

CI 39663

TRE5 – U&U Turbine Governor Refurbishment

REDACTED

September 2, 2010

NOVA SCOTIA
POWER
An Emera Company

UARB APPROVAL SHEET

Project Title: **TRE5 - U&U Turbine Governor Refurbishment**

CI Number: 39663

☒ Capital Project Authorization

Head Office Use:

☐ ATO

Project Number:

☐ Final Cost

Date: July 30, 2010

Location:			Division:	
Expenditure Profile			Schedule	
YEAR	Budget Estimate	Project Estimate		
2010		648,220	Estimated Start Date	2010-08
			Estimated In-Service Date	2010-08
			Estimated Close Date	2010-09
Total	\$0	\$648,220		

COMMENTS

This item is submitted pursuant to section 35

Submitted on behalf of NOVA SCOTIA POWER INCORPORATED

Approved on behalf of NOVA SCOTIA UTILITY AND REVIEW BOARD

M/S *Sm*

Aug 25/2010

Authorized Signatory

DATE

DATE

Mark Savory

VP Technical and Construction

Project Number

- TRE5 - (UU) Turbine Governor Refurbishment

CI Number : 39663

Parent CI Number :

-

Budget Version - 2010 07/05 Forecast

Cost Centre : 340 - 340-Trenton Unit 5 Capital

Forecast

Start :	08/01/2010
Operational :	09/30/2010
Final Cost :	11/30/2010
2010	\$637,704.60
Total :	\$637,704.60
Original Cost :	\$350,000.00

The purpose of this project was to repair the damaged governor on Trenton Unit 5 and return the unit back to service. Inspection of the governor during an un-planned outage in March 2010 (see attached) was completed. This inspection confirmed the governor worm and worm wheel failed as a result of insufficient backlash and tooth clearance between the worm and wheel. The insufficient backlash and tooth clearance resulted from normal wear. This work was completed during the unplanned outage.

Summary of Related CI's +/- 2 years.
No other projects in 2008,2009,2010,2011 or 2012

Project Number

Approved Date

Budget Version 2010 07/05 Forecast

- TRE5 - (UU) Turbine Governor Refurbishment

CI Number : 39663

Parent CI Number :

Cost Centre : 340 - 340-Trenton Unit 5 Capital

Capital Item Accounts

Acct	Actv	Account	Activity	Forecast Amount	Amount	Variance
094		094 - Interest Capitalized		10,515	0	10,515
095		095-Thermal Overtime Labour AO		6,088	0	6,088
095		095-Thermal & Hydro Contracts AO		20,711	0	20,711
095		095-Thermal Term Labour AO		11,912	0	11,912
095		095-Thermal Regular Labour AO		9,794	0	9,794
001	010	001 - THERMAL Regular Labour	010 - SGP - Turbo Gen.Instal.	37,000	0	37,000
002	010	002 - THERMAL Overtime Labour	010 - SGP - Turbo Gen.Instal.	46,000	0	46,000
004	010	004 - THERMAL Term Labour	010 - SGP - Turbo Gen.Instal.	45,000	0	45,000
012	010	012 - Materials	010 - SGP - Turbo Gen.Instal.	121,000	0	121,000
013	010	013 - POWER PRODUCTION Contracts	010 - SGP - Turbo Gen.Instal.	316,200	0	316,200
028	085	028 - Consulting	085 Design	3,000	0	3,000
028	087	028 - Consulting	087 Field Super.& Ops.	21,000	0	21,000
Total Cost:				648,220	0	648,220
Original Cost:				350,000		

CI Number : 39663	- TRE5 - (UU) Turbine Governor Refurb	Project Number
Parent CI Number :	-	Approved Date
Cost Centre : 340	- 340-Trenton Unit 5 Capital	

Capital Item Justification

Justification Criteria : Thermal

Sub-Criteria : Maintenance

Name of Report :

Document Location :

Person Responsible :

Why do this project?

This project must be done before Trenton #5 unit could be returned to service. With the unit off line, NSPI would incur replacement energy costs.

Why do this project now?

This project must be implemented in order to return Trenton Unit 5 to service and avoid replacement energy costs.

Why do this project this way?

The most cost effective and timely method to do this project was to replace the worm & wheel, rebuild the main & auxiliary governors and adjust both overspeed trip mechanisms to comply with recommended OEM (Original Equipment Manufacturer) dimensional clearances.

