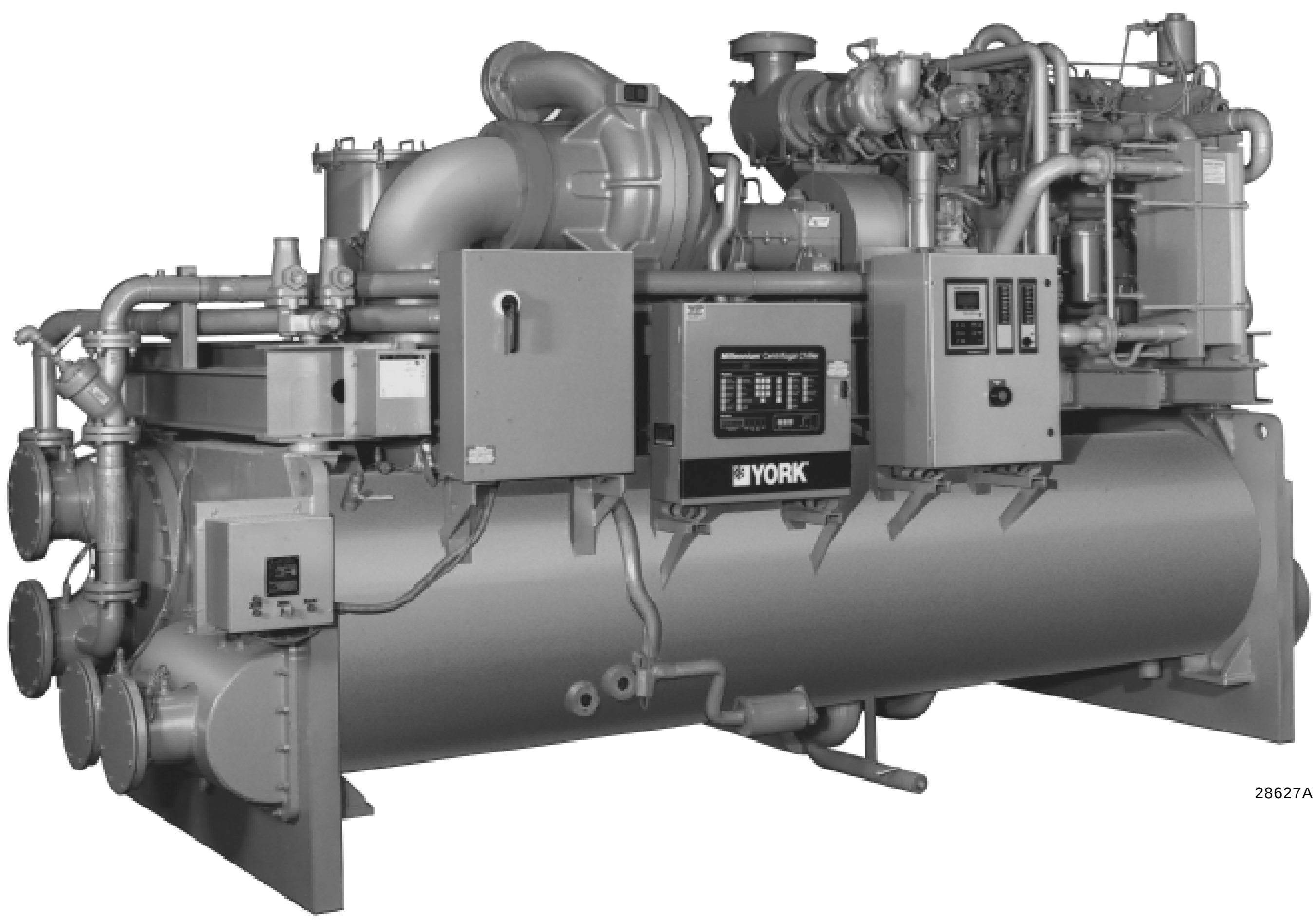
FORM 160.66-EG1 (797)

YORK®

MILLENNIUM™

Gas-Engine-Drive Chillers

Model YBMCMCG4 – G3406A



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Metric Conversions

Design Level "A"
400 TON
Utilizing HFC-134a

TABLE OF CONTENTS

INTRODUCTION 3
RATING 4
MILLENNIUM CONTROL CENTER 6
MECHANICAL SPECIFICATIONS 8
ACCESSORIES AND MODIFICATIONS 13
APPLICATION DATA 14
DIMENSIONS 19
GUIDE SPECIFICATIONS 22

NOMENCLATURE

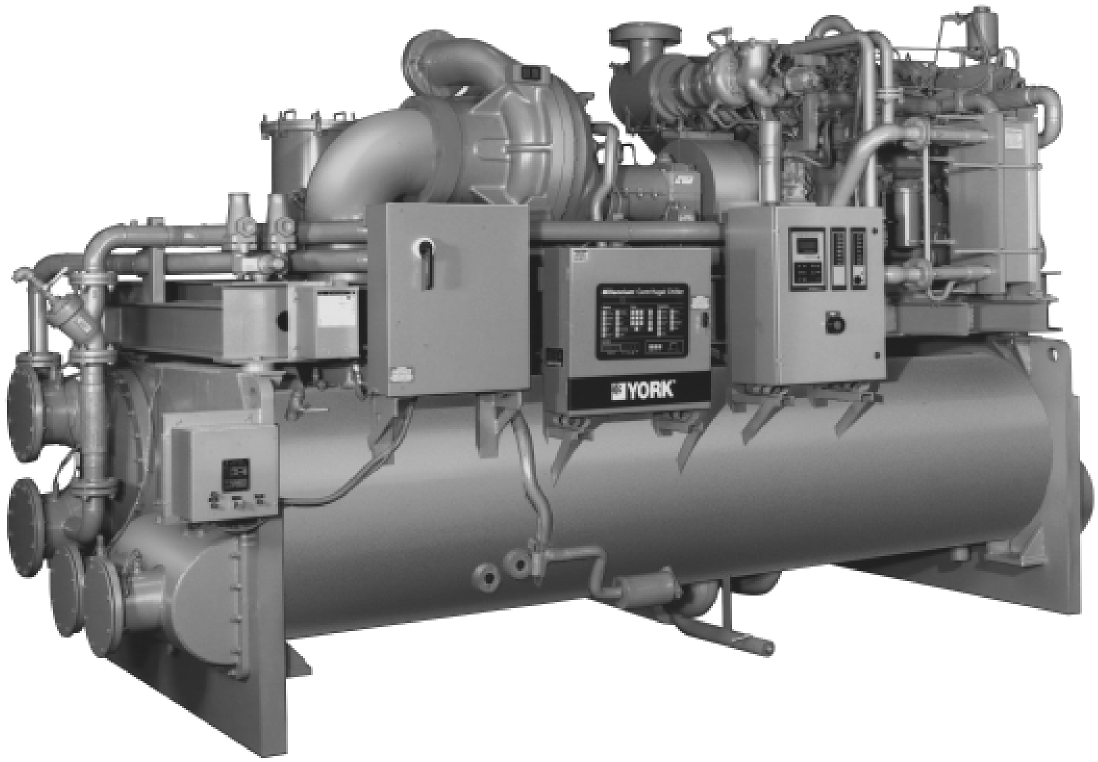
The model number denotes the following characteristics of the unit:

YB MC MC G4 – G3406 A

- YB — Model
- MC — Cooler Code
- MC — Condenser Code
- G4 — Compressor Code
- – — Power Supply: – for 60 Hz, 5 for 50 Hz
- G3406 — Engine Size
- A — Design Level

Introduction

YORK® *MILLENNIUM* ™ YB Gas-Engine-Drive Chiller 400 Tons



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YORK introduces the next evolution in its engine driven centrifugal chiller product offering – the Millennium YB Gas-Engine-Drive Chiller. The YB Chiller is an extension of the existing YG product line, specifically designed to minimize unit footprint. The unit is completely factory assembled and tested in York, PA to assure the highest levels of quality and performance. This, along with the combined experience and service of YORK and Caterpillar, bring the YB Chiller to levels of quality, reliability, efficiency, and product service required by the most demanding of applications.

HIGH EFFICIENCY RESULTS IN MAXIMUM OPERATIONAL COST SAVINGS

YB Chillers benefit from the integration of YORK's compressor and Caterpillar's engine technology to provide full load COP's as high as 1.8-1.9. Using the same patented variable-speed technology as is used in YORK's YG product line, the YB chiller can achieve partload COP's as high as 2.3. The high efficiency natural-gas-engine driven YB Chiller maximizes operational savings by avoiding the demand charges, ratchet rates and time-of-day charges associated with electrical use. And, because the engine's waste heat can be reclaimed to produce hot hater for heating, many applications will not require a boiler – saving even more money.

ENVIRONMENTALLY FRIENDLY DESIGN

The YORK YB Chiller is also an environmentally responsible choice for your cooling needs. YB Chillers operate exclusively with HFC-134a, a CFC-free refrigerant with zero ozone-depletion potential. Using clean-burning natural gas, SO_X emissions are negligible while total CO_2 emissions are less per ton-hour than an electric chiller.

Ratings

STANDARD

CHILLER	
MODEL	YBMCMCG4
CAPACITY (Tons)	400
FULL LOAD CONSUMPTION (Btu / Ton Hr)	6,277
FULL LOAD UNIT COP (HHV)	1.91
REFRIGERANT	R134a
ENGINE – Full Load Engine BHp	
CATERPILLAR ENGINE MODEL	G3406
MAX ENGINE POWER (BHp)	365
ENGINE F. L. PERFORMANCE (Btu / BHp Hr)	7,848
INLET GAS PRESSURE (PSIG)	1.5 – 5
RPM	1,800
EVAPORATOR	
FLOW (Gal / Min)	960
ENTERING TEMPERATURE (°F)	54
LEAVING TEMPERATURE (°F)	44
PRESSURE DROP (Ft H_2O)	19.3
CONDENSER	
FLOW (Gal / Min)	1,200
ENTERING TEMPERATURE (°F)	85
LEAVING TEMPERATURE (°F)	95
PRESSURE DROP (Ft H_2O)	14.8
ENGINE HX	
FLOW (Gal / Min)	130
ENTERING TEMPERATURE (°F)	85
LEAVING TEMPERATURE (°F)	105
PRESSURE DROP (Ft H_2O)	10.5
TOTAL CHILLER COOLING REQUIREMENTS	
FLOW (Gal / Min)	1,330
ENTERING TEMPERATURE (°F)	85
LEAVING TEMPERATURE (°F)	95.3
PRESSURE DROP (Ft H_2O)	14.8
HEAT RECOVERY (at 400 Tons)	
JACKET WATER (Btu / Hr)	770,700
EXHAUST TO 350°F (Btu / Hr)	365,940
PHYSICAL DATA	
MECHANICAL SOUND @ 3 Ft (dBA)*	96.5
APPROX. DIMENSIONS IN INCHES (L x W x H)	201 x 86 x 126
UNIT RIGGING WEIGHT (lbs)	31,000
UNIT OPERATING WEIGHT (lbs)	36,000

* @ ARI 575.

