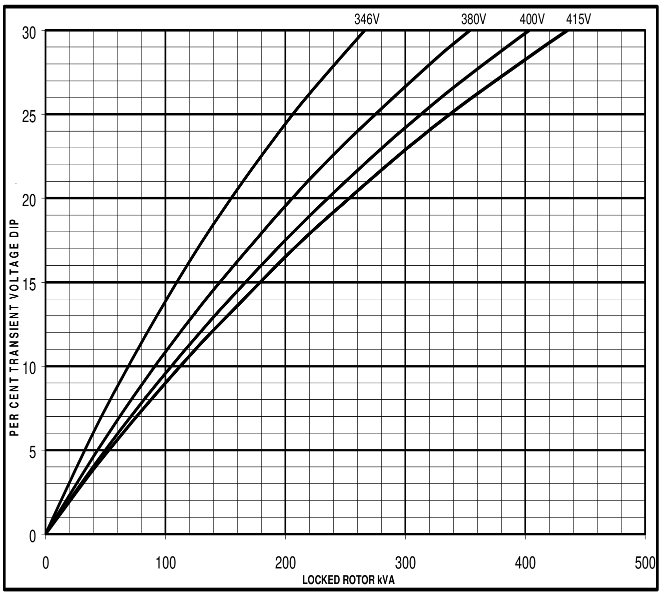
UCI274F

Winding 311

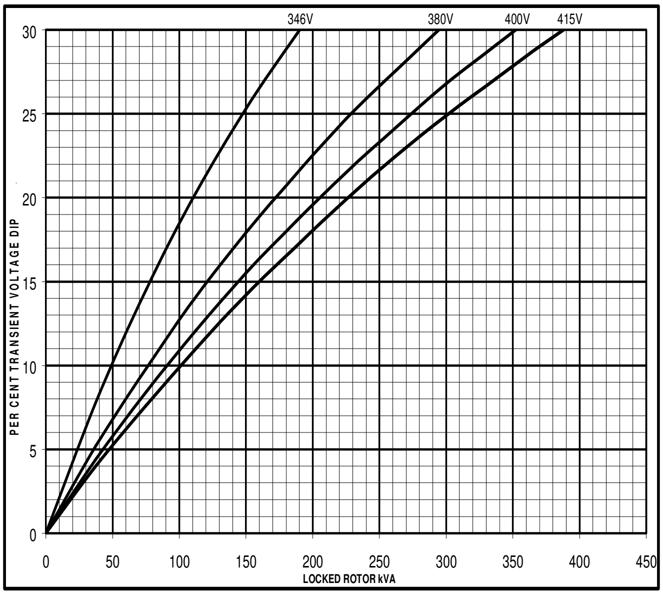
Locked Rotor Motor Starting Curve

50 Hz

MX

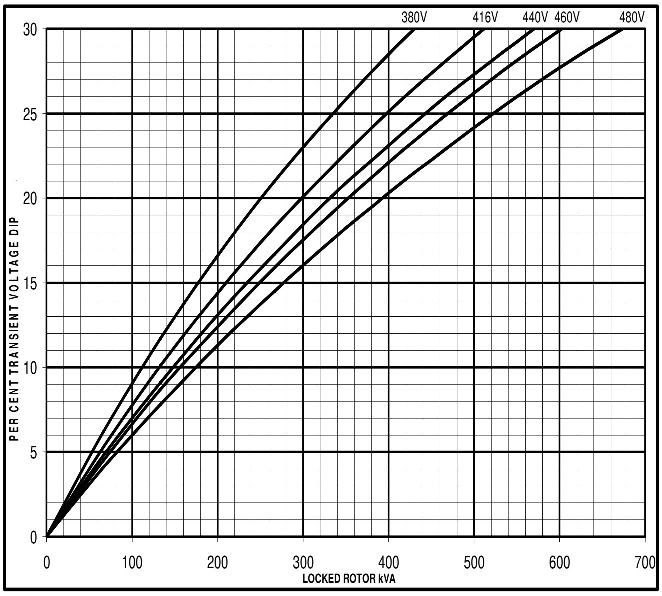


SX

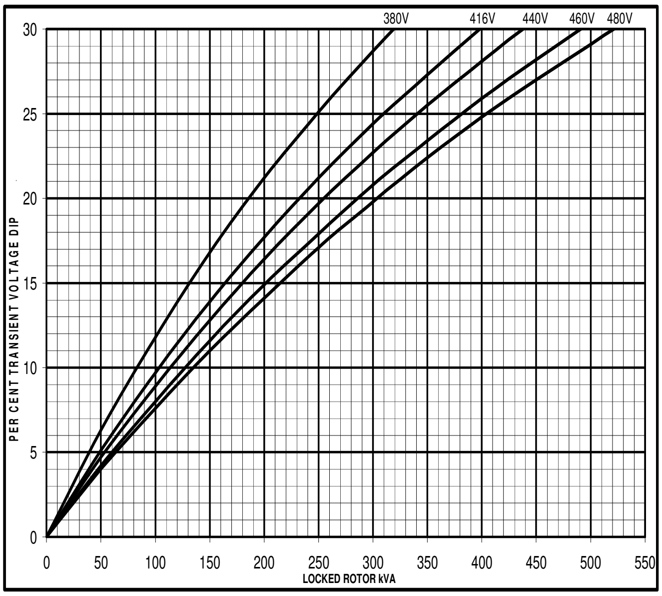


60 Hz

MX

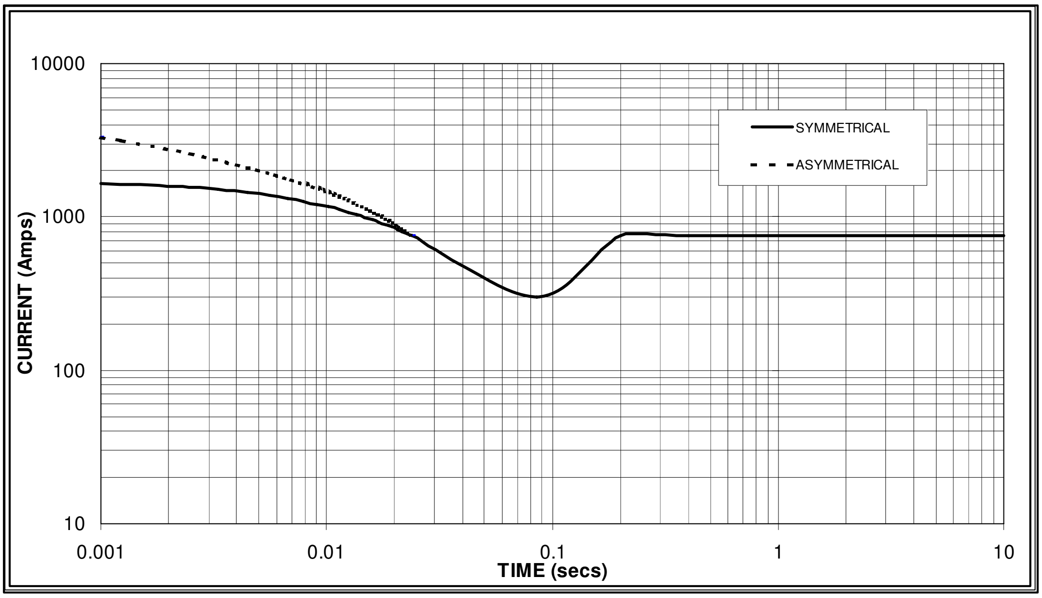


SX



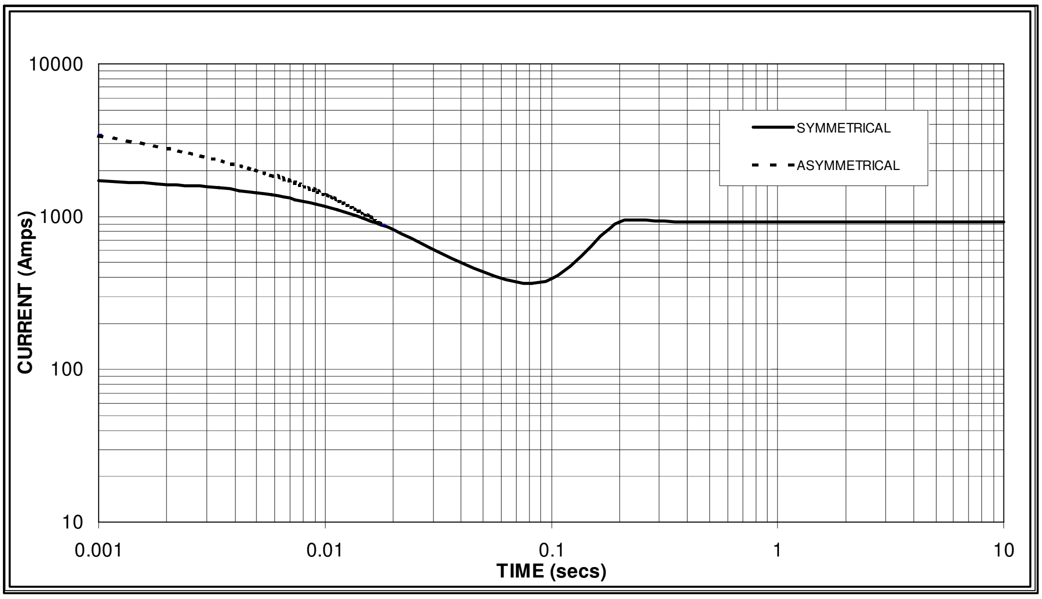
Three-phase Short Circuit Decrement Curve. No-load Excitation at Rated Speed
Based on star (wye) connection.

50 Hz



Sustained Short Circuit = 750 Amps

60 Hz



Sustained Short Circuit = 920 Amps

Note 1

The following multiplication factors should be used to adjust the values from curve between time 0.001 seconds and the minimum current point in respect of nominal operating voltage :

50Hz		60Hz	
Voltage	Factor	Voltage	Factor
380v	X 1.00	416v	X 1.00
400v	X 1.07	440v	X 1.06
415v	X 1.12	460v	X 1.12
		480v	X 1.17

The sustained current value is constant irrespective of voltage level

Note 2

The following multiplication factor should be used to convert the values calculated in accordance with NOTE 1 to those applicable to the various types of short circuit :

	3-phase	2-phase L-L	1-phase L-N
Instantaneous	x 1.00	x 0.87	x 1.30
Minimum	x 1.00	x 1.80	x 3.20
Sustained	x 1.00	x 1.50	x 2.50
Max. sustained duration	10 sec.	5 sec.	2 sec.

All other times are unchanged

Note 3

Curves are drawn for Star (Wye) connected machines. For other connection the following multipliers should be applied to current values as shown :

Parallel Star = Curve current value X 2

Series Delta = Curve current value X 1.732

UCI274F

STAMFORD

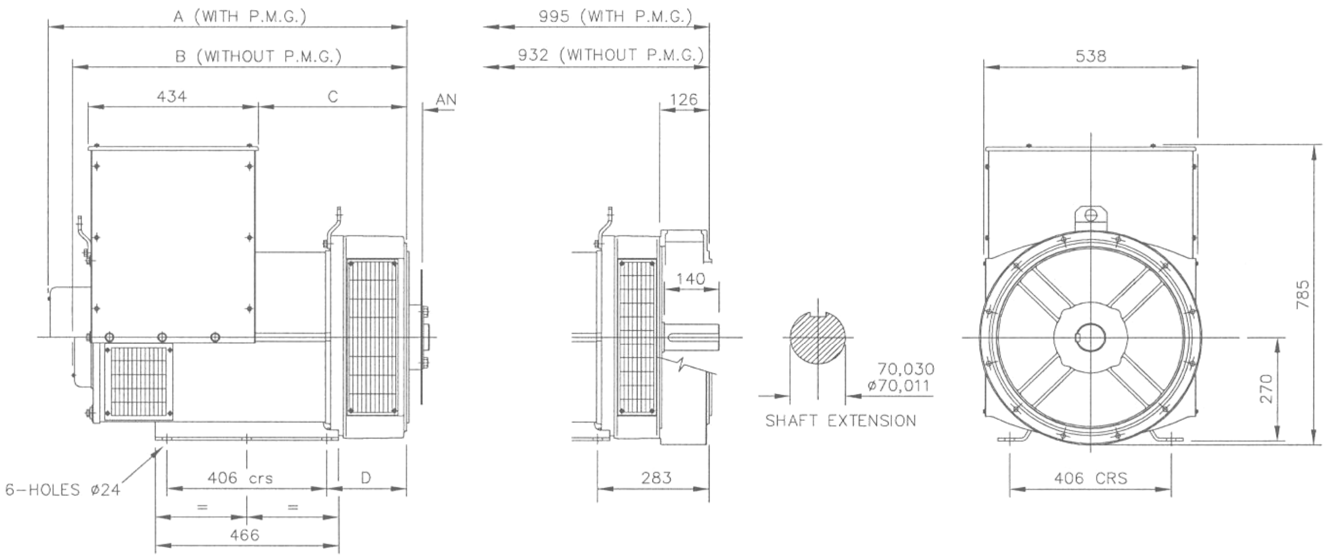
Winding 311 / 0.8 Power Factor

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	145.0	145.0	145.0	N/A	160.0	160.0	160.0	N/A	170.0	170.0	170.0	N/A	175.0	175.0	175.0	N/A
kW	116.0	116.0	116.0	N/A	128.0	128.0	128.0	N/A	136.0	136.0	136.0	N/A	140.0	140.0	140.0	N/A
Efficiency (%)	92.3	92.6	92.8	N/A	92.0	92.3	92.5	N/A	91.7	92.1	92.3	N/A	91.6	92.0	92.2	N/A
kW Input	125.7	125.3	125.0	N/A	139.1	138.7	138.4	N/A	148.3	147.7	147.3	N/A	152.8	152.2	151.8	N/A

60 Hz Series Star (V)	416	440	460	480	416	440	460	480	416	440	460	480	416	440	460	480
Parallel Star (V)	208	220	230	240	208	220	230	240	208	220	230	240	208	220	230	240
Series Delta (V)	240	254	266	277	240	254	266	277	240	254	266	277	240	254	266	277
kVA	162.5	172.5	172.5	187.5	181.3	190.0	190.0	206.3	187.5	200.0	200.0	212.5	192.5	206.3	206.3	218.8
kW	130.0	138.0	138.0	150.0	145.0	152.0	152.0	165.0	150.0	160.0	160.0	170.0	154.0	165.0	165.0	175.0
Efficiency (%)	92.5	92.7	92.9	92.9	92.1	92.4	92.7	92.7	92.0	92.2	92.5	92.6	91.9	92.1	92.4	92.5
kW Input	140.5	148.9	148.5	161.5	157.5	164.5	164.0	178.0	163.0	173.5	173.0	183.6	167.6	179.2	178.6	189.2

DIMENSIONS



SINGLE BEARING ADAPTORS				
ADAPTOR	A	B	C	D
SAE 1	928,3	865,3	389,3	216,3
SAE 2	914	851	375	202
SAE 3	914	851	375	202

COUPLING DISCS	
DISC	AN
SAE 10	53,98
SAE 11,5	39,68
SAE 14	25,40

STAMFORD

Barnack Road • Stamford • Lincolnshire • PE9 2NB

Tel: 00 44 (0)1780 484000 • Fax: 00 44 (0)1780 484100

Specification sheet

Diesel generator set QSB7 series engine

160 kVA - 220 kVA 50 Hz

135 kW - 200 kW 60 Hz

Description

This Cummins® commercial generator set is a fully integrated power generation system, providing optimum performance, reliability, and versatility for Stationary Standby, Prime Power, and Continuous Duty applications.

Features

Cummins heavy-duty engine - Rugged 4-cycle industrial diesel delivers reliable power, low emissions and fast response to load changes.

Optional Permanent Magnet Generator (PMG) - Offers enhanced motor starting and fault clearing short circuit capability.

Alternator - Low reactance 2/3 pitch windings; low waveform distortion with non-linear loads, fault clearing short-circuits capability, and class H insulation.

Cooling system - Standard integral set-mounted radiator system, designed and tested for rated ambient temperatures, simplifies facility design requirements for rejected heat.

Control system - The PowerCommand® electronic control is standard equipment and provides total genset system integration, including auto remote start/stop, alarm and status message display.

Enclosures - Optional weather-protective and sound-attenuated enclosures are available.

Warranty - Backed by a comprehensive warranty and worldwide distributor network.

Genset Model	Engine Model	Standby rating 50 Hz kVA (kWe)	Standby rating 60 Hz kWe (kVA)	Prime rating 50 Hz kVA (kWe)	Prime rating 60 Hz kWe (kVA)	Standard Controller	Emissions	Data sheet
C175 D5e	QSB7G5	175 (140)		160 (128)		PC1.2	EU SIIIA	DS329-CPGK
C200 D5e	QSB7G5	200 (160)		180 (144)		PC1.2	EU SIIIA	DS330-CPGK
C220 D5e	QSB7G5	220 (176)		200 (160)		PC1.2	EU SIIIA	DS331-CPGK
C150 D6e	QSB7G5		150 (188)		135 (169)	PC1.2	EPA T3	DS332-CPGK
C175 D6e	QSB7G5		175 (219)		160 (200)	PC1.2	EPA T3	DS333-CPGK
C200 D6e	QSB7G5		200 (250)		180 (225)	PC1.2	EPA T3	DS334-CPGK

Generator set specifications

Governor regulation class	ISO 8528 G3
Voltage regulation, no load to full load	± 1%
Random voltage variation	± 1%
Frequency regulation	Isochronous
Random frequency variation	± 0.25%
EMS compatibility	In compliance with VDE levels G and N

Engine specifications

Design	4 cycle, in-line, turbocharged
Bore	107 mm
Stroke	124 mm
Displacement	6.69 liter (408.0 in^3)
Cylinder block	Cast iron, 6 cylinder
Battery capacity	100 AH
Battery charging alternator	70 amps
Starting voltage	12 volt, negative ground
Fuel system	Direct injection
Fuel filter	Strata pore fuel filter
Air cleaner type	Heavy duty air cleaner
Lube oil filter type(s)	Strata pore lube oil filter
Standard cooling system	122 ºF (50 ºC) ambient radiator

*Open genset at 12.7 mm H_2O restriction

Alternator specifications

Design	Brushless, single bearing, revolving field
Stator	2/3 pitch
Rotor	Single bearing, flexible disc
Insulation system	Class H
Standard temperature rise	Standby 125-163 °C
Exciter type	Separately excited by PMG
Phase rotation	A (U), B (V), C (W)
Alternator cooling	Direct drive centrifugal blower fan
AC waveform Total Harmonic Distortion (THDV)	No load < 1.5%. Non distorting balanced linear load < 3%
Telephone Influence Factor (TIF)	< 50% per NEMA MG1-22.43
Telephone Harmonic Factor (THF)	< 2%

Available voltages

50 Hz Line-Neutral/Line-Line		60 Hz line-Neutral/Line-Line	
• 110/190 • 115/200 • 120/208	• 127/220 • 230/400 • 240/415	• 120/208 • 127/220 • 132/230 • 139/240 • 220/380*	• 240/416 • 254/440 • 266/460 • 277/480

*Derate may be applicable at this voltage. Please consult factory for details.

Generator set options

Engine
- Water jacket heater 220/240V

Cooling
- Antifreeze 50/50 (Ethylene glycol)

Enclosure
- Silent power canopy

Base frame
- Single Wall Fuel Tank

Alternator
- Alternator heater
- Exciter voltage regulator (PMG)

Control panel
- PowerCommand 1.2
- PowerCommand 3.3
- PowerCommand 3.3 with MLD
- Manual 3 or 4 pole main circuit breaker
- Motorised 3 or 4 pole circuit breaker

Warranty
- 2 years for Prime application
- 5 years for Standby application

Silencer
- 9 dB,16 dB, 25 dB attenuation for Industrial, Residential and Critical grade Silencer delivered loose for Open set
- 32 dB attenuation for Enclosed set

Genset Lifting Arrangement
- Enclosure lifting Provision
- Chassis lifting Provision

Note: Some options may not be available on all models – consult factory for availability.

Control system

PowerCommand 1.2 - The PowerCommand control system is a microprocessor-based generator set monitoring, metering and control system designed to meet the demands of today's engine driven generator sets. The integration of all control functions into a single control system provides enhanced reliability and performance compared to conventional generator set control systems. These control systems have been designed and tested to meet the harsh environment in which gensets are typically applied.

Description

The PowerCommand generator set control is suitable for use on a wide range of generator sets in non-paralleling applications. The PowerCommand control is compatible with shunt or PMG excitation style. It is suitable for use with connectable or non reconnectable generators, and it can be configured for any frequency, voltage and power connection from 120-600 VAC Line-to-Line.

Power for this control system is derived from the generator set starting batteries. The control functions over a voltage range from 8 VDC to 30 VDC.

Major features

- 128 x 128 pixels graphic LED backlight LCD.
- Digital voltage regulation. Single phase full wave SCR type regulator compatible with either shunt or PMG systems. Digital engine speed governing (where applicable).
- Generator set monitoring and protection.
- Advanced over-current protection.
- Modbus® interface for interconnecting to customer equipment.
- 12 and 24 VDC battery operation.
- Warranty and service. Backed by a comprehensive warranty and worldwide distributor service network.
- Certification. Suitable for use on generator sets that are designed, manufactured, tested and certified to relevant UL, NFPA, ISO, IEC Mil Std., CE and CSA standards.

Base control functions

HDMI capability

Operator adjustments – The HMI includes provisions for many set up and adjustment functions.

Data logs – Includes engine run time, controller on time, number of start attempts.

Fault history – Provides a record of the most recent fault conditions with control hours' time stamp. Up to 5 events are stored in the control non-volatile memory.

Alternator data

- Voltage (single or three phase Line-to-Line and Line-to-Neutral).
- Current (single or three phase).
- KVA (three phase and total).
- Frequency.

Engine data

- Starting battery voltage.
- Engine speed.
- Engine temperature.
- Engine oil pressure.
- Partial Full Authority Engine (FAE) data (where applicable).

Service adjustments – The HMI includes provisions for adjustment of generator set control functions. Adjustments are protected by a password. Functions include:

- Engine speed governor adjustments.
- Voltage regulation adjustments.
- Cycle cranking.
- Configurable fault set up.
- Configurable output set up.
- Meter calibration.
- Units of measurement.

Protective functions

Protective functions include:

- Battle short mode.
- Configurable alarm and status inputs.
- Emergency stop.
- Hydro mechanical fuel system engine protection.
- Overspeed shutdown.
- Low lube oil pressure warning.
- High lube oil temperature warning/shutdown.
- High engine temperature warning/shutdown.
- Low coolant temperature warning.
- Sensor failure indication.
- Full authority electronic engine protection.
- General engine protection.
- Low and high battery voltage warning.
- Weak battery warning.
- Fail to start (overcrank) shutdown.
- Fail to crank.
- Cranking lockout.

Alternator protection

- High AC voltage shutdown (59).
- Low AC voltage shutdown (27).
- Overcurrent warning/shutdown.
- Under frequency shutdown (81 u).
- Over frequency shutdown/warning (81 o).
- Loss of sensing voltage shutdown.
- Field overload shutdown.

Field control interface

Input signals to the base control include

- Remote start.
- Local and emergency stop.
- Configurable inputs: Control includes (4) input signals from customer.

Output signals from the control include

- Configurable relay outputs: Control includes (2) relay output contacts rated at 2 A.

PowerCommand 1.2 control operator / display panel

Ratings definitions

Emergency Standby Power (ESP):

Applicable for supplying power to varying electrical load for the duration of power interruption of a reliable utility source. Emergency Standby Power (ESP) is in accordance with ISO 8528. Fuel Stop power in accordance with ISO 3046, AS 2789, DIN 6271 and BS 5514.

