
BILLERICA (M.A296.01) - EQUIPMENT SUPPLY CONTRACT

APPENDIX A - SCOPE OF WORK

The Scope of Work includes the supply for four (4) Trent 60 Dual Fuel WLE Power Generation Packages (Units), designed in accordance with the specifications outlined in this contract, and for the testing, training, technical direction of installation and commissioning, and tools as more fully described herein.

A1 PROJECT SITE

The Site is located at 134 Rear Billerica Avenue, Billerica, MA 01682.

A2 POWER GENERATION PACKAGE SCOPE OF SUPPLY

Each of the four (4) Trent 60 Dual Fuel WLE Power Generation Packages (Units), designed in accordance with the specifications outlined in this contract, are comprised of:

A2.1 GAS TURBINE

- Rolls-Royce Industrial Trent 60 Dual Fuel WLE Gas Turbine with water injection for emissions control.
- On-engine mounted lubrication pump and hydraulic starter.
- Gas Turbine ignition system consisting of two on-engine ignitors and off-engine mounted exciter unit.
- On-engine mounted gas fuel injection manifold.
- On-engine mounted liquid fuel injection manifold.
- On-engine mounted water injection manifold.

A2.2 AC GENERATOR

- Two pole, OAC AC generator, 13.8 kV, 3 phase, 60 Hz, 0.85 power factor in accordance with ANSI C.50-14, fitted with class "F" insulation and designed for class "B" temperature rises with a brushless exciter.
- Rotor field ground protection equipment.
- AC generator cooling air system comprising air filter media, ducting and silencer and a generator shaft mounted cooling fan.

A2.3 GAS TURBINE MODULE

A2.3.1 Enclosure and Base

- Fabricated weatherproof painted carbon steel baseplate mounted enclosure to give an overall package acoustic performance of 85dB(A) avg. @ 3.3 ft from the module at an elevation of 5 ft and base for housing the gas turbine, inlet plenum, fuel and oil systems, exhaust volute and enclosure ventilation air systems all mounted on a fabricated baseplate.

VN.
BAL

- All internal lighting (main and emergency), maintenance power points, tubing, piping and cabling.
- Maintenance access and features, facilitating engine / module removal (sideways-removal from package) and in-situ maintenance. Anchor points and any special tooling are provided. Mechanical Handling Skid, standard walkways and ladders giving access to the roof of the package and to the inlet filter house are included.
- Fire protection and gas detection system, complete with thermal detectors and gas sensors for the gas turbine enclosure.
- Two-shot CO2 extinguishing system, including storage cylinders, manifold, fire dampers, pipework to nozzles within the gas turbine compartment, warning lamps, lock-offs, interlocks and high temperature cabling. A 100% discharge to extinguish the fire is followed by an additional 100% discharge to suppress re-ignition.
- Dry diaphragm flexible coupling shaft including bolts. A separate shaft guard is not required as the coupling shaft is protected by the cone arrangement in the exhaust diffuser.

A2.3.2 *Combustion Air System*

- Self-cleaning (pulsed) combustion air intake filter with first stage coalescer.
- Pulsed cleaning control system fitted on the filter unit. Customer will supply the air required for the pulse cleaning of the filter.
- Intake evaporative cooler system designed for a minimum effectiveness of 85%.
- Combustion air inlet silencer and ducting, with flexible joints to accommodate thermal movement.
- Mounted from the Gas Turbine module, including access door, ladder and internal lighting up to the silencer and filter units.
- Maintenance features such as anchor points and permanent tooling (internal filter element hoist).
- Radial air intake scroll with gas turbine compressor water wash supply rings.

A2.3.3 *Gas Turbine Exhaust System*

- Gas turbine exhaust diffuser exhausting horizontally to the machinery axis. Two Units handed left and two Units handed right, looking from the air intake to the AC generator.

A2.3.4 *Gas Turbine Enclosure Ventilation and Air Handling System*

A2.3.4.1 *Enclosure Ventilation Intake System*

- Air is drawn from the same filter house as the combustion air system. A designated section of the filter house is used to supply air exclusively for ventilation.
- The system includes ducting, silencing and fire dampers.

A2.3.4.2 *Enclosure Ventilation Exhaust System*

- Three 50% duty AC electric motor driven belt driven induced draft ventilation fans.
- Ventilation air exhaust fire dampers, silencer, ducting and weather hood.