METRIC

CHILLER	
MODEL	YBMCMCG4
CAPACITY (kW Re)	1406
FULL LOAD CONSUMPTION (kW Fuel / kW Re)	.523
FULL LOAD UNIT COP (HHV)	1.91
REFRIGERANT	R134a
ENGINE	
CATERPILLAR ENGINE MODEL	G3406
MAX ENGINE POWER (kW)	272.3
ENGINE F. L. PERFORMANCE (kW / BkW)	3.08
INLET GAS PRESSURE (kPa)	10.3 – 34.5
RPM	1,800
EVAPORATOR	
FLOW (L / S)	60.6
ENTERING TEMPERATURE (°C)	12.2
LEAVING TEMPERATURE (°C)	6.7
PRESSURE DROP (kPa)	57.7
CONDENSER	
FLOW (L / S)	75.7
ENTERING TEMPERATURE (°C)	29.4
LEAVING TEMPERATURE (°C)	35.0
PRESSURE DROP (kPa)	44.2
ENGINE HX	
FLOW (L / S)	8.2
ENTERING TEMPERATURE (°C)	29.4
LEAVING TEMPERATURE (°C)	40.6
PRESSURE DROP (kPa)	31.4
TOTAL CHILLER COOLING REQUIREMENTS	
FLOW (L / S)	83.9
ENTERING TEMPERATURE (°C)	29.4
LEAVING TEMPERATURE (°C)	35.2
PRESSURE DROP (kPa)	44.2
HEAT RECOVERY (at 400 Tons)	
JACKET WATER (kW)	225.8
EXHAUST TO 350°C (kW)	107.2
PHYSICAL DATA	
MECHANICAL SOUND @ 3 Ft (dBA)*	96.5
APPROX. DIMENSIONS IN mm (L x W x H)	5105 x 2184 x 3200
UNIT RIGGING WEIGHT (Kg)	14,061
UNIT OPERATING WEIGHT (Kg)	16,329

COMPUTERIZED PERFORMANCE RATING

It is not practical to provide tabulated performance data for every possible set of performance conditions since the energy requirements at both full and part-load vary significantly. Computerized ratings are available through each YORK sales office. These ratings can be tailored to specific job requirements.

PART-LOAD PERFORMANCE

A chiller should be chosen not only to meet the full-load design, but also for its ability to perform efficiently at lower loads and lower tower water temperatures. It is not uncommon for chillers with the same full-load COP to have an operating cost difference of over 10% due to part-load operation.

Part-load information can be easily and accurately generated by use of the computer. And because it is so important to an owner's operating budget, this information has now been standardized in the form of an Integrated Part-Load Value (IPLV), and Application Part-Load Value (APLV).

IPLV or APLV is a single COP value that describes part-load performance of a chiller. It was originally devised to satisfy the needs of the new ANSI/ASHRAE Standard 90.1 (Standard For Energy Efficient Design of New Nonresidential And High-Rise Residential Buildings). It is based on a schedule of "typical" operating hours spent at each load point. This allows direct comparison of each manufacturer's part-load performance on an equal basis. An example of the IPLV/APLV calculation is shown below.

$$\text{IPLV or APLV} = .17A + .39B + .33C + .11D$$

WHERE: A = COP AT 100% CAPACITY
B = COP AT 75% CAPACITY
C = COP AT 50% CAPACITY
D = COP AT 25% CAPACITY

While IPLV/APLV provides a quick method of comparing part-load capabilities, this should not be construed as being "typical" for every, or even the majority of jobs. The only valid information must take into account actual building load profiles, and local weather data. Part-load performance data should be obtained for each job using its own design criteria. "YorkCalc", available at your local YORK sales representative, is an excellent tool for such evaluations.

SAMPLE APLV CALCULATIONS

STANDARD

% CAP	ECWT °F	TONS	POWER HP	BTU/HP HR	BTU/ TRHR	COP	WEIGHT (LBS)	WEIGHTED COP
100	85.00	400	322	7,799	6,278	1.91	0.17	0.324944
75	78.75	300	197	8,452	5,550	2.16	0.39	0.843243
50	72.50	200	119	9,652	5,743	2.09	0.33	0.689535
25	66.25	100	75	11,068	8,301	1.45	0.11	0.159017

IPLV COP (HHV)	2.02

METRIC

% CAP	ECWT °C	KWRE	POWER BKW	KWRE/ BKW	KWFUEL/ KWRE	COP	WEIGHT (kPag)	WEIGHTED COP
100	29.40	1,406	240.1	3.06	0.523	1.91	0.17	0.324944
75	26.00	1055	146.9	3.32	0.463	2.16	0.39	0.843243
50	22.50	703.2	88.7	3.79	0.479	2.09	0.33	0.689535
25	19.00	351.6	55.9	4.35	0.692	1.45	0.11	0.159017

IPLV COP (HHV)	2.02

MILLENNIUM Control Center

The Millennium YB Control Center, furnished as standard on each Gas-Engine-Drive Chiller, provides the ultimate in efficiency and chiller protection. State-of-the-art micro-electronics assure precise, reliable chiller control logic and safety annunciations. The Control Center allows direct interfacing with the YORK Integrated Systems Network (ISN) building automation system, allowing complete integration of chiller, airside, and building automation controls. This feature makes the YORK chiller the most versatile in the market place.

INFORMATION DISPLAY

Vital chiller operating information can be shown on the 40-character alphanumeric display. All information is in the English language with numeric data provided in English or metric units.

Information provided on all units as standard includes:

- Chilled liquid temperatures - entering and leaving
- Condenser liquid temperatures - entering and leaving
- Refrigerant pressures - evaporator and condenser
- Differential oil pressure
- % Engine load
- Operating hours @ % load bins
- Number of compressor starts
- Saturation temperatures - evaporator and condenser
- Discharge temperature
- Compressor thrust bearing oil temperature
- Engine RPM
- Engine manifold pressure
- Engine oil pressure
- Engine jacket water temperature

In addition, all operating and setpoint information can be transmitted to an optional remote printer through the RS-232 port to obtain data logs:

- At any time by pressing PRINT button
- At set time intervals by programming the panel
- Record of time and cause of safety and cycling shutdowns with all operating information just prior to shutdown
- History printout of last four shutdowns

LEAVING CHILLED WATER TEMPERATURE CONTROL

- Digital keypad entry of setpoint to 0.1°F (0.06°C).
- Verify actual vs. setpoint temperature via alphanumeric display.

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- Remote reset capability standard with YORK ISN Building Automation System, optional for other analog or discrete remote signals.
- Adjustable remote reset range (up to 20°F, 11.1°C) provides flexible, efficient use of remote signal depending on reset needs.

SYSTEM CYCLING CONTROLS

- Programmable seven-day time clock for automatic start/stop of chiller, cooler and condenser water pumps, and cooling tower.
- Separate schedule input strictly for holidays.
- Remote cycling contacts available for other field-supplied signals.

SYSTEM SHUTDOWN CONTROLS

The following safeties responsible for system shutdown are shown in English on the alphanumeric display. Each annunciation details the day, time, reason for shutdown and type of restart required. All shutdowns are sequenced by the micro board except as noted.

Cycling – those controls which automatically reset and permit auto restart of the system

- Time clock
- Low water temperature as sensed through the LWT sensor. If a drop in water temperature occurs, the unit is stopped at 4°F (2.2°C) below the chilled liquid

temperature setpoint. On a rise in water temperature, the unit restarts automatically.

- Remote/local cycling devices (field supplied).
- Multi-unit sequencing.
- Power fault relay.
- Low compressor oil temperature
- Aftercooler high inlet water temperature (Manual restart required)
- Undervoltage
- Vanes open
- Low differential compressor oil temperature

Safety – those controls which (when employed) require a manual operation to depress the STOP-RESET switch and then COMPRESSOR START to restart the system.

- Chilled water pump interlock or flow switch. Flow must be interrupted for a minimum of two seconds before shutdown will occur.
- High Compressor Discharge Temperature
  - fixed cutout provided by thermistor sensor.
- Compressor Thrust Bearing Position and Oil Temperature
  - combination proximity probe and oil temperature module shuts down compressor if either threshold limit is reached.
- High Compressor Oil Reservoir Temperature
  - fixed cutout provided by thermistor sensor. Manual restart after Power Failure (jumper plug furnished if automatic restart is desired).
- High or Low Compressor Oil Pressure
  - fixed cutout provided by differential between separate transducer readings from the compressor sump and bearing feed line.
- Low Evaporator Pressure or High Condenser Pressure
  - to avoid nuisance cycling, the compressor capacity is held at cutout threshold for a safe period of time; if condition persists, a fixed cutout is provided by dedicated transducers.
- Remote stop (field-supplied signal).
- Differential between Leaving Chilled Water and Evaporator Saturation Temperatures
  - fixed cutout when value falls outside specified range to detect faulty sensors.
- Auxiliary shutdown
- Faulty discharge temperature sensor
- Engine overload
- High engine water temperature
- Low engine oil pressure
- Evaporator transducer or probe error
- Clutch failure
- Manual engine shutdown
- Faulty compressor oil pressure transducer
- Faulty proximity probe
- Open thermocouple probe
- Engine cranking, overspeed, fault
- Engine panel shutdown
- Engine PLC failure
- Surge shutdown
- Faulty condenser pressure transducer
- Power failure (manual restart)
- Compressor overspeed

CONTROL MODE SELECTION

There are three keys for the selection of the control center modes:

- ACCESS CODE permits access to the Micro Computer PROGRAM and MODE buttons.
- PROGRAM permits the operator to program the setpoints.
- MODE permits the operator to select the following control modes:
  - LOCAL allows manual compressor start from the compressor switch located on the control center.
  - REMOTE allows remote start and stop of the compressor and remote reset of the chilled water temperature and load limit.
  - SERVICE allows manual operation of the compressor prerotation vanes and engine speed through the OPEN, CLOSE, HOLD and AUTO keys. Manual operation of the oil pump is also included.

FIELD INTERLOCKS – CHILLER STATUS

- Remote mode ready to start – contact closure indicates that the panel is in REMOTE mode and that the unit will start (all safeties and cycling devices satisfied) when a remote start signal is received.
- Cycling shutdown – contact closure indicates that a cycling shutdown has occurred and that the unit will restart when the cycling control re-closes.
- Safety shutdown – contact closure indicates that a safety shutdown has occurred and that a manual reset is required to restart.
- Run contact – closure indicates that the panel is providing a run signal to the engine.
- Remote engine load limit – PWM signal used to limit engine's demand for natural gas.

Mechanical Specifications

GENERAL

The YORK Millennium YB Gas-Engine-Drive Centrifugal Chiller is completely factory packaged including evaporator, condenser with integral subcooler, compressor, compressor lubrication system, natural gas engine, air actuated clutch, speed increaser, torsional vibration reducing coupling, power panel, engine PLC panel, Chiller Control Panel and all interconnecting unit piping and wiring. The chiller is painted with durable alkyd-modified, vinyl enamel machinery paint prior to shipment.

The initial charge of compressor oil and refrigerant (HFC-134a) will be supplied, shipped in containers and cylinders for installation by YORK. The engine and the gearbox will be charged with the initial charge of oil prior to shipment. The engine jacket glycol and battery acid will be supplied and installed by the local Caterpillar dealer.