Limited-Time Running Power (LTP):

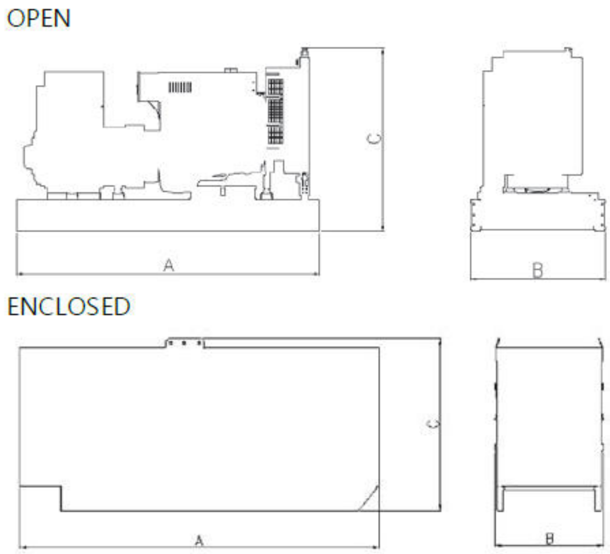
Applicable for supplying power to a constant electrical load for limited hours. Limited Time Running Power (LTP) is in accordance with ISO 8528.

Prime Power (PRP):

Applicable for supplying power to varying electrical load for unlimited hours. Prime Power (PRP) is in accordance with ISO 8528. Ten percent overload capability is available in accordance with ISO 3046, AS 2789, DIN 6271 and BS 5514.

Base Load (Continuous) Power (COP):

Applicable for supplying power continuously to a constant electrical load for unlimited hours. Continuous Power (COP) in accordance with ISO 8528, ISO 3046, AS 2789, DIN 6271 and BS 5514.



This outline drawing is to provide representative configuration details for Model series only.

See respective model data sheet for specific model outline drawing number.

Do not use for installation design

Model	Open					Enclosed				
	Length "A" mm	Width "B" mm	Height "C" mm	Dry Wt.* kg	Wet Wt.* kg	Length "A" mm	Width "B" mm	Height "C" mm	Dry Wt.* kg	Wet Wt.* kg
C175 D5e	2656	1130	1822	1928	1976	4209	1130	2227	2842	2890
						3690**	1130**	2100**	2592**	2640**
C200 D5e	2656	1130	1822	2070	2117	4209	1130	2227	2984	3031
						3690**	1130**	2100**	2734**	2781**
C220 D5e	2656	1130	1822	2070	2117	4209	1130	2227	2984	3031
						3690**	1130**	2100**	2734**	2781**
C150 D6e	2656	1130	1822	1928	1976	4209	1130	2227	2842	2890
						3690**	1130**	2100**	2592**	2640**
C175 D6e	2656	1130	1822	2070	2117	4209	1130	2227	2984	3031
						3690**	1130**	2100**	2734**	2781**
C200 D6e	2656	1130	1822	2070	2117	4209	1130	2227	2984	3031
						3690**	1130**	2100**	2734**	2781**

* Note: Weights represent a set with standard features. See outline drawings for weights of other configurations.

**Note: Weights and dimensions are for Chassis lifting arrangement option

Codes and standards

ISO 9001	This generator set is designed in facilities certified to ISO 9001 and manufactured in facilities certified to ISO 9001 or ISO 9002.	PTS	The Prototype Test Support (PTS) program verifies the performance integrity of the generator set design. Cummins products bearing the PTS symbol meet the prototype test requirements of NFPA 110 for Level 1 systems.
CE	This generator set is available with CE certification as an option.	CSA	All low voltage models are CSA certified to product class 4215-01.

For more information contact your local Cummins distributor or visit power.cummins.com

Our energy working for you.™

Specification Sheet

PowerCommand®
3.3 Generator Set Digital Integrated Control System

Bargraph Optional

Introduction

The PowerCommand® 3.3 control system is a microprocessor-based generator set monitoring, metering, and control system, which is comprised of PowerCommand® Control 3300 and the Human Machine Interface 320. PCC3300 supports multiple operation modes including:

- Standalone,
- Synchronization only,
- Isolated bus paralleling,
- Utility single generator set paralleling,
- Utility multiple generator set paralleling,
- Utility single generator set paralleling with power transfer control (automatic mains failure),
- Isolated bus paralleling with Masterless Load Demand

PowerCommand® Control 3300 is designed to meet the exacting demands of the harsh and diverse environments of today's typical power generation applications for Full Authority Electronic or Hydromechanical engine power generator sets.

Offering enhanced reliability and performance over more conventional generator set controls via the integration of all generator control functions into a single system, PCC3300 is your Power of One generator set control solution.

Benefits and Features

- 320 x 240 pixels graphical LED backlit LCD
- Multiple languages supported
- AmpSentry™ protection provides industry-leading generator overcurrent protection
- Digital Power Transfer Control (Automatic Mains Failure) provides load transfer operation in open transition, closed transition, or soft (ramping) transfer modes
- Extended Paralleling (Peak Shave/Base Load) regulates the genset real and reactive power output while paralleled to the utility. Power can be regulated at either the genset or utility bus monitoring point
- Digital frequency synchronization and voltage matching
- Isochronous Load Sharing
- Droop kW and kVAr control
- Real time clock for fault and event time stamping
- Exerciser clock and time of day start/stop initiate a test with or without load, or a Base Load or Peak Shave session
- Digital automatic voltage regulation is provided using three phase sensing and full wave FET type regulator, which is compatible with either shunt or PMG excited systems with a standard AUX103 AVR or an option for a more powerful high-current field drive capability AUX106 AVR
- Digital engine speed governing is provided on applicable platforms
- Generator set monitoring (including metering) and protection with PCC3300 measuring voltage, current, kW and kVAr offering a measurement accuracy of 1%
- Utility / AC Bus metering and protection with PCC3300 voltage, current, kW and kVAr offering a measurement accuracy of 1%
- 12 V (DC) and 24 V (DC) battery operation
- RS-485 Modbus® interface for interconnecting to customer equipment
- Warranty and service – Cummins Power Generation offers a comprehensive warranty and worldwide distributor service network
- Global regulatory certification and compliance: PCC3300 is suitable for use on gensets that are designed, manufactured, tested and certified to relevant UL, NFPA, ISO, IEC, Mil Std. and CE standards

PowerCommand® Generator Set Digital Control System PCC 3300

Introduction

PCC3300 is an industry-leading digital generator set control suitable for usage on a wide range of diesel and lean burn natural gas generator sets in both standalone as well as paralleling applications.

PowerCommand® is compatible with either shunt or PMG excitation, and is suitable for usage with reconnectable or non-reconnectable generators. Configuration for any frequency, voltage and power connection from 120 V (AC) to 600 V (AC) line-to-line or 601 V (AC) to 45k V (AC) with an external PT is supported. The PCC3300 derives its own power from the generator set starting batteries and functions over a voltage range of 8 V (DC) to 30 V (DC).

Features

- PCC3300 supports configurable control features via software download using InPower PC-compatible software
- 12 V (DC) and 24 V (DC) battery operation
- Digital automatic voltage regulation is provided using three phase sensing and full wave FET type regulator, which is compatible with either shunt or PMG excited systems with a standard AUX103 AVR or an option for a more powerful high-current field drive capability AUX106 AVR
- Digital engine speed governing on applicable platform is provided, which is capable of providing isochronous frequency regulation
- Full authority J1939 CANBus® prime mover communications and control is provided for platforms with an Engine Control Module (ECM)
- AmpSentry” protection provides industry-leading alternator overcurrent protection:
  - Time-based generator protection applicable to both line-to-line and line-to-neutral, that can detect an unbalanced fault condition and swiftly react appropriately. Balanced faults can also be detected by AmpSentry and appropriate acted upon.
  - Reduces the risk of Arc Flash due to thermal overload or electrical faults by inverse time protection
- Generator set monitoring offers status information for all critical prime mover and generator functions
- AC and DC digital generator set metering is provided. AC measurements are configurable for single or three phase sensing with PCC3300 measuring voltage, current, kW and kVAr offering a measurement accuracy of 1%
- Battery monitoring system continually monitors the battery output and warns of the potential occurrence of a weak battery condition
- Relay drivers for prime mover starter, fuel shutoff (FSO), glow plug/spark ignition power and switched B+ applications are provided
- Integrated generator set protection is offered to protect the prime mover and generator
- Real time clock for fault and event time stamping
- Exerciser clock and time of day start/stop initiate a test with or without load, or a Base Load or Peak Shave session
- Digital Power Transfer Control (Automatic Mains Failure) provides load transfer operation in open transition, closed transition, or soft (ramping) transfer modes
- Extended Paralleling (Peak Shave/Base Load) regulates the genset real and reactive power output while paralleled to the utility. Power can be regulated at either the genset or utility bus monitoring point
- Digital frequency synchronization and voltage matching
- Isochronous Load Sharing
- Droop kW and kVAr Control
- The synchronization check function provides adjustments for phase angle window, voltage window, frequency window and time delay
- Utility / AC Bus metering and protection with PCC3300 voltage, current, kW and kVAr offering a measurement accuracy of 1%
- Advanced serviceability is offered via InPower™, a PC-based software service tool
- PCC3300 is designed for reliable operation in harsh environments with the unit itself being a fully encapsulated module
- RS-485 ModBus interface for interconnecting to customer equipment
- Native on PCC3300: Four discrete inputs, two dry contact relay outputs and two low-side driver outputs are provided and are all configurable.
  - Optional extra PCC3300 input and output capability available via AUX101
- Warranty and service – Cummins Power Generation offers a comprehensive warranty and worldwide distributor service network
- Global regulatory certification and compliance: PCC3300 is suitable for use on gensets that are designed, manufactured, tested and certified to relevant UL, NFPA, ISO, IEC, Mil Std. and CE standards

Base Control Functions

HMI capability

Options: Local and remote HMI320 options are available

Operator adjustments: The HMI320 includes provisions for many set up and adjustment functions.

Genset hardware data: Access to the control and software part number, genset rating in kVA and genset model number is provided from the HMI320 or InPower.

Data logs: Information concerning all of the following parameters is periodically logged and available for viewing; engine run time, controller on time, number of start attempts, total kilowatt hours, and load profile. (Control logs data indicating the operating hours at percent of rated kW load, in 5% increments. The data is presented on the operation panel based on total operating hours on the generator.)

Fault history: Provides a record of the most recent fault conditions with control date and time stamp. Up to 32 events are stored in the control non-volatile memory.

Alternator data

- Voltage (single or three phase line-to-line and line-to-neutral)
- Current (single or three phase)
- kW, kVAr, Power Factor, kVA (three phase and total)
- Frequency

For Lean Burn Natural Gas Engine applications:

- Alternator heater status
- Alternator winding temperature (per phase) as well as alternator drive end and non-drive end bearing

Utility/AC bus data

- Voltage (three phase line-to-line and line-to-neutral)
- Current (three phase and total)
- kW, kVAR, Power Factor, kVA (three phase and total)
- Frequency

AmpSentry: 3x current regulation for downstream tripping/motor inrush management. Thermal damage curve (3-phase short) or fixed timer (2 sec for 1-Phase Short or 5 sec for 2-Phase short).

Engine data

- Starting battery voltage
- Engine speed
- Engine temperature
- Engine oil pressure
- Engine oil temperature
- Intake manifold temperature
- Coolant temperature
- Comprehensive Full Authority Engine (FAE) data (where applicable)

Lean Burn Natural Gas (LBNG) application parameters include:

- Safety shutoff valve status
- Valve proving status
- Downstream gas pressure
- Gas inlet pressure
- Gas mass flow rate
- Control valve position
- Gas outlet pressure
- Manifold pressure and temperature
- Throttle position
- Compressor outlet pressure
- Turbo speed
- Compressor bypass position
- Cylinder configuration (e.g., drive end and non-drive end configurations)
- Coolant pressure 1 and 2 as well as coolant temperature 1 and 2 for both HT/LT respectively
- Exhaust port temperature (up to 18 cylinders)
- Pre-filter oil pressure
- Exhaust back pressure
- Parent ECM internal temperature and isolated battery voltage
- Speed bias
- Child ECM internal temperature and isolated battery voltage
- Knock level, spark advance, and knock count (for up to 18 cylinders)
- Auxiliary supply disconnector status
- Engine heater status
- Coolant circulating pump status
- Lube oil priming pump status
- Lube oil status
- Oil heater status
- Derate authorization status
- Start system status
- Ventilator fan status
- Ventilation louvre status
- Radiator fan status
- DC PSU status
- Start inhibit/enable status and setup

Service adjustments – The HMI320 includes provisions for adjustment and calibration of genset control functions. Adjustments are protected by a password. Functions include:

- Engine speed governor adjustments
- Voltage regulation adjustments
- Cycle cranking
- Configurable fault set up
- Configurable input and output set up
- Meter calibration
- Paralleling setup
- Display language and units of measurement

Prime Mover Control

SAE-J1939 CAN interface to full authority ECMs (where applicable). Provides data transfer between genset and engine controller for control, metering and diagnostics.

12 V (DC) or 24 V (DC) nominal battery voltage is supported by PCC3300 for normal operation.

Temperature dependant prime mover governing dynamics: This function is supported enabling the engine to be responsive when warm and more stable when operating at lower temperature via providing control and modification over electronic governing parameters as a function of engine temperature.

Isochronous governing is provided in order to control prime mover speed within ±0.25% of nominal rated speed for any steady state load from no load to full load. During operation frequency drift should not exceed ±0.5% of nominal frequency given a 33ºC (or 60ºF) chance in ambient temperature within an eight-hour period.

Droop electronic speed is governing capability is natively offered by PCC3300 to permit droop from 0% to 10% between no load to full load.

Remote start capability is built into the PCC3300 as the unit accepts a ground signal from remote devices to automatically command the starting of the generator set as well as the reaching of rated speed, voltage and frequency or otherwise run at idle speed until prime mover temperature is adequate. The presence of a remote start signal shall cause the PCC3300 to leave sleep mode and return to normal power mode. PCC3300 supports an option for delayed start or stop.

Remote Start Integrity: In compliance with NEC2017 Start Signal Integrity standard – NFPA70 Article 700.10(D)(3), the remote start circuit from ATS to PCC3300 is continuously monitored for signal disturbance due to broken, disconnected or shorted wires via a configurable input. Loss of signal integrity results in activation of a remote start signal.

Remote and local emergency stopping capability: PCC3300 accepts ground signal from a locally or remoted mounted emergency stop switch to cause the generator set to immediately shutdown. The generator set is prevented from either running or cranking with the emergency stop switch engaged. If PCC3300 is in sleep mode, then the activation of any emergency stop switch shall return PCC3300 is normal powered state along with the activation of the corresponding shutdown and run-prevention states.

Sleep mode: PowerCommand 3.3 supports a configurable low current draw state, which is design with consideration to the needs of prime applications or others application without a battery charger (in order to minimize battery current drain).

Automatic prime mover starting: Any generator set controlled by PCC3300 is capable of automatic starting achieved via either magnetic pickup or main alternator output frequency. PCC3300 additionally supports configurable glow plug control where applicable.

Prime mover cycle cranking: PCC3300 supports configurable starting cycles and rest periods. Built in starter protection are incorporated to prevent the operator from specifying a starting sequence that may be damaging.

Configurable time delay functionality: PCC3300 supports time delayed generator set starting and stopping (for cooldown). Permissible time delays are as follows (noting a default setting is 0 seconds):

1. Start delay: 0 seconds to 300 seconds prior to starting after receiving a remote start signal.
2. Stop delay: 0 seconds to 600 seconds prior to shut down after receiving a signal to stop in normal operation modes.

Lean Burn Natural Gas application specific parameters

PCC3300 supports prime mover inhibiting in order to permit application-specific processes (i.e. Auxiliaries) to be started first.

Generator Control

PCC3300 performs both Genset voltage sensing and Genset voltage regulation as follows:

- Voltage sensing is integrated into PCC3300 via three phase line-to-line sensing that is compatible with shunt or PMG excitation systems
- Automatic voltage regulation is accomplished by using a three phase fully rectified input and has a FET output for good motor starting capability.

Major features of generator control include:

Digital output voltage regulation - Capable of regulating output voltage to within +/-1.0% for any loads between no load and full load. Voltage drift will not exceed +/-1.5% for a 40 ºC (104 ºF) change in temperature in an eight-hour period. On engine starting or sudden load acceptance, voltage is controlled to a maximum of 5% overshoot over nominal level.

The automatic voltage regulator feature can be disabled to allow the use of an external voltage regulator.

Droop voltage regulation - Control can be adjusted to droop from 0-10% from no load to full load.

Torque-matched V/Hz overload control - The voltage roll-off set point and rate of decay (i.e. the slope of the V/Hz curve) is adjustable in the control.

Fault current regulation - PowerCommand® will regulate the output current on any phase to a maximum of three times rated current under fault conditions for both single phase and three phase faults. In conjunction with a permanent magnet generator, it will provide three times rated current on all phases for motor starting and short circuit coordination purpose.

Cylinder Cut-off System (CCS): PCC 3300 supports Cylinder Cut-off System which is used to operate the engines on half bank at no load and light load conditions. CCS has below benefits on engine performance- improved emission standards, improved fuel efficiency, reduced hydrocarbons, reduced white smoke, reduced wet stacking and higher exhaust temperature at light loads to improve turbocharger operations and catalyst performance.

Step Timing Control (STC): PCC 3300 supports STC functionality which is used to advance the engine timing of a hydro-mechanical engine during start up and light load conditions. During ADVANCED injection timing, it:

- Improves cold weather idling characteristics
- Reduces cold weather white smoke
- Improves light load fuel economy
- Reduces injector carboning

Paralleling Functions

First Start Sensor™ system – PowerCommand® provides a unique control function that positively prevents multiple gensets from simultaneously closing to an isolated bus under black start conditions. The First Start Sensor system is a communication system between the gensets that allows the gensets to work together to determine which genset is a system should be the first to close to the bus. The system includes an independent backup function, so that if the primary system is disabled the required functions are still performed.

Synchronizing – Control incorporates a digital synchronizing function to force the genset to match the frequency, phase and voltage of another source such as a utility grid. The synchronizer includes provisions to provide proper operation even with highly distorted bus voltage waveforms. The synchronizer can match other sources over a range of 60-110% of nominal voltage and -24 to +6 hertz. The synchronizer function is configurable for slip frequency synchronizing for applications requiring a known direction of power flow at instant of breaker closure or for applications where phase synchronization performance is otherwise inadequate.

Load sharing control – The genset control includes an integrated load sharing control system for both real (kW) and reactive (kVar) loads when the genset(s) are operating on an isolated bus. The control system determines kW load on the engine and kVar load on the alternator as a percent of genset capacity, and then regulates fuel and excitation systems to maintain system and genset at the same percent of load without impacting voltage or frequency regulation. The control can also be configured for operation in droop mode for kW or Kvar load sharing.

Load govern control– When PowerCommand® receives a signal indicating that the genset is paralleled with an infinite source such as a utility (mains) service, the genset will operate in load govern mode. In this mode the genset will synchronize and close to the bus, ramp to a pre-programmed kW and kVar load level, and then operate at that point. Control is adjustable for kW values from 0-100% of standby rating, and 0.7-1.0 power factor (lagging). Default setting is 80% of standby and 1.0 power factor. The control includes inputs to allow independent control of kW and kVar load level by a remote device while in the load govern mode. The rate of load increase and decrease is also adjustable in the control. In addition, the control can be configured for operation in kW or kVAR load govern droop.

Load demand control – The control system includes the ability to respond to an external signal to initiate load demand operation. On command, the genset will ramp to no load, open its paralleling breaker, cool down, and shut down. On removal of the command, the genset will immediately start, synchronize, connect, and ramp to its share of the total load on the system.

Sync check – The sync check function decides when permissive conditions have been met to allow breaker closure. Adjustable criteria are: phase difference from 0.1-20 deg, frequency difference from 0.001-1.0 Hz, voltage difference from 0.5-10%, and a dwell time from 0.5-5.0 sec. Internally the sync check is used to perform closed transition operations. An external sync check output is also available.

Genset and utility/AC bus source AC metering – The control provides comprehensive three phase AC metering functions for both monitored sources, including: 3-phase voltage (L-L and L-N) and current, frequency, phase rotation, individual phase and totalized values of kW, kVAR, kVA and Power Factor; totalized positive and negative kW-hours, kVAR-hours, and kVA-hours. Three wire or four wire voltage connection with direct sensing of voltages to 600V, and up to 45kV with external transformers. Current sensing is accomplished with either 5 amp or 1 CT secondaries and with up to 10,000 amp primary. Maximum power readings are 32,000kW/kVAR/kVA.

Power transfer control – provides integrated automatic power transfer functions including source availability sensing, genset start/stop and transfer pair monitoring and control. The transfer/retransfer is configurable for open transition, fast closed transition (less than 100msec interconnect time), or soft closed transition (load ramping) sequences of operation. Utility source failure will automatically start genset and transfer load, retransferring when utility source returns. Test will start gensets and transfer load if test with load is enabled. Sensors and timers include:

Under voltage sensor: 3-phase L-N or L-L under voltage sensing adjustable for pickup from 85-100% of nominal. Dropout adjustable from 75-98% of pickup. Dropout delay adjustable from 0.1-30 sec.

Over voltage sensor: 3-phase L-N or L-L over voltage sensing adjustable for pickup from 95-99% of dropout. Dropout adjustable from 105-135% of nominal. Dropout delay adjustable from 0.5-120 sec. Standard configuration is disabled and is configurable to enabled in the field using the HMI or InPower service tools.

Over/Under frequency sensor: Center frequency adjustable from 45-65 Hz. Dropout bandwidth adjustable from 0.3-5% of center frequency beyond pickup bandwidth. Pickup bandwidth adjustable from 0.3-20% of center frequency. Field configurable to enable.

Loss of phase sensor: Detects out of range voltage phase angle relationship. Field configurable to enable.

Phase rotation sensor: Checks for valid phase rotation of source. Field configurable to enable.

Breaker tripped: If the breaker tripped input is active, the associated source will be considered as unavailable.

Timers: Control provides adjustable start delay from 0 - 300sec, stop delay from 0 - 800sec, transfer delay from 0-120sec, retransfer delay from 0-1800sec, programmed transition delay from 0-60sec, and maximum parallel time from 0-1800sec.

Negative Sequence Current Protection: PCC3300 supports this protection natively in order to determine if the generator is at any point was running subject to negative phase sequencing.

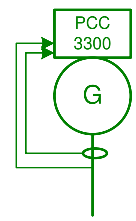
Breaker control – Utility and Genset breaker interfaces include separate relays for opening and closing breaker, as well as inputs for both 'a' and 'b' breaker position contacts and tripped status. Breaker diagnostics include Contact Failure, Fail to Close, Fail to Open, Fail to Disconnect, and Tripped. Upon breaker failure, appropriate control action is taken to maintain system integrity.

Exerciser clock –The exerciser clock (when enabled) allows the system to be operated at preset times in either test without load, test with load, or extended parallel mode. A Real Time Clock is built in. Up to 12 different programs can be set for day of week, time of day, duration, repeat interval, and mode. For example, a test with load for 1 hour every Tuesday at 2AM can be programmed. Up to 6 different exceptions can also be set up to block a program from running during a specific date and time period.

