DOCKETED

Docket Number:	15-AFC-02
Project Title:	Mission Rock Energy Center
TN #:	207160-9
Document Title:	Appendix 5.1A Emissions Support
Description:	Application for Certification (Vol. 2)
Filer:	Sabrina Savala
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Submitter Role:	Applicant
Submission Date:	12/31/2015 11:45:17 AM
Docketed Date:	12/31/2015

Appendix 5.1A
Emission Calculations and Support Data

APPENDIX 5.1A

Calculation of Maximum Hourly, Daily, and Annual Emissions

Tables presented in this Appendix are as follows:

In addition to the above tables, other miscellaneous support data for the device-specific emissions calculations may also be included in this Appendix.

Table 5.1A-1

Maximum Hourly, Daily, and Annual Emissions Calculations

Number of Identical Engines: 5

Case #: LM6000 Peaking Units-Mission Rock — Turbine Model: LM6000 PG Sprint

Input data per unit:

Max Operation hrs/day	Max Annual Op hrs	Avg # of Startups day			Startup Time hrs	Startup Time hrs		Shutdown Time hrs	Starts events/yr			Estimated Shutdowns yr	Max Estimated Shutdowns day
24	2500	2	0	0	0.5	0	0	0.15	150	0	0	150	2
Annual CF %:	29			SS Runtime	0.5	1	1	0.85					

	Startup Emissions lbs/event			Shutdown Emissions lbs/event	Steady State Emissions lbs/hr *Case 14 An Avg Day*	Steady State Emissions lbs/hr *Case 1 Cold Day*	Worst Hr Emissions lbs/hr *SU Cold Day*	Total Start hrs/yr
NOx	9.10	0.00	0.00	1.20	4.04	5.10	11.65	75
CO	5.50	0.00	0.00	1.80	4.92	4.97	7.99	
VOC	1.00	0.00	0.00	1.00	0.71	0.71	1.36	
SOx	0.30	0.00	0.00	0.09	0.20	0.59	0.59	
PM10	1.00	0.00	0.00	0.30	2.00	2.00	2.00	
PM2.5	1.00	0.00	0.00	0.30	2.00	2.00	2.00	
NH3	1.89	0.00	0.00	0.57	3.74	3.77	1.89	

	Total Shutdown hrs/yr	Annual Steady State Non SU/SD hrs/yr	Total Annual Emissions Starts lbs/yr	lbs/yr	lbs/yr	Shutdowns lbs/yr
	22.5	2402.5	1365.0	0.0	0.00	180.0
Total SU-SD Hours/Yr:		97.5	825.0	0.0	0.00	270.0
		Steady State Hour Breakdown	150.0	0.0	0.00	150.0
		Hrs/yr	44.3	0.0	0.00	13.5
		0	150.0	0.0	0.00	45.0
Base hours/yr:		2402.5	150.0	0.0	0.00	45.0
			283.5	0.0	0.00	85.5

Cold start plus shutdown = 0.65 hrs

0.15 hrs

0.15 hrs

Shut down = 0.15 hrs

Annual Fuel Use Values

	mmbtu/hr	hrs/yr		mmbtu/yr
Case 14 w/chiller	561.00	2500		1402500
	0.00	0		0
*includes SU/SD hours			Total =	1402500

Maximum Estimated Annual Emissions

Ops Scenario	NOx lbs/yr	CO lbs/yr	VOC lbs/yr	SOx lbs/yr	PM10 lbs/yr	PM2.5 lbs/yr	NH3 lbs/yr
Cold Startups	1365.0	825.0	150.0	44.3	150.0	150.0	
	0.0	0.0	0.0	0.0	0.0	0.0	
	0.0	0.0	0.0	0.0	0.0	0.0	
Shutdowns	180.0	270.0	150.0	13.5	45.0	45.0	
Steady State	9706.1	11820.3	1693.8	480.5	4805.0	4805.0	8985.4
	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Single Turbine, lbs/yr:	*11251.1*	*12915.3*	*1993.8*	*538.3*	*5000.0*	*5000.0*	*8985.4*
Single Turbine, tons/yr:	5.63	6.46	1.00	0.27	2.50	2.50	4.49

	NOx tpy	CO tpy	VOC tpy	SOx tpy	PM10 tpy	PM2.5 tpy	NH3 tpy
Total Tons/Yr All Units:	**28.13**	**32.29**	**4.98**	**1.35**	**12.50**	**12.50**	**22.46**
EPA PSD Program Trigger Levels, TPY:	250	250	250	250	250	250	
EPA PSD Significant Emissions Rates, TPY:	40	100	40	40	15	10	
VCAPCD Air Agency Offset Trigger Levels, TPY:	5	NA	5	15	15	NA	Ref: Rule 26.2

(If PTE for ROC or NOX is > 25 tpy then the offset ration is 1.3:1. Offset ratio for PM10 or SOx is 1:1.)

Maximum Estimated Daily Emissions based on a 24 Hr Ops Cold Day

Max Daily Emissions Assumptions (Per turbine):		**Hours**
starts per day =	2	1
	0	0
	0	0
shutdowns per day =	2	0.3
Steady state ops hrs/day =		22.7

	lbs/day	lbs/day all units
NOx	136.37	681.85
CO	127.42	637.10
VOC	20.12	100.59
SOx	14.16	70.82
PM10	48.00	240.00
PM2.5	48.00	240.00
NH3	90.50	452.50

Power Production Estimates

	All Units	
Case 14, Avg Day, 100% Load, Kw:	286605	Gross
Case 14, Avg Day, 100% Load, Kw:	276438	Net
MW	286.605	Gross
MW	276.438	Net
Annual MW	716513	Gross
Annual MW	691095	Net

Maximum Estimated Hourly Emissions

Max hourly emissions assumptions (Per turbine):	Hours
1. Startup, cold day	0.5
2. remainder of hour, cold day no DB, Case 1	0.5
3. NH3 is cold day data-steady state	

	lbs/hr	lbs/hr All Units	Case 1 used for remaining hour of start (lb/hr)
NOx	11.65	58.25	5.10
CO	7.99	39.93	4.97
VOC	1.35	6.76	0.71
SOx	0.59	2.95	0.26
PM10	2.00	10.00	1.00
PM2.5	2.00	10.00	1.00
NH3	3.77	18.85	3.77

GHG Emissions Estimates

Fuel:	Natural Gas				short
Btu/scf:	1021	HHV	*Emissions*	lbs/yr	tons/yr
Heat Rate:	1402500	mmbtu/yr		1.64E+08	8.20E+04
Fuel Rate:	1373.6533	mmscf/yr		3.09E+03	1.55E+00
Emissions Factors				3.09E+02	1.55E-01
CO2	116.89	lbs/mmbtu			
CH4	0.002205	lbs/mmbtu			
N2O	0.0002205	lbs/mmbtu			

	CO2e			
GWP	short			
Values	tons/yr			
1	8.20E+04			
25	3.87E+01			
298	4.61E+01			
Total CO2e:	82,054	short TPY	1 Engine	
Total CO2e:	410,269	short TPY	All Engines	
Total CO2e:	74,594	metric TPY	1 Engine	
Total CO2e:	**372,972**	**metric TPY**	All Engines	

Emissions Factors for GHG: 40 CFR 98, Subpart C, Tables C-1, C-2.
GWP values: 40 CFR 98, Subpart A, Table A-1
1 short ton = 2000 lbs, 1 metric ton = 2200 lbs.

Average CO2 Performance Estimate:

Gross MW:	1144.0	lbs CO2/Mw-hr
Net MW:	1186.1	lbs CO2/Mw-hr

Notes:

1. Turbine steady-state emissions based on the following:
   NOx 2.5 ppm (1-hour) and 2.0 (annual)
   CO 4.0 ppm
   VOC <= 1 ppm
2. Startup data has no margin and assumed 30 minutes
3. Start event data is based on 30 minute start cycle to achieve compliance with BACT limits.
4. Short-term emissions based on 30 degree day (Case 1 cold day)
5. Annual emissions based on ISO day (Case 9)

Data References:

1. GE Base Load Performance Data as provided by the applicant.
2. GE LM6000 PG Sprint SU/SD data as provided by the applicant.
3. Proposed operational data as provided by the applicant.
4. *
5. *

Table 5.1A-2 EXPECTED INTERNAL COMBUSTION ENGINE EMISSIONS

Liquid Fuel

# of Identical Engines: 1

Engine Service: Fire Pump

Mfg:	Clark	
Engine #:	JU6H-UFADP8	
Kw	164	
BHP:	220	
RPM:	1760	
Fuel:	#2 ULS Diesel	
Fuel Use:	11.2	Gph (1)
Fuel HHV:	139000	Btu/gal
mmbtu/hr:	1.56	HHV
EPA Tier:	3	
Fuel Wt:	6.87	Lbs/gal
Fuel S:	0.0015	% wt.
Fuel S:	0.10305	Lbs/1000 gal
SO2:	0.2061	Lbs/1000 gal

Stack Data (Optional)

Height:	13.5	Ft.	4.11	m
Diameter:	0.4167	Ft.	0.13	m
Temp:	986	deg F	802.9	deg K
ACFM:	1189		0.56	m3/sec
Area:	0.1364	Sq.Ft.	0.0127	m2
Velocity:	145.31	Ft/Sec	44.29	m/sec

# of Tests per Day:	1
Max Daily Op Hrs:	1
Max Annual Op Hrs:	52

		Single Engine				*All Engines*			
EFs (g/bhp-hr)		**Lb/Hr**	**Lb/Day**	**Lbs/Yr**	**Tons/Yr**	***Lb/Hr***	***Lb/Day***	***Lbs/Yr***	***Tons/Yr***
NOx	2.8	1.36	1.36	70.56	0.035	*1.36*	*1.36*	*70.56*	*0.035*
CO	2.6	1.26	1.26	65.52	0.033	*1.26*	*1.26*	*65.52*	*0.033*
VOC	0.2	0.10	0.10	5.04	0.003	*0.10*	*0.10*	*5.04*	*0.003*
PM10	0.15	0.07	0.07	3.78	0.002	*0.07*	*0.07*	*3.78*	*0.002*
SOx	NA	0.0023	0.00	0.12	0.00006	*0.00*	*0.00*	*0.12*	*0.00006*
	lbs/mmbtu								
CO2	163.052	254	254	13200	6.60	*254*	*254*	*13200*	*6.60*
Methane	0.00661	0.0103	0.010	0.54	2.6755E-04	*0.01*	*0.01*	*0.54*	*2.6755E-04*
N2O	0.001323	0.0021	0.002	0.11	5.3551E-05	*0.00*	*0.00*	*0.11*	*5.3551E-05*
CO2e					6.622				*6.622*
								Mtons	*6.02*

Each Engine

	1 HR g/sec	g/hr	Annual g/sec
NOx	0.1711	615.44	1.01E-03
CO	0.1589	571.48	9.42E-04
VOC	0.0122	43.96	7.25E-05
PM10	0.0092	32.97	5.44E-05
SOx	0.0003	1.05	1.73E-06

Notes:

1. fuel consumption based on 0.055 gal/hp-hr (avg EPA and SCAQMD values)
   if no value given by mfg for specific engine.
2. PM10 equals PM2.5.
3. PM10 used in HRA to represent DPM emissions.
4. GHG Efs: FR 74, #209, Part 98 Subpart C, 10-30-2009, Pg. 56409-56411, Tables C-1 and C-2. #2 Diesel Fuel.
   GWP values: 40 CFR 98, Subpart A, Table A-1
5. fuel density and heat values are EPA defaults unless otherwise specified

Greenhouse Gas Emissions Calculator

Table 5.1A-3
SF6-Direct Fugitive Emissions
Electrical Equipment Used by Utilities

Emissions Analysis Period: Annual

System ID: MREC

# of SF6 breakers:	4						
SF6 capacity of each unit, lbs:	250						
Total capacity of system identified, lbs:	1000	=	453.60	kg			
Calculated losses of SF6 (lbs) for the device and reporting period:					5.00	lbs/yr	2.27 kg/yr

GWP Factor: 22800

Total Annual Emissions of SF6: **51.7** **CO2e metric tons**

* estimated loss rate from circuit breakers is less than 0.5% wt. per year.
Ref: Calpine Proejct Team, 2015
Ref: GWP Factor - 40 CFR 98, Subpart A, Table A-1, updated 1/1/14.