MOUNTING BASE

The engine, speed increaser, clutch, and compressor are mounted to a common driveline base. The driveline base is of heavy duty 12" (305 mm) I-beam construction, specifically designed and built to resist deflection, maintain alignment, and to minimize linear vibration.

The driveline base is factory mounted on top of the chiller tubesheets. Four rubber isolators are installed (one at each corner of the driveline base) to isolate the driveline from the chiller shells. Spring isolators, designed for 2" (50.8 mm) deflection, are installed at each corner of the chiller shells to isolate the chiller from the workroom floor.

ENGINE

The industrial gas engine is manufactured by Caterpillar Inc. The engine is a spark-ignited, turbocharged, 6 cylinder stationary, liquid-cooled, four-cycle design, 1800 RPM, stoichiometric inline configuration. The engine is equipped with air filters, pressure gauges, lubricating oil cooler and filter, water pump and pressure gauge, service hour-meter, flywheel and flywheel housing.

Structure and Metallurgy – The design of the basic engine provides for maximum structural integrity to extend service life. Materials used in the engine incorporate the highest level of proven metallurgical and manufacturing technology.

The block is a one-piece design, cast of high tensile strength iron in the engine manufacturer's own foundry. Cylinder wear surfaces are induction hardened over their entire length. Pistons are made of a lightweight aluminum alloy which is elliptically ground across the skirt and tapered from crown to skirt. Oil jets supply piston cooling and lubricating oil. Valves are hard-faced with replaceable inserts. The crankshaft is a one piece design. Connecting rods are made of high strength steel with tapered pin bore.

Starting System – The engine has an electric starting system. The electric starting system includes 24 volt DC starting motor, starter relay, and automatic reset circuit breaker to protect against butt engagement. Batteries are maintenance free, lead acid type mounted on a corrosion resistant rack near the starting motor. (Battery acid supplied separately.) Also, a jacket water heater will be included to maintain the jacket water temperature to facilitate quick starts.

Engine Lubrication System – The lubrication oil pump is a positive displacement type that is integral with the engine and gear driven from the engine gear train. The system incorporates full flow filtration with bypass valve to continue lubrication in the event of filter clogging. The bypass valve is integral with the engine filter base. The pistons are oil cooled by continuous jet spray to the underside, inside of the crown and piston ring.

Gaseous Fuel System – The gaseous fuel system is designed for gas pressure of 1.5 - 5 PSIG (10.3 - 34.5 kPa), with an allowable fluctuation of .25 psi (1.7 kPa).The gaseous fuel system consists of gas pressure regulators and carburetors. A balance line between the regulator and engine inlet air manifold is provided to compensate for air cleaner restriction and turbocharger boost. Carburetors are of the diaphragm type with throttle body with a load screw for air-fuel ratio adjustment.

Ignition System – The unit is equipped with a magneto based breakerless ignition system.

Governor – The engine governor is a Woodward Electronic Speed Control with Flotech Electric Actuator. Speed is sensed by a magnetic pickup off the engine flywheel ring gear. A provision for remote speed adjustment is included to allow the chiller control panel to adjust engine speed based on load.

Cooling System – All waterside heat rejection from the engine is accomplished through factory piped connections from the condenser water nozzles. The engine jacket glycol cooling system is a closed circuit design with provision for filling, expansion, and de-aeration. The cooling pump is driven by the engine. The engine jacket coolant loop, aftercooler, and engine oil are cooled by the tower water through a plate and frame heat exchanger. Engine coolant temperature is internally regulated to bypass the external cooling systems until operating temperature is achieved.

Inlet Air System – The engine air cleaner is engine mounted with dry element. If external ducting is required, care should be taken to minimize the restriction associated with the combustion air inlet. The maximum allowable restriction to the combustion air inlet is 27 in H_2O (6.7 kPa).

Turbocharging – The turbocharger is of the axial turbine type driven by engine exhaust gases and direct-connected to the compressor supplying engine combustion air.

Aftercooling – An aftercooler is provided to lower the air/fuel mixture's temperature after compression. Aftercooler core air surfaces are coated with a corrosion inhibitor to minimize oxidation.

SPEED INCREASER

The system is equipped with a factory aligned speed increaser that will increase the rotating speed from the full load engine RPM to optimized RPM required by the low speed shaft of the compressor. The speed increaser is supplied with face hardened, single helical gears and anti-friction bearings.

TORSIONAL COUPLING

A torsional coupling is selected to assure that excessive torsional vibration levels are not transmitted to the gearbox and compressor at all operating speeds.

CLUTCH

The units are equipped with a drive disconnect. The drum-type clutch is air actuated and specifically designed and manufactured for heavy equipment applications. The clutch is an Airflex as manufactured by Eaton Corp. The clutch allows the engine to warm up before engaging and loading the compressor. The clutch also allows the engine to complete a cool down sequence, as recommended by Caterpillar, without the compressor being engaged. It acts as a quick disconnect in case of emergency shutdown and eliminates engine backspin. Finally, it allows engine operation and troubleshooting to be done without running the compressor, provided electricity and cooling water are supplied.

COMPRESSOR

The compressor is a single-stage centrifugal type, driven by the natural gas engine. The housing is fully accessible with vertical circular joints. The complete operating assembly is removable from the compressor and scroll housing. Compressor castings are designed for a minimum working pressure of 200 PSIG (1379 kPa g) and hydrostatic pressure tested at a minimum of 300 PSIG (2068 kPa g). The rotor assembly consists of a heat treated alloy steel drive shaft and impeller shaft with a cast aluminum, fully shrouded impeller. The compressor shaft is laser aligned to the speed increaser at the YORK factory. The impeller is designed for balanced thrust, and is dynamically balanced and overspeed tested for smooth, vibration-free operation. Insert type journal bearings are fabricated of aluminum alloy, precision bored and axially grooved.

Internal single helical gears with crowned teeth are designed so that more than one tooth is in contact at all times to provide even distribution of the compressor load. Each gear is individually mounted in its own journal and thrust bearings to isolate it from impeller and drive forces.

The open drive compressor shaft seal consists of a spring loaded, precision carbon ring, high temperature elastometer "O" ring static seal, and stress relieved, precision lapped collars. The seal features a small face area and low rubbing speed. It provides an efficient seal under high pressure conditions. The seal is oil flooded at all times and pressure-lubricated during compressor operation.

COMPRESSOR LUBRICATION SYSTEM

Lubrication oil is force-fed to all bearings, gears, and rotating surfaces by an oil pump which operates prior to start-up and continuously during operation and during coastdown. A gravity-fed oil reservoir is built into the top of the compressor to provide lubrication during coastdown in the event of a power failure. An oil reservoir, separate from the compressor, contains a submersible oil pump and two immersion-type oil heaters, thermostatically controlled to remove refrigerant from the oil.

Mechanical Specifications

Oil is filtered by an externally mounted replaceable cartridge oil filter equipped with service valves, and cooled by a refrigerant cooled oil cooler before entering the compressor. Oil piping on the driveline is completely factory installed and tested.

EVAPORATOR

The evaporator is of the flooded shell-and-tube type, designed for 180 PSIG (1241 kPa g) working pressure on the refrigerant side, and tested at 270 PSIG (1862 kPa g). The shell is fabricated from rolled carbon steel plate with fusion welded seams; has carbon steel tube sheets, drilled to accommodate the tubes; and intermediate tube supports spaced no more than three feet apart (914 mm). The refrigerant side is designed, tested and stamped in accordance with ASME Boiler and Pressure Vessel Code, Section VIII-Division 1.

Tubes are high efficiency, externally and internally enhanced type. Each tube is roller expanded into tube sheets providing a leak-proof seal. Tubes are 3/4" (19 mm) O.D., 22 BWG, copper alloy and are individually replaceable. Two liquid level sight glasses are located on the side of the shell to aid in determining proper refrigerant charge. The evaporator has two refrigerant relief devices sized to meet the requirements of ASHRAE 15 Safety code for Mechanical Refrigeration.

Water boxes are removable to permit tube cleaning and replacement. Stubout water box connections with 150 lb ANSI raised face flanges are provided. Water boxes are designed for 150 PSIG (1034 kPa g) design working pressure and tested at 225 PSIG (1551 kPa g). Plugged 3/4" (19 mm) vent and drain connections are provided in each water box.

Factory-applied thermal insulation of the flexible, closed-cell plastic type, 3/4" (19 mm) thick is attached with vapor-proof cement to the cooler shell, flow chamber, tube sheets, suction connection, and (as necessary) to the auxiliary tubing. Not included is the insulation of compact water boxes and nozzles.

CONDENSER

The condenser is of the shell-and-tube type, designed for 180 PSIG (1241 kPa g) working pressure on the refrigerant side, and tested at 270 PSIG (1861 kPa g). The shell is fabricated from rolled carbon steel plate with fusion welded seams; has carbon steel tube sheets, drilled to accommodate the tubes; and intermediate tube supports spaced no more than four feet apart (1219 mm). An integral refrigerant subcooler is provided for improved cycle efficiency. The refrigerant side is designed, tested and stamped in accordance with ASME Boiler and Pressure Vessel Code, Section VIII-Division 1. Tubes are high efficiency, externally and internally enhanced type. Each tube is roller expanded into tube sheets providing a leak-proof seal. Tubes are 3/4" O.D. (19 mm), 22 BWG, copper alloy and are individually replaceable.

Water boxes are removable to permit tube cleaning and replacement. Stubout water box connections with 150 lb ANSI raised face flanges are provided. Water boxes are designed for 150 PSIG (1034 kPa g) design working pressure and tested at 225 PSIG (1551 kPa g). Plugged 3/4" (19 mm) vent and drain connections are provided in each water box. Condenser water boxes also include factory supplied and piped connections for cooling water to the plate frame heat exchanger to cool engine aftercooler and engine jacket glycol.

REFRIGERANT FLOW CONTROL

Refrigerant flow to the evaporator is controlled by a single variable orifice. The variable orifice automatically adjusts to maintain proper refrigerant level in the condenser and evaporator. This optimizes unit performance at varying load and temperature conditions and allows capacity above design at off-design conditions.

MICROCOMPUTER CONTROL CENTER

The unit is furnished complete with a MicroComputer Control Center in a locked enclosure. The chiller is controlled through a single panel. The panel has the capability to control inlet guide vane position as well as engine speed in response to chiller load requirements. The control center includes a 40 character alphanumeric display showing all system parameters in the English language with numeric data in English or metric units.

Digital programming of setpoints through a color coded, non-tactile keypad includes: leaving chilled liquid temperature, percent engine load limit, seven day time clock for starting and stopping chiller and pumps, (complete with holiday schedule), remote reset temperature range, and data logger.

Security access is provided to prevent unauthorized change of setpoints, to allow local or remote control of the chiller, and to allow manual operation of the prerotation vanes and compressor oil pump.

