

Natural Gas Engine Fumigation System Statement of Work

Background:

Pittsburgh Region Clean Cities (PRCC) has established a team and successfully proposed and awarded a project by the U.S. Maritime Administration (MARAD) to convert an inland waterways towboat to run with natural gas in a dual fuel mode – part diesel and part natural gas. This project is expected to run about 2 years including a one year period of to design and convert the vessel and one year of operational demonstration of the technology including measurement of exhaust emissions. The project recently was kicked off by MARAD.

The vessel to be converted is the M/V RON-CHRIS (soon to be M/V O.B. DEMENT). It is a twin screw 56' x 20' towboat built in 1952 by St. Louis Shipbuilding and Steel Company. It currently is powered by twin Cummins Model NTA855M diesel engines rated at 350 bhp @ 1800 rpm. Each currently operating engine was built in 1987 and installed by Walden Industries in Tiltonsville, Ohio.

Vessel Description:

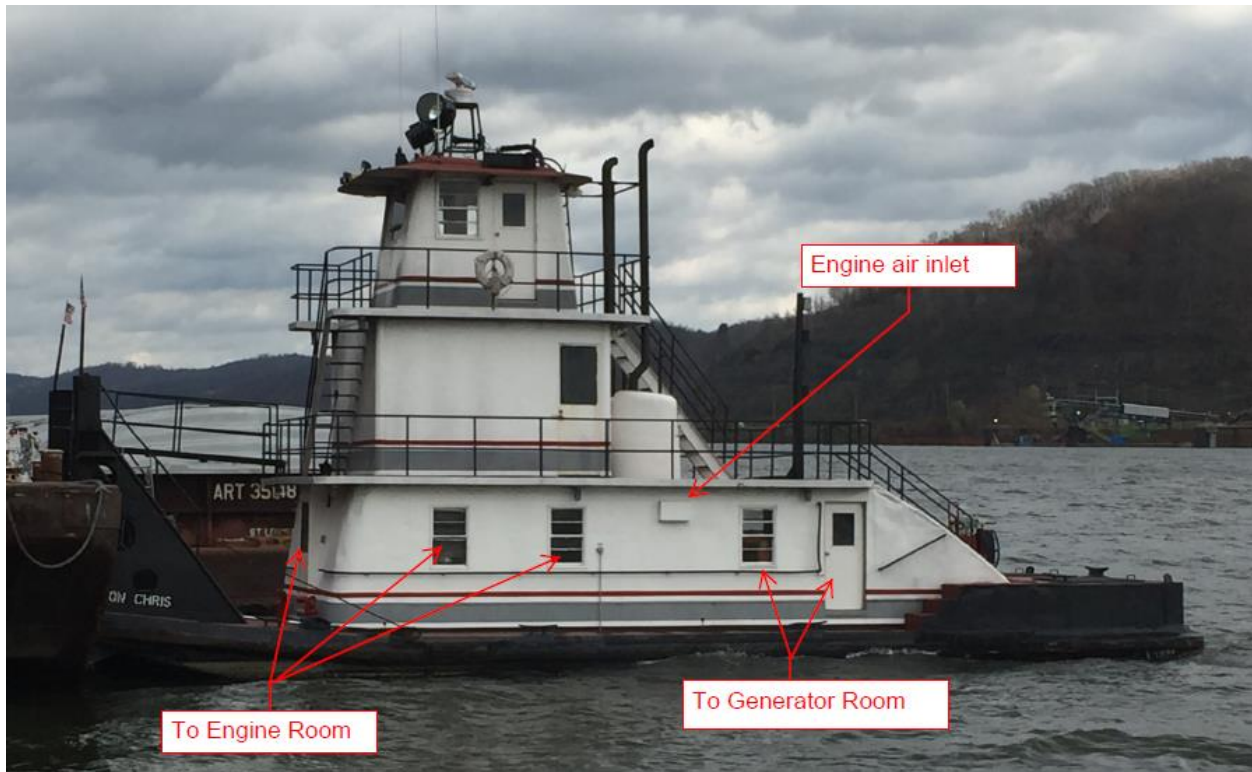


Figure 1: Ron-Chris Profile

This section describes the 58' x 20' x 6' twin screw inland towboat "Ron-Chris". The vessel is an all-welded steel, diesel fuel-powered, twin screw, towboat suitable for push towing on inland and intracoastal waterways.

The principle dimensions of the vessel as designed are:

Length, molded	17.7m (58'- 0")
Beam, molded	6.1m (20'- 0")
Depth, molded at side	1.8m (6'- 0")
Draft	1.3m (4'- 3") est.

The hull is of all-welded steel construction consisting of the main hull, main deckhouse, upper deckhouse, and pilot house.