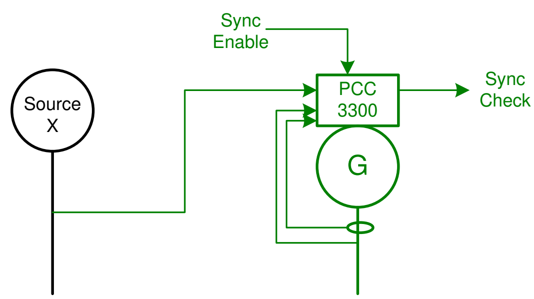
Extended paralleling – In extended paralleling mode (when enabled) the controller will start the genset and parallel to a utility source and then govern the real and reactive power output of the genset based on the desired control point. The control point for the real power (kW) can be configured for either the genset metering point ("Base Load") or the utility metering point ("Peak Shave"). The control point for the reactive power (kVAR or Power Factor) can also be independently configured for either the genset metering point or the utility metering point. This flexibility would allow base kW load from the genset while maintaining the utility power factor at a reasonable value to avoid penalties due to low power factor. The System always operates within genset ratings. The control point can be changed while the system is in operation. Set points can be adjusted via hardwired analog input or adjusted through an operator panel display or service tool.

Application types – Controller is configured to operating in one of six possible application types. These topologies are often used in combinations in larger systems, with coordination of the controllers in the system either by external device or by interlocks provided in the control. Topologies that may be selected in the control include:

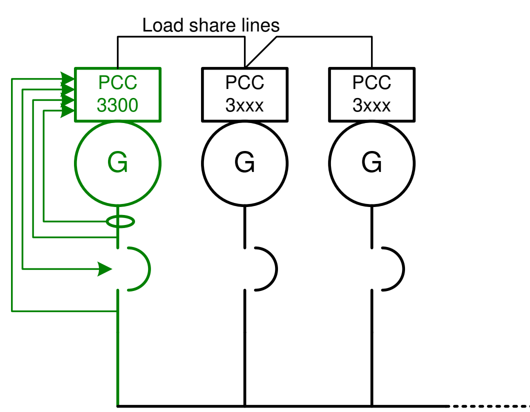
Standalone: Control provides monitoring, protection and control in a non-paralleling application.



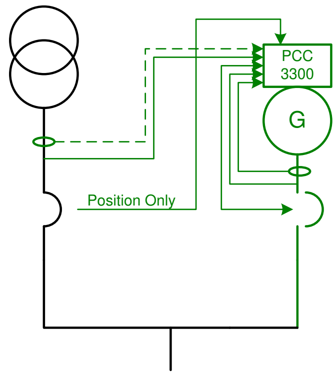
Synchronizer only: control will synchronize the genset to other source when commanded to either via a hardwired or Modbus driven input.



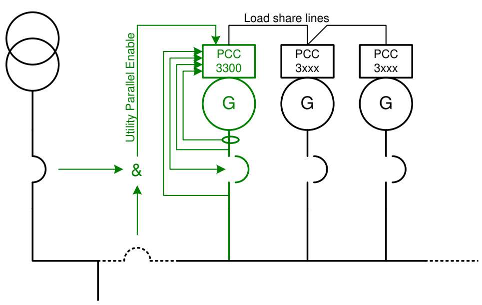
Isolated Bus: allows the genset to perform a dead bus closure or synchronize to the bus and isochronously share kW and kVAR loads with other gensets.



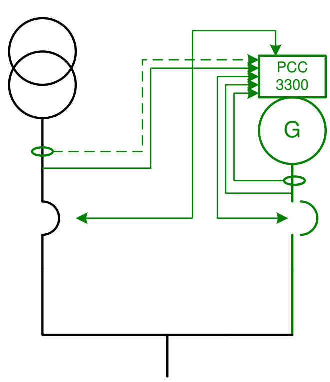
Utility Single: Control monitors one genset and utility. The control will automatically start and provide power to a load if the utility fails. The control will also resynchronize the genset back to the utility and provides extended paralleling capabilities.



Utility Multiple: Supports all functionality of Isolated Bus and provides extended paralleling to the utility. Extended paralleling load set points follow a constant setting; dynamically follow an analog input, Modbus register or HMI.

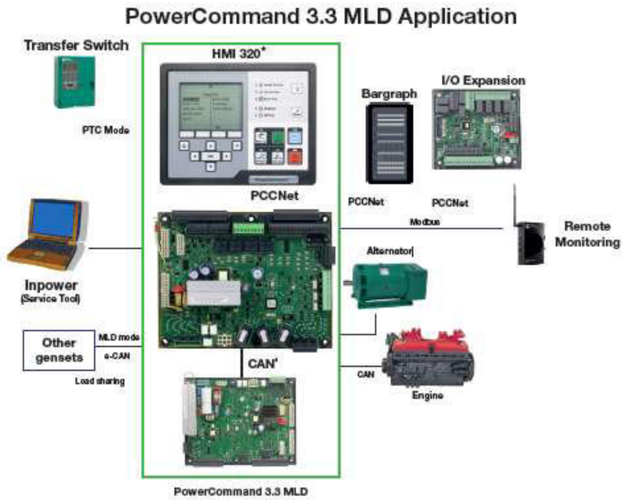


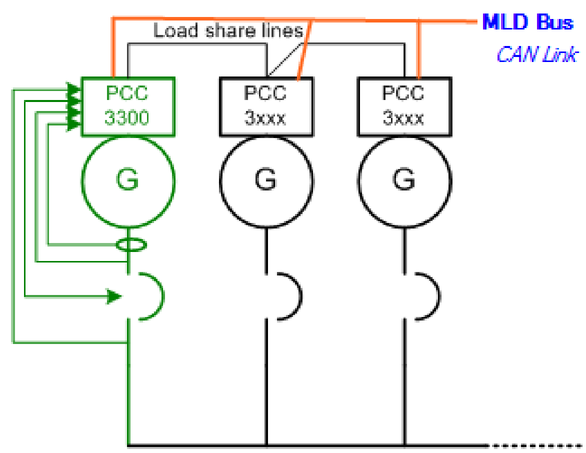
Power Transfer Control: Control operates a single genset/single utility transfer pair in open transition, fast closed transition, or soft closed transition. Extended paralleling functionality also provides base load and peak shave options.



Masterless Load Demand (Optional Feature):

PowerCommand® 3.3 with Masterless Load Demand (MLD) technology enables generator sets to start/stop automatically based on load demand. Masterless Load Demand-capable generators are equipped with an additional s-CAN network connection that allows sharing of information amongst paralleled generator sets. MLD has been designed for hassle-free installation, commissioning and operation. MLD functionality. Integrated on-board system logic provides the MLD topology control without the need for any additional system.





PCC3300 External Voltage and Frequency Biasing Inputs

PCC3300 supports externally driven voltage and frequency biasing capability in order to permit external paralleling (if intending to use this feature please contact your local distributor for further information).

Protective Functions

On operation of a protective function the control will indicate a fault by illuminating the appropriate status LED on the HMI, as well as display the fault code and fault description on the LCD. The nature of the fault and time of occurrence are logged in the control. The service manual and InPower service tool provide service keys and procedures based on the service codes provided. Protective functions include:

Battle short mode

When enabled and the *battle short* switch is active, the control will allow some shutdown faults to be bypassed. If a bypassed shutdown fault occurs, the fault code and description will still be annunciated, but the genset will not shutdown. This will be followed by a *fail to shutdown* fault. Emergency stop shutdowns and others that are critical for proper operation (or are handled by the engine ECM) are not bypassed. Please refer to the Control Application Guide or Manual for list of these faults.

Derate

The Derate function reduces output power of the genset in response to a fault condition. If a Derate command occurs while operating on an isolated bus, the control will issue commands to reduce the load on the genset via contact closures or Modbus. If a Derate command occurs while in utility parallel mode, the control will actively reduce power by lowering the base load kW to the derated target kW.

Configurable alarm and status inputs

The control accepts up to four alarm or status inputs (configurable contact closed to ground or open) to indicate a configurable (customer-specified) condition.

The control is programmable for warning, derate, shutdown, shutdown with cooldown or status indication and for labeling the input.

Emergency stop

Annunciated whenever either emergency stop signal is received from external switch.

General prime mover protection

Low and high battery voltage warning - Indicates status of battery charging system (failure) by continuously monitoring battery voltage.

Weak battery warning - The control system will test the battery each time the genset is signaled to start and indicate a warning if the battery indicates impending failure.

Low coolant level warning – Can be set up to be a warning or shutdown.

Low coolant temperature warning – Indicates that engine temperature may not be high enough for a 10 second start or proper load acceptance.

Fail to start (overcrank) shutdown - The control system will indicate a fault if the genset fails to start by the completion of the engine crack sequence.

Fail to crank shutdown - Control has signaled starter to crank engine but engine does not rotate.

Cranking lockout - The control will not allow the starter to attempt to engage or to crank the engine when the engine is rotating.

Fault simulation –The control in conjunction with InPower software, will accept commands to allow a technician to verify the proper operation of the control and its interface by simulating failure modes or by forcing the control to operate outside of its normal operating ranges. InPower also provides a complete list of faults and settings for the protective functions provided by the controller.

For Lean Burn Natural Gas Engine applications:

Off load running (protection) – This feature protects the engine in the event the genset is being called to go off load for too long.

Hydro Mechanical fuel system engine protection:

Overspeed shutdown – Default setting is 115% of nominal

Low lube oil pressure warning/shutdown – Level is preset (configurable with InPower or HMI) to match the capabilities of the engine used. Control includes time delays to prevent nuisance alarms.

High lube oil temperature warning/shutdown – Level is preset (configurable with InPower or HMI) to match the capabilities of the engine used. Control includes time delays to prevent nuisance alarms.

High engine temperature warning/shutdown – Level is preset (configurable with InPower or HMI) to match the capabilities of the engine used. Control includes time delays to prevent nuisance alarms.

Low coolant temperature warning – Indicates that engine temperature may not be high enough for a 10 second start or proper load acceptance.

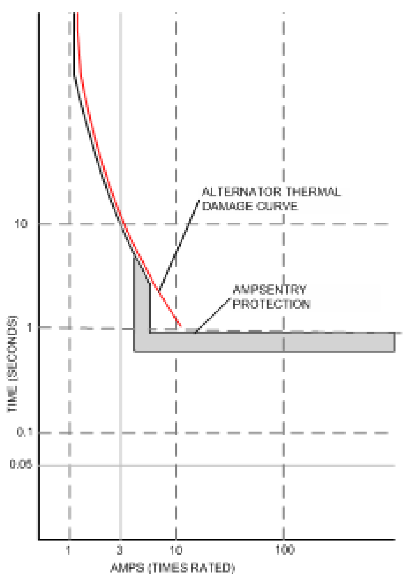
High intake manifold temperature shutdown – Level is preset (configurable with InPower or HMI) to match the capabilities of the engine used. Control includes time delays to prevent nuisance alarms.

Full authority electronic engine protection:

Engine fault detection is handled inside the engine ECM. Fault information is communicated via the SAE-J1939 data link for annunciation in the HMI.

Alternator Protection

AmpSentry protective relay - A comprehensive monitoring and control system integral to the PowerCommand® Control System that guards the electrical integrity of the alternator and power system by providing protection against a wide array of fault conditions in the genset or in the load. It also provides single and three phase fault current regulation (3x Current) so that downstream protective devices have the maximum current available to quickly clear fault conditions without subjecting the alternator to potentially catastrophic failure conditions. Thermal damage curve (3 phase short) or fixed timer (2sec for 1P short, 5sec for 2P short). See document R1053 for a full-size time over current curve. The control does not included protection required for interconnection to a utility (mains) service.



AmpSentry Maintenance Mode (AMM) - Instantaneous tripping, if AmpSentry Maintenance mode is active (50mS response to turn off AVR excitation/shutdown genset) for arc flash reduction when personnel are near genset.

High AC voltage shutdown (59) - Output voltage on any phase exceeds preset values. Time to trip is inversely proportional to amount above threshold. Values adjustable from 105-125% of nominal voltage, with time delay adjustable from 0.1-10 seconds. Default value is 110% for 10 seconds.

Low AC voltage shutdown (27) - Voltage on any phase has dropped below a preset value. Adjustable over a range of 50-95% of reference voltage, time delay 2-20 seconds. Default value is 85% for 10 seconds. Function tracks reference voltage. Control does not nuisance trip when voltage varies due to the control directing voltage to drop, such as during a V/Hz roll-off or synchronizing.

Under frequency shutdown (81 u) - Genset output frequency cannot be maintained. Settings are adjustable from 2-10 Hz below reference governor set point, for a 5-20 second time delay. Default: 6 Hz, 10 seconds. Under frequency protection is disabled when excitation is switched off, such as when engine is operating in idle speed mode.

Over frequency shutdown/warning (81o) - Genset is operating at a potentially damaging frequency level. Settings are adjustable from 2-10 Hz above nominal governor set point for a 1-20 second time delay. Default: 6 Hz, 20 seconds, disabled.

Overcurrent warning/shutdown (51) - Implementation of the thermal damage curve with instantaneous trip level calculated based on current transformer ratio and application power rating.

Loss of sensing voltage shutdown - Shutdown of genset will occur on loss of voltage sensing inputs to the control.

Field overload shutdown - Monitors field voltage to shutdown genset when a field overload condition occurs.

Over load (kW) warning - Provides a warning indication when engine is operating at a load level over a set point. Adjustment range: 80-140% of application rated kW, 0-120 second delay. Defaults: 105%, 60 seconds.

Reverse power shutdown (32) - Adjustment range: 5-20% of standby kW rating, delay 1-15 seconds. Default: 10%, 3 seconds.

Reverse Var shutdown (40) - Shutdown level is adjustable: 15-50% of rated Var output, delay 10-60 seconds. Default: 20%, 10 seconds.

Short circuit protection - Output current on any phase is more than 175% of rating and approaching the thermal damage point of the alternator. Control includes algorithms to protect alternator from repeated over current conditions over a short period of time.

Negative sequence overcurrent warning (46) – Control protects the generator from damage due to excessive imbalances in the three phase load currents and/or power factors.

Custom overcurrent warning/shutdown (51) – Control provides the ability to have a custom time overcurrent protection curve in addition to the AmpSentry protective relay function.

Ground fault overcurrent (51G) – Control detects a ground fault either by an external ground fault relay via a contact input or the control can measure the ground current from an external current transformer. Associated time delays and thresholds are adjustable via InPower or HMI.

Paralleling Protection

Breaker fail to close Warning: When the control signals a circuit breaker to close, it will monitor the breaker auxiliary contacts and verify that the breaker has closed. If the control does not sense a breaker closure within an adjustable time period after the close signal, the fail to close warning will be initiated.

Breaker fail to open warning: The control system monitors the operation of breakers that have been signaled to open. If the breaker does not open within and adjustable time delay, a Breaker Fail to Open warning is initiated.

Breaker position contact warning: The controller will monitor both 'a' and 'b' position contacts from the breaker. If the contacts disagree as to the breaker position, the breaker position contact warning will be initiated.

Breaker tripped warning: The control accepts inputs to monitor breaker trip / bell alarm contact and will initiate a breaker tripped warning if it should activate.

Fail to disconnect warning: In the controller is unable to open either breaker, a fail to disconnect warning is initiated. Typically, this would be mapped to a configurable output, allowing an external device to trip a breaker.

Fail to synchronize warning: Indicates that the genset could not be brought to synchronization with the bus. Configurable for adjustable time delay of 10 -900 seconds, 120 default.

Phase sequence sensing warning: Verifies that the genset phase sequence matches the bus prior to allowing the paralleling breaker to close.

Maximum parallel time warning (power transfer control mode only): During closed transition load transfers, control independently monitors paralleled time. If time is exceeded, warning is initiated and genset is disconnected.

Bus or genset PT input calibration warning: The control system monitors the sensed voltage from the bus and genset output voltage potential transformers. When the paralleling breaker is closed, it will indicate a warning condition if the read values are different.

Field Control Interface

Input signals to the PowerCommand® control include:

- Coolant level (where applicable)
- Fuel level (where applicable)
- Remote emergency stop
- Remote fault reset
- Remote start
- Rupture basin
- Start type signal
- Battle short
- Load demand stop
- Synchronize enable
- Genset circuit breaker inhibit
- Utility circuit breaker inhibit
- Single mode verify
- Transfer inhibit – prevent transfer to utility (in power transfer control mode)
- Retransfer inhibit – prevent retransfer to genset (in power transfer control mode)
- kW and kVAR load setpoints

Configurable inputs - Control includes (4) input signals from customer discrete devices that are configurable for warning, shutdown or status indication, as well as message displayed

Input signals for Lean Burn Natural Gas Engine applications:

- Gearbox oil pressure/temperature protection
- Fire fault
- Earth fault support as a discrete input via an appropriate secondary detection device
- Differential fault
- DC power supply fault
- Genset Interface Box (GIB) isolator open fault
- Start inhibit/enable (x3)
- Radiator fan trip
- Ventilator fan trip
- Ventilation louvers closed
- Start system trip
- Alternator heater trip
- Alternator heater status
- Alternator winding temperature (PT100 RTDx3)
- Alternator drive end bearing temperature (PT100 RTD)
- Alternator non-drive end bearing temperature (PT100 RTD)

Output signals from the PowerCommand® control include:

- Load dump signal: Operates when the genset is in an overload condition.
- Delayed off signal: Time delay-based output which will continue to remain active after the control has removed the run command. Adjustment range: 0 - 120 seconds. Default: 0 seconds.

- Configurable relay outputs: Control includes (4) relay output contacts (3 A, 30VDC). These outputs can be configured to activate on any control warning or shutdown fault as well as ready to load, not in auto, common alarm, common warning and common shutdown.
- Ready to load (genset running) signal: Operates when the genset has reached 90% of rated speed and voltage and latches until genset is switched to off or idle mode.
- Paralleling circuit breaker relays outputs: Control includes (4) relay output contacts (3.5A, 30 VDC) for opening and closing of the genset and utility breakers.

Output Signals for Lean Burn Natural Gas Engine applications:

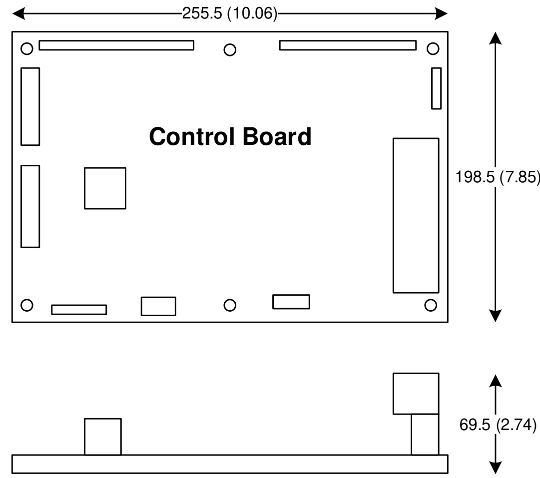
- Start inhibit/enable event
- Emergency stop event
- Ventilator fan run control
- Louvre control
- Radiator fan control
- Alternator heater control
- Engine at idle speed event

Communications connections include:

- PC tool interface: This RS-485 communication port allows the control to communicate with a personal computer running InPower software.
- Modbus RS-485 port: Allows the control to communicate with external devices such as PLCs using Modbus protocol.

  Note - An RS-232 or USB to RS-485 converter is required for communication between PC and control.
- Networking: This RS-485 communication port allows connection from the control to the other Cummins Power Generation products.

Mechanical Drawing



PowerCommand® Human Machine Interface HMI320

Description

This control system includes an intuitive operator interface panel that allows for complete genset control as well as system metering, fault annunciation, configuration and diagnostics. The interface includes five genset status LED lamps with both internationally accepted symbols and English text to comply with customer's needs. The interface also includes an LED backlit LCD display with tactile feel soft-switches for easy operation and screen navigation. It is configurable for units of measurement and has adjustable screen contrast and brightness.

The *run/off/auto* switch function is integrated into the interface panel.

All data on the control can be viewed by scrolling through screens with the navigation keys. The control displays the current active fault and a time-ordered history of the five previous faults.

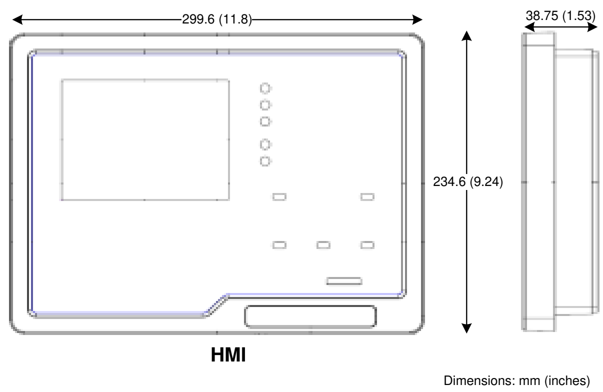
Features:

- LED indicating lamps
  - genset running
  - remote start
  - not in auto
  - shutdown
  - warning
  - auto
  - manual and stop
  - Circuit breaker open (if equipped)
  - Circuit breaker closed (if equipped)
- 320 x 240 pixels graphic LED backlight LCD.
- Four tactile feel membrane switches for LCD defined operation. The functions of these switches are defined dynamically on the LCD.
- Seven tactile feel membrane switches dedicated screen navigation buttons for up, down, left, right, ok, home and cancel.
- Six tactile feel membrane switches dedicated to control for auto, stop, manual, manual start, fault reset and lamp test/panel lamps.
- Two tactile feel membrane switches dedicated to control of circuit breaker (where applicable).
- Allows for complete genset control setup.
- Certifications: Suitable for use on gensets that are designed, manufactured, tested and certified to relevant UL, NFPA, ISO, IEC, Mil Std. and CE standards.
- Languages supported: English, Spanish, French, German, Italian, Greek, Portuguese, Finnish, Norwegian, Danish, Russian (Cyrillic), Chinese, Hungarian, Japanese, Polish, Korean, Romanian, Brazilian Portuguese, Turkish, Dutch, and Czech

Communications connections include:

- PC tool interface - This RS-485 communication port allows the HMI to communicate with a personal computer running InPower.
- This RS-485 communication port allows the HMI to communicate with the main control board.

Mechanical Drawing



Software

InPower (beyond 6.5 version) is a PC-based software service tool that is designed to directly communicate to PowerCommand® gensets and transfer switches, to facilitate service and monitoring of these products.

Environment

The control is designed for proper operation without recalibration in ambient temperatures from -40 ºC (-40 ºF) to +70º C (158 ºF), and for storage from -55 ºC (-67 ºF) to +80 ºC (176 ºF). Control will operate with humidity up to 95%, non-condensing.

The HMI is designed for proper operation in ambient temperatures from -20 ºC (-4 ºF) to +70 ºC (158 ºF), and for storage from -30 ºC (-22 ºF) to +80 ºC (176 ºF).

The control board is fully encapsulated to provide superior resistance to dust and moisture. Display panel has a single membrane surface, which is impervious to effects of dust, moisture, oil and exhaust fumes. This panel uses a sealed membrane to provide long reliable service life in harsh environments.

The control system is specifically designed and tested for resistance to RFI/EMI and to resist effects of vibration to provide a long reliable life when mounted on a genset. The control includes transient voltage surge suppression to provide compliance to referenced standards.

Certifications

PowerCommand® meets or exceeds the requirements of the following codes and standards:

- NFPA 110 for level 1 and 2 systems.
- ISO 8528-4:2005 compliance, controls and switchgear (second edition)
- CE marking: The control system is suitable for use on generator sets to be CE-marked.
- EN 50081-1,2 residential/light industrial emissions or industrial emissions.
- EN 50082-1,2 residential/light industrial or industrial susceptibility.
- ISO 7637-2, level 2; DC supply surge voltage test.
- Mil Std 202C, Method 101 and ASTM B117: Salt fog test.
- UL 6200 recognized, suitable for use on UL 2200 Listed generator sets.
- CSA C282-M1999 compliance
- CSA 22.2 No. 14 M91 industrial controls.
- PowerCommand® control systems and generator sets are designed and manufactured in ISO 9001 certified facilities.
- ROHS (Restriction of Hazardous substance) complaint both for HMI 320 & PCC3300v2.