All safety and cycle shutdowns are annunciated through an alphanumeric display and consist of day, time, cause of shutdown, and type of restart required. Safety shutdowns include: low evaporator pressure, high condenser pressure, auxiliary safety, high discharge temperature, faulty discharge temperature sensor, high compressor oil temperature, power failure, engine overload, loss of chilled water flow, high engine water temperature, low engine oil pressure, low compressor oil pressure, high compressor oil pressure, evaporator transducer or probe error, clutch failure, manual engine shutdown, faulty compressor oil pressure transducer, proximity sensor fault, high speed thrust bearing oil drain temperature, faulty proximity probe, open thermocouple probe, engine cranking, engine fault, engine overspeed, compressor overspeed, engine PLC fault, engine panel shutdown, faulty condenser, and pressure transducer. Cycling shutdowns will include: low compressor oil temperature, power failure (auto restart), low chilled water temperature, remote unit cycling, multi-unit cycling, internal time clock, vanes open, compressor low differential oil temperature, DC undervoltage, high aftercooler water temperature (manual restart required), remote stop (field-supplied signal), remote/local cycling device, and multi-unit sequencing.

System operating information includes: return/leaving chilled liquid temperature, return/leaving condenser liquid temperatures; evaporator/condenser refrigerant pressures; differential compressor oil pressure, percent engine load, engine RPM, engine manifold pressure, evaporator/condenser saturation temperatures; compressor discharge temperature; compressor oil temperature; operating hours; and number of starts counter, engine oil pressure, engine jacket temperature and engine speed.

The chiller is provided with an RS-232 port to output all system operating data, shutdown/cycling messages, and a record of the last four cycling or safety shutdowns to a remote printer (field supplied). The control center is programmable to provide data logs to the optional printer at a preset time interval.

The Control Center is able to interface with a building automation system to provide remote chiller start/stop; reset of chilled water temperature; remote engine load limit; and status messages indicating chiller is ready to start, chiller is operating, chiller is shut down on a safety requiring a manual reset, and chiller is shut down on a cycling safety.

The operating program is stored in nonvolatile memory (EPROM) to eliminate chiller failure due to AC power failure/battery discharge. In addition, programmed setpoints are retained in lithium battery-backed TRC memory for a minimum of 5 years.

VARIABLE SPEED CONTROL

Capacity control is achieved by use of prerotation vanes and varying engine speed. Capacity control logic is matched to the specific chiller/compressor system. Control logic continually integrates the actual chiller operating conditions, including chilled water temperature and temperature setpoint, evaporator and condenser refrigerant pressures, engine speed and prerotation vane position. Prerotation vane position and engine speed are automatically controlled by the panel to maintain leaving chilled liquid temperature at the desired setpoint. Engine speed is set to optimize system energy efficiency. The unit is capable of operating at full and part load conditions with lower cooling tower water temperatures (down to 55°F / 12.8°C) at design condenser water flow rates. Prerotation vane position is automatically controlled by an external electric actuator.

POWER PANEL

The power panel enclosure houses the following components: single point wiring connection for incoming AC power supply; fused disconnect switch, compressor oil pump motor starter with overloads; heater relay; circuit breakers for 115VAC, 50/60 Hz, 3KVA control supply transformer.

NATURAL GAS ENGINE CONTROLS

Engine sensors include: engine oil pressure, jacket water temperature, RPM, and inlet manifold pressure. As part of the engine control/safety system, the engine and related components are monitored and provided with gauges or safety shutdowns to protect against any system failures. The safety shutoffs are low oil pressure, high water temperature, low jacket water level, and overspeed.

WATER STRAINERS

A water strainer of 1/16" (1.6 mm) mesh is factory installed in the plate frame cooling water inlet. A water strainer of max 1/8" mesh must be installed in the tower water circuit, as close to the condenser inlet as possible. A water strainer of maximum 1/8" (3 mm) mesh may be installed in the chilled water inlet as close as possible to the chiller if desired. Contact YORK Marketing for details.

ISOLATION MOUNTING

The entire unit is provided with industrial vibration isolation mounts. These level adjusting, spring type isolators are mounted on the tubesheets and are designed for two inch (50.8 mm) deflection.

TESTING

Prototype Testing – Specific prototype tests include:

ENGINE:

- Performance (part load, full load)
- Oil Consumption
- Fuel Consumption
- Exhaust Emissions
- Noise Levels (mechanical and exhaust)
- Startability (cold and hot ambients)
- Piston, Ring, and Liner Wear Rates
- Piston Structural Integrity
- Lubrication System Evaluation
- Cooling System Evaluation
- Valve Train Overspeed Qualification
- Deep Thermal Cycle Endurance
- Field Endurance

CHILLER ASSEMBLY:

- Mechanical Compatibility
- Structural Integrity
- Mounting Evaluation
- Wiring Compatibility
- Control Panel Functionality
- Linear Vibration Measurement
- Torsional Vibration Analysis
- Load Performance
- Safety Shutdowns and Alarms
- Start-Stop Evaluations

Production Testing – The refrigerant compressor is air run tested prior to mounting on the chiller. The engine is run tested at full and part loads prior to assembly of the chiller. After assembly, the chiller package may be factory performance tested (if customer purchased) in YORK's test facility. A certified report of these tests is available if requested at the time of a chiller order which includes the factory performance testing.

START-UP AND OPERATOR TRAINING

Factory-trained field service representatives will supervise the final leak testing, charging and the initial start-up, including driveline alignment. The complete installation will be checked for procedural and operational compliance by a factory trained service representative from YORK. YORK will retain factory trained service representatives from Caterpillar to provide start-up service and operator instruction for the gas engine.

WARRANTY AND SERVICE

The standard warranty is for a period of one year from the date of start-up or eighteen months from shipment, whichever occurs first. The warranty includes parts and labor during this period. This warranty does not include parts an labor required for routine maintenance, such as oil filters, air filters, oil, etc. This service is only to be performed by YORK and Caterpillar factory trained and authorized service personnel. YORK has a local direct service office that will provide factory trained servicemen, the required stock of replacement parts, technical assistance, and warranty administration. Engine maintenance will only be performed by Caterpillar's local, factory trained and authorized representative. YORK service is the prime customer contact. Engine Maintenance / Warranty administration will only be performed through the local YORK service office by Caterpillar's local, factory trained and authorized representative.

Accessories and Modifications

BAS REMOTE CONTROL

A communication interface permitting complete exchange of chiller data with any BAS System is available with optional translator. Translator also allows BAS System to issue commands to the chiller to control its operation. Translators come in two models, controlling up to 4 chillers and 8 chillers respectively.

OIL PRE-LUBE PUMP

This option provides a factory installed and tested continuous pre-lube oil pump. This pump will lubricate engine components prior to engine start.

WATER FLOW SWITCHES

These are paddle-type, vapor-proof water flow switches suitable for 150 PSIG (1034 kPa g) DWP for chilled and condenser water circuits. Switch for 115V-1-60 service. A chilled water flow switch is required. Condenser water flow switch is optional.

SEQUENCE CONTROL KIT

For two, three or four units with chilled water circuits connected in series or parallel, the kit consists of return water thermostat, lead-lag selector switch for sequence starting, and time delay relay, with NEMA-1 enclosures, 115V-60 service.

AIR START SYSTEM

The air starting system will include air starting motor(s), silencer, start valve, and pressure regulator. The system shall have an operating pressure of 100 PSIG. DC power will be supplied to the engine PLC panel by a Regulated DC power supply mounted on the unit.

REMOTE RESET CONTROLS

Option board card file allows for continuous reset of either leaving chilled water temperature or percent engine load with Building Automation System. 4 to 20mA, 0 to 10VDC, or discrete stepped signals can be wired directly to panel terminal block on the card file without any external interfacing.

VICTAULIC CONNECTIONS

Stub-out water nozzle connections with victaulic grooves. Nozzles are suitable for either victaulic or welded connections and are capped for shipment.

REFRIGERANT STORAGE / RECYCLING SYSTEM

A refrigerant storage/recycling system is a self-contained package consisting of a refrigerant compressor with oil separator, storage receiver, water-cooled condenser, filter drier and necessary valves and hoses to remove, replace and distill HFC-134a. All necessary controls and safety devices are a permanent part of the system.

OPTIONAL TUBES

Standard tubes for this unit will be 3/4" O.D., 22 BWG (.028" wall Cu). Optional tubes are available. (Contact factory.)

Application Data

LOCATION

The YB Gas-Engine-Drive chiller operating weight should be considered when choosing the unit location. In selecting a site, consider structural support, access for service, and tube pull area. The unit site must be a floor, mounting pad or foundation which is level within 1/4" (6.4 mm) and capable of supporting the operating weight of the unit.

Sufficient clearance is required to permit normal service and maintenance work. A minimum of 36" (914 mm) should be provided all around and above the unit. Additional space equal to the shell length should be provided at one end of the unit to permit cleaning and removal of cooler and condenser tubes as required. A doorway or other properly located opening may be used.

The standard chiller should be installed in an indoor location where the temperature ranges from 50°F to 110°F (10°C to 43.3°C).

VENTILATION

The ASHRAE Standard 15 Safety Code for Mechanical Refrigeration requires that all machinery rooms be vented to the outdoors utilizing mechanical ventilation by one or more power-driven fans. This standard, plus National Fire Protection Association Standard 90A, state, local, and other codes should be checked for specific requirements. These requirements should be compared to the requirements for engine ventilation to ensure the equipment room is properly ventilated. (See Form 160.60-AD1)

An engine converts fuel into shaft horsepower and heat. This heat is removed through the jacket water system, aftercooler, exhaust gas system, and radiation from engine surfaces. As a result, engine drives require different installation considerations than electric motors.

Engine Driven Chiller equipment room considerations should include the following:

Fuel Supply – Natural gas fuel is a mixture of several gases, each having different characteristics (heat value, specific gravity, etc.). The composition of natural gas varies, but usually contains large amounts of methane, a smaller amount of ethane, and traces of other hydrocarbons. The amount of combustion air required will vary with the gas mixture provided by the local utility. The consumer must provide gas piping to the fuel inlet of the chiller driveline. (Gas pressure required per Table 1 and Table 1A.) If other than pipeline natural gas is used as the fuel source, contact your local YORK sales office for project specific requirements.

Engine Radiation – Three to six percent of the input energy (fuel) is typically lost as heat radiated to the surrounding air. The removal of this radiated heat causes an additional ventilation requirement that is added to the combustion air. (Maximum radiation value is provided in Table 1 and 1A.)

Exhaust Systems – The waste gases produced by the engine must be exhausted from the equipment room. See Form 160.60-AD1 for Exhaust Duct Details. Exhaust systems must be designed and installed to discharge exhaust gases as quickly and silently as possible with a minimum amount of backpressure. Excessive

TABLE 1 – FULL LOAD ENGINE DATA

STANDARD

RPM	1800
Max. BHP	365
Full Load Btu/Bhp Hr. (HHV)	7848
Required Combustion Air (SCFM)	540
Required Inlet Gas Pressure (psig)	1.5 - 5 ± .25 max.
Max Exhaust Backpressure (IN. WC)	27
Exhaust Flow (Lb/Hr)	2412
Exhaust Temp (°F)	986
Radiated Heat (MBH)	115
Recoverable Jacket (MBH)	856
Recoverable Exhaust Heat (MBH)	430
NO_x Emissions (gram/BHP Hr)	17.4

TABLE 1A – FULL LOAD ENGINE DATA

METRIC

RPM	1800
Max. kW	272.3
Full Load Btu/Bhp Hr. (HHV)	3.08
Required Combustion Air (L /S)	255
Required Inlet Gas Pres. (kPa g)	10.3-34.5 ± 1.7 max.
Max Exhaust Backpressure (KPa)	6.7
Exhaust Flow (Kg / Hr)	1094
Exhaust Temp (°C)	530
Radiated Heat (kW)	33.6
Recoverable Jacket (kW)	251
Recoverable Exhaust Heat (kW)	126
NO_x Emissions (gram / kW)	23.3

TABLE 2 – WATER FLOW RATE LIMITS (GPM)

		MINIMUM	MAXIMUM
COOLER	1-Pass	1006	3626
	2-Pass	503	1813
	3-Pass	335	1209
CONDENSER	2-Pass	916	2834

TABLE 2A – WATER FLOW RATE LIMITS (L/S)

		MINIMUM	MAXIMUM
COOLER	1-Pass	63.5	228.8
	2-Pass	31.7	114.4
	3-Pass	21.1	76.3
CONDENSER	2-Pass	57.8	178.8

backpressure can cause horsepower losses and exhaust temperature increases. (Exhaust flow, temperature and maximum back pressure are provided in Table 1 and 1A.)