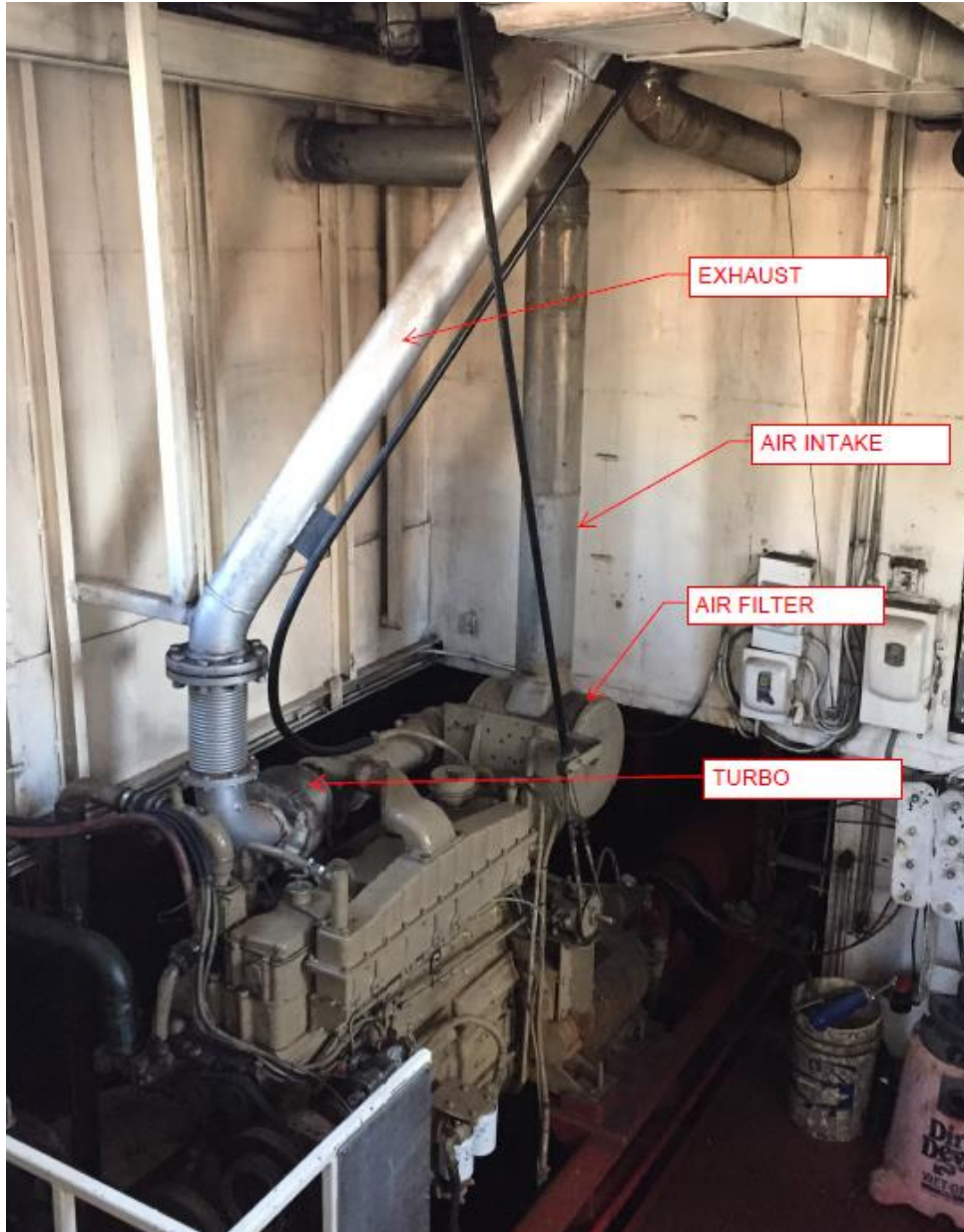


Figure 2: Engine Space

The two diesel fuel engines shown in Figure 2 are to be fitted with an air fumigation system. They produce roughly 700 HP total, the engine specs are given below. The values are based on the engine nameplate data. The air intakes for the engines are located outside the engine compartment on the side bulkhead of the space, these can be seen in Figure 1.

Manufacturer:	Cummins
Model:	NTA-855
Rated Power:	350 HP each
Type:	4 Cycle, in-line turbo charged
Bore:	140 mm (5.5 in)
Stroke:	152mm (6.0 in)
Displacement:	14.0 liter (855 cu.in)
Cylinder block:	Cast iron, 6 cylinder
Fuel System:	Direct injection
Cooling System:	Jacket water
Coolant Ratio:	50% ethylene glycol, 50% water

General:

The following specification / Scope of Work (SOW) for Natural Gas Conversion of the referenced marine vessel describe the project in general terms. It is preliminary in nature and subject to change based on design development or equipment selection.

