

Something for everyone Mercury Research Center is Formally Dedicated

By Dr. Scott Hinton, Southern Research Institute

A formal dedication ceremony was held December 5, 2005 for the Gulf Power / Southern Company Mercury Research Center (MRC). The facility represents a state-of-the art, integrated approach for investigating emissions control strategies. Although there is a focus on mercury control, the facility is ideal for examining other topics such as multi-pollutant control strategies, fine particulate control, SO₃ mitigation, scrubber performance, monitoring technologies, etc. Jim Vick, Gulf Power's Manager of Environmental Affairs, says "We are establishing something here that does not exist anywhere else in the world and we believe we will make great strides in discovering new methods of reducing emissions." The facility is located at Gulf Power's Plant Crist, near Pensacola, Florida. *continued on page 6*



Figure 1: The pulse-jet baghouse and SCR de-NO_x tower portion of the Mercury Research Center located at Gulf Power Company's Plant Crist Unit 5.

Scope it out!

Maximizing the Effectiveness of Precipitator Inspections

By Jack Dumbauld and Tom Lugar, Buell Division of Fisher-Klosterman, Inc.

Much has been documented about the benefits of conducting both a dirty and clean internal precipitator inspection. In addition to these physical inspections, another important diagnostic tool that should be a key component of the inspection is the documenting and evaluating of the electrical characteristics of the precipitator. When this is done, it is usually in the form of observing/recording transformer-rectifier (TR) electrical readings during an air-load energization of the ESP. This is conducted after inspection and maintenance work, just prior to "buttoning up" before coming back on line. This serves as an insurance policy to check that there are no missed close electrical clearances or dead shorts caused by debris or tools left inside.

However, some detrimental conditions of the precipitator do not manifest themselves until the ESP is operating in flue gas conditions and components have

expanded as operating temperature is reached and normal sparking conditions prevail. Thus, the electrical characterization of the precipitator should also be conducted just prior to the unit coming off line and would include the recording of TR electrical readings, noting secondary voltages at sparking, spark rates and the generating of voltage-current characteristic curves (VI curves). This data can provide quite a bit of information about precipitator operation and condition.

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When is dust collecting a good thing?

Filter Technology Improves Coal Handling Capability: A Case Study

By Jeff Ladwig, GE Energy

Case Study

Conversion from Carter Day™ RF style filters to BHA PulsePleat® pleated filter elements from GE Energy dramatically increases coal handling baghouse airflow capacity.

Problem

An electric power producer was experiencing bottom bag abrasion of the felt filter bags in its coal crusher baghouse. Poor ventilation and excessive emissions resulted due to increased differential pressure associated with high air-to-cloth ratios.

Solution

GE Energy engineers reviewed the coal handling system and recommended the installation of RF-style BHA PulsePleat filter elements in place of the traditional felt filter bags and cages. This retrofit would provide substantially increased cloth area without the need for physical modifications to the unit.

Results

The following results were documented by plant personnel:

- ➔ The total filtration area of the baghouse increased 87% (from 5,906 ft² to 11,092 ft²)
- ➔ With pleated filters, the design airflow of 40,000 acfm was reached, significantly improving the ventilation of the crusher house.
- ➔ Differential pressure was decreased from 6" w.g. at 32,300 acfm (with conventional felt filter bags and cages) to 4" w.g. at 40,000 acfm (with pleated elements).

- ➔ Air-to-cloth ratios were reduced from 5.5:1 at 32,300 acfm to 3.8:1 at 40,000 acfm with elements.

Benefits of RF Style BHA PulsePleat Filter Elements

Pleated filter elements can make a significant improvement in the operation of material handling dust collectors through:

- ✓ More filtration area - allowing lower operating differential pressures across the dust collector and increased air volumes towards production.
- ✓ Reduction of emissions - due to improved filtration efficiency.
- ✓ Decreased maintenance - due to the reduced time required to change out elements vs. bags and costly support cages.
- ✓ Longer filter life - through elimination of bottom bag abrasion and reduced cleaning frequency.

For more information, contact Jeff Ladwig, GE Energy, at jeffery.ladwig@ge.com

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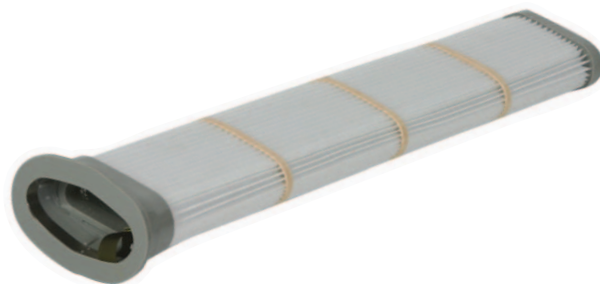


Figure 2: GE Energy's BHA PulsePleat® RF-style pleated filter element.