Table 5.1A-4 Natural Gas Analysis Data

Component Analysis	Component Analysis
	Sulfur 0.25 grs/100 scf (long term)
Methane – 95.83% vol	Sulfur 0.75 grs/100 scf (short term)
Ethane – 2.32% vol	
Nitrogen – 0.51% vol	Sp Gr – 0.58
Carbon Dioxide – 0.99% vol	Btu/lb LHV – 20727
Propane – 0.25% vol	Btu/lb HHV – 22979
Butane – 0.07% vol	scf/mmbtu HHV – 979.432
Hexane – 0.01% vol	
	LHV 921 btu/scf
	HHV 1021 btu/scf

Fuel data from SCE, Calpine revised fuel spec (Aero Energy Fuel Number 900-4186)
Supplied by GE and applicant.

Table 5.1A-5 Typical California Ultra-Low Sulfur Diesel Fuel Analysis

Parameter	Average Data
Carbon % wt	85.86
Hydrogen % wt	13.35
Oxygen % wt	0.65
Nitrogen % wt	0.097
Sulfur % wt	<=0.0015
Ash % wt	0.01
Btu/gal (HHV)	~139,000
Lbs/gal	~6.87
Btu/lb	~19857

Data derived from AB2588 fuel testing for sources in the South Coast AQMD.
Total number of samples used for averages = 10.

Table 5.1A-6

Calculation of Hazardous and Toxic Pollutant Emissions from Combustion Turbines

# of Units: 5
Fuel HHV: 1021 btu/scf

				Single Turbine			All Turbines				
Compound	EF Src	Uncontrolled Emission Factor, lb/MMscf	CO Catalyst Control Multiplier	Maximum Hourly Emissions, lb/hr	Maximum Daily Emissions, lb/day	Annual Emissions, lb/yr	Maximum Hourly Emissions, lb/hr	Maximum Daily Emissions, lb/day	Annual Emissions, lb/yr	Annual Emissions, tons/yr	Federal HAP
Acetaldehyde	EPA	4.08E-02	2.00E-01	4.52E-03	1.09E-01	1.12E+01	2.26E-02	5.43E-01	5.60E+01	2.80E-02	Yes
Acrolein	EPA	6.50E-03	2.00E-01	7.21E-04	1.73E-02	1.79E+00	3.60E-03	8.65E-02	8.93E+00	4.46E-03	Yes
Ammonia	MFG	(3)		3.77E+00	9.05E+01	9.43E+03	1.89E+01	4.52E+02	4.71E+04	2.36E+01	No
Benzene	EPA	1.23E-02	2.00E-01	1.36E-03	3.26E-02	3.37E+00	6.79E-03	1.63E-01	1.68E+01	8.41E-03	Yes
1,3-Butadiene	EPA	4.39E-04	2.00E-01	4.87E-05	1.17E-03	1.21E-01	2.43E-04	5.84E-03	6.03E-01	3.02E-04	Yes
Ethylbenzene	EPA	3.27E-02	2.00E-01	3.63E-03	8.70E-02	8.98E+00	1.81E-02	4.35E-01	4.49E+01	2.25E-02	Yes
Formaldehyde	EPA	7.25E-01	5.00E-01	2.01E-01	4.82E+00	4.98E+02	1.00E+00	2.41E+01	2.49E+03	1.24E+00	Yes
Hexane	CATEF	2.59E-01	2.00E-01	2.87E-02	6.89E-01	7.12E+01	1.44E-01	3.45E+00	3.56E+02	1.78E-01	Yes
Naphthalene	EPA	1.33E-03	2.00E-01	1.47E-04	3.54E-03	3.65E-01	7.37E-04	1.77E-02	1.83E+00	9.13E-04	Yes
PAHs (BaP)	CATEF	2.41E-04	2.00E-01	2.67E-05	6.41E-04	6.62E-02	1.34E-04	3.21E-03	3.31E-01	1.66E-04	Yes
Propylene	CATEF	7.71E-01	2.00E-01	8.55E-02	2.05E+00	2.12E+02	4.28E-01	1.03E+01	1.06E+03	5.30E-01	No
Propylene oxide	EPA	2.96E-02	2.00E-01	3.28E-03	7.88E-02	8.13E+00	1.64E-02	3.94E-01	4.07E+01	2.03E-02	Yes
Toluene	EPA	1.33E-01	2.00E-01	1.47E-02	3.53E-01	3.65E+01	7.36E-02	1.77E+00	1.82E+02	9.11E-02	Yes
Xylene	EPA	6.53E-02	2.00E-01	7.25E-03	1.74E-01	1.80E+01	3.62E-02	8.69E-01	8.98E+01	4.49E-02	Yes
*		0.00E+00	5.00E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
*		0.00E+00	5.00E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
*		0.00E+00	5.00E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
*		0.00E+00	5.00E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
*		0.00E+00	5.00E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
*		0.00E+00	5.00E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
*		0.00E+00	5.00E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
*		0.00E+00	5.00E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
*		0.00E+00	5.00E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
*		0.00E+00	5.00E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
*		0.00E+00	5.00E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	

Federal HAPs, tons/yr: 1.64E+00

Notes:

(1) Provided by CATEF database and EPA AP-42, Section 3.1, 2000.

(2) Based on maximum hourly turbine fuel use of: 5.5450E-01 mmscf/hr

Based on a maximum daily turbine fuel use of: 1.3307E+01 mmscf/day

Based on maximum annual turbine fuel use of: 1.3737E+03 mmscf/yr

Fuel use values from Fuel Calculation Sheet

(3) Values from ammonia slip calculations by GE Case 1 (cold day)

(4) Fuel use values include HRSG duct burner(s) (Yes or No) No

Each Turbine 24 Max hrs/day
Each Turbine 2500 Max Hrs/yr

CO Catalyst Control Efficiencies

	Control Frac.	Multiplier
Organic HAPs	0.80	0.20
Inorganic HAPs	0.50	0.50

Table 5.1A-7 Turbine Commissioning Schedule and Emissions Estimates

Ref: GE Energy, 9/3/15, Estimated Commissioning Schedule and Emissions

			Per Turbine Basis							
			Emissions, lbs/event				Emissions. Lbs/Hr			
Commisioning Phase	**Phase #**	**Length, Hrs**	**NOx**	**CO**	**VOC**	**PM10**	**NOx**	**CO**	**VOC**	**PM10**
Dry Fire GTG	1	12	0	0	0	0	0.00	0.00	0.00	0.00
First Fire and Shutdown	2	16	292	1137	20	48	18.25	71.06	1.25	3.00
Sync and Check E-stop	3	12	219	853	15	36	18.25	71.08	1.25	3.00
AVR, Sync to Grid	4	12	666	1000	18	36	55.50	83.33	1.50	3.00
Break In	5	8	444	667	12	24	55.50	83.38	1.50	3.00
Dynamic Commissioning 1		3	167	250	5	9	55.67	83.33	1.67	3.00
Dynamic Commissioning 2		3	204	218	4	9	68.00	72.67	1.33	3.00
Dynamic Commissioning 3		3	68	232	4	9	22.67	77.33	1.33	3.00
Dynamic Commissioning 4		3	80	267	5	9	26.67	89.00	1.67	3.00
Dynamic Commissioning 5	6	3	90	294	6	9	30.00	98.00	2.00	3.00
Dynamic Commissioning 6		3	102	311	6	9	34.00	103.67	2.00	3.00
Dynamic Commissioning 7		3	114	322	7	9	38.00	107.33	2.33	3.00
Dynamic Commissioning 8		3	126	330	8	9	42.00	110.00	2.67	3.00
Dynamic Commissioning 9		3	139	340	8	9	46.33	113.33	2.67	3.00
Dynamic Commissioning 10		3	154	352	9	9	51.33	117.33	3.00	3.00
Base Load AVR	7	12	615	1407	35	36	51.25	117.25	2.92	3.00
ECS Tuning-Break In		2	20	47	5	6	10.00	23.50	2.50	3.00
ECS Startup		4	24	78	5	12	6.00	19.50	1.25	3.00
ECS Tuning 1		1.5	6	21	2	6	4.00	14.00	1.33	4.00
ECS Tuning 2		1.5	17	25	2	6	11.33	16.67	1.33	4.00
ECS Tuning 3		1.5	20	22	2	6	13.33	14.67	1.33	4.00
ECS Tuning 4		1.5	7	23	2	6	4.67	15.33	1.33	4.00
ECS Tuning 5	8	1.5	8	27	2	6	5.33	18.00	1.33	4.00
ECS Tuning 6		1.5	9	29	2	6	6.00	19.33	1.33	4.00
ECS Tuning 7		1.5	10	31	2	6	6.67	20.67	1.33	4.00
ECS Tuning 8		1.5	11	32	3	6	7.33	21.33	2.00	4.00
ECS Tuning 9		1.5	13	33	3	6	8.67	22.00	2.00	4.00
ECS Tuning 10		1.5	14	34	3	6	9.33	22.67	2.00	4.00
ECS Tuning 11		1.5	15	35	4	6	10.00	23.33	2.67	4.00
Prelim Peformance Test	9	8	41	40	12	32	5.13	5.00	1.50	4.00
PPA Performance Test	10	8	41	40	12	32	5.13	5.00	1.50	4.00
Reliability Test	11	72	396	360	103	288	5.50	5.00	1.43	4.00

	Hrs	**NOx, lbs**	**CO, lbs**	**VOC, lbs**	**PM10, lbs**	**PM2.5, lbs**	(PM2.5 assumed equal to PM10)
Firing Hours without Catalyst	125	3480	7980	162	270	270.00	
Firing hours with Catalyst	88	626	878	165	436	436.00	
Totals	213	4106	8858	327	706	706.00	
Period Avg, lbs/hr		*19.28*	*41.59*	*1.54*	*3.31*	*3.31*	