TRENTON GENERATING STATION - PROJECT COST ESTIMATE (2010)							
FP# :	39663						
Title :	TRE5 - (UU) Turbine Governor Refurbishment						
Item	Description	Acct	Actv	Unit	Quantity	Unit Price	Total
1	Supply of Materials						
1.1	Wormwheel (March outage)			Each	1		
1.2	Governor regulating bush & adaptor (July outage)			Each	1		
1.3	Governor regulating bush (July outage)			Each	1		
1.4	Governor springs (July outage)			Each	2		
1.5	Baffle plates with caulking strip (July outage)			Each	2		
1.6	Governor gland bush - top (July outage)			Each	2		
1.7	Governor gland bush - bottom (July outage)			Each	2		
1.8	Governor valve spindle (July outage)			Each	1		
1.9	Shaft overspeed governor sleeve (July outage)			Each	2		
1.10	Miscellaneous materials			Lot	1		
Supply of Materials Sub-Total						\$	121,000.00
2	Equipment Rental & Charges						
2.1	Miscellaneous rentals			Lot	1	\$ 2,000.00	\$ 2,000.00
Equipment Rental & Charges Sub-Total						\$	2,000.00
3	Plant Labour						
3.1	Plant regular labour (March)			Lot	1	\$ 31,000.00	\$ 31,000.00
3.2	Plant OT labour (March)			Lot	1	\$ 46,000.00	\$ 46,000.00
3.3	Term Labour (March)			Lot	1	\$ 45,000.00	\$ 45,000.00
3.4	Crane operator (July)			Lot	1	\$ 3,200.00	\$ 3,200.00
3.5	Utility labour (July)			Lot	1	\$ 2,800.00	\$ 2,800.00
3.6							\$ -
3.7							\$ -
Plant Labour Sub-Total						\$	128,000.00
4	Contractor Labour						
4.1	Technical direction & governor refurbishment (March)			Lot	1		
4.2	Service rep (March)			Lot	1		
4.3	Pipe bore inspection (March)			Lot	1		
4.4	Vibration monitoring during start-up (March)			Lot	1		
4.5	Oil flush (March)			Lot	1		
4.6	NDT Services (March)			Lot	1		
4.7	Piping mods for oil flush (March)			Lot	1		
4.8	Crane services (March)			Lot	1		
4.9	Millwright labour (July)			Lot	1		
4.10	Siemens technical director (July)			Lot	1		
4.11	Insulation services (March)			Lot	1		
Contractor Labour Sub-Total						\$	314,200.00
5	Engineering & Project Management						
5.1	Consulting design (March)			Lot	1		
5.2	Contract Supervisor (March)			Lot	1		
5.3	Contract Supervisor (July)			Lot	1		
5.4							\$ -
5.5							\$ -
Engineering & Project Management Sub-Total						\$	24,000.00
Project Sub-Total Before Indirect Costs						\$	589,200.00
6	Indirect Costs						
6.1	Interest	094	N/A	Lot	1	\$ 10,515.39	\$ 10,515.39
6.2	Thermal Regular Labour AO	095	005	Lot	1	\$ 9,793.90	\$ 9,793.90
6.3	Thermal Overtime Labour AO	095	005	Lot	1	\$ 6,088.10	\$ 6,088.10
6.4	Thermal & Hydro Contracts AO	095	005	Lot	1	\$ 20,711.10	\$ 20,711.10
6.5	Thermal Term Labour AO	095	005	Lot	1	\$ 11,911.50	\$ 11,911.50
6.6							\$ -
Indirect Costs Sub-Total						\$	59,019.99
Total Project Cost Estimate						\$	648,219.99
7	Retirement Costs						
7.1	Retirement Costs	097		Lot	1	\$ 350,000.00	\$ 350,000.00



TRE5 (UU) Turbine Governor Refurbishment Summary of Alternatives

Budget Year :
Division :
Department :
Originator :

2010
Power Production
Trenton Generating Station

Date :
CI Number:
Project No. :

23-Aug-10
39663

	Alternative	After Tax WACC	PV of EVA / NPV	Rank	IRR	Disc Pay
A	Refurbish turbine governor	6.55%	3,163,190	1	67.34%	2.7 years
B	Test 2	6.55%	0	2	#NUM!	0.0 years
C	Test 3	6.55%	0	2	#NUM!	0.0 years
D	Test 4	6.55%	0	2	#NUM!	0.0 years

