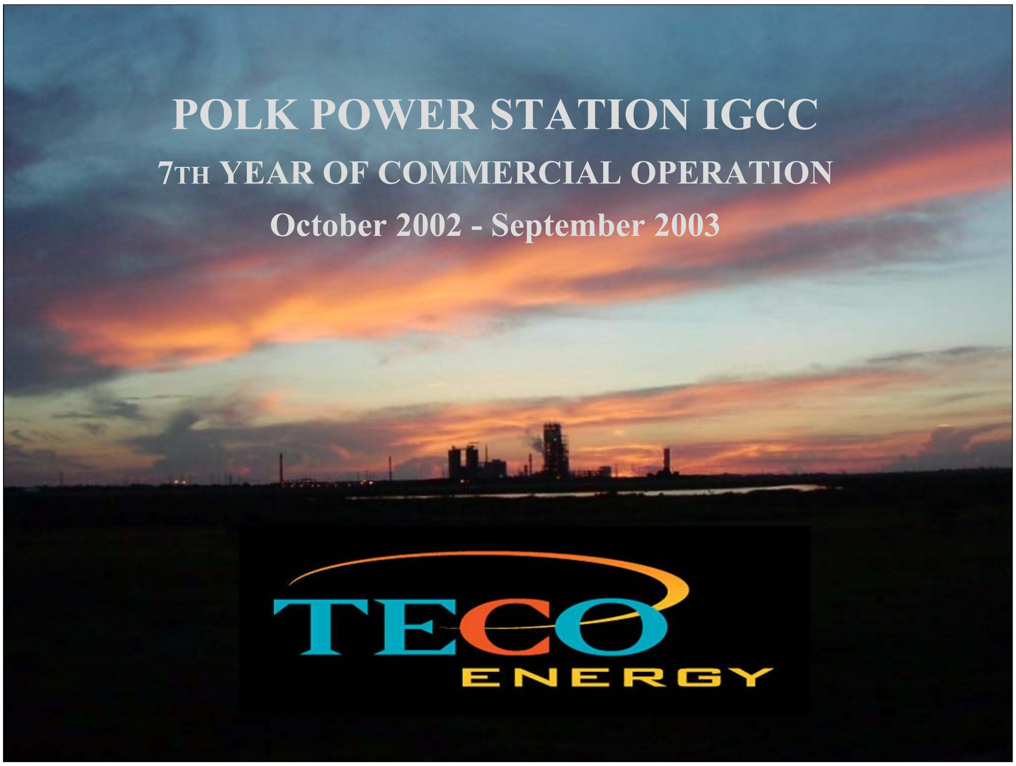

POLK POWER STATION - 7TH COMMERCIAL YEAR OF OPERATION

by

John E. McDaniel - Senior Engineering Fellow (Speaker)

and

Mark Hornick - General Manager, Polk Power Station

PRESENTED AT

2003 GASIFICATION TECHNOLOGIES CONFERENCE

SAN FRANCISCO OCTOBER 13-15, 2003

Polk Power Station recently completed its 7th year of commercial operation.
Today's presentation will contain:

- •Discussion of significant accomplishments in year 7,
- •Summary of the major outage causes encountered in year 7,
- •Polk's operating statistics prescribed by the GTC's guidelines.

