REINHOLD ENVIRONMENTAL Ltd.

2014 NOx-Combustion Round Table & Expo Presentations

February 10 & 11, 2014, in Charlotte, NC / Hosted by Duke Energy

O&M Issues
Startup, Shutdown & Cycling Loads

Tony Licata – Licata Energy

2014 NOx-Combustion/PCUG Conference

Panel

- *Tony Licata, Licata Energy*
- *Cindy Khalaf, Johnson Matthey*
- *Bill Medeiros, Babcock Power*
- *Mike O'Connor, Duke Energy*
- *Ed Healy, Southern Company*
- *Kyle Neidig, Hitachi*

EPA Requested Comments on Proposed New Rules Startup-Shutdown-Maintenance (SSM)

- Request published on 6/25/14 based on rules proposed 12/30/12
- Reopened comment period limited to 3 questions
- Institute of Clean Air Companies (ICAC) submitted comments on 8/26/13 addressing
  - SCRs & SNCR
  - ESPs
  - Baghouses
  - Wet and Dry FGD
  - DSI & carbon injection

EPA Request for Comments

- The use of a default electrical production rate value to calculate output-based emission limits during startup and shutdown hours where the electrical load is zero. Could startup be defined at coal-fired EGUs as occurring at 25% of nameplate capacity plus 3 hrs. or the start of electricity generation plus 6 hours, whichever comes first;
- The use of default diluent gas cap values during periods of startup and shutdown; and
- How to calculate startup/shutdown emissions when multiple affected EGUs share a common stack.

SCR O&M Issues Coal Fired Plants

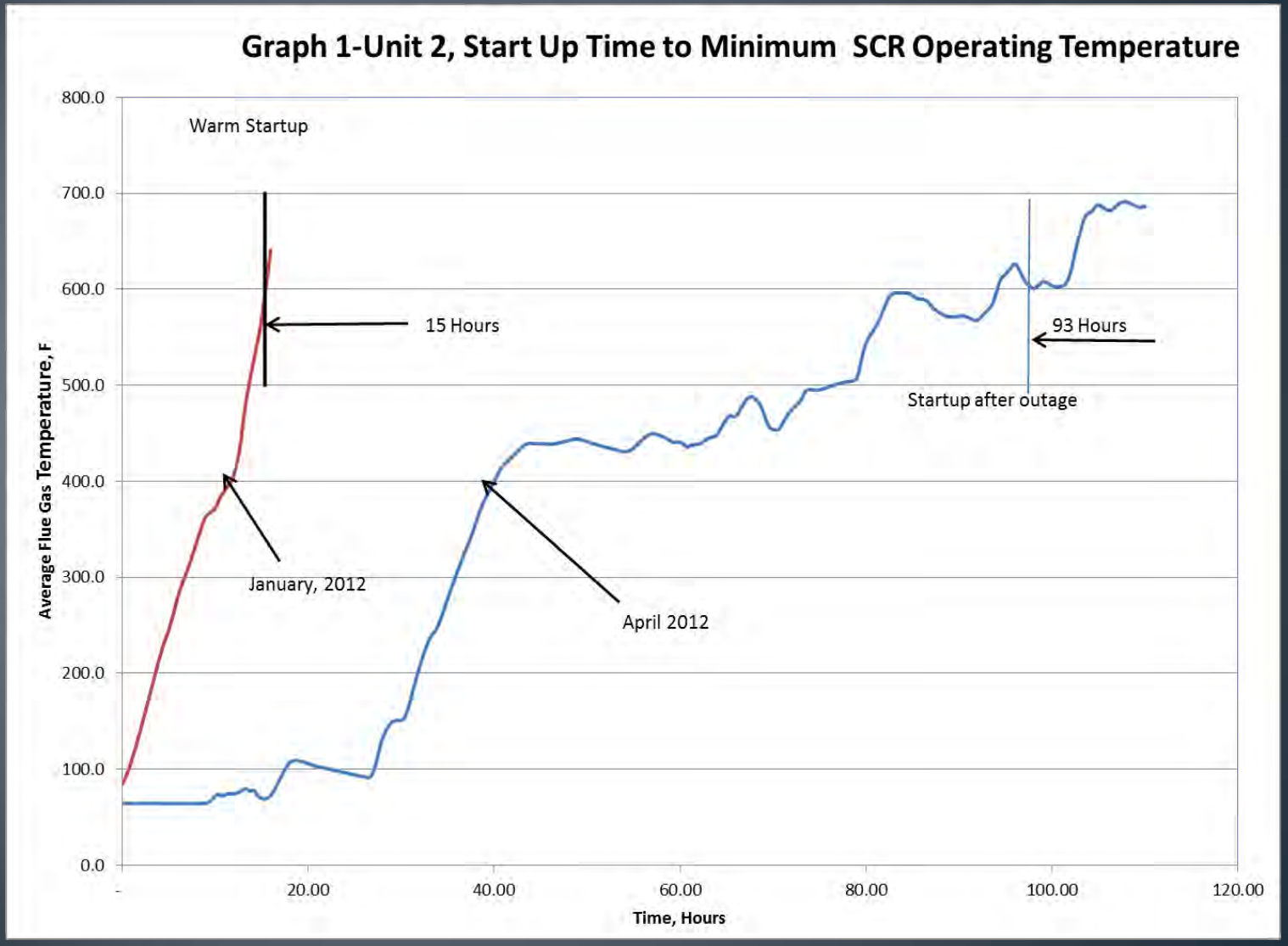
- Startup – Shutdown Rules
- Start averaging time using a default electrical production
  - 25% of nameplate capacity plus 3 hrs. or
  - the start of electricity generation plus 6 hrs., whichever comes first;