Heat Recovery – Heat is produced as a byproduct of combustion. 20% to 50% of the input energy to the engine must be removed by the cooling system. Engine heat is rejected into the oil cooler and engine jacket water. The YORK driveline is provided with a unit mounted heat exchanger that has been sized and preplumbed and tested at the factory to reject the heat from these sources to the cooling tower. (Tower water flow and temperature are provided on page 4.) Heat can be recovered from the engine jacket water and the exhaust gas (minimum leaving exhaust temperature of 350°F / 176.7°C). Heat recovery can significantly increase the thermal efficiency of the system.

Cranckcase Fumes – Normal combustion pressures of the internal combustion engine cause a certain amount of blowby past the piston rings into the crankcase. To prevent pressure buildup in the crankcase, vent tubes are provided on the engine to allow the gas to escape. Crankcase gases must be discharged to the atmosphere and not into the equipment room. A separate ventilation system for the crankcase must be installed to connections provided on the engine to remove the blowby gases from the workroom.

Clutch Air Supply – A regulated clean air supply sufficient to provide 7SCFM @ 125 PSIG (3.3 L / S @ 861 kPa g) is required for pressurization of the air clutch. Instrument quality air is not required.

ENGINE STARTER

The YB chiller is provided with factory mounted electric engine starting systems. Electric starting is the most convenient, and adaptable for remote control and automation. The electric starting system includes a starting motor, batteries, battery pack and charger. Each of these items is discussed in detail in Form 160.60-AD1.

WATER CIRCUITS

Temperature Ranges – For normal water chilling duty, leaving chilled water temperatures may be selected between 40°F and 50°F (4.4°C and 10°C) for water temperature ranges between 3°F and 20°F (1.6°C and 11.1°C). Contact YORK marketing for applications outside this range.

Water Quality – The practical and economical application of liquid chillers requires that the quality of the water supply for the condenser and cooler be analyzed by a water treatment specialist. Water quality may affect the performance of any chiller through corrosion, deposition of heat-resistant scale, sedimentation or organic growth. These will hurt chiller performance and increase operating and maintenance costs. Normally, performance may be maintained by corrective water treatments and periodic cleaning of tubes. If water conditions exist which cannot be corrected by proper water treatment, it may be necessary to provide a larger allowance for fouling, and/or to specify special materials of construction.

General Piping – All chilled water and condenser water piping should be designed and installed in accordance with accepted piping practice. Chilled water and condenser water pumps should be located to discharge through the chiller to assure positive pressure and flow through the unit. Piping should include offsets to provide flexibility and should be arranged to prevent drainage of water from the cooler and condenser when the pumps are shut down. Piping should be adequately supported and braced independent of the chiller to avoid the imposition of strain on chiller components. Hangers must allow for alignment of the pipe. Isolators in the piping and in the hangers are highly desirable in achieving sound and vibration control.

Convenience Considerations – With a view to facilitating the performance of routine maintenance work, some or all of the following steps may be taken by the purchaser. Cooler and condenser water boxes are equipped with plugged vent and drain connections. If desired, vent and drain valves may be installed with or without piping to an open drain. Pressure gauges with stop cocks, and stop valves, may be installed in the inlets and outlets of the condenser and chilled water line as close as possible to the chiller. An overhead monorail or beam may be used to facilitate servicing.

Connections – The standard chiller is designed for 150 PSIG working pressure in both the chilled water and condenser water circuits. The connections (water nozzles) to these circuits are furnished with 150 # ANSI raised face flanges. Piping should be arranged for ease of disassembly at the unit for performance of such routine maintenance as tube cleaning. All water piping should be thoroughly cleaned of all dirt and debris before final connections are made to the chiller. Connections include single point electrical power connection, gas supply connection, cooling water connection, exhaust, crankcase ventilation, clutch air supply, and air start supply (if applicable), chilled water connection.

Chilled Water – The chilled water circuit should be designed for constant flow. A flow switch must be installed in the chilled water line of every circuit. The switch must be located in the horizontal piping close to the unit, where the straight horizontal runs on each side of the flow switch are at least five pipe diameters in length. The switch must be electrically connected to the chilled water interlock position in the unit control center. A water strainer of maximum 1/8" (3 mm) mesh can be field-installed in the chilled water inlet line as close as possible to the chiller. If located close enough to the chiller, the chilled water pump may be protected by the same strainer. The flow switch and strainer assure chilled water flow during unit operation. The loss or severe reduction of water flow could seriously impair the chiller performance or even result in tube freeze-up.

Condenser Water – The condenser water circuit should be designed for constant flow. A flow switch should be installed in the condenser water line of every circuit. The switch must be located in the horizontal piping close to the unit, where the straight horizontal runs on each side of the flow switch are at least five pipe diameters in length. The switch must be elec-trically connected to the condenser water interlock position in the unit control center. A water strainer of maximum 1/8" (3 mm) mesh must be field-installed in the condenser water inlet line as close as possible to the chiller. If located close enough to the chiller, the condenser water pump may be protected by the same strainer. The flow switch and strainer assure con-denser water flow during unit operation. The loss or severe reduction of water flow could seriously impair the chiller performance or even result in tube freeze-up.

The chiller is engineered for maximum efficiency at both design and part load operation by taking advantage of the colder cooling tower water temperatures which naturally occur during the winter months. Appreciable power savings are realized from these reduced heads. Exacting control of condenser water temperature, requiring an expensive cooling tower bypass, is not necessary for most applications.

For the usual full load design of 10°F (5.5°C) condenser water temperature range, the chiller only requires that the minimum entering condenser water temperature be at least 7°F (3.9°C) higher than the leaving chilled water temperature.

The minimum entering condenser water temperature for other full and part load conditions is provided by the following equation:

Min. ECWT = LCHWT – C RANGE + 17

Where:

ECWT = entering condensing water temperature

LCHWT = leaving chilled water temperature

C RANGE = condensing water temperature range

At initial startup, entering condensing water temperature may be as much as 25°F (13.9°C) colder than the standby chilled water temperature. Cooling tower fan cycling will normally provide adequate control of entering condenser water temperature on most installations, to keep above the minimum temperature. Cycling for any other reason will cost significantly more HP than what is saved on the tower fans and pumps.

Additional tower water is required for engine cooling. This is factory piped to the condenser cooling water connections. Maximum water temperature allowable to the heat exchanger is 85°F (29.4°C). Water flows and temperatures for the engine are provided in Table 1 and 1A.

MULTIPLE UNITS

Many applications require multiple units to meet the total capacity requirements as well as to provide flexibility and some degree of protection against equipment shutdown. There are several common unit arrangements for this type of application. The Millennium chiller has been designed to be readily adapted to the requirements of these various arrangements.

Parallel Arrangement (Refer to Fig. 1) **–** Chillers may be applied in multiples with chilled and condenser water circuits connected in parallel between the units. Assuming two units of equal size, each will reduce in capacity as the load decreases to about 40% of the total capacity, at which point one of the units will be shut down by a sequence control.

Assuming chilled water flow to the inoperative unit is stopped by pump shutdown and/or a closed valve, the remaining unit will pick up the total remaining load and continue to reduce in capacity as the load decreases. The unit will cycle off on the low chilled water temperature control when the load reduces below minimum unit capacity. The controls can maintain constant (+/– .5°F / .28°C) leaving chilled water temperature at all loads.

If chilled water continues to flow through the non-operating unit, the chilled water flowing through the operating unit will mix with the water leaving the non-operating unit to produce a common water supply to the load. Since control of the operating unit is from its own leaving chilled water temperature, the common temperature to the load will rise above the full load design temperature. This higher chilled water temperature occurs below 40% load when the dehumidification load in normal air conditioning applications is usually quite low. In such instances, this temperature rise will save additional energy.

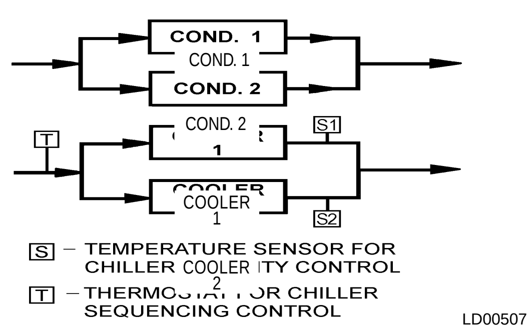
The running time may be apportioned between both units by alternating the shutoff sequence.

Series Arrangement (Refer to Fig. 2) **–** Chillers may be applied in multiples with chilled water circuits connected in series and condenser water circuits connected in parallel. All of the chilled water flows through both coolers with each unit handling approximately one-half of the total load. When the load decreases to about 40% of the total capacity, one of the units will be shut down by sequence control. Since all water is flowing through the operating unit, that unit will cool the water to the desired temperature.

REFRIGERANT RELIEF PIPING

Each chiller is equipped with a dual pressure-relief valve. The purpose of the relief valve is to quickly relieve excess pressure of the refrigerant charge to the atmosphere, as a safety precaution in the event of an emergency such as fire. They are set to relieve at an internal pressure of 180 psig, are located on the cooler and are provided in accordance with the ASHRAE 15 Safety Code and ASME Code for Unfired Pressure vessels.

Sized to the requirements of applicable codes, a vent line must run from the relief device to the outside of the building. This refrigerant relief piping must include a cleanable, vertical-leg dirt trap to catch vent-stack condensation. Vent piping must be arranged to avoid imposing a strain on the relief connection and should include one flexible connection.



S – Temperature Sensor For Chiller Capacity Control
T – Thermostat For Chiller Capacity Control

FIG. 1 – PARALLEL COOLERS
PARALLEL CONDENSERS

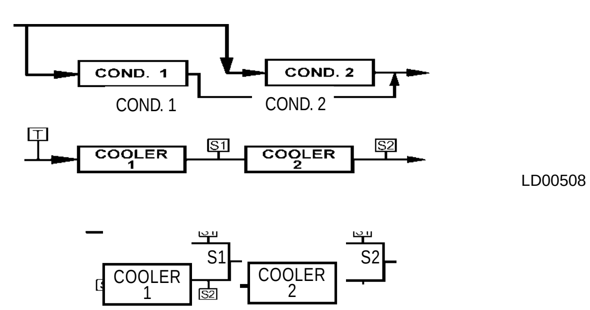


FIG. 2 – SERIES COOLERS
PARALLEL CONDENSERS

VIBRATION AND SOUND CONSIDERATIONS

A Gas-Engine-Drive Millennium chiller is not a source of objectionable vibration in normal air conditioning applications. The unit is furnished with vibration isolation in the form of spring isolators on the chiller tubesheets.