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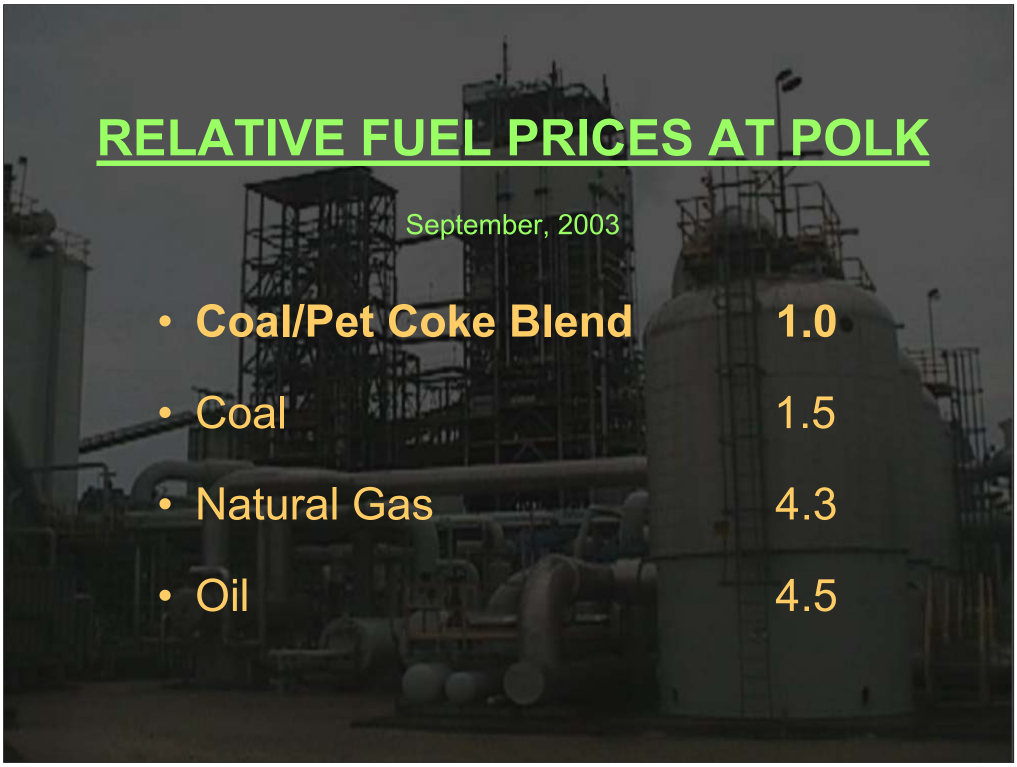
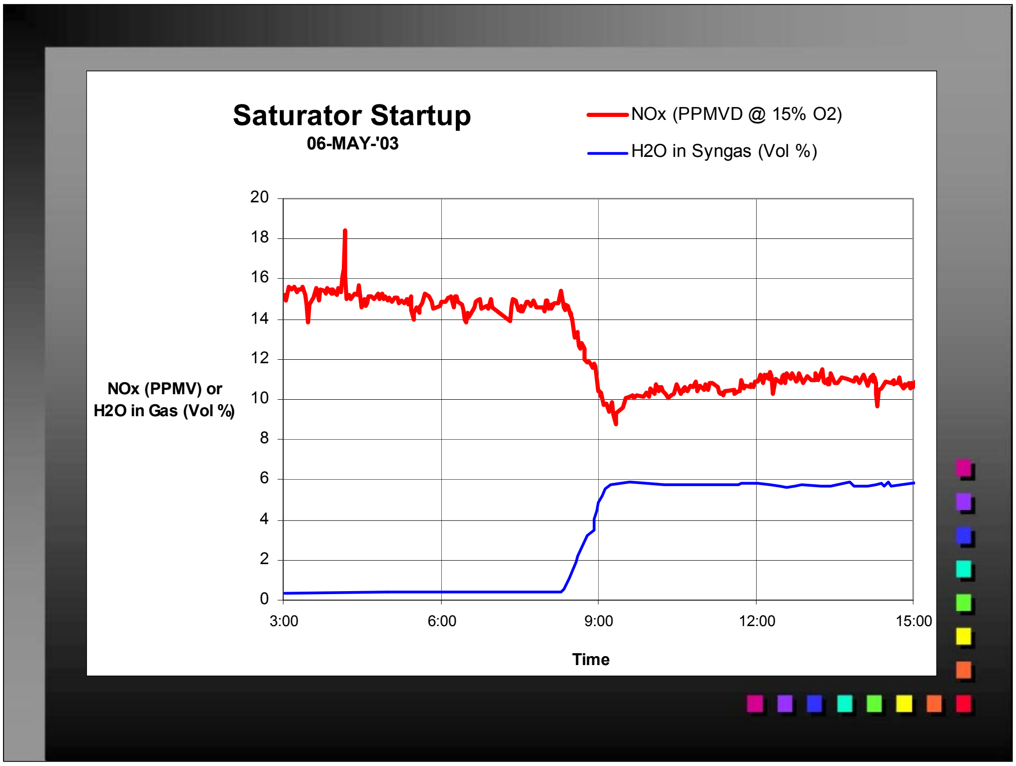


Polk 1 has now completed 7 years of commercial operation. It continues to have the lowest incremental generation cost on the TECO system. It is first in the dispatch order since we produce electricity cleanly from very inexpensive solid feedstock, our 50/50 blend of coal and petroleum coke. Straight coal currently costs 50% more and natural gas and oil are 4 to 5 times higher.

Gasification and the oxygen plant operated well during year 7. Our major issues occurred in the power block and were unrelated to syngas operation. This paper will discuss the unavailability causes and present the availability statistics for Polk's 7th operating year. But first, there were three specific accomplishments which are not directly reflected in those statistics.



Polk was required to reduce NOx emissions from 25 to 15 ppmvd (15% O_2) by July, 2003. As we discussed in last year's paper, we elected to do this by supplementing diluent nitrogen with syngas saturation using low level waste heat. The system was successfully commissioned in early May. This shows the initial run. The saturator has been operating trouble-free ever since, enabling us to comply with the new permit limit.

The above is the design basis we used for the saturator, I.e., we expected a 1.9 ppm reduction in NOx for every 100 KSCFH of water vapor. Although we haven't exhaustively tested the system, it appears from a few data snapshots that we only achieve about 75% of this NOx reduction. Nevertheless, this is quite enough to enable us to meet our new permit limits, and it does indicate that water vapor is significantly more effective than diluent nitrogen for NOx reduction as we expected.

Slag has been a significant problem throughout Polk's operating history, but we are now making significant progress.

The Charah system, discussed in a paper at last year's conference, has been separating the accumulated slag along with our daily production into three components:

1. coarse slag with very low carbon content which is being sold,
2. a medium particle size cut, high in carbon content and heating value, which is being used as fuel at our Big Bend Power Station, and
3. fines, intermediate in carbon content with no commercial value, which we are now recycling along with all the fuel and fines from our syngas scrubbers to our slurry preparation system.

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As the photo shows, this has enabled us to empty our second slag storage area since last year.

