Progress Update on Chariton Valley Biomass Project

Prepared for: EPRI Biomass Interest Group

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Presentation Outline

- Objectives of Long Term Test Burn
- Photos & Layout for New Processing System
- Results from Long Term Test Burn
- Project Status / Next Steps

Acknowledgements

- Project Partners:
  - Chariton Valley RC&D
  - Alliant Energy
  - Dept. of Energy
  - USDA
- Team Members & Others:
  - OGS Plant Staff
  - PrairieLands Biomass LLC
  - Kelderman Manufacturing
  - Antares Group Inc.
  - Bradford, Conrad, Crow Engineering
  - Elsam Engineering (now Dong Energy)
  - TR Miles Consulting
  - Many other state & local organizations

Switchgrass Cofiring
Ottumwa, Iowa

- Ottumwa Generating Station
  - Alliant Energy / Mid-American
  - 726 MW, PRB Coal, 1982 startup
  - Twin furnace T-fired PC boiler
  - 2.5 to 5% heat input from switchgrass, 12.5 ton/hr feed rate targeted
  - Separate biomass injection, 2 - 4 ports
- Long Term Test Objectives
  - 2000 hr continuous test to measure long term effects, refine/prove system operation
  - Long term test to investigate fouling, slagging, and corrosion impacts
  - Collect information on all operational costs & impacts for use in business planning
  - Burn up to 25,000 tons of switchgrass

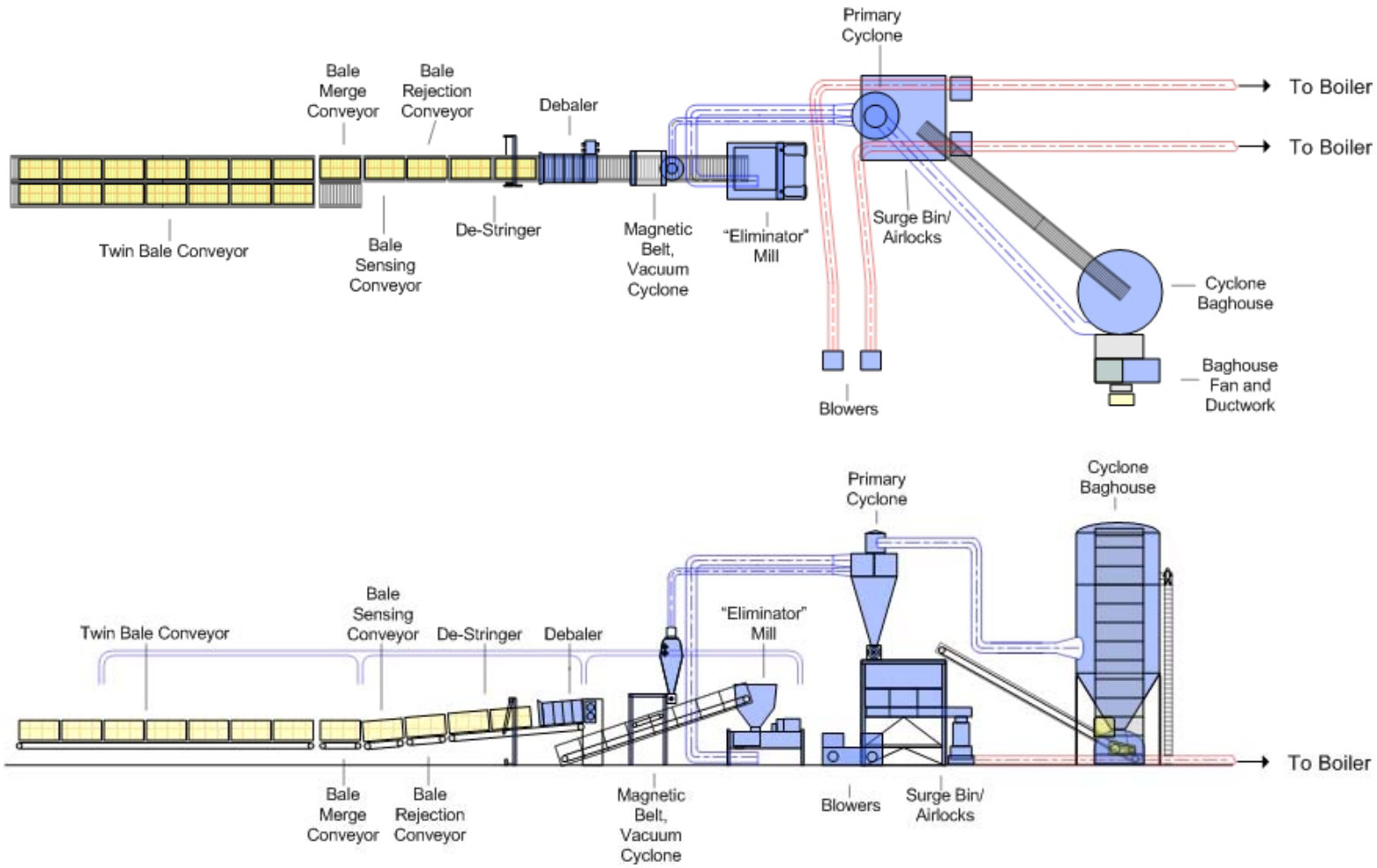
On-site Facilities at OGS

Processing & Fuel Delivery

Replacing up to 5% of this . . . .

with this . . . .

Processing System at OGS



Front End of Processing System . . .

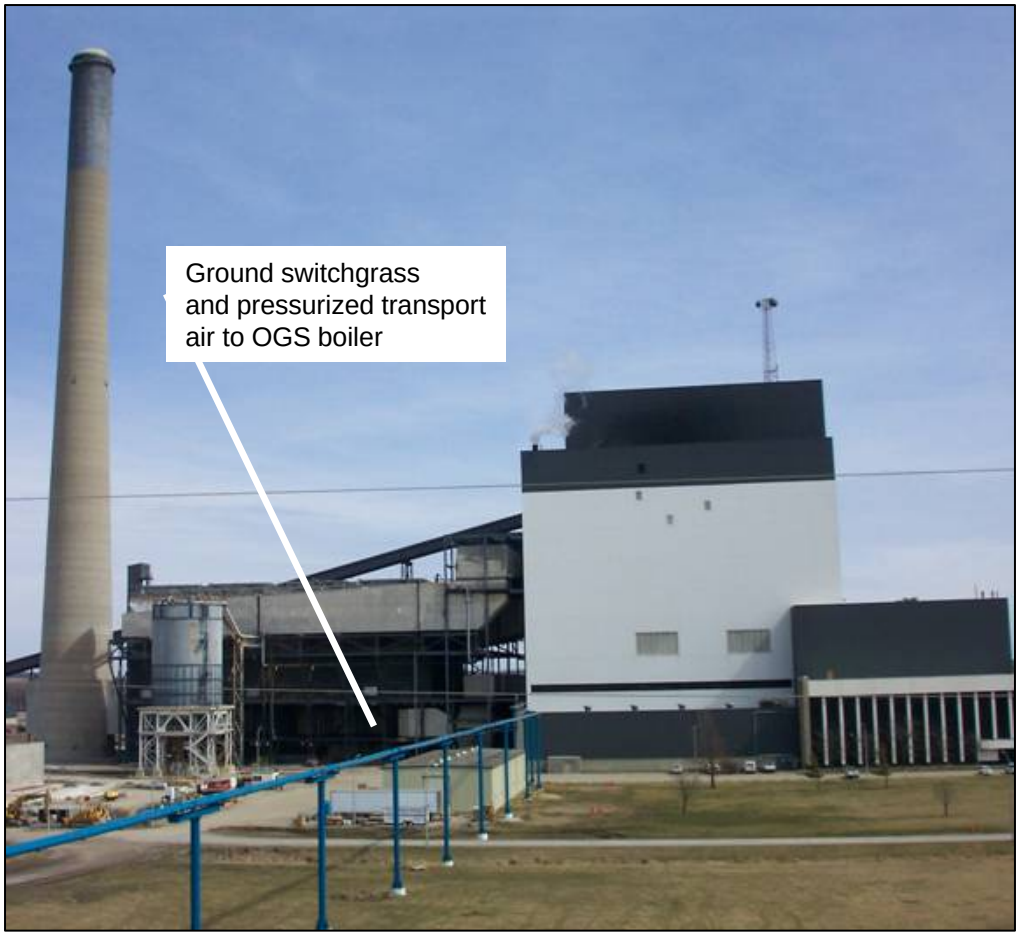
- Teleboom loading
- Automated bale handling
  - **Moisture, weight, reject, de-string, debale, metal removal, mill, blow, burn**