Recommendation :

Based on favourable metrics detailed above, proceed with project approval

Notes/Comments :

Refurbish turbine governor

This EAM is based on the following assumptions: a life of 15 years and a capital cost of \$648,220. The justification of this project is determined using the avoided cost of replacement energy. These avoided costs for 2010 and 2011 are \$154,224 and \$494,496 respectively

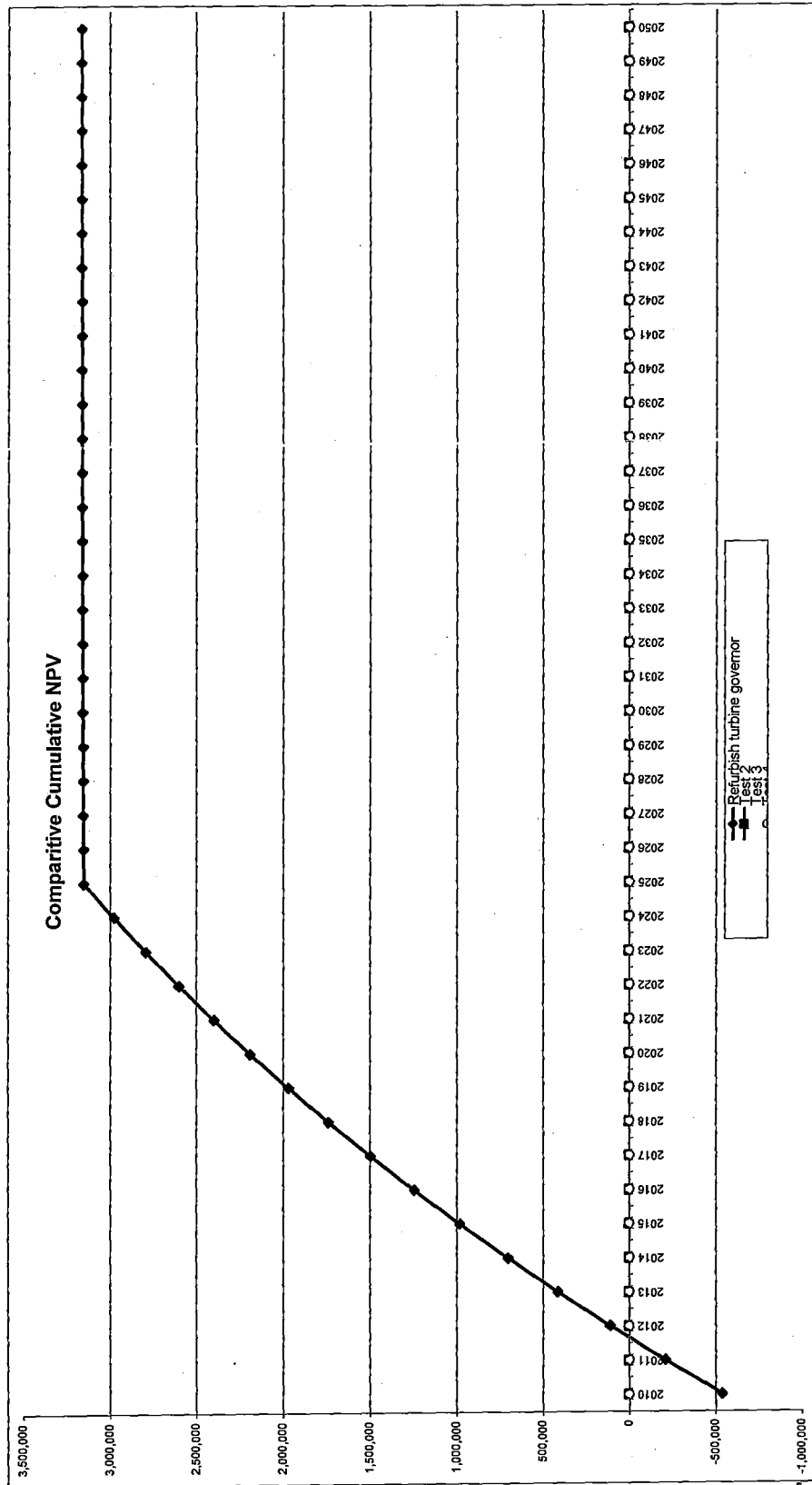
Test 2

Test 3

Test 4

TRE5 (UU) Turbine Governor Refurbishment
Refurbish turbine governor

Year	Total Revenue	Operating Costs	Capital	CCA	UCC	CFBT	Applicable Taxes	CFAT	Discount Factor	PV of CF	GNPV
2010	154,224.0	-	(648,220.0)	25,938.8	622,291.2	(493,996.0)	(44,133.8)	(538,129.8)	1.000	(538,129.8)	(538,129.8)
2011	494,496.0	-	-	49,783.3	572,507.9	494,496.0	(144,821.5)	349,674.5	0.939	328,178.8	(209,950.9)
2012	504,385.9	-	-	45,800.6	526,707.3	504,385.9	(142,252.3)	362,133.6	0.881	318,978.9	109,028.0
2013	514,473.6	-	-	42,136.6	484,570.7	514,473.6	(146,424.5)	368,049.2	0.827	304,260.4	413,288.4
2014	524,763.1	-	-	38,765.7	445,805.0	524,763.1	(150,736.1)	374,027.0	0.776	290,194.5	703,482.8
2015	535,258.4	-	-	35,664.4	410,140.6	535,258.4	(154,874.1)	380,384.2	0.728	276,984.4	980,467.2
2016	545,963.5	-	-	32,811.3	377,329.4	545,963.5	(159,077.2)	386,886.3	0.683	264,400.7	1,244,867.9
2017	556,882.8	-	-	30,186.4	347,143.0	556,882.8	(163,275.9)	393,606.9	0.641	252,457.6	1,497,325.6
2018	568,020.5	-	-	27,771.4	319,371.6	568,020.5	(167,477.2)	400,543.3	0.602	241,113.7	1,738,439.3
2019	579,380.9	-	-	25,549.7	293,821.9	579,380.9	(171,687.7)	407,693.2	0.565	230,331.0	1,968,770.3
2020	590,968.5	-	-	23,505.7	270,316.1	590,968.5	(175,913.5)	415,055.0	0.530	220,075.2	2,188,845.5
2021	602,787.9	-	-	21,625.3	248,690.8	602,787.9	(180,160.4)	422,627.5	0.498	210,314.7	2,399,160.2
2022	614,843.6	-	-	19,895.3	228,795.6	614,843.6	(184,434.0)	430,409.6	0.467	201,020.6	2,600,180.8
2023	627,140.5	-	-	18,303.6	210,491.9	627,140.5	(188,739.4)	438,401.1	0.438	192,166.1	2,792,346.9