Attachment 5.1A-1
Turbine Case Run Data Matrix

ATTACHMENT 5.1A-1 TURBINE PERFORMANCE DATA

BASE LOAD PERFORMANCE

			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33
Ambient	Dry-Bulb, °F		30.0	30.0	30.0	30.0	39.4	39.4	39.4	39.4	59.0	59.0	59.0	59.0	59.0	61.0	61.0	61.0	61.0	61.0	79.2	79.2	79.2	79.2	79.2	76.0	76.0	76.0	76.0	76.0	96.0	96.0	96.0	96.0	96.0
	Wet-Bulb, °F		23.3	23.3	23.3	23.3	30.4	30.4	30.4	30.4	51.4	51.4	51.4	51.4	51.4	53.2	53.2	53.2	53.2	53.2	63.9	63.9	63.9	63.9	63.9	63.3	63.3	63.3	63.3	63.3	71.4	71.4	71.4	71.4	71.4
	% rh		30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	60.0	60.0	60.0	60.0	60.0	60.0	60.0	60.0	60.0	60.0	43.2	43.2	43.2	43.2	43.2	50.0	50.0	50.0	50.0	50.0	30.0	30.0	30.0	30.0	30.0
Load Condition			100	75	50	25	100	75	50	25	100	100	75	50	25	100	100	75	50	25	100	100	75	50	25	100	100	75	50	25	100	100	75	50	25
Inlet Conditioning			NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE	CHILL	NONE	NONE	NONE	NONE	CHILL	NONE	NONE	NONE	NONE	CHILL	NONE	NONE	NONE	NONE	CHILL	NONE	NONE	NONE	CHILL	NONE	NONE	NONE	NONE
Compressor Inlet Temperature	deg F		30.0	30.0	30.0	30.0	39.4	39.4	39.4	39.4	50.0	59.0	59.0	59.0	59.0	50.0	61.0	61.0	61.0	61.0	50.0	79.2	79.2	79.2	79.2	50.0	76.0	76.0	76.0	76.0	50.0	96.0	96.0	96.0	96.0
Gross GT Output			58,089	43,568	29,048	14,523	57,606	43,203	28,807	14,402	57,336	56,189	42,147	28,097	14,047	57,321	55,929	41,946	27,967	13,981	57,302	52,685	39,513	26,346	13,170	57,302	53,366	40,026	26,683	13,342	57,302	46,940	35,205	23,469	11,734
Gross Heat Rate (LHV)			8,658	8,959	9,958	13,421	8,681	8,998	10,018	13,503	8,692	8,709	9,078	10,138	13,717	8,690	8,710	9,078	10,158	13,755	8,689	8,742	9,245	10,418	14,233	8,689	8,730	9,189	10,361	14,124	8,689	8,893	9,492	10,889	15,134
Heat Input LHV (calculated)			502.9	390.3	289.3	194.9	500.1	388.7	288.6	194.5	498.4	489.4	382.6	284.8	192.7	498.1	487.1	380.8	284.1	192.3	497.9	460.6	365.3	274.5	187.4	497.9	465.9	367.8	276.5	188.4	497.9	417.4	334.2	255.6	177.6
GT Auxiliaries			490	490	490	490	490	490	490	490	490	490	490	490	490	490	490	490	490	490	490	490	490	490	490	490	490	490	490	490	490	490	490	490	490
BOP Auxiliaries																																			
HTIC Fin - Fan Power			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gas Compressors			862	669	496	334	857	666	495	333	854	839	656	488	330	854	835	653	487	330	853	790	626	471	321	853	799	630	474	323	853	716	573	438	304
SCR/Air Temp (Assumed)			94	94	94	94	94	94	94	94	94	94	94	94	94	94	94	94	94	94	94	94	94	94	94	94	94	94	94	94	94	94	94	94	94
Chiller			0	0	0	0	0	0	0	0	148	0	0	0	0	181	0	0	0	0	626	0	0	0	0	603	0	0	0	0	1,034	0	0	0	0
Service Water Pump			10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
Water Treatment			25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25
HVAC			50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50
UPS			10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
Battery			5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
Motor Valves			2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
	Subtotal		1,058	865	692	530	1,053	863	691	530	1,199	1,035	852	684	526	1,232	1,031	849	683	526	1,676	986	822	667	518	1,652	995	827	670	519	2,084	912	769	634	501
0.5%	Transformer Loss: CT		290	218	145	73	288	216	144	72	287	281	211	140	70	287	280	210	140	70	287	263	198	132	66	287	267	200	133	67	287	235	176	117	59
	Transformer Loss: Aux		25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25
	Trx Loss		315	243	170	98	313	241	169	97	312	306	236	165	95	312	305	235	165	95	312	288	223	157	91	312	292	225	158	92	312	260	201	142	84
	Number of CTGs		5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
New and Clean	Gross Plant Output, kW		290,445	217,840	145,240	72,615	288,030	216,015	144,035	72,010	286,680	280,945	210,735	140,485	70,235	286,605	279,645	209,730	139,835	69,905	286,510	263,425	197,565	131,730	65,850	286,510	266,830	200,130	133,415	66,710	286,510	234,700	176,025	117,345	58,670
	Auxiliaries, kW		9,320	7,992	6,763	5,591	9,284	7,969	6,751	5,584	10,004	9,156	7,891	6,701	5,560	10,167	9,131	7,870	6,692	5,555	12,390	8,822	7,676	6,569	5,493	12,271	8,885	7,711	6,594	5,506	14,427	8,309	7,302	6,335	5,373
	Net Output, kW		**281,125**	**209,848**	**138,477**	**67,024**	**278,746**	**208,046**	**137,284**	**66,426**	**276,676**	**271,789**	**202,844**	**133,784**	**64,675**	**276,438**	**270,514**	**201,860**	**133,143**	**64,350**	**274,120**	**254,603**	**189,889**	**125,161**	**60,357**	**274,239**	**257,945**	**192,419**	**126,821**	**61,204**	**272,083**	**226,391**	**168,723**	**111,010**	**53,297**

Ambient Data																																			
Dry Bulb	deg F		30.0	30.0	30.0	30.0	39.4	39.4	39.4	39.4	59.0	59.0	59.0	59.0	59.0	61.0	61.0	61.0	61.0	61.0	79.2	79.2	79.2	79.2	79.2	76.0	76.0	76.0	76.0	76.0	96.0	96.0	96.0	96.0	96.0
Relative Humidity	%		30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	60.0	60.0	60.0	60.0	60.0	60.0	60.0	60.0	60.0	60.0	43.2	43.2	43.2	43.2	43.2	50.0	50.0	50.0	50.0	50.0	30.0	30.0	30.0	30.0	30.0
Elevation	feet		185.0	185.0	185.0	185.0	185.0	185.0	185.0	185.0	185.0	185.0	185.0	185.0	185.0	185.0	185.0	185.0	185.0	185.0	185.0	185.0	185.0	185.0	185.0	185.0	185.0	185.0	185.0	185.0	185.0	185.0	185.0	185.0	185.0
Fuel			Natural Gas	Natural Gas	Natural Gas	Natural Gas	Natural Gas	Natural Gas	Natural Gas	Natural Gas	Natural Gas	Natural Gas	Natural Gas	Natural Gas	Natural Gas	Natural Gas	Natural Gas	Natural Gas	Natural Gas	Natural Gas	Natural Gas	Natural Gas	Natural Gas	Natural Gas	Natural Gas	Natural Gas	Natural Gas	Natural Gas	Natural Gas	Natural Gas	Natural Gas	Natural Gas	Natural Gas	Natural Gas	Natural Gas
Gas Turbine Load	%		100	75	50	25	100	75	50	25	100	100	75	50	25	100	100	75	50	25	100	100	75	50	25	100	100	75	50	25	100	100	75	50	25
Number of Gas Turbines			5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
Net Plant Output	kW		281,125	209,848	138,477	67,024	278,746	208,046	137,284	66,426	276,676	271,789	202,844	133,784	64,675	276,438	270,514	201,860	133,143	64,350	274,120	254,603	189,889	125,161	60,357	274,239	257,945	192,419	126,821	61,204	272,083	226,391	168,723	111,010	53,297
Plant Heat Input	MMBtu/h HHV		2,831	2,201	1,633	1,102	2,815	2,192	1,630	1,100	2,805	2,754	2,157	1,609	1,090	2,804	2,742	2,147	1,604	1,088	2,802	2,592	2,059	1,550	1,060	2,802	2,622	2,074	1,561	1,066	2,802	2,350	1,884	1,443	1,004
Net Plant Heat Rate	Btu/kWh HHV		10,069	10,486	11,796	16,449	10,098	10,534	11,871	16,560	10,138	10,134	10,634	12,023	16,852	10,142	10,136	10,635	12,049	16,904	10,223	10,182	10,846	12,384	17,567	10,219	10,166	10,776	12,310	17,415	10,300	10,378	11,166	13,000	18,846
Stack Characteristics																																			
Number of CTGs			1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Stack Temperature	deg F		867	837	808	757	868	846	826	774	869	867	863	861	812	870	868	862	865	815	870	868	868	866	845	869	870	870	863	841	869	853	869	868	858
Stack Flow	lb/hr		1,197,006	1,013,213	842,286	683,703	1,198,275	1,007,085	829,660	673,537	1,195,857	1,186,022	993,607	801,365	651,055	1,195,430	1,182,387	993,311	797,936	648,436	1,205,031	1,142,884	974,477	794,734	624,207	1,205,031	1,149,812	973,339	800,506	628,324	1,225,031	1,094,899	921,411	766,082	600,434
Stack Volumetric Flow	ACFM		693,778	571,410	462,029	358,002	695,543	572,146	461,727	357,837	696,775	690,079	572,987	459,718	357,342	697,007	688,467	572,215	459,133	357,019	701,869	665,994	564,626	457,804	352,269	701,464	670,838	564,705	460,044	353,410	711,444	630,000	534,197	441,997	342,493
Stack Diameter	feet		12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
Stack Velocity	feet/s		102.6	84.5	68.3	53.0	102.9	84.6	68.3	52.9	103.1	102.1	84.8	68.0	52.9	103.1	101.8	84.6	67.9	52.8	103.8	98.5	83.5	67.7	52.1	103.8	99.2	83.5	68.0	52.3	105.2	93.2	79.0	65.4	50.7
Stack Emissions (Total of 1 CTG)																																			
	ppmvd@15%O2		2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
NOx	lb/h		5.10	3.96	2.93	1.98	5.07	3.94	2.93	1.97	5.05	4.96	3.88	2.89	1.95	5.05	4.94	3.86	2.88	1.95	5.05	4.67	3.70	2.78	1.90	5.05	4.72	3.73	2.80	1.91	5.05	4.23	3.39	2.59	1.80
	lb/MMBtu HHV		0.00901	0.01158	0.01561	0.02312	0.00906	0.01163	0.01564	0.02317	0.00909	0.00926	0.01182	0.01585	0.02339	0.00909	0.00930	0.01187	0.01589	0.02343	0.00910	0.00983	0.01238	0.01645	0.02404	0.00910	0.00972	0.01229	0.01633	0.02392	0.00910	0.01085	0.01353	0.01766	0.02538
	ppmvd@15%O2		4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
CO	lb/h		4.97	3.85	2.86	1.92	4.94	3.84	2.85	1.92	4.92	4.83	3.78	2.81	1.90	4.92	4.81	3.76	2.81	1.90	4.92	4.55	3.61	2.71	1.85	4.92	4.60	3.63	2.73	1.86	4.92	4.12	3.30	2.52	1.75
	lb/MMBtu HHV		0.00877	0.01128	0.01520	0.02252	0.00882	0.01133	0.01524	0.02257	0.00885	0.00902	0.01151	0.01544	0.02278	0.00886	0.00906	0.01157	0.01548	0.02283	0.00886	0.00958	0.01206	0.01602	0.02342	0.00886	0.00947	0.01198	0.01591	0.02330	0.00886	0.01057	0.01318	0.01721	0.02472
	ppmvd@15%O2		2.0	2.0	2.0	2.2	2.0	2.0	2.0	2.2	2.0	2.0	2.0	2.0	2.2	2.0	2.0	2.0	2.0	2.2	2.0	2.0	2.0	2.0	2.2	2.0	2.0	2.0	2.0	2.2	2.0	2.0	2.0	2.0	2.2
VOC	lb/h		1.42	1.10	0.82	0.61	1.41	1.10	0.82	0.61	1.41	1.38	1.08	0.81	0.61	1.41	1.38	1.08	0.81	0.61	1.41	1.30	1.03	0.78	0.59	1.41	1.32	1.04	0.78	0.59	1.41	1.18	0.94	0.72	0.56
	lb/MMBtu HHV		0.00251	0.00323	0.00435	0.00645	0.00253	0.00324	0.00436	0.00646	0.00254	0.00258	0.00330	0.00442	0.00652	0.00254	0.00259	0.00331	0.00443	0.00654	0.00254	0.00274	0.00345	0.00459	0.00671	0.00254	0.00271	0.00343	0.00455	0.00667	0.00254	0.00303	0.00377	0.00493	0.00708
	ppmvd@15%O2		5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
NH3	lb/h		3.77	2.93	2.17	1.46	3.75	2.92	2.17	1.46	3.74	3.67	2.87	2.14	1.45	3.74	3.66	2.86	2.13	1.44	3.74	3.46	2.74	2.06	1.41	3.74	3.50	2.76	2.07	1.41	3.74	3.13	2.51	1.92	1.33
PM10	lb/h		4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0

