

Memorandum From: Jack Casey P.Eng.
To: Sean LaCour,
Manager Energy Supply
Subject: Proposed 2003 Governor Replacements
Date: November 7, 2002

This summarizes the recommendation made during the 2003 Capital Budget review process for governor replacements. The recommendation was that the replacement of the governors on Tors Cove generators G2 and G3 be included with the 2003 Capital Budget for Energy Supply, along with the replacement of the electronic controller for the Voist Alpine governor system at Topsail Plant.

These conclusions are based upon a review of the plant availability reports for the preceding three years (1999 through 2001), and discussion with the plant coordinators and operations staff. In the case of Tors Cove, this plant represents 8% of available generation while it accounts for 14% of all unscheduled downtime in the past three years. A detailed review of the unscheduled outages confirms that governors and control systems are the most common causes for unscheduled outages at Tors Cove. Similarly, Topsail Plant represents 2% of available generation while it accounts for 7% of all unscheduled outages in the past three years. Based upon the previous three years of operations these two plants consistently are the worst performers with respect to governor and control system failures.

These findings are consistent with the Plant Availability Review completed in December 2000. At that time governor failures were identified as the second biggest contributor to plant downtime across all hydro plants.

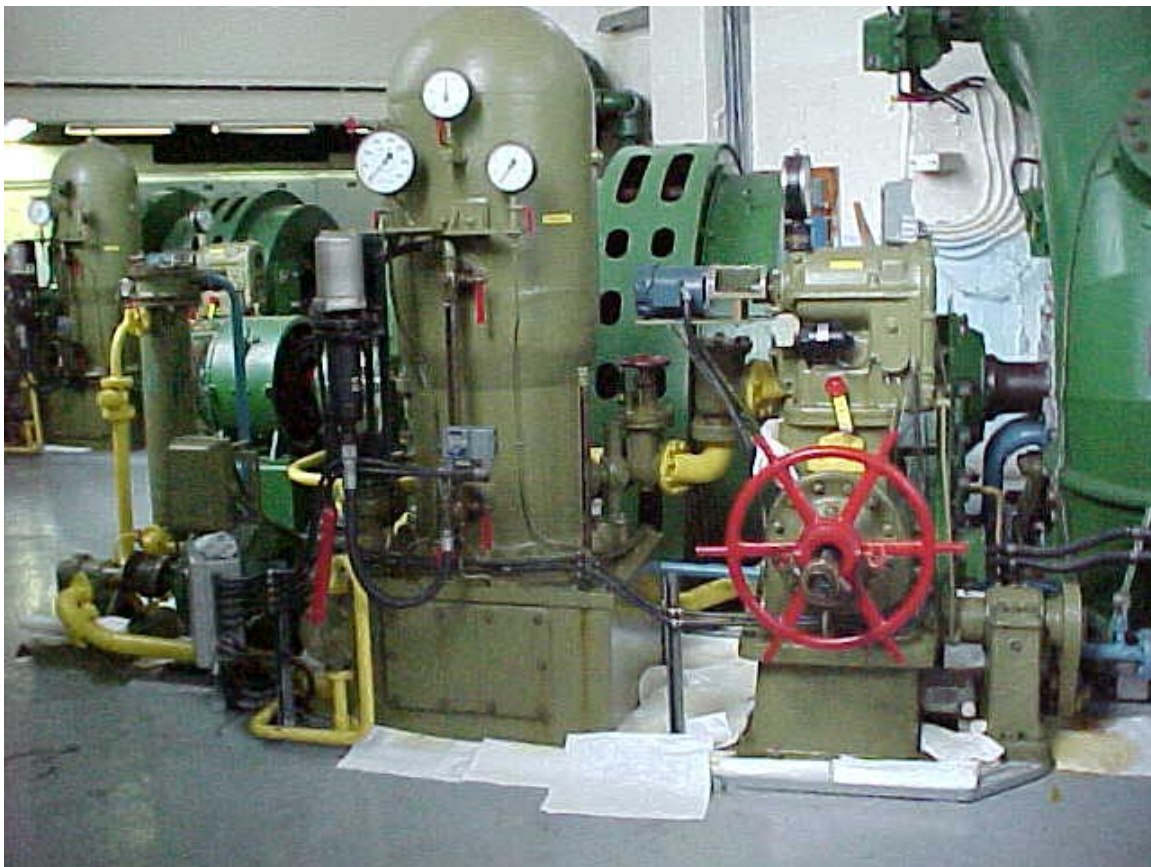
Attached you will find a brief summary of the governor technology at Tors Cove and Topsail plants. These summaries identify problems with the governors at these plants and potential solutions. Of particular concern at Tors Cove is the age of the units and the environmental risk associated with oil seepage from the governors. At Topsail the problem with governor instability resulting from poor regulation provided by the electronic components is of primary concern. The hydraulic unit can be salvaged with only the electronics requiring attention at this time.