Perpetual motion means smooth sailing

SCR Management Ensures SCR Performance at Minimum Operating Cost

By Hans Hartenstein, STEAG LLC

During the last 5 years, approximately 100,000 MW of coal-fired electric generating capacity was retrofitted with mostly high-dust SCRs in order to comply with the CAAA Title I SIP call aimed for ground level ozone reduction. After installation and successful commissioning, most SCR operators are now faced with the challenge of long-term SCR operations. As virtually all SCRs will go from a 5 months ozone seasonal operation between May and September to year-round operation in the foreseeable future, managing an SCR

for maximum performance, while ensuring minimum long-term operating costs, has become the most recent challenge for SCR operators.

STEAG, who owns and operates 24 SCRs in their own power plants, has been faced with this challenge since 1986 when the first SCR went into operation on a year-round basis. As Germany never operated their SCRs on a seasonal basis, STEAG was forced to immediately develop all the

tools and procedures needed to manage the SCR system for minimum operating cost while ensuring year-round compliance. These tools can be categorized into two fundamentally different types, namely:

1. SCR equipment management, which addresses properly tuning, maintaining and keeping up critical SCR equipment components besides the SCR reactor(s) and duct work including:
 - a. Ammonia Injection Grid (AIG) tuning grid and valves.
 - b. Dampers and expansion joints.
 - c. Fixed installed sampling grid downstream of the last catalyst layer.
 - d. Flue gas seals between the catalyst modules as well as the walls.
 - e. Large Particle Ash (LPA) screens.
 - f. NOx analyzers.
 - g. Seal air system.
 - h. Turning vanes and flow distribution devices.

2. Catalyst management, which addresses properly testing, analyzing, forecasting, exchanging, replacing, purchasing and/or regenerating the catalyst, including:
 - a. Bench scale testing for activity, SO₂/SO₃ conversion rate and pressure drop of new, unused catalyst in order to establish a baseline, as well as of used catalyst in order to track the catalyst's actual changes.
 - b. Chemical analysis (catalyst surface and bulk material).
 - c. Determination of catalyst deactivation causes.
 - d. Determination of the initial, the required minimum, and the actual DeNOx potentials.
 - e. Forecast of DeNOx potential development.
 - f. Determination of catalyst deactivation mitigation opportunities and development of catalyst deactivation mitigation strategies.
 - g. Development of an optimum catalyst management strategy either for a single unit or for a fleet of units.
 - h. Considerations considering the exchange frequency, purchase of new and/or regeneration of existing catalyst layers

STEAG, as well as other SCR users, developed and have used for two decades what is referred to as the perpetual cycle of SCR management (see figure 3). It describes all tasks and responsibilities to be undertaken during each outage when the SCR reactor is accessible. Particularly in the early years of SCR operation, every opportunity given, scheduled or unscheduled, during which one can get into the SCR reactor, should be taken advantage of in order to assess the system and establish a data history of its behavior including the experienced catalyst deactivation.

Perpetual Cycle of SCR Management

As soon as a reasonably long operating history has been documented, which typically takes three to four cycles, one can

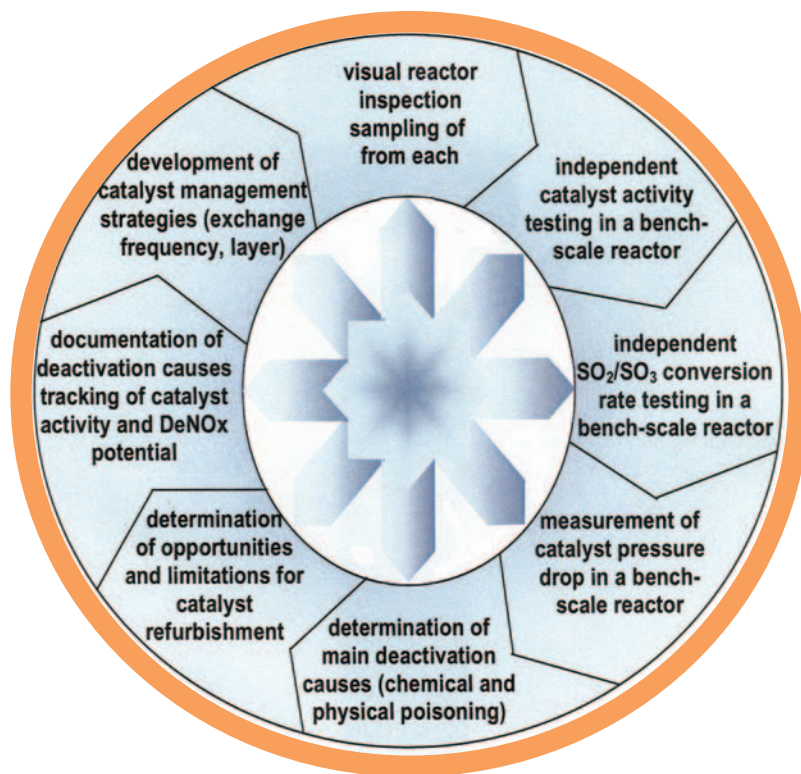


Figure 3: Perpetual Cycle of SCR Management

then start consolidating the data and begin developing an optimized catalyst management strategy. Such a strategy can either be developed for a single unit or for an entire fleet of SCRs. As a user of 24 SCRs, STEAG quickly realized the enormous economic benefit of managing the entire inventory of catalyst on a fleet-wide basis with catalyst flowing freely among the units. Such a strategy includes the exchange frequency, regeneration, and purchase of new catalyst layers as necessary.