Attachment 5.1A-2
Fire Pump Engine Specification Sheet

CLARKE®

FIRE PUMP ENGINES

MODELS

JU6H-UFADMG	JU6H-UFADP0	JU6H-UFADR0	JU6H-UFADT0
JU6H-UFAD58	JU6H-UFADP8	JU6H-UFADR8	JU6H-UFADW8
JU6H-UFADNG	JU6H-UFADQ0	JU6H-UFADS8	JU6H-UFADX8
JU6H-UFADN0	JU6H-UFAD88	JU6H-UFADS0	JU6H-UFAD98

FM-UL-cUL APPROVED RATINGS BHP/*KW*

JU6H MODEL ♦	RATED SPEED 1760		2100		2350		2400		US-EPA (NSPS) Available Until ●
UFADMG			**175**	*131*	**175**	*131*			*No Expiration*
UFAD58	**183**	*137*							*No Expiration*
UFADNG	**190**	*142*	**181**	*135*	**183**	*137*	**183**	*137*	*No Expiration*
UFADN0	**197**	*147*	**197**	*147*	**200**	*149*	**200**	*149*	*No Expiration*
UFADP0			**209**	*156*	**211**	*157*	**211**	*157*	*No Expiration*
UFADP8	**220**	*164*							*No Expiration*
UFADQ0			**224**	*167*	**226**	*169*	**226**	*169*	*No Expiration*
UFAD88	**237**	*177*							*No Expiration*
UFADR0			**238**	*177.5*	**240**	*179*	**240**	*179*	*No Expiration*
UFADR8	**250**	*187*							*No Expiration*
UFADS8	**260**	*194*							*No Expiration*
UFADS0			**260**	*194*	**268**	*200*	**268**	*200*	*No Expiration*
UFADT0			**274**	*204*	**275**	*205*	**275**	*205*	*No Expiration*
UFADW8	**282**	*211*							*No Expiration*
UFADX8	**305**	*227.5*							*No Expiration*
UFAD98	**315**	*235*							*No Expiration*

Picture represents JU6H-TRWA Power Tech Plus Engine Series

● USA EPA (NSPS) Tier 3 Emissions Certified Off-Road (40 CFR Part 89) and NSPS Stationary (40 CFR Part 60 Sub Part IIII). Meet EU Stage IIIA emission levels.

♦ All Models available for Export

SPECIFICATIONS

ITEM	JU6H MODELS MG	58	NG	N0	P8	88	P0	Q0	R0	S0	T0	R8	S8	W8	X8	98
Number of Cylinders	6															
Aspiration	TRWA															
Rotation*	CW															
Overall Dimensions – in. (mm)	59.8 (1519) H x 56.7 (1414) L x 36.7 (933) W						60.9 (1547) H x 58.6 (1488) L x 40.0 (1015) W									
Crankshaft Centerline Height – in. (mm)	14 (356)															
Weight – lb (kg)	1747 (791)															
Compression Ratio	19.0:1						17.0:1									
Displacement – cu. in. (L)	415 (6.8)															
Engine Type	4 Stroke Cycle – Inline Construction															
Bore & Stroke – in. (mm)	4.19 x 5.00 (106 x 127)															
Installation Drawing	D628															
Wiring Diagram AC	C07651															
Wiring Diagram DC	C071367, C072146, C071361						C071368, C072146, C071761									
Engine Series	John Deere 6068 Series Power Tech E						John Deere 6068 Series Power Tech Plus									
Speed Interpolation	N/A															

Abbreviations: CW – Clockwise TRWA – Turbocharged with Raw Water Aftercooling N/A - Not Available L – Length W – Width H - Height

*Rotation viewed from Heat Exchanger / Front of engine

CERTIFIED POWER RATING

- Each engine is factory tested to verify power and performance.
- FM-UL power ratings are shown at specific speeds, Clarke engines can be applied at a single rated RPM setting ± 50 RPM.

ENGINE RATINGS BASELINES

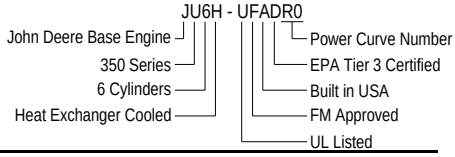
- Engines are to be used for stationary emergency standby fire pump service only. Engines are to be tested in accordance with NFPA 25.
- Engines are rated at standard SAE conditions of 29.61 in. (752.1 mm) Hg barometer and 77°F (25°C) inlet air temperature [approximates 300 ft. (91.4 m) above sea level] by the testing laboratory (see SAE Standard J 1349).
- A deduction of 3 percent from engine horsepower rating at standard SAE conditions shall be made for diesel engines for each 1000 ft. (305 m) altitude above 300 ft. (91.4 m)
- A deduction of 1 percent from engine horsepower rating as corrected to standard SAE conditions shall be made for diesel engines for every 10°F (5.6°C) above 77°F (25°C) ambient temperature.

ENGINE EQUIPMENT

EQUIPMENT	STANDARD	OPTIONAL
Air Cleaner	Direct Mounted, Washable, Indoor Service with Drip Shield	Disposable, Drip Proof, Indoor Service Outdoor Type, Single or Two Stage (Cyclonic)
Alarms	Overspeed Alarm & Shutdown, Low Oil Pressure, Low & High Coolant Temperature, Low Raw Water Flow, High Raw Water Temperature, Alternate ECM Warning, Fuel Injection Malfunction, ECM Warning and Failure with Automatic Switching	Low Coolant Level, Low Oil Level, Oil Filter Differential Pressure, Fuel Filter Differential Pressure, Air Filter Restriction
Alternator	12V-DC, 42 Amps with Poly-Vee Belt and Guard	24V-DC, 40 Amps with Poly-Vee Belt and Guard
Coupling	Bare Flywheel	UL Listed Driveshaft and Guard, JU6H-UFAD58/NG/ADMG/ADM8/K0/N0/Q0/R0-CDS30-S1; JU6H-UFADP8/P0/T0/88/R8/S8/S0/W8/X8/98- CDS50-SC at 1760/2100 RPM only
Electronic Control Module	12V-DC, Energized to Stop, Primary ECM always Powered on	24V-DC, Energized to Stop, Primary ECM always Powered on
Engine Heater	115V-AC, 1360 Watt	230V-AC, 1360 Watt
Exhaust Flex Connection	SS Flex, 150# ANSI Flanged Connection, 5" for JU6H-UFAD58/MG/NG/N0/P8/88; SS Flex, 150# ANSI Flanged Connection, 6" for JU6H-UFADP0/Q0/R0/S0/T0/R8/S8/W8/X8/98 (w/ orifice plate)	SS Flex, 150# ANSI Flanged Connection, 6" for JU6H-UFAD58/MG/NG/N0/P8/88; SS Flex, 150# ANSI Flanged Connection, 8" for JU6H-UFADP0/Q0/R0/S0/T0/R8/S8/W8/X8/98 (w/ orifice plate)
Exhaust Protection	Metal Guards on Manifolds and Turbocharger	
Flywheel Housing	SAE #3	
Flywheel Power Take Off	11.5" SAE Industrial Flywheel Connection	
Fuel Connections	Fire Resistant, Flexible, USA Coast Guard Approved, Supply and Return Lines	SS, Braided, cUL Listed, Supply and Return Lines
Fuel Filter	Primary Filter with Priming Pump	
Fuel Injection System	High Pressure Common Rail	
Governor, Speed	Dual Electronic Control Modules	
Heat Exchanger	Tube and Shell Type, 60 PSI (4 BAR), NPT(F) Connections – Sea Water Compatible	
Instrument Panel	Multimeter to Display English and Metric, Tachometer, Hourmeter, Water Temperature, Oil Pressure and One (1) Voltmeter with Toggle Switch, Front Opening	
Junction Box	Integral with Instrument Panel; For DC Wiring Interconnection to Engine Controller	
Lube Oil Cooler	Engine Water Cooled, Plate Type	
Lube Oil Filter	Full Flow with By-Pass Valve	
Lube Oil Pump	Gear Driven, Gear Type	
Manual Start Control	On Instrument Panel with Control Position Warning Light	
Overspeed Control	Electronic, Factory Set, Not Field Adjustable	
Raw Water Cooling Loop w/Alarms	Galvanized	Seawater, All 316SS, High Pressure
Raw Water Cooling Loop Solenoid Operation	Automatic from Fire Pump Controller and from Engine Instrument Panel (for Horizontal Fire Pump Applications)	Not Supplied (for Vertical Turbine Fire Pump Applications)
Run – Stop Control	On Instrument Panel with Control Position Warning Light	
Starters	Two (2) 12V-DC	Two (2) 24V-DC
Throttle Control	Adjustable Speed Control by Increase/Decrease Button, Tamper Proof in Instrument Panel	
Water Pump	Centrifugal Type, Poly-Vee Belt Drive with Guard	

Abbreviations: DC – Direct Current, AC – Alternating Current, SAE – Society of Automotive Engineers, NPT(F) – National Pipe Tapered Thread (Female), ANSI – American National Standards Institute, SS – Stainless Steel

MODEL NOMENCLATURE: (10 Digit Models)