Estimates for this work have been included with the attached summaries.

TORS COVE GOVERNOR REPLACEMENT Generators G2 and G3

The governor systems at Tors Cove are original to the 1940 construction of the generating station. English Electric, the original manufacturer of the generator and turbine, supplied the governors as well. English Electric ceased to exist in 1968 when it merged with GEC Alstom. As a result the support for the governors has been non-existent for many years.

Over the years the governors have been overhauled numerous times. If replacement parts are unavailable they have to be machined in local machine shops by reproducing the broken part. The specifications of these replacement parts are not within the tolerances of the original equipment and frequently oil leaks develop. In the photograph below the governor system is olive green with the generator and turbine forest green in colour. Take special notice of the absorbent pads used to contain oil leaks from the governor.



There are three generators in the Tors Cove generating station. The proposed project involves the replacement of two governor systems. Tors Cove generator G1 is not under remote control and requires an operator on site to start and operate the generator. This unit is only operated during the spring runoff and the

amount of energy produced does not warrant any significant capital investment at this time. Parts with a history of failing in service will be salvaged from units G2 and G3 and maintained for service in unit G1. These English Electric governors are unique and are the only ones of their type in the system. This makes it difficult to source parts and requires considerable ingenuity to maintain these systems.

Originally the governors were belt driven from the main generator shaft. The belt drives had become unreliable and were replaced by variable speed motors controlled by generator shaft speed. This modification was completed in the early 1990s.

The current state of the governors is such that they are unable to maintain a constant load. The generators tend to drift away from efficient load and require frequent adjustment by the SCADA operator. Acres International addressed the role of governors and control systems in efficiently operating Newfoundland Power's hydroelectric plants in their December 2000 Water management Study.



A review of the plant availability reports for the past four years has identified twenty-nine unscheduled outages that can be attributed to failures of the governor and control systems at Tors Cove. These twenty-nine outages accumulated 2,236 hours of downtime in the plant.

Replacement of the Tors Cove G2 and G3 governors with oil free all electric governors are recommended. These units working in conjunction with the PLC based control system will provide a reliable system that can be easily maintained. Also this design minimizes the use of oil in the generating station thereby reducing the risk of an environmental incident.

The budget estimate for the project is \$287,000 Non-Labour and \$33,000 Labour. The non-labour cost is based upon a \$105,000 per unit budgetary figure received from North American Hydro of Schofield WI, a \$19,000 per unit allowance for wiring materials (including auxiliaries such as speed switches) and a \$19,500 per unit allowance for plant control PLC changes. The labour estimate is based upon 120 man-days of effort to complete the design, procurement, installation and commissioning of the new equipment.