Control of sound and vibration transmission must be taken into account in the equipment room construction as well as in the selection and installation of the equipment. Sound attenuation may be required for equipment room, exhaust gas systems, or mechanical noise. The design of the equipment room should address these sources of noise. (Additional information is provided in Form 160.60-AD1)

Millennium chiller sound pressure level ratings per ARI 575 will be furnished on request.

THERMAL INSULATION

No appreciable operating economy can be achieved by thermally insulating the chiller. However, the chiller's cold surfaces should be insulated with a vapor barrier insulation sufficient to prevent condensation. Insulation requirements are provided in Table 3.

TABLE 3 – COOLER INSULATION REQUIREMENTS

WATERBOX	(SQ. FT.)	(SQ. M)
STANDARD	280	26

Muffler and exhaust pipe insulation is recommended to minimize radiation from these sources to the chiller room. This will minimize ventilation requirements. This is not covered by the scope of supply of York International.

ELECTRICAL DATA

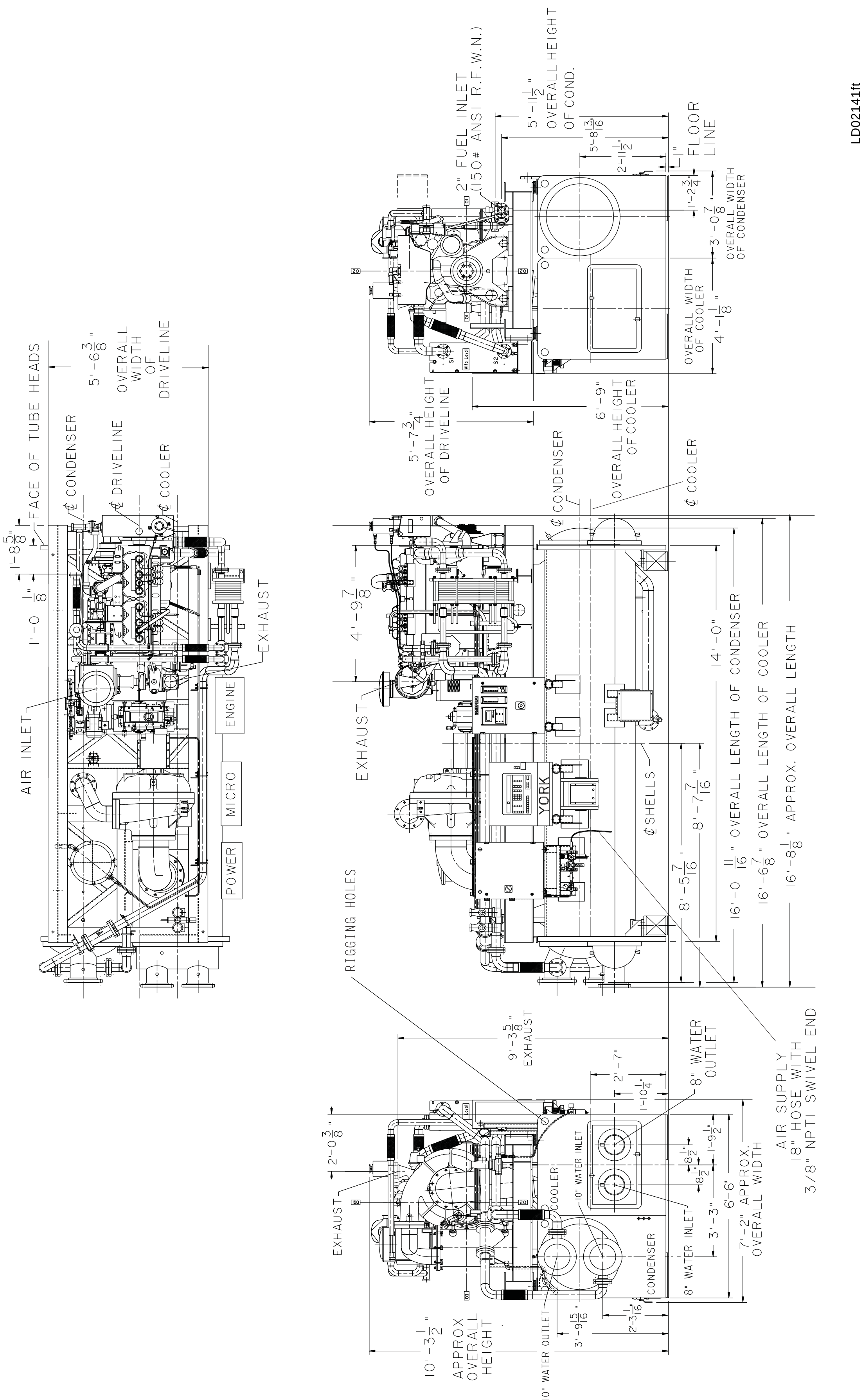
Table 4 contains unit electrical data.

TABLE 4 – ELECTRICAL REQUIREMENTS

AC POWER PANEL LUG SIZE RANGE	#14 - #4
JACKET WATER HEATER KW	6
MINIMUM CIRCUIT AMPACITY	17.1
MINIMUM FUSE SIZE	25
MAXIMUM FUSE SIZE	30

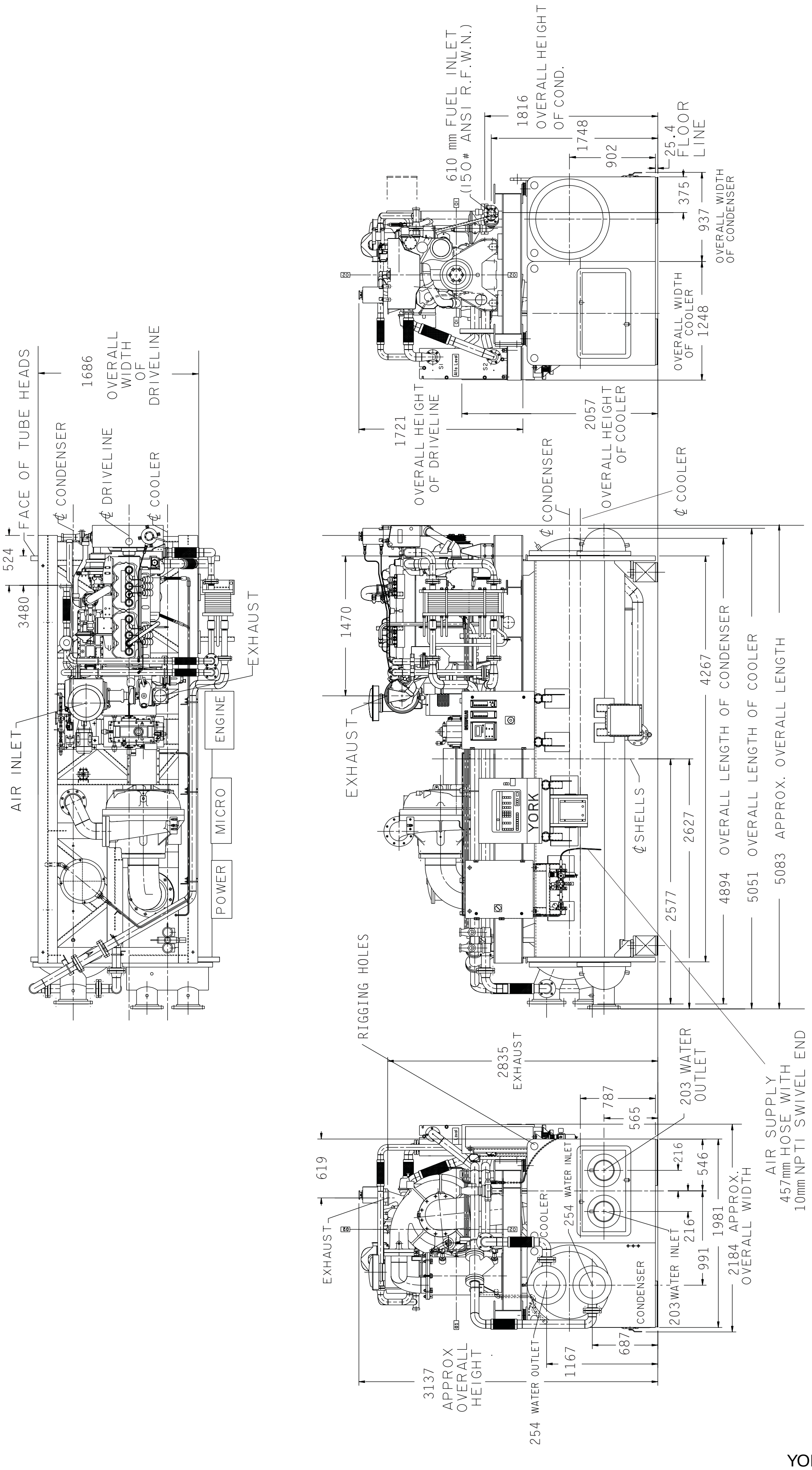
NOTE: All values are for 460V – 3-Phase – 60 Hz electrical service.

Dimensions (Ft. - Ins.)



NOTE: 2-Pass Cooler and Condenser shown. For other Pass arrangements, see Page 21.

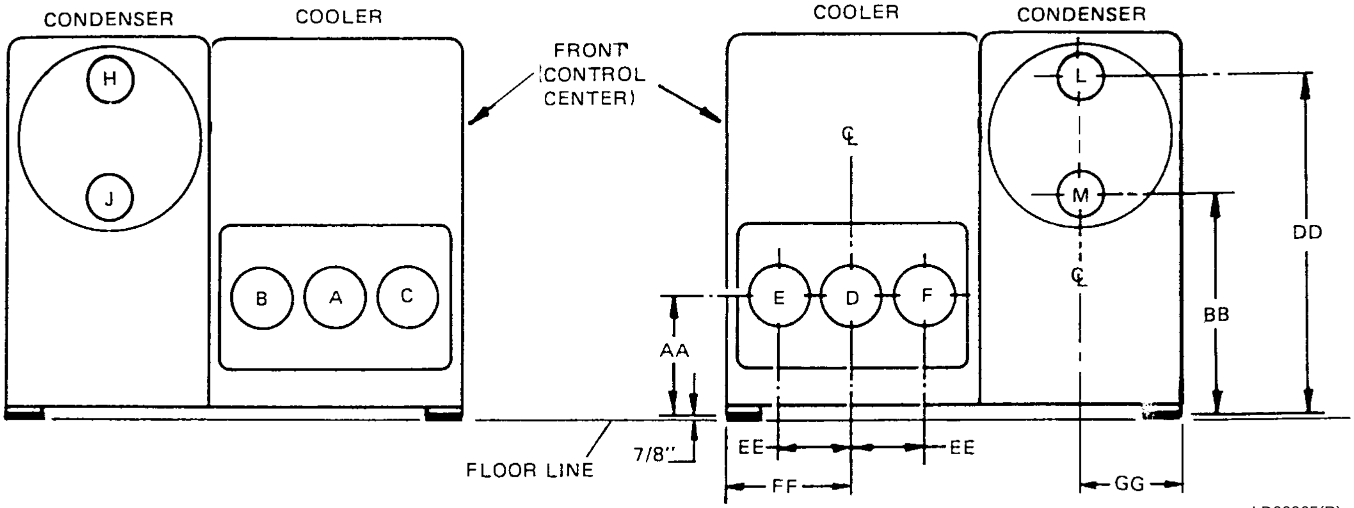
Dimensions (mm)



LD02141mm

NOTE: 2-Pass Cooler and Condenser shown. For other Pass arrangements, see Page 21.