CLARKE®

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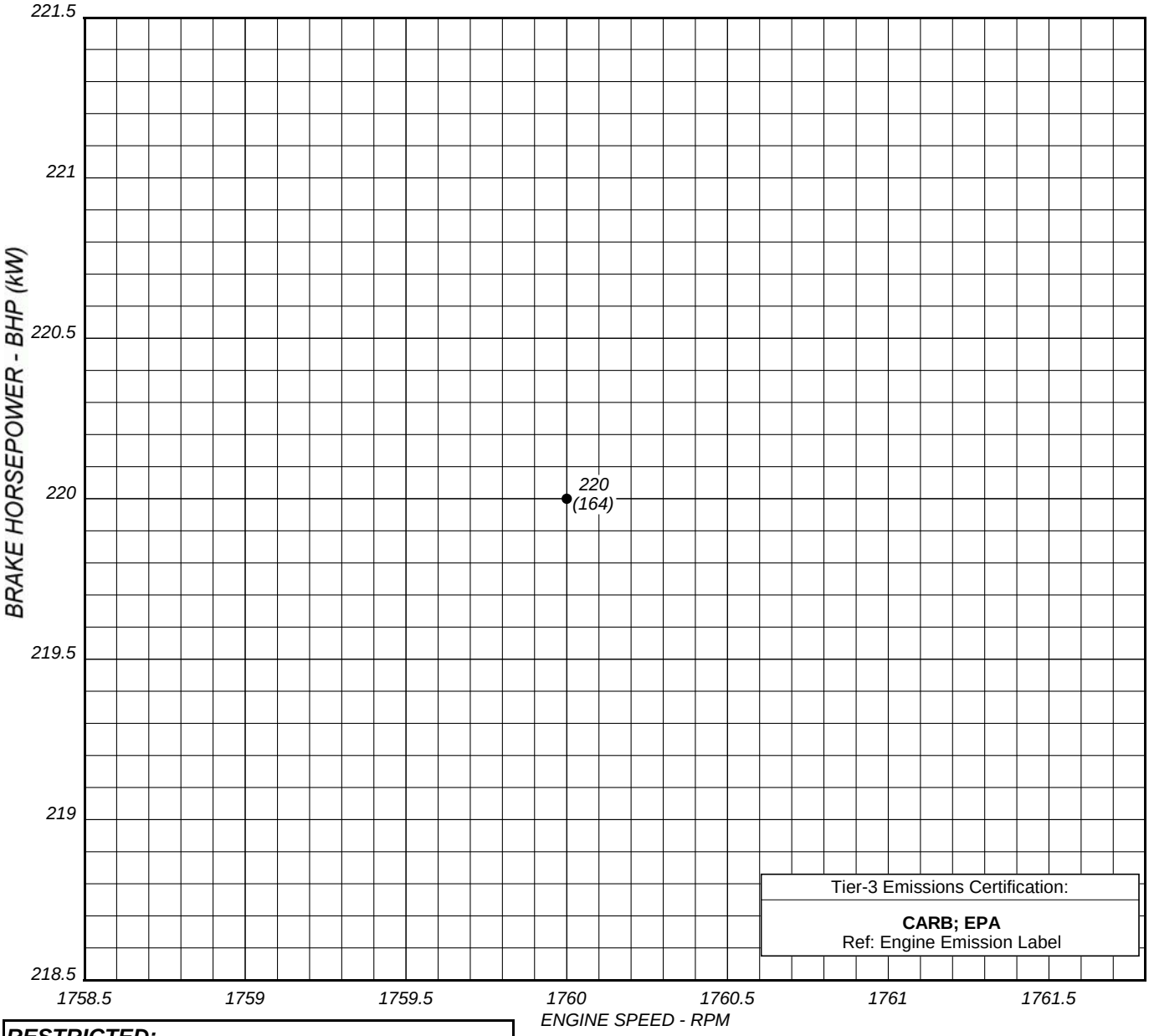
Fire Protection Products, Inc.

FIRE PUMP MODEL: JU6H-UFADP8
Heat Exchanger Cooled
Raw Water Charge Cooling
Tier 3 Emissions Certified



RESTRICTED:
USE ONLY FOR STAND-BY FIRE PUMP APPLICATIONS

ENGINE PERFORMANCE:
STANDARD CONDITIONS: (SAE J1349, ISO 3046)
77°F (25°C) AIR INLET TEMPERATURE
29.61 IN. (751.1MM) HG BAROMETRIC PRESSURE
#2 DIESEL FUEL (SEE C13940)

KEVIN KUNKLER 23FEB09

NAMEPLATE BHP (MAXIMUM PUMP LOAD)

CREATED	DATE CREATED

ENGINE MODEL JU6H-UFADP8

DRAWING NO.	REV
C132984	A

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JU6H-UFADP8

INSTALLATION & OPERATION DATA (I&O Data)

USA Produced

Basic Engine Description

Engine Manufacturer	John Deere Co.
Ignition Type	Compression (Diesel)
Number of Cylinders	6
Bore and Stroke - in (mm)	4.19 (106) X 5 (127)
Displacement - in³ (L)	415 (6.8)
Compression Ratio	19.0:1
Valves per cylinder	
Intake	1
Exhaust	1
Combustion System	Direct Injection
Engine Type	In-Line, 4 Stroke Cycle
Fuel Management Control	Electronic, High Pressure Common Rail
Firing Order (CW Rotation)	1-5-3-6-2-4
Aspiration	Turbocharged
Charge Air Cooling Type	Raw Water
Rotation, viewed from front of engine, Clockwise (CW)	Standard
Engine Crankcase Vent System	Open
Installation Drawing	D628
Weight - lb (kg)	1747 (792)

Power Rating	**1760**
Nameplate Power - HP (kW)	220 (164)

Cooling System - [C051386]	**1760**
Engine Coolant Heat - Btu/sec (kW)	74 (78.1)
Engine Radiated Heat - Btu/sec (kW)	49 (51.7)
Heat Exchanger Minimum Flow	
60°F (15°C) Raw H_20 - gal/min (L/min)	13 (49.2)
100°F (37°C) Raw H_20 - gal/min (L/min)	20 (75.7)
Heat Exchanger Maximum Cooling Raw Water	
Inlet Pressure - psi (bar)	60 (4.1)
Flow - gal/min (L/min)	40 (151)
Typical Engine H_20 Operating Temp - °F (°C)[1]	180 (82.2) - 195 (90.6)
Thermostat	
Start to Open - °F (°C)	180 (82.2)
Fully Opened - °F (°C)	203 (95)
Engine Coolant Capacity - qt (L)	20.5 (19.4)
Coolant Pressure Cap - lb/in² (kPa)	15 (103)
Maximum Engine Coolant Temperature - °F (°C)	230 (110)
Minimum Engine Coolant Temperature - °F (°C)	160 (71.1)
High Coolant Temp Alarm Switch - °F (°C)[2]	235 (113) - 241 (116)

Electric System - DC	**Standard**		**Optional**	
System Voltage (Nominal)	12		24	
Battery Capacity for Ambients Above 32°F (0°C)				
Voltage (Nominal)	12	[C07633]	24	[C07633]
Qty. Per Battery Bank	1		2	
SAE size per J537	8D		8D	
CCA @ 0°F (-18°C)	1400		1400	
Reserve Capacity - Minutes	430		430	
Battery Cable Circuit, Max Resistance - ohm	0.0012		0.0012	
Battery Cable Minimum Size				
0-120 in. Circuit Length[3]	00		00	
121-160 in. Circuit Length[3]	000		000	
161-200 in. Circuit Length[3]	0000		0000	
Charging Alternator Maximum Output - Amp,	40	[C071363]	55	[C071365]
Starter Cranking Amps, Rolling - @60°F (15°C)	440	[RE69704/RE70404]	250	[C07819/C07820]

NOTE: This engine is intended for indoor installation or in a weatherproof enclosure. [1]Engine H_2O temperature is dependent on raw water temperature and flow. [2]High Coolant Switch threshold varies with engine load. [3]Positive and Negative Cables Combined Length.

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JU6H-UFADP8
INSTALLATION & OPERATION DATA (I&O Data)
USA Produced

Exhaust System	**1760**
Exhaust Flow - ft.³/min (m³/min)	1189 (33.7)
Exhaust Temperature - °F (°C)	986 (530)
Maximum Allowable Back Pressure - in H_20 (kPa)	30 (7.5)
Minimum Exhaust Pipe Dia. - in (mm)[4]	5 (127)

Fuel System	**1760**
Fuel Consumption - gal/hr (L/hr)	11.2 (42.4)
Fuel Return - gal/hr (L/hr)	16.6 (62.8)
Fuel Supply - gal/hr (L/hr)	27.8 (105)
Fuel Pressure - lb/in² (kPa)	3 (20.7) - 6 (41.4)
Minimum Line Size - Supply - in.	.50 Schedule 40 Steel Pipe
Pipe Outer Diameter - in (mm)	0.848 (21.5)
Minimum Line Size - Return - in.	.375 Schedule 40 Steel Pipe
Pipe Outer Diameter - in (mm)	0.675 (17.1)
Maximum Allowable Fuel Pump Suction Lift with clean Filter - in H_20 (mH_20)	80 (2)
Maximum Allowable Fuel Head above Fuel pump, Supply or Return - ft (m)	6.6 (2)
Fuel Filter Micron Size	2 (Secondary)

Heater System	**Standard**	**Optional**
Engine Coolant Heater		
Wattage (Nominal)	1360	1360
Voltage - AC, 1 Phase	115 (+5% -10%)	230 (+5%, -10%)
Part Number	[C123640]	[C123644]

Air System	**1760**	
Combustion Air Flow - ft.³/min (m³/min)	445 (12.6)	
Air Cleaner	**Standard**	**Optional**
Part Number	[C03396]	[C03327]
Type	Indoor Service Only, with Shield	Canister, Single-Stage
Cleaning method	Washable	Disposable
Air Intake Restriction Maximum Limit		
Dirty Air Cleaner - in H_20 (kPa)	10 (2.5)	10 (2.5)
Clean Air Cleaner - in H_20 (kPa)	6 (1.5)	5 (1.2)
Maximum Allowable Temperature (Air To Engine Inlet) - °F (°C)[5]	130 (54.4)	

Lubrication System	
Oil Pressure - normal - lb/in² (kPa)	40 (276) - 60 (414)
Low Oil Pressure Alarm Switch - lb/in² (kPa)[6]	30 (207) to 35 (241)
In Pan Oil Temperature - °F (°C)	220 (104) - 245 (118)
Total Oil Capacity with Filter - qt (L)	21.1 (20)

Lube Oil Heater	**Optional**	**Optional**
Wattage (Nominal)	150	150
Voltage	120V (+5%, -10%)	240V (+5%, -10%)
Part Number	C04430	C04431

Performance	**1760**
BMEP - lb/in² (kPa)	239 (1650)
Piston Speed - ft/min (m/min)	1467 (447)
Mechanical Noise - dB(A) @ 1m	C133370
Power Curve	C132984

[4]Based on Nominal System. Back pressure flow analysis must be done to assure maximum allowable back pressure is not exceeded. (Note: minimum exhaust Pipe diameter is based on: 15 feet of pipe, one 90° elbow, and a silencer pressure drop no greater than one half of the maximum allowable back pressure.) [5]Review for horsepower derate if ambient air entering engine exceeds 77°F (25°C). [6]Low Oil Pressure Switch threshold varies w/engine speed. [ ] indicates component reference part number.

