

CLARKE

Fire Protection Products, Inc.

CLARKE UK, LTD.

Fire Protection Products

Cincinnati, Ohio USA - Glasgow, Scotland UK

**Diesel Engines for
NFPA-20 Fire Protection
Applications**

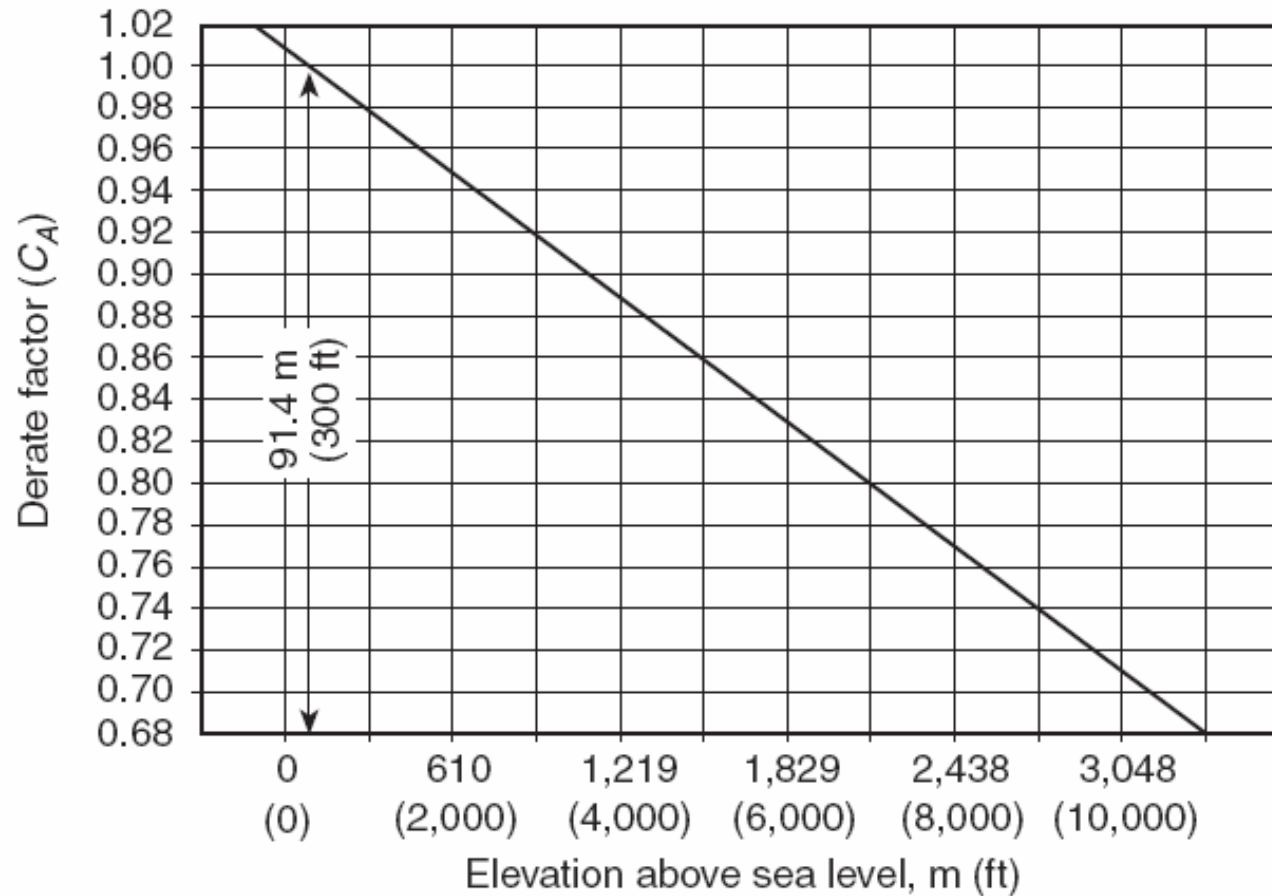
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NFPA 20 – Engine Type

- **Diesel Engines for fire pump drive shall be of the compression ignition type.**
- **Spark-ignited internal combustion engines shall not be used. (i.e. natural gas, propane or gasoline)**

NFPA 20 - Engine Ratings

- **Rated at SAE Conditions 25°C (77°F) and 91 m (300 ft) above sea level.**
- **Engines must have at least a 10% reserve in horsepower. (This is a UL-FM requirement and all UL-FM engine ratings reflect this requirement).**
- **Engines must be derated for Altitude and Temperature.**
 - **3% Derate for every 300 m (1000 ft) above 91 m (300 ft).**
 - **1% Derate for every 5.6°C (10°F) above 25°C (77° F).**



Note: The correction equation is as follows:

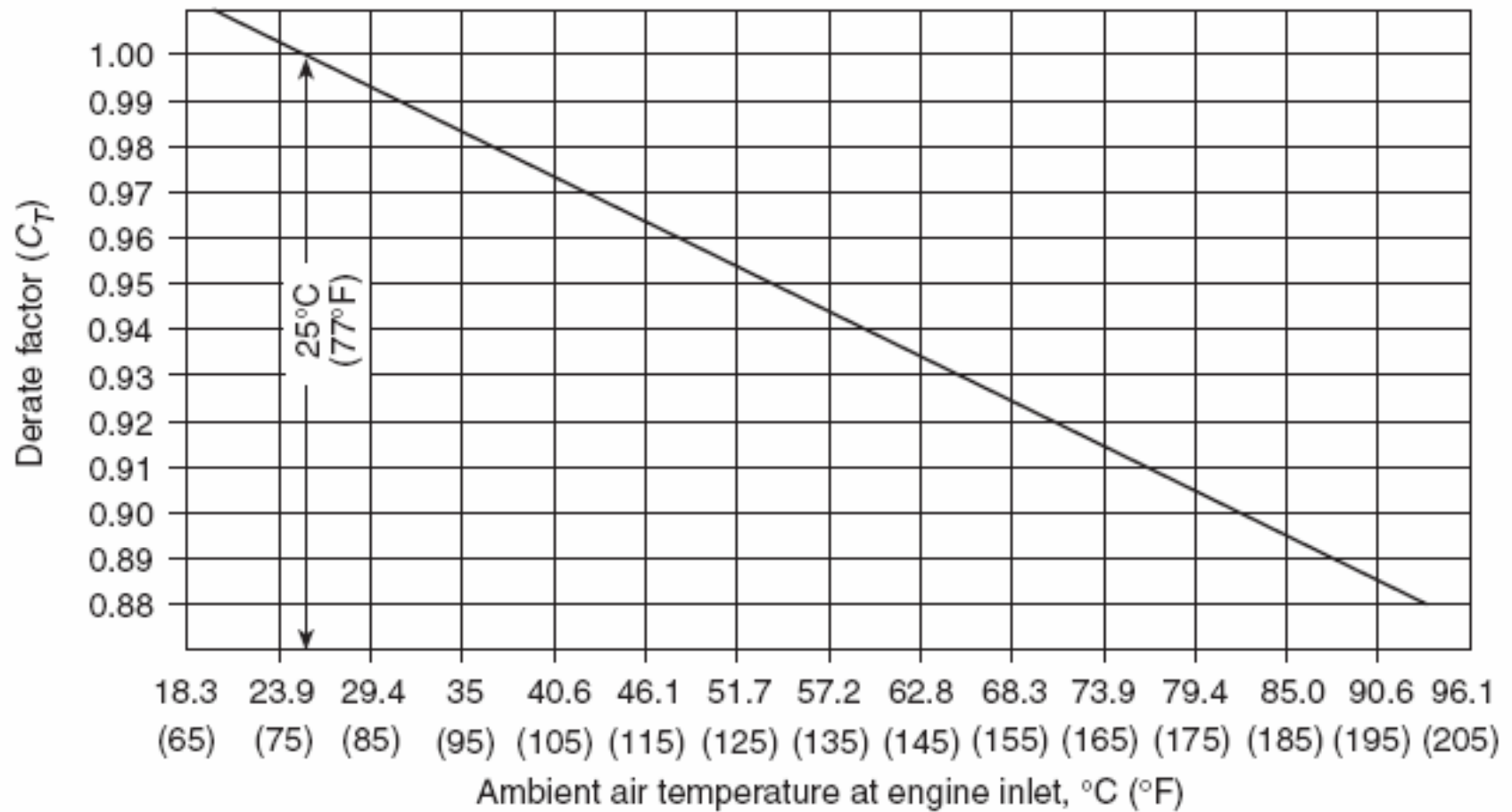
Corrected engine horsepower = $(C_A + C_T - 1) \times$ listed engine horsepower