- Other Industry Challenges Cycling Loads
- "Green" Energy and gas price: coal plant cycling
- Low load operations
- Shutdowns: hours to a few days

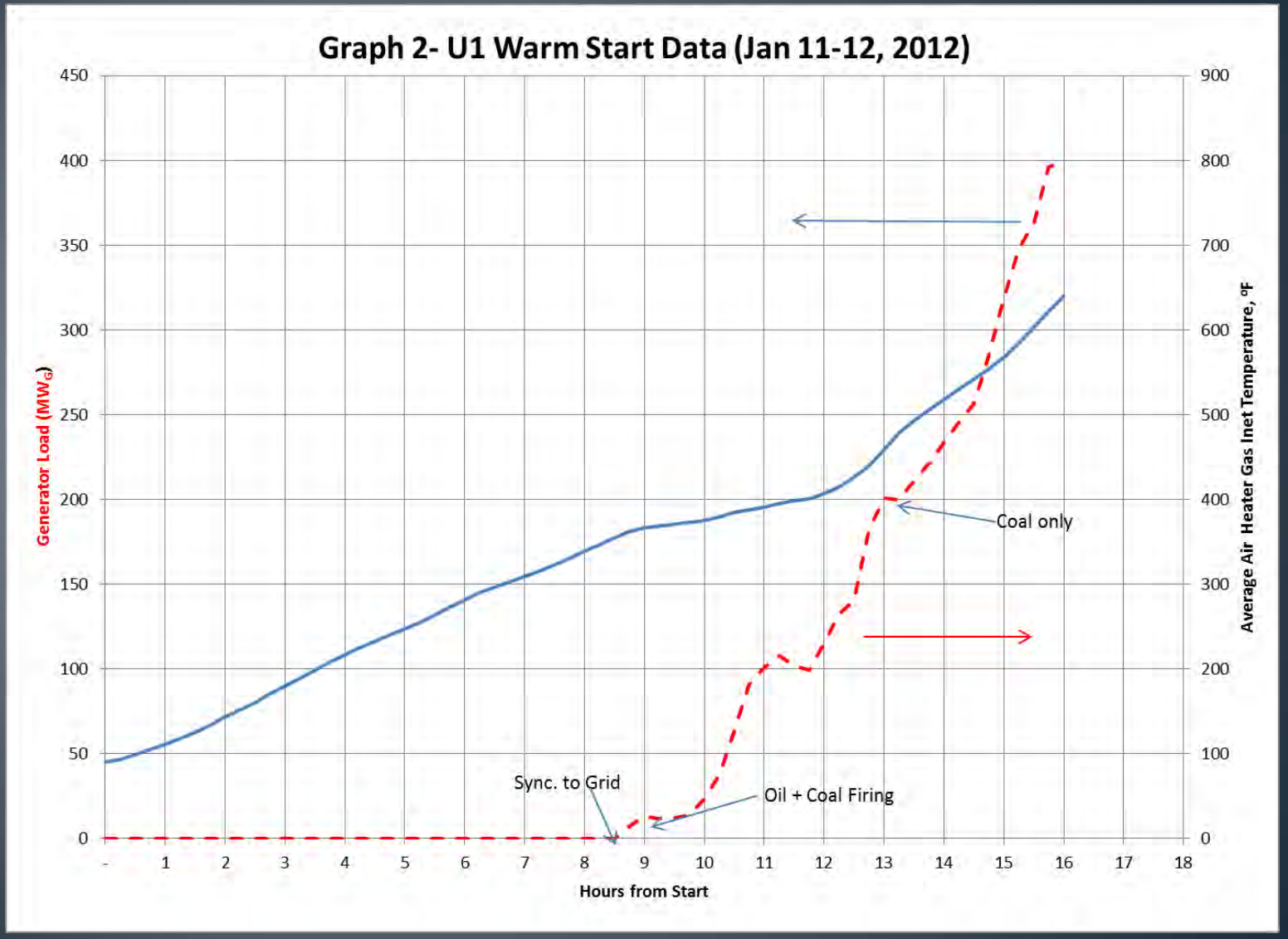
SCR Startup & Shutdown

- Startup - Shutdown Conditions
- Turn on ammonia ≈ 600 °F
  - Actual depends on fuel primarily sulfur
- SCRs are temperature driven – no relationship to MW generation