Reference Documents

Please refer to the following reference documents available in the PowerSuite library:

- PowerCommand™ 3.3. Application Guide
- T-037: PowerCommand Control Application Manual (ANSI Protective Functions)
- T-040: PowerCommand 3.3 Paralleling Application Guide

Please refer to the following reference documents available on Cummins Quickserve:

- Service Manuals for PC3.3 (non-MLD) and PC3.3 (MLD)
- Modbus Register Mapping

Warranty

All components and subsystems are covered by an express limited one-year warranty. Other optional and extended factory warranties and local distributor maintenance agreements are available.

PCCNet COMPATIBLE

Generator set data sheet

Model: C175 D5e
Frequency: 50 Hz
Fuel type: Diesel

Fuel consumption	Standby				Prime			
	kVA (kWe)				**kVA (kWe)**			
Ratings	175 (140)				160 (128)			
Load	**1/4**	**1/2**	**3/4**	**Full**	**1/4**	**1/2**	**3/4**	**Full**
gph	3.0	5.4	7.3	9.1	2.7	5.0	6.8	8.4
L/hr	13.6	24.5	33.3	41.3	12.3	22.7	31.1	38.4

Engine	Standby rating	Prime rating
Engine manufacturer	Tata Cummins Limited (JV)	
Engine model	QSB7-G5	
Configuration	4 cycle; in-line; 6 cylinder diesel	
Aspiration	Turbocharged and change air-cooled	
Gross engine power output, kWm	213	36
BMEP at set rated load, kPa	2537	719.9
Bore, mm	107	
Stroke, mm	124	
Rated speed, rpm	1500	
Piston speed, m/s	6.2	
Compression ratio	17.2:1	
Lube oil capacity, L	19	
Overspeed limit, rpm	1800 ± 50	
Regenerative power, kW	14	
Governor type	Electronic	
Starting voltage	12 Volts DC	

Fuel flow	
Maximum fuel flow, L/hr	106
Maximum fuel inlet restriction, mm Hg	254
Maximum fuel inlet temperature, °C	71

Air	Standby rating	Prime rating
Combustion air, m^3/min	12.72	12.30
Maximum air cleaner restriction, kPa	6.2	

Exhaust		
Exhaust gas flow at set rated load, m^3/min	35.8	34.1
Exhaust gas temperature, °C	561	544
Maximum exhaust back pressure, kPa	10.2	

Standard set-mounted radiator cooling		
Ambient design, °C – Open Genset @ 12.7 mm H2O	55	
Fan load, kW_m	6.8	
Coolant capacity (with radiator), L	30.2	
Cooling system air flow, m^3/sec @ 12.7 mm H_2O	5.91	
Total heat rejection, Btu/min	6516	5825
Maximum cooling air flow static restriction, mm H_2O	8.12	

Weights*	Open	Enclosed
Unit dry weight, kgs	1928	2842 / 2592**
Unit wet weight, kgs	1976	2890 / 2640**

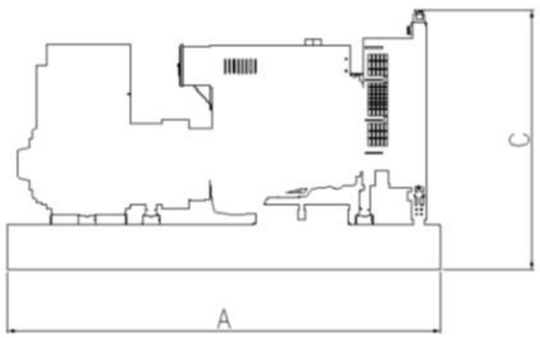
* Note: Weights represent a set with standard features. See outline drawing for weights of other configurations.
**Note: Weights are for Chassis lifting arrangement option

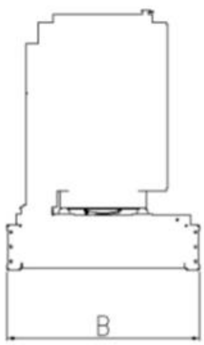
Dimensions	Length	Width	Height
Standard open set dimensions, mm	2656	1130	1822
Enclosed set standard dimensions, mm	4209 / 3690**	1130 / 1130**	2227 / 2100**

**Note: Dimensions are for Chassis lifting arrangement option

Genset outline

Open set





Enclosed set

Outlines are for illustrative purposes only. Please refer to the genset outline drawing for an exact representation of this model.

Alternator data

Connection	Temp rise ºC	Duty	Alternator	Voltage
Wye, 3-phase	163/125	S/P	UCI274F	380-415 V
Wye, 3-phase	125/105	S/P	UCI274G	380-440 V

Ratings definitions

Emergency Standby Power (ESP):	Limited-Time running Power (LTP):	Prime Power (PRP):	Base load (Continuous) Power (COP):
Applicable for supplying power to varying electrical load for the duration of power interruption of a reliable utility source. Emergency Standby Power (ESP) is in accordance with ISO 8528. Fuel Stop power in accordance with ISO 3046, AS 2789 and DIN 6271.	Applicable for supplying power to a constant electrical load for limited hours. Limited-Time Running Power (LTP) is in accordance with ISO 8528.	Applicable for supplying power to varying electrical load for unlimited hours. Prime Power (PRP) is in accordance with ISO 8528. Ten percent overload capability is available in accordance with ISO 3046, AS 2789 and DIN 6271.	Applicable for supplying power continuously to a constant electrical load for unlimited hours. Continuous Power (COP) is in accordance with ISO 8528, ISO 3046, AS 2789 and DIN 6271.

Formulas for calculating full load currents:

Three phase output

$$\frac{\text{kW} \times 1000}{\text{Voltage} \times 1.73 \times 0.8}$$

Single phase output

$$\frac{\text{kW} \times \text{SinglePhaseFactor} \times 1000}{\text{Voltage}}$$

For more information contact your local Cummins distributor or visit power.cummins.com

Our energy working for you.™

DS329-CPGK (09/20)

Sound data
C175 D5e 50 Hz

A-weighted sound pressure level @ 7 meters, dB(A)

See notes 2, 5 and 7-11 listed below

Configuration	Exhaust	Applied Load	Position (note 1)								8 Position average
			1	2	3	4	5	6	7	8	
Enclosed	Genset mounted muffler	@ 75% load	63.2	63.3	63.7	66.4	66.4	66.8	63.8	63.9	64.9
		@ 100% load	63.6	64.0	64.6	67.4	67.1	68.0	64.8	64.6	65.8
		@110% load	64.0	64.6	65.2	67.8	67.1	68.3	65.3	65.0	66.2

A-weighted sound pressure level @ 1 meter, dB(A)

See notes 1, 5 and 7-12 listed below

Configuration	Exhaust	Distance from the boundary of the enclosure	Sound pressure level dB(A) @ 75 % load EN ISO 8528	Sound pressure level dB(A) @ 100 % load (Prime) EN ISO 8528	Sound pressure level dB(A) @ 110 % load (Standby) EN ISO 8528
Enclosed	Genset mounted muffler	@ 1m	76.0	76.6	76.9
		@ 15m*	58.3*	59.2*	59.5*

A-weighted sound power level, dB(A)

See notes 1, 3 and 6-11 listed below

Configuration	Exhaust	Applied load	Octave band center frequency (Hz)											Overall sound power level
			16	31.5	63	125	250	500	1000	2000	4000	8000	16000	
Enclosed	Genset mounted muffler	@ 75% load	NA	63.1	76.0	82.4	90.5	87.5	87.3	86.8	84.8	76.5	64.1	95.1
		@ 100% load	NA	61.1	76.4	83.4	90.5	88.0	88.0	87.6	86.2	78.2	67.2	95.7
		@ 110% load	NA	62.3	76.3	84.1	90.8	88.3	88.2	87.9	86.9	79.2	68.3	96.1

A-weighted exhaust sound power level, dB(A)

See note 4-6 and 9 listed below

Open exhaust (no muffler rated load)	Octave band center frequency (Hz)											Overall sound power level
	16	31.5	63	125	250	500	1000	2000	4000	8000	16000	
	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Note:

1. Sound pressure levels at 1 meter are measured per the requirements of ISO 3744, ISO 8528-10, ANSI S1.13, ANSI S12.1 and European Communities Directive 2000/14/EC as applicable. The microphone measurement locations are 1 meter from a reference parallelepiped just enclosing the generator set (enclosed or unenclosed).
2. Seven-meter measurement location 1 is 7 meters (23 feet) from the generator (alternator) end of the generator set, and the locations proceed counterclockwise around the generator set at 45° angles at a height of 1.2 meters (48 inches) above the ground surface.
3. Sound power levels are calculated according to ISO 3744, ISO 8528-10, and or CE (European Union) requirements.
4. Exhaust sound levels are measured and calculated per ISO 6798, Annex A.
5. Reference sound pressure level is 20 μPa.
6. Reference sound power level is 1 pW (10^{-12} Watt).
7. Sound data for remote-cooled generator sets are based on rated loads without cooling fan noise.
8. Sound data for the generator set with infinite exhaust do not include the exhaust noise contribution.
9. Sound levels are subject to instrumentation, measurement, installation, and manufacturing variability.
10. Unhoused/open configuration generator sets refers to generator sets with no sound enclosures of any kind.
11. Housed/enclosed/closed/canopy configuration generator sets refer to generator sets that have noise reduction sound enclosures installed over the generator set and usually integrally attached to the skid base/base frame/fuel container base of the generator set.
12. *Sound pressure levels are calculated and not measured.

Cooling system data
C175 D5e

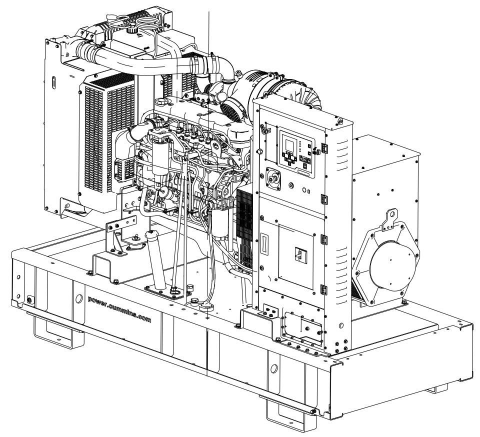
High ambient air temperature radiator cooling system

	Fuel type	Duty	Rating (kW)	Max cooling @ air flow static restriction, unhoused (inches water/mm water)					Housed in free air, no air discharge restriction	
				0.0/0.0	0.25/6.4	0.5/12.7	0.75/19.1	1.0/25.4	Enclosed	
				Maximum allowable ambient temperature, degree C						
50 Hz	Diesel	Standby	140	70	N/A	69	66	63	53.4	
		Prime	128	66	N/A	66	63	60	51.1	

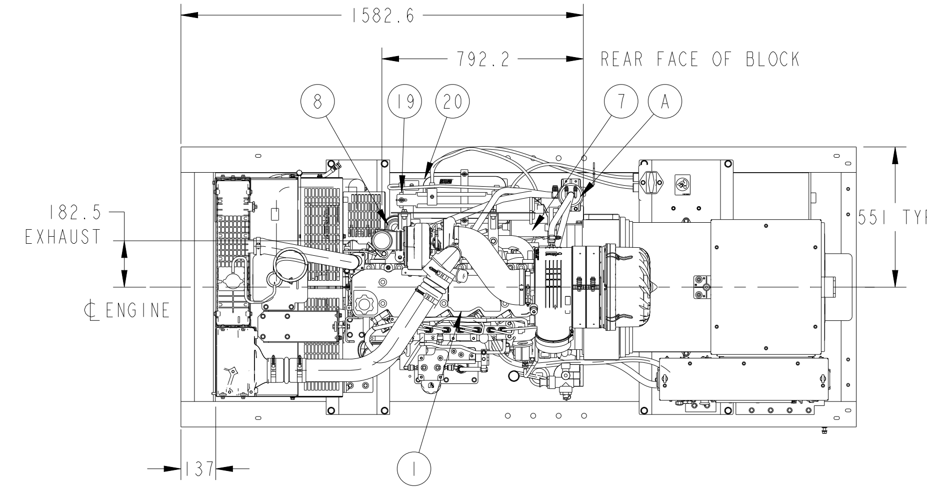
Notes:

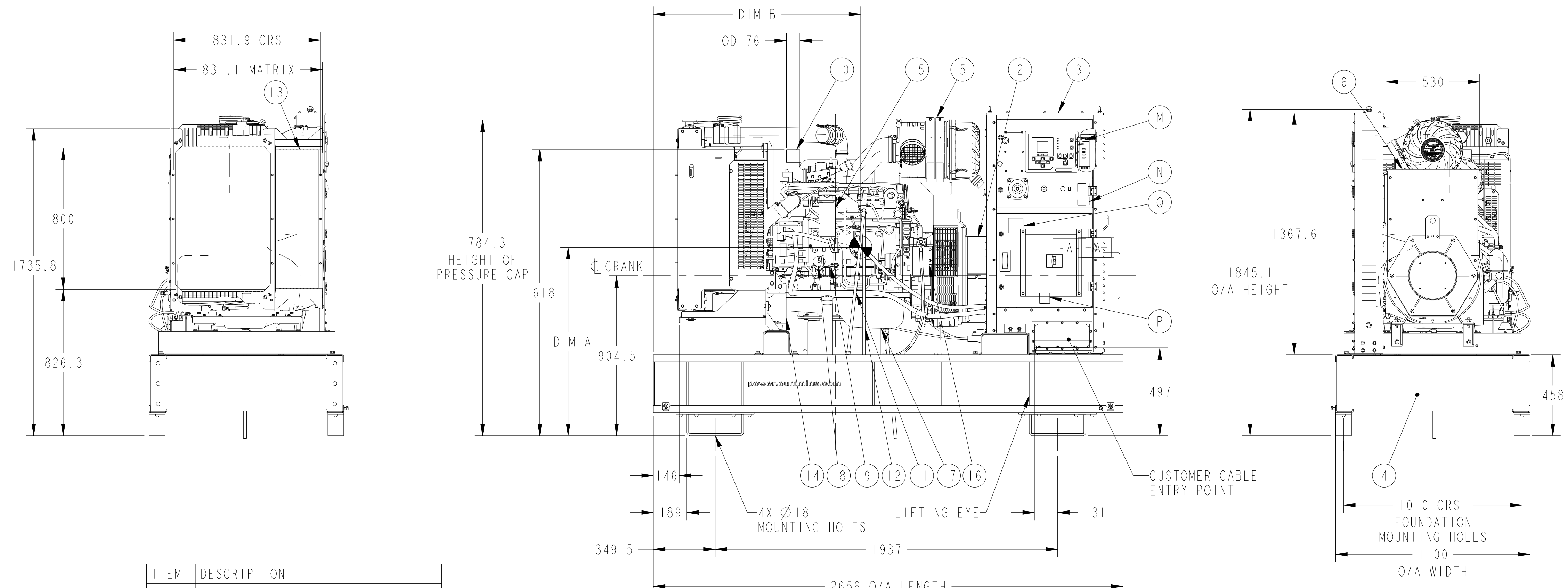
1. Data shown are anticipated cooling performance for typical generator set.
2. Cooling data is based on 1000 ft (305 m) site test location.
3. Generator set power output may need to be reduced at high ambient conditions. Refer generator set data sheet for derate schedules.
4. Cooling performance may be reduced due to several factors including but not limited to: Incorrect installation, improper operation, fouling of the cooling system, and other site installation variables.

REL NO	LTR	NO	REVISION	DWN	CKD	APVD	DATE
ECO-161180	C	1	REDRAWN WITH CHANAGES - SEE ECO	OS	SJ	A_DANTALE	28APR16



3D VIEW
SCALE 1/20





ITEM	DESCRIPTION
A	COOLANT HEATER (SHOWN)
B	EXHAUST BELLOWS
C	EXHAUST FIXING KIT
D	INLINE ENTRY 9 dB SILENCER
E	SIDE ENTRY 9 dB SILENCER
F	INLINE ENTRY 25 dB SILENCER
G	SIDE ENTRY 25 dB SILENCER
H	INLINE ENTRY 35 dB SILENCER
J	SIDE ENTRY 35 dB SILENCER
K	FUEL TRANSFER PUMP
L	TOOKIT
M	BATTERY CHARGER (SHOWN)
N	AUXILLARY SUPPLY 115-230V (SHOWN)
P	LOAD CONNECTIONS (SHOWN)
Q	MAIN EARTH CONNECTION (SHOWN)

		WT WITH WET ENGINE (KG)	WT WITH WET ENGINE & FUEL (KG)	WT WITH DRY ENGINE (KG)	USABLE FUEL CAPACITY (LITRES)	C.G. DIMENSIONS	
ENGINE	ALTERNATOR	OPEN BED	OPEN BED	OPEN BED	OPEN BED	DIM A	DIM B
QSB7-G5	UC274J	2000	2464	1945	464	678.4	1410.2
QSB7-G5	UC274H	1905	2369	1850	464	670.6	1387.0
QSB7-G5	UC274G	1859	2323	1804	464	666.5	1369.3
QSB7-G5	UC274F	1807	2271	1752	464	661.8	1350.0

MATERIAL TABULATION FOR REFERENCE ONLY

QTY	PART NO	DESCRIPTION OF MATERIAL
1	20	BATTERY (12V 1100 CCA)
1	19	BATTERY TRAY & LEADS
1	18	OIL FILLER
1	17	SUMP DRAIN
1	16	FUEL/WATER SEPERATOR
1	15	FUEL FILTER
4	14	RESILIENT MOUNTING
1	13	RADIATOR 50°C
1	12	FUEL LINE RETURN-3/8" I/D
1	11	FUEL LINE INLET 3/8" I/D
1	10	EXHAUST OUTLET (3" O/D)
1	9	OIL LEVEL DIPSTICK
1	8	LUB-OIL FILTER
1	7	12V STARTER - FARSIDE
1	6	CONTROL HOUSING
1	5	AIR CLEANER (HD)
1	4	CHASIS
1	3	CONTROL PANEL PCC1302
1	2	ALTERNATOR-CGT UC274
1	1	ENGINE

UNLESS OTHERWISE SPECIFIED, ALL DIMENSIONS ARE IN MILLIMETERS

DIM		HOLE	
	X ± 1		0.00- 4.99 +0.15/-0.08
	.X ± 0.8		5.00- 9.99 +0.20/-0.10
	.XX± 0.08		10.00-17.49 +0.25/-0.13
			17.50-24.99 +0.30/-0.13

ANG TOL: ± 1.0° SCALE: 23/320

SIM TO 0500_5022
DO NOT SCALE PRINT

- CONFIDENTIAL -
PROPERTY OF CUMMINS POWER GENERATION GROUP

DWN S_ARAVIND
CKD S_PAYMAL
APVD A_DANTALE
DATE 13MAY14

FOR INTERPRETATION OF DIMENSIONING AND TOLERANCING, SEE ASME Y14.5M-1994

FIRST USED ON QSB7 CLONE

SITE CODE CIL

CUMMINS POWER GENERATION

OUTLINE,GENSET

DWG SIZE D | A049B605 | SHEET 1 OF 1 | DWG REV C

Regulatory Review and Approval is required prior to changing this item per PGG 1-01-01-116. This item impacts compliance with these External Regulations: CE

Drawing Name: A049B606 Revision: C
Part Name: A049B605 Revision: C
ECO-161180 Sheet 1 of 2

Part A049B605 C

Description	Legacy Name	External Regulations	Application Status	Release Phase Code	Security Classification	Alternates
OUTLINE,GENSET	A049B605	CE	Production Only	Production	Confidential	

Part Specifications :A049B605 C

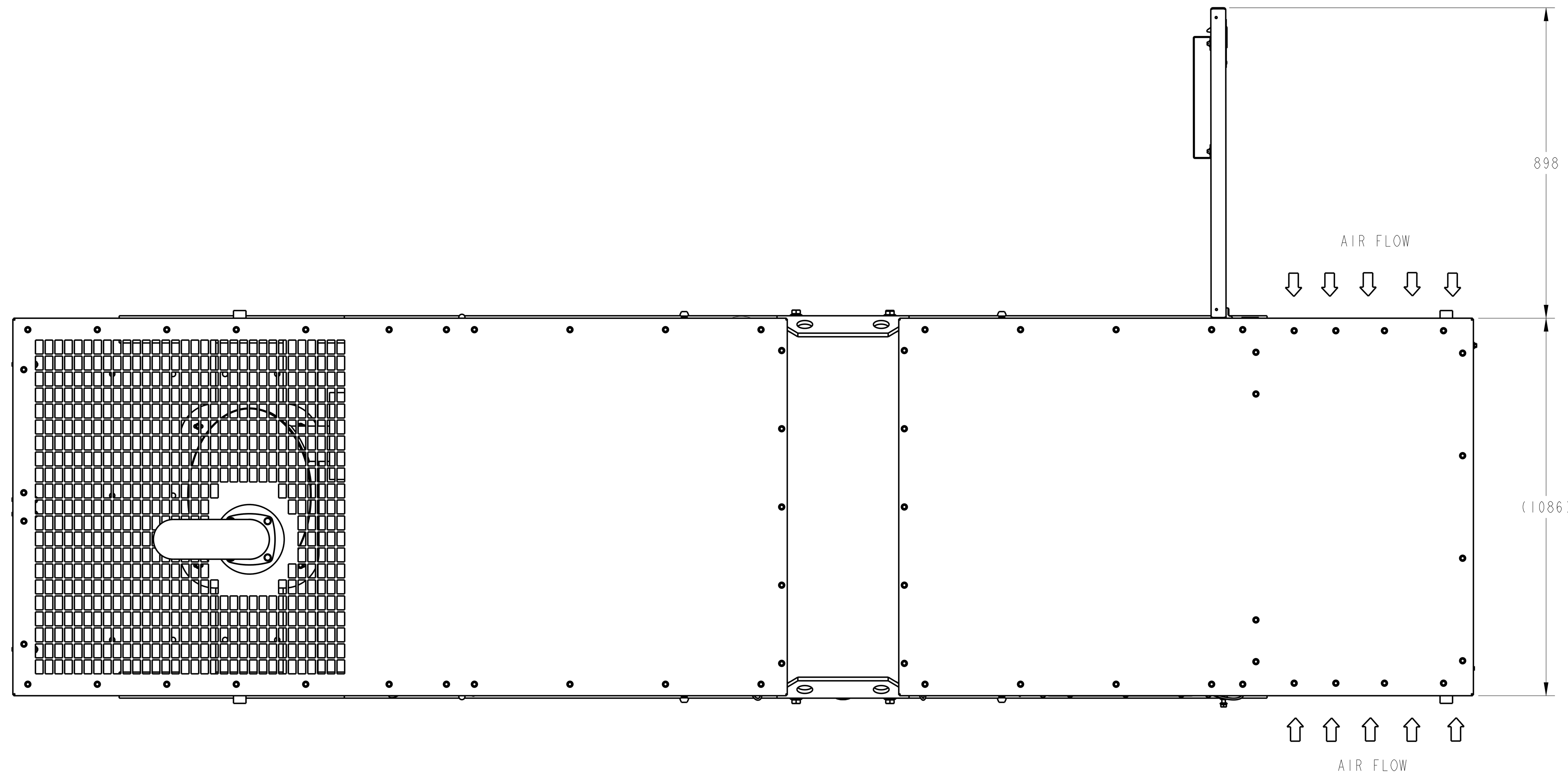
Name	Description	Legacy Name
A030B356	SPECIFICATION,MATERIAL	CES10903
A049B606	DRAWING,ENGINEERING	A049B606