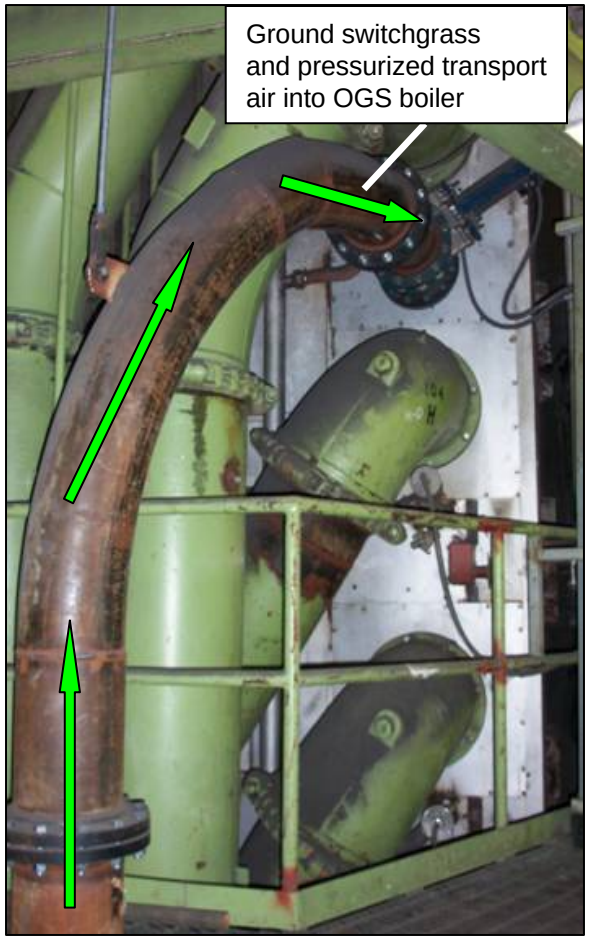
Back End of Processing System . . .

- 2-stage milling process to reduce particle size
- Final product fed into 2 blow lines to boiler

- High-efficiency cyclone and baghouse for dust control and filtering
- Emissions test last week

Pneumatic Transport to Boiler





Switchgrass blow lines transporting ground switchgrass into boiler house (left) and boiler (right).

Summary of Accomplishments

- Delivered, processed, and burned 31,568 bales of locally grown switchgrass, totaling 15,647 tons.
- Generated 19,607,000 kWhs of electricity from switchgrass--enough to provide 100% of the electricity needs for an entire year for over 1,874 average Iowa homes.
- Set a world record for electricity generation from switchgrass.
- Processed and burned switchgrass as fuel at OGS for more than 1,675 hours from mid-February mid-May, 2006.
- Processing hours per day improved significantly from the beginning of the test burn, with the facility operating without downtime nearly continuously throughout the past month of the test burn.
- Reduced emissions of sulfur dioxide (SO2) from OGS by about 62 tons.
- Reduced emissions of carbon dioxide (CO2) by a total estimated amount over 50,800 tons through reductions at the power plant, carbon neutral biomass fuel, and through sequestration on local farms.

Summary of Accomplishments

- Generated about 626 tons of fly ash which has been approved for sale from the power plant for use in concrete and other valuable byproducts.
- Demonstrated that the processing system designed, installed, and operated by the project team throughout the test burn can be operated reliably at and above its designed process rate of 12.5 tons per hour, especially if the switchgrass delivered to the facility contains moisture contents of 12% and under. The average moisture content of switchgrass burned throughout the test burn has been about 13%.
- Average processing rate throughout the test burn was about 10 tons/hr.
- Maximum sustained feed rate was above 16 tons/hr.
- Replaced about 12,060 tons of coal purchased from Wyoming with switchgrass that was planted, grown, harvested, stored, delivered, and processed by local Iowa farmers.
- Generated 19,607 Renewable Energy Credits (RECs) that have received independent third-party certification under Environmental Resource Trust's EcoPower program.

Summary of Accomplishments

- All permits in place for commercial operation.
- Resulted in development in new equipment for baling, bale handling, twine removal, debaling and secondary milling.
- Fly ash approved by Iowa DOT for use in concrete for cofiring rates up to 5% heat input from switchgrass.