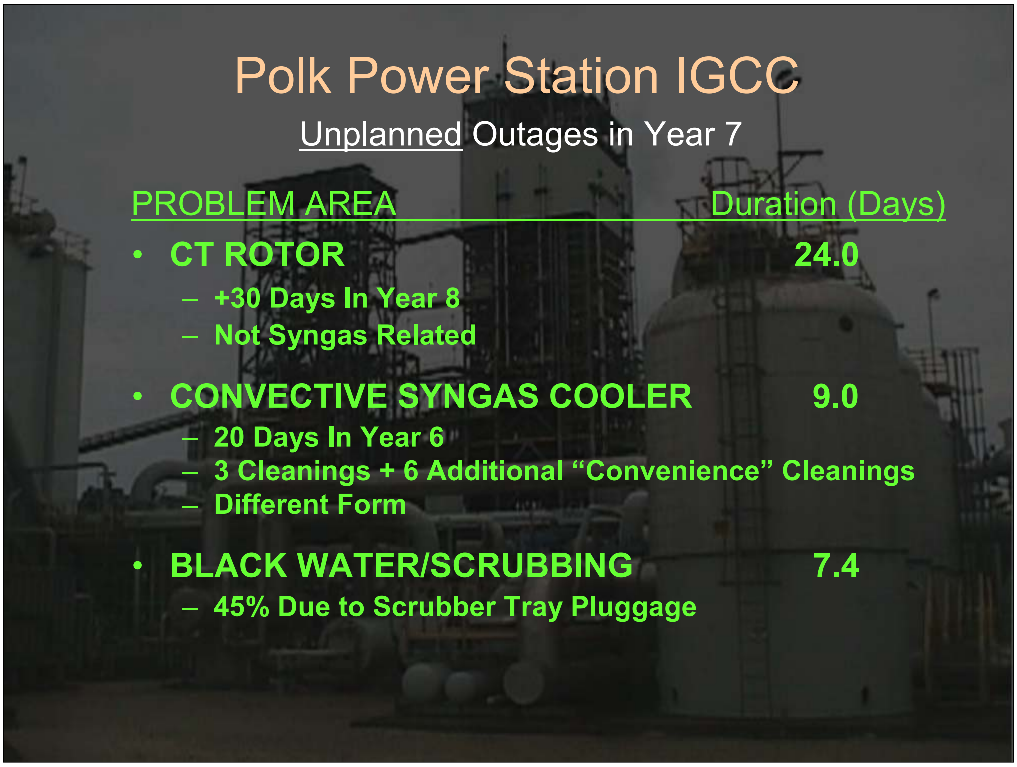
Moving forward, we are installing a new larger coarse slag screen during the current outage. It will receive our slag directly from our lockhopper and drag flight conveyor, eliminating double handling. The screen will separate the coarse, low carbon, marketable material from the fuel and fines portion. The plant is already configured to recycle this fuel and fines to slurry preparation and the coarse material can be sold with little or no post-treatment.

The new screen will relieve Charah of the burden of processing our daily production along with the material from the pile, enabling them to make even more rapid progress in depleting the pile.

Once the pile is gone, we will have the option to continue recycling all fuel and fines from daily production (which is somewhat inefficient and currently causes a load restriction), or to return to post-processing and marketing the fuel fraction.

Last year, we reported commissioning our ion exchange system to remove heat stable salts from our MDEA solution. We were experiencing some accelerated corrosion in areas of the amine system that are typically vulnerable.

This year, we are pleased to report that the operation of the ion exchange system has improved dramatically and we no longer are experiencing any corrosion. The MDEA system has been trouble-free for the first complete summer season in memory. We now believe the specific salts which were the corrosion culprits were oxilate ion $\{(CO_2)_2^{=}\}$ as reported last year and also bicine {(2-hydroxyethyl) glycine}, both of which are degradation products of MDEA and oxygen.



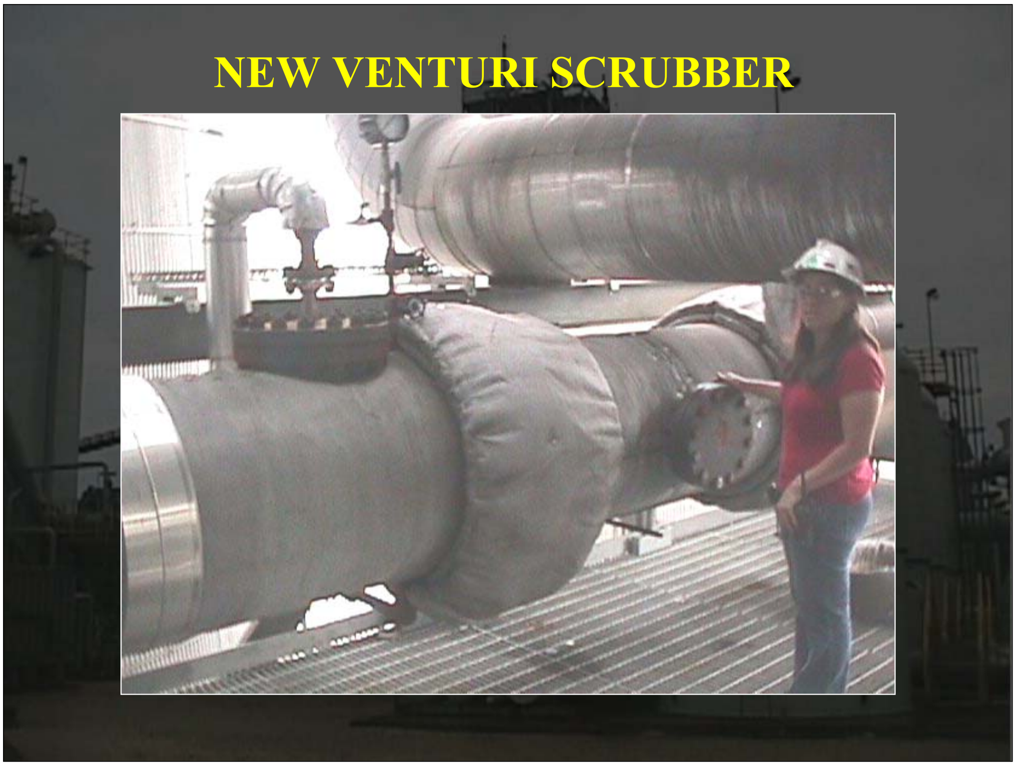
This slide identifies the leading unplanned outages.