Along the same line, the SCR equipment, including the ammonia system, must be properly maintained at all times. An inspection should be performed at least once per year.

Also, at least once annually, during seasonal operation preferably at the start of the ozone season, the ammonia injection grid (AIG) should be properly tuned. This required realignment of the AIG tuning valves in such a way that the fully O₂-corrected NO profile after the last catalyst layer, as determined by use of the fixed installed sampling grid, should be as flat and uniform as possible.

Performing all these tasks diligently on a perpetual basis allows for achievement of the lowest overall SCR operating cost while ensuring the desired SCR efficient performance.

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Blue Plume Acid Mist Formation

By Wayne Buckley & Buzz Reynolds, Wheelabrator Air Pollution Control Inc., A Siemens Company

Depending upon the type of FGD technology installed, a considerable portion of ammonia salts and sulfuric acid may exit the stack as respirable sub-micron fine particle emissions. Sulfur trioxide (SO₃), when hydrated with moisture in the gas stream or in the atmosphere, forms sulfuric acid (H₂SO₄), which contributes to visible plume and may violate local opacity regulations. Control of sulfuric acid mist presents an extremely difficult air pollution control problem due to its uniform 0.3-0.5 sub-micron size.

Sulfuric acid emissions are problematic in both wet and dry FGD processes. In wet processes, where the flue gas leaving the absorber is saturated with moisture, sulfuric acid mist forms instantly after the flue gas is saturated and creates a stack opacity problem. Dry processes, where the flue gas is not saturated with moisture, typically remove fine particles such as (NH₄)₂SO₄. However, dry processes typically have lower removal efficiency for SO₃ vapors. Upon exiting the stack, these vapors convert to sulfuric acid mist and produce significantly visible emissions.

Sulfuric acid formation takes place through the oxidation of SO₂ to SO₃, followed by reaction with H₂O to form H₂SO₄. During the combustion process, the sulfur in the fossil fuel reacts to form about 95-97 percent sulfur dioxide (SO₂) and the remainder sulfur trioxide (SO₃). Most of the SO₃ in boiler flue gas likely forms during the several seconds when the combustion gas cools from 2900-3100° F to about 1830° F. SCR technologies will generate an additional quantity of SO₃ through catalytic conversion of SO₂ to SO₃ even at low temperatures.

There are two primary mechanisms for sulfuric acid mist formation. The first mechanism is the reaction between H₂O vapors and SO₃ vapors that form liquid droplets. The second mechanism is sulfuric acid vapor condensation in the bulk gas phase when the gas stream temperature is lowered below the H₂SO₄ dew point. While an FGD system will remove some H₂SO₄, the majority will exit the stack.

If reductions of mass emissions, stack opacity, or both are required, it is necessary to use a technology that will simultaneously remove both sulfuric acid mist and solid particulate material from the flue gas. Wet electrostatic precipitation (WESP) technology can satisfy this requirement and has the added potential for abatement of heavy metals (including mercury), as well as water mist carryover from an FGD scrubber system.

Future PM_{2.5} and Regional Haze regulations will require control of SO₃ and sub-micron particulate. Any plant planning to install an FGD system for SO₂ control should consider leaving room for the future addition of a WESP and performing preliminary engineering design concurrently with the FGD to minimize future outage time and cost.

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Plan ahead; Be trendy Troubleshooting Tools to Ease Operations

By Larry Boyer, EPSCO International

Plan View Charts

The use of a plan view chart showing all electrostatic precipitator (ESP) electrical sections with pertinent operating data can be a useful tool in diagnosing problems, and watching over operating situations. Trying to analyze a multi-field multi-bus section box without a map of the operation may hinder observing changes in the operation.

Typical section data might be

- ◆ primary and secondary voltages and
- ◆ primary and secondary currents and spark rates.
- ◆ Electrical section nametags are a plus.
- ◆ A summary of KW input, DCMA/MAFT² and/or

watts/1000 CFM as a box summary at the bottom of the chart may be useful in comparing overall power on a day-to-day basis.

- ◆ Typical boiler operational data such as gross MW, opacity, and a date and time stamp should be provided for clarity.

A second more comprehensive chart might include

- peak and minimum DCKV values,
- firing angles or degrees on one of the SCR's,
- software versions,
- board serial numbers, and other pertinent control information.

With multiple bus sections across a precipitator, average values for the typical section data may provide the engineer with an “at a glance picture” which could be compared to previous logged charts. As fuels or operational changes may occur, the averages will move and alert the engineer to the reaction to a new fuel or operating condition.

Trending Software

With the advent of DCS control systems, software packages, and computer-based EMS (energy management systems) and their internal data logging, the available data for aiding in troubleshooting is endless.

Independent trending software programs can put not only all control parameters and real time boiler operating data at the operator’s fingertips, but provide the mix of these values to aid in troubleshooting.

