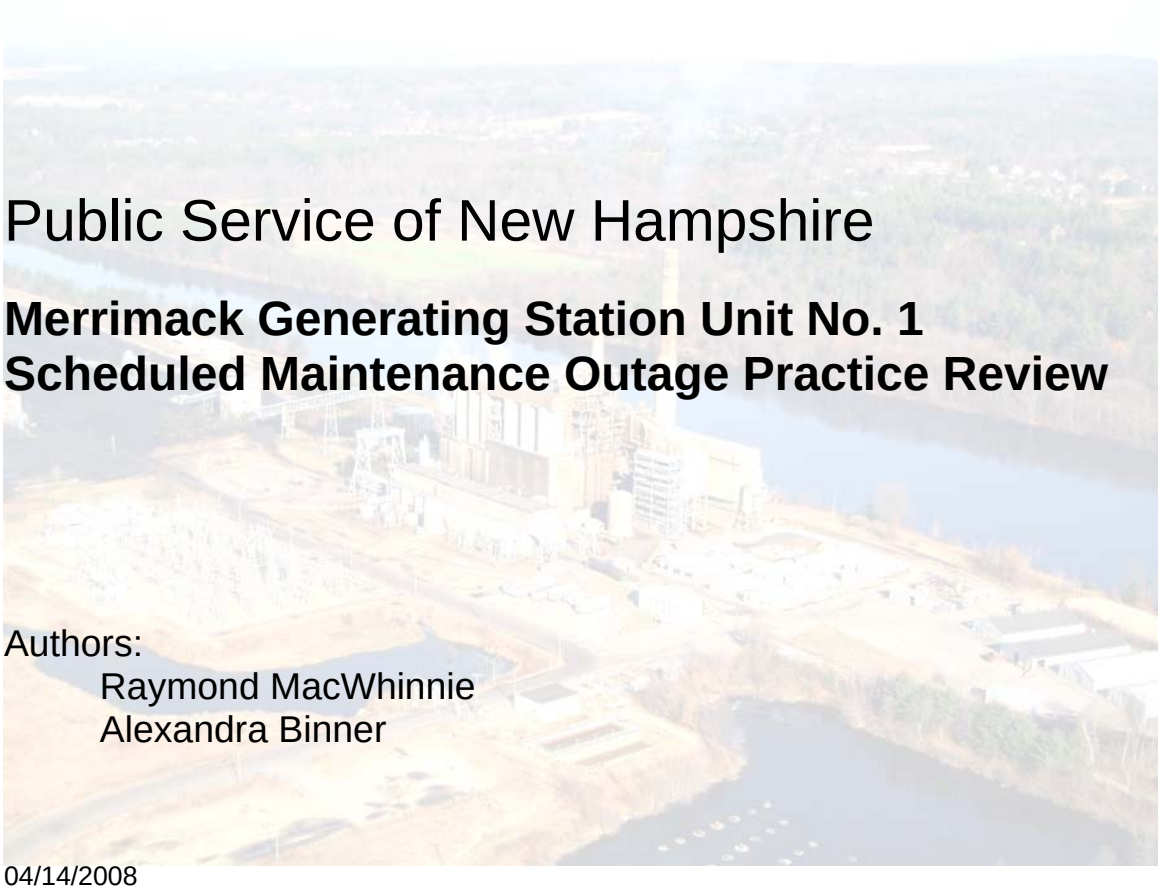
ATTACHMENT WHS – 4

MERRIMACK UNIT NO. 1
SCHEDULED MAINTENANCE OUTAGE ANALYSIS



Public Service of New Hampshire

Merrimack Generating Station Unit No. 1 Scheduled Maintenance Outage Practice Review

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04/14/2008

Summary:

Public Service of New Hampshire, PSNH, performed an internal assessment of Merrimack Station Unit No. 1's biennial scheduled maintenance outage practice. This study was completed to determine the degree of economic value and available power to the customer that a biennial scheduled maintenance practice provides when compared to that of an annual scheduled maintenance practice.

The resulting study showed, based on data ranging from 11/12/1992 through 04/02/2008, that the biennial schedule produces 36% more available power and saves the PSNH customer 41% in direct outage maintenance costs and 36% in replacement power costs.

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Introduction

Public Service of New Hampshire performed an internal assessment of Merrimack Station Unit No. 1's current biennial scheduled maintenance outage practice. The effort was to determine the degree of economic value and available power to the customer that a biennial scheduled maintenance practice provides when compared to that of an annual scheduled maintenance practice.

The core focus of the assessment was customer value, which has been divided into two categories: Availability of Unit No.1 affecting higher cost replacement power, and incremental O&M and Capital cost benefit.

Additionally a description of why maintenance requirements and overhaul schedule for Unit No.1 differs from the maintenance requirements needed for Unit No.2, can be found in the Appendix.

Data

The assessment utilized financial and event outage records ranging from 11-12-1992 to 04-02-2008, which can be found in the Appendix. Financial records used, are maintained by Merrimack Station and Northeast Utilities accounting groups, and are captured through the use of task specific accounting. The Unit's event records are recorded by PSNH's GENIS system, which captures date, time, duration, and reason for a loss generation event.

Data used throughout this analysis only considered outage related events that pertained to system or equipment reliability and integrity. Outage events that were "process related" or that were resolved in less than 24 hours were excluded from the analysis.

The reasons for the data point exclusions are that "process related" events would have occurred no matter how many weeks of planning or scheduled outages were taken, over any time period. Examples of this are air heater fouling, which is related to hours of continuous operation, or wet coal in coal feeder equipment, which is highly circumstantial. Additionally, outages that are

resolved within 24 hours tend to be minor equipment failures such as instrumentation which instantaneously fail rather than degrade over time, thus making it near impossible to preventively predict failure.