Heading the list is the combustion turbine rotor. The CT was shut down for a detailed inspection in early September shortly after GE notified us of a potential problem. Cracks were found, necessitating a rotor replacement which is currently underway. We expect to return to service near the end of October. This problem cost 24 days of production in year 7 and will cost the first month of operation in year 8. On a positive note, the failure was not related to syngas operation. GE's root cause analysis is underway.

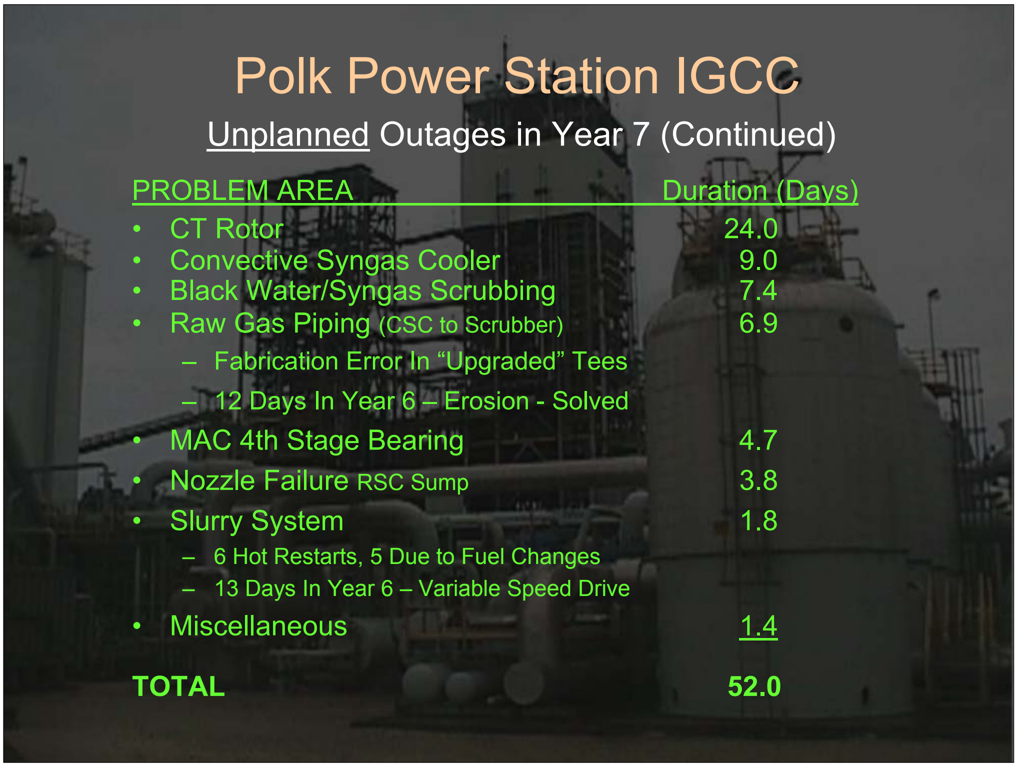
Syngas coolers plugging was the direct cause of 3 outages, costing 9 days of operation in year 7, down from 20 days in year 6. 6 additional cleanings took place during outages due to other causes. The nature of the plugging has been different this year. It was heavily concentrated in the east cooler and its physical form is different. We suspect a small water leak but have been unable to find one. The problem is not solved.

Syngas scrubbing and its associated grey and black water system cost 7.4 days of production. Most were leaks which were resolved during hot restarts so they had minimal impact on availability. Two of the longer outages were caused by inefficient scrubber particulate removal which caused fouling in COS hydrolysis immediately downstream. We've taken two steps to eliminate this.

First, we are upgrading part of the syngas scrubber internals. The "polishing" section consists of trays followed by a demister. The original trays were valve type which would have been satisfactory at the design solids loading. However, since our fines production is much higher than expected, the valve caps plug and are very difficult to clean. We are replacing the trays with a new type which should perform better in this service. We are also upgrading the demister.



We have also installed an additional venturi scrubber upstream of the COS hydrolysis KO drum. This provides protection for the COS hydrolysis superheater and catalyst bed from particulate fouling in case the upstream syngas scrubbers malfunction.