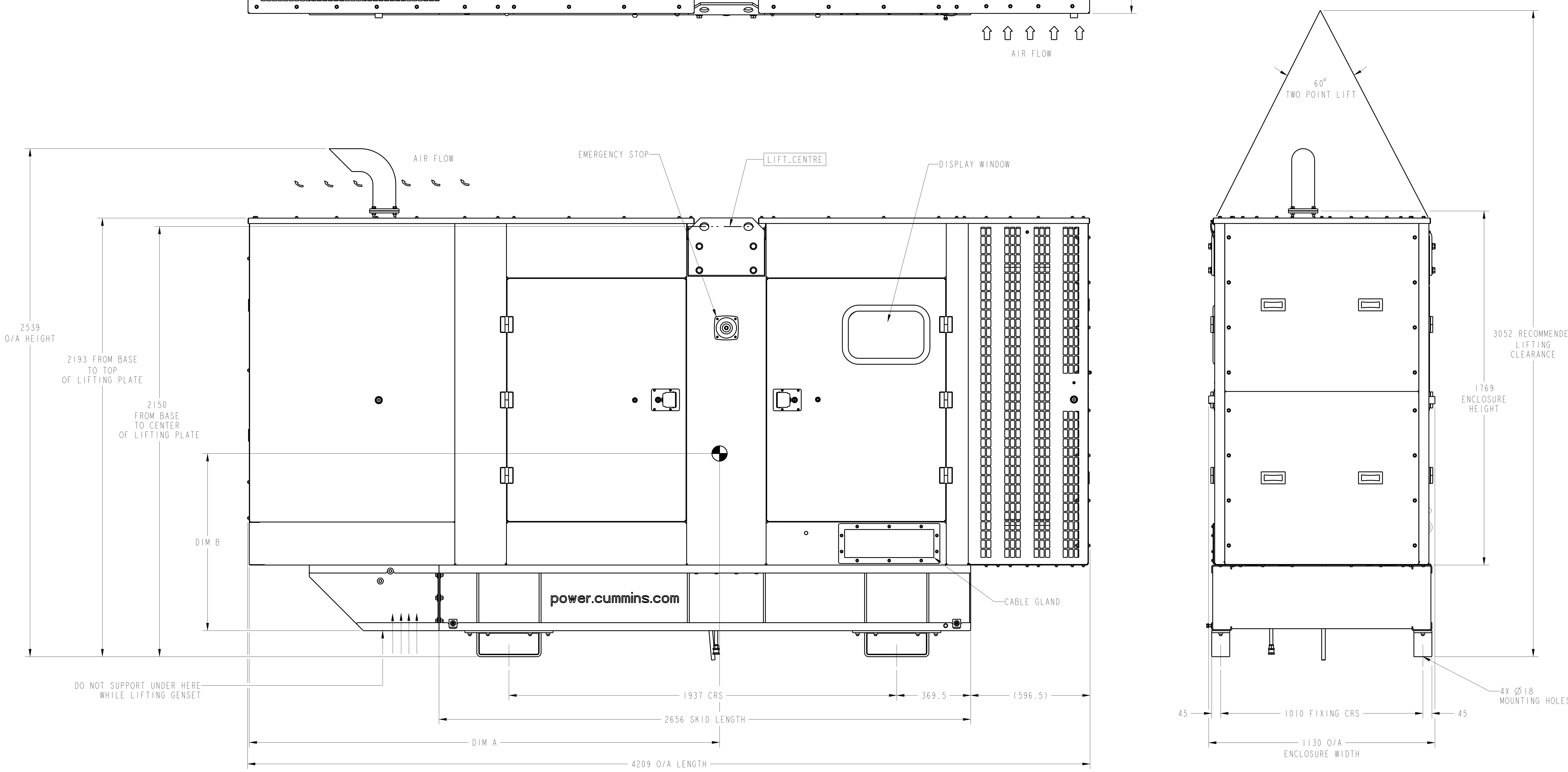
PTC® Creo® Parametric

REL NO	REV	NO	REVISION	DWN	CKD	APVD	DATE
ECO-182603	A	1	PRODUCTION RELEASE	ND	RW	A_DANTALE	24JAN19

NOTES :

1. PLEASE ALLOW THE FOLLOWING PARAMETER CLEARANCES AROUND THE ENCLOSURE : SIDE (INCL. OPEN DOORS) : 500 MM ABOVE THE CANOPY : 1000 MM
2. BEDFRAME FIXING POINTS REQUIRE AN M20 FASTENING ARRANGEMENT.
3. PLEASE REFER TO MANUAL FOR TWO-POINT LIFTING INSTRUCTIONS.
4. CENTRE OF GRAVITY IS CALCULATED USING WET WEIGHT (WITHOUT FUEL) WITH SAFETY MARGIN OF 1%.





ENGINE	ALTERNATOR	WT WITH WET ENGINE (KG)	WT WITH WET ENGINE & FUEL (KG)	WT WITH DRY ENGINE (KG)	C.G. DIMENSIONS	
					DIM A	DIM B
QSB7-G5	UC274J	3030	3516	2983	2348	884
QSB7-G5	UC274H	2935	3421	2888	2329	887
QSB7-G5	UC274G	2889	3375	2842	2314	889
QSB7-G5	UC274F	2837	3323	2790	2299	891

UNLESS OTHERWISE SPECIFIED, ALL DIMENSIONS ARE IN MILLIMETERS

DIM: X ±1; .X ±0.8; .XX± 0.38

HOLE: 0.00- 4.99 +0.15/-0.08; 5.00- 9.99 +0.20/-0.10; 10.00-17.49 +0.25/-0.13; 17.50-24.99 +0.30/-0.13

ANG TOL ±1.0° | SCALE 1/8

SIM TO A049N370

DO NOT SCALE PRINT

THIS DOCUMENT (AND THE INFORMATION SHOWN THEREON) IS **CONFIDENTIAL AND PROPRIETARY** AND SHALL NOT BE DISCLOSED TO OTHERS IN HARD COPY OR ELECTRONIC FORM, REPRODUCED BY ANY MEANS, OR USED FOR ANY PURPOSE WITHOUT WRITTEN CONSENT OF CUMMINS INC.

DWN N_DENGALE
CKD R_WANKAR
APVD A_DANTALE
DATE 24JAN19

FOR INTERPRETATION OF DIMENSIONING AND TOLERANCING, SEE ASME Y14.5-2009

FIRST USED ON QSB7

SITE CODE CIL

CUMMINS POWER GENERATION

OUTLINE, ENCLOSURE

DWG SIZE E | A062B180 | CAD SHEET 1 OF 1

Regulatory Review and Approval is required prior to changing this item per PGG-1-01-01-116. This item impacts compliance with these External Regulations: CE

Drawing Name: A062B181 Revision: A
Part Name: A062B180 Revision: A
ECO-182603 Sheet 1 of 2

Part A062B180 A

Description	Legacy Name	External Regulations	Application Status	Release Phase Code	Security Classification	Alternates
OUTLINE,ENCLOSURE	A062B180	CE	Production Only	Production	Internal use Only	

Part Specifications :A062B180 A

Name	Description	Legacy Name
A030B356	SPECIFICATION,MATERIAL	CES10903
A062B181	DRAWING,ENGINEERING	A062B181

CUMMINS

PROJECT: **MIL03**

REFERENCE NUMBER: **MSFT-EU-REF-1MW**

TECHNICAL SUBMITTAL: **FOR CONSTRUCTION APPROVAL**

WORKS PACKAGE: GENERATORS

TECH SUB TITLE: DQGAN GENERATORS

TECHNICAL SUBMITTAL NUMBER:

MSFT-REF-DES–CMM–GT–ZZ–TS–E–ADMIN–0002

REVISION P00

Issue No. & Date Key:

Revision No.	Date	Prepared by:	Details
P00	11th Nov 2022	Ife Lawal	Issue P00 for construction approval

Approval Status Key:

A = Approved – No Comments
B = Approved for build / minor comments
C = Rejected

Consultant Name	Approval Status	Date	Signed

Specification sheet

Diesel Generator set QSK50 series engine

1025 kVA-1825 kVA 50 Hz

Emissions regulated

Description

Cummins® commercial generator sets are fully integrated power generation systems providing optimum performance, reliability and versatility for stationary standby and prime power applications.

Features

Cummins heavy-duty engine - Rugged 4-cycle industrial diesel delivers reliable power, low emissions and fast response to load changes.

Alternator - Several alternator sizes offer selectable motor starting capability with low reactance 2/3 pitch windings, low waveform distortion with non-linear loads and fault clearing short-circuit capability.

Permanent Magnet Generator (PMG) - Offers enhanced motor starting and fault clearing short circuit capability.

Control system - The PowerCommand® digital control is standard equipment and provides total genset system integration including automatic remote starting/stopping, precise frequency and voltage regulation, alarm and status message display, AmpSentry™ protective relay, output metering and auto-shutdown at fault detection and NFPA 110 Level 1 compliance.

Cooling system - Standard and enhanced integral set-mounted radiator systems, designed and tested for rated ambient temperatures, simplifies facility design requirements for rejected heat.

NFPA - The genset accepts full rated load in a single step in accordance with NFPA 110 for Level 1 systems.

Warranty and service - Backed by a comprehensive warranty and worldwide distributor network.

ISO8528-5 G3 Capable - refer to factory for site and configuration specific transient performance classification

	Standby rating	Prime rating	Continuous rating	Emissions compliance	Data sheets
Model	**50 Hz kVA (kW)**	**50 Hz kVA (kW)**	**50 Hz kVA (kW)**	**TA Luft - EPA**	**50 Hz**
DQGAN	1400 (1120)	1275 (1020)	1025 (820)	2g TA Luft – EPA Tier 2	D-3519
DQGAH	1540 (1232)	1400 (1120)	1125 (900)	2g TA Luft – EPA Tier 2	D-3521
DQGAG	1700 (1360)	1540 (1232)	1250 (1000)	2g TA Luft – EPA Tier 2	D-3523
DQGAM	1825 (1460)	1650 (1320)	1425 (1140)	EPA Tier 2	D-3524

Generator set specifications

Governor regulation class	ISO 8528 Part 1
Voltage regulation, no load to full load	± 0.5%
Random voltage variation	± 0.5%
Frequency regulation	Isochronous
Random frequency variation	± 0.25%
Radio Frequency (RF) emission compliance	IEC 801.2 through IEC 801.5; MIL STD 461C, Part 9
EMC compatibility	Radiated emissions to EN61000-6.3 Conducted immunity to EN61000-6.2

Engine specifications

Bore	159 mm (6.25 in.)
Stroke	159 mm (6.25 in.)
Displacement	50.3 litres (3067 in^3)
Configuration	Cast iron, V 16 cylinder
Battery capacity	1800 amps minimum at ambient temperature of 0 °C (32 °F)
Battery charging alternator	55 amps
Starting voltage	24 volts, negative ground
Fuel system	Cummins' modular common rail system
Fuel filter	Two stage spin-on fuel filter and water separator system. Stage 1 has a three element 7 micron filter and stage 2 has a three element 3 micron filter.
Air cleaner type	Dry replaceable element
Lube oil filter type(s)	Four spin-on, combination full flow filter and bypass filters
Standard cooling system	High ambient cooling system

Alternator specifications

Design	Brushless, 4 pole, drip proof, revolving field
Stator	2/3 pitch
Rotor	Single bearing, flexible disc
Insulation system	Class H
Standard temperature rise	125 ºC standby / 105 ºC prime
Exciter type	Permanent Magnet Generator (PMG)
Phase rotation	A (U), B (V), C (W)
Alternator cooling	Direct drive centrifugal blower fan
AC waveform Total Harmonic Distortion (THDV)	< 5% no load to full linear load, < 3% for any single harmonic
Telephone Influence Factor (TIF)	< 50 per NEMA MG1-22.43
Telephone Harmonic Factor (THF)	< 3

Available voltages

60 Hz Line-Neutral/Line-Line	50 Hz Line – Neutral/Line – Line
	• 220/380 • 230/400 • 240/415 • 254/440 • 1905/3300 • 3637/6300 • 3810/6600 • 6350/11000

Note: Consult factory for other voltages.

Generator set options and accessories

Engine

- 208/240/480 V thermo-statically controlled coolant heater for ambient above and below 4.5 °C (40 °F)
- Dual 120/208/240/480 V 300 W lube oil heaters
- Heavy duty air cleaner
- Duplex fuel filter

Alternator

- 80 °C rise
- 105 °C rise
- 125 °C rise
- 150 °C rise
- 120/240 V 300 W anti-condensation heater

Control panel

- PowerCommand 3.3
- Multiple language support
- 120/240 V 100 W control anti-condensation heater
- Exhaust pyrometer
- Ground fault indication
- Remote annunciator panel

Generator set options and accessories (continued)

Control panel

- Paralleling relay package
- Shutdown alarm relay package
- Audible engine shutdown alarm
- AC output analog meters (bargraph)

Exhaust system

- Industrial grade exhaust silencer
- Residential grade exhaust silencer
- Critical grade exhaust silencer
- Exhaust packages

Cooling system

- Remote cooling
- Enhanced high ambient temperature (50 °C)

Generator set

- Battery
- Battery charger
- Bottom entry chute
- Circuit breaker – skid mounted up to 3000 Amps
- Circuit breaker auxiliary and trip contacts
- IBC and OSHPD seismic certification
- In-skid AVM
- LV and MV entrance box
- Manual language – English, French and Spanish
- Spring isolators

Note: Some options may not be available on all models - consult factory for availability.

PowerCommand 3.3 – control system

An integrated microprocessor based generator set control system providing voltage regulation, engine protection, alternator protection, operator interface and isochronous governing. Refer to document S-1570 for more detailed information on the control.

AmpSentry – Includes integral AmpSentry protection, which provides a full range of alternator protection functions that are matched to the alternator provided.

Power management – Control function provides battery monitoring and testing features and smart starting control system.

Advanced control methodology – Three phase sensing, full wave rectified voltage regulation, with a PWM output for stable operation with all load types.

Communications interface – Control comes standard with PCCNet and Modbus interface.

Regulation compliant – Prototype tested: UL, CSA, UKCA and CE compliant.

Service - InPower™ PC-based service tool available for detailed diagnostics, setup, data logging and fault simulation.

Easily upgradeable – PowerCommand controls are designed with common control interfaces.

Reliable design – The control system is designed for reliable operation in harsh environment.

Multi-language support

Operator panel features

Operator/display functions

- Displays paralleling breaker status
- Provides direct control of the paralleling breaker
- 320 x 240 pixels graphic LED backlight LCD
- Auto, manual, start, stop, fault reset and lamp test/panel lamp switches
- Alpha-numeric display with pushbuttons

Operator/display functions

- LED lamps indicating genset running, remote start, not in auto, common shutdown, common warning, manual run mode, auto mode and stop.

Paralleling control functions

- First Start Sensor™ system selects first genset to close to bus
- Phase lock loop synchronizer with voltage matching
- Sync check relay
- Isochronous kW and kVar load sharing
- Load govern control for utility paralleling
- Extended paralleling (base load/peak shave) mode
- Digital power transfer control, for use with a breaker pair to provide open transition, closed transition, ramping closed transition, peaking and base load functions.

Alternator data

- Line-to-Neutral and Line-to-Line AC volts
- 3-phase AC current
- Frequency
- kW, kVAr, power factor kVA (three phase and total)

Engine data

- DC voltage
- Engine speed
- Lube oil pressure and temperature
- Coolant temperature
- Comprehensive FAE data (where applicable)

Other data

- Genset model data
- Start attempts, starts, running hours, kW hours
- Load profile (operating hours at % load in 5% increments)
- Fault history
- Data logging and fault simulation (requires InPower)

Standard control functions

Digital governing

- Integrated digital electronic isochronous governor
- Temperature dynamic governing

Digital voltage regulation

- Integrated digital electronic voltage regulator
- 3-phase, 4-wire line-to-line sensing
- Configurable torque matching

Standard control functions (continued)

AmpSentry AC protection

- AmpSentry protective relay
- Over current and short circuit shutdown
- Over current warning
- Single and three phase fault regulation
- Over and under voltage shutdown
- Over and under frequency shutdown
- Overload warning with alarm contact
- Reverse power and reverse var shutdown
- Field overload shutdown

Engine protection

- Battery voltage monitoring, protection and testing
- Overspeed shutdown
- Low oil pressure warning and shutdown
- High coolant temperature warning and shutdown
- Low coolant level warning or shutdown
- Low coolant temperature warning
- Fail to start (overcrank) shutdown
- Fail to crank shutdown
- Cranking lockout
- Sensor failure indication
- Low fuel level warning or shutdown
- Fuel-in-rupture-basin warning or shutdown
- Full authority electronic engine protection

Control functions

- Time delay start and cool down
- Real time clock for fault and event time stamping
- Exerciser clock and time of day start/stop
- Data logging
- Cycle cranking
- Load shed
- Configurable inputs and outputs (4)
- Remote emergency stop

Options

- Auxiliary output relays (2)

Ratings definitions

Emergency standby power (ESP):

Applicable for supplying power to varying electrical loads for the duration of power interruption of a reliable utility source. Emergency Standby Power (ESP) is in accordance with ISO 8528. Fuel Stop power in accordance with ISO 3046, AS 2789, DIN 6271 and BS 5514.

Limited-time running power (LTP):

Applicable for supplying power to a constant electrical load for limited hours. Limited Time Running Power (LTP) is in accordance with ISO 8528.

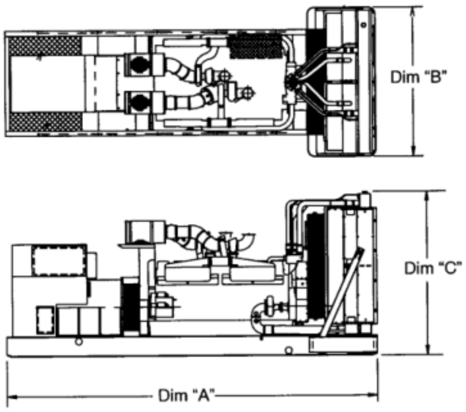
Prime power (PRP):

Applicable for supplying power to varying electrical loads for unlimited hours. Prime Power (PRP) is in accordance with ISO 8528. Ten percent overload capability is available in accordance with ISO 3046, AS 2789, DIN 6271 and BS 5514.

Base load (Continuous) power (COP):

Applicable for supplying power continuously to a constant electrical load for unlimited hours. Continuous Power (COP) in accordance with ISO 8528, ISO 3046, AS 2789, DIN 6271 and BS 5514.

No sustained overload capability is available at this rating.



This outline drawing is for reference only. See respective model data sheet for specific model outline drawing number.

Do not use for installation design

Model	Dim "A" mm (in.)	Dim "B" mm (in.)	Dim "C" mm (in.)	Set weight* dry kg (lbs)	Set weight* wet kg (lbs)
DQGAN	6381 (251)	2285 (90)	2474 (97)	11551 (25465)	12184 (26861)
DQGAH	6381 (251)	2285 (90)	2474 (97)	11293 (24897)	11926 (26292)
DQGAG	6381 (251)	2285 (90)	2474 (97)	11851 (26127)	12484 (27522)
DQGAM	6381 (251)	2285 (90)	2474 (97)	11293 (24897)	11926 (26292)

* Weights represent a set with standard features. See outline drawings for weights of other configurations.

Codes and standards

Codes or standards compliance may not be available with all model configurations – consult factory for availability.

	This generator set is designed in facilities certified to ISO 9001 and manufactured in facilities certified to ISO 9001 or ISO 9002.	CE	The CE marking is only valid when equipment is used in a fixed installation application. Material compliance declaration is available upon request.
		UK CA	The UKCA marking is only valid when equipment is used in a fixed installation application. Material compliance declaration is available upon request.
	The Prototype Test Support (PTS) program verifies the performance integrity of the generator set design. Cummins products bearing the PTS symbol meet the prototype test requirements of NFPA 110 for Level 1 systems.	2000/14/EC	All enclosed products are designed to meet or exceed EU noise legislation 2000/14/EC step 2006.
	All low voltage models are CSA certified to product class 4215-01.	ISO 8528	This generator set has been designed to comply with ISO 8528 standards

Warning: Back feed to a utility system can cause electrocution and/or property damage. Do not connect to any building's electrical system except through an approved device or after building main switch is open.

For more information contact your local Cummins distributor or visit power.cummins.com

Our energy working for you.™

Specification Sheet

PowerCommand®
3.3 Generator Set Digital Integrated Control System

Bargraph Optional

Introduction

The PowerCommand® 3.3 control system is a microprocessor-based generator set monitoring, metering, and control system, which is comprised of PowerCommand® Control 3300 and the Human Machine Interface 320. PCC3300 supports multiple operation modes including:

- Standalone,
- Synchronization only,
- Isolated bus paralleling,
- Utility single generator set paralleling,
- Utility multiple generator set paralleling,
- Utility single generator set paralleling with power transfer control (automatic mains failure),
- Isolated bus paralleling with Masterless Load Demand

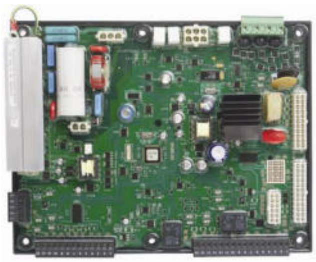
PowerCommand® Control 3300 is designed to meet the exacting demands of the harsh and diverse environments of today's typical power generation applications for Full Authority Electronic or Hydromechanical engine power generator sets.

Offering enhanced reliability and performance over more conventional generator set controls via the integration of all generator control functions into a single system, PCC3300 is your Power of One generator set control solution.

Benefits and Features

- 320 x 240 pixels graphical LED backlit LCD
- Multiple languages supported
- AmpSentry™ protection provides industry-leading generator overcurrent protection
- Digital Power Transfer Control (Automatic Mains Failure) provides load transfer operation in open transition, closed transition, or soft (ramping) transfer modes
- Extended Paralleling (Peak Shave/Base Load) regulates the genset real and reactive power output while paralleled to the utility. Power can be regulated at either the genset or utility bus monitoring point
- Digital frequency synchronization and voltage matching
- Isochronous Load Sharing
- Droop kW and kVAr control
- Real time clock for fault and event time stamping
- Exerciser clock and time of day start/stop initiate a test with or without load, or a Base Load or Peak Shave session
- Digital automatic voltage regulation is provided using three phase sensing and full wave FET type regulator, which is compatible with either shunt or PMG excited systems with a standard AUX103 AVR or an option for a more powerful high-current field drive capability AUX106 AVR
- Digital engine speed governing is provided on applicable platforms
- Generator set monitoring (including metering) and protection with PCC3300 measuring voltage, current, kW and kVAr offering a measurement accuracy of 1%
- Utility / AC Bus metering and protection with PCC3300 voltage, current, kW and kVAr offering a measurement accuracy of 1%
- 12 V (DC) and 24 V (DC) battery operation
- RS-485 Modbus® interface for interconnecting to customer equipment
- Warranty and service – Cummins Power Generation offers a comprehensive warranty and worldwide distributor service network
- Global regulatory certification and compliance: PCC3300 is suitable for use on gensets that are designed, manufactured, tested and certified to relevant UL, NFPA, ISO, IEC, Mil Std., UKCA, and CE standards

PowerCommand® Generator Set Digital Control System PCC 3300



Introduction

PCC3300 is an industry-leading digital generator set control suitable for usage on a wide range of diesel and lean burn natural gas generator sets in both standalone as well as paralleling applications.