Process Equipment Development

Debaler Hammers 30,000 t/set
Screens 8,000 t/set

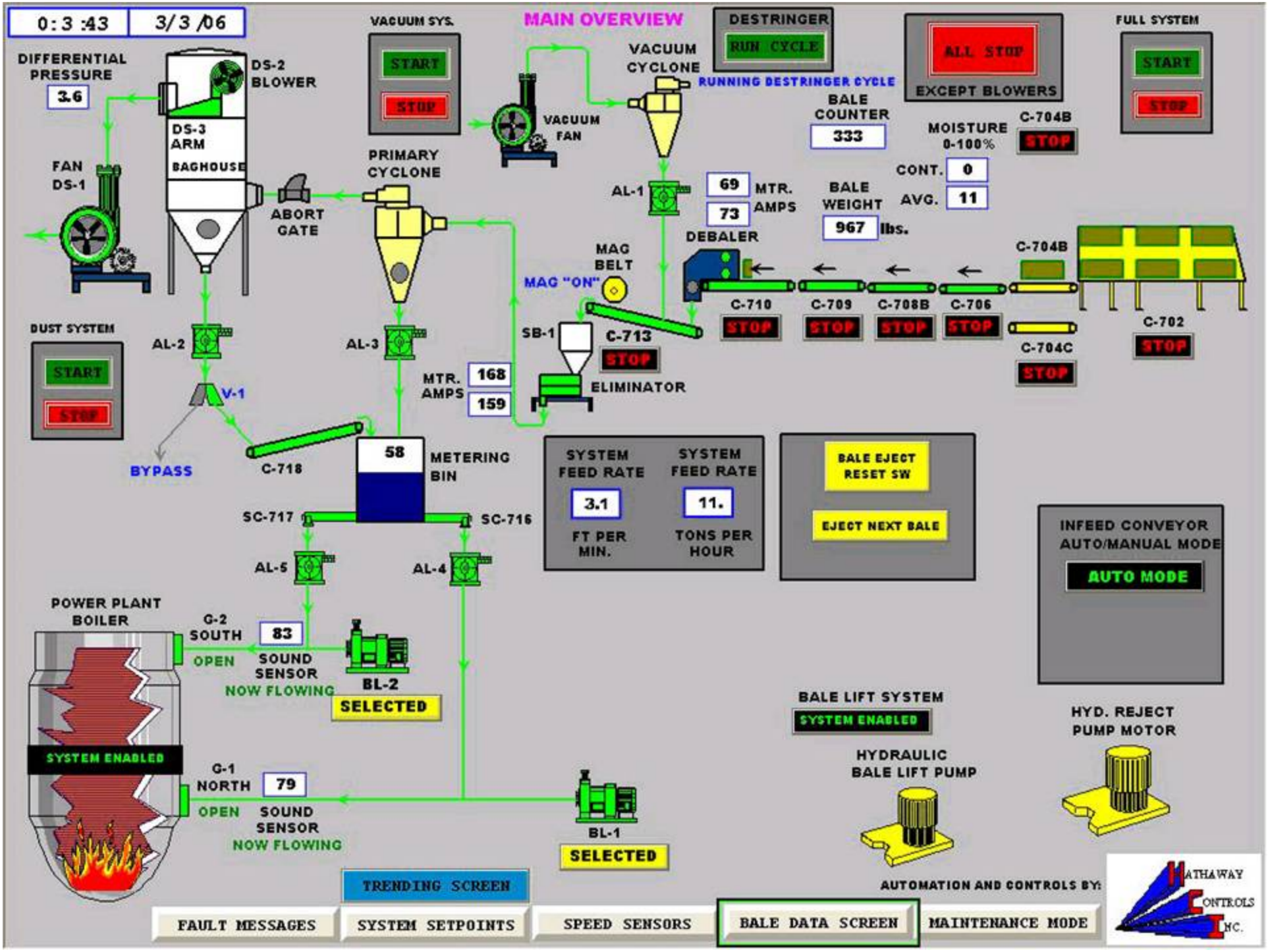
Steffen Systems 2 t Bale Hooks

Attrition hammers 7,000 t/set

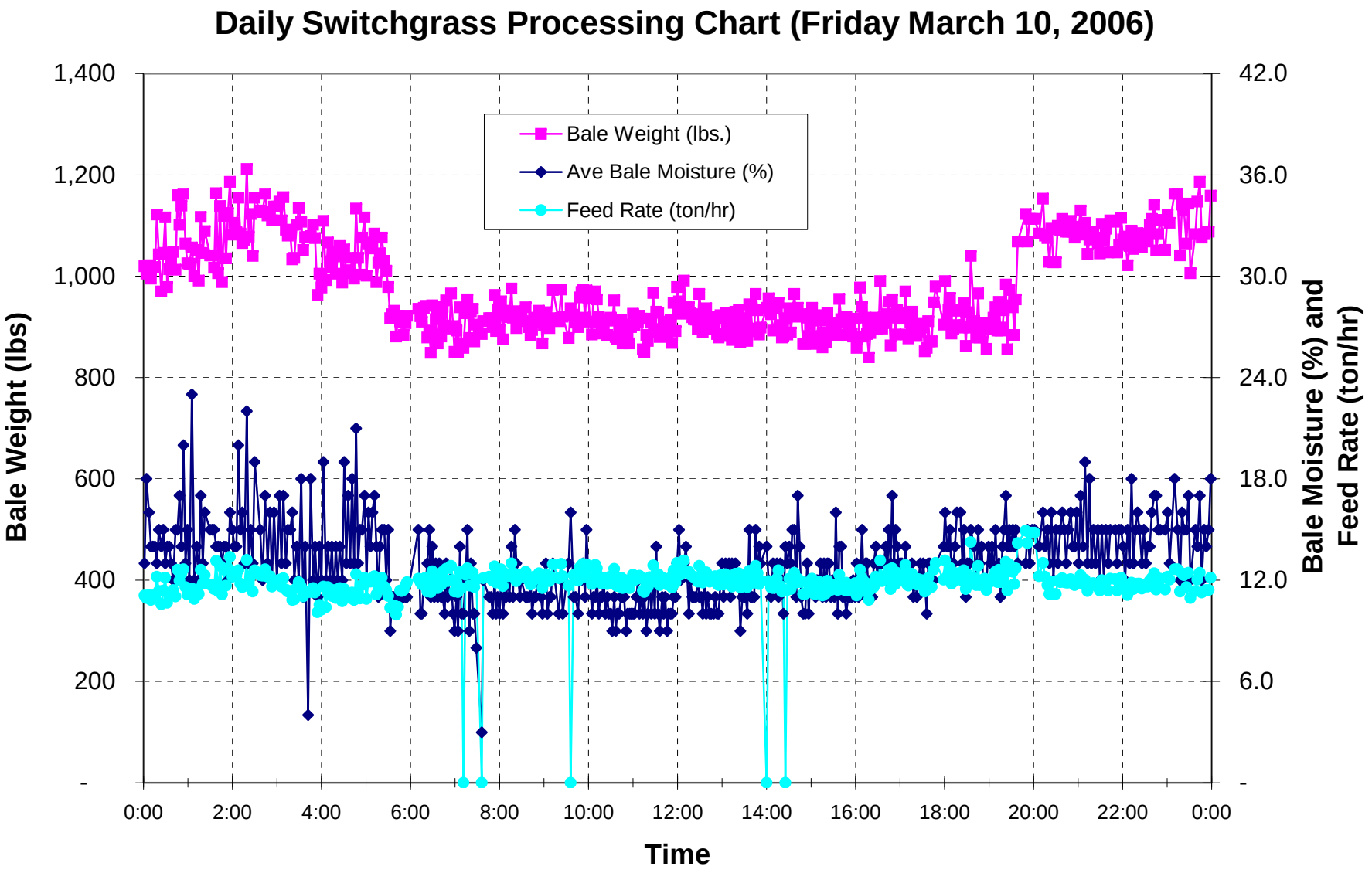
400hp De-baler 12tph, 2in screen, Warren & Baerg