Dimensions - Nozzle Arrangements (Compact Water Boxes)



WATER BOX DIMENSIONS

COMP. CODE	SHELL CODE	COOLER			CONDENSER		
		AA	EE	FF	BB	DD	GG
G4	M	1'–10"	0'–8-1/2"	1'–9-1/2"	2'–2-3/4"	3'–9-3/4"	1'–5-1/2"
		559 mm	216 mm	546 mm	679 mm	1162 mm	445 mm

NOZZLE SIZES

SHELL CODE	COOLER			CONDENSER
	NO. OF PASSES			NO. OF PASSES
	1	2	3	2
M	10"	8"	6"	10"
	254 mm	203 mm	152 mm	254 mm

NOZZLE ARRANGEMENTS

NO. OF PASSES	COOLER		CONDENSER	
	IN	OUT	IN	OUT
1	A	D	—	—
	D	A	—	—
2	B	C	J	H
	C	B	M	L
	E	F	—	—
	F	E	—	—
3	A	D	—	—
	D	A	—	—

NOTES:

1. All dimensions are approximate. Certified dimensions are available upon request.
2. Standard water nozzles are furnished with 150 lb. (1034 kPa g) ANSI raised face flanges. Companion flanges, nuts, bolts and gaskets are not furnished. Victaulic groove connections, suitable for victaulic or welded connections, are available.
3. Nozzle arrangements are available only as shown. Any pair of cooler nozzles used in combination with any pair of condenser nozzles.
4. Condenser water must enter the water box through the bottom connection for proper operation of the sub-cooler to achieve rated performance.
5. Connected piping should allow for removal of compact water box for tube access and cleaning.

Guide Specifications

Furnish and install where indicated on the drawings _____ YORK factory-packaged gas engine driven centrifugal liquid chilling unit(s). Each unit shall produce a capacity of _____ tons cooling ______ GPM of water from _____ °F to _____ °F when the condenser is supplied with ______ GPM of tower water at 85°F. Shaft power requirements shall be ______ HP. Unit HHV COP shall be ______ at full load. The cooler shall be selected for .00025 Hr-Ft^2-°F/Btu fouling factor with a maximum chilled water pressure drop of ______ feet H_2O. Evaporator water side shall be designed for 150 PSIG working pressure. Total tower water required shall not exceed ____ GPM with a water pressure drop of ____ feet H_2O. The total tower water required shall be distributed by factory assembled and flow balanced piping to supply ____ GPM of water to the condenser and 130 GPM to the engine cooling heat exchanger at 85°F. The tower water circuit shall be selected for .00025 Hr-Ft^2-°F/Btu fouling factor. The tower water side shall be designed for 150 PSIG working pressure. Power shall be supplied to the unit at 460 volts – 3-phase – 60 hertz.

– or –

Furnish and install where indicated on the drawings _____ YORK factory-packaged gas engine driven centrifugal liquid chilling unit(s). Each unit shall produce a capacity of _____ kW cooling ______ L/s of water from _____ °C to _____ °C when the condenser is supplied with _____ L/s of tower water at _____ °C. Shaft power requirements shall be ______ kW. Unit HHV COP shall be______ at full load. The cooler shall be selected for .000044 m^{2}C/W fouling factor with a maximum chilled water pressure drop of ______ kPa. Evaporator water side shall be designed for 10.3 bar g working pressure. Total tower water required shall not exceed ____ L/s with a water pressure drop of ____ kPa. The total tower water required shall be distributed by factory assembled and flow balanced piping to supply ____ L/s of water to the condenser and 8.2 L/s to the engine cooling heat exchanger at 29.4°C. The tower water circuit shall be selected for .000044 m^{2}C/W fouling factor. The tower water side shall be designed for 10.3 bar g working pressure. Power shall be supplied to the unit at ____ volts – 3-phase – 50 hertz.

GENERAL

The gas engine driven centrifugal chiller shall be a completely factory packaged unit including evaporator, condenser with integral subcooler, compressor, compressor lubrication system, natural gas engine, air actuated clutch, speed increaser, torsional vibration reducing coupling, power panel, engine PLC panel, chiller control panel and all interconnecting unit piping and wiring. The chiller shall be painted with durable alkyd-modified, vinyl enamel machinery paint prior to shipment.

The initial charge of compressor oil and refrigerant (HFC-134a) will be supplied, shipped in containers and cylinders for field installation by YORK. The engine and the gearbox will be charged with the initial charge of oil prior to shipment. The engine jacket glycol and battery acid will be supplied and installed by the local engine manufacturer's representative.

MOUNTING BASE

The engine, speed increaser, clutch, and compressor shall be mounted to a common driveline base. The driveline base shall be of heavy duty 12" (305 mm) I-beam construction, specifically designed and built to resist deflection, maintain alignment, and to minimize linear vibration.

The driveline base shall be factory mounted on top of the chiller tubesheets. Four rubber isolators shall be installed (one at each corner of the driveline base) to isolate the driveline from the chiller shells. Spring isolators, designed for 2 inch (51 mm) deflection, shall be installed at each corner of the chiller shells to isolate the chiller from the workroom floor.

ENGINE

The industrial gas engine shall be manufactured by Caterpillar Inc. The engine shall be a spark-ignited, turbocharged, 6-cylinder, stationary, liquid-cooled, four-cycle design, 1800 RPM, stoichometric inline configuration. The engine shall be equipped with air filters, pressure gauges, lubricating oil cooler and filter, water pump and pressure gauge, service hour-meter, flywheel and flywheel housing.

Structure and Metallurgy – The design of the basic engine shall provide for maximum structural integrity to extend service life. Materials used in the engine shall incorporate the highest level of proven metallurgical and manufacturing technology.

The block shall be a one-piece design and cast of high tensile strength iron in the engine manufacturer's own foundry. Cylinder wear surfaces shall be induction hardened over their entire length. Pistons shall be made of a lightweight aluminum alloy which shall be elliptically ground across the skirt and tapered from crown to skirt. Oil jets supply piston cooling and lubricating oil. Valves shall be hard-faced with replaceable inserts. The crankshaft shall be a one-piece design. Connecting rods shall be made of high strength steel with tapered pin bore.

Starting System – The engine shall have an electric starting system. The electric starting system includes 24 volt DC starting motor, starter relay, and automatic reset circuit breaker to protect against butt engagement. Batteries shall be maintenance free, lead acid type mounted on a corrosion resistant rack near the starting motor. Also, a jacket water heater will be included to maintain the jacket water temperature to facilitate quick starts.

Engine Lubrication System – The lubrication oil pump shall be a positive displacement type that shall be integral with the engine and gear driven from the engine gear train. The system shall incorporate full flow filtration with bypass valve to continue lubrication in the event of filter clogging. The bypass valve shall be integral with the engine filter base. The pistons shall be oil cooled by continuous jet spray to the underside, inside of the crown and piston ring.

Gaseous Fuel System – The gaseous fuel system shall consist of gas pressure regulators and carburetors. A balance line between the regulator and engine inlet air manifold shall be provided to compensate for air cleaner restriction and turbocharger boost. Carburetors shall be of the diaphragm type with throttle body with a load screw for air-fuel ratio adjustment. The engine shall operate with a gas supply from 1.5 to 5 PSIG (10.3 to 34.5 kPa g), with a maximum fluctuation no greater than ± 0.25 psi (1.7 kPa).

Ignition System – The unit shall be equipped with a magneto based breakerless ignition system.

Governor – The engine governor shall be a Woodward Electronic Speed Control with Flotech Electric Actuator. Speed shall be sensed by a magnetic pickup off the engine flywheel ring gear. A provision for remote speed adjustment shall be included to allow the chiller control panel to adjust engine speed based on load.

Cooling System – All waterside heat rejection from the engine shall be accomplished through factory piped connections from the condenser water nozzles. The engine jacket glycol cooling system shall be a closed circuit design with provision for filling, expansion, and deaeration. The cooling pump shall be driven by the engine. The engine jacket coolant loop, aftercooler, and engine oil, shall be cooled by the tower water through a plate and frame heat exchanger. Engine coolant temperature shall be internally regulated to bypass the external cooling systems until operating temperature is achieved.

Inlet Air System – The engine air cleaner shall be engine mounted with dry element. If external ducting is required, care should be taken to minimize the restriction associated with the combustion air inlet. The maximum restriction to the combustion air inlet shall be 27 inches H_2O (6.7 kPa).

Turbocharging – The turbocharger shall be of the axial turbine type driven by engine exhaust gases and direct – connected to the compressor supplying engine combustion air.

Aftercooling – An aftercooler shall be provided to lower the air\fuel mixture's temperature after compression. Aftercooler core air surfaces shall be coated with a corrosion inhibitor to minimize oxidation.

SPEED INCREASER

The system shall be equipped with a factory aligned speed increaser that will increase the rotating speed from the full load engine RPM to optimized RPM required by the low speed shaft of the compressor. The speed increaser shall be supplied with face hardened, single helical gears and anti-friction bearings.

TORSIONAL COUPLING

A torsional coupling shall be selected to assure that excessive torsional vibration levels are not transmitted to the gearbox and compressor at all operating speeds.

CLUTCH

The units shall be equipped with a drive disconnect. The drum-type clutch shall be air actuated and specifically designed and manufactured for heavy equipment applications. The clutch shall be an Airflex as manufactured by Eaton Corp. The clutch allows the engine to warm up before engaging and loading the compressor.

The clutch also allows the engine to complete a cool down sequence, as recommended by the engine manufacturer, without the compressor being engaged.

The clutch also eliminates engine backspin upon shutdown of the chiller. Additionally, the clutch allows for quick disconnect in the event of emergency shutdown and for engine operation/troubleshooting without engaging and loading the compressor (provided electric power and cooling water are supplied).

COMPRESSOR

The compressor shall be a single stage centrifugal type, driven by the natural gas engine. The housing shall be fully accessible with vertical circular joints. The complete operating assembly shall be removable from the compressor and scroll housing. Compressor castings shall be designed for a minimum working pressure of 200 PSIG (1379 kPa g) and hydrostatic pressure tested at a minimum of 300 PSIG (2068 kPa g). The rotor assembly consists of a heat treated alloy steel drive shaft and impeller shaft with a cast aluminum, fully shrouded impeller. The compressor shaft shall be laser aligned to the speed increaser at the chiller manufacturer's factory. The impeller shall be designed for balanced thrust, and shall be dynamically balanced and overspeed tested for smooth, vibration free operation. Insert type journal bearings shall be fabricated of aluminum alloy, precision bored and axially grooved.