PowerCommand® is compatible with either shunt or PMG excitation, and is suitable for usage with reconnectable or non-reconnectable generators. Configuration for any frequency, voltage and power connection from 120 V (AC) to 600 V (AC) line-to-line or 601 V (AC) to 45k V (AC) with an external PT is supported. The PCC3300 derives its own power from the generator set starting batteries and functions over a voltage range of 8 V (DC) to 30 V (DC).

Features

- PCC3300 supports configurable control features via software download using InPower PC-compatible software
- 12 V (DC) and 24 V (DC) battery operation
- Digital automatic voltage regulation is provided using three phase sensing and full wave FET type regulator, which is compatible with either shunt or PMG excited systems with a standard AUX103 AVR or an option for a more powerful high-current field drive capability AUX106 AVR
- Digital engine speed governing on applicable platform is provided, which is capable of providing isochronous frequency regulation
- Full authority J1939 CANBus® prime mover communications and control is provided for platforms with an Engine Control Module (ECM)
- AmpSentry” protection provides industry-leading alternator overcurrent protection:
  - Time-based generator protection applicable to both line-to-line and line-to-neutral, that can detect an unbalanced fault condition and swiftly react appropriately. Balanced faults can also be detected by AmpSentry and appropriate acted upon.
  - Reduces the risk of Arc Flash due to thermal overload or electrical faults by inverse time protection
- Generator set monitoring offers status information for all critical prime mover and generator functions
- AC and DC digital generator set metering is provided. AC measurements are configurable for single or three phase sensing with PCC3300 measuring voltage, current, kW and kVAr offering a measurement accuracy of 1%
- Battery monitoring system continually monitors the battery output and warns of the potential occurrence of a weak battery condition
- Relay drivers for prime mover starter, fuel shutoff (FSO), glow plug/spark ignition power and switched B+ applications are provided
- Integrated generator set protection is offered to protect the prime mover and generator
- Real time clock for fault and event time stamping
- Exerciser clock and time of day start/stop initiate a test with or without load, or a Base Load or Peak Shave session
- Digital Power Transfer Control (Automatic Mains Failure) provides load transfer operation in open transition, closed transition, or soft (ramping) transfer modes
- Extended Paralleling (Peak Shave/Base Load) regulates the genset real and reactive power output while paralleled to the utility. Power can be regulated at either the genset or utility bus monitoring point
- Digital frequency synchronization and voltage matching
- Isochronous Load Sharing
- Droop kW and kVAr Control
- The synchronization check function provides adjustments for phase angle window, voltage window, frequency window and time delay
- Utility / AC Bus metering and protection with PCC3300 voltage, current, kW and kVAr offering a measurement accuracy of 1%
- Advanced serviceability is offered via InPower™, a PC-based software service tool
- PCC3300 is designed for reliable operation in harsh environments with the unit itself being a fully encapsulated module
- RS-485 ModBus interface for interconnecting to customer equipment
- Native on PCC3300: Four discrete inputs, two dry contact relay outputs and two low-side driver outputs are provided and are all configurable.
  - Optional extra PCC3300 input and output capability available via AUX101
- Warranty and service – Cummins Power Generation offers a comprehensive warranty and worldwide distributor service network
- Global regulatory certification and compliance: PCC3300 is suitable for use on gensets that are designed, manufactured, tested and certified to relevant UL, NFPA, ISO, IEC, Mil Std., UKCA and CE standards

Base Control Functions

HMI capability

Options: Local and remote HMI320 options are available

Operator adjustments: The HMI320 includes provisions for many set up and adjustment functions.

Genset hardware data: Access to the control and software part number, genset rating in kVA and genset model number is provided from the HMI320 or InPower.

Data logs: Information concerning all of the following parameters is periodically logged and available for viewing; engine run time, controller on time, number of start attempts, total kilowatt hours, and load profile. (Control logs data indicating the operating hours at percent of rated kW load, in 5% increments. The data is presented on the operation panel based on total operating hours on the generator.)

Fault history: Provides a record of the most recent fault conditions with control date and time stamp. Up to 32 events are stored in the control non-volatile memory.

Alternator data

- Voltage (single or three phase line-to-line and line-to-neutral)
- Current (single or three phase)
- kW, kVAr, Power Factor, kVA (three phase and total)
- Frequency

For Lean Burn Natural Gas Engine applications:

- Alternator heater status
- Alternator winding temperature (per phase) as well as alternator drive end and non-drive end bearing

Utility/AC bus data

- Voltage (three phase line-to-line and line-to-neutral)
- Current (three phase and total)
- kW, kVAR, Power Factor, kVA (three phase and total)
- Frequency

AmpSentry: 3x current regulation for downstream tripping/motor inrush management. Thermal damage curve (3-phase short) or fixed timer (2 sec for 1-Phase Short or 5 sec for 2-Phase short).

Engine data

- Starting battery voltage
- Engine speed
- Engine temperature
- Engine oil pressure
- Engine oil temperature
- Intake manifold temperature
- Coolant temperature
- Comprehensive Full Authority Engine (FAE) data (where applicable)

Lean Burn Natural Gas (LBNG) application parameters include:

- Safety shutoff valve status
- Valve proving status
- Downstream gas pressure
- Gas inlet pressure
- Gas mass flow rate
- Control valve position
- Gas outlet pressure
- Manifold pressure and temperature
- Throttle position
- Compressor outlet pressure
- Turbo speed
- Compressor bypass position
- Cylinder configuration (e.g., drive end and non-drive end configurations)
- Coolant pressure 1 and 2 as well as coolant temperature 1 and 2 for both HT/LT respectively
- Exhaust port temperature (up to 18 cylinders)
- Pre-filter oil pressure
- Exhaust back pressure
- Parent ECM internal temperature and isolated battery voltage
- Speed bias
- Child ECM internal temperature and isolated battery voltage
- Knock level, spark advance, and knock count (for up to 18 cylinders)
- Auxiliary supply disconnector status
- Engine heater status
- Coolant circulating pump status
- Lube oil priming pump status
- Lube oil status
- Oil heater status
- Derate authorization status
- Start system status
- Ventilator fan status
- Ventilation louvre status
- Radiator fan status
- DC PSU status
- Start inhibit/enable status and setup

Service adjustments – The HMI320 includes provisions for adjustment and calibration of genset control functions. Adjustments are protected by a password. Functions include:

- Engine speed governor adjustments
- Voltage regulation adjustments
- Cycle cranking
- Configurable fault set up
- Configurable input and output set up
- Meter calibration
- Paralleling setup
- Display language and units of measurement

Prime Mover Control

SAE-J1939 CAN interface to full authority ECMs (where applicable). Provides data transfer between genset and engine controller for control, metering and diagnostics.

12 V (DC) or 24 V (DC) nominal battery voltage is supported by PCC3300 for normal operation.

Temperature dependant prime mover governing dynamics: This function is supported enabling the engine to be responsive when warm and more stable when operating at lower temperature via providing control and modification over electronic governing parameters as a function of engine temperature.

Isochronous governing is provided in order to control prime mover speed within ±0.25% of nominal rated speed for any steady state load from no load to full load. During operation frequency drift should not exceed ±0.5% of nominal frequency given a 33ºC (or 60ºF) chance in ambient temperature within an eight-hour period.

Droop electronic speed is governing capability is natively offered by PCC3300 to permit droop from 0% to 10% between no load to full load.

Remote start capability is built into the PCC3300 as the unit accepts a ground signal from remote devices to automatically command the starting of the generator set as well as the reaching of rated speed, voltage and frequency or otherwise run at idle speed until prime mover temperature is adequate. The presence of a remote start signal shall cause the PCC3300 to leave sleep mode and return to normal power mode. PCC3300 supports an option for delayed start or stop.

Remote Start Integrity: In compliance with NEC2017 Start Signal Integrity standard – NFPA70 Article 700.10(D)(3), the remote start circuit from ATS to PCC3300 is continuously monitored for signal disturbance due to broken, disconnected or shorted wires via a configurable input. Loss of signal integrity results in activation of a remote start signal.

Remote and local emergency stopping capability: PCC3300 accepts ground signal from a locally or remoted mounted emergency stop switch to cause the generator set to immediately shutdown. The generator set is prevented from either running or cranking with the emergency stop switch engaged. If PCC3300 is in sleep mode, then the activation of any emergency stop switch shall return PCC3300 is normal powered state along with the activation of the corresponding shutdown and run-prevention states.

Sleep mode: PowerCommand 3.3 supports a configurable low current draw state, which is design with consideration to the needs of prime applications or others application without a battery charger (in order to minimize battery current drain).

Automatic prime mover starting: Any generator set controlled by PCC3300 is capable of automatic starting achieved via either magnetic pickup or main alternator output frequency. PCC3300 additionally supports configurable glow plug control where applicable.

Prime mover cycle cranking: PCC3300 supports configurable starting cycles and rest periods. Built in starter protection are incorporated to prevent the operator from specifying a starting sequence that may be damaging.

Configurable time delay functionality: PCC3300 supports time delayed generator set starting and stopping (for cooldown). Permissible time delays are as follows (noting a default setting is 0 seconds):

1. Start delay: 0 seconds to 300 seconds prior to starting after receiving a remote start signal.
2. Stop delay: 0 seconds to 600 seconds prior to shut down after receiving a signal to stop in normal operation modes.

Lean Burn Natural Gas application specific parameters

PCC3300 supports prime mover inhibiting in order to permit application-specific processes (i.e. Auxiliaries) to be started first.

Generator Control

PCC3300 performs both Genset voltage sensing and Genset voltage regulation as follows:

- Voltage sensing is integrated into PCC3300 via three phase line-to-line sensing that is compatible with shunt or PMG excitation systems
- Automatic voltage regulation is accomplished by using a three phase fully rectified input and has a FET output for good motor starting capability.

Major features of generator control include:

Digital output voltage regulation - Capable of regulating output voltage to within +/-1.0% for any loads between no load and full load. Voltage drift will not exceed +/-1.5% for a 40 ºC (104 ºF) change in temperature in an eight-hour period. On engine starting or sudden load acceptance, voltage is controlled to a maximum of 5% overshoot over nominal level.

The automatic voltage regulator feature can be disabled to allow the use of an external voltage regulator.

Droop voltage regulation - Control can be adjusted to droop from 0-10% from no load to full load.

Torque-matched V/Hz overload control - The voltage roll-off set point and rate of decay (i.e. the slope of the V/Hz curve) is adjustable in the control.

Fault current regulation - PowerCommand® will regulate the output current on any phase to a maximum of three times rated current under fault conditions for both single phase and three phase faults. In conjunction with a permanent magnet generator, it will provide three times rated current on all phases for motor starting and short circuit coordination purpose.

Cylinder Cut-off System (CCS): PCC 3300 supports Cylinder Cut-off System which is used to operate the engines on half bank at no load and light load conditions. CCS has below benefits on engine performance- improved emission standards, improved fuel efficiency, reduced hydrocarbons, reduced white smoke, reduced wet stacking and higher exhaust temperature at light loads to improve turbocharger operations and catalyst performance.

Step Timing Control (STC): PCC 3300 supports STC functionality which is used to advance the engine timing of a hydro-mechanical engine during start up and light load conditions. During ADVANCED injection timing, it:

- Improves cold weather idling characteristics
- Reduces cold weather white smoke
- Improves light load fuel economy
- Reduces injector carboning

Paralleling Functions

First Start Sensor™ system – PowerCommand® provides a unique control function that positively prevents multiple gensets from simultaneously closing to an isolated bus under black start conditions. The First Start Sensor system is a communication system between the gensets that allows the gensets to work together to determine which genset is a system should be the first to close to the bus. The system includes an independent backup function, so that if the primary system is disabled the required functions are still performed.

Synchronizing – Control incorporates a digital synchronizing function to force the genset to match the frequency, phase and voltage of another source such as a utility grid. The synchronizer includes provisions to provide proper operation even with highly distorted bus voltage waveforms. The synchronizer can match other sources over a range of 60-110% of nominal voltage and -24 to +6 hertz. The synchronizer function is configurable for slip frequency synchronizing for applications requiring a known direction of power flow at instant of breaker closure or for applications where phase synchronization performance is otherwise inadequate.

Load sharing control – The genset control includes an integrated load sharing control system for both real (kW) and reactive (kVar) loads when the genset(s) are operating on an isolated bus. The control system determines kW load on the engine and kVar load on the alternator as a percent of genset capacity, and then regulates fuel and excitation systems to maintain system and genset at the same percent of load without impacting voltage or frequency regulation. The control can also be configured for operation in droop mode for kW or Kvar load sharing.

Load govern control– When PowerCommand® receives a signal indicating that the genset is paralleled with an infinite source such as a utility (mains) service, the genset will operate in load govern mode. In this mode the genset will synchronize and close to the bus, ramp to a pre-programmed kW and kVar load level, and then operate at that point. Control is adjustable for kW values from 0-100% of standby rating, and 0.7-1.0 power factor (lagging). Default setting is 80% of standby and 1.0 power factor. The control includes inputs to allow independent control of kW and kVar load level by a remote device while in the load govern mode. The rate of load increase and decrease is also adjustable in the control. In addition, the control can be configured for operation in kW or kVAR load govern droop.

Load demand control – The control system includes the ability to respond to an external signal to initiate load demand operation. On command, the genset will ramp to no load, open its paralleling breaker, cool down, and shut down. On removal of the command, the genset will immediately start, synchronize, connect, and ramp to its share of the total load on the system.

Sync check – The sync check function decides when permissive conditions have been met to allow breaker closure. Adjustable criteria are: phase difference from 0.1-20 deg, frequency difference from 0.001-1.0 Hz, voltage difference from 0.5-10%, and a dwell time from 0.5-5.0 sec. Internally the sync check is used to perform closed transition operations. An external sync check output is also available.

Genset and utility/AC bus source AC metering – The control provides comprehensive three phase AC metering functions for both monitored sources, including: 3-phase voltage (L-L and L-N) and current, frequency, phase rotation, individual phase and totalized values of kW, kVAR, kVA and Power Factor; totalized positive and negative kW-hours, kVAR-hours, and kVA-hours. Three wire or four wire voltage connection with direct sensing of voltages to 600V, and up to 45kV with external transformers. Current sensing is accomplished with either 5 amp or 1 CT secondaries and with up to 10,000 amp primary. Maximum power readings are 32,000kW/kVAR/kVA.

Power transfer control – provides integrated automatic power transfer functions including source availability sensing, genset start/stop and transfer pair monitoring and control. The transfer/retransfer is configurable for open transition, fast closed transition (less than 100msec interconnect time), or soft closed transition (load ramping) sequences of operation. Utility source failure will automatically start genset and transfer load, retransferring when utility source returns. Test will start gensets and transfer load if test with load is enabled. Sensors and timers include:

Under voltage sensor: 3-phase L-N or L-L under voltage sensing adjustable for pickup from 85-100% of nominal. Dropout adjustable from 75-98% of pickup. Dropout delay adjustable from 0.1-30 sec.

Over voltage sensor: 3-phase L-N or L-L over voltage sensing adjustable for pickup from 95-99% of dropout. Dropout adjustable from 105-135% of nominal. Dropout delay adjustable from 0.5-120 sec. Standard configuration is disabled and is configurable to enabled in the field using the HMI or InPower service tools.

Over/Under frequency sensor: Center frequency adjustable from 45-65 Hz. Dropout bandwidth adjustable from 0.3-5% of center frequency beyond pickup bandwidth. Pickup bandwidth adjustable from 0.3-20% of center frequency. Field configurable to enable.

Loss of phase sensor: Detects out of range voltage phase angle relationship. Field configurable to enable.

Phase rotation sensor: Checks for valid phase rotation of source. Field configurable to enable.

Breaker tripped: If the breaker tripped input is active, the associated source will be considered as unavailable.

Timers: Control provides adjustable start delay from 0 - 300sec, stop delay from 0 - 800sec, transfer delay from 0-120sec, retransfer delay from 0-1800sec, programmed transition delay from 0-60sec, and maximum parallel time from 0-1800sec.

Negative Sequence Current Protection: PCC3300 supports this protection natively in order to determine if the generator is at any point was running subject to negative phase sequencing.

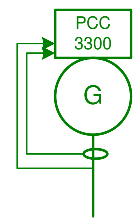
Breaker control – Utility and Genset breaker interfaces include separate relays for opening and closing breaker, as well as inputs for both 'a' and 'b' breaker position contacts and tripped status. Breaker diagnostics include Contact Failure, Fail to Close, Fail to Open, Fail to Disconnect, and Tripped. Upon breaker failure, appropriate control action is taken to maintain system integrity.

Exerciser clock –The exerciser clock (when enabled) allows the system to be operated at preset times in either test without load, test with load, or extended parallel mode. A Real Time Clock is built in. Up to 12 different programs can be set for day of week, time of day, duration, repeat interval, and mode. For example, a test with load for 1 hour every Tuesday at 2AM can be programmed. Up to 6 different exceptions can also be set up to block a program from running during a specific date and time period.

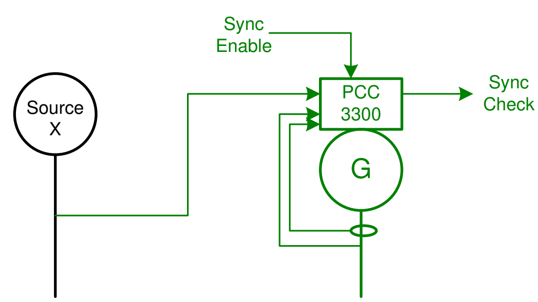
Extended paralleling – In extended paralleling mode (when enabled) the controller will start the genset and parallel to a utility source and then govern the real and reactive power output of the genset based on the desired control point. The control point for the real power (kW) can be configured for either the genset metering point ("Base Load") or the utility metering point ("Peak Shave"). The control point for the reactive power (kVAR or Power Factor) can also be independently configured for either the genset metering point or the utility metering point. This flexibility would allow base kW load from the genset while maintaining the utility power factor at a reasonable value to avoid penalties due to low power factor. The System always operates within genset ratings. The control point can be changed while the system is in operation. Set points can be adjusted via hardwired analog input or adjusted through an operator panel display or service tool.

Application types – Controller is configured to operating in one of six possible application types. These topologies are often used in combinations in larger systems, with coordination of the controllers in the system either by external device or by interlocks provided in the control. Topologies that may be selected in the control include:

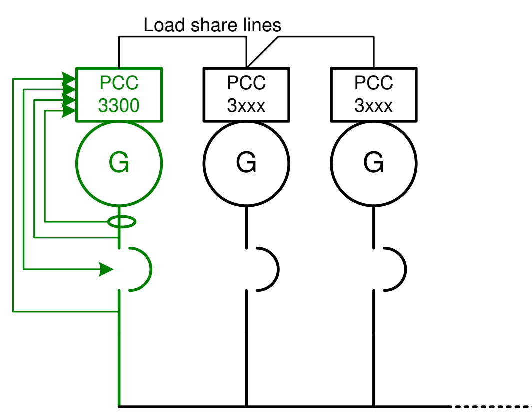
Standalone: Control provides monitoring, protection and control in a non-paralleling application.



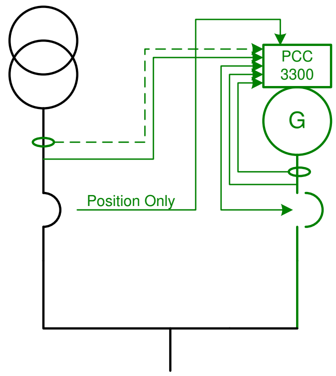
Synchronizer only: control will synchronize the genset to other source when commanded to either via a hardwired or Modbus driven input.



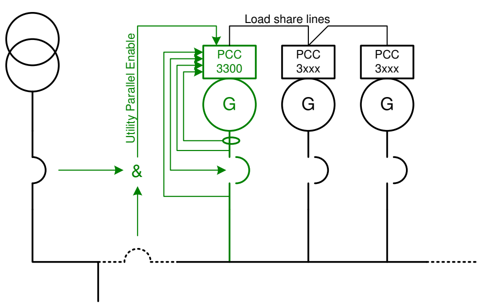
Isolated Bus: allows the genset to perform a dead bus closure or synchronize to the bus and isochronously share kW and kVAR loads with other gensets.



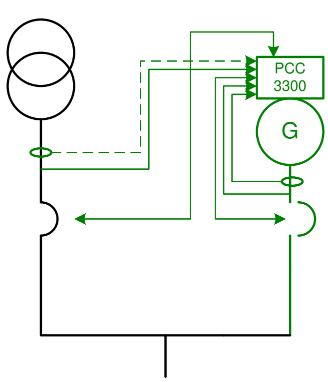
Utility Single: Control monitors one genset and utility. The control will automatically start and provide power to a load if the utility fails. The control will also resynchronize the genset back to the utility and provides extended paralleling capabilities.



Utility Multiple: Supports all functionality of Isolated Bus and provides extended paralleling to the utility. Extended paralleling load set points follow a constant setting; dynamically follow an analog input, Modbus register or HMI.

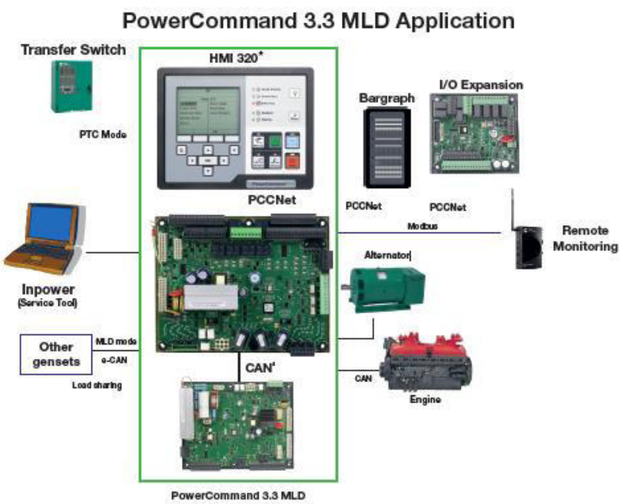


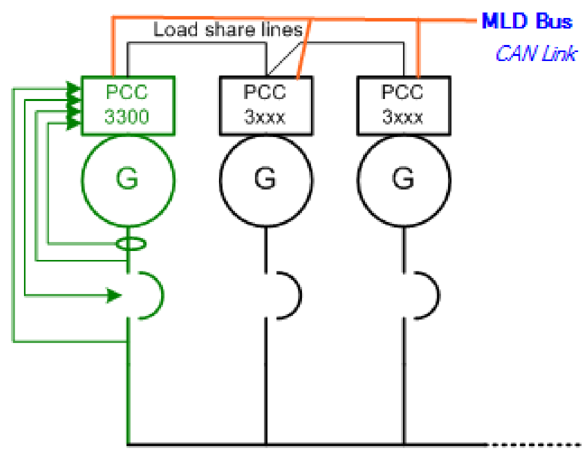
Power Transfer Control: Control operates a single genset/single utility transfer pair in open transition, fast closed transition, or soft closed transition. Extended paralleling functionality also provides base load and peak shave options.



Masterless Load Demand (Optional Feature):

PowerCommand® 3.3 with Masterless Load Demand (MLD) technology enables generator sets to start/stop automatically based on load demand. Masterless Load Demand-capable generators are equipped with an additional s-CAN network connection that allows sharing of information amongst paralleled generator sets. MLD has been designed for hassle-free installation, commissioning and operation. MLD functionality. Integrated on-board system logic provides the MLD topology control without the need for any additional system.





PCC3300 External Voltage and Frequency Biasing Inputs

PCC3300 supports externally driven voltage and frequency biasing capability in order to permit external paralleling (if intending to use this feature please contact your local distributor for further information).

