Attachment 3

Avalon Combustion Turbine – Basis of Design

Newfoundland and Labrador Hydro

Avalon Combustion Turbine

Basis of Design

NLH Doc. No. HRDCT2-NLH-49100-EN-BOD-0001-01

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List of Attachments

1.0 Purpose

The purpose of this document is to establish a Basis of Design ("BOD") for the Avalon Combustion Turbine (ACT) Project. This BOD will form the overarching project definition that will be used to prepare engineering design philosophies, project contract packaging, project estimates, project schedules, design briefs, detailed design specifications and drawings, construction planning, and all other project functions that depend on a clear definition of what is to be specifically financed and constructed.

2.0 Scope

The objectives of this document are to establish the BOD for the Avalon Combustion Turbine Generating Facility.

3.0 Definitions

Term	Definition
Basis of Design	A compilation of the fundamental criteria, principles and/or assumptions upon which design philosophies and engineering design briefs will be developed.
Combustion Turbine	An engine consisting of a compressor, a combustion chamber, and an expansion turbine. The engine is coupled to a drive train to convert mechanical energy.
Generator	An assembly of stationary and rotating components, coupled to the combustion turbine drive train, converting mechanical energy to electrical energy.
Good Utility Practice	The practices, methods and acts engaged in, or approved by, a significant portion of the electrical utility industry in North America, or any of the practices, methods and acts which, in the exercise of reasonable judgment in light of the facts known at the time the decision was made, are expected to accomplish the desired result at a reasonable cost consistent with good business practices, reliability, safety and expedition. Good Utility Practice is not intended to be limited to optimum practice, method or act to the exclusion of all others, but rather to include all practices, methods or acts generally accepted in North America.
Life Cycle Cost Analysis	The process of selecting the most cost-effective approach from a series of alternatives so that the least long-term cost of ownership is achieved where life cycle costs are total costs estimated to be incurred in the design, development, production, operation, maintenance, support, and final disposition of an asset over its anticipated useful life from inception to disposal.
Proven Technology	This is the state of technology used in the design, construction and operation of any system including each piece of equipment, component or structure

Term	Definition
	that has a proven record of performance. (First technology applications will only be considered after review by the ACT team and then only after approval by Executive Management).

4.0 Abbreviations

Abbreviation	Term
ac	Alternating Current
ACT	Avalon Combustion Turbine
BOD	Basis of Design
CTG	Combustion Turbine Generator
DCS	Distributed Control System
DNP	Distributed Network Protocol
ECC	Energy Control Center
FEED	Front-End Engineering and Design
GSU	Generator Step-Up Transformer
HMI	Human Machine Interface
Hydro	Newfoundland and Labrador Hydro
kV	Kilovolts
MW	Megawatt
NLH	Newfoundland and Labrador Hydro
NLSO	Newfoundland and Labrador System Operator
NOx	Nitrogen Oxides
pf	Power factor
PLC	Programmable Logic Controller
SAC	Singular Annular Combustor
SCADA	Supervisory Control and Data Acquisition
SLD	Single Line Diagram
TEWAC	Totally Enclosed Water-Air Cooled
Vac	Voltage Alternating Current
Vdc	Voltage Direct Current

5.0 Reference Documents

Document Number	Document Title
HRDCT2-HAT-49100-EV-LTR-0001-01	Best Available Control Technology Memorandum
HRDCT2-HAT-49314-PI-PFD-0001-01	Fuel System Preliminary Process Flow Diagram
HRDCT2-HAT-49326-PI-PFD-0001-01	Service and Demineralization Water System Preliminary Process Flow Diagram