JU4H, JU4R & JU6H, JU6R ENGINE MODELS
ENGINE MATERIALS AND CONSTRUCTION

Air Cleaner
Type……. .. Indoor Usage Only
Oiled Fabric Pleats
Material……. Surgical Cotton
Aluminum Mesh

Air Cleaner - Optional
Type……. Canister
Material……Pleated Paper
Housing……. Enclosed

Camshaft
Material……. Cast Iron
Chill Hardened
Location……..In Block
Drive……... Gear, Spur
Type of Cam……..... Ground

Charge Air Cooler (JU6H-60,62,68,74,84, ADK0, AD58, ADNG, ADN0, ADQ0, ADR0, AAQ8, AARG, ADP8, ADP0, ADT0, AD88, ADR8, AD98, ADS0, ADW8, ADX8, AD98 only)
Type…….. ……Raw Water Cooled
Materials (in contact with raw water)
Tubes…… ……. 90/10 CU/NI
Headers …….. 36500 Muntz
Covers …….. 83600 Red Brass
Plumbing …….. 316 Stainless Steel/ Brass
90/10 Silicone

Charge Air Cooler (JU6R-AA67, 59, 61, PF, Q7, RF, S9, 83 only)
Type…..……Air to Air Cooled
Materials
Core……Aluminum

Coolant Pump
Type…… …….. Centrifugal
Drive…… ……. ……Poly Vee Belt

Coolant Thermostat
Type……. Non Blocking
Qty……1

Cooling Loop (Galvanized)
Tees, Elbows, Pipe……. Galvanized Steel
Ball Valves…… Brass ASTM B 124,
Solenoid Valve…… Brass
Pressure Regulator……. Bronze
Strainer……. Cast Iron (1/2" - 1" loops) or
Bronze (1.25" - 2" loops)

Cooling Loop (Sea Water)
Tees, Elbows, Pipe……. 316 Stainless Steel
Ball Valves…… 316 Stainless Steel
Solenoid Valve…… 316 Stainless Steel
Pressure Regulator/Strainer Cast Brass ASTM B176
C87800

Cooling Loop (316SS)
Tees, Elbows, Pipe……. 316 Stainless Steel
Ball Valves…… 316 Stainless Steel
Solenoid Valve…… 316 Stainless Steel
Pressure Regulator/Strainer 316 Stainless Steel

Connecting Rod
Type……. I-Beam Taper
Material……Forged Steel Alloy

Crank Pin Bearings
Type……. Precision Half Shell
Number……1 Pair Per Cylinder
Material……Wear-Guard

Crankshaft
Material……Forged Steel
Type of Balance……Dynamic

Cylinder Block
Type……. One Piece with
Non-Siamese Cylinders
Material……Annealed Gray Iron

Cylinder Head
Type…….. …… Slab 2 Valve
Material……Annealed Gray Iron

Cylinder Liners
Type…….. …… Centrifugal Cast, Wet Liner
Material……..... Alloy Iron Plateau, Honed

Fuel Pump
Type…….. …… Diaphragm
Drive……Cam Lobe

Heat Exchanger (USA) - JU4H & JU6H Only
Type……. Tube & Shell
Materials
Tube & Headers…… Copper
Shell…….. …… Copper
Electrode…… Zinc

Heat Exchanger (UK) - JU4H & JU6H Only
Type……. Tube & Bundle

Materials
Tube & Headers…… Copper
Shell…….. Aluminum

Injection Pump
Type……... Rotary
Drive……Gear

Lubrication Cooler
Type……. Plate

Lubrication Pump
Type……. Gear
Drive……Gear

Main Bearings
Type……. Precision Half Shells
Material…… Steel Backed-Aluminum
Lined

Piston
Type and Material……. Aluminum Alloy with
Reinforced Top Ring Groove
Cooling…… Oil Jet Spray

Piston Pin
Type……. Full Floating - Offset

Piston Rings
Number/Piston…… 3
Top……. Keystone Barrel Faced -
Plasma Coated
Second…… Tapered Cast Iron
Third……Double Rail Type
w/Expander Spring

Radiator - JU4R & JU6R Only
Type……. Plate Fin
Materials
Core…… Copper & Brass
Tank & Structure……. Steel

Valves
Type…….. …… Poppet
Arrangement…… ….. Overhead Valve
Number/Cylinder……1 intake
1 exhaust
Operating Mechanism…… Mechanical Rocker Arm
Type of Lifter…….. Large Head
Valve Seat Insert…… Replaceable

DO NOT SCALE

DATUMS:

-A- - MOUNTING FACE OF FLYWHEEL

-B- - ENGINE CRANKSHAFT HORIZONTAL CENTERLINE

-C- - ENGINE CRANKSHAFT VERTICAL CENTERLINE

- CENTER OF GRAVITY OF ENGINE

- CLOCKWISE ROTATION WHEN VIEWED FROM FRONT OF ENGINE

NOTE:
THE LOOP SHOWN IS BASED ON STANDARD LOOP CONSTRUCTION AND FM SIZING CONDITIONS

FOR ALTERNATE LOOP CONSTRUCTION (STAINLESS STEEL, SEA WATER, AND HIGH PRESSURE) SIZES MAY VARY

DRAWING SUBJECT TO CHANGE WITHOUT NOTICE

CAUTION:

ALL PLUMBING MUST BE SUPPORTED AND/OR ISOLATED SO THAT NO WEIGHT OR STRESS IS APPLIED TO ANY ENGINE COMPONENT

ATTENTION

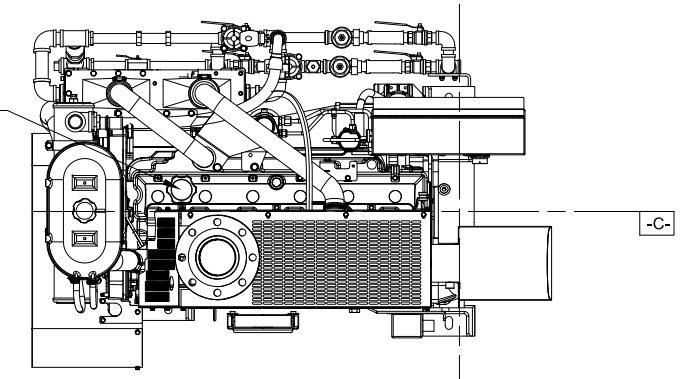
REFER TO THE SPECIFIC MODEL "INSTALLATION AND OPERATION DATA" FOR INSTALLATION GUIDELINES

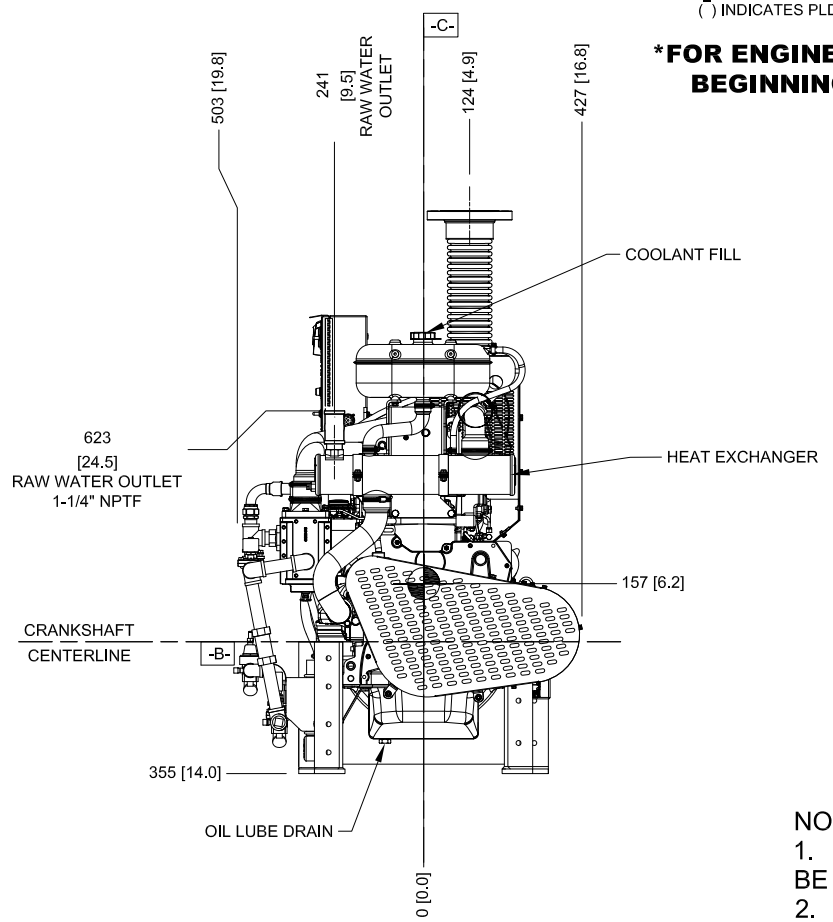
"TRWA" (TURBOCHARGED w/ RAW WATER AFTERCOOLING) MODELS	JU6H-UFAD58, -UFAD88 JU6H-UFADK0= , -UFADNG JU6H-UFADP8, -UFADN0 JU6H-UFADM8, -UFADMG JU6H-UFADP8 (MODELS SHOWN)
	JU6H-UFAD98 -UFADP0 JU6H -UFADQ0, -UFADR0 JU6H-UFADR8, -UFADS0 JU6H-UFADS8, -UFADT0 JU6H-UFADW8,-UFADX8 SEE PG. 3 FOR RAW WATER INLET DIMENSIONS

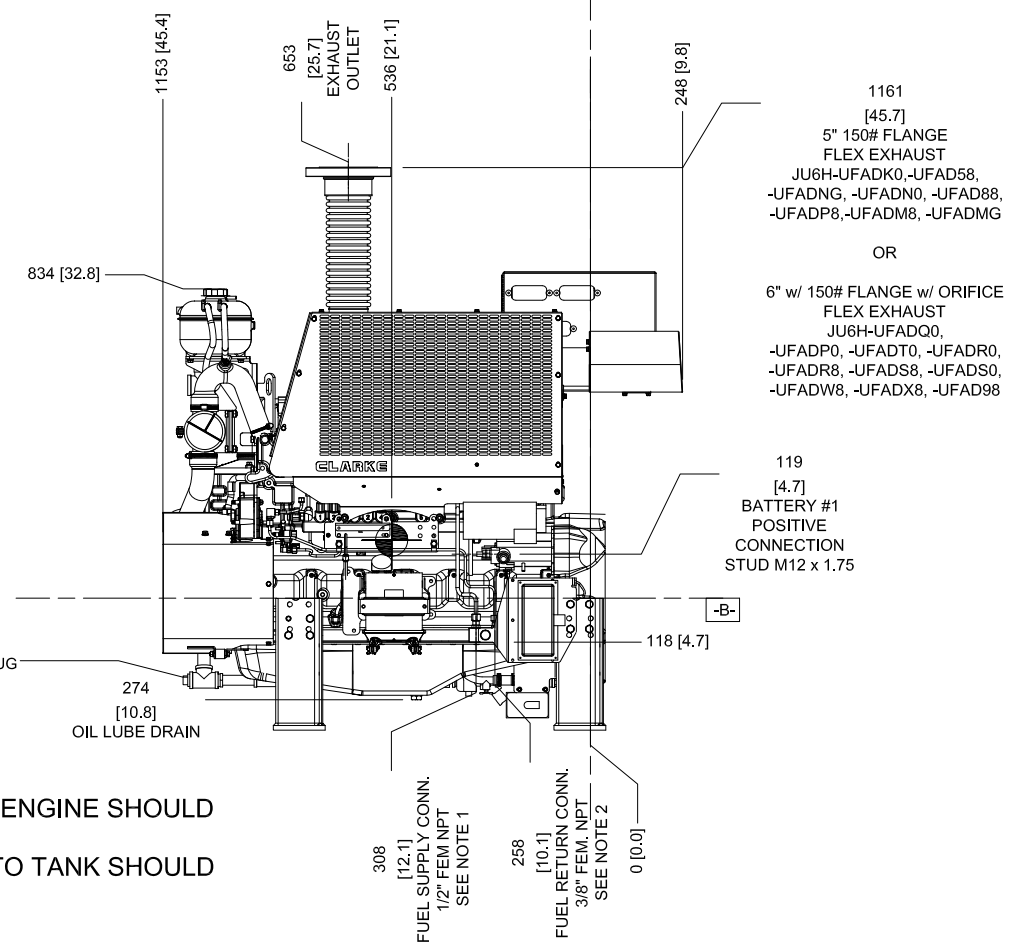
(=) INDICATES PLD ENINGE MODEL ONLY

***FOR ENGINES BUILT IN USA BEGINNING APRIL 2015**

VIEW FROM TOP OF ENGINE







NOTES:
1. FUEL SUPPLY PIPING FROM TANK TO ENGINE SHOULD BE 1/2"MINIMUM PIPE DIAMETER.
2. FUEL RETURN PIPING FROM ENGINE TO TANK SHOULD BE 3/8" MINIMUM PIPE DIAMETER.