Protective Functions

On operation of a protective function the control will indicate a fault by illuminating the appropriate status LED on the HMI, as well as display the fault code and fault description on the LCD. The nature of the fault and time of occurrence are logged in the control. The service manual and InPower service tool provide service keys and procedures based on the service codes provided. Protective functions include:

Battle short mode

When enabled and the *battle short* switch is active, the control will allow some shutdown faults to be bypassed. If a bypassed shutdown fault occurs, the fault code and description will still be annunciated, but the genset will not shutdown. This will be followed by a *fail to shutdown* fault. Emergency stop shutdowns and others that are critical for proper operation (or are handled by the engine ECM) are not bypassed. Please refer to the Control Application Guide or Manual for list of these faults.

Derate

The Derate function reduces output power of the genset in response to a fault condition. If a Derate command occurs while operating on an isolated bus, the control will issue commands to reduce the load on the genset via contact closures or Modbus. If a Derate command occurs while in utility parallel mode, the control will actively reduce power by lowering the base load kW to the derated target kW.

Configurable alarm and status inputs

The control accepts up to four alarm or status inputs (configurable contact closed to ground or open) to indicate a configurable (customer-specified) condition.

The control is programmable for warning, derate, shutdown, shutdown with cooldown or status indication and for labeling the input.

Emergency stop

Annunciated whenever either emergency stop signal is received from external switch.

General prime mover protection

Low and high battery voltage warning - Indicates status of battery charging system (failure) by continuously monitoring battery voltage.

Weak battery warning - The control system will test the battery each time the genset is signaled to start and indicate a warning if the battery indicates impending failure.

Low coolant level warning – Can be set up to be a warning or shutdown.

Low coolant temperature warning – Indicates that engine temperature may not be high enough for a 10 second start or proper load acceptance.

Fail to start (overcrank) shutdown - The control system will indicate a fault if the genset fails to start by the completion of the engine crack sequence.

Fail to crank shutdown - Control has signaled starter to crank engine but engine does not rotate.

Cranking lockout - The control will not allow the starter to attempt to engage or to crank the engine when the engine is rotating.

Fault simulation –The control in conjunction with InPower software, will accept commands to allow a technician to verify the proper operation of the control and its interface by simulating failure modes or by forcing the control to operate outside of its normal operating ranges. InPower also provides a complete list of faults and settings for the protective functions provided by the controller.

For Lean Burn Natural Gas Engine applications:

Off load running (protection) – This feature protects the engine in the event the genset is being called to go off load for too long.

Hydro Mechanical fuel system engine protection:

Overspeed shutdown – Default setting is 115% of nominal

Low lube oil pressure warning/shutdown – Level is preset (configurable with InPower or HMI) to match the capabilities of the engine used. Control includes time delays to prevent nuisance alarms.

High lube oil temperature warning/shutdown – Level is preset (configurable with InPower or HMI) to match the capabilities of the engine used. Control includes time delays to prevent nuisance alarms.

High engine temperature warning/shutdown – Level is preset (configurable with InPower or HMI) to match the capabilities of the engine used. Control includes time delays to prevent nuisance alarms.

Low coolant temperature warning – Indicates that engine temperature may not be high enough for a 10 second start or proper load acceptance.

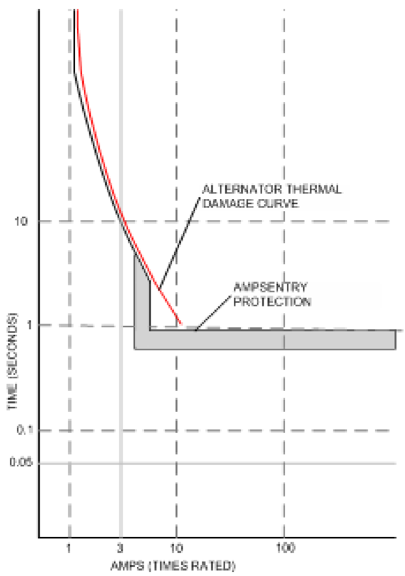
High intake manifold temperature shutdown – Level is preset (configurable with InPower or HMI) to match the capabilities of the engine used. Control includes time delays to prevent nuisance alarms.

Full authority electronic engine protection:

Engine fault detection is handled inside the engine ECM. Fault information is communicated via the SAE-J1939 data link for annunciation in the HMI.

Alternator Protection

AmpSentry protective relay - A comprehensive monitoring and control system integral to the PowerCommand® Control System that guards the electrical integrity of the alternator and power system by providing protection against a wide array of fault conditions in the genset or in the load. It also provides single and three phase fault current regulation (3x Current) so that downstream protective devices have the maximum current available to quickly clear fault conditions without subjecting the alternator to potentially catastrophic failure conditions. Thermal damage curve (3 phase short) or fixed timer (2sec for 1P short, 5sec for 2P short). See document R1053 for a full-size time over current curve. The control does not included protection required for interconnection to a utility (mains) service.



AmpSentry Maintenance Mode (AMM) - Instantaneous tripping, if AmpSentry Maintenance mode is active (50mS response to turn off AVR excitation/shutdown genset) for arc flash reduction when personnel are near genset.

High AC voltage shutdown (59) - Output voltage on any phase exceeds preset values. Time to trip is inversely proportional to amount above threshold. Values adjustable from 105-125% of nominal voltage, with time delay adjustable from 0.1-10 seconds. Default value is 110% for 10 seconds.

Low AC voltage shutdown (27) - Voltage on any phase has dropped below a preset value. Adjustable over a range of 50-95% of reference voltage, time delay 2-20 seconds. Default value is 85% for 10 seconds. Function tracks reference voltage. Control does not nuisance trip when voltage varies due to the control directing voltage to drop, such as during a V/Hz roll-off or synchronizing.

Under frequency shutdown (81 u) - Genset output frequency cannot be maintained. Settings are adjustable from 2-10 Hz below reference governor set point, for a 5-20 second time delay. Default: 6 Hz, 10 seconds. Under frequency protection is disabled when excitation is switched off, such as when engine is operating in idle speed mode.

Over frequency shutdown/warning (81o) - Genset is operating at a potentially damaging frequency level. Settings are adjustable from 2-10 Hz above nominal governor set point for a 1-20 second time delay. Default: 6 Hz, 20 seconds, disabled.

Overcurrent warning/shutdown (51) - Implementation of the thermal damage curve with instantaneous trip level calculated based on current transformer ratio and application power rating.

Loss of sensing voltage shutdown - Shutdown of genset will occur on loss of voltage sensing inputs to the control.

Field overload shutdown - Monitors field voltage to shutdown genset when a field overload condition occurs.

Over load (kW) warning - Provides a warning indication when engine is operating at a load level over a set point. Adjustment range: 80-140% of application rated kW, 0-120 second delay. Defaults: 105%, 60 seconds.

Reverse power shutdown (32) - Adjustment range: 5-20% of standby kW rating, delay 1-15 seconds. Default: 10%, 3 seconds.

Reverse Var shutdown (40) - Shutdown level is adjustable: 15-50% of rated Var output, delay 10-60 seconds. Default: 20%, 10 seconds.

Short circuit protection - Output current on any phase is more than 175% of rating and approaching the thermal damage point of the alternator. Control includes algorithms to protect alternator from repeated over current conditions over a short period of time.

Negative sequence overcurrent warning (46) – Control protects the generator from damage due to excessive imbalances in the three phase load currents and/or power factors.

Custom overcurrent warning/shutdown (51) – Control provides the ability to have a custom time overcurrent protection curve in addition to the AmpSentry protective relay function.

Ground fault overcurrent (51G) – Control detects a ground fault either by an external ground fault relay via a contact input or the control can measure the ground current from an external current transformer. Associated time delays and thresholds are adjustable via InPower or HMI.

Paralleling Protection

Breaker fail to close Warning: When the control signals a circuit breaker to close, it will monitor the breaker auxiliary contacts and verify that the breaker has closed. If the control does not sense a breaker closure within an adjustable time period after the close signal, the fail to close warning will be initiated.

Breaker fail to open warning: The control system monitors the operation of breakers that have been signaled to open. If the breaker does not open within and adjustable time delay, a Breaker Fail to Open warning is initiated.

Breaker position contact warning: The controller will monitor both 'a' and 'b' position contacts from the breaker. If the contacts disagree as to the breaker position, the breaker position contact warning will be initiated.

Breaker tripped warning: The control accepts inputs to monitor breaker trip / bell alarm contact and will initiate a breaker tripped warning if it should activate.

Fail to disconnect warning: In the controller is unable to open either breaker, a fail to disconnect warning is initiated. Typically, this would be mapped to a configurable output, allowing an external device to trip a breaker.

Fail to synchronize warning: Indicates that the genset could not be brought to synchronization with the bus. Configurable for adjustable time delay of 10 -900 seconds, 120 default.

Phase sequence sensing warning: Verifies that the genset phase sequence matches the bus prior to allowing the paralleling breaker to close.

Maximum parallel time warning (power transfer control mode only): During closed transition load transfers, control independently monitors paralleled time. If time is exceeded, warning is initiated and genset is disconnected.

Bus or genset PT input calibration warning: The control system monitors the sensed voltage from the bus and genset output voltage potential transformers. When the paralleling breaker is closed, it will indicate a warning condition if the read values are different.

Field Control Interface

Input signals to the PowerCommand® control include:

- Coolant level (where applicable)
- Fuel level (where applicable)
- Remote emergency stop
- Remote fault reset
- Remote start
- Rupture basin
- Start type signal
- Battle short
- Load demand stop
- Synchronize enable
- Genset circuit breaker inhibit
- Utility circuit breaker inhibit
- Single mode verify
- Transfer inhibit – prevent transfer to utility (in power transfer control mode)
- Retransfer inhibit – prevent retransfer to genset (in power transfer control mode)
- kW and kVAR load setpoints

Configurable inputs - Control includes (4) input signals from customer discrete devices that are configurable for warning, shutdown or status indication, as well as message displayed

Input signals for Lean Burn Natural Gas Engine applications:

- Gearbox oil pressure/temperature protection
- Fire fault
- Earth fault support as a discrete input via an appropriate secondary detection device
- Differential fault
- DC power supply fault
- Genset Interface Box (GIB) isolator open fault
- Start inhibit/enable (x3)
- Radiator fan trip
- Ventilator fan trip
- Ventilation louvers closed
- Start system trip
- Alternator heater trip
- Alternator heater status
- Alternator winding temperature (PT100 RTDx3)
- Alternator drive end bearing temperature (PT100 RTD)
- Alternator non-drive end bearing temperature (PT100 RTD)

Output signals from the PowerCommand® control include:

- Load dump signal: Operates when the genset is in an overload condition.
- Delayed off signal: Time delay-based output which will continue to remain active after the control has removed the run command. Adjustment range: 0 - 120 seconds. Default: 0 seconds.

- Configurable relay outputs: Control includes (4) relay output contacts (3 A, 30VDC). These outputs can be configured to activate on any control warning or shutdown fault as well as ready to load, not in auto, common alarm, common warning and common shutdown.
- Ready to load (genset running) signal: Operates when the genset has reached 90% of rated speed and voltage and latches until genset is switched to off or idle mode.
- Paralleling circuit breaker relays outputs: Control includes (4) relay output contacts (3.5A, 30 VDC) for opening and closing of the genset and utility breakers.

Output Signals for Lean Burn Natural Gas Engine applications:

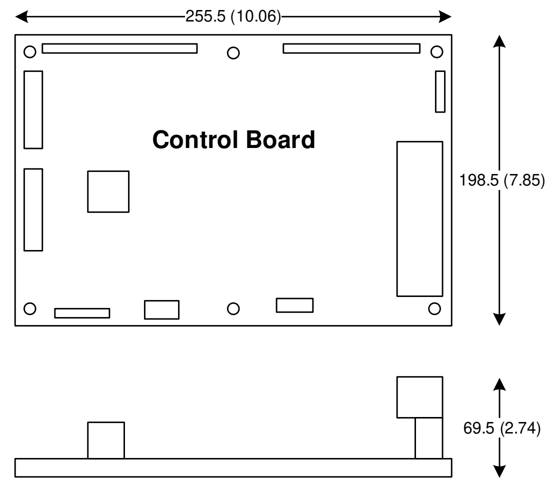
- Start inhibit/enable event
- Emergency stop event
- Ventilator fan run control
- Louvre control
- Radiator fan control
- Alternator heater control
- Engine at idle speed event

Communications connections include:

- PC tool interface: This RS-485 communication port allows the control to communicate with a personal computer running InPower software.
- Modbus RS-485 port: Allows the control to communicate with external devices such as PLCs using Modbus protocol.

  Note - An RS-232 or USB to RS-485 converter is required for communication between PC and control.
- Networking: This RS-485 communication port allows connection from the control to the other Cummins Power Generation products.

Mechanical Drawing



PowerCommand® Human Machine Interface HMI320

Description

This control system includes an intuitive operator interface panel that allows for complete genset control as well as system metering, fault annunciation, configuration and diagnostics. The interface includes five genset status LED lamps with both internationally accepted symbols and English text to comply with customer's needs. The interface also includes an LED backlit LCD display with tactile feel soft-switches for easy operation and screen navigation. It is configurable for units of measurement and has adjustable screen contrast and brightness.

The *run/off/auto* switch function is integrated into the interface panel.

All data on the control can be viewed by scrolling through screens with the navigation keys. The control displays the current active fault and a time-ordered history of the five previous faults.

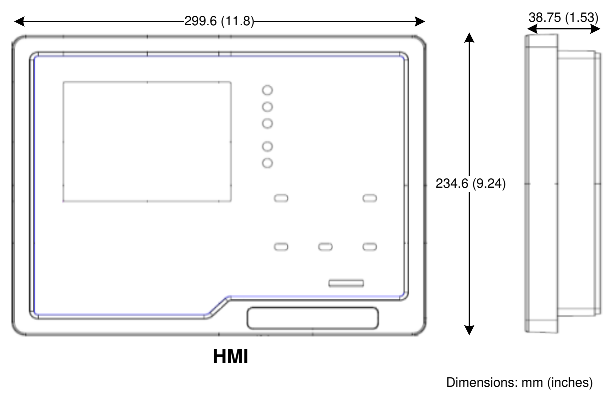
Features:

- LED indicating lamps
  - genset running
  - remote start
  - not in auto
  - shutdown
  - warning
  - auto
  - manual and stop
  - Circuit breaker open (if equipped)
  - Circuit breaker closed (if equipped)
- 320 x 240 pixels graphic LED backlight LCD.
- Four tactile feel membrane switches for LCD defined operation. The functions of these switches are defined dynamically on the LCD.
- Seven tactile feel membrane switches dedicated screen navigation buttons for up, down, left, right, ok, home and cancel.
- Six tactile feel membrane switches dedicated to control for auto, stop, manual, manual start, fault reset and lamp test/panel lamps.
- Two tactile feel membrane switches dedicated to control of circuit breaker (where applicable).
- Allows for complete genset control setup.
- Certifications: Suitable for use on gensets that are designed, manufactured, tested and certified to relevant UL, NFPA, ISO, IEC, Mil Std., UKCA and CE standards.
- Languages supported: English, Spanish, French, German, Italian, Greek, Portuguese, Finnish, Norwegian, Danish, Russian (Cyrillic), Chinese, Hungarian, Japanese, Polish, Korean, Romanian, Brazilian Portuguese, Turkish, Dutch, and Czech

Communications connections include:

- PC tool interface - This RS-485 communication port allows the HMI to communicate with a personal computer running InPower.
- This RS-485 communication port allows the HMI to communicate with the main control board.

Mechanical Drawing



Software

InPower (beyond 6.5 version) is a PC-based software service tool that is designed to directly communicate to PowerCommand® gensets and transfer switches, to facilitate service and monitoring of these products.

Environment

The control is designed for proper operation without recalibration in ambient temperatures from -40 ºC (-40 ºF) to +70º C (158 ºF), and for storage from -55 ºC (-67 ºF) to +80 ºC (176 ºF). Control will operate with humidity up to 95%, non-condensing.

The HMI is designed for proper operation in ambient temperatures from -20 ºC (-4 ºF) to +70 ºC (158 ºF), and for storage from -30 ºC (-22 ºF) to +80 ºC (176 ºF).

The control board is fully encapsulated to provide superior resistance to dust and moisture. Display panel has a single membrane surface, which is impervious to effects of dust, moisture, oil and exhaust fumes. This panel uses a sealed membrane to provide long reliable service life in harsh environments.

The control system is specifically designed and tested for resistance to RFI/EMI and to resist effects of vibration to provide a long reliable life when mounted on a genset. The control includes transient voltage surge suppression to provide compliance to referenced standards.

Certifications

PowerCommand® meets or exceeds the requirements of the following codes and standards:

- NFPA 110 for level 1 and 2 systems.
- ISO 8528-4:2005 compliance, controls and switchgear (second edition)
- CE marking: The CE marking is only valid when equipment is used in a fixed installation application. Material compliance declaration is available upon request.
- UKCA marking- The UKCA marking is only valid when equipment is used in a fixed installation application. Material compliance declaration is available upon request.
- EN 50081-1,2 residential/light industrial emissions or industrial emissions.
- EN 50082-1,2 residential/light industrial or industrial susceptibility.
- ISO 7637-2, level 2; DC supply surge voltage test.
- Mil Std 202C, Method 101 and ASTM B117: Salt fog test.
- UL 6200 recognized, suitable for use on UL 2200 Listed generator sets.
- CSA C282-M1999 compliance
- CSA 22.2 No. 14 M91 industrial controls.
- PowerCommand® control systems and generator sets are designed and manufactured in ISO 9001 certified facilities.
- ROHS (Restriction of Hazardous substance) complaint both for HMI 320 & PCC3300v2.

Reference Documents

Please refer to the following reference documents available in the PowerSuite library:

- PowerCommand™ 3.3. Application Guide
- T-037: PowerCommand Control Application Manual (ANSI Protective Functions)
- T-040: PowerCommand 3.3 Paralleling Application Guide

Please refer to the following reference documents available on Cummins Quickserve:

- Service Manuals for PC3.3 (non-MLD) and PC3.3 (MLD)
- Modbus Register Mapping

Warranty

All components and subsystems are covered by an express limited one-year warranty. Other optional and extended factory warranties and local distributor maintenance agreements are available.

PCCNet COMPATIBLE

Generator Set Data Sheet

Model:	**DQGAN**
Frequency:	**50 Hz**
Fuel Type:	**Diesel**
kVA Rating:	**1400 Standby** **1275 Prime** **1025 Continuous**
Emissions Level:	**EPA NSPS Stationary Emergency Tier 2** **<2000 mg NOx Emitter***

Exhaust emission data sheet:	**EDS-1141**
Exhaust emission compliance sheet:	**EPA-1206**
Sound performance data sheet:	**MSP-1131**
Cooling performance data sheet:	**MCP-228**
Prototype test summary data sheet:	**PTS-310**
Standard set-mounted radiator cooling outline:	**A042V080**
Optional set-mounted radiator cooling outline:	**A042V082**
Optional heat exchanger cooling outline:	**A043A395**
Optional remote radiator cooling outline:	**A042V084**

Fuel Consumption

	Standby				**Prime**				**Continuous**			
	kVA (kW)				**kVA (kW)**				**kVA (kW)**			
Ratings	1400 (1120)				1275 (1020)				1025 (820)			
Load	**1/4**	**1/2**	**3/4**	**Full**	**1/4**	**1/2**	**3/4**	**Full**	**1/4**	**1/2**	**3/4**	**Full**
US gph	24.0	43.0	62.0	79.0	22.0	40.0	57.0	72.0	19.0	33.0	47.0	61.0
L/hr	91.0	163.0	235.0	299.0	83.0	151.0	216.0	273.0	72.0	125.0	178.0	231.0

Engine

	Standby Rating	**Prime Rating**	**Continuous Rating**
Engine manufacturer	Cummins Inc.		
Engine model	QSK50-G4 NR2		
Configuration	Cast iron, V 16 cylinder		
Aspiration	Turbocharged and low temperature after-cooled		
Gross engine power output, kWm (bhp)	1477 (1980)	1328 (1780)	1100 (1474)
BMEP at set rated load, kPa (psi)	2344 (340)	2110 (306)	1759 (255)
Bore, mm (in.)	159 (6.25)		
Stroke, mm (in.)	159 (6.25)		
Rated speed, rpm	1500		
Piston speed, m/s (ft/min)	7.9 (1562)		
Compression ratio	15:1		
Lube oil capacity, L (qt)	235 (248)		
Overspeed limit, rpm	1725		
Regenerative power, kW	116		

Engine designed to emit <2000 mg/Nm^3 @ 5% O_2 (<750 mg/Nm^3 NOx @ 15% O_2) NOx from 30% - 100 % load at standard conditions of 25C, 100 kPa, 30% RH and <7% FAME diesel fuel.

Fuel Flow

Maximum fuel flow, L/hr (US gph)	840 (222)
Maximum fuel inlet restriction, kPa (in Hg)	16.9 (5)
Maximum fuel inlet temperature, °C (°F)	71 (160)

Air

	Standby Rating	Prime Rating	Continuous Rating
Combustion air, m³/min (scfm)	106 (3736)	100 (3526)	86 (3047)
Maximum air cleaner restriction, kPa (in H_2O)	3.7 (15)		
Alternator cooling air, m³/min (cfm)	161 (5700)		

Exhaust

Exhaust flow at set rated load, m³/min (cfm)	225 (9012)	239 (8424)	209 (7389)
Exhaust temperature, °C (°F)	475 (887)	467 (872)	467 (872)
Maximum back pressure, kPa (in H_2O)	6.78 (27)		

Standard Set-Mounted Radiator Cooling

Ambient design, °C (°F)	40 (104)		
Fan load, kW_m (HP)	37 (50)		
Coolant capacity (with radiator), L (US gal)	401 (106)		
Cooling system air flow, m³/min (scfm)	1722 (60809)		
Total heat rejection, MJ/min (Btu/min)	49 (46443)	43 (40756)	36 (34121)
Maximum cooling air flow static restriction, kPa (in H_2O)	0.12 (0.5)		
Maximum fuel return line restriction kPa (in Hg)	34 (10)		

Optional Set-Mounted Radiator Cooling

Ambient design, °C (°F)	50 (122)		
Fan load, kW_m (HP)	40 (53)		
Coolant capacity (with radiator), L (US gal)	496 (131)		
Cooling system air flow, m³/min (scfm)	2082 (73537)		
Total heat rejection, MJ/min (Btu/min)	49 (46443)	43 (40756)	36 (34121)
Maximum cooling air flow static restriction, kPa (in H_2O)	0.12 (0.5)		
Maximum fuel return line restriction, kPa (in Hg)			

Optional Heat Exchanger Cooling

Set coolant capacity, L (US gal)	
Heat rejected, jacket water circuit, MJ/min (Btu/min)	
Heat rejected, aftercooler circuit, MJ/min (Btu/min)	
Heat rejected, fuel circuit, MJ/min (Btu/min)	
Total heat radiated to room, MJ/min (Btu/min)	
Maximum raw water pressure, jacket water circuit, kPa (psi)	
Maximum raw water pressure, aftercooler circuit, kPa (psi)	
Maximum raw water pressure, fuel circuit, kPa (psi)	
Maximum raw water flow, jacket water circuit, L/min (US gal/min)	
Maximum raw water flow, aftercooler circuit, L/min (US gal/min)	
Maximum raw water flow, fuel circuit, L/min (US gal/min)	
Minimum raw water flow at 27 °C (80 °F) inlet temp, jacket water circuit, L/min (US gal/min)	
Minimum raw water flow at 27 °C (80 °F) inlet temp, aftercooler circuit, L/min (US gal/min)	
Minimum raw water flow at 27 °C (80 °F) inlet temp, fuel circuit, L/min (US gal/min)	
Raw water delta P at min flow, jacket water circuit, kPa (psi)	
Raw water delta P at min flow, aftercooler circuit, kPa (psi)	
Raw water delta P at min flow, fuel circuit, kPa (psi)	
Maximum jacket water outlet temp, °C (°F)	
Maximum aftercooler inlet temp, °C (°F)	
Maximum aftercooler inlet temp at 25 °C (77 °F) ambient, °C (°F)	
Maximum fuel return line restriction, kPa (in Hg)	

Optional Remote Radiator Cooling[1]

	Standby rating	Prime rating	Continuous rating
Set coolant capacity, L (US gal)			
Max flow rate at max friction head, jacket water circuit, L/min (US gal/min)	1575 (416)		
Max flow rate at max friction head, aftercooler circuit, L/min (US gal/min)	458 (121)		
Heat rejected, jacket water circuit, MJ/min (Btu/min)	31 (39382)	26 (24643)	21 (19904)
Heat rejected, aftercooler circuit, MJ/min (Btu/min)	18 (17060)	16 (15165)	13 (12321)
Heat rejected, fuel circuit, MJ/min (Btu/min)			
Total heat radiated to room, MJ/min (Btu/min)	10 (9452.6)	9.1 (8671.6)	7.5 (7109.7)
Maximum friction head, jacket water circuit, kPa (psi)	48 (7)		
Maximum friction head, aftercooler circuit, kPa (psi)	35 (5)		
Maximum static head, jacket water circuit, m (ft)	18.3 (60)		
Maximum static head, aftercooler circuit, m (ft)	18.3 (60)		
Maximum jacket water outlet temp, °C (°F)	104 (220)	100 (212)	100 (212)
Maximum aftercooler inlet temp at 25 °C (77 °F) ambient, °C (°F)	49 (120)		
Maximum aftercooler inlet temp, °C (°F)	71 (160)	66 (150)	66 (150)
Maximum fuel flow, L/hr (US gph)			
Maximum fuel return line restriction, kPa (in Hg)			

Weights[2]

Unit dry weight kgs (lbs)	11551 (25465)
Unit wet weight kgs (lbs)	12184 (26861)

Notes:
[1] For non-standard remote installations contact your local Cummins representative.
[2] Weights represent a set with standard features. See outline drawing for weights of other configurations.