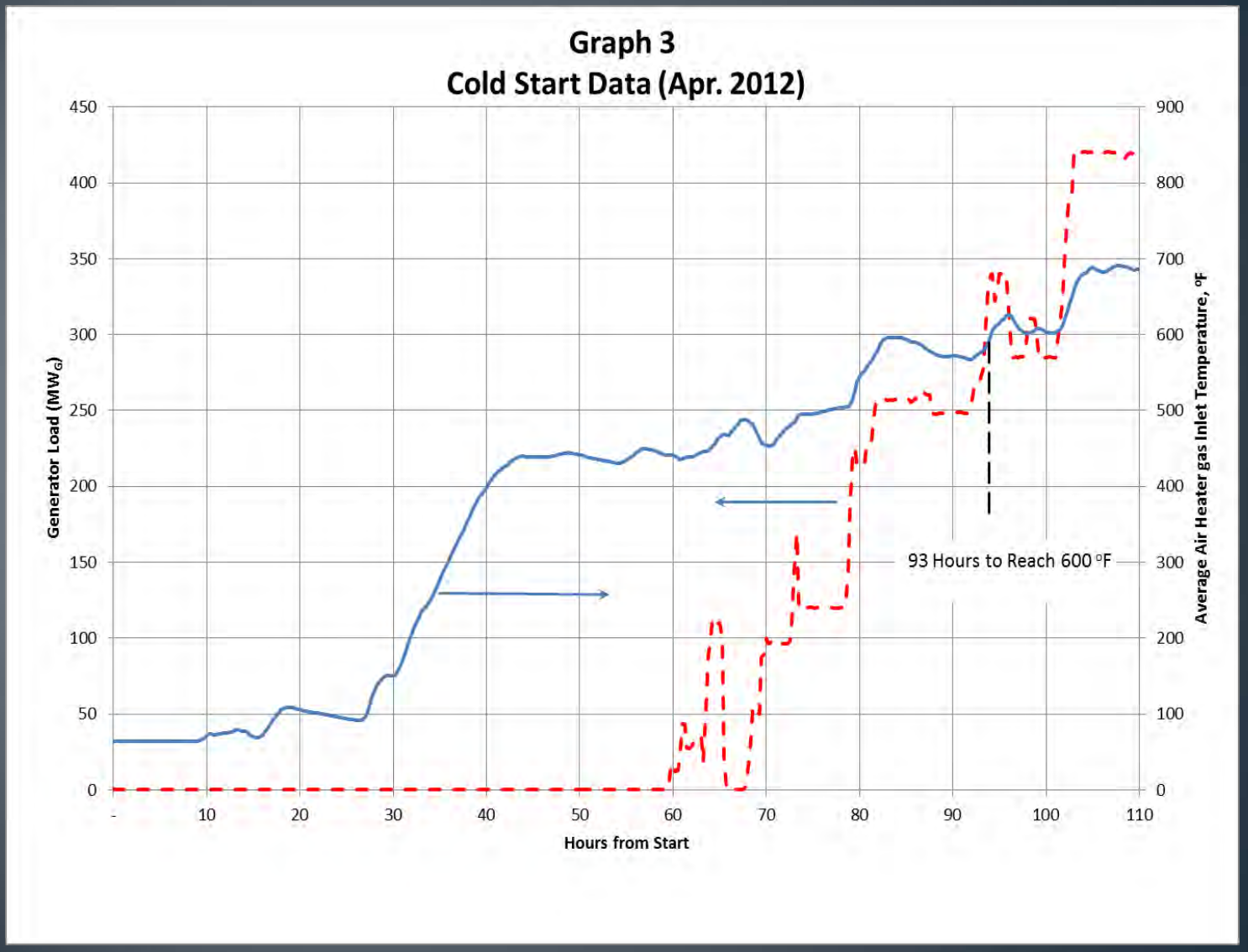
SCR Startup


Graph 1-Unit 2, Start Up Time to Minimum SCR Operating Temperature
Warm Startup
15 Hours
93 Hours
Startup after outage
January, 2012
April 2012
Average Flue Gas Temperature, F
Time, Hours
800.0
700.0
600.0
500.0
400.0
300.0
200.0
100.0
0.0
-
20.00
40.00
60.00
80.00
100.00
120.00

