FOR BOARD ACTION

Agenda Item # 14 **Meeting Date:** 3/28/06

SUBJECT: Change Order to Purchase Order #10219
Power Generation Services
SLP Unit 4 Turbine Generator Overhaul

PREPARED BY: Wally Schlink, Director of Power Resources

ITEM DESCRIPTION:

At the January, 2006 Utility Board meeting the Board approved a purchase order agreement with Power Generation Services (PGS) for the materials and services required to overhaul SLP Unit 4 turbine generator unit. Subsequently PO #10219 was issued in the approved amount of $383,441 to PGS to perform the work. The work scope was identified as Workscope I with a defined scope and firm price; and Workscope II which was an anticipated work scope with prices quoted for the work that RPU staff projected they would find when the unit was disassembled, inspected and tested.

The unit was removed from service and the outage began on March 3, 2006 and as of this writing the unit has been completely disassembled, grit blasted, non-destructive tested and inspected. The damage that was found exceeded the level of damage that was expected and in the case of some rotating components, will require complete replacement.

The work that is required can be divided into 2 categories, structural and efficiency restoration. The structural work is required before the unit can safely be returned to service and consists of replacement of 3 stages of turbine buckets, restoration of high pressure nozzle blades, replacement of erosion shield on the 2 last stages of the turbine and various component replacements related to the valves, bearings and bushings.

The efficiency restoration consists of restoring the physical configuration of several diaphragms, replacing gland seal packing, replacing spill strips and restoring the surface finish of the steam path components. The overhaul takes place every 6 years and the payback for the efficiency restoration portion of the work is approximately 2 years.

The original Workscope I package was priced at $186,700; the structural work that is required is priced at $320,760 and the efficiency restoration work is priced at $244,175 for a total of $751,635. The original amount approved by the Board was $383,441 so the request is for a change order of $368,194 bringing the total approved amount to $751,635.

The 2006 approved budget for this project is $500,000. To make up the shortfall, staff is requesting the transfer of $251,635 from the 2006 approved project identified as the Air Quality Control System which will make this expenditure revenue neutral in 2006 and will not impact the adjusted 2006 budget.

Larry Koshire — General Manager

3/24/06 — Date

ROCHESTER PUBLIC UTILITIES

FOR BOARD ACTION

Agenda Item # 14 **Meeting Date:** 3/28/06

Attached is a report on the turbine condition which includes structural repairs and the efficiency repairs and paybacks as well as pictures of the significant damage. Also attached is a matrix detailing the specific individual repairs and the costs on an individual basis.

UTILITY BOARD ACTION REQUESTED:

Staff recommends that the Board request that the Common Council approve a purchase order agreement change order to PO #10219 with Power Generation Services Inc. in the amount of $368,194 to provide services and materials for additional work that is required to the SLP Unit 4 Turbine Generator Overhaul as defined in the attachments. The total revised purchase order agreement will be for $751,635.

Staff also requests that the Board requests that the Common Council approve the transfer of $251,635 from the Air Quality Control System line item in the 2006 budget to the Unit 4 turbine generator overhaul line item.

_____ _____

General Manager Date

ROCHESTER PUBLIC UTILITIES

2006 - SLP Unit No. 4 Turbine Generator
Overhaul Cost Matrix

Item / Quote Number	Description	Quote
Firm Scope	Grit Blasting	$ 10,300
Firm Scope	NDE	$ 7,300
Firm Scope	Generator Testing	$ 14,700
Firm Scope	Steam Path Audit	$ 15,000
Firm Scope	Technical Assistance	$ 52,750
Firm Scope	Craft Support	$ 86,650
1	Steam Path Audit	$ -
2	2nd Stage Buckets	$ 53,130
3	3rd Stage Buckets	$ 55,110
4	7th Stage Buckets	$ 62,300
5	Buckets 1A, 1B, 5-6, 8-15	$ 3,770
6	Erosion Shields - 17	$ 36,500
7	Erosion Shields - 16	$ 26,800
8	LS Balance Turbine Rotor	$ 3,500
9	HP Nozzle Plate	$ 9,650
10	Intermediate Blade Ring	$ 8,350
11	2nd Stage Diaphragm	$ 10,600
12	3rd Stage Diaphragm	$ 10,750
13	4th Stage Diaphragm	$ 9,050
14	6th Stage Diaphragm	$ 10,750
15	10th Stage Diaphragm	$ 16,850
16	11th Stage Diaphragm	$ 18,050
17	12th Stage Diaphragm	$ 18,050
18	13th Stage Diaphragm	$ 47,150
19	8 Stages of Diaphragms	$ 20,800
20	HP Gland Seal Packing	$ 21,750
21	Diaphragm Spill Strips 2-16	$ 11,825
22	Install Spill Strips 2-16	$ 21,750
23	Stop Valve Bushing	$ 5,300
24	Stop Valve Rivets	$ 3,650
estimate	#5 NR Valve Bushing	$ 1,000
estimate	T-2 Bearing Rebabbit	$ 5,000
estimate	H2 Seal Rings	$ 10,000
estimate	T-2 Oil Deflector	$ 2,500
estimate	CV Stems & Pins - 6 each	$ 15,000
estimate	CV Upper Bushings - 5 each	$ 10,000
estimate	CV Lower Bushings - 3 each	$ 6,000
estimate	Shipping	$ 10,000
estimate	OT	$ 20,000
	TOTAL	**$ 751,635**