Results

Unplanned Outage Occurrences

The overall focus of this study is to evaluate the benefit to the PSNH customer that the current biennial scheduled maintenance practice provides when compared to that of an annual practice. It is then important to understand and examine when the unplanned outages are occurring, and answer the question: Is Unit No.1 incurring more unplanned outage hours in the second year beyond the scheduled maintenance outage?

To answer this question, Genis outage data from 11-12-1992 though 4-2-2008 was segregated into three categories;

1. Scheduled maintenance outage
2. Unplanned outage occurring within first year of scheduled maintenance
3. Unplanned outage occurring beyond first year of scheduled maintenance

Figure 1 shows the comparison of outage hours incurred within the first year of scheduled maintenance to the outage hours incurred beyond the first year. Figure 2 shows that, on average, the majority, 56%, of unplanned hours occur within the first year of a scheduled maintenance outage.

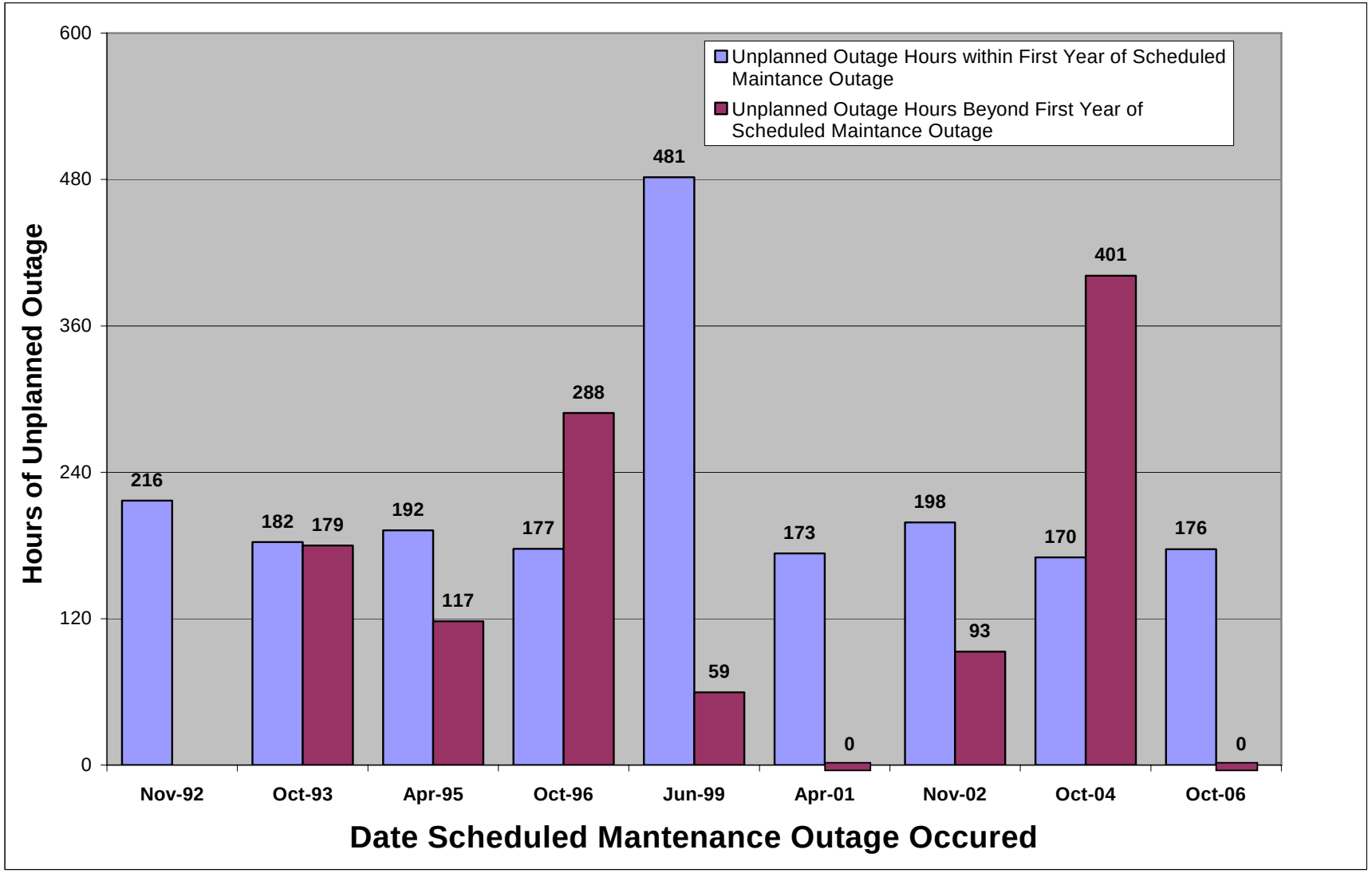

Figure 1 Outage Occurrence

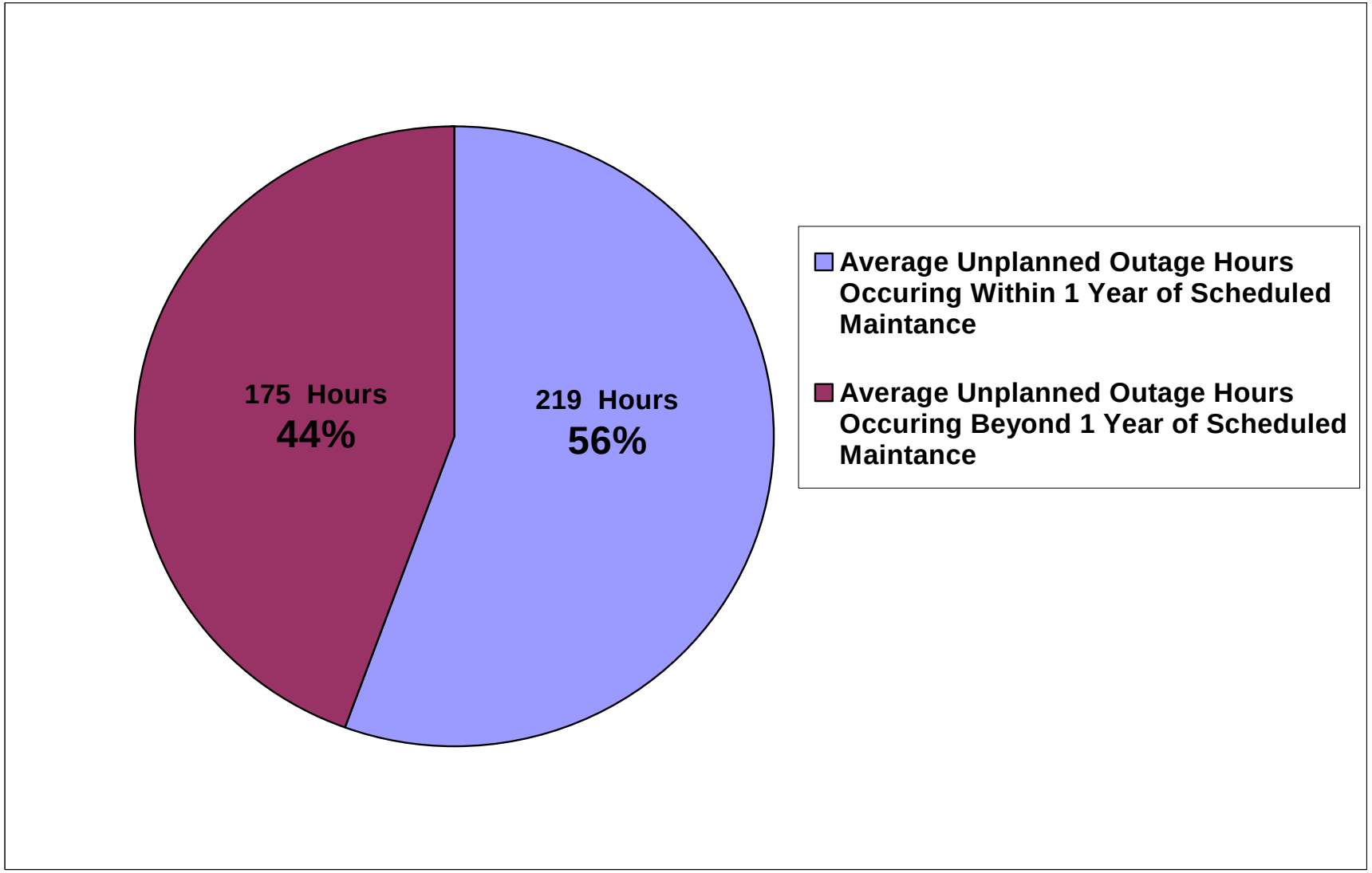

Figure 2 Outage Occurrence by Period

Replacement Power and Availability

Replacement power must be purchased any time it can not be generated, regardless if the outage is planned or unplanned. Though, advanced planning, such as a scheduled maintenance overhaul, can minimize replacement power costs, this power is typically purchased at a premium when compared to the generation costs at Merrimack Station, thus making it advantageous to the customer that Merrimack Station follows an outage practice that will require the least amount of purchased replacement power.