where:

C_A = derate factor for elevation

C_T = derate factor for temperature

FIGURE A.11.2.2.4 Elevation Derate Curve.



Note: The correction equation is as follows:

$$\text{Corrected engine horsepower} = (C_A + C_T - 1) \times \text{listed engine horsepower}$$

where:

C_A = derate factor for elevation

C_T = derate factor for temperature

FIGURE A.11.2.2.5 Temperature Derate Curve.

NFPA 20 – Instrument & Control

- **Engines shall be regulated to have no more the 10% speed difference between shutoff and maximum load. (Defined as droop).**
- **Engines shall be provided with an overspeed shutdown at 20% above rated engine speed with a manual reset. (Only overspeed shutdown or a signal from the diesel controller will shut down an engine.)**

Derate Example

- **150 hp engine**
- **Altitude 5,000 ft: $C_A = .86$**
- **Temperature 105F: $C_T = .973$**
- **Formula: $(C_A + C_T - 1) \times \text{hp} = \text{derated hp}$**
- **$(.86 + .973 - 1) = .833 \times 150 \text{ hp} = 124.95 \text{ hp}$**

- **Clarke Selection/Derate Calculator program can calculate the exact size engine you need to use.**

Overspeed Setting Verification

To verify the engine overspeed setting and function without overspeeding the engine, follow this procedure:

- **Start engine manually from the controller while holding the overspeed verification switch in the 'up' position. Observe the shutdown RPM.**
- **Test switch returns to normal position when released.**
- **Reset the overspeed switch on the engine instrument panel and restart the engine from the controller to verify normal operation.**
- **EXAMPLE:**

Rated engine speed:	2100 rpm
Overspeed setting:	2520 rpm (120% 2100 rpm)
Verification shutdown:	1688 rpm (67% of 2520 rpm)

JU and JW Series Instrument Panel



- 1** Tachometer with Hour-meter
- 2** Mode Selector Switch
- 3** Manual Operating Instructions
- 4** 'Red' Warning Light
- 5** Overspeed Reset Switch
- 6** Manual Start Contactor #1

- 7** Manual Start Contactor #2
- 8** Overspeed Verification @ 67%
- 9** Engine Oil Pressure Gauge
- 10** Voltmeter - Battery Set #1
- 11** Voltmeter - Battery Set #2
- 12** Coolant Temperature Gauge

NFPA 20 – Instrumentation & Control

- **Required Gauges:**
 - **Tachometer – indicates rpms**
 - **Oil Pressure Gauge**
 - **Coolant Temperature Gauge**
 - **Hour meter – record engine run time**
- **Additional Gauges:**
 - **Two voltmeters – one for each set of batteries**

NFPA 20 – Instrumentation & Control

- **The engine instrument panel shall not be used as a junction box or conduit for any ac supply.**
- **Interconnections between the automatic controller and engine junction box shall be made using stranded wire sized on a continuous-duty basis.**
- **The dc interconnections between the automatic controller and engine junction box and any ac power supply to the engine shall be routed in separate conduit.**

Clarke Fire Protection Products Controller - Diesel Engine Interconnection Terminal Post Identification

Terminal
Marking

Interconnect Function

W	~ Water Solenoid Connection - Made by the Pump OEM
1	~ Signal from Controller - Energize Engine Governor Fuel Solenoid
2	~ Signal to Controller - Engine Running
3	~ Signal to Controller - Engine Overspeed Condition
4	~ Signal to Controller - Low Oil Pressure
5	~ Signal to Controller - High Engine Coolant Temperature
6	~ Battery Charging from Controller - Battery Set #1
7	~ [Unused Terminal - Not Identified on Terminal Strip]
8	~ Battery Charging from Controller - Battery Set #2
9	~ Start Circuit Signal from Controller - Starter #1
10	~ Start Circuit Signal from Controller - Starter #2
11	~ Common Engine System Ground Connections