Power Generation Service, Inc.

1160 McKinley Street
Anoka, MN 55303
(763) 421-1104 Phone
(763) 421-3451 Fax

March 17, 2006

To: Wally Schlink and Lloyd Lynch, Rochester Public Utilities
From: Troy Gehrett
Re: Silver Lake Unit #4 Initial SPA Findings and Recommendations

On March 14, 2006 I traveled to the Rochester Public Utilities Silver Lake Plant in Rochester, MN to perform an opening steam path audit inspection of the unit #4 General Electric 54 MW turbine generator. The audit was conducted during a scheduled maintenance outage for this unit. After finishing the audit inspection I reviewed some of my visual inspection findings with Lloyd Lynch. This report summarizes my visual findings as well as the results of the efficiency calculations.

Generally speaking, the unit was found to be in good condition. There were some areas of the unit, however, that showed signs of damage. Most notably, the stages 2 and 3 buckets were badly damaged on the leading edges due to foreign object damage (FOD). Additionally, these buckets had thin leading and trailing edges (see *Figure 1* and *Figure 2* for examples of the damage).

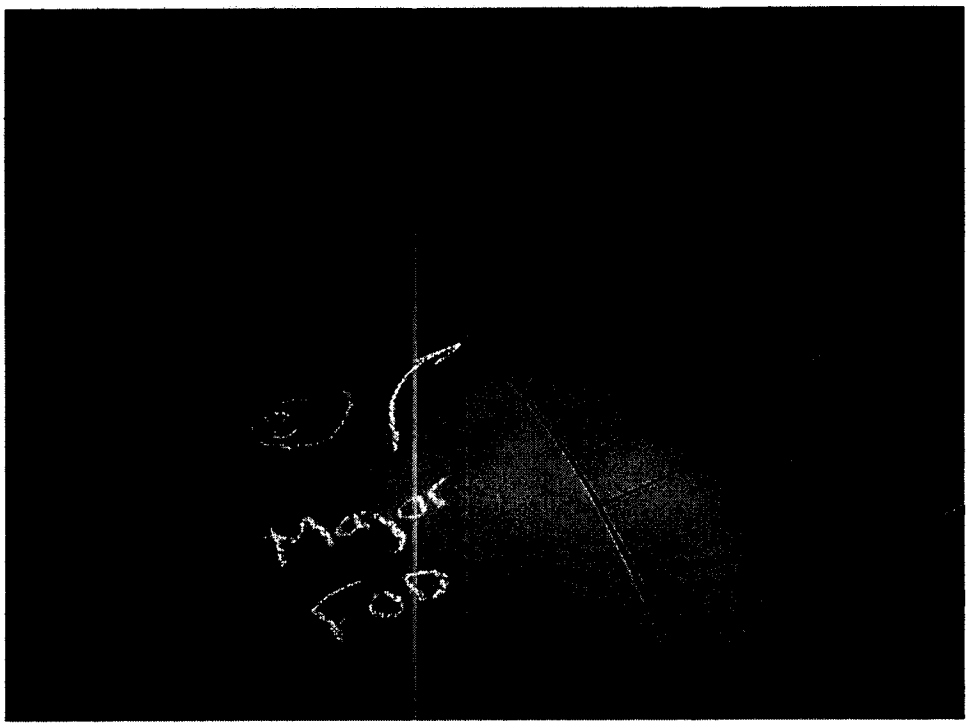

Figure 1 – Stage 2 bucket leading edges with FOD

Figure 2 – Stage 3 bucket leading edges with FOD

In some cases, moderate amounts of FOD may be repaired through straightening and polishing the leading and or trailing edges of the bucket to restore the proper thickness and inlet/exhaust angles. These buckets are unfortunately too thin on the leading and trailing edges to perform this type of repair. It is recommended that these stages be replaced.