Comparisons of DCKV, DCMA, SPK/MIN, KW, firing angles, and other pertinent control data, can lead an operator to a cause/effect of an erratically operating precipitator control, transformer rectifier, and or field problem. History trending can provide the demise and help tie it to some other event.

During the operation of a multi-fuel power plant, it was extremely informative as to the changes in DCKV and SPK/MIN (spark rate), when certain fuels were introduced to the boiler. Changes were observed and differences between fields, chambers and bus sections were clearly observed with the trending software. The differences would not have been readily observed when looking only at plan view charts or the meters.

DCKV readings at one plant changed throughout the day as load and operational parameters changed, but also varied from lane to lane or Pazar to Pazar. Firing angle or degrees on valves were noted to also change as process and fuel characteristics changed.

One needs to consider plotting a variety of supposedly non-typical parameters which may provide an additional picture of cause and effect of erratic operation. Be also cautious to not plot or trend too much data which may mask and or confuse the evaluation process. Review the trending history and understand the averaging periods as data is stored. This may also

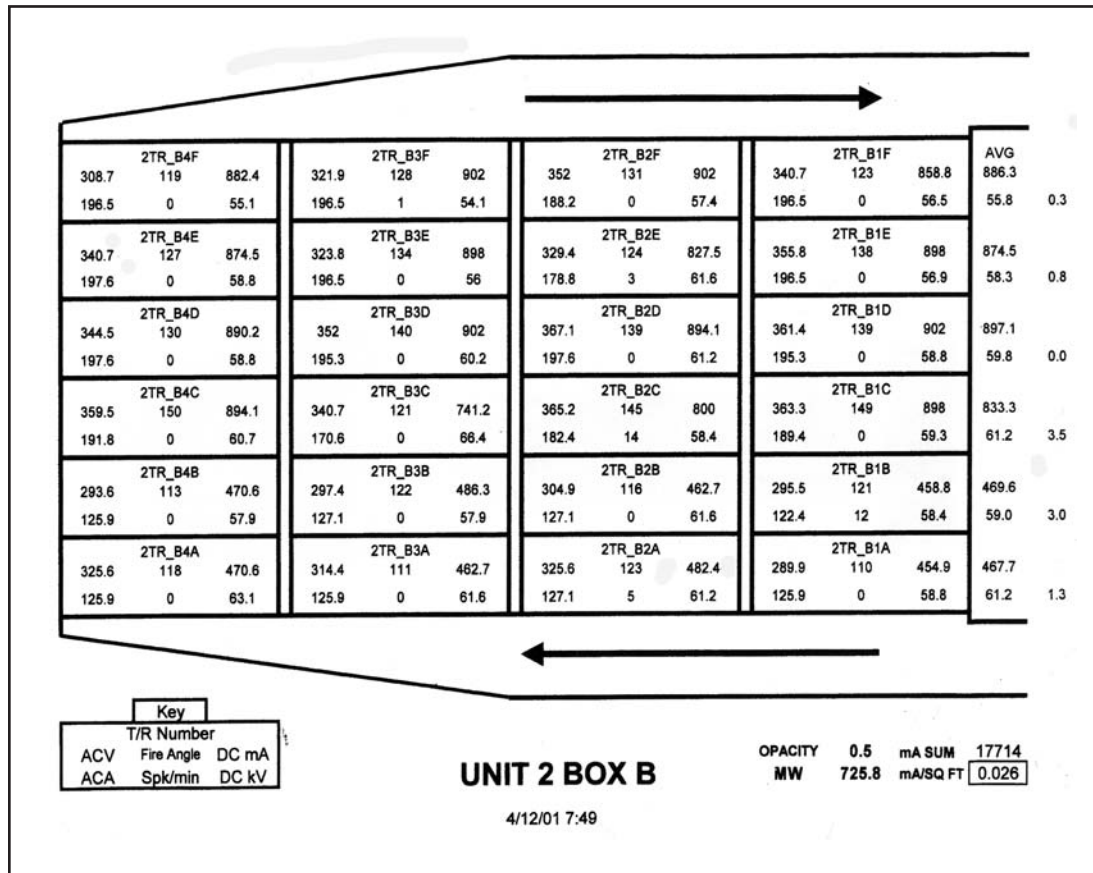


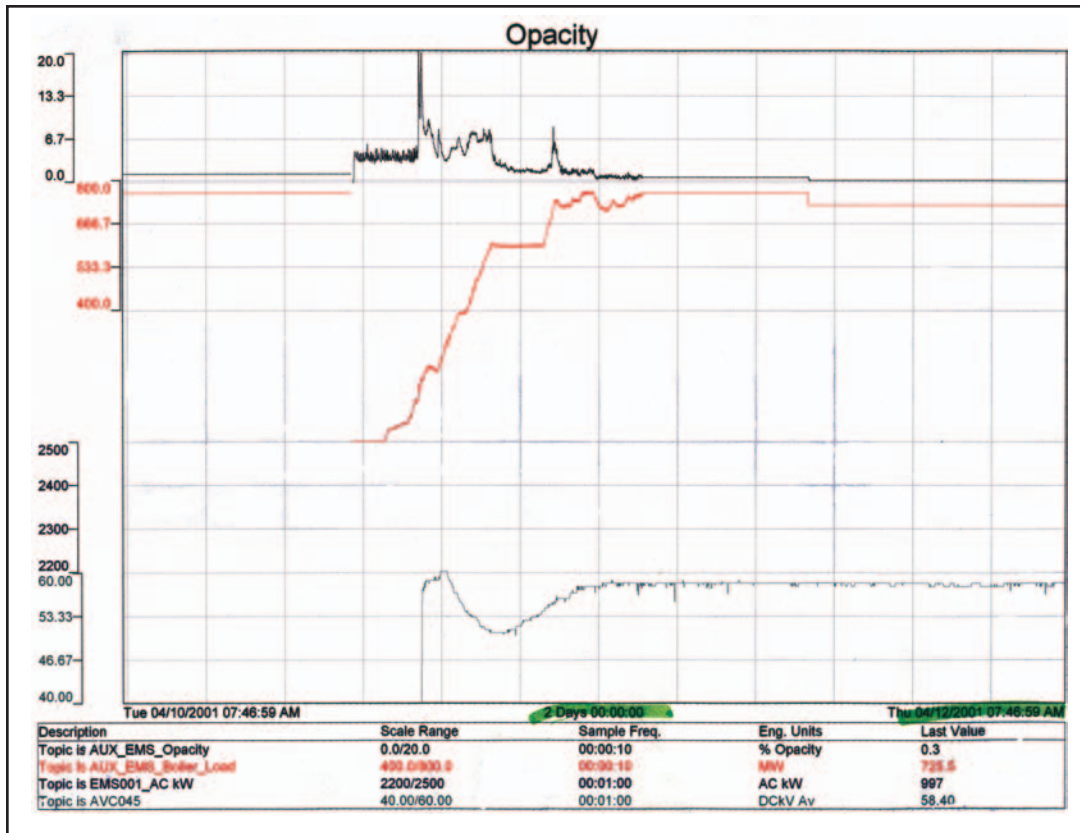
Figure 4: Sample View Chart

These “at a glance” averages by field were instrumental at one site in determining the effect of several specification fuels and the time of reaction to the new dust layers and resistivity changes.

These “at a glance” averages could be applied to lane by lane or Pazar by Pazar, thus showing changes across the box. They may help diagnose

- uneven gas distribution,
- particulate stratification,
- temperature stratification,
- hopper evacuation faults,
- leakage of ambient air, and/or other abnormal operating conditions.

Develop and utilize these operating parameters in a chart form to provide the tools for quick review on a day to day basis and to assist in troubleshooting a problem. Site specific revisions can provide the engineer with a useful time saving tool.



diminish an event and make it appear less dramatic or dampened with time.

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Figure 5:
Sample
Trend
Chart

Mercury Research Center is Formally Dedicated

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Southern Research Institute will operate and market the facility as an independent and non-biased third party. The operating philosophy is to make this facility available to virtually any group interested in performing research to insure that the facility is utilized to the maximum extent possible for the benefit of the industry and public. "We believe that this facility can best serve the industry and public by making it available to any organization wishing to perform beneficial research. We want all interested parties to feel that this facility represents a unique and readily available resource for them," says Dr. Scott Hinton, Director of the Mercury Research Center for Southern Research Institute.