Control System Monitoring

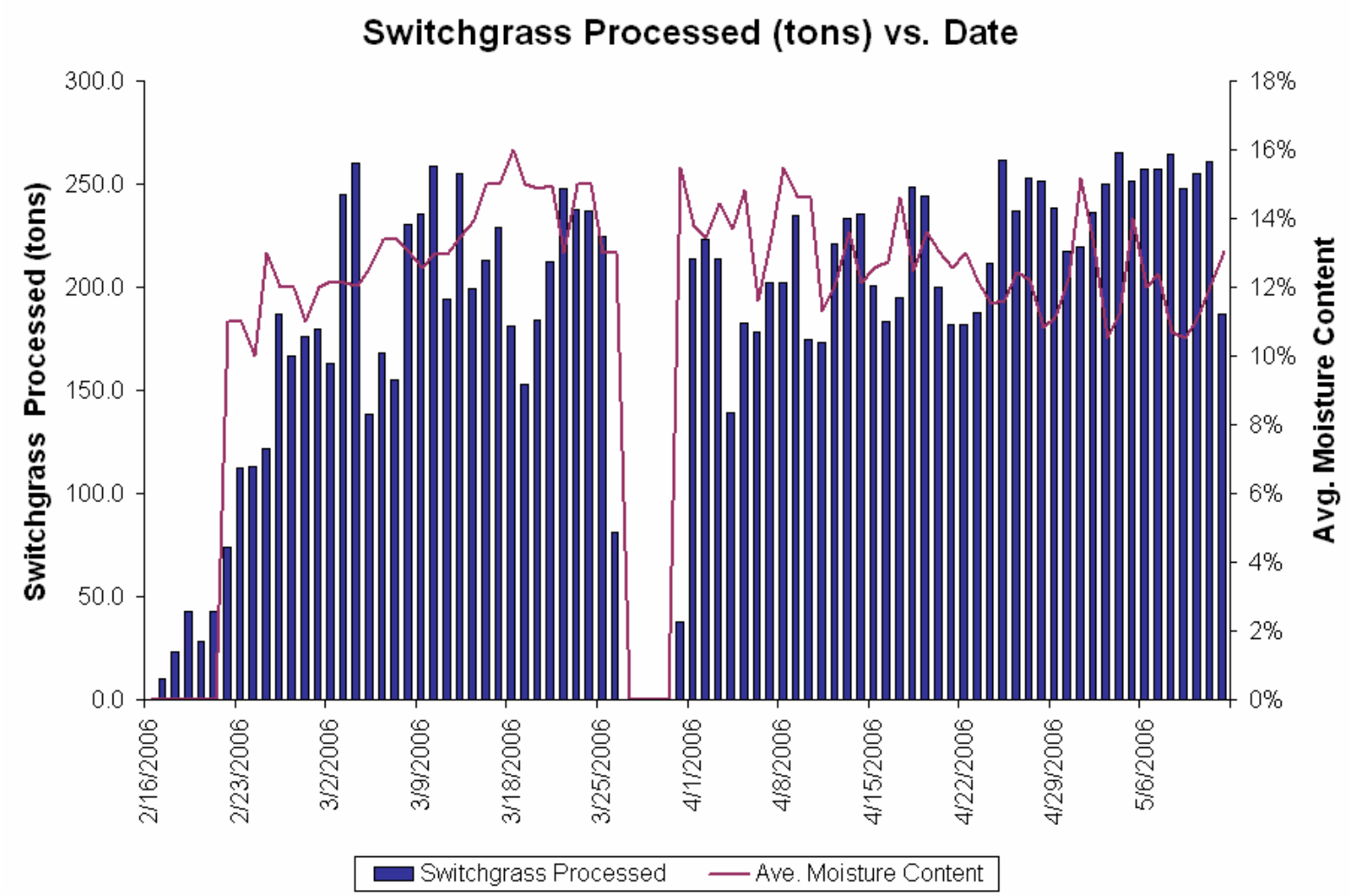
- Parameters monitored throughout test burn:
  - At the “Grass Station” (Processing Facility):
    - Bale moisture, counts, feed rate, and weight
    - Power consumption (whole facility, each mill motor)
    - Default messages on all process equipment
    - Detailed trucking logs
  - At OGS:
    - Emissions
    - Fuel & air flows
    - Heat rate
    - Test “coupons” installed in boiler for corrosion, slagging, & fouling investigations


0:3 :43
3/3 /06
MAIN OVERVIEW
VACUUM SYS.
START
STOP
DESTRINGER
RUN CYCLE
RUNNING DESTRINGER CYCLE
ALL STOP
EXCEPT BLOWERS
FULL SYSTEM
START
STOP
DIFFERENTIAL PRESSURE
3.6
DS-2 BLOWER
DS-3 ARM BAGHOUSE
VACUUM FAN
VACUUM CYCLONE
BALE COUNTER
333
MOISTURE 0-100%
C-704B
STOP
CONT.
0
AVG.
11
FAN DS-1
ABORT GATE
PRIMARY CYCLONE
AL-1
69
73
MTR. AMPS
BALE WEIGHT
967
lbs.
DEBALER
MAG BELT
MAG "ON"
C-704B
C-710
C-709
C-708B
C-706
C-702
STOP
DUST SYSTEM
START
STOP
AL-2
AL-3
SB-1
C-713
STOP
ELIMINATOR
C-704C
STOP
V-1
MTR. AMPS
168
159
BYPASS
C-718
58
METERING BIN
SYSTEM FEED RATE
3.1
FT PER MIN.
SYSTEM FEED RATE
11.
TONS PER HOUR
BALE EJECT RESET SW
EJECT NEXT BALE
INFEED CONVEYOR AUTO/MANUAL MODE
AUTO MODE
SC-717
SC-716
AL-5
AL-4
POWER PLANT BOILER
G-2 SOUTH
83
OPEN
SOUND SENSOR
NOW FLOWING
BL-2
SELECTED
BALE LIFT SYSTEM
SYSTEM ENABLED
HYD. REJECT PUMP MOTOR
HYDRAULIC BALE LIFT PUMP
SYSTEM ENABLED
G-1 NORTH
79
OPEN
SOUND SENSOR
NOW FLOWING
BL-1
SELECTED
TRENDING SCREEN
AUTOMATION AND CONTROLS BY:
HATHAWAY CONTROLS INC.
FAULT MESSAGES
SYSTEM SETPOINTS
SPEED SENSORS
BALE DATA SCREEN
MAINTENANCE MODE