An analysis that compares current practice of biennial maintenance outages against a calculated annual maintenance practice was performed to determine which maintenance scenario provides the most generation and least replacement power costs. The results of this analysis are summarized in Table 1. The table shows that the current biennial maintenance practice produces 36% less outage hours directly resulting in a 36% reduction in need and cost of Replacement power.

Table 1 Replacement Power Summary: Current Biennial Scheduled Maintenance Practice vs. Calculated Annual Maintenance Practice.

Period: 11/12/92--4/02/08	Total Outage Hours	Total Replacement Power Needed	Total Cost of Replacement Power
	h	MWh	$
Current Biennial Maintenance Practice	10,548	1,192,029	$93,466,334
Calculated Annual Maintenance Basis	16,592	1,874,924	$145,986,055
Difference	6,044	682,895	$52,519,720

Note: Costs are calculated using 2009 projected cost of replacement power.

The Calculated Annual Maintenance Basis results were based upon averages obtained using the data shown in the Appendix, namely unplanned outages that occurred with in the first year after a scheduled maintenance outage, 219 hours per year, and the average time to complete an Scheduled Maintenance outage, 826 hours. The unplanned outage hours were fractioned into their appropriate season, Winter Peak Season (22% of the time), Summer Peak Season (11%), and Off-Peak Season

(67%), in order to capture the appropriate replacement power cost. These values were then projected over the same time period as the biennial practice, 11-12-1992 through 04-02-2008. PSNH's 2009 projected replacement power costs were used to calculate the value of power purchased. Table 2 and Table 3 show the detailed results for each season, including the hours required to complete scheduled maintenance.