Document Number	Document Title
HRDCT2-HAT-49327-PI-PFD-0001-01	Service, Fire and Waste Water System Preliminary Process Flow Diagram
HRDCT2-HAT-49322-PI-PFD-0001-01	Instrument Air System Preliminary Process Flow Diagram
HRDCT2-HAT-49327-PI-PID-0001-01	Piping and Instrumentation Diagram - Raw Water Storage
HRDCT2-HAT-49326-PI-PID-0001-01	Piping and Instrumentation Diagram - Demineralized Water Distribution System
HRDCT2-HAT-49314-PI-PID-0001-01	Piping and Instrumentation Diagram - Fuel Storage
HRDCT2-HAT-49326-PI-PID-0002-01	Piping and Instrumentation Diagram - Demineralized Water Storage
HRDCT2-HAT-49327-PI-PID-0002-01	Piping and Instrumentation Diagram - Fire Water Distribution
HRDCT2-HAT-49322-PI-PID-0001-01	Piping and Instrumentation Diagram - Instrument and Service Air Distribution
HRDCT2-HAT-49314-PI-PID-0002-01	Piping and Instrumentation Diagram - Fuel Distribution
HRDCT2-HAT-49327-PI-PID-0003-01	Piping and Instrumentation Diagram - Raw Water Distribution System
HRDCT2-HAT-49327-PI-PID-0004-01	Piping and Instrumentation Diagram - Fuel Pump House
HRDCT2-HAT-49100-PI-PID-0001-01	Piping and Instrumentation Diagram - Area - Legend Sheet 1 - Asset Tagging
HRDCT2-HAT-49100-PP-DAL-0001-01	General Arrangement - Overall Site Plot Plan - Layout
HRDCT2-HAT-49100-PP-DAL-0002-01	Combustion Turbine Building General Arrangement
HRDCT2-HAT-49100-FS-DAL-0001-01	Fuel Storage - Mechanical - General Arrangement
HRDCT2-HAT-49890-EL-DSL-0001-01	Overall Operation Single Line Diagram
HRDCT2-HAT-49890-EL-DSL-0005-01	Protection and Controls Single Line Diagram (sheet 1/2)
HRDCT2-HAT-49890-EL-DSL-0005-02	Protection and Controls Single Line Diagram (sheet 2/2)
HRDCT2-HAT-49890-EL-DSL-0003-01	600V Unit Auxiliary Board - UAB1 Single Line Diagram
HRDCT2-HAT-49890-EL-DSL-0003-02	600V Unit Auxiliary Board - UAB2 Single Line Diagram
HRDCT2-HAT-49890-EL-DSL-0003-03	600V Unit Auxiliary Board - UAB3 Single Line Diagram

Document Number	Document Title
HRDCT2-HAT-49890-EL-DSL-0004-01	600V Auxiliary Station Board - ASB1 Single Line Diagram
HRDCT2-HAT-49890-EL-DSL-0004-02	600V Auxiliary Station Board - ASB2 Single Line Diagram
HRDCT2-HAT-49890-EL-DSL-0004-03	Balance of Plant - 4.16kV Emergency Generator Board - EGB1 - Single Line Diagram
HRDCT2-HAT-49100-EL-DBD-0001-01	System Operating Diagram
HRDCT2-HAT-49900-TE-DBD-0001-01	System Overall Architecture Drawing
HRDCT2-HAT-49100-EL-DAL-0001-01	230kV Switchyard - General Layout
HRDCT2-HAT-49890-EL-DSL-0002-01	230kV Switchyard - Sections - Sheet 1 of 2
HRDCT2-HAT-49100-EL-DSL-0002-02	230kV Switchyard - Sections and Isometric - Sheet 2 of 2
HRDCT2-HAT-49100-EL-DAL-0002-01	138kV Switchyard - SST1 Layout - Sections and ISO
HRDCT2-HAT-49100-EL-DSE-0002-01	138kV Switchyard Sections
HRDCT2-HAT-49100-PI-LST-0001-01	Piping Line List
HRDCT2-HAT-49100-ME-LST-0001-01	Mechanical Equipment List
HRDCT2-HAT-49100-EV-TEN-0001-01	Community Noise Impact Assessment
HRDCT2-HAT-49100-EV-TEN-0002-01	Water Supply Analysis and Environmental Review Report
HRDCT2-HAT-49327-EV-TEN-0003-01	PFD Stream Tables Basis and Assumptions
HRDCT2-HAT-49100-ME-TEN-0001-01	Combustion Turbine Technology Comparison
HRDCT2-HAT-20000-ST-CRT-0001-01	Structural Design Criteria
HRDCT2-HAT-22000-PI-CRT-0001-01	Piping Design Criteria
HRDCT2-HAT-22000-PI-IDX-0001-01	Piping Material Class Index
HRDCT2-HAT-49100-EN-BOD-0001-01	Combustion Turbine Plant FEED Study - Design Basis
HRDCT2-HAT-49890-EL-DAL-0001-01	Plant Electrical Room General Layout