Warm Startup



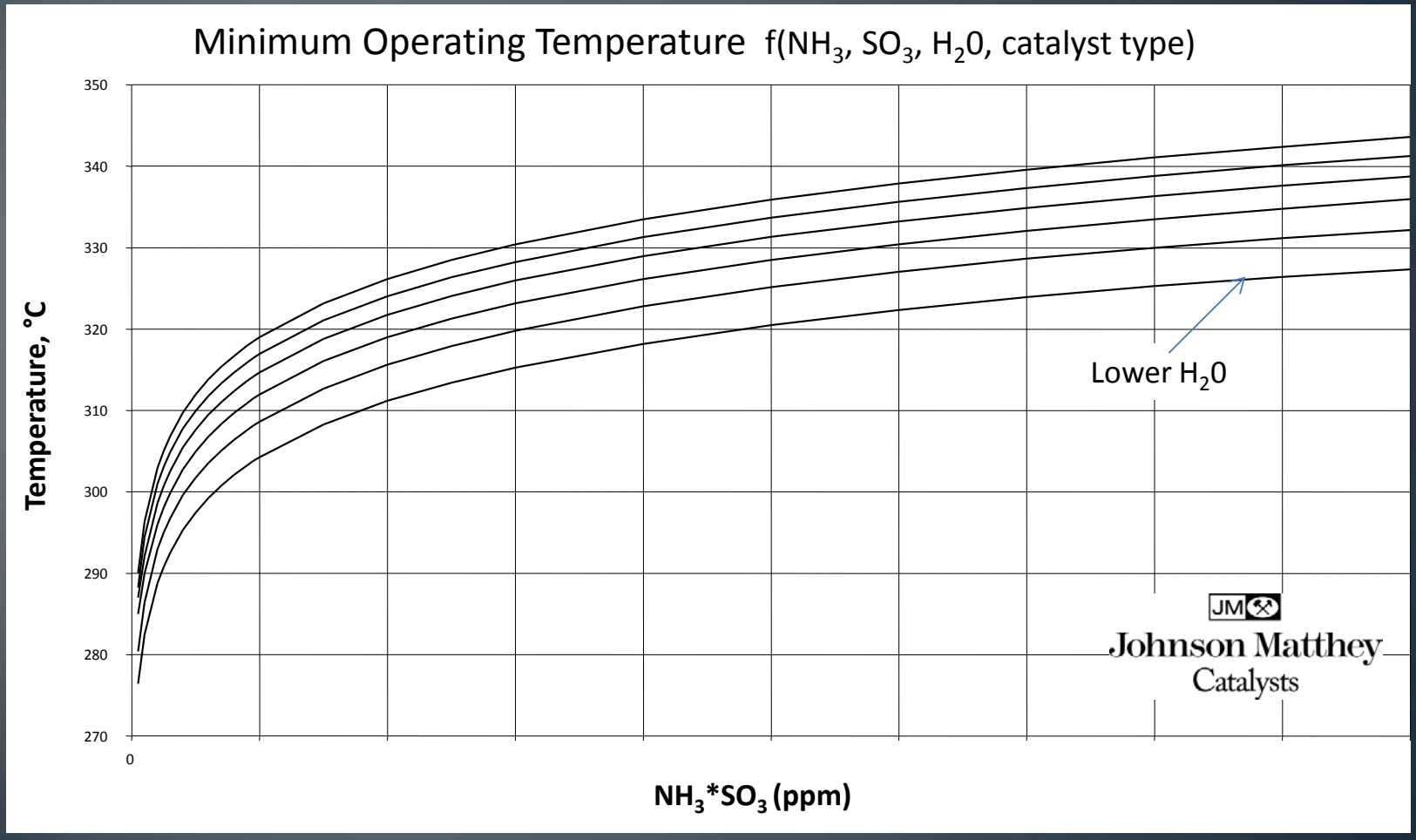
Cold Startup



ICAC Recommendations

- Boiler startup and shutdown are critical periods for the operations of APC Systems. Do not believe that there is a one set rule that can cover all the diverse designed power plants that exist today.
- Recommends a Work Practice Process for each plant to determine when startup and shutdown start the clock for compliance.
- Periods of operation, especially for boiler startup, characterized by rapid transient changes in flue gas composition, quantity, temperature, and moisture conditions.
- The problems are aggravated with installation of multiple APC equipment and processes, especially those required to achieve MATs compliance.

SCR Catalyst – Cindy Khalaf



Cycling Operations – Ed Healy

- Thermally Induced Failures
- Operating History
- Industry Experience – Audience Participation

Start Up and Shutdown Rules on SCR Operation

Reinhold Conference
Charlotte, NC
February 10, 2014

William Medeiros
Riley Power Inc.

Riley Power
a Babcock Power Inc. company

Extended Range

- Start up unit without using SCR bypass
- Increase removal at full load