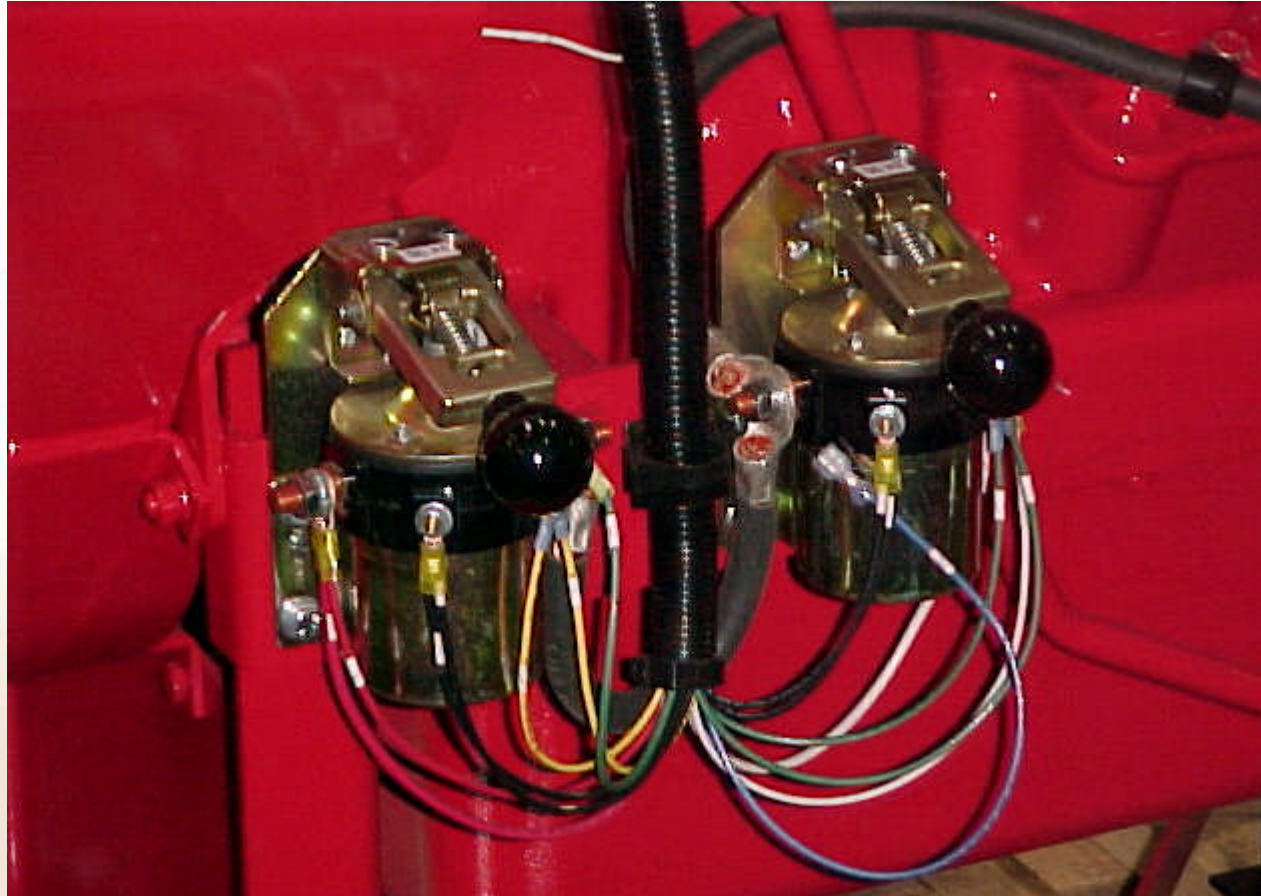
Typical Wire Size Utilized **

** Refer to Controller Manufacturer's installation instructions for minimum wire size recommendations.

# W, 1-5, 9 & 10	14 Gauge Stranded Wire
# 6, 8, & 11	10 Gauge Stranded Wire

NFPA 20 – Instrumentation & Control

- **Main battery contactors supplying current to the starting motor shall be capable of manual mechanical operation to energize starting motor.**
 - **Manual toggles are provided on the Clarke instrument panel and additionally manual start contactors for only the JW6H & JX6H series engines.)**
- **Clarke electric starting standard;**
 - **One (1) starter on JW6H, JX6H units.**
 - **Two (2) starters on JU4H, JU6H units.**



NFPA 20 – Instrumentation & Control Electronic Engines

- **Engines with an electronic control module (ECM) shall have an alternate ECM wired to produce full power in the event of primary ECM failure.**
- **There shall be a single ECM Selector Switch, with no off position, to transition from the primary ECM to the alternate ECM.**
- **A visual indicator shall show when the engine is running with the alternate ECM. (On both the engine panel and on the diesel controller)**

JX Series Instrument Panel



NFPA 20 – Instrumentation & Control Electronic Engines

- **Any sensor necessary for the function of the ECM shall have a redundant sensor that shall operate automatically in case of failure.**
- **A signal shall be provided to the diesel controller for fuel injector failure, low fuel pressure and any primary sensor failure.**

NFPA 20 – Instrumentation & Control

- **Each engine shall be provided with two storage battery units.**
- **Electrolyte shall be added to the batteries a minimum of 24 hours prior to the time the engine has to be started.**
- **At 4.5°C (40°F) each battery shall have twice the capacity sufficient to maintain 3 minute attempt-to-start cycle (15 seconds of cranking and 15 seconds of rest in six consecutive cycles).**

NFPA 20 – Instrumentation & Control

- **Storage batteries shall be rack supported above the floor to prevent water damage.**
- **Storage batteries shall be readily accessible for servicing.**
- **Storage batteries shall not be located in front of the engine mounted instruments and controls.**

NFPA 20 – Instrumentation & Control

- **There should be two means for recharging the storage batteries.**
 - **The battery chargers in the diesel controller is the primary source.**
 - **The alternator on the engine is the secondary source.**

NFPA 20 – Engine Cooling

- **The engine cooling system shall be of the closed-circuit type.**
 - **Heat exchanger type**
 - **Radiator type**

NFPA 20 – Engine Cooling

- **Cooling water shall be piped through a threaded rigid pipe from the discharge of the pump to the inlet of the heat exchanger.**
- **It is not permitted to use flexible tubing attached to the cooling loop.**