Document Number	Document Title
HRDCT2-HAT-49890-EL-DCS-0001-01	Electrical Cable Schedule
HRDCT2-HAT-49100-PI-LST-0002-01	Manual Valve List
HRDCT2-HAT-49890-EL-LST-0001-01	Electrical Load List
HRDCT2-HAT-49900-PT-IDX-0001-01	Instrument Index
HRDCT2-HAT-49900-PT-LST-0002-01	Instrument and Control Cable List
HRDCT2-HAT-60200-TE-LST-0001-01	Communication Cable List
HRDCT2-HAT-49900-PT-DIO-0001-01	Input and Output (I/O) List
HRDCT2-HAT-49314-EN-CAL-0001-01	Hydraulic Calculation - Fuel Distribution to Turbines
HRDCT2-HAT-49327-EN-CAL-0001-01	Hydraulic Calculation - Raw Water From Quarry Brook
HRDCT2-HAT-49327-EN-CAL-0002-01	Hydraulic Calculation - Fire Water Supply to Combustion Turbine
HRDCT2-HAT-49314-EN-CAL-0002-01	Hydraulic Calculation - Fuel Oil Unloading From Trucks
HRDCT2-HAT-49314-EN-CAL-0003-01	Hydraulic Calculation - Fuel Oil Offloading From Vessel
HRDCT2-HAT-49327-PI-DGA-0002-01	Quarry Brook Raw Water Tie-in G.A.
HRDCT2-HAT-49327-PI-DGA-0001-01	Fire Water Main Tie-in G.A. - Plan and Sections
HRDCT2-HAT-49314-ME-DGA-0001-01	Tank Foundations General Arrangement Plan
HRDCT2-HAT-49327-CV-DGA-0001-01	Site Civil Drainage Design
HRDCT2-HAT-49900-PM-SPC-0001-01	Functional Description
HRDCT2-HAT-79100-CV-DAL-0001-01	Project Wide Sanitary Drainage General Arrangement

6.0 Roles and Responsibilities

Role	Responsibilities
Sr. Manager	Responsible for approval of the BOD.

Role	Responsibilities
Major Projects, PM, & Engineering	
Program Manager Major Projects	Review the BOD to ensure it is compliant within the program scope.
Project Manager Avalon Combustion Turbine	Responsible to ensure that all related project estimates and schedules respect the BOD.
Lead Engineer Avalon Combustion Turbine	Prepare the BOD and ensure that all design parameters reflect the intentions of the BOD.
Long-Term Asset Planner Gas Turbines and Diesels	Review BOD and ensure the proposed project meets the current and future needs.

7.0 Descriptions

7.1 General

This BOD includes a combustion turbine plant, fuel handling and storage system, black start generators, raw water supply and storage system, demineralized water storage system, fire-water system, sanitary sewer system, terminal station, transmission tie-in, and balance of plant.

The primary reason for developing the Avalon Combustion Turbine facility is to meet load growth and provide reliable peaking and backup generation to enable the planned retirement of aging fossil fuel-based assets. Hydro has reviewed a number of alternative scenarios and determined additional investment for generation resources is required to ensure adequate supply. The ACT is one of three minimum investments Hydro will progress to maintain the reliability of the Island Interconnected System.