2024	639,683.3	-	-	16,839.4	193,652.6	639,683.3	(193,081.6)	446,601.7	0.411	183,726.6	2,976,073.5
2025	652,477.0	-	-	15,492.2	178,160.4	652,477.0	(197,465.3)	455,011.7	0.386	175,679.4	3,151,752.8
2026	-	-	-	14,252.8	163,907.5	-	4,418.4	4,418.4	0.362	1,601.1	3,153,353.9
2027	-	-	-	13,112.6	150,794.9	-	4,064.9	4,064.9	0.340	1,382.4	3,154,736.3
2028	-	-	-	12,063.6	138,731.3	-	3,739.7	3,739.7	0.319	1,193.6	3,155,930.0
2029	-	-	-	11,098.5	127,632.8	-	3,440.5	3,440.5	0.300	1,030.6	3,156,950.6
2030	-	-	-	10,210.6	117,422.2	-	3,165.3	3,165.3	0.281	889.9	3,157,850.5
2031	-	-	-	9,393.8	108,028.4	-	2,912.1	2,912.1	0.264	768.4	3,158,618.9
2032	-	-	-	8,642.3	99,386.1	-	2,679.1	2,679.1	0.248	663.5	3,159,282.4
2033	-	-	-	7,950.9	91,435.3	-	2,464.8	2,464.8	0.232	572.9	3,159,855.2
2034	-	-	-	7,314.8	84,120.4	-	2,267.6	2,267.6	0.218	494.6	3,160,349.9
2035	-	-	-	6,729.6	77,390.8	-	2,086.2	2,086.2	0.205	427.1	3,160,776.9
2036	-	-	-	6,191.3	71,199.5	-	1,919.3	1,919.3	0.192	368.8	3,161,145.7
2037	-	-	-	5,696.0	65,503.6	-	1,765.7	1,765.7	0.180	318.4	3,161,464.1
2038	-	-	-	5,240.3	60,263.3	-	1,624.5	1,624.5	0.169	274.9	3,161,739.0
2039	-	-	-	4,821.1	55,442.2	-	1,494.5	1,494.5	0.159	237.4	3,161,976.4
2040	-	-	-	4,435.4	51,006.8	-	1,375.0	1,375.0	0.149	205.0	3,162,181.4
2041	-	-	-	4,080.5	46,926.3	-	1,265.0	1,265.0	0.140	177.0	3,162,358.4
2042	-	-	-	3,754.1	43,172.2	-	1,163.8	1,163.8	0.131	152.8	3,162,511.2
2043	-	-	-	3,453.8	39,718.4	-	1,070.7	1,070.7	0.123	131.9	3,162,643.1
2044	-	-	-	3,177.5	36,540.9	-	985.0	985.0	0.116	113.9	3,162,757.1
2045	-	-	-	2,923.3	33,617.7	-	906.2	906.2	0.109	98.4	3,162,855.4
2046	-	-	-	2,689.4	30,928.3	-	833.7	833.7	0.102	84.9	3,162,940.4
2047	-	-	-	2,474.3	28,454.0	-	767.0	767.0	0.096	73.3	3,163,013.7
2048	-	-	-	2,276.3	26,177.7	-	705.7	705.7	0.090	63.3	3,163,077.0
2049	-	-	-	2,094.2	24,083.5	-	649.2	649.2	0.084	54.7	3,163,131.7
2050	-	-	-	1,926.7	22,156.8	-	734.4	734.4	0.079	58.1	3,163,189.8
Total	8,705,749.5	-	(648,220.0)	626,063.2	7,523,837.0	8,057,529.5	(2,516,066.1)	5,541,473.4	15.1	3,163,189.8	103,030,647.4