Table 2 Replacement Power: Current Maintenance Practice

Current Maintenance Practice: 11-12-1992 to 4-2-2008 Cost of Replacement Power in 2009 Projected Power Costs					
	Outage Hours	MK1 Net Capacity	Replacement Power Needed	Replacement Power Unit Cost	Cost
	h	MW	MWh	$/MWh	$
Unplanned Winter Peak Season (Jan-Feb)	683	113	77,190	$ 101.43	$ 7,829,267
Unplanned Summer Peak Season (July-Aug)	347	113	39,305	$ 81.52	$ 3,204,108
Unplanned Off-Peak Season	2,080	113	235,063	$ 76.64	$ 18,016,079
Planned Maintenance Outage Total	7,437	113	840,471	$ 76.64	$ 64,416,880
Totals	10,548		1,192,029		$ 93,466,334

Table 3 Replacement Power: Calculated Annual Maintenance Basis

Calculated Annual Maintenance Basis: 11-12-1992 to 4-2-2008 Cost of Replacement Power in 2009 Projected Power Costs					
	Outage Hours	MK1 Net Capacity	Replacement Power Needed	Replacement Power Unit Cost	Cost
	h	MW	MWh	$/MWh	$
Unplanned Winter Peak Season (Jan-Feb)	743	113	83,934	$ 101.43	$ 8,513,225
Unplanned Summer Peak Season (July-Aug)	371	113	41,967	$ 81.52	$ 3,421,080
Unplanned Off-Peak Season	2,262	113	255,616	$ 76.64	$ 19,591,360
Planned Annual Maintenance Outage Total	13,216	113	1,493,408	$ 76.64	$114,460,389
Totals	16,592		1,874,924		$145,986,055

Availability Comparison

Figure 3 shows a comparison of Unit No.1's availability to that of other Radiant Cyclone Boilers. Data for other Radiant Cyclone Boilers was obtained from Cyclone Users Association's Questions and Answers publications dated 2002 and 2007. The Radiant Boiler data spanned years 2000-2001 and 2005-2006. Unit No. 1 data was obtained from station records that spanned from 1995 to 2007.

The results show that Merrimack Station Unit No. 1's availability is as good or better than other Radiant Cyclone Boilers from other utilities.

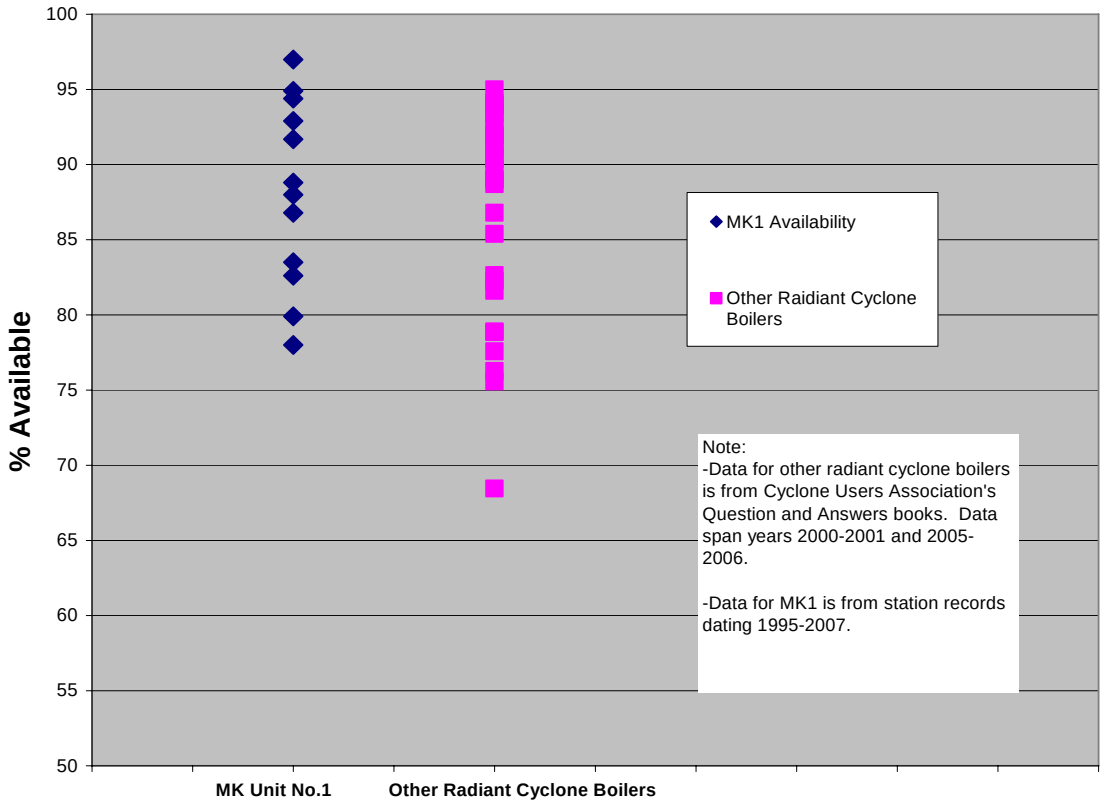

Figure 3 Unit No.1 Availability Comparison

Cost of Maintenance

The cost of maintenance, which includes parts and labor, is incurred during every outage regardless if it is scheduled or unplanned. Accounting data from Merrimack Station's records, as shown in the Appendix, was used to derive an average hourly cost of an unplanned outage and a scheduled maintenance outage. The average costs for both the scheduled and unplanned outage were projected from 11-12-1992 through 04-02-2008 for the current biennial scheduled maintenance timeline and the calculated annual scheduled maintenance timeline. The results can be seen in Figure 4, which shows that following the current biennial schedule reduces outage related maintenance cost by 41%. This is mostly due to the fact that outages were generally lower in the period beyond 12 months, and that the current schedule does not incur additional scheduled maintenance hours as would following an annual schedule.