With a design flue gas flow rate of 50,500 lb/h (23,990 acfm @ 700°F), roughly equivalent to 5 MW, the facility represents one of the largest and certainly most comprehensive facilities of its type in the world. The facility's size and available equipment allows it to simulate full scale operation for virtually any coal-fired boiler configuration and operating conditions found in the domestic fleet. Primary equipment includes an SCR, Ljungstrom-type air preheater, ESP, baghouse, wet scrubber, and sorbent injection system.

Southern Research Institute is actively seeking research projects which would utilize the facility. According to Dr. Hinton, "We're open to virtually any operating arrangement that makes the facility attractive to a potential customer. Southern Research Institute's role in the various projects at the MRC will range from simply operating the facility and providing basic testing services (with the customer providing general project oversight, reporting, etc.) to a scenario where Southern Research Institute provides a turn-key product by developing test plans, carrying out the research, and providing all project management and reporting services. In many cases we can even help to find other interested parties to assemble a consortium to fund particular projects."

The facility is expected to begin start-up and validation activities in early February, 2006 and research for the coming several years is currently being booked.

For more information on the facility see www.MercuryResearchCenter.org or contact Dr. Scott Hinton, Southern Research Institute, at hinton@sri.org.

Maximizing the Effectiveness of Precipitator Inspections

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In addition, observing the electrical characteristics of each TR with an oscilloscope with storage capability, can provide an added dimension of analysis as a diagnostic tool.

An oscilloscope 'EKG' of each TR can pinpoint problems in the precipitator requiring a more thorough inspection of specific areas after unit shutdown. Some existing problems adversely affecting ESP performance and/or reliability may go undetected without the use of the oscilloscope as a diagnostic tool. With an oscilloscope, the location of spark initiation on the secondary current waveform can be determined as well as an evaluation of spark detection, response and recovery of the voltage controllers. With the precipitator on line, and observing electrical characteristics with an oscilloscope, one can also determine if performance problems are related to ash characteristics, internal mechanical/electrical conditions within the precipitator, response of the voltage controllers or a combination of the above.