Objectives:

Provide a “fumigation” type system, one separately for both main propulsion engines, on the M/V Ron-Chris. This system shall allow the engine/s to burn diesel and/or natural gas (LNG) efficiently and automatically. Fumigation is defined as the supply of natural gas in the form of LNG converted to gas and delivered as gas to the engines combustion air inlet system.

Line Items:

Item 001 – LNG Storage & Gasification System
Item 002 – Natural Gas Delivery and Fumigation System

Project POC:

Primary: Mr. Thomas Risley
859 Missionary Drive
Suite 210
Pittsburgh, PA 15236
(412) 253-8380 Ext 3001 (O)
(412) 352-3224 (C)

Back-up: Mr. Kenneth Siegman
80 M Street SE
Suite 726
Washington, DC 20003
(202)349-0940 Ext 2004 (O)
(804) 894-3254 (C)

ITEM 001 – LNG Storage & Gasification System

Scope of Work:

Vendor shall supply the following equipment, meeting all specifications and performance requirements listed below, at a minimum. Other requirements per the design specifications are incorporated by reference:

- 1) General Design Specifications:
 - a. SAE J2343
 - b. ASME Boiler and Pressure Vessel Code, Section VIII, Division 1 or 2.
 - c. ASME B31.3
 - d. NFPA 52, 59A
 - e. DOT4L (49CFR178.57)

- 2) LNG Storage Tanks (type C)
 - a. Capacity (NET): 100-150 Gallons of LNG (ea.)
 - b. Inner Tank Working Temperature(F) : -265
 - c. Maximum Allowable Working Pressures (PSIG): 230
 - d. Fill Receptacle: JC Carter
 - e. Fill Rate : 10-20 DGE/min
 - f. Hold Time (days) from 100 PSIG: 12

- 3) Gasification System
 - a. Heat Exchanger
 - a. Designed for vessel engine rated loads
 - b. Coolant will be provided separately, per requirements of Heat Exchanger
 - c. Designed for 50/50 Water/Ethylene Glycol mixture from external heat source (TBD)
 - b. Shut Off Solenoid
 - c. Over Pressure Regulator
 - d. Pressure Gauge
 - e. Low Temperature Switch

- 4) Additional Tank and Gasification related equipment
 - a. Tank to be equipped with Fill Check Valve to prevent the backflow of LNG in the event of a fuel coupler failure.
 - b. Fuel Shutoff Valve (Liquid Valve)
 - c. Excess Flow Valve located between fuel storage and heat exchanger
 - d. Vapor Shutoff Valve (Vent Valve)
 - e. Pressure Control Regulator
 - f. Primary Relief Valve
 - g. Secondary Relief Valve
 - h. Evacuation Port
 - i. Fuel Gauge
 - j. Fill Fitting
 - k. Automatic Fuel Shutoff Valve
 - l. Tank Pressure Gauge
 - m. Pipe connections to the tank should be above highest liquid level if possible.

- 5) Prohibited materials in construction for any areas anticipated to be below 32F:
 - a. Carbon Steel
 - b. 400 Series Stainless Steel
 - c. Zinc
 - d. PVC
 - e. Rubber

- 6) Piping. All Piping material used in construction of the LNG Storage and Gasification System must be able to withstand the effects of low temperature without failure. All lines that carry LNG Liquid shall be 300 series stainless steel tubing. Fill and fill cross over lines may be rigid or flexible metallic or non-metallic tubing rated for cryogenic services. Vent and relief lines may be constructed out of flexible tubing or hose suitable for natural gas service. Since liquid and vent lines repeatedly go from ambient to cryogenic temperature allowance for thermal expansion must be designed into the piping system. This is typically accomplished by incorporating S Bends or expansions loops into the rigid lines. If temperatures fall below -110 °C (-166 °F,) a stress analysis to be completed for each applicable branch of piping. This stress analysis will account for the weight of the pipes plus cargo and accelerations, internal pressure, thermal contraction, and loads induced by movements of the vessel.

- 7) Pipe Support. Piping and tubing shall be supported along its length to guard against vibration. A general guideline is one support per two (2) feet of tubing.

- 8) System shall be installed by contractor, and tested, IAW manufacturer's instructions.

- 9) Training to be provided to the vessel crew on operation of the tank, including but not limited to filling operations, venting operations, and emergency shut down procedures.