All design assumptions used to establish the BOD respect the following overarching principles:

- Only proven technologies will be considered, unless it can be clearly demonstrated to the satisfaction of Hydro that they can be as reliable and provide significant capital/operating cost and/or schedule savings
- Local climatic/service conditions such as ambient temperature, elevation, humidity, wind, ice accretion, and annual snow fall will be respected throughout the Project;
- Avalon Combustion Turbine facility and transmission systems will have the ability to be remotely operated and monitored from Hydro's Energy Control Centre;
- All designs shall assume a 50 year design life for the purposes of evaluation;
- As a part of the environmental assessment process with the Newfoundland and Labrador Department of Environment, Hydro will determine all environmental mitigation and

rehabilitation provisions issuing requests for proposals leading to construction contracts. This will include any requirements dictated by the Environmental Assessment approval;

- The designs will assume the use of existing transportation infrastructure to the maximum extent possible. In particular, existing roads, bridges, and marine offload facilities;
- Good Utility Practice will be observed;
- Principles of Life Cycle Cost Analysis will be employed;
- The designs will be consistent with Hydro's Safety and Health Program;
- The designs will be consistent with Hydro's Environmental Policy and Guiding Principles;
- The designs will be consistent with Hydro's Asset Management Policy and Guiding Principles;
- The designs will be consistent with all applicable governing Standards, Codes, Acts and Regulations; and
- All assets and systems will be designed to ensure safety, reliability, efficiency and minimal impact to the environment.

7.2 Avalon Combustion Turbine Facility

7.2.1 Access – General

- Site roads to be gravel surfaced. Parking areas to be asphalt;
- Temporary site access will be installed off the Thermal Plant Road before entering the main security gate;
- Permanent site access will continue to be from the main security gate entrance for the main thermal plant; and
- Refer to Attachment 1: General Arrangement Overall Site Plot Plan – Layout.

7.2.2 Avalon Combustion Turbine Plant

The combustion turbine generators will be in a winterized building which will include the following features:

- CT packages including turbines, generators, lube oil system, starting system, air intakes;
- Balance of Plant (BOP) auxiliary process and utility equipment including:
  - CT ancillary process and utility skids;
  - Electrical and battery rooms;
  - Office and meeting room space;
  - Lunchroom, first-aid facilities, washrooms, and a locker room;
  - Warehousing space for materials handling, parts and tool storage;
  - Hazardous materials storage area;

- Workshop for minor operations and maintenance activities;
- Lounge area/room;
- Exercise room; and
- Sleep quarters.

- Refer to Attachment 2 - Combustion Turbine Building General Arrangement.

7.2.3 Combustion Turbines

- Multiple unit arrangement providing a nominal 150 MW of capacity at a power factor of 0.85 pf;
- The turbines must have a fast start capability of 10 minutes;
- Failure of any equipment/system of one unit not to affect the operation of the remaining units;
- Best available control technology for emission control;
- Ability for fuel flexibility with options to transition to either renewable diesel, natural gas, or natural gas/hydrogen blend fuels, as these fuel sources become more readily available;
- Units will utilize hydraulic or electric start; and
- A single annular combustion (SAC) system will be used for liquid fuel operation. A SAC system is expected to produce NOx emissions of 38ppm with the use of water injection technology.

7.2.4 Generators

- Power generation shall be achieved by multi-unit 13.8kV generators;
- Each generating unit will be Totally Enclosed Water-Air Cooled (TEWAC);
- Synchronous Condensing capability;
- Each generating unit shall be connected to an individual generator step-up transformer (GSU);
- All generators will operate at 3600 RPM;
- System will require exciters, automatic voltage regulators, synchronizing relays; and
- Isolated Phase Bus ducts will be used for connections between the generating units and the GSU's.

7.2.5 Generator Step-up Transformers

- Generator Step up transformers will step up the generator voltage from 13.8kV to connect to the grid at 230kV. There will be one spare transformer purchased and located outside the power house;
- Transformers will be on concrete pads with containment for oil leaks;
- Each transformer will include drainage to a common oil water separator;
- Each unit will have a generator circuit breaker; and

- Transformers will be separated from each other by a concrete firewall.