Also the stage 7 buckets were found to have extensive corrosive pitting damage. It was not apparent when this damaged occurred although the previous steam path audit report from General Electric made mention of this damage. The pitting is so severe on some buckets that the leading edges have holes through them (see *Figure 3* for examples of the damage).

Figure 3 – Stage 7 bucket corrosive pitting damage

It would appear that this condition has become worse since the previous steam path audit inspection in 2000. It is recommended that the stage 7 buckets are replaced and that the plant re-evaluate its boiler water chemistry to make sure it is free from potential corrosive compounds.

There were other stages of buckets subjected to FOD and corrosive pitting to a lesser degree. The stage 4, 5, 6, 8, and 9 buckets were becoming thin on the leading and trailing edges as well as showing some signs of impact damage. It is recommended that the leading and trailing edges for these stages be straightened and polished to improve their existing condition.

The last two stages of buckets on the rotor were found to have sustained significant water particle impact damage. These buckets have existing erosion shields on their leading edges. However, the water particle impact damage has worn away the shields to the point where they are no longer protecting the buckets (see *Figure 4* for examples of the damage). It is recommended that the erosion shields for the stage 16 and stage 17 buckets be replaced.

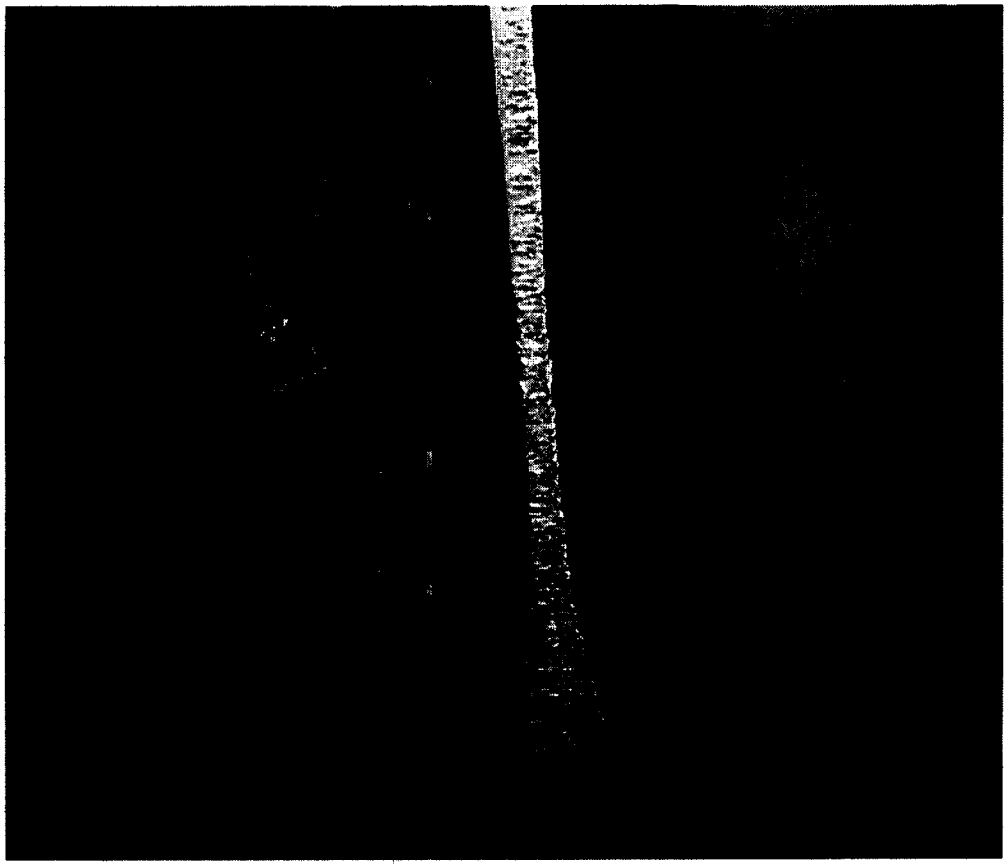

Figure 4 – Water particle impact damage to stage 17 bucket leading edge

Damage was also discovered to some stages of diaphragms, the inlet nozzle, and the Curtis intermediate partitions. Both the nozzle and Curtis partitions were subjected to solid particle erosion on specific partitions. This erosion removed a significant amount of the trailing edges (see *Figure 5* for examples of damage).