- 10) Bunkering. Bunkering station will be open to atmosphere. A control and monitoring station shall be provided at a remote station. At this station, tank pressure and level and overfill alarm and automatic shutdown will be indicated. Manual and remote-operated stop/shutdown valves, in series, will be fitted in each bunkering line. Means for draining, inerting and gas freeing of the bunkering lines will be provided.

Owner Supplied Items:

- 1) Tank Saddles
- 2) Stainless Steel Drip Trays

Alternative design standards will be evaluated on a case by case basis, vendor to provide explanation of how requested alternative meets or exceeds above standards.

Place of Performance:

M/V RON CHRIS (name to change to M/V O.B. DEMENT) currently docked on the Ohio River in Tiltonsville, Ohio (see attached vessel profile)

Delivery:

Walden Industries
101 Walden Avenue
Tiltonsville, OH 43963
Phone: (740) 632-2722

Place of Performance:

M/V RON CHRIS (name to change to M/V O.B. DEMENT) currently docked on the Ohio River in
Tiltonsville, Ohio

Period of Performance:

Six months from Contract Award

ITEM 002 – Natural Gas Delivery & Fumigation System

Scope of Work:

Vendor shall supply the following equipment, meeting all specifications and performance requirements listed below, at a minimum. Other requirements per the design specifications are incorporated by reference:

- 1) General Design Specifications:
 - a. SAE J2343
 - b. ASME Boiler and Pressure Vessel Code
 - c. ASME B31.3 (Code for Pressure Piping)
 - d. NFPA 52, 59A
 - e. DOT4L (49CFR178.57)
- 2) Performance Requirements:
 - a. Low Pressure System, less than 10 bar
 - b. Up to 40% - 60% Substitution Rate
- 3) Piping systems shall be installed by the contractor from the outlet of the fuel storage system, to the injector in the intake piping for the engine.
- 4) Fumigation System Shall be installed, located per the supplied drawings with the following equipment as part of the system, installed in order from the gas supply
 - a. Manual Shutoff Valve
 - b. Filter
 - c. Vapor Draw Regulator
 - d. Dual Shutoff Solenoid Valve
 - e. Electronic Throttle Body
- 5) Prohibited materials in construction for any areas anticipated to be below 32F:
 - a. Carbon Steel
 - b. 400 Series Stainless Steel
 - c. Zinc
 - d. PVC
 - e. Rubber
- 6) Piping. All Piping material used in construction of the LNG Storage and Gasification System must be able to withstand the effects of low temperature without failure. Piping shall use the maximum of the following design conditions: vapor pressure specified in 4.2.6.2 of IGC Code, the MARVS of the gas tanks, pressure of the discharge relief valve setting, maximum total discharge or loading head of gas piping system, a pressure of 10 bar. Piping shall be joined by welding, flanged connection must be avoided whenever possible. Minimum wall thickness must be in accordance with recognized standards. All lines that carry LNG Liquid shall be 300 series stainless steel tubing. Fill and fill cross over lines may be rigid or flexible metallic or non-metallic tubing rated for cryogenic services. Vent and relief lines may be constructed out of flexible

tubing or hose suitable for natural gas service. Since liquid and vent lines repeatedly go from ambient to cryogenic temperature allowance for thermal expansion must be designed into the piping system. This is typically accomplished by incorporating S Bends or expansions loops into the rigid lines. If temperatures fall below -110 °C (-166 °F,) a stress analysis to be completed for each applicable branch of piping. This stress analysis will account for the weight of the pipes plus cargo and accelerations, internal pressure, thermal contraction, and loads induced by movements of the vessel. Gas pipes must be color marked based on a recognized standard.

- 7) Pipe Support. Piping and tubing shall be supported along its length to guard against vibration. A general guideline is one support per two (2) feet of tubing.
- 8) System shall be installed by contractor, and tested, IAW manufacturer's instructions.
- 9) Training to be provided to the vessel crew on operation of the fumigation system, including but not limited to start, stop and emergency shut down procedures.
- 10) The gas fumigation system shall be *automatic* when *turned on*, and also allow for the option to *turn off* the fumigation system, and run the engines in normal diesel mode.

Owner Supplied Items:

- 1) Double walled ventilation
- 2) Vented box for installation of Gas Train Unit.

Alternative design standards will be evaluated on a case by case basis, vendor to provide explanation of how requested alternative meets or exceeds above standards.

Delivery:

Walden Industries
101 Walden Avenue
Tiltonsville, OH 43963
Phone: (740) 632-2722

Place of Performance:

M/V RON CHRIS (name to change to M/V O.B. DEMENT) currently docked on the Ohio River in Tiltonsville, Ohio

Period of Performance:

Six months from Contract Award

PRICING:

ITEM 001

Price per engine: _____

Price Total (2x) : _____

ITEM 002

Price per engine: _____

Price Total (2x) : _____