W.A.
BAL

A2.3.4.3 *Gas Turbine Bleed Air*

- Bleed air exhaust ducting and silencer.

A2.3.4.4 *Gas Turbine Internal Auxiliary Gearbox Cooling Air and Bearing Pressurization Air System*

- Cooling air pipework.

A2.3.5 *Gas Turbine Synthetic Lube Oil System*

- Gas turbine lube oil system including a stainless steel lube oil reservoir with thermostatically controlled electric heater (reservoir common with the hydraulic start system), mist eliminator, engine driven supply pumps, simplex oil filter, simplex water cooled plate oil cooler, stainless steel pipework and fittings, associated valves and instrumentation.

A2.3.6 *Gas Turbine Hydraulic Synthetic Control Oil System*

- Gas turbine hydraulic synthetic control oil system comprising of two 100% duty AC electric motor driven variable displacement pumps, stainless steel tank, oil mist separator, simplex bladder type accumulator, simplex oil filter, simplex water cooled plate oil cooler, stainless steel pipework and fittings, associated valves and instrumentation.

A2.3.7 *Gas Turbine Hydraulic Synthetic Oil Start System*

- Gas turbine hydraulic synthetic oil start system comprising of one AC electric motor driven 100% variable displacement pump and fixed displacement charge pump in tandem, stainless steel pipework and fittings, associated filters, valves and instrumentation.

A2.3.8 *Gas Turbine Fuel Gas System*

- Fuel gas supply system, located to the side of the gas turbine, comprising of metering valves, high speed shutoff valves, stainless steel pipe work and fittings, associated valves and instrumentation.

A2.4 *AC GENERATOR MODULE*

A2.4.1 *Base*

- Fabricated weatherproof painted carbon steel baseplate mounted enclosure to give an overall package acoustic performance of 85dB(A) avg. @ 3.3 ft from the module at an elevation of 5 ft and base for housing the AC generator, cooling air system, exciter and line and neutral cubicles all mounted on a fabricated baseplate.
- All internal lighting (main and emergency), maintenance power points, tubing, piping and cabling.

A2.4.2 *AC Generator Mineral Lube Oil System*

Vm.
BAL

- A lube oil system comprising one (1) shaft driven oil pump, one (1) AC electric motor driven auxiliary oil pump, one (1) AC electric motor driven jacking oil pump and one (1) DC electric motor driven emergency lube oil pump for run down. Simplex oil filters, carbon steel oil reservoir with mist eliminator, vent and thermostatically controlled electric heater, associated pipework (stainless steel downstream of filters/carbon steel upstream), fittings, valves and instrumentation.

A2.5 LIQUID FUEL SYSTEM

- High Pressure Liquid Fuel system comprising AC electric motor driven fixed displacement, bent axis, axial piston pump, metering valves, high speed shutoff valves, stainless steel pipe work and fittings, associated valves and instrumentation. The system is mounted on a freestanding skid to be located adjacent to the gas turbine module.

A2.6 WATER INJECTION SYSTEM

- Water injection system comprising three (3) AC electric motor driven fixed displacement, bent axis, axial piston pumps, stainless steel pipework and fittings, associated simplex filter, valves and instrumentation. The system is mounted on a freestanding skid to be located adjacent to the gas turbine module.

A2.7 SELECTIVE CATALYTIC REDUCTION (SCR) AND CARBON MONOXIDE (CO) CATALYST SYSTEM W/ STACK AND CONTINUOUS EMISSIONS MONITORING SYSTEM (CEMS)

A2.7.1 SCR Catalyst System

- Catalyst and catalyst housing.
- Inlet and outlet transition ducts.
- Catalyst handling platform and ladder.

A2.7.2 CO Conversion System

- Catalyst and catalyst housing.
- Inlet and outlet ducts.

A2.7.3 Ammonia System

- Skid mounted ammonia vaporize system with 2 x 100% Forced Draft (FD) fans, electric heater, vaporizer tank, atomizing air piping.
- Ammonia distribution manifold and injection grid.
- System interconnect piping, flow valves and drain valves.

A2.7.4 Exhaust Stack

Fabricated painted carbon steel exhaust stack discharging at or equal to 80 feet above grade with ladders and platforms for access to the CEMS system equipment.

A2.7.5 Tempering Air System

WJ
BAL

- FD fan, fan inlet silencer and ducting.
- Isolation and seal air dampers.