  - Better distribution
  - More frequent tuning
  - Frequent cleaning
    - Catalyst
    - Airheater
  - Closer monitoring of slip
  - Operate at higher slip value
    - DSI injection ahead of airheater
- Evaluation of catalyst minimum operating temperature (calculated vs actual operating)
  - Permanent temperature grid
  - Actual total catalyst potential

Extended Range

- Start up below minimum operating temperature for limited times
- SNCR operation at low load
- DSI to remove SO_3 ahead of SCR
- Extending load with start up fuel

Startup and Shutdown

SCR Operation

Reinhold NOx Conference 2014

February 11, 2014

Kyle Neidig

MITSUBISHI HITACHI POWER SYSTEMS AMERICA – ENERGY AND ENVIRONMENT, LTD.

MIT and MOT at Startup and Shutdown

MIT – Minimum NH3 Injection Temperature
MOT – Minimum Continuous Operating Temperature
Both are Functions of ABS Formation Temperature

Best Case Scenario

- Very Low SO3 at SCR Inlet
- Low SCR Inlet NOx
- Lower DeNOx Removal Efficiency

MIT = 530-540 F
MOT = 560-570 F

Worst Case Scenario

- Very High SO3 at SCR Inlet
- High SCR Inlet NOx
- Higher DeNOx Removal Efficiency (90+%)