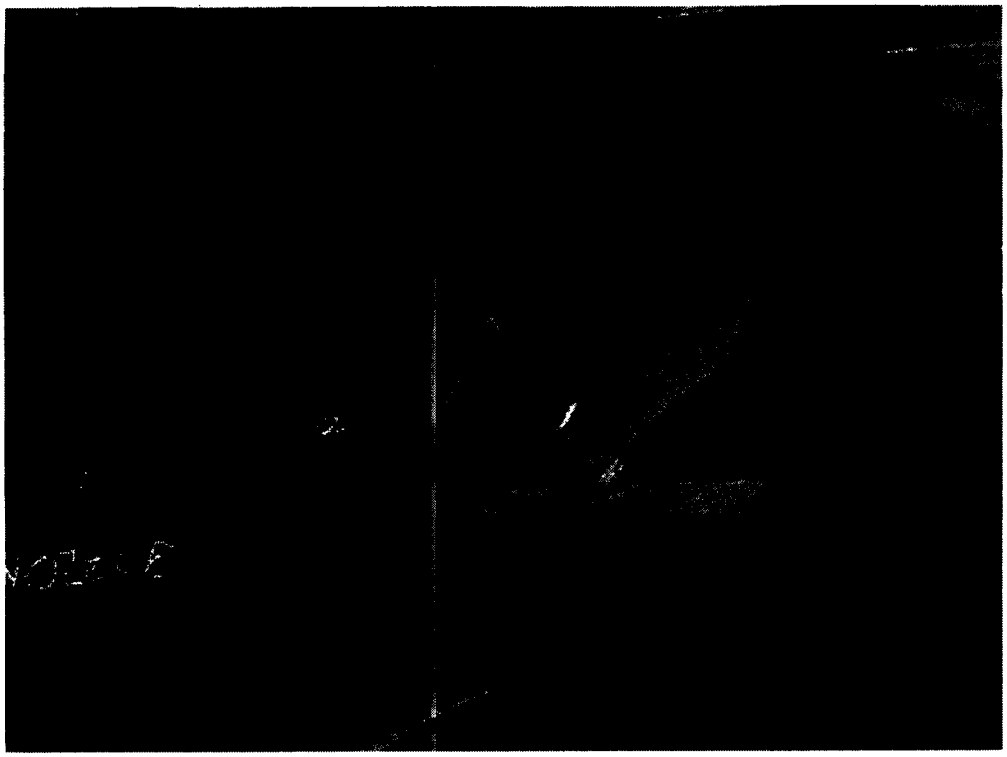

Figure 5 – Solid particle damage to inlet nozzle trailing edges

There are approximately 7 affected partitions on both the nozzle and Curtis stage. There was also damage discovered to the trailing edges of several diaphragm partitions. In particular, the stage 13 diaphragm had severely thinned trailing edges. Other stages with thin trailing edges include stages 10, 11, and 12. The condition of these trailing edges poses primarily a structural threat to the unit as their ability to withstand the steam bending loads is reduced as the trailing edge thickness decreases. They are also are at greater risk of becoming cracked from impact damage. If portions of the trailing edges become dislodged they may cause consequential damage to steam path elements downstream. It is recommended that the nozzle, Curtis stage, and these diaphragms have their trailing edges weld repaired. There were other stages of diaphragm partitions with thinning trailing edges as well. Stages 2, 3, 4, 5, and 6 all had thinning trailing edges to varying degrees. These partitions have also sustained minor amounts of impact damage from foreign objects. The damage to these partitions is not as severe as to the stages 10 through 13, however, these stages should be considered for weld repairs. If the repairs to the stage 2 through 6 diaphragm partitions are not carried out during this outage they should be completed during the next scheduled outage.

The following table summarizes the results of the efficiency calculations (see *Table 1* for details). The table shows the potential recoverable losses based upon the existing conditions of the unit.