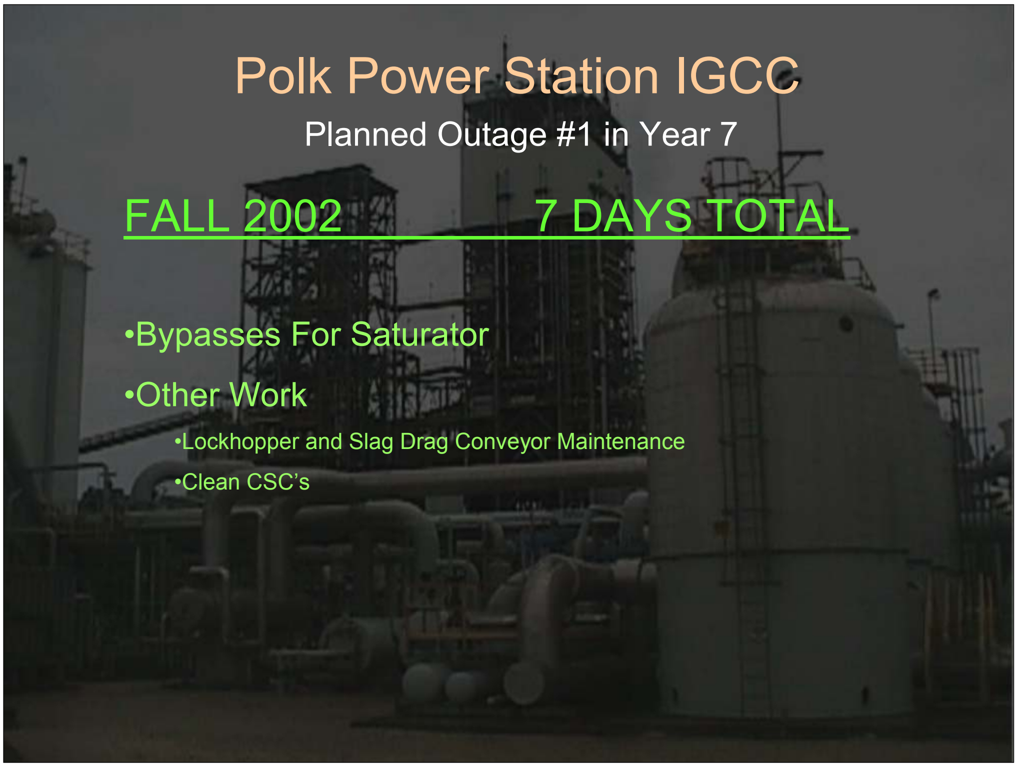
Continuing with the year 7 unplanned outages:

A manufacturing defect in the raw gas piping between the convective syngas coolers and scrubbers led to a 7-day outage. In the spring 2003 planned outage, we had upgraded the piping material since this line was operating near its design temperature limit. Two tees purchased for the upgrade were not properly stress relieved per our specifications, so they failed after only a few hours of service. This same piping system cost 12 days of lost production in year 6 due to erosion. That problem has been successfully eliminated with the line rerouting discussed last year.

The ASU main air compressor 4th stage bearing failed during normal service, leading to a 4.7 day forced outage. Another 3.8 day forced outage occurred as a result of a radiant syngas cooler sump nozzle failure from a small long term leak which had gone undetected behind the insulation.

A total of 1.8 days of production were lost due to six slurry feed pump trips. We quickly recovered from all of them with hot restarts. Five of these occurred during fuel changes, most likely due to "residue" from the coal pile and coal silos as the last of the old fuel was processed. This is a significant improvement from year 6 when we lost over 13 days due to the feed pump system, mostly due to problems with its variable speed drive. This drive has been replaced, so we have experienced no trips due to variable speed drive failures this year.

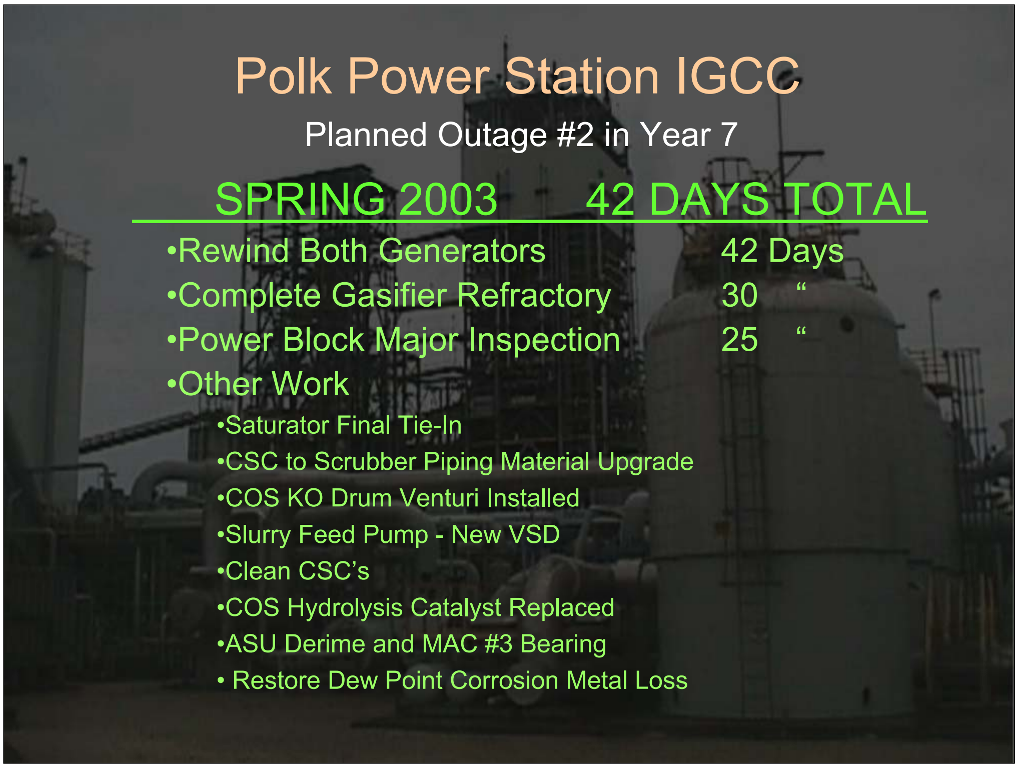
Finally, there were 3 brief outages due to miscellaneous causes costing a total of 1.4 lost production days.



This slide begins the summary of our planned outages in year 7.

The 2002 fall planned outage lasted 7 days and was for the sole purpose of making provisions for the installation of the saturator during operation so it could be quickly tied in the following spring.

We took advantage of the outage to clean the convective syngas coolers and perform maintenance on the slag removal and handling system.