A2.7.6 Continuous Emissions Monitoring System (located at final Discharge of stack)

- Inlet and outlet NOx analyzer, outlet CO analyzer and O2 analyzer.
- CEMS data acquisition system including probe with filter and sample line, calibration kit and Sample conditioner.
- CEMS shelter.

A2.7.7 Acoustic (Sound Abatement) Options for SCR

- Option #1a - Sound Abatement for the SCR Unit (Silencer) - This option will increase the length of the SCR by 6 feet and consisting of a 14-foot silencer in the SCR and a 14-foot silencer in the stack.
- Option #1b - Sound Abatement for the SCR Unit (Wall Cladding) - This option will increase the increase wall thickness to ½".

A2.8 CONTROL SYSTEM

- Human Machine Interface (HMI) – To be mounted in the facilities main control room, shipped loose for installation in the operator's control room. All control systems are accessible remotely via the HMI system.
- Gas turbine control system will be installed in the front of the package on the gas turbine base plate. The following is included in the on-skid Controls Scope of Supply:
 - Package Control System (PCS);
 - Engine Management System (EMS);
 - Fire and Gas Protection System;
 - Vibration monitoring for all rotating equipment; and
 - Temperature monitoring of all rotating equipment.
- AC Generator Control and Protection Panel (GCPP) comprising a two bay cubicle with automatic voltage regulator, AC generator metering and protective relay acceptable for grid connection, automatic and manual synchronizing facility, with synchroscope and check synchronizer, free issued for installation by others.

A2.9 SPECIAL TOOLS

- Coupling alignment tool, gas turbine transportation stand, lifting beams and slings, packing case, protection cover, blanks and restraints will be supplied to protect the engine during transportation and installation at site. These items remain the property of Rolls-Royce and will be returned after installation is complete.

A2.10 EQUIPMENT TESTING

- Gas turbine factory test.
- AC Generator factory test.

VAN.
BAL

- Sub-system factory flushing and pressure testing.
- Auxiliary motor testing.
- Instrument and power cable insulation and continuity tests.
- Assembled package checkout test in the factory shop.

A3 NON-UNIT SCOPE OF WORK

A3.1 WATER WASH SYSTEM

- One mobile gas turbine compressor cleaning system, suitable for unfired washing, is supplied per site. Attachment points for the water wash system are externally located on the outside of the gas turbine module and on the wash cart.

A3.2 OFF-SKID AIR WATER/GLYCOL HEAT EXCHANGER

- Air to Water/Glycol Fin Fan type heat exchanger system composed of fan cooler and water pump skid for cooling the water for both mineral and synthetic lube oil. The system is mounted on a freestanding skid to be located adjacent to the gas turbine module. Based on further design study by RR, this system may be provided as one skid to serve two Units.

A3.3 TRAINING

- Rolls-Royce Phase 1, 2 and 3 for Rolls-Royce Scope of Supply, based at Rolls-Royce Training Facility.

A3.4 INSTALLATION & COMMISSIONING

- Technical direction of Installation and Commissioning, as detailed below, based on standard RR installation 63 days installation and commissioning schedule per Unit, with one month stagger between Units, 72 hr continuous reliability run is included.
- Project Manager and Installation and Commissioning Services Manager (ICM) must be experienced with Trent machines and identified by name below and ICM must be based on site for the entire installation and startup. In the event that Rolls-Royce change the Project Manager and Installation and Commissioning Services Manager (ICM) resumes will be submitted for approval to the Customer, which will not be unreasonably withheld.
- The nominated Project Manager is Fred Curren.
- The nominated Installation and Commissioning Services Manager (ICM) is Gordon Smith.
- One set of special tooling required for the Gas Turbine Generating Package Operation and Maintenance.
- ICS Manuals in English.

A3.5 DOCUMENTATION

- The Operating and Maintenance Manuals will be delivered in three sets of bound copies and three sets in pdf/CD format, in English.

WAL
BAL

BILLERICA (M.A296.01) - EQUIPMENT SUPPLY CONTRACT

APPENDIX A - SCOPE OF WORK

- .
- Project drawings and document list.
- All documents and drawings will be in English (one set of CD's required).