DRAFT COPY

SIEMENS

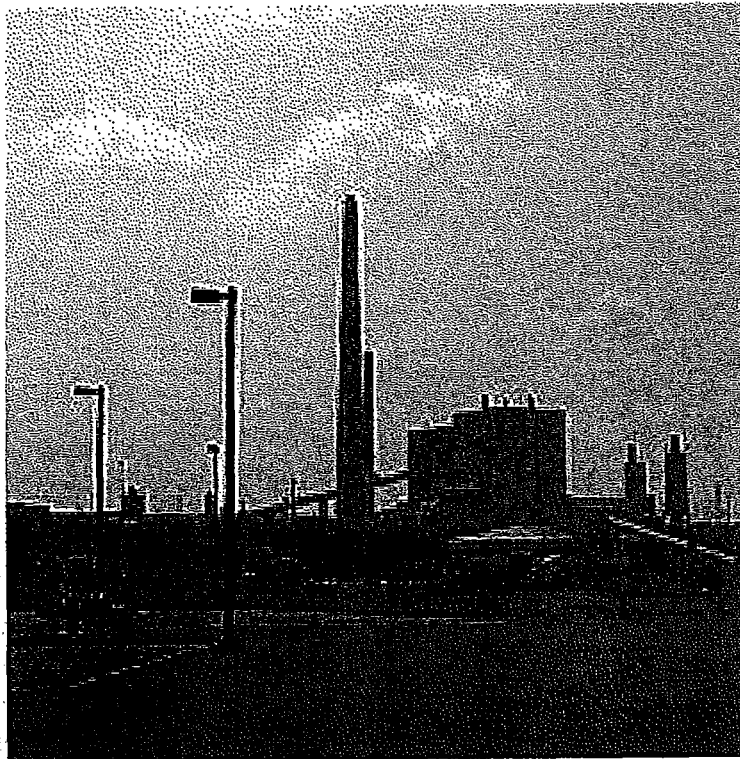
REPORT NO: 10-844

Siemens Reference - 27S3433

**Nova Scotia Power Inc.
TRENTON G.S.**

Unit5
m-c 3902

EMERGENCY OUTAGE



NSPI, TRENTON G.S., Unit 5, MC 3902 – EMERGENCY OUTAGE

DRAFT COPY

SIEMENS

SIEMENS ENERGY SERVICES

REPORT NO: 10-844

EMERGENCY OUTAGE

CUSTOMER: Nova Scotia Power Inc.