REV	DESCRIPTION	ECN#	DWN	APVD	DATE
E	REVISED EXH FLEX CONNECTION DATA	1997	JCA		23JUN10
F	REVISED ENGINE FOOT MOUNTING HOLE LOCATIONS - PAGE 2	1901	JCA		28JUL10
G	ADDED DIMENSIONS FRONT VIEW ZONE D6 PG1	2106	DMP		28OCT10
H	ADDED ENGINE MODELS: JU6H-UFADM8 & JU6H-UFADMG	2173	JCA		09DEC10
J	UPDATED MOUNTING FEET AND HEATER SETUP	2063	AMC		19JUL12
K	RAW WATER OUTLET WAS 1" NPTF	2649	MOH		04DEC12
L	ADDED PIPING KIT/COOLING LOOP	3631	BKK		25NOV14
M	ADDED FLYWHEEL INFORMATION	4071	JGV		04AUG15
N	REVISED ENGINE FOOT MOUNTING HOLE LOCATIONS PAGE 2	4275	CMM		01OCT15

MACHINE TOLERANCE

DECIMAL	mm	Inch
X	± 1.5	
X.X	± 0.8	± 0.06
X.XX	± 0.3	± 0.03
X.XXX	± 0.025	± 0.01
X.XXXX		± 0.001

ANGULAR: ± 0.5°

FABRICATION TOLERANCE

DECIMAL	mm	Inch
X	± 3	
X.X	± 1.5	± 0.12
X.XX		± 0.06

ANGULAR: ± 1.0°

YES ☒ NO ☐ CONTROLLED DRAWING

CLARKE
Fire Protection Products, Inc.

DRWN	MWLEMING
DATE	2/25/2009
ENGR	KJKUNKLER
MATERIAL	
ASSEMBLY	

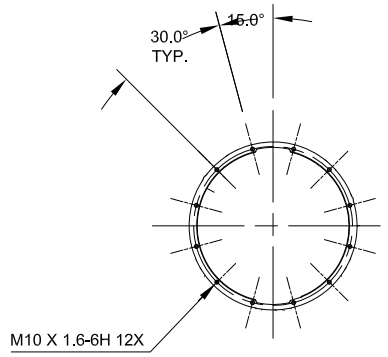
NAME: INSTALLATION DRAWING, FIRE PUMP ENGINE JU6H TIER 3 MODELS

PART NO. D628 REV N

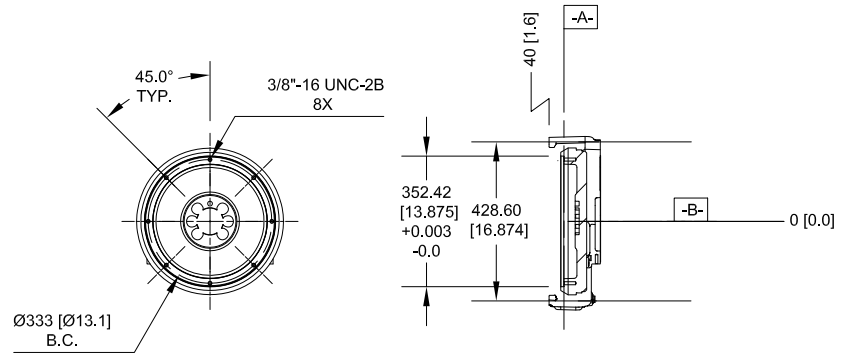
SCALE NTS | UNITS MM [INCH] | PAGE 1 OF 3

DO NOT SCALE

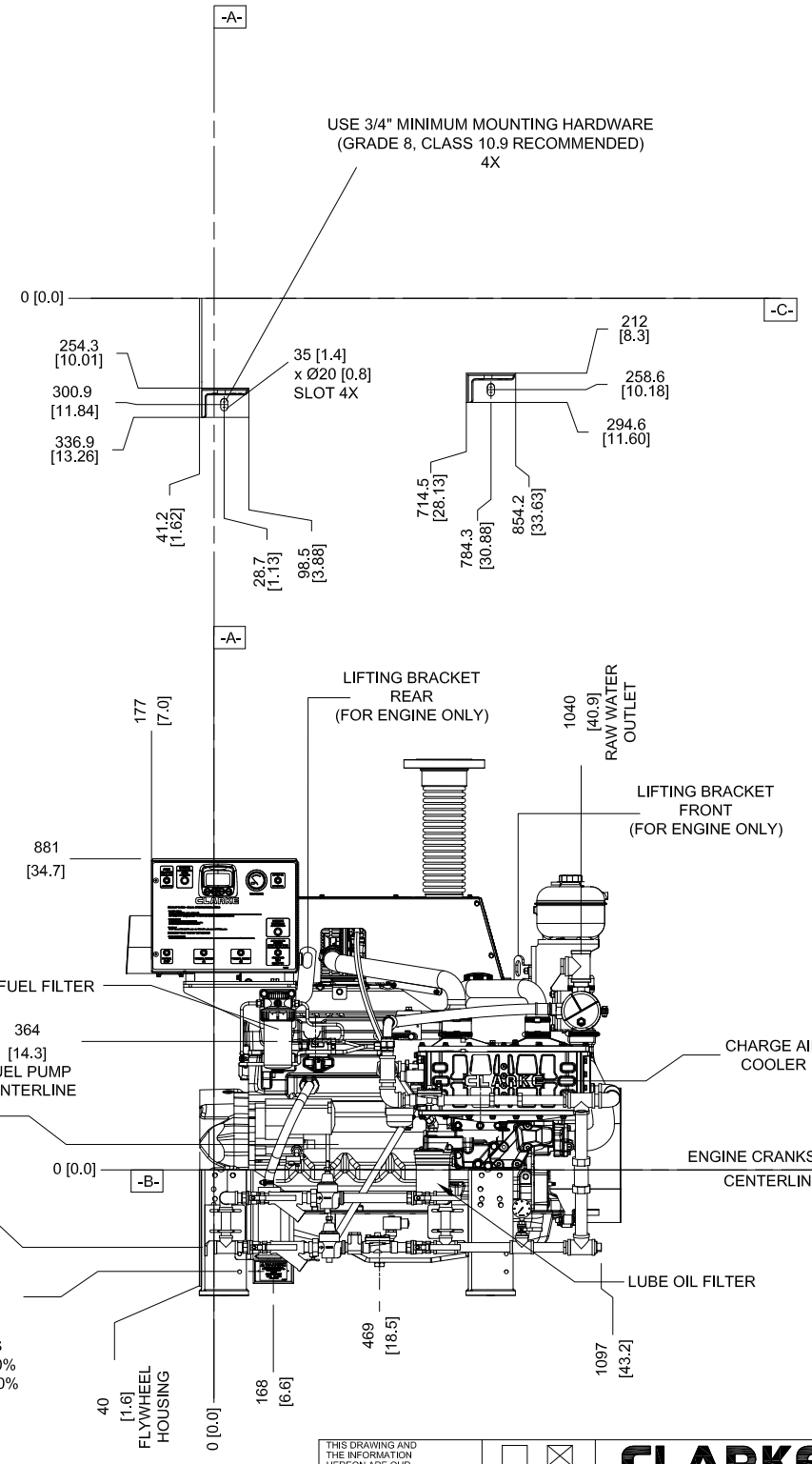
DETAIL DATUM -A-

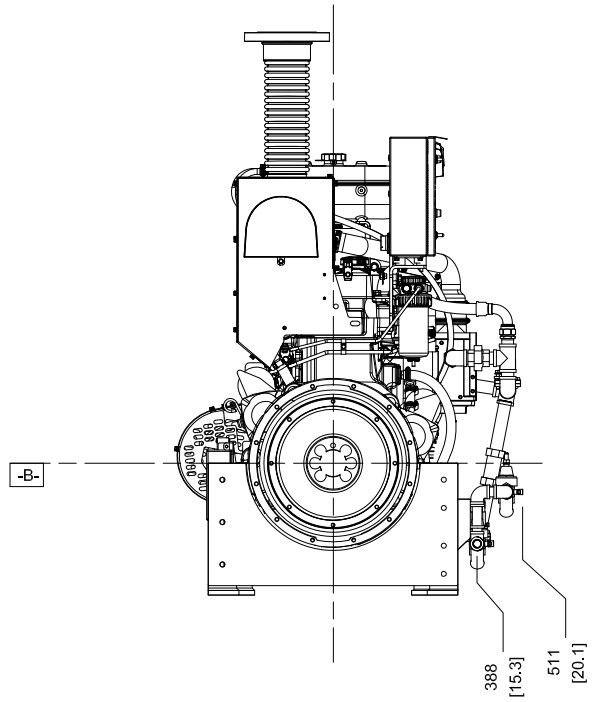


SAE #3
FLYWHEEL HOUSING



SAE 11.5 FLYWHEEL WITH
129 TEETH AND 8/10 PITCH RING GEAR





***FOR ENGINES BUILT IN USA BEGINNING APRIL 2015**

FOR ENGINE SPECIFIC OPTIONS
SEE www.CLARKEFIRE.com

DRAWING SUBJECT TO CHANGE WITHOUT NOTICE

MACHINE TOLERANCES

DECIMAL	mm	inch
X.	±1.5	
X.X	±0.5	±0.02
X.XX	±0.3	±0.01
X.XXX	±0.025	±0.01
X.XXXX		±0.001

ANGULAR: ±0.5°

FABRICATION TOLERANCES

DECIMAL	mm	inch
X.	±3	
X.X	±1.5	±1/32
X.XX		±1/64

ANGULAR: ±1.42°

CONTROLLED DRAWING: YES / NO

CLARKE
Fire Protection Products, Inc.

DRWN	MWLEMING
DATE	2/25/2009
ENGR	KKUNKLER
MATERIAL	
ASSEMBLY	

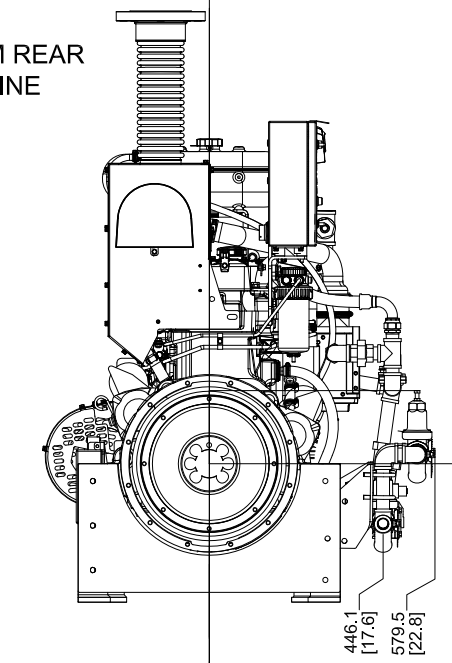
NAME: INSTALLATION DRAWING, FIRE PUMP ENGINE JU6H TIER 3 MODELS

PART NO. D628 REV N

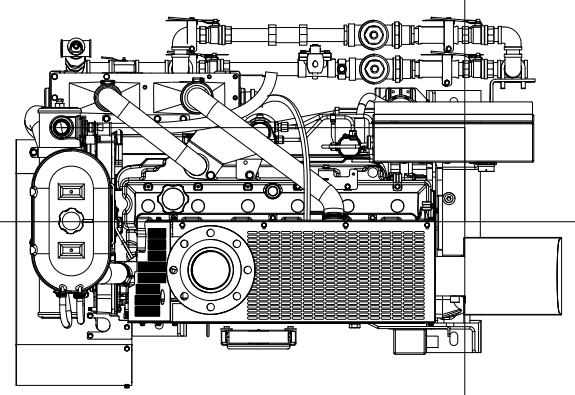
SCALE NTS | UNITS MM [INCH] | PAGE 2 OF 3