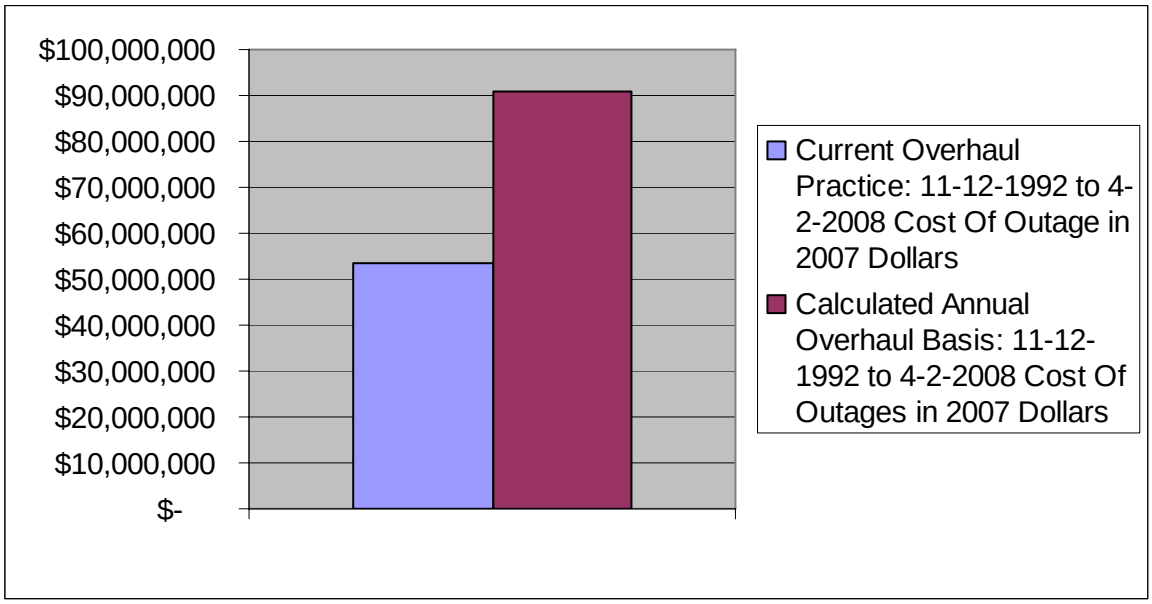

Figure 4 Cost of Maintenance

Conclusion

An analysis of 15.5 years of outage records for Unit No. 1 shows that the current biennial scheduled maintenance program produces more customer benefit than following an annual scheduled maintenance program. This assessment highlighted several main reasons why the biennial schedule produces better customer benefits over the annual schedule, namely;

- Merrimack Station's current methods reduce the need to purchase premium priced replacement power by 36%
- The current maintenance program will save the PSNH customer 41% in total outage maintenance costs.
- 56% of the unplanned outages occur within the first year of a scheduled maintenance outage.
- Biennial schedules avoid nearly 826 hours of scheduled maintenance that is required by the annual schedule. Scheduled maintenance outages are approximately 3 times the cost, on an hourly basis, as unplanned outages. This is due to the specialty work typically accomplished during a maintenance outage.
- Unit No.1's availability is as good as or better than other Radiant Cyclone Boilers from other utilities.

Appendix

Why Are Unit NO.1's Overhauls Different From Unit No.2's?

Simply stated, Unit No.1 and Unit No.2 do not follow the same overhaul schedule. While both units accomplish the same task of producing usable electricity, similarities quickly dissipate much beyond this point. Unit No. 1 is a completely different type of steam boiler than Unit No.2. Unit No.1 is a Radiant Boiler which operates with boiler walls completely filled with a saturated liquid water and steam mixture, and utilizes a steam drum to separate the steam from the liquid water. Unit No. 2 is a Universal Pressure Boiler that controls water flow into the boiler walls such that part of the boiler wall are filled with liquid water and part is filled with steam, resulting in the boiler walls providing the separation of the steam from the liquid water. The difference, shown in Figure 5, dictates that Unit No. 1 has a different water chemistry requirement, different steam circuit, and different operating pressure from that of Unit No. 2.

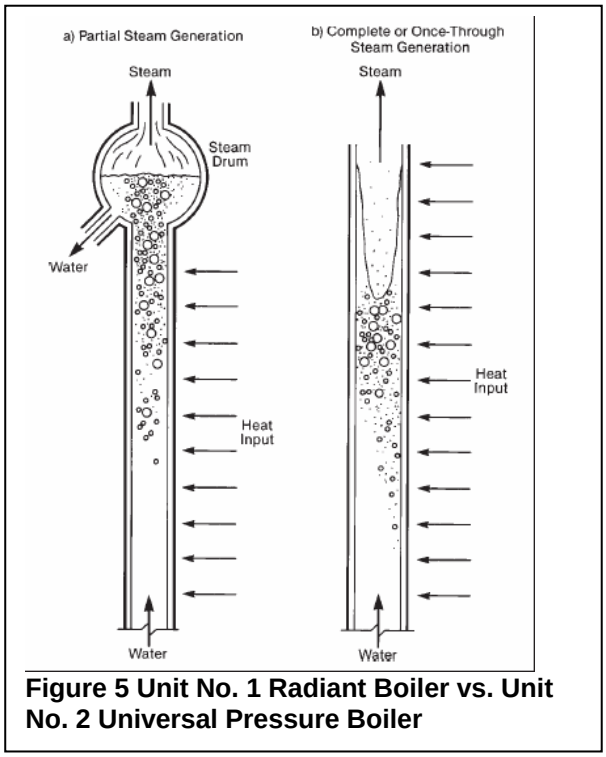

Figure 5 Unit No. 1 Radiant Boiler vs. Unit No. 2 Universal Pressure Boiler

Many other important differences between exist between the two units. Different heat transfer surface configuration and burner arrangement between the two units, 3 burners on Unit No. 1 and 7 burners on Unit No.2, require each unit to have different coal blend requirements and slag tap arrangement. The steam turbine and generator configuration is different between the two units. Unit No. 1 has only one low-pressure turbine while Unit No. 2 has two, requiring Unit No. 1 to have a shorter two-pass

condenser while Unit No.2 uses a long single-pass condenser. Additionally each unit uses different methods of gas side heat recovery.