MIT = 615-625 F
MOT = 650-660 F

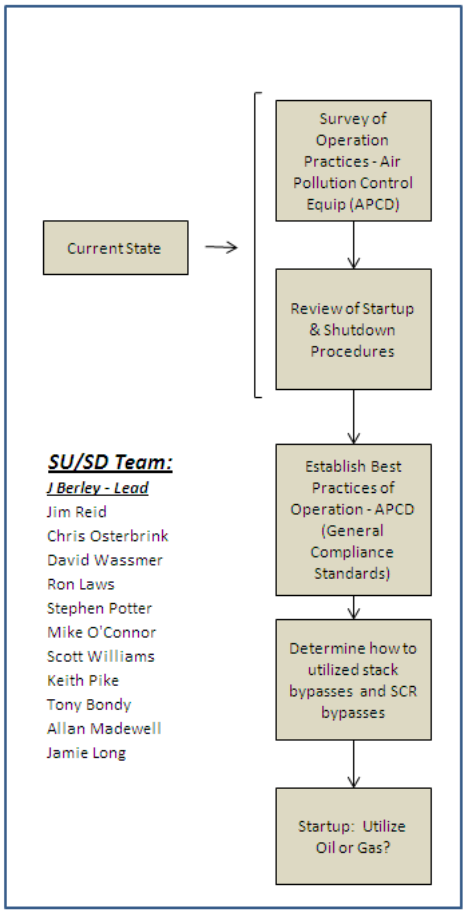
Hitachi Rules for MIT and MOT

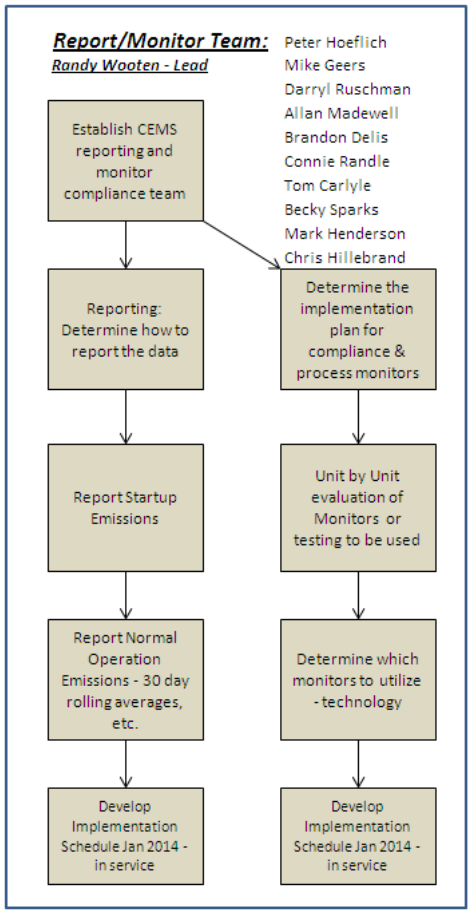
- ***Never Inject NH3 Below MIT***
- Startup – Start Injection at MIT Only if Temp Will Soon Reach MOT Otherwise, Wait for MOT
- Shutdown – Turn Off NH3 When Temp Falls Below MOT

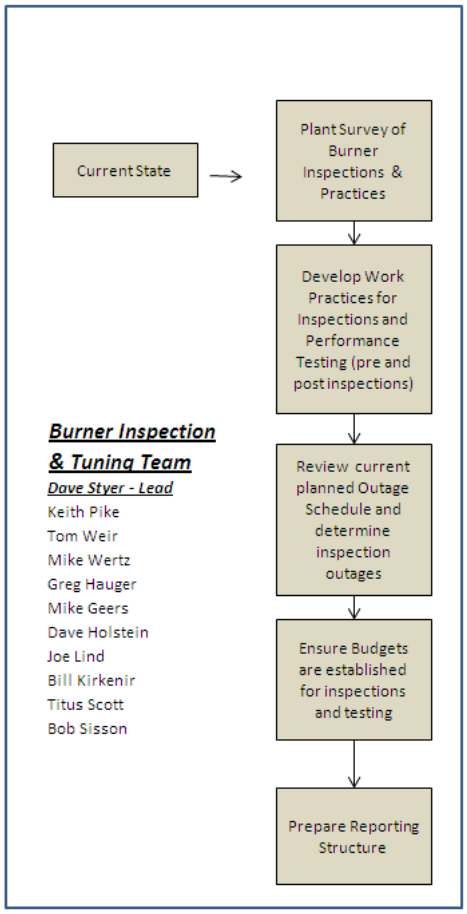
The Acceptable Operational Range for Each SCR is Different
Low Temperature Operation has Potential to Damage Catalyst

Work Practice Standards Teams

Steering Team: Harry Sideris, Brent Dueitt, Randy Wooten, John Burney, J Berley







Work Practice Standards – Why do we have these?