DO NOT SCALE

VIEW FROM REAR OF ENGINE



VIEW FROM TOP OF ENGINE



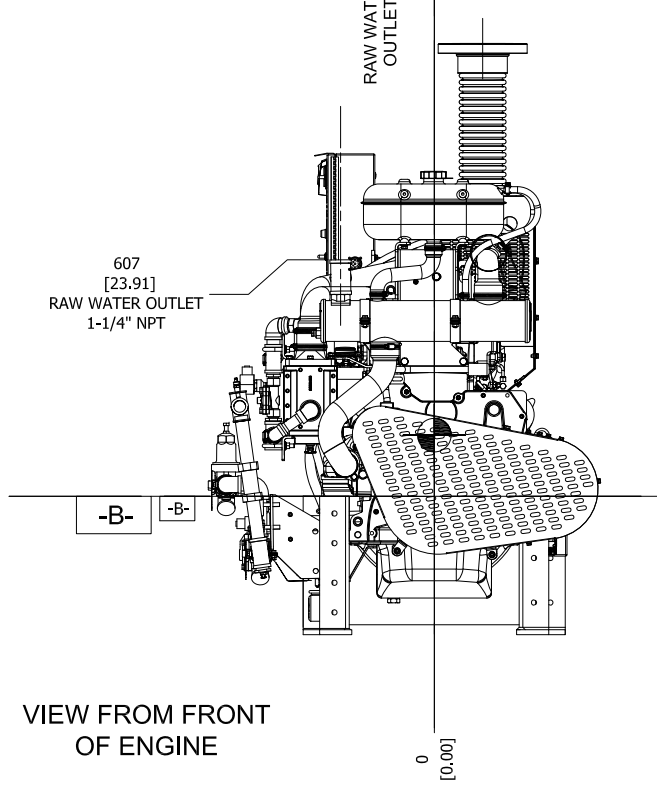
TRWA 1" LOOP w/ 1 ½" REGULATORS MODELS	JU6H-UFAD98 -UFADP0 JU6H -UFADQ0, -UFADR0 JU6H-UFADR8, -UFADS0 JU6H-UFADS8, -UFADT0 JU6H-UFADW8,-UFADX8

FOR ALL OTHER MODELS SEE PAGE 2

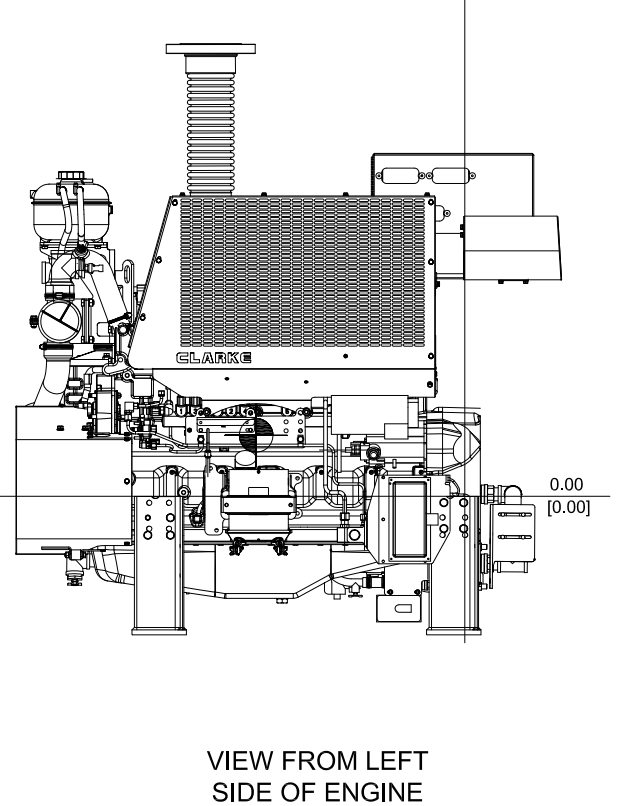
DATUMS

- -A- - MOUNTING FACE OF FLYWHEEL
- -B- - ENGINE CRANKSHAFT HORIZONTAL CENTERLINE
- -C- - ENGINE CRANKSHAFT VERTICAL CENTERLINE
- ⌖ - CENTER OF GRAVITY OF ENGINE
- ↷ - CLOCKWISE ROTATION WHEN VIEWED FROM FRONT OF ENGINE

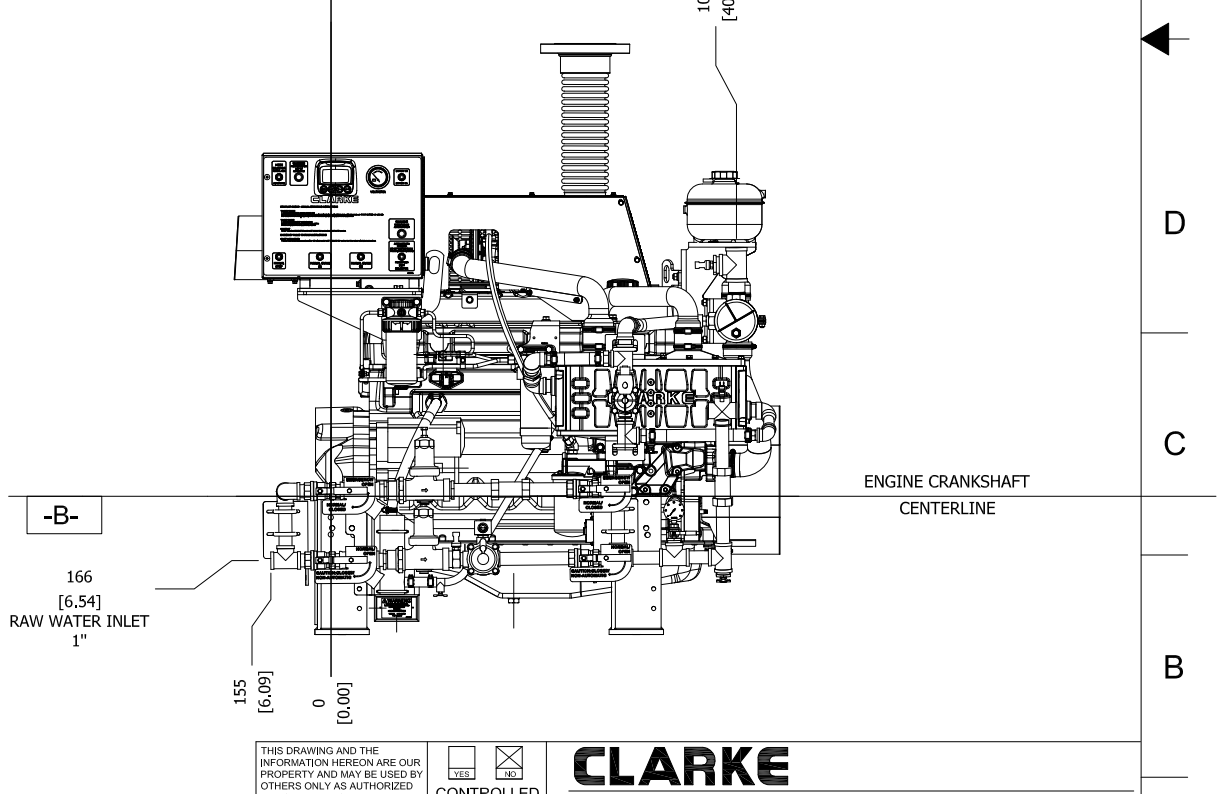
VIEW FROM FRONT OF ENGINE



VIEW FROM LEFT SIDE OF ENGINE



VIEW FROM RIGHT SIDE OF ENGINE



MACHINE TOLERANCE

DECIMAL	mm	Inch
X.	± 1.5	
X.X	± 0.8	± 0.06
X.XX	± 0.3	± 0.03
X.XXX	± 0.025	± 0.01
X.XXXX		± 0.001

ANGULAR: ± 0.5°

FABRICATION TOLERANCE

DECIMAL	mm	Inch
X.	± 3	
X.X	± 1.5	± 0.12
X.XX		± 0.06

ANGULAR: ± 1.0°

CONTROLLED DRAWING: YES ☒ NO ☐

CLARKE
Fire Protection Products, Inc.

DRWN	PMKOWALL
DATE	11SEP09
ENGR	ACRISTOFARO
MATERIAL	
REFERENCE	EC1626

NAME: INSTALLATION DRAWING FIRE PUMP ENGINE JU6H TIER 3 MODELS

PART NO. D628 REV N

SCALE NTS UNITS MM [INCH] PAGE 3 OF 3

Rating Specific Emissions Data - John Deere Power Systems

Nameplate Rating Information

Clarke Model	JU6H-UFADP8
Power Rating (BHP / kW)	220 / 164
Certified Speed (RPM)	1760

Rating Data

Rating	6068HFC28A
Certified Power (kW)	177
Rated Speed	1760
Vehicle Model Number	Clarke Fire Pump

Units	g/kW-hr	g/hp-hr
NOx	3.6	2.7
HC	0.2	0.1
NOx + HC	3.8	2.8
Pm	0.13	0.10
CO	1.2	0.9

Certificate Data

Engine Model Year	2011
EPA Family Name	BJDXL06.8120
EPA JD Name	350HAK
EPA Certificate Number	JDX-NRCI-11-29
CARB Executive Order	Not Applicable
Parent of Family	6068HFG82A

Units	g/kW-hr
NOx	3.8
HC	0.1
NOx + HC	3.9
Pm	0.12
CO	1.2

* The emission data listed is measured from a laboratory test engine according to the test procedures of 40 CFR 89 or 40 CFR 1039, as applicable. The test engine is intended to represent nominal production hardware, and we do not guarantee that every production engine will have identical test results. The family parent data represents multiple ratings and this data may have been collected at a different engine speed and load. Emission results may vary due to engine manufacturing tolerances, engine operating conditions, fuels used, or other conditions beyond our control.

JDPS 2/16/2011

JU6H-UFADP8

FIRE PUMP DRIVER

NOISE DATA

Mechanical Engine Noise *

RPM	BHP	OVERALL dB(A)	Octave Band 31.5 Hz dB(A)	63 Hz dB(A)	125 Hz dB(A)	250 Hz dB(A)	500 Hz dB(A)	1k Hz dB(A)	2k Hz dB(A)	4k Hz dB(A)	8k Hz dB(A)	16k Hz dB(A)
1760	220	105.6	65.2	66.8	78.8	82.2	89.7	97.9	100.1	98.7	94.2	87.7

Raw Exhaust Engine Noise **

RPM	BHP	OVERALL dB(A)	Octave Band 31.5 Hz dB(A)	63 Hz dB(A)	125 Hz dB(A)	250 Hz dB(A)	500 Hz dB(A)	1k Hz dB(A)	2k Hz dB(A)	4k Hz dB(A)	8k Hz dB(A)	16k Hz dB(A)
1760	220	110.2		99.9	104.3	99	101.2	100.8	103.5	100.7	90.4	84

** Values above are provided at 3.3ft (1m) from engine block and do not include the raw exhaust noise.*

*** Values above are provided at 23ft (7m), 90° horizontal, from a vertical exhaust outlet and does not include noise created mechanically by the engine.*

The above data reflects values for a typical engine of this model, speed and power in a free-field environment.

Installation specifics such as background noise level and amplification of noise levels from reflecting off of surrounding objects, will affect the overall noise levels observed. As a result of this, Clarke makes no guarantees to the above levels in an actual installation.