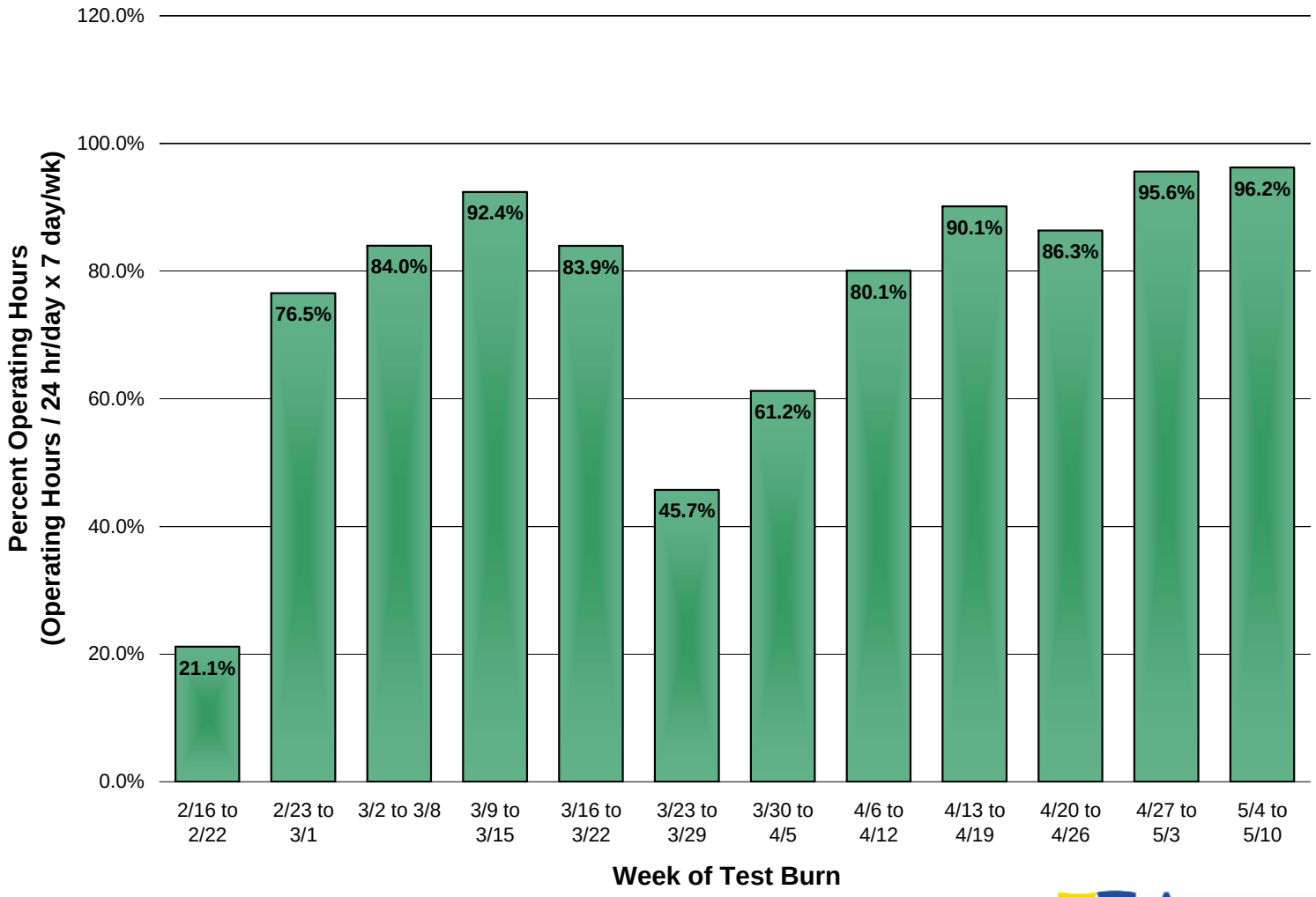
Sample Processing Day Profile



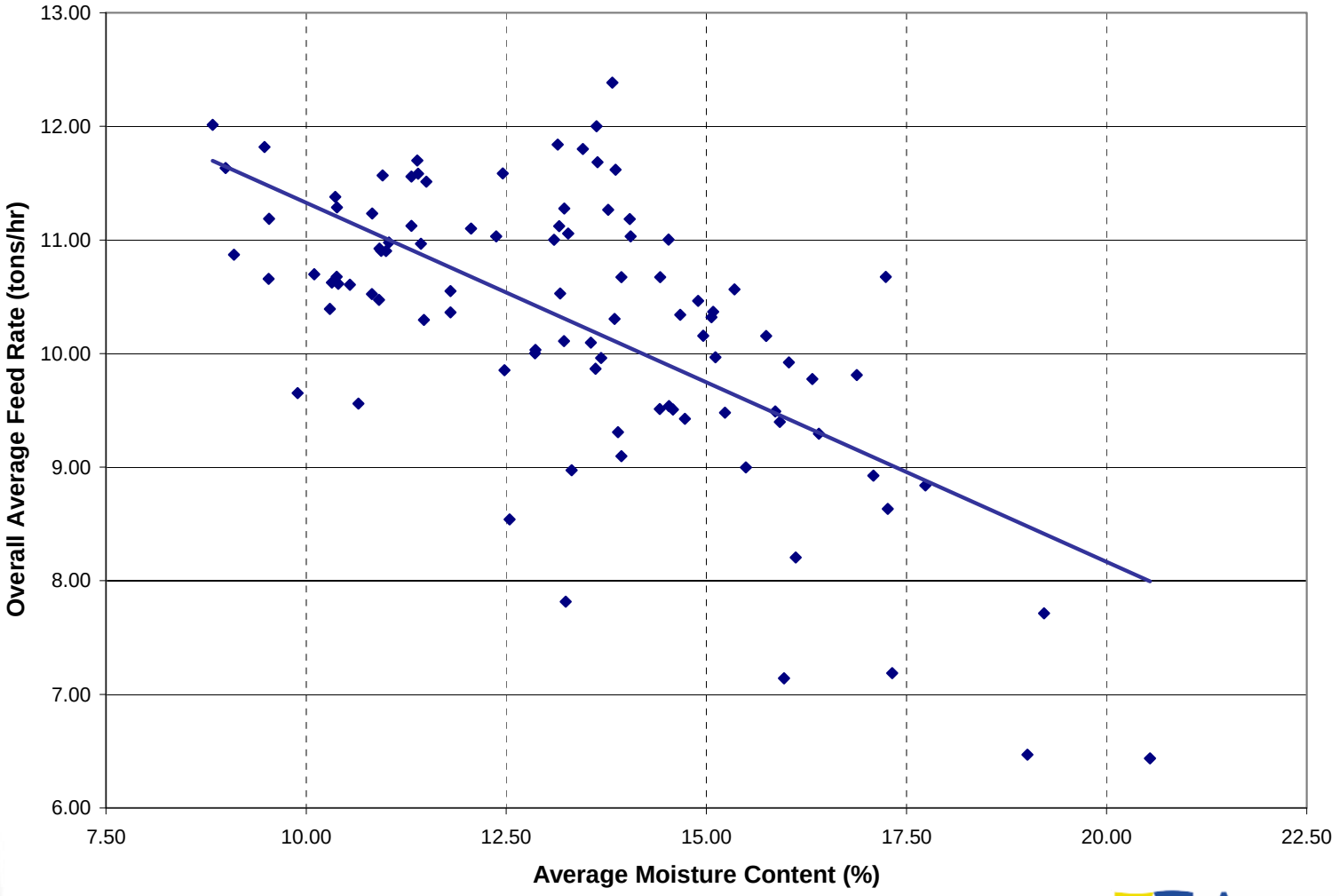
Daily Processing Profile



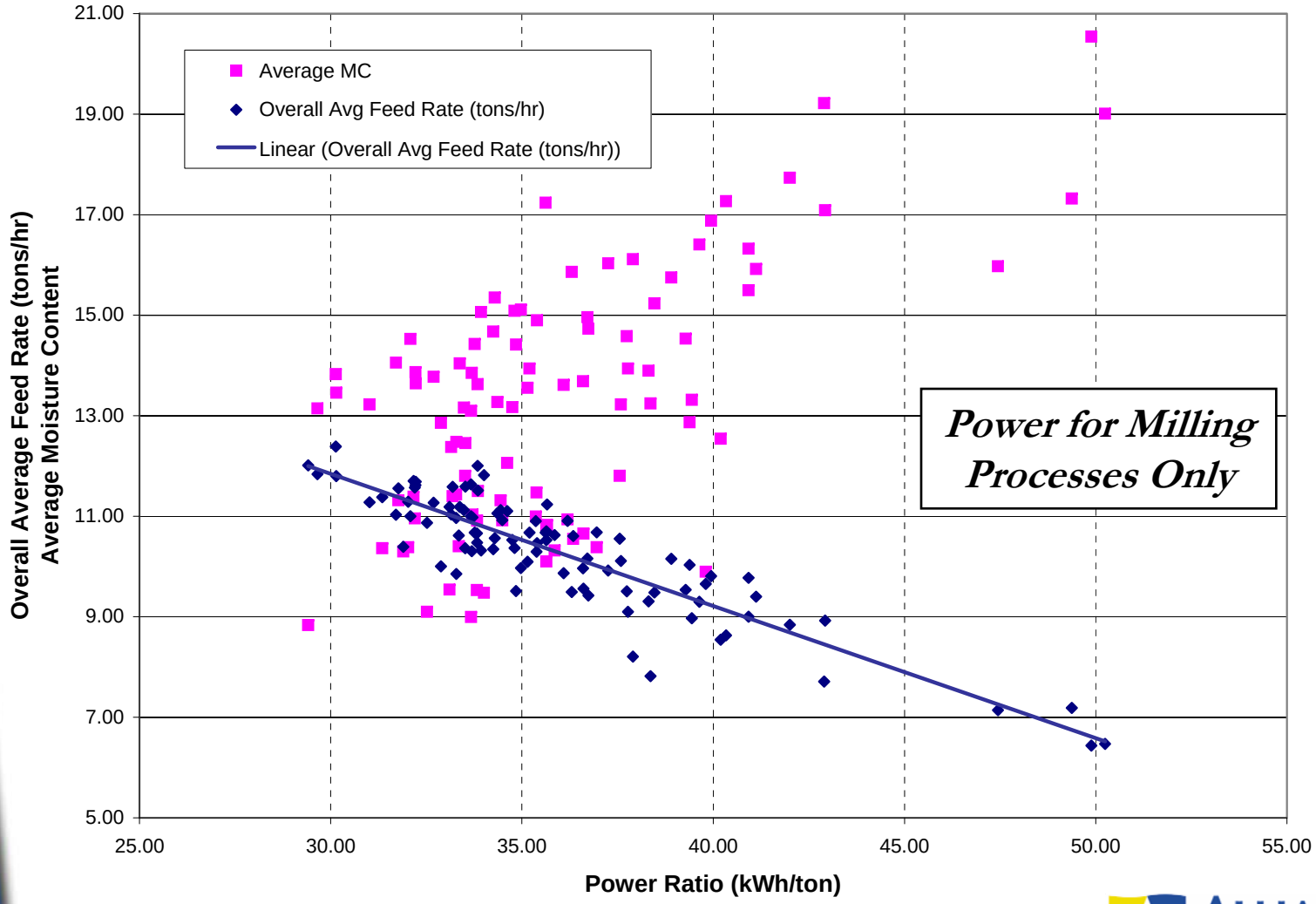