- Instead of measuring and controlling for organic compounds, **Boiler Work Practice Standards** are required:
  - Boiler tuning for combustion optimization
  - Burner inspection for combustion equipment reliability and performance

- Instead of regulating emissions during **Startup and Shutdown** (SU/SD), emissions are exempt from the rolling average calculation during defined startup windows.

- **MATS Reconsideration** is still 'outstanding' impacting Monitoring and SU/SD. Duke filed comments on 8/26/2013. Final Reconsideration ruling not expected before the end of 1st Qtr 2014.

Boiler Work Practice Standards

The Work Practice Standard Rule outlines nine (9) specific requirements for the organics:

1. *Inspect the burner* ***(at least once every 36* months) *48 months if neural net optimizer is employed. Clean or replace any components of burner as necessary within 3 months of the inspection.***

2. ***Inspect the flame pattern***
   - *Make any adjustments to the burner necessary to optimize the flame pattern*
   - *Adjustment should be consistent with the manufacturer's specifications*

3. ***Observe damper operations as a function of mill or feeder loadings***
   - *Make adjustments and effect repairs to dampers, pulverizers, controls, etc.*

4. ***Evaluate windbox pressures and air proportions***
   - *Make adjustments and effect repair to dampers, actuators, controls, and sensors.*

Boiler Work Practice Standards

5. ***Inspect the system controlling the air-to-fuel ratio***
   - *Ensure that it is correctly calibrated and functioning properly*

6. ***Optimize combustion to minimize generation of CO and NO_X***
   - *Consistent with the manufacturer's specifications*
   - *Includes burners, overfire air, and add-on controls such as* ***SCR and SNCR***

7. **Measure the concentration in the effluent stream of CO, NO_X, and O_2 - Measure before and after adjustments are made (measurements may be either on a dry or wet basis, as long as it is the same basis before and after the adjustments are made)**

8. ***Maintain and submit if requested, an annual report detailing this information, within 60 days after completion of the performance tests/tuning:***
   - *CO, NOX, and O2 measurements before and after tuning*
   - *Description of corrective actions taken*
   - *Type and amount of fuel used in the prior 12 months*

9. ***Report the dates of the initial and subsequent tune-ups in hard copy and electronically***

SU/SD Work Practice Standards

TABLE 3 TO SUBPART UUUUU OF PART 63—WORK PRACTICE STANDARDS
[As stated in §§ 63.9991, you must comply with the following applicable work practice standards]

You must operate all CMS during startup. Startup means either the first-ever firing of fuel in a boiler for the purpose of producing electricity, or the firing of fuel in a boiler after a shutdown event for any purpose. Startup ends when any of the steam from the boiler is used to generate electricity for sale over the grid or for any other purpose (including on site use). For startup of a unit, you must use clean fuels, either natural gas or distillate oil or a combination of clean fuels for ignition. Once you convert to firing coal, residual oil, or solid oil-derived fuel, you must engage all of the applicable control technologies except dry scrubber and SCR. You must start your dry scrubber and SCR systems, if present, appropriately to comply with relevant standards applicable during normal operation. You must comply with all applicable emissions limits at all times except for periods that meet the definitions of startup and shutdown in this subpart. You must keep records during periods of startup. You must provide reports concerning activities and periods of startup, as specified in § 63.10011(g) and § 63.10021(h) and (i).