Derating Factors

Standby	Standard cooling system: Full rated power available up to 1590 m (5215 ft) at 40 °C. Above these conditions, derates by 19% per 1000 m (3281 ft) and 19% per 10 °C. Enhanced cooling system: Full rated power available up to 598 m (1961 ft) at 50 °C. Above these conditions derates by 18.5% per 1000 m (3281 ft).
Prime	Standard cooling system: Full rated power available up to 1565 m (5133 ft) at 40 °C. Above these conditions, derates by 19% per 1000 m (3281 ft) and 19% per 10 °C. Enhanced cooling system: Full rated power available up to 573 m (1879.4 ft) at 50 °C. Above these conditions derates by 18.5% per 1000 m (3281 ft).
Continuous	Standard cooling system: Full rated power available up to 1296 m (4251 ft) at 40 °C. Above these conditions, derates by 24.5% per 1000 m (3281 ft) and 22.5% per 10 °C. Enhanced cooling system: Full rated power available up to 425 m (1394 ft) at 50 °C. Above these conditions derates by 23% per 1000 m (3281 ft).

Ratings Definitions

Emergency Standby Power (ESP):	**Limited-Time Running Power (LTP):**	**Prime Power (PRP):**	**Base Load (Continuous) Power (COP):**
Applicable for supplying power to varying electrical load for the duration of power interruption of a reliable utility source. Emergency Standby Power (ESP) is in accordance with ISO 8528. Fuel stop power in accordance with ISO 3046, AS 2789, DIN 6271 and BS 5514.	Applicable for supplying power to a constant electrical load for limited hours. Limited Time Running Power (LTP) is in accordance with ISO 8528.	Applicable for supplying power to varying electrical load for unlimited hours. Prime Power (PRP) is in accordance with ISO 8528. Ten percent overload capability is available in accordance with ISO 3046, AS 2789, DIN 6271 and BS 5514.	Applicable for supplying power continuously to a constant electrical load for unlimited hours. Continuous Power (COP) is in accordance with ISO 8528, ISO 3046, AS 2789, DIN 6271 and BS 5514. No sustained overload capability is available at this rating.

Alternator Data

Voltage	Connection[1]	Temp Rise Degrees C	Duty[2]	Single Phase Factor[3]	Max Surge kVA[4]	Winding No.	Alternator Data Sheet	Feature Code
380	Wye, 3-phase	150/125/80	S/P/C		3375	312	ADS-330	BA21-2
400-415	Wye, 3-phase	125/105/80	S/P/C		3375	312	ADS-330	BA12-2
380-440	Wye, 3-phase	105/80/80	S/P/C		3688	312	ADS-331	BA09-2
400-415	Wye, 3-phase	80/80/80	S/P/C		3960	312	ADS-332	BA26-2
380-440	Wye, 3-phase	80/80/80	S/P/C		4563	312	ADS-333	BA27-2
3300	Wye, 3-phase	80	C		4287	51	ADS-322	BA28-2
3300	Wye, 3-phase	105/80/80	S/P/C		4922	51	ADS-323	BA32-2
3300	Wye, 3-phase	80/80/80	S/P/C		5398	51	ADS-324	BA35-2
6300-6600	Wye, 3-phase	80/80/80	S/P/C		5250	61	ADS-521	BA47-2
11000	Wye, 3-phase	80/80/80	S/P/C		5196	83	ADS-521	BA46-2
380-440	Wye, 3-phase	150/105/80	S/P/C		3375	312	ADS-330	BA19-2

Notes:

[1] Limited single phase capability is available from some three phase rated configurations. To obtain single phase rating, multiply the three phase kW rating by the Single Phase Factor[3]. All single phase ratings are at unity power factor.

[2] Standby (S), Prime (P) and Continuous ratings (C).

[3] Factor for the *Single phase output from Three phase alternator* formula listed below.

[4] Maximum rated starting kVA that results in a minimum of 90% of rated sustained voltage during starting.

Formulas for Calculating Full Load Currents:

Three phase output

$$\frac{kW \times 1000}{Voltage \times 1.73 \times 0.8}$$

Single phase output

$$\frac{kW \times SinglePhaseFactor \times 1000}{Voltage}$$

Warning: Back feed to a utility system can cause electrocution and/or property damage. Do not connect to any building's electrical system except through an approved device or after building main switch is open.

For more information contact your local Cummins distributor or visit power.cummins.com

Our energy working for you.™

Sound data

1400DQGAN

50 Hz

Sound pressure level @ 7 meters, dB(A)

See Notes 1-6 listed below

Configuration		Position (Note 1)								8 position average
		1	2	3	4	5	6	7	8	
Standard – Unhoused high ambient cooling system	Infinite exhaust	90	91	91	94	97	94	92	92	93
Standard – Unhoused enhanced high ambient cooling system	Infinite exhaust	94	94	92	94	94	93	93	93	94
Standard – Unhoused remote cooled	Infinite exhaust	88	88	88	90	91	87	88	88	89

Sound power level, dB(A)

See Notes 2-4, 7, 8 listed below

Configuration		Octave band center frequency (Hz)									Overall sound power level
		31.5	63	125	250	500	1000	2000	4000	8000	
Standard – Unhoused high ambient cooling system	Infinite exhaust	69	90	107	113	119	117	113	109	106	123
Standard – Unhoused enhanced high ambient cooling system	Infinite exhaust	67	85	104	113	117	115	111	108	105	121
Standard – Unhoused remote cooled	Infinite exhaust	63	83	97	105	111	109	107	104	102	115

Exhaust sound power level, dB(A)

See Notes 2, 9 listed below

Open exhaust (no muffler) @ rated load	Octave band center frequency (Hz)									Overall sound power level
	31.5	63	125	250	500	1000	2000	4000	8000	
	78	96	117	122	126	128	128	127	125	134

Note:

1. Position 1 faces the generator front per ISO 8528-10. The positions proceed around the generator set in a counter-clockwise direction in 45° increments. All positions are at 7 m (23 ft) from the surface of the generator set and 1.2 m (48”) from floor level.
2. Sound levels are subject to instrumentation, measurement, installation and manufacturing variability.
3. Data based on full rated load. Sound data with remote-cooled generator sets are based on rated loads without cooling fan noise.
4. Sound data for generator set with infinite exhaust do not include exhaust noise.
5. Sound Pressure Levels are measured per ANSI S1.13 and ANSI S12.18, as applicable.
6. Reference sound pressure is 20 μPa.
7. Sound power levels per ISO 3744 and ISO 8528-10, as applicable.
8. Reference power = 1 pw (10^{-12} W)
9. Exhaust sound power levels are per ISO 6798, as applicable.

Cooling System Data
DQGAN

High Ambient Air Temperature Radiator Cooling System

	Fuel Type	Duty	Rating (kW)	Max Cooling @ Air Flow Static Restriction, Unhoused (inches water/mm water)					Housed in Free Air, No Air Discharge Restriction		
				0.0/0.0	0.25/6.4	0.5/12.7	0.75/19.1	1.0/25.4	Weather	Sound Level 1	Sound Level 2
				Maximum Allowable Ambient Temperature, Degree C							
50 Hz	Diesel	Standby	1120	45	43	40	38	37	N/A	N/A	N/A
		Prime	1020	45	44	40	39	38	N/A	N/A	N/A
		Continuous	820	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
		DCC	1020	45	44	40	39	38	N/A	N/A	N/A

Enhanced High Ambient Air Temperature Radiator Cooling System

	Fuel Type	Duty	Rating (kW)	Max Cooling @ Air Flow Static Restriction, Unhoused (inches water/mm water)					Housed in Free Air, No Air Discharge Restriction		
				0.0/0.0	0.25/6.4	0.5/12.7	0.75/19.1	1.0/25.4	Weather	Sound Level 1	Sound Level 2
				Maximum Allowable Ambient Temperature, Degree C							
50 Hz	Diesel	Standby	1120	56	55	50	49	48	N/A	N/A	N/A
		Prime	1020	55	54	50	49	48	N/A	N/A	N/A
		Continuous	820	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
		DCC	1020	55	54	50	49	48	N/A	N/A	N/A

Notes:

1. Data shown are anticipated cooling performance for typical generator set.
2. Cooling data is based on 1000 ft (305 m) site test location.
3. Generator set power output may need to be reduced at high ambient conditions. Consult generator set data sheet for derate schedules.
4. Cooling performance may be reduced due to several factors including but not limited to: Incorrect installation, improper operation, fouling of the cooling system, and other site installation variables.

Prototype Test Support (PTS)
50 HZ test summary

Generator set models		Representative prototype	
DQGAN	DQGAH	Model:	DQGAM
DQGAG	DQGAM	Alternator:	P734G
DQGAJ	DQGAK	Engine:	QSK50-G7

The following summarizes prototype testing conducted on the designated representative prototype of the specified models. This testing is conducted to verify the complete generator set electrical and mechanical design integrity. Prototype testing is conducted only on generator sets not sold as new equipment.

Maximum surge power: 1625 kW

The generator set was evaluated to determine the stated maximum surge power.

Maximum motor starting: 5280 kVA

The generator set was tested to simulate motor starting by applying the specified kVA load at low lagging power factor (0.2 or lower). With this load applied, the generator set recovered to a minimum of 90% rated voltage.

Torsional analysis and testing:

The generator set on P7G was tested to verify that the design is not subjected to harmful torsional stresses. A spectrum analysis of the transducer output was conducted over the speed range.

Cooling system: 40 °C ambient
Enhanced high ambient

The cooling system was tested to determine ambient temperature and static restriction capabilities. The test was performed at full rated load in elevated ambient temperature under stated static restriction conditions.

Durability:

The generator set was subjected to endurance test replicating field duty cycles operating at variable load up to the standby rating based upon MIL-STD-705 to verify structural soundness and durability of the design.

Electrical and mechanical strength:

The generator set was tested to several single phase and three phase faults to verify that the generator can safely withstand the forces associated with short circuit conditions. The generator set was capable of producing full rated output at the conclusion of the testing.

Steady state performance:

The generator set was tested to verify steady state operating performance. It was within the specified maximum limits.

Voltage regulation:	±0.5%
Random voltage variation:	±0.5%
Frequency regulation:	Isochronous
Random frequency variation:	±0.25%

Transient performance:

The generator set was tested with the listed alternator to verify single step loading capability as required by NFPA 110. Voltage and frequency response on load addition or rejection were evaluated. The following results were recorded 0.8 power factor:

Full load acceptance:

Voltage dip:	43.3 %
Recovery time:	6.6 Second
Frequency dip:	16 %
Recovery time:	6.9 Second

Full load rejection:

Voltage dip:	26.9 %
Recovery time:	3.1 Second
Frequency dip:	8.3 %
Recovery time:	1.5 Second

(All data based on 0.8 power factor)

Harmonic analysis:

(per MIL-STD-705B, Method 601.4)

	Line to Line		Line to Neutral	
Harmonic	No load	Full load	No load	Full load
3	0.18	0.26	0.12	0.31
5	1.38	6.95	0.8	3.97
7	3.12	1.93	1.81	1.07
9	0.11	0.14	0.07	0.19
11	2.47	0.93	1.44	1.15
13	1.17	1.61	0.69	0.92
15	0.15	0.06	0.69	0.14

2022 EPA Tier 2 Exhaust Emission Compliance Statement 1400DQGAN Stationary Emergency

50 Hz Diesel generator set

Compliance Information:

The engine used in this generator set complies with Tier 2 emissions limit of U.S. EPA New Source Performance Standards for stationary emergency engines under the provisions of 40 CFR 60 Subpart IIII when tested per ISO8178 D2.

Engine Manufacturer:	Cummins Inc.
EPA Certificate Number:	NCEXL050.AAD-004
Effective Date:	05/29/2021
Date Issued:	05/29/2021
EPA Engine Family (Cummins Emissions Family):	NCEXL050.AAD

Engine information:

Model:	QSK50-G4 NR2	Bore:	6.25 in. (159 mm)
Engine Nameplate HP:	2218	Stroke:	6.25 in. (159 mm)
Type:	4 cycle, 60°V, 16 Cylinder Diesel	Displacement:	3082 cu. in. (50.5 liters)
Aspiration:	Turbocharged and CAC	Compression Ratio:	15.0:1
Emission Control Device:	Electronic Control		

Diesel Fuel Emissions Limits

D2 Cycle Exhaust Emissions	Grams per BHP-hr			Grams per kW_m-hr		
	NO_X + NMHC	CO	PM	NO_X + NMHC	CO	PM
Test Results	4.6	0.9	0.06	6.1	1.2	0.08
EPA Emissions Limit	4.8	2.6	0.15	6.4	3.5	0.20

Test methods: EPA emissions recorded per 40 CFR Part 60, 89, 1039, 1065 and weighted at load points prescribed in the regulations for constant speed engines.

Diesel fuel specifications: Cetane number: 40-50. Reference: ASTM D975 No. 2-D, 300-500 ppm Sulfur.

Reference conditions: Air inlet temperature: 25°C (77°F), Fuel inlet temperature: 40°C (104°F). Barometric pressure: 100 kPa (29.53 in Hg), Humidity: 10.7 g/kg (75 grains H2O/lb) of dry air; required for NOx correction, Restrictions: Intake restriction set to a maximum allowable limit for clean filter; Exhaust back pressure set to a maximum allowable limit.

Tests conducted using alternate test methods, instrumentation, fuel or reference conditions can yield different results. Engine operation with excessive air intake or exhaust restriction beyond published maximum limits, or with improper maintenance, may result in elevated emission levels.

Exhaust Emission Data Sheet
1400DQGAN
50 Hz Diesel Generator Set

Engine Information:			
Model:	Cummins Inc. QSK50-G4 NR2	Bore:	6.25 in. (159 mm)
Type:	4 Cycle, 60° V, 16 cylinder diesel	Stroke:	6.25 in. (159 mm)
Aspiration:	Turbocharged and Low Temperature After-Cooled (2 pump/2 loop)	Displacement:	3067 cu. in. (50.2 liters)
Compression Ratio:	15.0:1		
Emission Control Device:	Turbocharged with Low Temperature After-Cooled		

Performance Data	**1/4 Standby**	**1/2 Standby**	**3/4 Standby**	**Full Standby**	**Full Prime**	**Full Continuous**
BHP @ 1500 RPM (50 Hz)	406	813	1219	1625	1485	1205
Fuel Consumption L/Hr (Gal/Hr)	91 (24)	163 (43)	235 (62)	299 (79)	273 (72)	231 (61)
Exhaust Gas Flow m^3/min (CFM)	80 (2841)	152 (5353)	211 (7452)	255 (9012)	239 (8424)	209 (7389)
Exhaust Gas Temperature °C (°F)	366 (690)	448 (838)	467 (872)	475 (887)	467 (872)	467 (872)
Exhaust Emission Data						
HC (Total Unburned Hydrocarbons)	0.28 (120)	0.17 (70)	0.12 (53)	0.09 (41)	0.11 (50)	0.12 (54)
NOx (Oxides of Nitrogen as NO_2)	3.8 (1660)	4.1 (1750)	3.9 (1690)	4.1 (1840)	4.1 (1840)	4.0 (1700)
CO (Carbon Monoxide)	1.3 (550)	1.4 (570)	1.3 (570)	1.1 (470)	1.3 (580)	1.3 (580)
PM (Particulate Matter)	0.21 (81)	0.12 (44)	0.07 (25)	0.014 (17)	0.05 (18)	0.07 (26)
SO_2 (Sulfur Dioxide)	0.006 (2.2)	0.005 (1.9)	0.005 (1.8)	0.005 (1.8)	0.005 (1.8)	0.005 (1.8)
Smoke (Bosch)	0.75	0.54	0.34	0.25	0.25	0.35

All values (except smoke) are cited as: g/BHP-hr (mg/Nm^3 @ 5% O_2)

Test Conditions

Steady-state emissions recorded per ISO8178-1 during operation at rated engine speed (± 2%) and stated constant load (±2%) with engine temperatures, pressures and emission rates stabilized.

Fuel specification:	42-48 Cetane Number, 0.0015 Wt. % Sulfur; Reference ISO8178-5, 40 CFR 86, 1313-98 Type 2-D and ASTM D975 No. 2-D. Fuel Density at 0.85 Kg/L (7.1 lbs/US Gal)
Air Inlet Temperature	25 °C (77 °F)
Fuel Inlet Temperature:	40 °C (104 °F)
Barometric Pressure:	100 kPa (29.53 in Hg)
Humidity:	NOx measurement corrected to 10.7 g/kg (75 grains H_2O/lb) of dry air
Intake Restriction:	Set to maximum allowable limit for a clean filter.
Exhaust Back Pressure:	Set to maximum allowable limit

Mg/Nm^3 values are measured dry, corrected to 5% O_2 and normalized to standard temperature and pressure (0 °C, 101.325 kPa)

SSE# 2022_128

October 19th, 2022

To Whom It May Concern:

With regards to Cummins Power Systems (CPS) manufactured diesel generator set model DQGAN rated for 50 Hz operation and equipped with Cummins QSK50-G4 engine:

When tested under the following conditions:

Table 1	
Fuel Specification:	ASTM D975 No. 2-D S15 diesel fuel with 0.0015% sulfur content (by weight), and 42-48 cetane number.
Air Inlet Temperature:	77 °F
Fuel Inlet Temperature:	104 °F (at fuel pump inlet)
Barometric Pressure:	29.53 in. Hg
Humidity:	NOx measurement corrected to 75 grains H2O/lb. dry air

Based on engine emissions validation testing, the table below represents the nominal performance and exhaust emissions data for the generator set listed above:

	Standby						**Prime**
PERFORMANCE DATA	**0%**	**10%**	**25%**	**50%**	**75%**	**100%**	**100%**
Electrical Power (kWe)	0	112	280	560	840	1120	1000
BHP @ 1500 RPM (50Hz)	54	210	445	836	1227	1619	1451
Fuel Consumption (L/Hr)	33	57	96	166	234	300	269
Exhaust Gas Flow (m^3/min)	40	54	86	156	212	254	234
Exhaust Gas Temperature (°C)	206	284	382	451	467	474	466
NOx (Oxides of Nitrogen)	1697	1776.00	1638	1754	1688	1841	1779
NMHC (Nonmethane hydrocarbons)	550	199	104	69	53	42	48
CO (Carbon Monoxide)	1004	575	547	575	575	478	574
PM (Particulate Matter)	136	102	79	42	25	17	17
All emissions values above are cited as mg/Nm^3 @5% O_2, 0°C and 101.325 kPa							

Steady-State emissions recorded per ISO8178-1 during operation at rated engine speed (+/-2%) and stated constant load (+/-2%) with engine temperatures, pressures and emission rates stabilized.

The NOx, HC, CO, and PM emission data tabulated here are representative of test data taken from a single engine under the test conditions shown above. Data for the other components are estimated. This data is subject to instrumentation and engine-to-engine variability. Field emissions test data is not guaranteed to these levels. Actual field test results may vary due to test ambient, site conditions, installation, fuel specification, test procedures, instrumentation and ambient correction factors. Engine operation with excessive air intake or exhaust restriction beyond published maximum limits, or with improper maintenance, may result in elevated emission levels.

SSE# 2022_128

Values provided in the table below are representative of "Potential Site Variation" for a Microsoft site. These values account for variances as indicated above without consideration of improper generator set maintenance.

	Standby						Prime
PERFORMANCE DATA	**0%**	**10%**	**25%**	**50%**	**75%**	**100%**	**100%**
POWER OUTPUT (kWe)	0	112	280	560	840	1120	1000
BHP @ 1500 RPM (50Hz)	54	210	445	836	1227	1619	1451
NOx (Oxides of Nitrogen)	2094	2192	2021	2164	2083	2272	2195
NMHC (Nonmethane hydrocarbons)	935	338	177	117	90	71	82
CO (Carbon Monoxide)	2008	1150	1094	1150	1150	956	1148
PM (Particulate Matter)	272	204	158	84	50	34	34
All emissions values above are cited as mg/Nm^3 @5% O_2, 0°C and 101.325 kPa							
Potential Site variation values provided above are accounted for Engine, Ambient variation and measurement with no correction factors.							

The values in this letter are applicable for engines operating on ASTM D975 DF2 and paraffinic fuels conforming to EN15940, including Hydrotreated Vegetable Oil (HVO). Please consult Fluids for Cummins Engines bulletin # 3379001 for more information on the applicability of HVO.

The data and information provided in this letter is for informational purposes to assist customers in making purchasing decisions appropriate for their site-specific compliance needs. Owners/operators of compression ignition internal combustion engines are responsible for ensuring compliance with applicable local, state, and federal standards when CI engines are installed at the owner/operator site. The data and information contained herein regarding site variation values in particular should be considered as part of a site-specific compliance evaluation.

This letter does not supersede any of the commercial terms of sale, including, but not limited to, warranty coverage and compliance with law obligations. THE INFORMATION IN THIS LETTER IS PROVIDED "AS IS" AND WITH ALL FAULTS AND DEFECTS. CUMMINS DOES NOT WARRANT THE ACCURACY OF THE INFORMATION PROVIDED AND THIS LETTER SHOULD NOT BE SHARED WITH THIRD PARTIES WITHOUT CUMMINS PRIOR WRITTEN CONSENT. For further questions on this product or application, please contact the local Cummins Sales and Service representative.

Best Regards,

Mohammed Yusuf
Product Integration Engineer - Europe
Cummins Power Generation