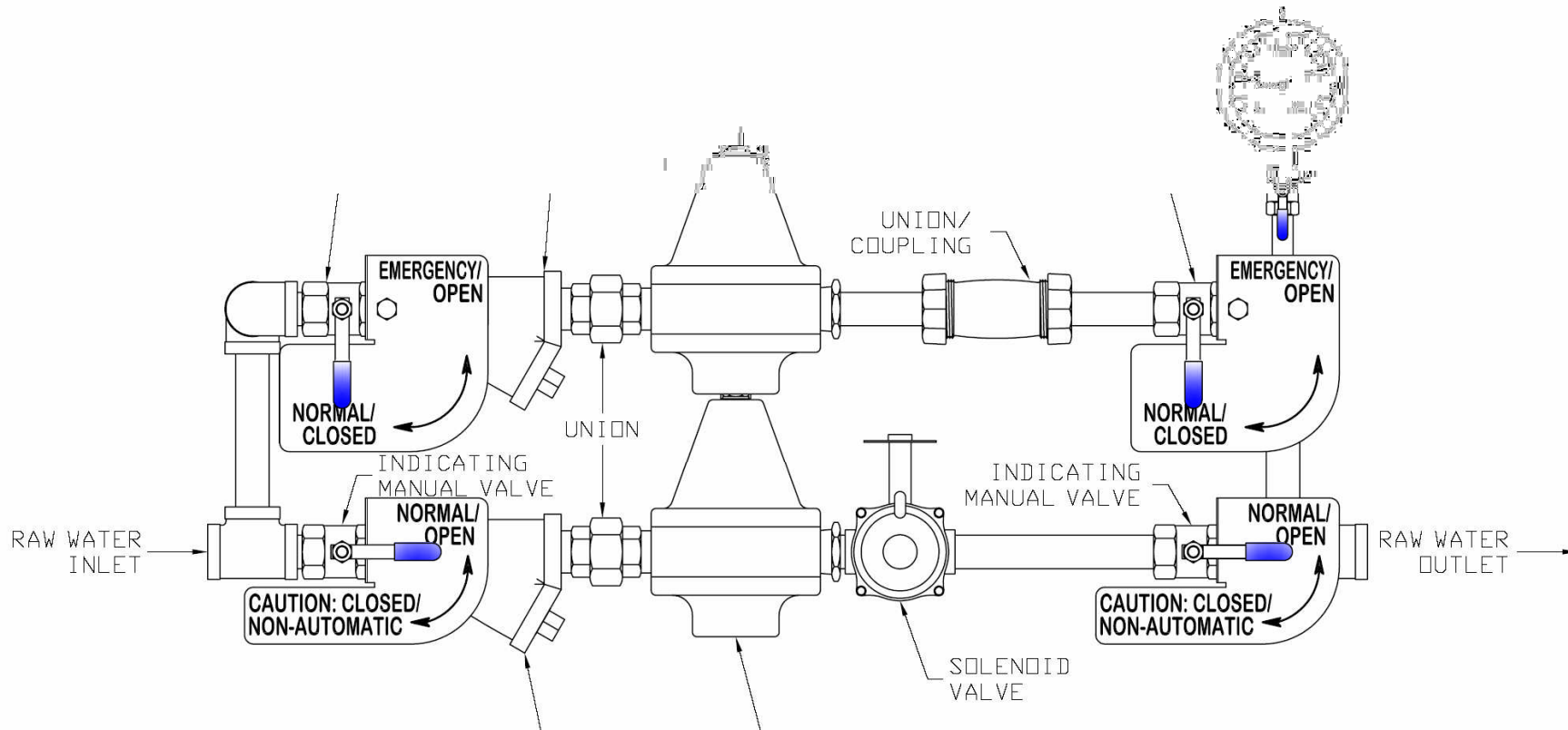
NFPA 20 – Engine Cooling

- **The outlet for the wastewater coming from the heat exchanger shall be one size larger than the inlet.**
- **The wastewater shall be discharged into a visible open waste cone.**
- **Discharge can be piped to a suction reservoir provided a visual flow indicator and temperature indicators are installed.**

NFPA 20 – Engine Cooling

- **Heat exchanger standard equipment.**
- **Sea water or fresh water; sacrificial anode optional.**
- **Engines are shipped without coolant.**
- **Cooling water line (cooling loop) shall have a manual by-pass.**
- **Cooling water line and by-pass shall include:**
 - **indicating manual shutoff valve**
 - **approved flushing-type strainer**
 - **pressure regulator**
 - **automatic valve**
 - **second indicating manual valve or check valve**
 - **pressure gauge**

Cooling Water Line



Engine Coolant

- **Water, ethylene glycol, inhibitor coolant mixture. 50% water 50% coolant.**
- **Coolant to conform to ASTM D4985.**
 - **Heat transfer**
 - **Corrosion resistance**
 - **Prevents scale and sludge build up**
 - **Provides freeze and boil over protection**
- **Pre-mix before installing in engine to prevent premature engine heater failure.**

NFPA 20 – Engine Cooling

- **Coolant heater is the only AC power on engine; Separate AC junction box required. Do not use controller AC for power supply.**
- **Add coolant mixture before applying AC power.**
- **All heaters single voltage; Optional AC voltages available - location specific.**
- **Engine coolant maintained at 49°C (120°F).**

NFPA 20 – Engine Protection

- **The engine shall be protected against possible interruption of service through explosion, fire, flood, earthquake, rodents, insects, windstorm, freezing, vandalism and other adverse conditions.**
- **Application: The engine must be installed inside or protected from the weather and low temperature.**

NFPA 20 – Room Requirements

- **Rooms containing fire pumps shall be free from storage & penetrations not essential to the operation of the pump.**
- **Floors shall be pitched for adequate drainage of escaping water from critical equipment.**
- **The pump room shall be provided with a floor drain that will discharge to a frost free location.**

NFPA 20 – Air Requirements

- **The minimum ambient temperature for the pump room is 4.5°C (40°F).**
- **The maximum temperature for the pump room is 49°C (120°F) at the air cleaner inlet with the engine running at rated load.**

NFPA 20 – Air Requirements

- **Inlet louver and ventilating system must:**
- **Maintain 49°C (120°F) in the room**
- **Supply adequate air for engine combustion**
- **Adequate air for ventilating radiated heat; both engine & exhaust system.**
- **(Radiator Cooled Units shall be ducted outdoors in a manner that will prevent recirculation and requires more air for combustion and radiated heat removal.)**