TOPSAIL GOVERNOR UPGRADE

Electronic Controls

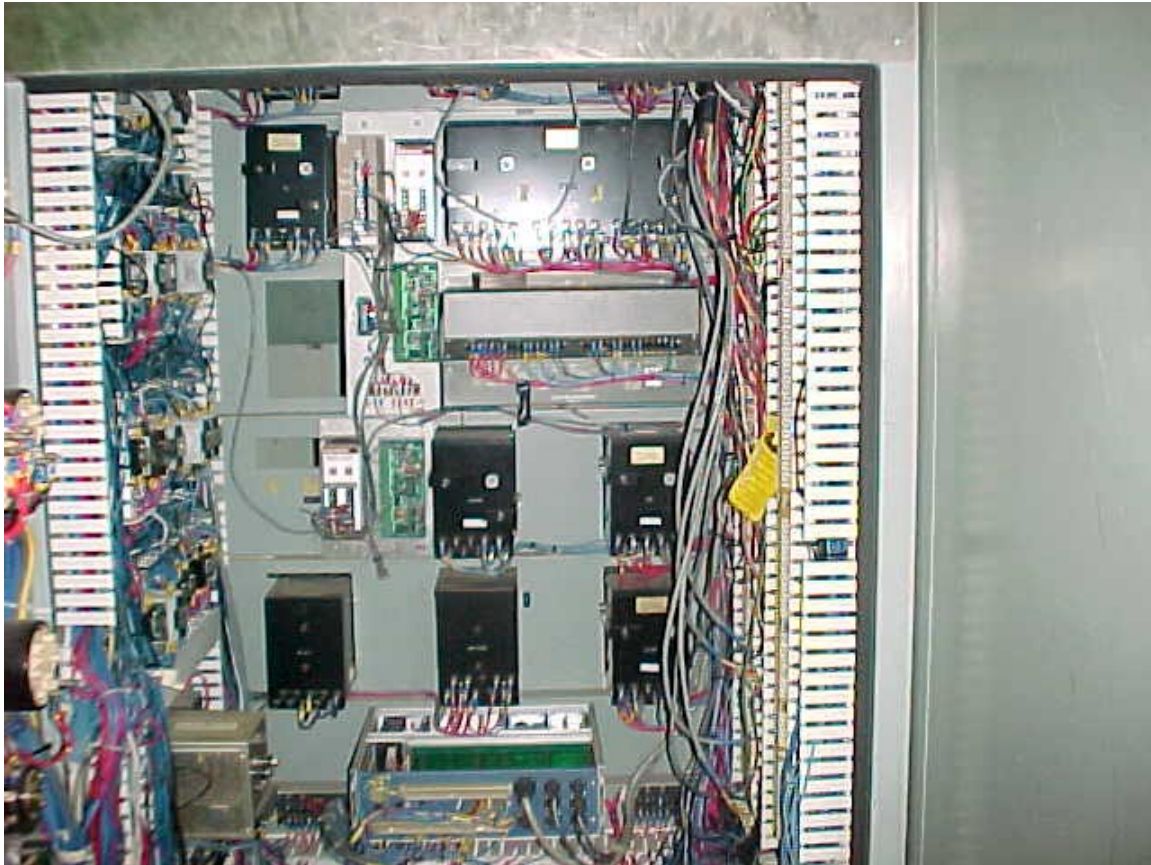
Topsail generating station was originally developed in 1932. In 1983 the generator and turbine were replaced along with most protection, control and auxiliary systems. At that time a Voist Alpine governor system was supplied to replace the original Woodward gate shaft governor. The hydraulic portion of the Voist Alpine governor system has operated reliably in recent years. However the electronic controls have been a problem since the 1983 installation. Within the first ten years of service, replacement modules were purchased from the original equipment manufacturer. In the early 1990s the manufacturer ceased to support the product.



The electronic controller is incapable of operating the generator in a stable condition. The controller issues multiple commands in an attempt to regulate the speed of the turbine, even when the unit is operating at synchronous speed. As a result an Allen-Bradley PLC has been added to filter the commands between the controller and the wicket gate actuator. If the generator is operating at synchronous speed then commands from the controller are ignored. The PLC logic is modified as different operating situations are encountered. As a result the PLC implementation remains a work in progress. This contributes to plant

outages, as new ladder logic must be developed to accommodate operating scenarios as they are encountered.

It is recommended that a solution be found to replace the Voist Alpine electronic governor at Topsail Plant with a PLC based solution. The electronic module is located in the bottom center of the picture below. The hydraulic portion of the system as shown on the previous page should be capable of being maintained into the future.



A review of plant availability statistics for the preceding four years has identified thirty-six (36) separate incidents where governor and control related problems have caused plant outages. These outages accounted for 886 hours of downtime at Topsail plant over this period.

The budget estimate for the project is \$110,000 Non-Labour and \$20,000 Labour. The non-labour cost is based upon a \$50,000 US budgetary figure received from L&S Electric Limited of Schofield WI and a \$15,000 allowance for wiring materials and plant control PLC changes. The labour estimate is based upon 70 man-days of effort to complete the design, procurement, installation and commissioning of the new equipment.