The following are just some of the examples of the oscilloscope as a precipitator diagnostic tool.

Whipping Wires or Swinging Grid

One important but not widely recognized problem with weighted-wire precipitators is whipping wires caused by inadequate wire tension due to bottle weights resting on the alignment grid rather than hanging free. This often occurs after a wire change-out because one or more new wires may be longer than the rest. Another cause of this problem is not enough clearance between the top of the post style anti-sway insulator and the wire alignment grid system. The anti-sway insulator may also have broken allowing the alignment grid to sway.

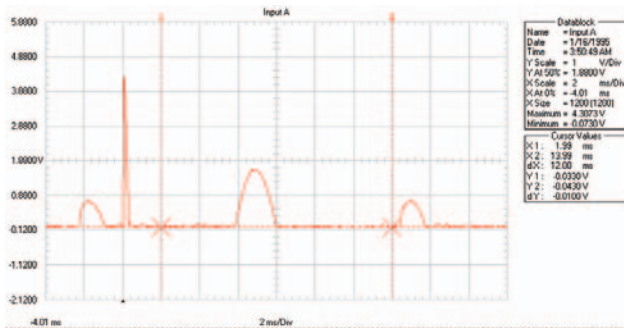


Figure 6: Whipping wire – spark between pulses.

Like the strength of a chain, the amount of power input to an electrical section could be limited by just one rogue slack wire. You may not know that you have a whipping wire causing observed low power level sparking since this condition will only occur when the emitting wire lengthens at precipitator operating temperatures. How does one determine that

there is a wire whipping or grid swaying in an ESP electrical section? Referring to the oscillogram of the secondary current waveform in Figure 6, sparks normally occur near the peak or just off the peak of the secondary current waveform. When a spark occurs between the secondary current pulses, it is highly likely that the cause is a high voltage component moving. For this situation, the spark occurs randomly and is not dependent on the applied precipitator voltage or power level.

Figure 7 shows one cause of a slack wire. The alignment grid ring is just below and very close to the bottle weight rivet. When operating temperature is reached, the wire will lengthen and hang up on the ring, eliminating wire tension.



Figure 7: Alignment ring should be below the rivet pin to account for wire lengthening when on-line.

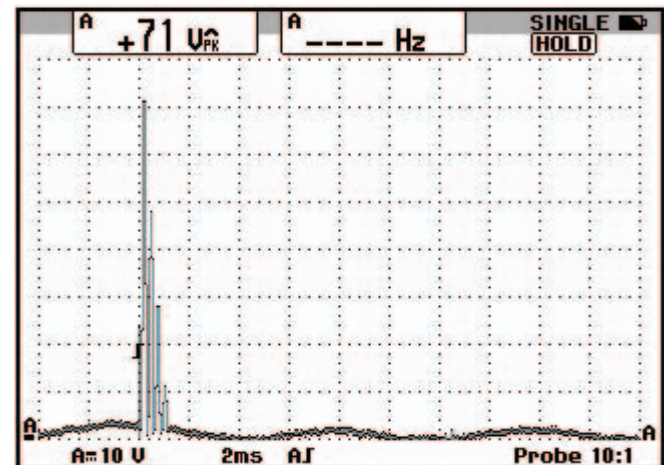


Figure 8: Ringing sparks

Ringling Sparks

A spark should be observed as a narrow spike whenever it occurs. The oscillogram, Figure 8, shows many oscillations of a spark instead of a single spike on the secondary current waveform. These oscillations can cause spark response insta-

bility with the voltage controllers. At the installation that this oscillogram was recorded, the problem has been present for quite some time. Filtering circuits were added in an attempt to mitigate the problem when the controls were upgraded but had little effect on correcting the problem.