Heat Exchanger Ventilation

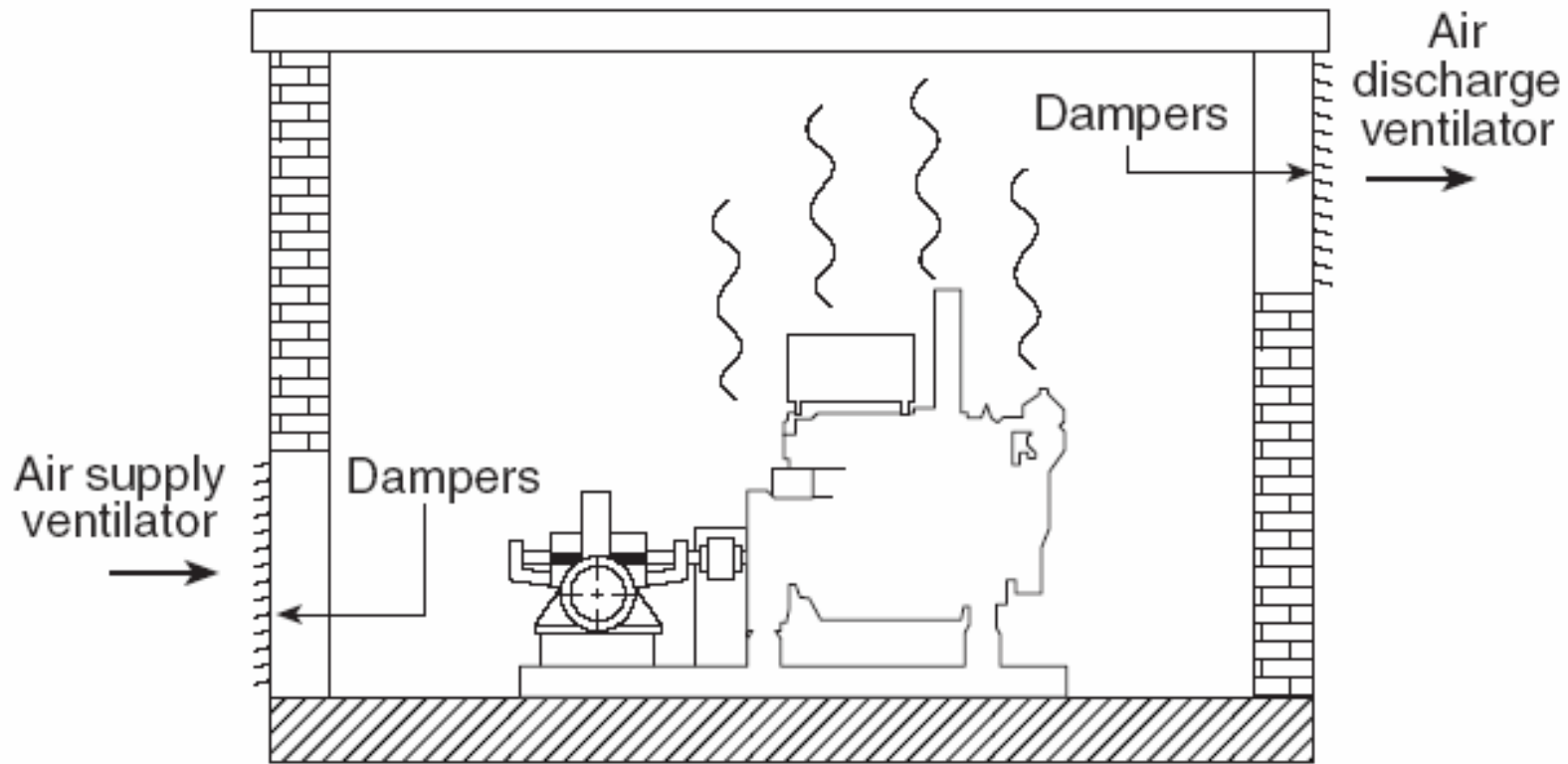


FIGURE A.11.3.2(a) Typical Ventilation System for a Heat Exchanger–Cooled Diesel-Driven Pump.

Radiator Ventilation

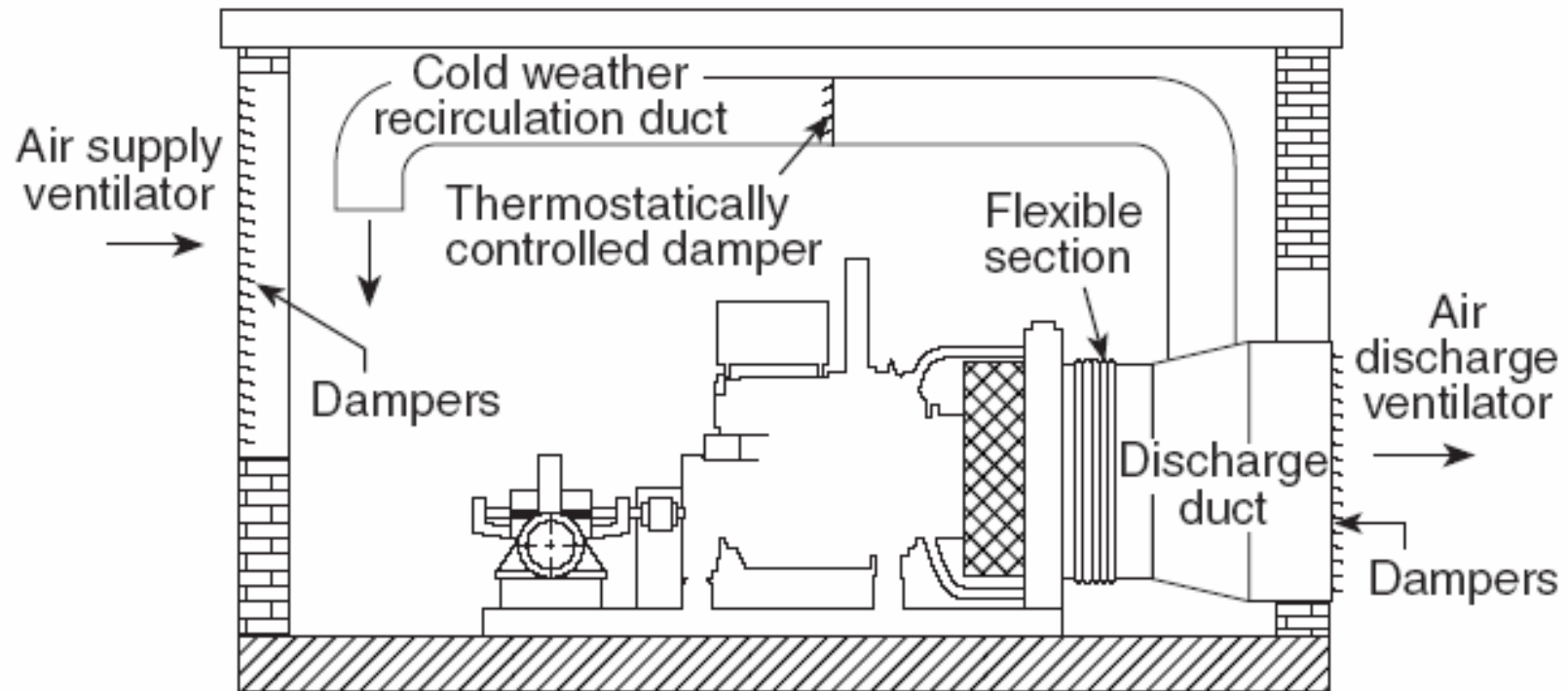
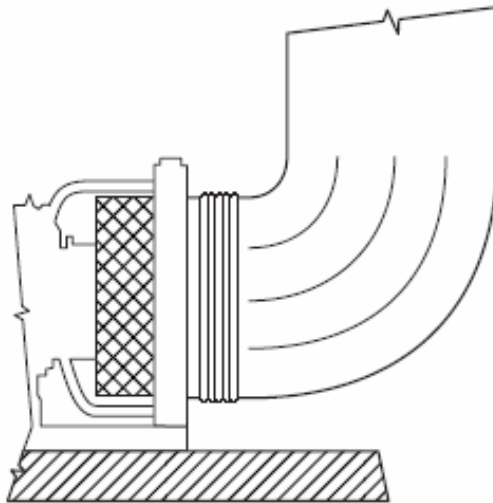


FIGURE A.11.3.2(b) Typical Ventilation System for a Radiator-Cooled Diesel-Driven Pump.