In short, significant differences between process and equipment exist between Unit No.1 and Unit No.2, and it's the specifics of these differences that dictate when a unit needs to be overhauled. Thus, any similarity in maintenance requirements is most likely coincidental than synergistic.

An example of a major difference between the units that plays a significant role in dictating the timing of an overhaul is gas-side heat recovery. Unit No.1 utilizes a rotary air preheater, Figure 6, while Unit No.2 utilizes a tubular air preheater, Figure 7. Each type of air preheater has its unique positive and negative attributes that affect process and maintenance, but both are subject to process related fouling that requires the air preheater to be cleared of restriction.

Unit No.2's tubular air preheater is much better at maximizing process efficiencies, but requires the boiler to be shut down for more than a week to clean and repair. The fact that air preheater maintenance takes such a long time to complete is a

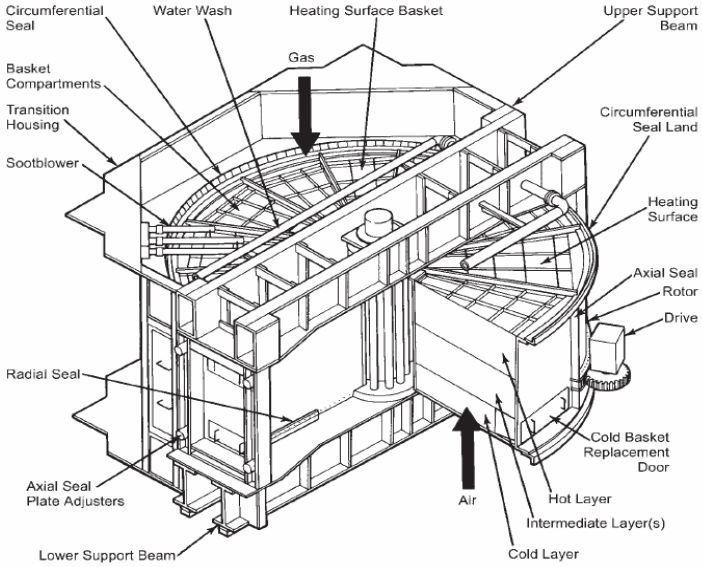

Figure 6 Unit No. 1 Air Preheater (typ)

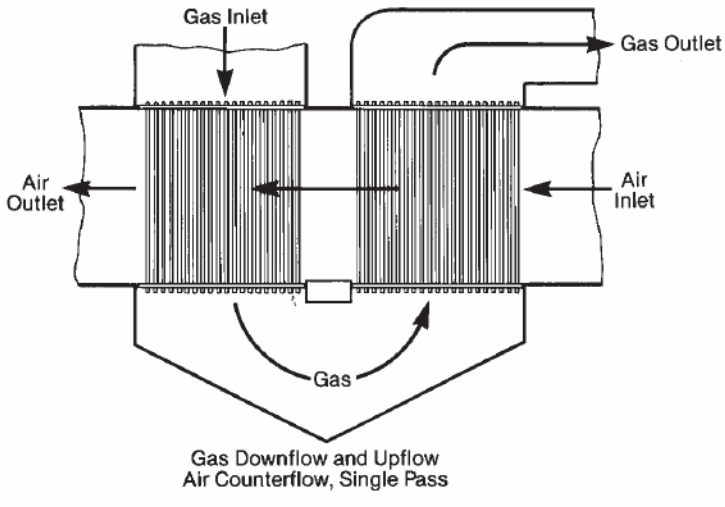

Figure 7 Unit No. 2 Air Preheater (typ)

major driving factor for conducting annual overhauls on Unit No.2.

Conversely Unit No.1's rotating air preheater does not offer as good process efficiencies as a tubular air preheater, but offer much easier maintenance. A plugged rotating air preheater can be cleaned and returned to service in less than 60 hours. Because work on the preheater can be conducted with such a short turn around time, it is has very little influence on overhaul schedule. Thus, other equipment such as valves and pressure parts dictate the overhaul schedule, which has been shown to be of a better benefit following a biennial overhaul schedule.