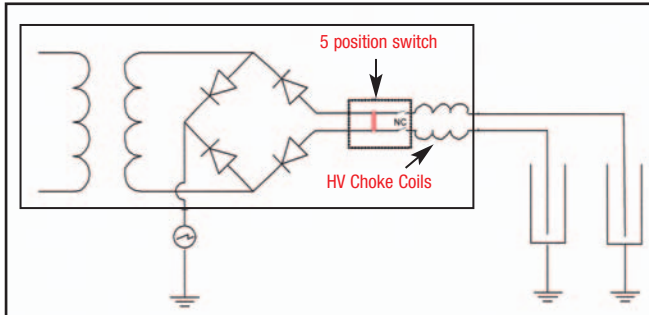


Figure 9: Existing configuration

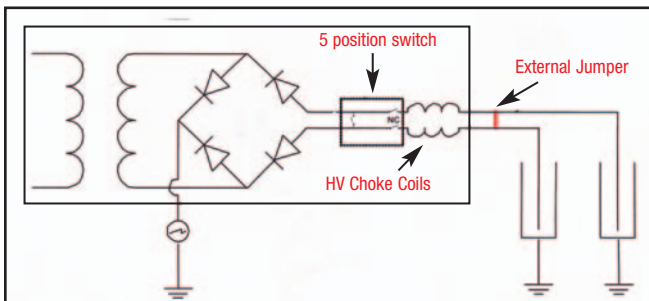


Figure 10: Position #4 with jumper between HV output bushings

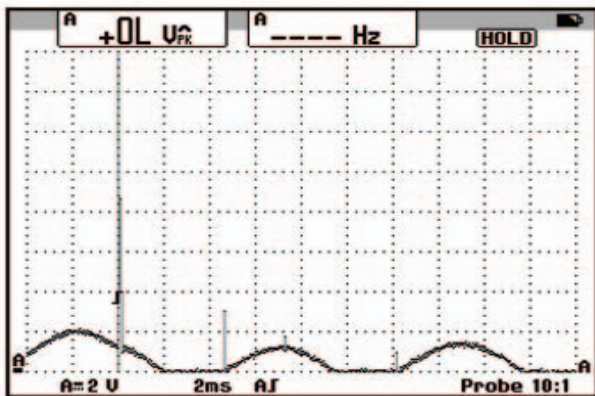


Figure 11: Ringing Sparks Eliminated

This problem is caused by the full wave connection of older, double outlet bushing, TRs being made by a switch located before the high voltage choke coils rather than after, as is the case with modern TRs, Figure 9. To demonstrate the fix for this problem, the 5- position high voltage switch was placed on Position #4, double half-wave mode of operation. This opened the full wave switch connection before the choke coils, Figure 10. An external jumper was placed across the high voltage output bushings to establish full wave operation. Figure 11 oscillogram shows the elimination of spark ringing after the TR was re-energized.

Voltage Controller Spark Response

Use of an oscilloscope is required to evaluate the TR voltage controllers to determine that they are properly detecting and responding to sparking. This evaluation is best done with the unit on-line under flue gas conditions with the resulting spark conditions prevailing. Under air-load energization, some electrical fields may exhibit little or no sparking. Some examples of common control problems are shown in Figure 12 through 15 oscillograms.

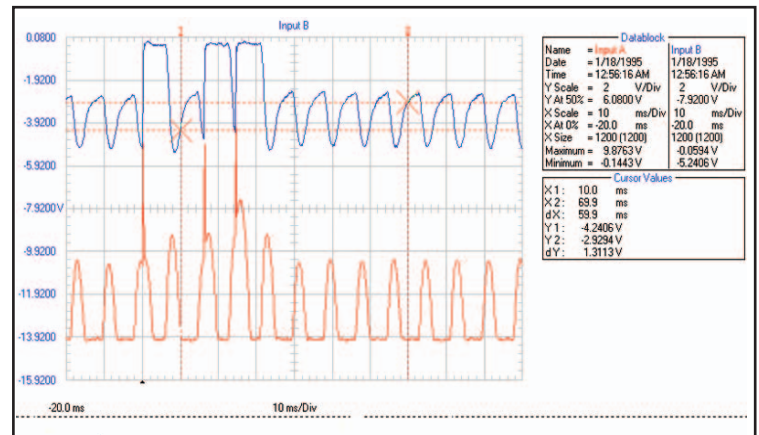


Figure 12: Missed Sparks

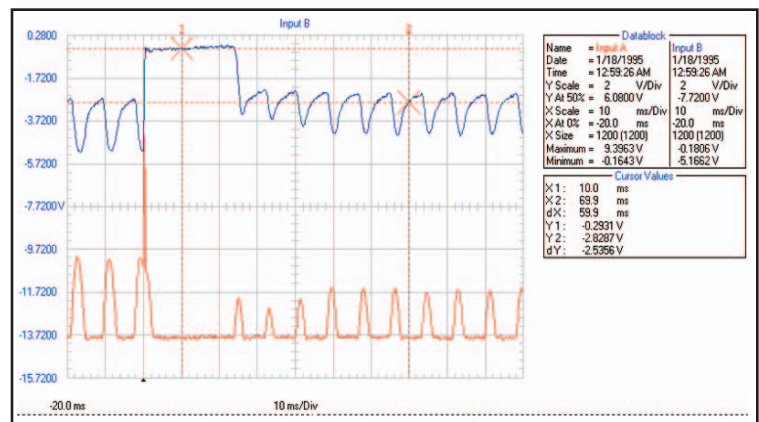


Figure 13: Typical spark response

Figure 12's oscillogram shows a controller not detecting sparks. The power level is increasing, causing multiple sparking.

Figure 13 shows a typical controller spark response to a high energy spark. Note that spark detection and response will vary depending on the controller manufacturer's philosophy of spark response and the settings chosen.

Figure 14 shows an excessively long, 74 millisecond, off-time response after a spark is detected. The magnitude of the reduction in average power input to the affected electrical field(s) will depend on the sparking rate.