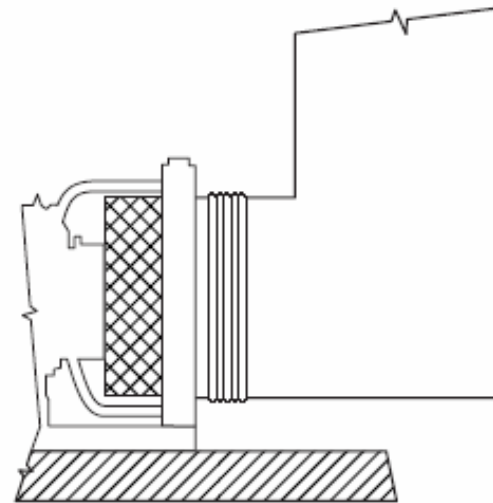
Radiator Ventilation

Right



If a bend in the ducting cannot be avoided, it should be radiused and should include turning vanes to prevent turbulence and flow restriction.

Wrong



This configuration should not be used; turbulence will not allow adequate air flow.

Radiator Ventilation

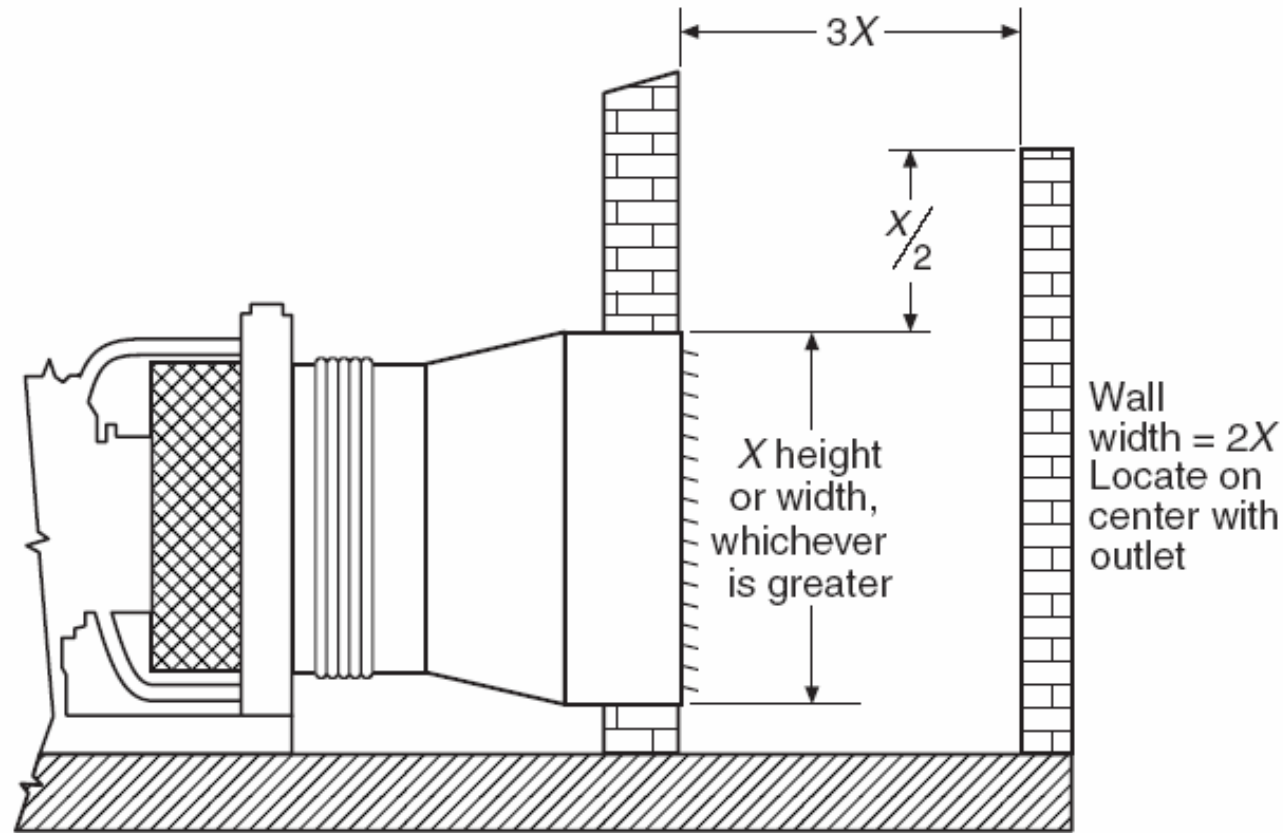


FIGURE A.11.3.2.4 Typical Wind Wall.

NFPA 20 – Fuel Tank Arrangement

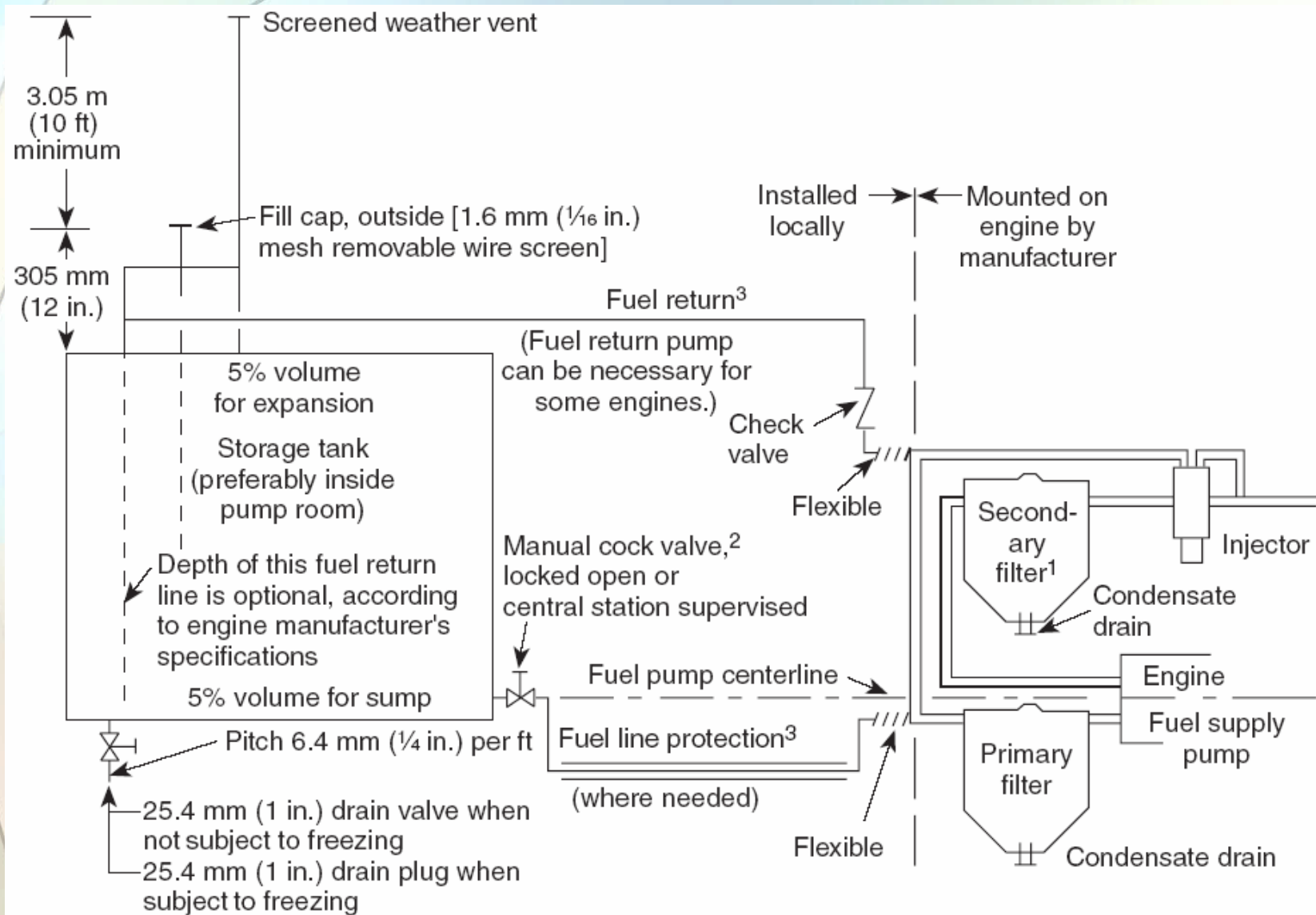
- **The fuel tank is sized for 5.07 liter/kW (1 gal/HP) plus 10% (5% for expansion and 5% for sump).**
- **The fuel tank shall be reserved exclusively for the fire pump diesel engine.**
- **There shall be one fuel tank per engine.**