LOCATION: Trenton G.S.

ORDER No: 27S

UNIT No: 5

M-C: 3902

PERIOD OF CONTRACT:

REPORT BY:

APPROVED BY:

Engineering Manager

DISTRIBUTION:

(2 Copies)

(2 Copies)

(1 Copy)

NSPI, TRENTON G.S., Unit 5, MC 3902 – EMERGENCY OUTAGE

DRAFT COPY

1.0 INDEX

- 1.0 INDEX
- 2.0 INTRODUCTION
- 3.0 CONCLUSIONS
- 4.0 RECOMMENDATIONS
- 5.0 REPORT

NSPI, TRENTON G.S., Unit 5, MC 3902 - EMERGENCY OUTAGE

DRAFT COPY

2.0 INTRODUCTION

Nova Scotia Power, Trenton Generating Station contacted Siemens with a request for TFA support for a forced outage on Unit 5, Parsons Machine 3902.

The machine was taken out of service with high vibration, noise and poor control from the governing system.

The work was completed by Nova Scotia Power trades personnel, with first line supervision from in-house. Technical direction was provided by one Siemens TFA covering two shifts.

From the onset of the outage, the priority was a speedy and safe return to service. The major problem became evident as soon as the number one (1) pedestal cover was removed for inspection. The wheel on the cross shaft was severely worn by the worm on the end of the HP spindle.

Other additional problems became evident as the inspection unfolded.

Five key items were identified for repair.

- (i) the removal and replacement of the worm and wheel driving the cross shaft
- (ii) The main and auxiliary governors, which are secured to opposing ends of the cross shaft.
- (iii) Left and right hand reheat emergency stop valves.
- (iv) The main thrust bearing
- (v) The clean up of the large amount of brass particulate, spread throughout the oil system from the wheel disintegration.

All items were addressed in a timely and safe manor, with a successful return to service Saturday 27th March 2010.

The two mechanical trip bolts were tested and deemed acceptable to Siemens specifications prior to loading the machine to 160MW.

NSPI, TRENTON G.S., Unit 5, MC 3902 – EMERGENCY OUTAGE

DRAFT COPY

3.0 CONCLUSIONS

The wheel on the cross shaft was severely worn, which in turn caused the noise and vibration at the #1 pedestal area. The cause of the rapid deterioration of the wheel was the absence of sufficient back lash and tooth clearance between the worm and wheel. The poor condition of the main and auxiliary governors created the unstable control condition. The slight rise in speed after the machine was tripped was caused by the poor condition of the seating area in the left and right hand reheat emergency stop valves.

4.0 RECOMMENDATIONS

Due to the nature of this outage and the quick turn around, the following items are identified for extra work at your earliest convenience:

- The #1 bearing should be rebabbitted and the journal dressed to return clearances to original specifications.
- The spherical seat and spherical pads bedded and blue checked.
- The #1 pedestal oil baffle brass inserts should be replaced and machined to original specifications.
- The main and auxiliary governor bushes should be replaced as wear is evident from before the governors were rebuilt.
- The number 1 and 2 trip plungers require new operating sleeves
- The number 2 and 3 pedestal sliding feet should be removed, cleaned and grease lines checked.
- ALL other bearings should be inspected during the next outage
- The LH#2 governor valve was identified as excessively tight at the spindle to bushing area and should be repaired.

NSPI, TRENTON G.S., Unit 5, MC 3902 - EMERGENCY OUTAGE

DRAFT COPY**5.0 REPORT**

The work required to return the components to acceptable condition for return to service are detailed below:

- The main and auxiliary governors were shipped off-site and refurbished to original specifications by Siemens.
- The speed and axial pickup collar was removed and machined to suit the new clearances required for the larger wheel. The collar is held into position by an interference fit of 0.005". The key on the shaft is no longer used to secure the collar. Nova Scotia Power declined the opportunity to fill the keyway with a half key.
- The new worm was fitted to HP spindle with a 0.002" interference fit and a 0.001" clearance on the .999" key.
- The cross shaft was checked for run out journal to wheel fit area to other journal at 0.001". The new wheel was fit to the cross shaft with a 0.004" interference fit.
- The auxiliary hub of the cross shaft was 'found' and 'left' at a size for size fit with a new drive key fit to provide a sliding fit.
- The cross shaft with the new wheel was placed into position to find zero backlash. The required move to achieve the correct backlash was 0.022".
- The four (4) brass sliding feet under #1 pedestal was removed and 0.022" machined from the blank side. There is no relief in the fir tree design OF THE GREASE PATTERN OF THE SLIDING FEET. They must lift to alleviate pressure from the grease injection. The grease lines were cleaned and sliding feet installed in their perspective positions. Final sizes were 'x'-side generator end 0.925", turbine end 0.973" and 'y' side generator end 0.940", turbine end 0.970".
- Turbine end HP cylinder palm support shim packs were removed and 0.022" added to the four packs. They were cleaned and placed back in position at 'x'-side generator end 0.56", turbine end 0.560" and 'y'-side generator end 0.556", turbine end .555".
- The #1 bearing was removed, NDE inspected and shimmed up 0.022". This places the #1 journal back in the 'as found' alignment position relative to overall centenary.
- The run out was checked #1 journal to collar to worm at 0.001".
- The cross shaft was placed into position with the cross shaft thrust bearing adjusted to suit the correct blue pattern. Final position was left at main side 0.252 and auxiliary side at 0.250 with a backlash of 0.016". This position is 0.015" more towards the auxiliary governor than 'as found'.
- The cross shaft was removed and the refurbished main and auxiliary govers fitted and checked for run out. They were outside of specifications at 0.010" to 0.012" adjustments were made to achieve 0.002".
- Due to lack of time, a new set of coupling bolts was not fitted.

NSPI, TRENTON G.S., Unit 5, MC 3902 – EMERGENCY OUTAGE

DRAFT COPY

-
- The cross shaft was placed back in position end float checked at 0.0015".
 - The main and auxiliary housings and bush assemblies were installed with new 'o'-rings, except the square ring at the bush.
 - The keep nip was adjusted to 0.001" and radial probes set on bearing.
 - The main thrust bearing at bearing two (2) was opened and inspected. The stop gap reading 'as found' was 0.102 hard on the turbine side pads and 0.113 on the generator side.
 - The top half thrust pads had been slightly damaged last time the top half was assembled.
 - The pads both generator and turbine sides were removed cleaned up and blue checked. They were then installed with instrumentation and keep nip check at 0.002". The stop gap was rechecked at 0.094" turbine side and 0.113" on the generator side, the axial probes were then set at the #1 pedestal and subsequently boxed up.
 - The reheat emergency stop valves were a parallel event with simultaneous completion.
 - The seats were lapped and blue checked to a suitable contact.
 - The steam strainers were in poor operating condition with a cross section of 100 holes showing debris lodged in 60 of the 100. They were totally cleaned out before being reassembled.
 - The cleaning of the brass particulate from the oil system was also a parallel event with simultaneous completion. The cleaning was completed under the supervision of Nova Scotia Power with the assistance of an outside contractor.
 - The filters were changed, oil from the tank cleaned and drain lines flushed.
 - The oil available at start up was of sufficient cleanliness to provide system stability.
 - The oil system was started up and the jacking oil check at:
 - #3 950 psi
 - #4 1100 psi
 - #5 1050 psi
 - #6 1050 psi
 - #7 850 psi
 - #8 1000 psi

The lube oil at 93.4 kpa and the power oil at 1064 kpa on the auxiliary oil pump. The #1 and #2 trip plungers were reset and all valves were stroked, the only anomaly was the left hand #2 governor valve. The customer was available to witness the tightness of the leak off gland area to the spindle

- The machine was warmed up and slowly raised to 3600 rpm with a very prominent critical at 2200 rpm.
- The governor took control at 3340 rpm with successful run to 3600 rpm.

NSPI, TRENTON G.S., Unit 5, MC 3902 -- EMERGENCY OUTAGE

DRAFT COPY

-
- With the gauge rods, the main and auxiliary were set at 3600 rpm and the pilot oil regulating valve set. The machine was then loaded to 60 megawatts and a trip initiated.
 - The inner bolt tripped at 3965 rpm with no unusual rise in speed after the trip.