Type	Recoverable Loss (kW)	% Total kW	Heat Rate Reduction (Btu/kWhr)	Fuel Cost Reduction ($/year)
Diaphragm Packing Leakage Loss	48.27	0.09%	8.37	$5,724.28
Spill Strip Leakage Loss	541.14	1.00%	92.59	$64,173.14
HP Gland Seal Leakage Loss	516.25	0.96%	89.89	$61,221.23
Stationary Surface Finish Loss	135.98	0.25%	23.23	$16,125.70
Rotating Surface Finish Loss	95.38	0.18%	16.28	$11,311.00
Totals	***1,337.02***	2.48%	***230.36***	***$158,555.36***

Table 1 – summary of efficiency calculations

The greatest potential recoverable loss would result from the replacement of all of the spill strips in the unit (see *Figure 6* for details on stage by stage spill strip loss). This is estimated to produce an improvement of 541.14 kW, which is approximately 1.00% of the rated output for the unit. The second largest potential recoverable loss would result from the replacement of the HP gland seals. This would be estimated to account for an improvement of 516.25 kW, which is approximately 0.96% of the rated output for the unit.

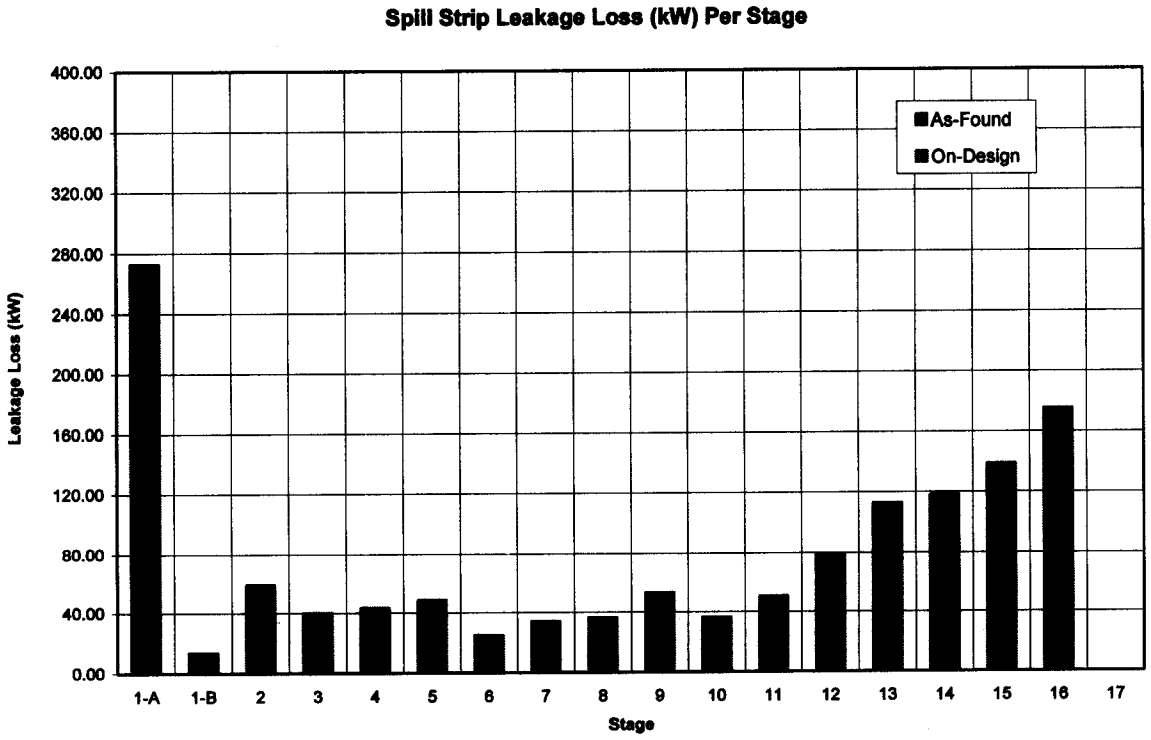

Figure 6 – Spill strip leakage loss breakdown by stage

In addition, grit blast cleaning of the diaphragms and buckets is expected to produce a total combined improvement of 231.36 kW, which is approximately 0.43% of the rated output for the unit. However, this calculation does not account for the removal of heavy deposits on the stage 13 and stage 14 diaphragm partitions (see *Figure 7* for examples of the deposits). These deposits, though apparently non-corrosive, substantially impacted the flow of steam from the diaphragm partitions to the buckets. Samples of this deposit were taken from both the stage 13 and 14 diaphragms. It is recommended that this sample

be analyzed to determine its chemistry. It is further recommended that efforts should be made to locate the source of this fouling and reduce or eliminate it.