Genis Outage Data

12/01/2006 0:00	12/05/2006 4:47	100:47:00	UNPLANNED OUTAGE	FEEDWATER PUMP 003410
11/30/2006 13:32	11/30/2006 23:59	10:27:00	UNPLANNED OUTAGE	FEEDWATER PUMP 003410
11/01/2006 0:00	11/02/2006 11:50	35:50:00	UNPLANNED OUTAGE	BOILER TUBE LEAK IN FURNACE WALL. 001000
10/30/2006 18:09	10/31/2006 23:59	29:50:00	UNPLANNED OUTAGE	BOILER TUBE LEAK IN FURNACE WALL. 001000
09/05/2006 15:10	10/03/2006 9:22	666:12:00	PLANNED OUTAGE	MAJOR OVERHAUL BOILER (PRIMARY ACTIVITY) 001800
06/19/2006 0:28	06/25/2006 1:51	145:23:00	UNPLANNED OUTAGE	OUTER CASING 004000
05/23/2006 17:40	05/27/2006 2:45	81:05:00	UNPLANNED OUTAGE	SUPERHEATER (HIGH TEMP-SECONDARY) LEAKS 001050
05/05/2006 16:24	05/09/2006 22:00	101:36:00	UNPLANNED OUTAGE	BOILER TUBE LEAK IN FURNACE WALL. 001000
02/01/2006 16:20	02/04/2006 17:22	73:02:00	UNPLANNED OUTAGE	CYCLONE-MEMBRANE HOLE 010435
08/08/2005 13:26	08/10/2005 8:23	42:57:00	UNPLANNED OUTAGE	FLUE GAS EXPANSION JOINTS
05/01/2005 0:00	05/01/2005 5:48	5:48:00	UNPLANNED OUTAGE	FLUE GAS EXPANSION JOINTS
04/28/2005 16:58	04/30/2005 23:59	55:01:00	UNPLANNED OUTAGE	FLUE GAS EXPANSION JOINTS
01/06/2005 8:35	01/07/2005 12:00	27:25:00	UNPLANNED OUTAGE	FORCED DRAFT FANS 001400
01/04/2005 13:32	01/06/2005 4:34	39:02:00	UNPLANNED OUTAGE	OUTER CASING 004000
09/28/2004 16:19	10/31/2004 12:05	787:46:00	PLANNED OUTAGE	MAJOR OVERHAUL BOILER (PRIMARY ACTIVITY) 001800
11/20/2003 18:56	11/24/2003 15:59	93:03:00	UNPLANNED OUTAGE	SLAG SWIPER 020890
07/17/2003 2:47	07/19/2003 6:20	51:33:00	UNPLANNED OUTAGE	FLUE GAS EXPANSION JOINTS
04/14/2003 17:24	04/16/2003 5:57	36:33:00	UNPLANNED OUTAGE	FLUE GAS EXPANSION JOINTS
03/14/2003 17:28	03/18/2003 2:48	81:20:00	UNPLANNED OUTAGE	BOILER TUBE LEAK IN FURNACE WALL. 001000
11/12/2002 17:18	11/13/2002 22:48	29:30:00	UNPLANNED OUTAGE	SUPERHEATER (HIGH TEMP-SECONDARY) LEAKS 001050
09/10/2002 22:00	11/12/2002 2:16	1492:16:00	PLANNED OUTAGE	MAJOR OVERHAUL BOILER (PRIMARY ACTIVITY) 001800
04/09/2002 14:37	04/12/2002 22:48	80:11:00	UNPLANNED OUTAGE	SECOND SUPERHEATER 001150
02/13/2002 19:05	02/17/2002 16:24	93:19:00	UNPLANNED OUTAGE	SECOND SUPERHEATER 001150
03/27/2001 17:44	04/25/2001 9:07	687:23:00	PLANNED OUTAGE	MAJOR OVERHAUL BOILER (PRIMARY ACTIVITY) 001800
03/05/2001 23:40	03/08/2001 3:30	51:50:00	UNPLANNED OUTAGE	HEATER LEVEL CONTROL 003502
03/05/2001 13:47	03/05/2001 21:34	7:47:00	UNPLANNED OUTAGE	HEATER LEVEL CONTROL 003502
05/22/2000 17:33	05/23/2000 20:52	27:19:00	UNPLANNED OUTAGE	FORCED DRAFT FAN MOTOR BEARINGS 011410
05/21/2000 18:00	05/22/2000 17:33	23:33:00	UNPLANNED OUTAGE	ECONOMIZER TUBE LEAK 001080
05/19/2000 22:00	05/21/2000 18:00	44:00:00	UNPLANNED OUTAGE	OTHER POLLUTION CONTROL PROBLEMS 008699
04/06/2000 20:43	04/11/2000 22:20	121:37:00	UNPLANNED OUTAGE	FLOOR OR SLAG TAP LEAK 011000