NFPA 20 – Fuel Tank Arrangement

- **The fuel tank shall be located above ground.**
- **The fuel tank outlet shall be located so that its opening is no lower than the level of the engine's fuel transfer pump.**
- **The static head pressure limits shall not be exceeded when the level of fuel in the tank is at a maximum.**
- **In sites where temperatures below 0°C (32°F) could be encountered, the fuel tank shall be located in the pump room.**

NFPA 20 – Fuel Arrangement

- **The diesel engine must use clean #2 diesel.**
- **#1, blended fuel, or jet fuel have a lower cetane ratings, which reduces the power output by 10% of the engine compared with the listed power.**
- **Residual fuels, domestic heating furnace oils, and drained lubrication oils shall not be used.**
- **A guard, pipe protection, or approved double walled pipe shall be provided for all exposed fuel lines.**



¹Secondary filter behind or before engine fuel pump, according to engine manufacturer's specifications.

²Excess fuel can be returned to fuel supply pump suction, if recommended by engine manufacturer.

³Size fuel piping according to engine manufacturer's specifications.

FIGURE A.11.4.6 Fuel System for Diesel Engine–Driven Fire Pump.

NFPA 20 – Fuel Arrangement

- **Fuel supply and return lines shall be flame-resistant reinforced flexible hose.**
- **Fuel piping shall not be galvanized steel or copper.**
- **There shall be no shut-off in the fuel return line to the tank.**
- **The grade of fuel oil shall be indicated on the fuel tank by letters that are a minimum of 152mm (6 in) in height and in contrasting color to the tank.**

NFPA 20 – Engine Exhaust

- **Each engine shall have an independent exhaust system.**
- **A flex connector shall be used between the engine and the exhaust pipe.**
- **The flex connector shall not be used for misalignment. (The purpose of the flex is to allow for thermal expansion and for isolating engine vibration from the rest of the exhaust system.)**

NFPA 20 – Engine Exhaust

- **Back pressure in the exhaust system shall not exceed the engine's limit.**
 - **The exhaust sizing program on the Clarke website can calculate the back pressure)**
- **Building supported; not engine supported**
- **Insulation wrap the exhaust systems in-room components.**
- **Rain cap on outlet if necessary; tight connections.**
- **Exhaust system shall terminate outside where hot gases and sparks are discharged to a safe location.**

Exhaust Sizing

EXHAUST SIZING

EXHAUST BACKPRESSURE IN INCHES OF WATER (H2O) COLUMN

Step 1 : Select the Engine Model Name and RPM

Engine Series : Engine Model : RPM :
JU6H ▾ UF50 ▾ 2100 ▾

Step 2 : Enter Exhaust Pipe Data

Pipe ID (inches): # of 90° elbows: # of 45° elbows: # of Tee's: Straight Pipe (feet):
5" ▾ 2 ▾ 1 ▾ 0 ▾ 100

Step 3 : Calculate Water Volume

Calculate Results

English/Metric to Metric/English Converter	
Feet	Meter
<input type="text"/>	<input type="text"/>
Inch	Millimeter
<input type="text"/>	<input type="text"/>
°F	°C
<input type="text"/>	<input type="text"/>
<input checked="" type="radio"/> English to Metric	<input type="radio"/> Metric to English
Convert	

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Any Questions or Comments please let us know at: info@clarkefire.com

Exhaust Sizing

Exhaust Calculation Results

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EXHAUST BACKPRESSURE IN INCHES OF WATER (H2O) COLUMN

Variables	Input	Engine Data						
PIPE ID (INCHES)	5	M/N	RPM	EXH	TEMP	B	C	H2O
90 ELBOW OR Y	2			(CFM)	(°F)			
45 Elbow	1	JU6H-UF50	2100	1204	1034	3.79	0.00056	30
TEE	0							
STRAIGHT PIPE (FEET)	100							
INCHES OF WATER	14.71							

EXHAUST PIPE RECOMMENDATION

Max Allowed Backpressure: 30" of water, total system
Pipe Size: 5" ID = 14.71" of water, backpressure
Max Available Silencer Backpressure: 15.29" of water, (see note below)

NOTE: Silencer Backpressure must be added to Pipe Backpressure to get Total System Backpressure. The Silencer Manufacturer must be contacted for specific silencer backpressure data.

All Pipe Sizes & Lengths Are In Inches and Feet.