Internal single helical gears with crowned teeth shall be designed so that more than one tooth is in contact at all times to provide even distribution of the compressor load. Each gear shall be individually mounted in its own journal and thrust bearings to isolate it from impeller and drive forces.

The open drive compressor shaft seal consists of a spring loaded, precision carbon ring, high temperature elastometer "O" ring static seal, and stress relieved, precision lapped collars. The seal features a small face area and low rubbing speed. It provides an efficient seal under high pressure conditions. The seal shall be oil flooded at all times and pressure-lubricated during compressor operation.

COMPRESSOR LUBRICATION SYSTEM

Lubrication oil shall be force-fed to all bearings, gears, and rotating surfaces by an oil pump which operates prior to start-up and continuously during operation and during coastdown. A gravity-fed oil reservoir shall be built into the top of the compressor to provide lubrication during coastdown in the event of a power failure. An oil reservoir, separate from the compressor, contains a submersible oil pump and two immersion-type oil heaters, thermostatically controlled to remove refrigerant from the oil. Oil shall be filtered by an externally mounted replaceable cartridge oil filter equipped with service valves, and cooled by a refrigerant cooled oil cooler before entering the compressor. Oil piping on the driveline shall be completely factory installed and tested.

EVAPORATOR

The evaporator shall be of the flooded shell-and-tube type, designed for 180 PSIG (1862 kPa g) working pressure on the refrigerant side, and tested at 270 PSIG (1241 kPa g). The shell shall be fabricated from rolled carbon steel plate with fusion welded seams; shall have carbon steel tube sheets, drilled to accommodate the tubes; and intermediate tube supports spaced no more than three feet apart (914 mm). The refrigerant side shall be designed, tested and stamped in accordance with ASME Boiler and Pressure Vessel Code, Section VIII-Division 1.

Tubes shall be high efficiency, externally and internally enhanced type. Each tube shall be roller expanded into tube sheets providing a leak-proof seal. Tubes shall be 3/4" O.D. (19 mm), 22 BWG, copper alloy and shall be individually replaceable. Two liquid level sight glasses shall be located on the side of the shell to aid in determining proper refrigerant charge. The evaporator shall have two refrigerant relief devices sized to meet the requirements of ASHRAE 15 Safety code for Mechanical Refrigeration.

Water boxes shall be removable to permit tube cleaning and replacement. Stubout water box connections with 150 lb (1034 kPa) ANSI raised face flanges shall be provided. Water boxes shall be designed for 150 PSIG (1034 kPa g) design working pressure and be tested at 225 PSIG (1551 kPa g). Plugged 3/4" (19 mm) vent and drain connections shall be provided in each water box. Factory-applied thermal insulation of the flexible, closed-cell plastic type, 3/4" (19 mm) thick shall be attached with vapor-proof cement to the cooler shell, flow chamber, tube sheets, suction connection, and (as necessary) to the auxiliary tubing.

CONDENSER

The condenser shall be of the shell-and-tube type, designed for 180 PSIG (1241 kP g) working pressure on the refrigerant side, and tested at 270 PSIG (1862 kPa g). The shell shall be fabricated from rolled carbon steel plate with fusion welded seams; shall have carbon steel tube sheets, drilled to accommodate the tubes; and intermediate tube supports spaced no more than four feet apart (1219 mm). An integral refrigerant subcooler shall be provided for improved cycle efficiency. The refrigerant side shall be designed, tested and stamped in accordance with ASME Boiler and Pressure Vessel Code, Section VIII-Division 1. Tubes shall be high efficiency, externally and internally enhanced type. Each tube shall be roller expanded into tube sheets providing a leakproof seal. Tubes shall be 3/4" O.D. (19 mm), 22 BWG, copper alloy and shall be individually replaceable.

Water boxes shall be removable to permit tube cleaning and replacement. Stubout water box connections with 150 lb (1034 kPa) ANSI raised face flanges shall be provided. Water boxes shall be designed for 150 PSIG (1034 kPa g) design working pressure and be tested at 225 PSIG (1551 kPa g). Plugged 3/4" (19 mm) vent and drain connections shall be provided in each water box. Condenser water boxes also include factory supplied and piped connections for cooling water supply to the engine plate frame heat exchanger.

REFRIGERANT FLOW CONTROL

Refrigerant flow to the evaporator shall be controlled by a single variable orifice.The variable orifice shall automatically adjust to maintain proper refrigerant level in the condenser and evaporator. This shall optimize unit performance at varying load and temperature conditions and allow capacity above design at off-design conditions.

CHILLER MICROCOMPUTER CONTROL CENTER

The unit shall be furnished complete with a Micro-Computer Control Center in a locked enclosure. The chiller shall be controlled through a single panel. The panel shall have the capability to control inlet guide vane position as well as engine speed in response to chiller load requirements. The Control Center shall include a 40 character alphanumeric display showing all system parameters in the English language with numeric data in English or metric units.

Digital programming of setpoints through a color coded, non-tactile keypad shall include: leaving chilled liquid temperature, percent engine load limit, seven day time clock for starting and stopping chiller and pumps, (complete with holiday schedule), remote reset temperature range, and data logger.

Security access shall be provided to prevent unauthorized change of setpoints, to allow local or remote control of the chiller, and to allow manual operation of the prerotation vanes and compressor oil pump.

All safety and cycle shutdowns shall be annunciated through an alpha numeric display and consist of day, time, cause of shutdown, and type of restart required. Safety shutdowns shall include: low evaporator pressure, high condenser pressure, auxiliary safety, high discharge temperature, faulty discharge temperature sensor, high compressor oil temperature, power failure, engine overload, loss of chilled water flow, high engine water temperature, low engine oil pressure, low compressor oil pressure, high compressor oil pressure, evaporator transducer or probe error, clutch failure, manual engine shutdown, faulty compressor oil pressure transducer, proximity sensor fault, high speed thrust bearing oil drain temperature, faulty proximity probe, open thermocouple probe, engine cranking, engine fault, engine overspeed, compressor overspeed, engine PLC fault, engine panel shutdown, faulty condenser, and pressure transducer. Cycling shutdowns will include: low compressor oil temperature, power failure (auto restart), low chilled water temperature, remote unit cycling, multi unit cycling, internal time clock, vanes open, compressor low differential oil temperature, DC under-voltage, high aftercooler water temperature (manual restart required), remote stop (field-supplied signal), remote/local cycling device, and multi-unit sequencing.

System operating information shall include: return/leaving chilled liquid temperature, return/leaving condenser liquid temperatures; evaporator/condenser refrigerant pressures; differential compressor oil pressure, percent engine load, engine RPM, engine manifold pressure, evaporator/condenser saturation temperatures; compressor discharge temperature; compressor oil temperature; operating hours; and number of starts counter, engine oil pressure, engine jacket temperature and engine speed.

The chiller shall be provided with an RS-232 port to output all system operating data, shutdown/cycling messages, and a record of the last four cycling or safety shutdowns to a remote printer (field supplied). The control center shall be programmable to provide data logs to the optional printer at a preset time interval.

The Control Center shall be able to interface with a building automation system to provide remote chiller start/stop; reset of chilled water temperature; remote engine load limit; and status messages indicating chiller is ready to start, chiller is operating, chiller is shut down on a safety requiring a manual reset, and chiller is shut down on a cycling safety.

The operating program shall be stored in nonvolatile memory (EPROM) to eliminate chiller failure due to AC power failure\battery discharge. In addition, programmed setpoints shall be retained in lithium battery-backed TRC memory for a minimum of 5 years.

VARIABLE SPEED CONTROL

Capacity control shall be achieved by use of prerotation vanes and varying engine speed. Capacity control logic shall be matched to the specific chiller/compressor system. Control logic shall continually integrate the actual chiller operating conditions, including chilled water temperature and temperature set point, evaporator and condenser refrigerant pressures, engine speed and prerotation vane position. Prerotation vane position and engine speed shall be automatically controlled by the chiller control panel to maintain leaving chilled liquid temperature at the desired setpoint. Engine speed shall be set to optimize system energy efficiency. During part load operation, the chiller shall be able to operate with cooling tower water as low as 55°F (12.8°C) at design condenser water flow rates. Pre-rotation vane position shall be automatically controlled by an external electric actuator.

POWER PANEL

The power panel enclosure shall house the following components: single point wiring connection for incoming AC power supply; fused disconnect switch, compressor oil pump motor starter with overloads; heater relay; circuit breakers for 115VAC, 60 Hz, 3KVA control supply transformer. The chiller shall be available in 460V – 3-phase – 60 Hz.

NATURAL GAS ENGINE CONTROLS

Engine sensors shall include: engine oil pressure, jacket water temperature, RPM, and inlet manifold pressure. As part of the engine control/safety system the engine and related components shall be monitored and provided with gauges or safety shutdowns to protect against any system failures. The safety shutoffs shall be low oil pressure, high water temperature, low jacket water level, and overspeed.

ISOLATION MOUNTING

The entire unit shall be provided with industrial vibration isolation mounts. These level adjusting, spring type isolators shall be mounted on the tubesheets and shall be designed for two inch (51 mm) deflection.

TESTING

Prototype Testing –

Specific prototype tests shall include:

ENGINE:

- Performance (part load, full load)
- Oil Consumption
- Fuel Consumption
- Exhaust Emissions
- Noise Levels (mechanical and exhaust)
- Startability (cold and hot ambients)
- Piston, Ring, and Liner Wear Rates
- Piston Structural Integrity
- Lubrication System Evaluation
- Cooling System Evaluation
- Valve Train Overspeed Qualification
- Deep Thermal Cycle Endurance
- Field Endurance

CHILLER ASSEMBLY:

- Mechanical Compatibility
- Structural Integrity
- Mounting Evaluation
- Wiring Compatibility

Control Panel Functionality
Linear Vibration Measurement
Torsional Vibration Analysis
Load Performance
Safety Shutdowns and Alarms
Start-Stop Evaluations

Production Testing – The refrigerant compressor shall be air run tested prior to mounting on the chiller. The engine shall be run tested at full and part loads prior to assembly of the chiller. After assembly, the chiller package may be factory performance tested (if purchased) in the manufacturer's factory test facility. A certified test report will be available if requested at the time the unit is purchased with the factory performance testing.

START-UP AND OPERATOR TRAINING

Factory trained field service representatives shall supervise the final leak testing, charging and the initial start-up. The complete installation shall be checked for procedural and operational compliance by a factory trained service representative from the chiller manufacturer. The chiller manufacturer shall retain factory trained service representatives from Caterpillar to provide start up service and operator instruction for the gas engine.

WARRANTY AND SERVICE

The standard warranty shall be for a period of one year from the date of start-up or eighteen months from shipment, whichever occurs first. The warranty includes parts and labor during this period. This warranty does not include parts and labor associated with routine maintenance, such as oil filters, air filters, oil, etc. This service shall be performed by the chiller manufacturer and the engine manufacturer factory trained and authorized service personnel. The chiller manufacturer shall have a local direct service office that can provide factory trained servicemen, the required stock of replacement parts, technical assistance, and warranty administration. Engine maintenance shall only be performed by the engine manufacturer's local, factory trained and authorized representative. All maintenance, service, or repairs shall be coordinated through the chiller manufacturer's authorized representative. The chiller manufacturer's representative shall be responsible for coordinating warranty/service with the engine manufacturer's service representative.

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