02/14/2000 21:48	02/15/2000 4:31	6:43:00	UNPLANNED OUTAGE	OTHER TURBINE INSTRUMENT AND CONTROL PROBLEMS 004309
02/07/2000 22:57	02/08/2000 14:47	15:50:00	UNPLANNED OUTAGE	GENERATOR VOLTAGE CONTROL 004700
02/07/2000 2:49	02/07/2000 22:55	20:06:00	UNPLANNED OUTAGE	GENERATOR VOLTAGE CONTROL 004700
06/28/1999 14:31	06/29/1999 13:34	23:03	UNPLANNED OUTAGE	OTHER TUBES 001090
06/20/1999 6:10	06/20/1999 20:20	14:10	UNPLANNED OUTAGE	TURBINE TRIP DEVICES (INCLUDING INSTRUMENTS) 004302
06/17/1999 4:03	06/18/1999 19:26	39:23:00	UNPLANNED OUTAGE	TURBINE TRIP DEVICES (INCLUDING INSTRUMENTS) 004302
06/11/1999 19:24	06/15/1999 5:15	81:51:00	UNPLANNED OUTAGE	FLUE GAS EXPANSION JOINTS
06/06/1999 10:05	06/09/1999 9:06	71:01:00	UNPLANNED OUTAGE	BOILER FEED PUMP-PUMP BEARING 043416
04/30/1999 20:58	06/05/1999 11:45	854:47:00	PLANNED OUTAGE	BOILER ANNUAL INSPECTION 001810
03/26/1999 8:23	03/27/1999 16:53	32:30:00	UNPLANNED OUTAGE	FORCED DRAFT FAN MOTOR BEARINGS 011410
03/20/1999 2:19	03/21/1999 21:00	42:41:00	UNPLANNED OUTAGE	ELECTROSTATIC PRECIPITATOR PROBLEMS 008560
01/22/1999 15:28	01/25/1999 23:37	80:09:00	UNPLANNED OUTAGE	BOILER TUBE LEAK IN FURNACE WALL. 001000
08/06/1998 17:35	08/08/1998 19:57	50:22:00	UNPLANNED OUTAGE	CYCLONE FURNACE (IN CYCLONE AREA ONLY) 001010
02/03/1998 21:08	02/07/1998 8:07	82:59:00	UNPLANNED OUTAGE	OTHER TUBES 001090
09/23/1997 3:25	09/25/1997 12:10	56:45:00	UNPLANNED OUTAGE	BOILER TUBE LEAK IN FURNACE WALL. 001000
07/28/1997 15:33	08/01/1997 12:49	93:16:00	UNPLANNED OUTAGE	EXCITER COMMUTATOR AND BRUSHES 004602
05/01/1997 20:47	05/03/1997 0:09	27:22:00	UNPLANNED OUTAGE	SOOT BLOWERS - AIR 000860
08/30/1996 21:00	10/25/1996 17:15	1340:15:00	PLANNED OUTAGE	MAJOR OVERHAUL BOILER (PRIMARY ACTIVITY) 001800
08/12/1996 10:22	08/13/1996 17:37	31:15:00	UNPLANNED OUTAGE	VERTICAL REHEATER LEAK 021060
08/08/1996 22:00	08/10/1996 9:05	35:05:00	UNPLANNED OUTAGE	VERTICAL REHEATER LEAK 021060
06/23/1996 18:58	06/25/1996 22:30	51:32:00	UNPLANNED OUTAGE	VERTICAL REHEATER LEAK 021060
03/22/1996 10:09	03/23/1996 23:59	37:50:00	UNPLANNED OUTAGE	VERTICAL REHEATER LEAK 021060
01/24/1996 12:17	01/26/1996 10:45	46:28:00	UNPLANNED OUTAGE	TUBE EXTERNAL FINS/MEMBRANES 000859
11/27/1995 18:03	11/29/1995 5:18	35:15:00	UNPLANNED OUTAGE	REHEATER (LOW) TUBE LEAKS 001060
11/13/1995 22:02	11/16/1995 22:55	72:53:00	UNPLANNED OUTAGE	VERTICAL REHEATER LEAK 021060
03/24/1995 20:59	04/21/1995 19:30	670:31:00	PLANNED OUTAGE	MAJOR OVERHAUL BOILER (PRIMARY ACTIVITY) 001800
02/02/1995 13:21	02/04/1995 16:34	51:13:00	UNPLANNED OUTAGE	VERTICAL REHEATER LEAK 021060
01/29/1995 13:34	02/01/1995 11:16	69:42:00	UNPLANNED OUTAGE	HORIZONTAL REHEATER LEAK 011060
11/18/1994 19:10	11/21/1994 6:12	59:02:00	UNPLANNED OUTAGE	VERTICAL REHEATER LEAK 021060
04/25/1994 14:18	04/27/1994 18:38	52:20:00	UNPLANNED OUTAGE	VERTICAL REHEATER LEAK 021060
04/10/1994 1:53	04/14/1994 6:05	100:12:00	UNPLANNED OUTAGE	SECOND SUPERHEATER 001150
01/29/1994 0:07	01/30/1994 6:21	30:14:00	UNPLANNED OUTAGE	DESUPERHEATER/ATTEMPERATOR CONTROLS 001720
09/10/1993 20:10	10/07/1993 9:59	637:49:00	PLANNED OUTAGE	MAJOR OVERHAUL BOILER (PRIMARY ACTIVITY) 001800
07/22/1993 20:23	07/24/1993 15:45	43:22:00	UNPLANNED OUTAGE	VERTICAL REHEATER LEAK 021060

03/29/1993 22:17	04/02/1993 0:23	74:06:00	UNPLANNED OUTAGE	CASING 000820
03/25/1993 6:59	03/27/1993 4:42	45:43:00	UNPLANNED OUTAGE	ROTOR COLLECTOR RINGS 004510
02/10/1993 7:44	02/12/1993 13:21	53:37:00	UNPLANNED OUTAGE	BOILER SCREEN, WING WALL OR SLAG SCREEN
10/30/1992 20:02	11/12/1992 8:51	300:49:00	PLANNED OUTAGE	MAJOR OVERHAUL BOILER (PRIMARY ACTIVITY) 001800

Outage Cost Data

								With Inflation to 2007 $$	
Inflation%	Year	Annual $$	Hours Offline	Forced $$	Hours Offline	Cost P/H Offline AO	Cost P/H Offline FO	Cost P/H Offline AO	Cost P/H Offline FO
1.0219	1999			$383,918.45	533.41		$719.74		$896.09
1.0338	2000			$706,273.63	578.05		$1,221.82		$1,471.44
1.0283	2001			$183,479.44	93.08		$1,971.20		$2,308.59
1.0159	2002	$6,842,955.95	1492.27	$355,262.00	318.85	$4,585.60	$1,114.20	$5,286.42	$1,284.48
1.0227	2003			$742,360.21	420.53		$1,765.30		$1,989.91
1.0268	2004	$4,616,002.62	788.77	$413,464.53	226.57	$5,852.15	$1,824.89	$6,424.61	$2,003.40
1.0339	2005			$957,593.14	506.05		$1,892.29		$2,009.28
1.0324	2006	$4,842,436.84	666.2	$1,487,404.04	791.37	$7,268.74	$1,879.53	$7,475.90	$1,933.10
1.0285	2007			$772,995.49	224.57		$3,442.11		$3,442.11