The critical path item during the spring 2003 outage was repairing the electrical insulation on both generators which took 42 days. This was the longest outage in Polk’s 7 year history.

During the outage, we completely relined the gasifier for the first time which required 30 days and a 25-day major inspection was performed on the entire power block.

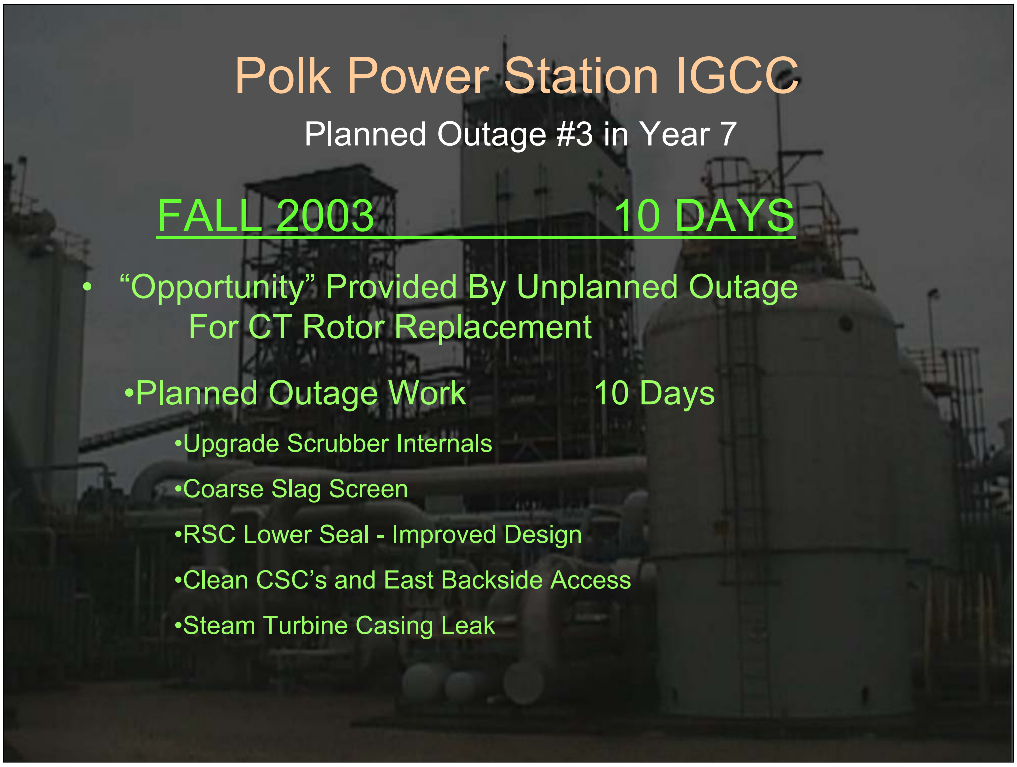
Several other activities were accomplished during the outage which have already been discussed. The final tie-ins for the saturator were made, the piping materials between the convective syngas coolers and scrubbers were upgraded, and we installed the new COS inlet gas venturi scrubber and new variable speed drive for the slurry feed pump.

The CSC’s were cleaned as always during a planned outage.

The COS hydrolysis catalyst was replaced so it would be in good condition for the summer peak generating period.

The air separation unit slowly builds up ice during operation which must periodically be removed by warming and purging. This process, called “deriming”, was done. We also replaced the third stage main air compressor bearing, an activity which had been deferred from the previous year’s outage to repair the fourth stage impeller.

We had experienced some dew point corrosion which had not impeded operation and had been arrested. We took advantage of the outage to restore the metal thickness to its original design condition.



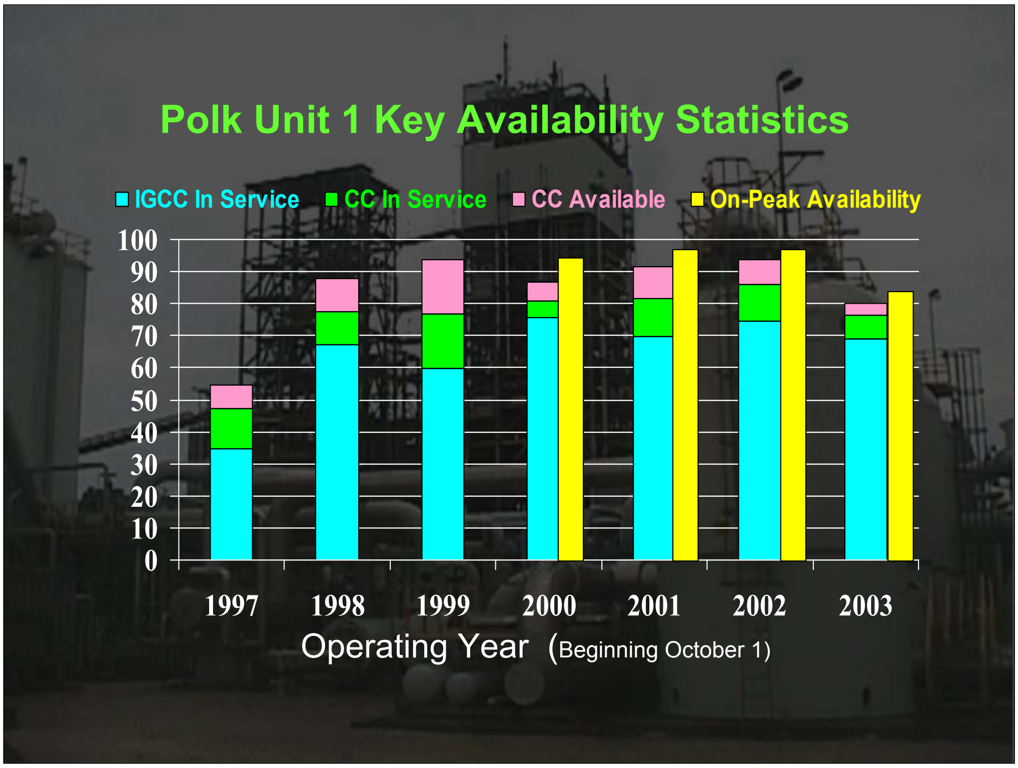
The lengthy unplanned outage to replace the combustion turbine rotor in fall 2003 provided the opportunity to do some planned outage work, mostly in gasification, much of which was originally scheduled for spring 2004.