Conversion Info: millimeters (mm) x 0.03937 = inches, 3.281 feet = meter

NFPA 20 – System Operation

- **Engines shall be started no less than once a week and run for no less than 30 minutes.**
- **The fire pump shall be started and brought up to rated speed without interruption within 20 seconds.**

NFPA 20 – System Operation

- **Batteries shall be kept charged at all times and tested frequently (weekly test) to determine condition.**
- **Only distilled water shall be used.**
- **Battery plates shall be kept submerged at all times.**
- **The fuel storage tanks shall be kept as full as practical at all times, but never below 66% of tank capacity. A fuel level indicator shall be provided to activate at the 2/3rds tank level.**



**Basic Information –
Regarding Clarke Diesel Fire
Pump Drivers**

Clarke Engine Series

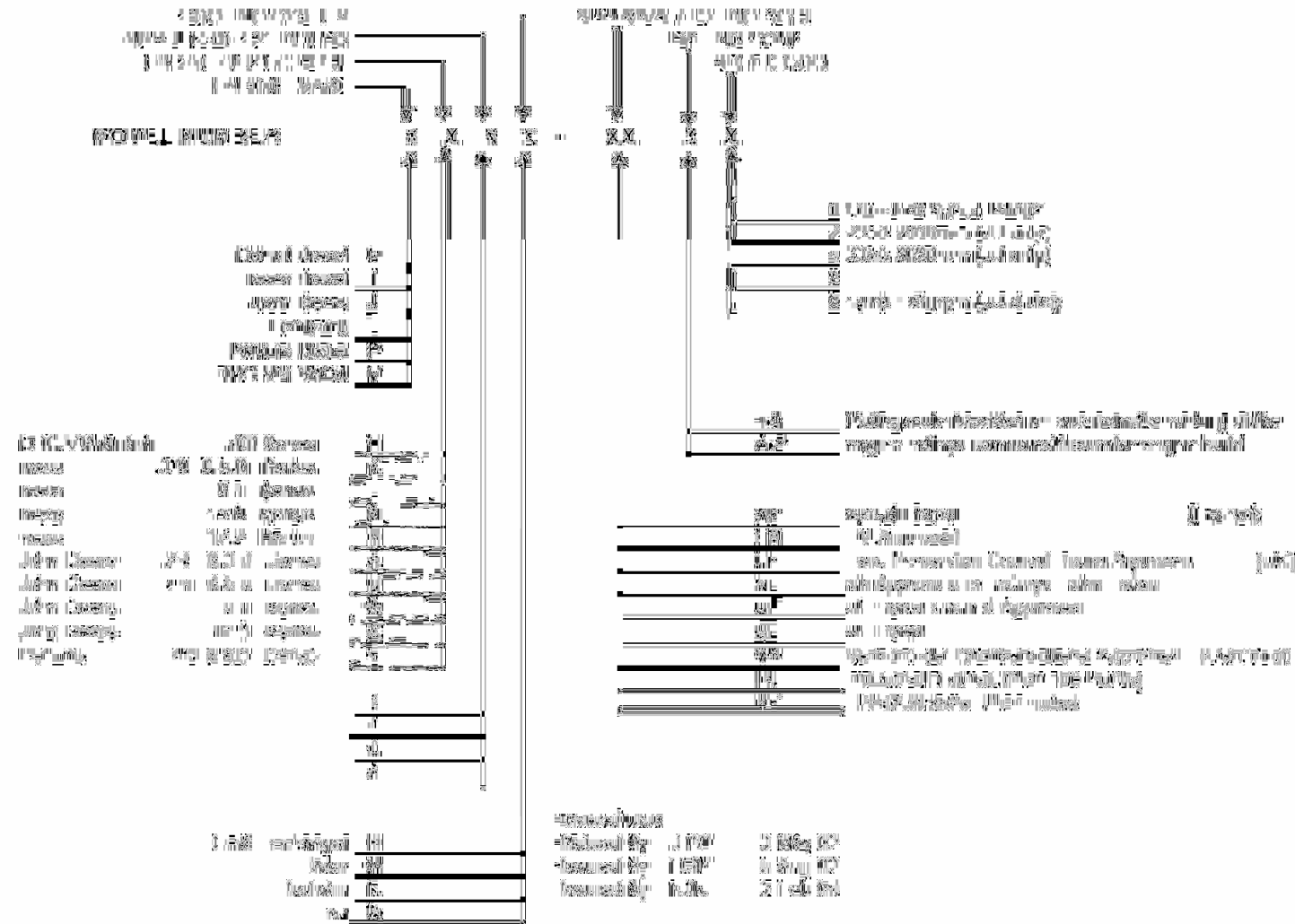
Current Models

- JU4H Series -
John Deere 4045 Series,
4 stroke cycle; Torreon,
Mexico; Saran, France
- JU6H Series -
John Deere 6068 Series,
4 stroke cycle; Torreon,
Mexico; Saran, France
- JW6H Series -
John Deere 6081 Series
4 stroke cycle; Waterloo,
Iowa USA
- JX6H Series -
John Deere 6125 Series
4 stroke cycle; Waterloo,
Iowa USA

Obsolete Models

- DDFP Series -
Detroit Diesel 53 & 92
Series, 2 stroke cycle;
Detroit, MI, USA.
- VMFP Series -
VM Motori (DDC) 700 Series
4 stroke cycle, Cento, Italy.
- IK6H/R Series -
Iveco 8000 Series,
4 stroke cycle; Milan, Italy
- PDFP Series -
Perkins 1000 Series, 4
stroke cycle, 4 & 6 cylinder
from Petersborough,
England

Clarke Model Nomenclature



NFPA 20 – System Operation

- **Oil Viscosity and Grade Specification**
- **JU4H/JU6H/JW6H/JX6H Series engines have a break in oil for the first year, afterwards require SAE 15W-40**
- **All engines are shipped with oil, unless the engine is shipped via airfreight.**

Installation and Start Up Procedure

- **Checklists on web-site for:**
 - **Engine Installation**
 - **Pre-Start-up**
 - **Start-Up**
- **Clarke Service Dealer locator on web-site.**
- **Warranty: Engine 24 mo./ Clarke components 12 mo.**
- **Special preparation for long term storage.**
- **Service parts shown on web-site.**

Installation Inspection

- **Engine Pump Alignment Check**
- **Unit properly secured & grouted**
- **Control wiring connected to junction box**
- **Batteries serviced and charged 24 hours; connected to the engine**

Installation Inspection

- **Cooling water connections properly installed on engine heat exchanger, both inlet and outlet; water solenoid operational.**
- **Exhaust System properly sized and connected**
- **Cooling System filled with premixed water and coolant conditioner.**

Installation Inspection

- **Add engine oil to proper level**
- **Fuel lines (supply and return) connected to tank and engine**
- **Fuel tank filled with clean #2 diesel, drain water and sediment from tank**
- **Engine jacket water heater connected to correct AC Power**
- **Air inlet filter installed on engine. Fresh air supply adequate for engine combustion and room ventilation.**

Start Up Inspection

- **Installation Inspection Checklist Verification**
- **Manual start at engine panel**
- **Manual start at controller**
- **Cooling water line solenoid operation**
- **Engine panel gauges operation**
- **No leaks of fuel, engine coolant, raw water or exhaust gases**
- **High coolant temperature alarm**
- **Low oil pressure alarm**
- **Overspeed shutdown verification**

Clarke Website

www.Clarkefire.com

- **Current Models**
- **Installation & Operation Data**
- **Emission Data**
- **Exhaust Sizing**
- **Operations Manual**
- **Spare Parts Illustration**
- **Installation Checklist**
- **Power Curves**
- **Installation Drawings**
- **Contact List**
- **Wiring Diagrams**
- **Technical Manual**
- **Service Dealer Directory**
- **Startup and Warranty Forms**