Processing System Availability



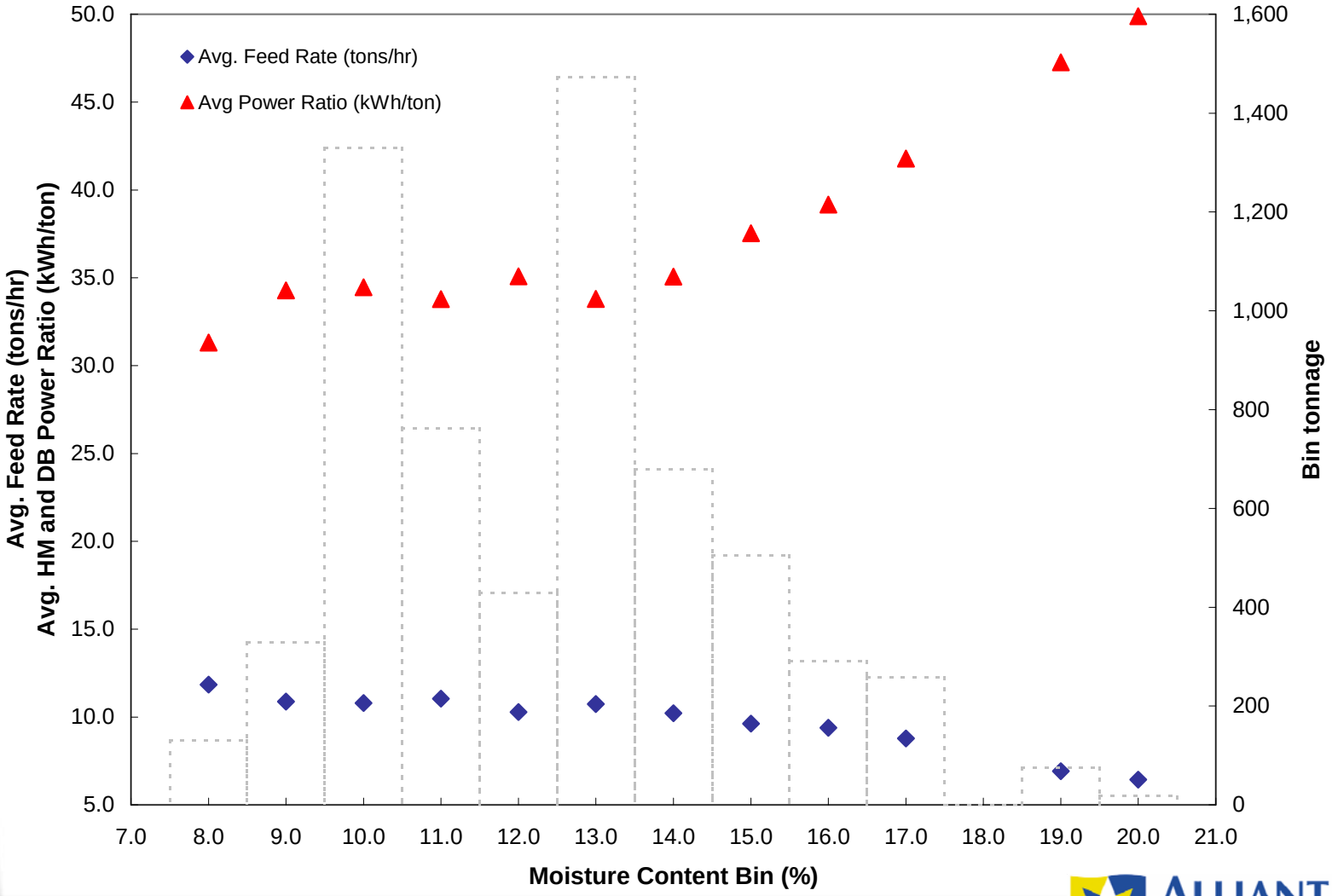
Moisture Content vs. Feed Rate



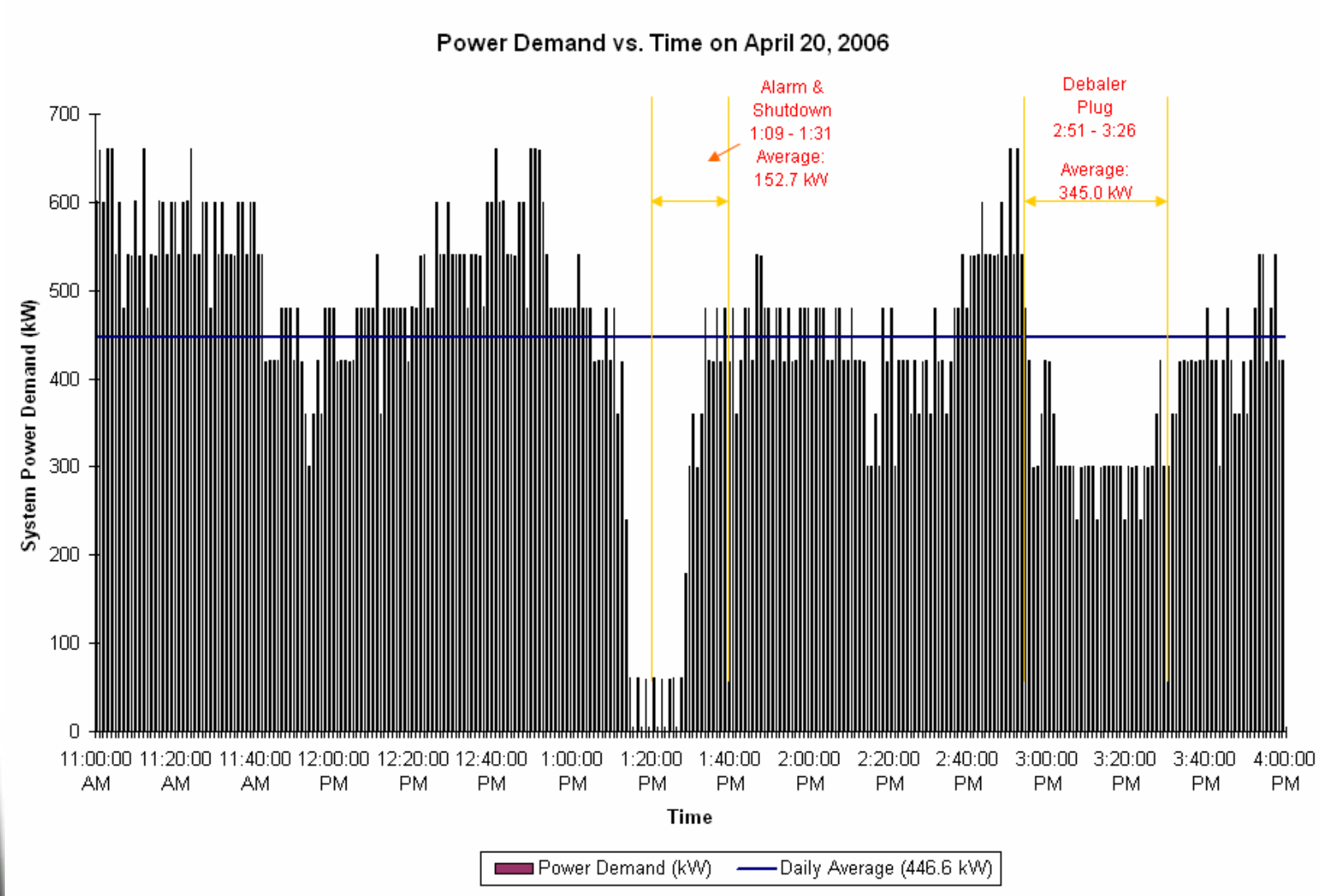