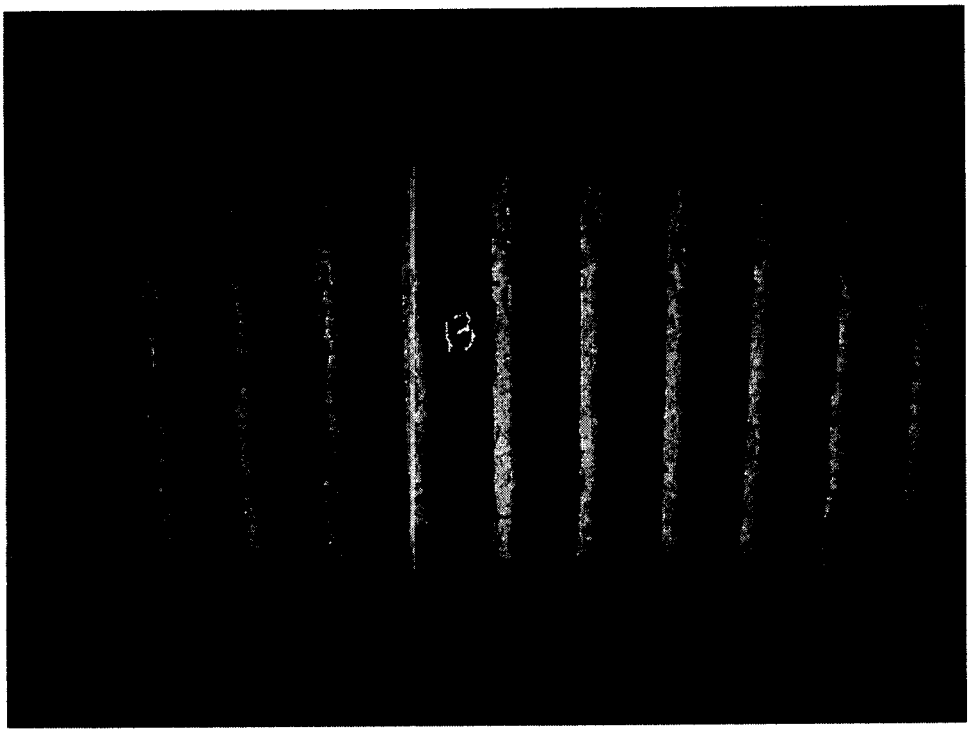

Figure 7 – Stage 13 diaphragm partitions with heavy build up of deposits

Based upon the findings of the visual inspection and efficiency calculations, the following repair recommendations are offered:

1. Remove and replace the stage 2 buckets
2. Remove and replace the stage 3 buckets
3. Straighten and polish the leading and trailing edges of the stage 4, 5, 6, 8, and 9 buckets to improve their existing condition
4. Remove and replace the stage 7 buckets
5. Remove and replace the existing erosion shields on the stage 16 buckets
6. Remove and replace the existing erosion shields on the stage 17 buckets
7. Weld repair inlet nozzle partitions as necessary (approximately 7)
8. Weld repair Curtis stage partitions as necessary (approximately 7)
9. Weld repair all stage 10 diaphragm partitions
10. Weld repair all stage 11 diaphragm partitions
11. Weld repair all stage 12 diaphragm partitions
12. Weld repair all stage 13 diaphragm partitions
13. Consider the stage 2, 3, 4, 5, and 6 diaphragm partitions for weld repair
    - If not repaired during this outage these partitions should be repaired during the next scheduled outage
14. Remove and replace spill strips in all stages of the unit
15. Remove and replace the HP gland packing seals
16. Perform chemical analysis of samples taken from the stage 13 and 14 diaphragm partitions so that the source of this fouling be located and reduced or eliminated
17. Re-evaluate boiler water chemistry to ensure that it is free from potentially corrosive compounds

If you have any questions regarding the content of this report please feel free to contact me at your convenience. As always, we at PGS appreciate your business and we look forward to assisting you with your maintenance needs in the future.

Sincerely,

Troy W. Gehrett
Technology Manager
Power Generation Service, Inc.

rpu
we pledge. we deliver

RESOLUTION

BE IT RESOLVED by the Public Utility Board of the City of Rochester, Minnesota, that the Common Council of the said City is requested to approve a purchase order agreement change order to PO #10219 with Power Generation Services Inc. in the amount of $368,194 to provide services and materials for additional work that is required to the SLP Unit 4 Turbine Generator Overhaul as defined in the attachments. The total revised purchase order agreement will be for $751,635.

BE IT FURTHER RESOLVED that Board requests that the Common Council approve the transfer of $251,635 from the Air Quality Control System line item in the 2006 RPU budget to the Unit 4 turbine generator overhaul line item.

Passed by the Public Utility Board of the City of Rochester, Minnesota, this 28th day of March, 2006.

_____
President

_____
Secretary