WJ.
BAL

A3.6

TERMINATION POINTS

Interface Description	Terminal Points
Combustion Air	Inlet to intake filter house.
Compressed / Instrument Air	Compressed air connection at air intake filter house and gas turbine module edge.
Exhaust Gas	The exit of the SCR exhaust stack.
Ventilation	Enclosure vent outlets.
Mountings	Locations on skid baseplates and all other structural members.
Fuel Gas	Inlet flange on side of gas turbine module and vent flange on the roof of the gas turbine module.
Liquid Fuel	Inlet and outlet connections on liquid fuel skid and gas turbine module.
Water Injection	Inlet and outlet connections on water injection skid and gas turbine module.
Lubricants	Filling points at oil reservoirs. Drains connections at oil reservoirs.
Drains	Drains system connections on all modules as necessary.
Grounding	Grounding terminals on modules and auxiliary skids.
Control and Instrumentation	Serial link connection between HMI and gas turbine module mounted control panels. GCPP Terminal blocks in control panels and on-skid connections.
HV Electric Power	Line side terminals of AC generator. Neutral terminal of AC generator.
Evaporative Cooling	Inlet and outlet connections on Evaporative Cooling Skid and Air Filter.
Coolant	Inlet and outlet connections on gas turbine and AC generator modules.
Fin Fan Cooler Skid	Inlet and outlet connections on cooler skid.
Compressor Cleaning	Filling point of wash tanks.
Medium Voltage Electric Power	At motor terminals inside the package. Motors include, AC generator lube oil pumps, gas turbine control oil pumps, starting motor, water injection pumps and enclosure ventilation fans.
SCR / CO Catalyst System	Ammonia Inlet, Power Terminals, CEMS connections and Control Terminals.
Low Voltage Power	Single line connection on the gas turbine module, AC Generator module, CO2 extinguishant skid and water injection skid.

✓
BAL

A3.7 TECHNICAL DIRECTION OF INSTALLATION AND COMMISSIONING

A3.7.1 *Rolls-Royce Responsibilities*

Included in the Scope of Work is Technical Direction of Installation and Commissioning of each Trent 60 Dual Fuel WLE Package (Unit) and for witnessing of performance testing of each Unit.

Installation and commissioning is based upon the RR 63 days installation schedule assumes that civil works are complete, ready for equipment installation, per Unit, with one month stagger between Units.

A3.7.2 *Rolls-Royce Staff*

RR will provide an Installation & Commissioning Manager throughout the on-site period, supported by a team of advisors comprising mechanical plant engineers, controls engineers, AC generator engineer, fire and gas engineer, and performance engineer. Performance testing will be under the witness of a performance engineer. This schedule is based on 10 hours per day.

This schedule assumes that the Customer's installation contractor's productivity will be such that it will meet the schedule provided. If circumstances beyond the control of RR arise or if the Customer's contractor does not maintain the schedule, and therefore exceeds the number of hours for the installation and commissioning, our standard Day Rates will apply.

A3.7.3 *Customer Responsibilities*

Customer shall provide the following facilities and support for Rolls-Royce personnel:

- Site office space and mechanical working areas and access phone lines, broadband and sanitary facilities.
- Medical assistance (if required)
- Storage facilities.
- Assist Rolls-Royce in obtaining local work permits, when requested.
- Details of Site emergency procedures, instruction on all Site safety guidelines and procedures.
- Reasonable access to any area of the site where necessary to perform their work.
- All necessary Permits and Licenses applicable to the work being performed.

The following are required to be provided by Customer to support the Installation and Commissioning:

- Adequate qualified trade labor required to complete activities.
- Supply of all fluids required for operation of the equipment.
- Ensure power, water, light, lubricants, rags and consumables are available to complete activities
- Adequate lifting devices required for the heaviest lift.
- All special and hand tooling and instrumentation required for completion of activities.
- Expenses associated with calibration of tooling or instrumentation.
- Removal and proper disposal of all generated waste.

KW
BAL

BILLERICA (M.A296.01) - EQUIPMENT SUPPLY CONTRACT

APPENDIX A - SCOPE OF WORK

- Installation productivity to meet the schedule provided.
- Complete all Civil and all underground mechanical installations before Rolls-Royce packages arrive.
- Cable tray racking and trenching.
- Ensure all cables are laid before all major electrical & instrumentation equipment is installed on site.

A3.7.4

Tools

Customer has responsibility for all tooling (with the exception of the special tools being supplied by RR). As a minimum, tooling will include drive sockets, allen keys, torque wrenches, adjustable spanners, operational overhead crane, chain blocks, shackles, multi-meter, RTD calibrator pressure source calibrator, two way radios, adequate lighting, micrometers, feeler gauges etc.

'Special Tooling' is provided by RR and is included in the pricing.

✓
BAL