Feed Rate, Power, Moisture Content



Feed Rate, Power, Moisture Content



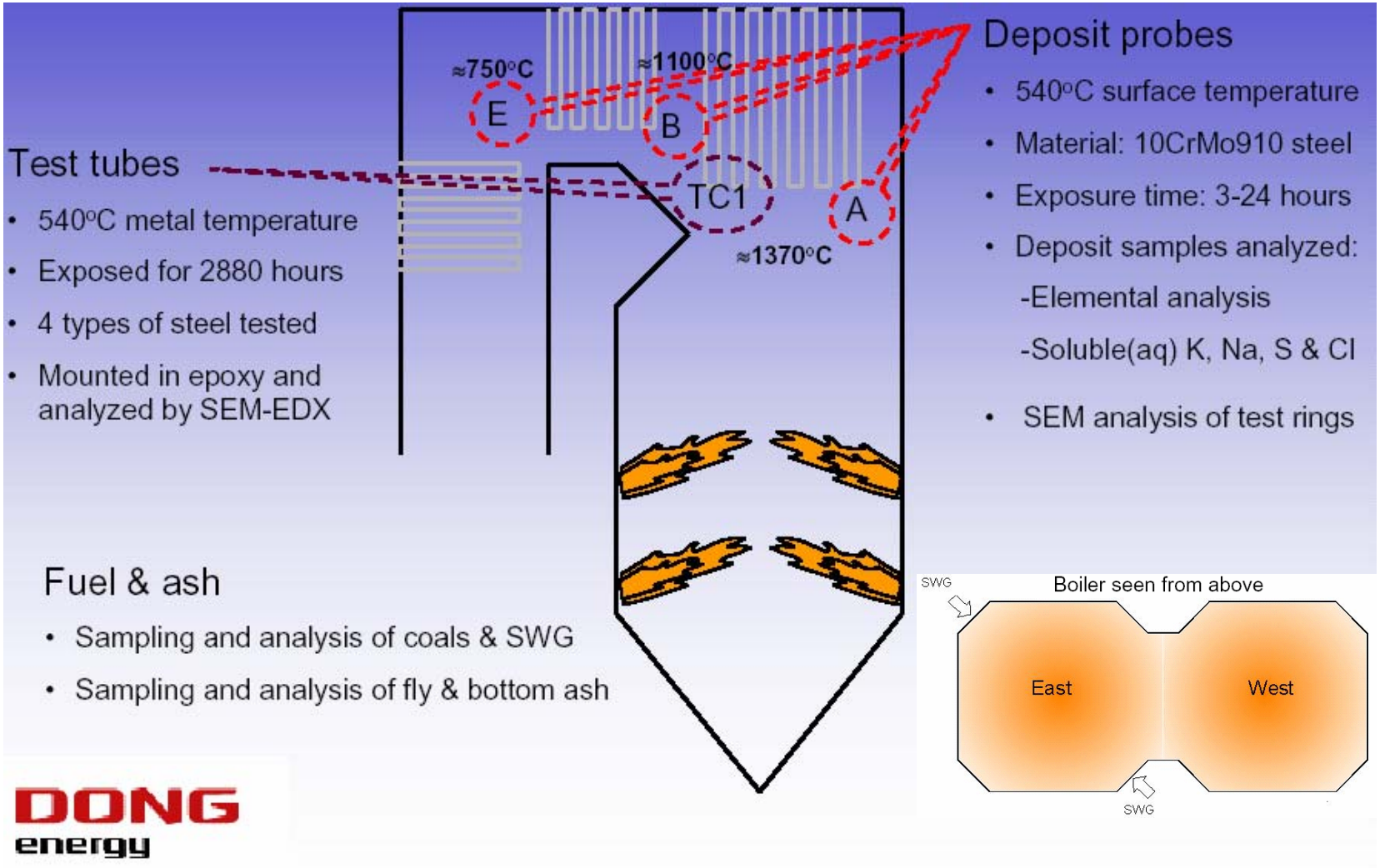
Daily Demand Profile (Entire Facility)