We are installing the new coarse slag screen and upgrading the syngas scrubber internals as previously discussed.

In previous papers and reports, we identified radiant syngas cooler lower seal leakage as being a problem. We've improved the seal design over the years, and this was an opportunity to install the latest version.

The convective syngas coolers were cleaned as they always are whenever there is an opportunity. In last year's paper, we discussed the difficulty of accessing the west CSC outlet tubesheet to make a repair. We installed a manway there at that time. During this outage, we installed a similar manway for access to the outlet tubesheet of the east CSC.

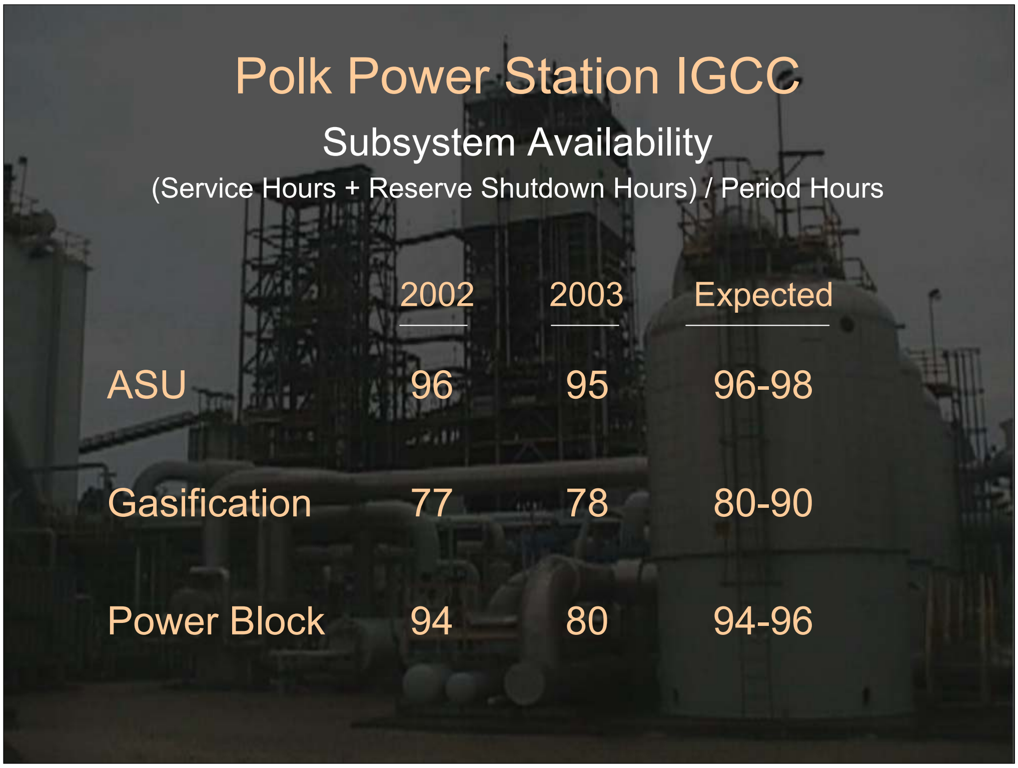
Finally, a steam turbine casing leak has defied repair attempts for several years, and another attempt is now being made.



This slide shows the key overall plant performance statistics.

The decline in performance in all categories reflects the lengthy spring 2003 planned outage due to the repair of the generators and the unplanned fall 2003 outage for the combustion turbine rotor replacement.

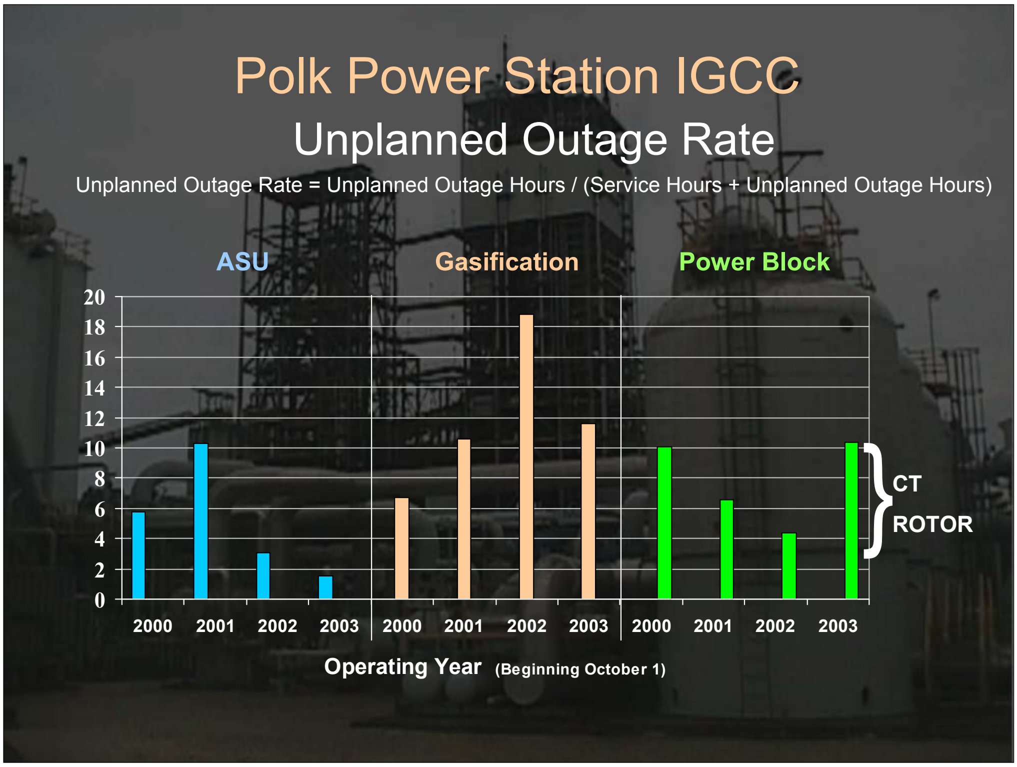
The individual subsystem statistics provide more insights.