7.2.6 Electrical Ancillary Equipment

- Each generating unit will have its own 13.8kV switchgear containing the equipment necessary for interruption, grounding, and protection of the generator output;
- The plant will have a 600 Vac motor control center for all large motor loads and a 120/208Vac for lighting and auxiliary systems;
- Battery systems complete with redundant chargers will be used to provide 125Vdc, 48Vdc, 24Vdc;
- Station service will consist of a primary and secondary connection;
- Lighting will be LED and use occupancy sensors were required;
- Arc flash category two or lower for all electrical panels of 600 Vac or greater;
- Emergency diesel generator connection and essential panel for the powerhouse essential loads required for a black start as necessary; and
- Refer to Attachment 4 - Overall Operation Single Line Diagram.

7.2.7 Mechanical Ancillary Equipment

- Fire suppression system in the main building and combustion turbine enclosures;
- Water treatment plant for demineralized water production;
- Bulk fuel storage and fuel handling. Two vertical tanks with a combined capacity of 10 days fuel storage (approx. 4.8M litres per tank). Refer to Attachment 5: Fuel Storage - Mechanical - General Arrangement Plan;
- Domestic water supplied by water treatment plant;
- Domestic waste water to septic tank and disposal field or connection to existing site services if possible;
- Oil-water separator system for drains, fuel dyke de-watering, lube oil coolers, 138kV station service transformer and generator step-up transformer concrete containments;
- Main lube oil system for combustion turbine units;
- Overhead powerhouse crane; and
- Black start diesel generators (2 x 2MW), as necessary.

7.2.8 Protection, Control & Monitoring

- Combustion turbine controls will utilize vendor supplied systems;
- Auxiliary systems to be controlled by PLC's;

- Plant will be controlled locally by an overarching DCS system. Each unit will be equipped with an HMI; and
- Standard NLH protection relaying with be implemented.

7.2.9 DCS and Communications System

- A Distributed Control System (DCS) will provide Monitoring and Control function to each CTG unit and all Balance of Plant equipment for the new plant;
- The plant's overall DCS shall interface with the turbine control system and all other plant systems. The DCS shall also interface with the Owner's SCADA and PI historian. The SCADA protocol shall be DNP 3.0;
- All critical alarms and data points shall be hardwired to the Control System and local operating station;
- The plant will include redundant instrumentation and control equipment consistent with good engineering design and Hydro norms;
- Standard NLH networking equipment will be implemented, (i.e., cisco switch, routers and firewalls, VoIP phone system, and security camera systems); and
- NLSO will have the ability to control plant from ECC.

7.3 Terminal Station

- Concrete foundations and galvanized steel structures to support the electrical equipment and switchgear;
- Electrical layout of the switchyard is to be in accordance with the SLD;
- Terminal Station control building including fire suppression, domestic water and sanitary services; and
- Refer to Attachment 3 - 230kV Switchyard - General Layout.

7.4 Transmission

- Relocation of Newfoundland Power distribution lines 38L and 39L;
- Interconnection to the 230 kV transmission line TL218 between the Holyrood Terminal Station and the Oxen Pond Terminal Station;
- Reconfiguration of TL218 will require a new section of transmission towers and shield wire; and
- 138kV transmission line from Holyrood Terminal Station Bus 8 to new ACT Terminal station for station service supply.

Avalon Combustion Turbine

Basis of Design

Attachment 1: General Arrangement Overall Site Plot Plan - Layout

Document No: HRDTC2-HAT-49100-PP-DAL-0001-01, Rev.B0

Document Date: September 27, 2024

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Avalon Combustion Turbine

Basis of Design

Attachment 2: Combustion Turbine Building General Arrangement

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Avalon Combustion Turbine

Basis of Design

Attachment 3: 230 kV Switchyard – General Layout

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Avalon Combustion Turbine

Basis of Design

Attachment 4: Overall Operation Single Line Diagram

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Avalon Combustion Turbine

Basis of Design

Attachment 5: Fuel Storage – Mechanical – General Arrangement Plan

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