Summary of Impacts

- Emissions
  - Reduced SO2
  - Neutral on NOx
  - Reduced CO2
  - Neutral on CO (OGS has extremely low CO)
  - Increased Opacity (about 1 percentage point)
    - Required higher soda ash addition rates during test
- Other
  - Minimal Impact on Heat Rate (in the “noise”)
  - Some unburned biomass in bottom ash
  - No significant impact on LOI in fly ash
  - Bale moisture, weed content, package quality has large impact on processing achievable rates

Corrosion / Slagging Testing

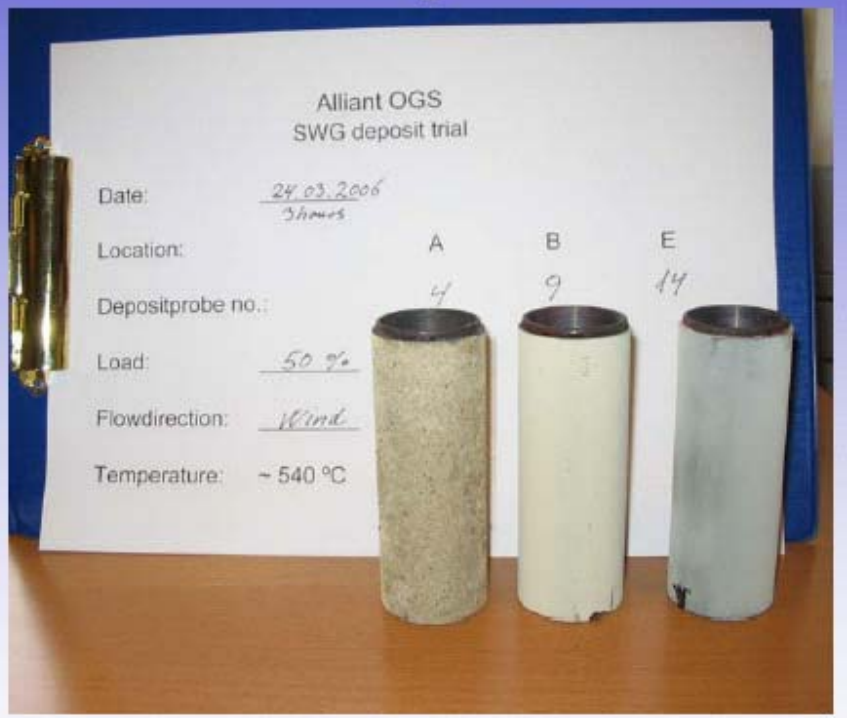


DONG energy

Example Probe Samples

SWG co-firing 100% load

SWG co-firing 50% load

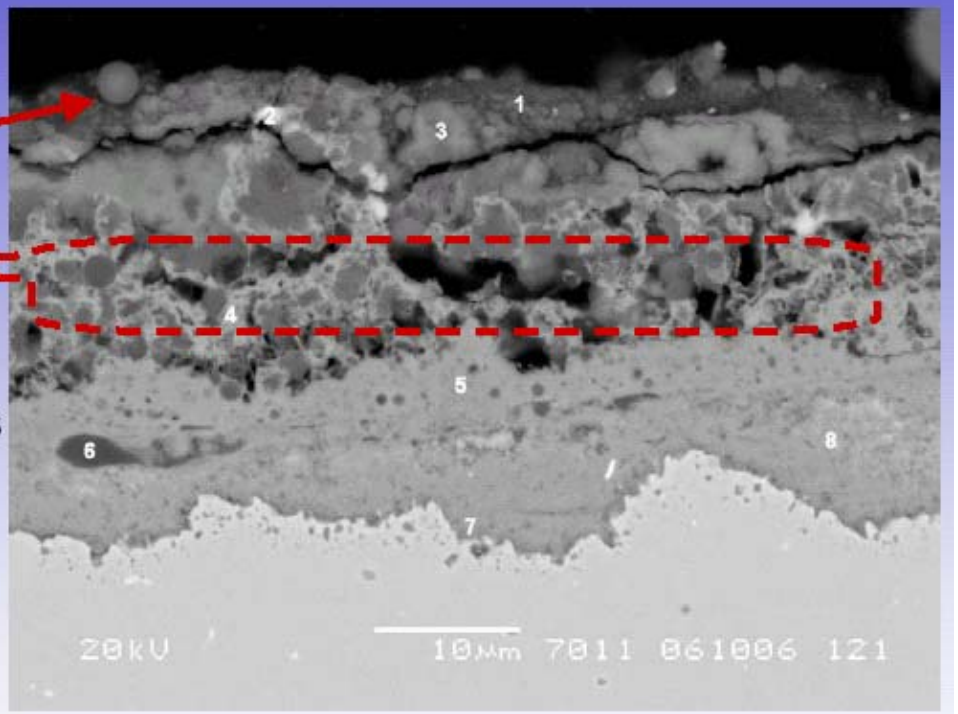


Corrosion Analysis Example

SEM-EDX results

- Al, Ca & Si rich particles
- Inner deposit rich in Ca & S
- Outer oxide layer (#4,5): Fe-oxides
- Inner oxide layer (#7,8): Fe,Cr,Ni-oxides
- No traces of chlorine!!

SEM image of test tube of 347H (pos. TC1)



Corrosion / Slagging Results To Date

- A 1675 hours co-firing test with up to 5%-weight SWG has been successfully completed at Ottumwa Generation Station
- The deposition investigation indicated that:
  - The deposition flux to the super/re-heaters was unaffected by co-firing
  - The chemical composition of the deposits was not significantly influenced
  - A marginal increase in the concentration of water-soluble potassium of the deposits and fly ash was observed
  - Generally, the effects of co-firing 5% SWG were low compared to that of variations in the coal composition

Corrosion / Slagging Results To Date

- The conducted corrosion studies indicated that SWG co-firing (up to 5%-weight) had virtually no influence on the corrosion behavior:
  - No evidence of chlorine-induced corrosion was observed
  - Only small amounts of potassium was found in the inner deposits
  - Sulfur played a dominating role in the corrosion mechanism. The sulfur input with SWG is negligible compared to that of the coals
  - No distinct difference in the corrosion resistance was observed between the four steel materials tested

Next Steps . . . . .

- Complete Analyses from Long Term Test Burn
  - Coal-only tube and deposit analysis
- Complete Final Technical Reports
  - Overall Test Burn Results and Project Economics
  - Corrosion / Slagging / Fouling
- Complete sale of Carbon Credits on Chicago Climate Exchange
- Attempt to negotiate agreements for burning remaining switchgrass inventory and beginning commercial operation