The ASU performed only slightly below its expected range, due mostly to main air compressor bearings.

The gasification plant showed slight improvement over 2002. Gasification would have been over 80% available and into its expected range were it not for the planned outage work undertaken during the fall 2003 power block forced outage. On a positive note, this will reduce the length of the planned gasification system outage in spring 2004.

The power block clearly did not have a good year. The extended outage for the generator repair in the spring of 2003 and the unplanned outage for CT rotor replacement in the fall of 2003 were responsible.



The trends of unplanned outage rates of the three main subsystems over the last three years are consistent with the previous statistics.

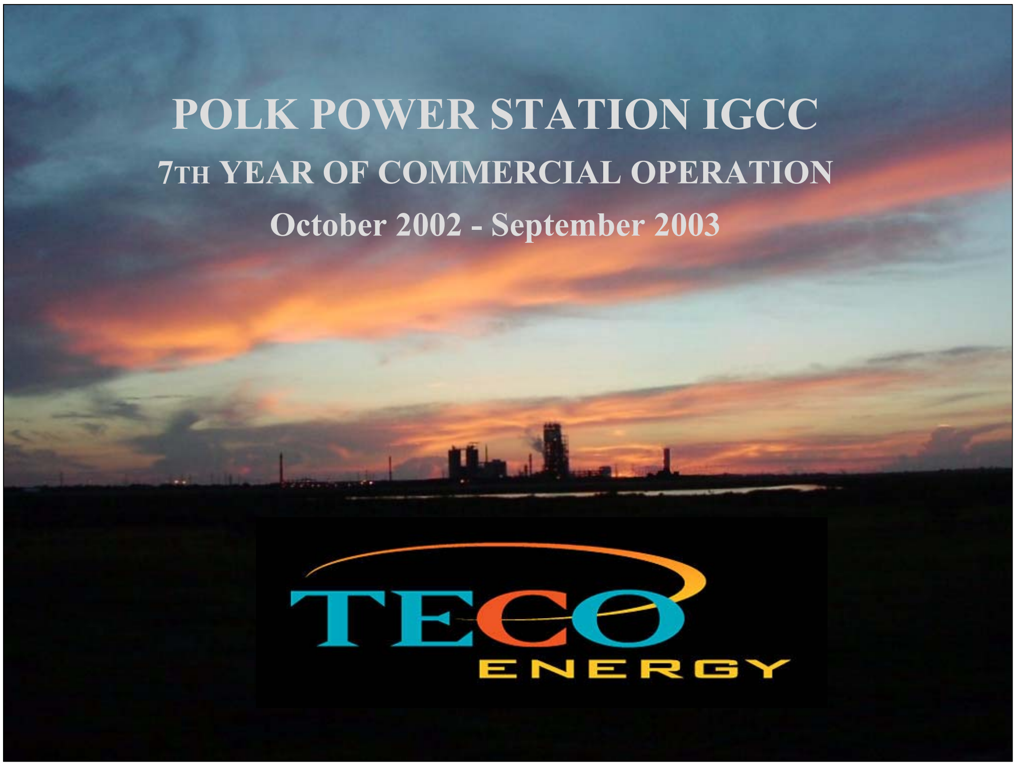
The ASU experienced a serious column leak in 2000 (Year 4) and a main air compressor failure in 2001 (Year 5), unique problems. It improved considerably in 2002 (Year 6), and its performance in Year 7 at 1.6% unplanned outage rate is more typical of this technology.

The previous somewhat disturbing upward trend in the gasification system's unplanned outage rate from 2000 through 2002 was reversed in 2003 due to significant reductions in many types of gasification system unplanned outages. We expect continued improvement through year 8.

The power block's high unplanned outage rate in 2003 is largely due to the combustion turbine rotor failure. Were it not for that, the power block unplanned outage rate would have been only 2.5%, reflecting the significant progress made on solving fuel transfer and startup problems which hurt its performance in previous years.

During the 7th year of commercial operation, Polk Unit #1 maintained its position as the lowest dispatch cost unit in the TECO generation fleet. The saturator was successfully placed in operation and the amount of accumulated slag was significantly reduced. The power block was the main source of unavailability, but the causes were not related to syngas operation.

The CT rotor replacement will continue through the first month year 8. We expect 11 months of excellent operation after that.



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