Figure 15's oscillogram shows an example of loss of control. Upon detection of a spark, the controller should immediate-

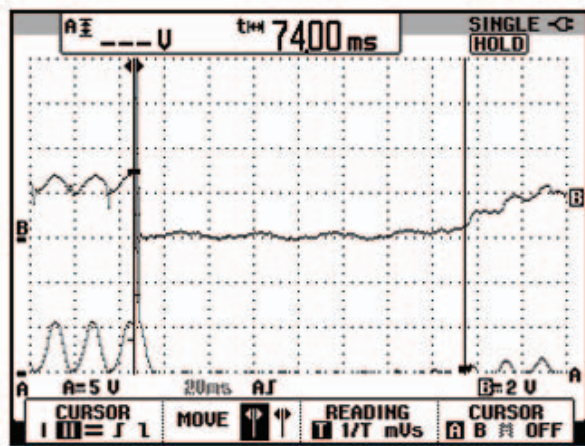


Figure 14: Excessive off-time after spark detection

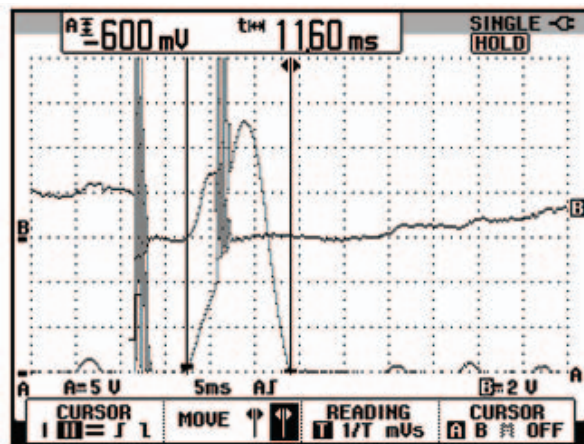


Figure 15: Loss of control

ly turn off or reduce power, depending on the spark intensity, to reduce the potential of multiple sparking or burst sparking occurring. In this example, a burst of sparks is not detected and the controller actually raises the amplitude of the next half cycle of secondary current which results in a large amplitude arc.

Back Corona Detection

In many cases, the useful operating current density in the precipitator is limited by the resistivity (electrical conductivity) of the ash layer on the plates. If the ash resistivity is sufficiently high, electrical breakdown of the ash layer will occur at a precipitator voltage level below sparking. Glow points of corona will form on the ash layer surface generating ions of opposite polarity to those produced by corona emission from the emitting electrodes. Thus the term back corona and also referred to as back ionization. Back corona positive ions are attracted to the negative polarity emitting electrodes and will neutralize negative ions for particulate charging and disrupt the space charge that stabilizes the corona formed on the emitting electrodes. The resulting performance of the precipitator will be reduced to an extent dependent upon the severity of the back corona condition.

Back corona electrical characteristics can easily be observed with an oscilloscope and also with VI curves. As precipitator voltage and current rise with increasing power applied, a

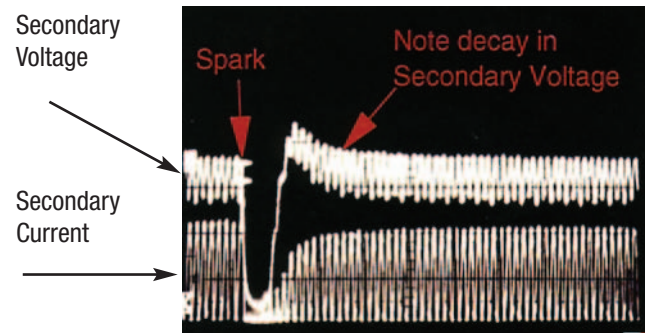


Figure 16: Scope trace showing back corona (secondary voltage rises then drops as current increases)

Courtesy of Russ Ridgeway, AEP

point is reached where the secondary voltage (KV) does not increase further or reduces as secondary current (MA) continues to increase. Figure 16's oscillogram shows the secondary voltage rising but then dropping as current continues to increase. Figure 17 shows a classic decay in the trough of the KV waveform with increasing current indicating back corona.

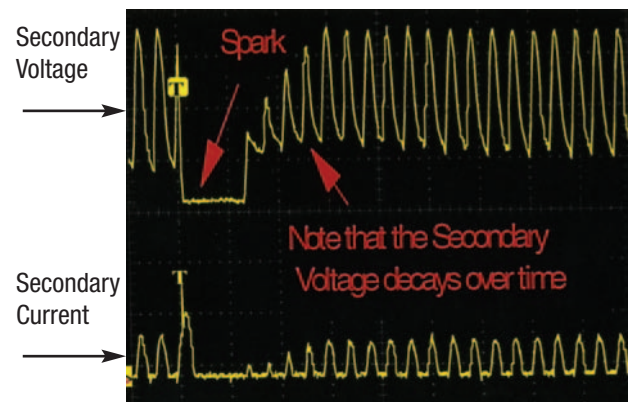


Figure 17: Scope trace showing back corona (classic decay of KV waveform as current increases)

Courtesy of Russ Ridgeway, AEP

In conclusion, the examples presented have shown that the oscilloscope can be an integral tool in conducting a more thorough inspection of the precipitator. In fact, these problems may not be identified at all without the use of the oscilloscope. So, for your next scheduled precipitator inspection, scope it out!

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