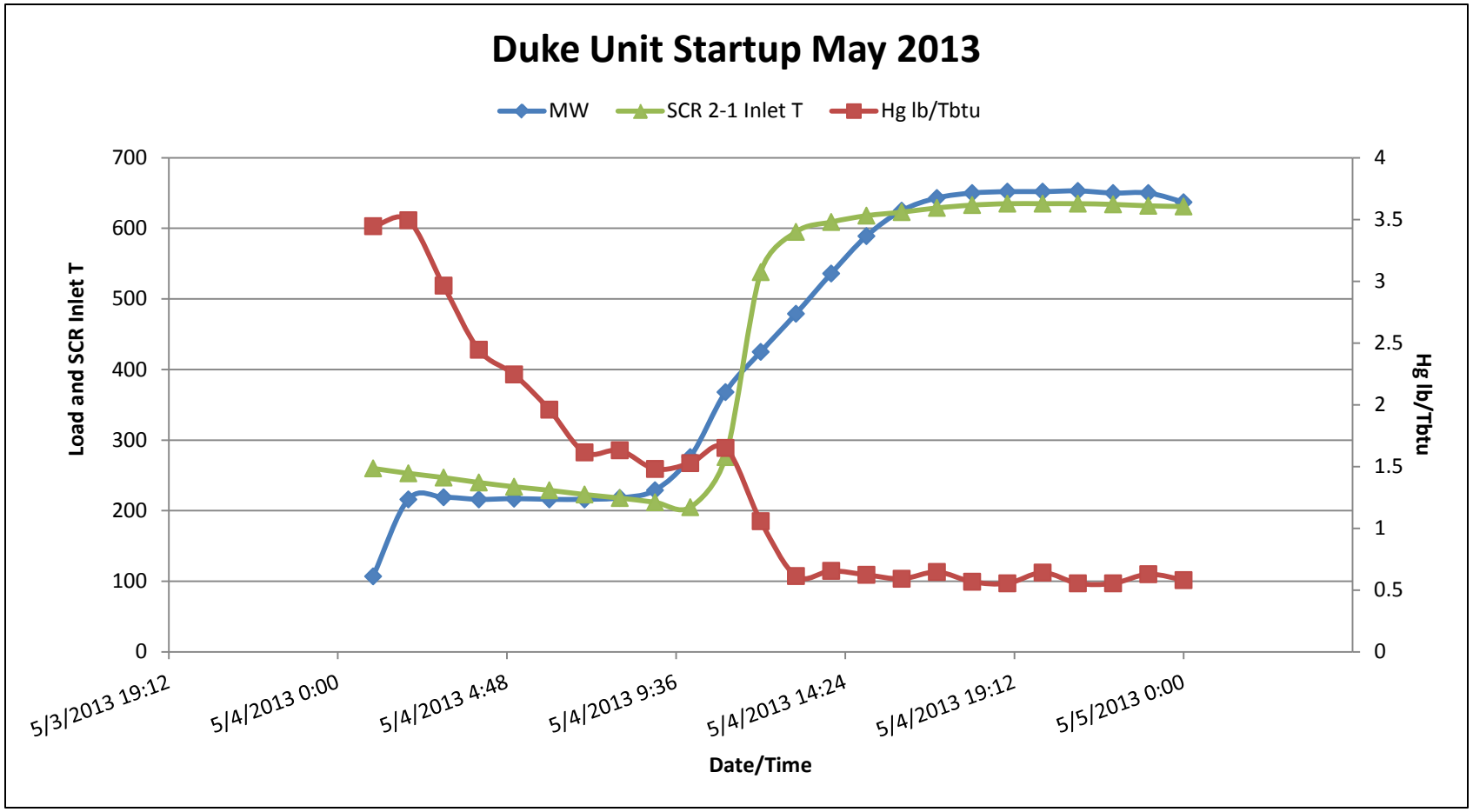
SU/SD Work Practice Standards

Know what it means for your equipment to be 'in service' - draft

- Selective Catalytic Reduction (SCR) systems shall be placed into service when the minimum flue gas temperature is reached. Minimum temperatures are determined based on boiler design, catalyst design, and coal characteristics. They will vary based on some parameters such as coal sulfur content. Minimum SCR inlet gas temperature guidelines shall be documented for each unit such as in the boiler operating procedures or other plant procedures. The SCR may be physically bypassed up to the point the minimum inlet temperature is meet. However, after the flue gas reaches the minimum temperature, the SCR shall be aligned with all the boiler flue gas, and the bypass dampers shall be closed. After the SCR flue gas inlet reaches minimum temperature, the reagent flow shall be initiated and the SCR considered operational.

Duke Current Plans

- Put SCR into gas path prior to or when flue gas temperature reaches minimum operating temperature.
- Many Duke Units do not have SCR bypass dampers so are in gas path all the times.
- Several Duke Units blanking off bypass dampers to better control NOx.
- Duke plans to put SCR in service earlier to minimize Mercury emissions.


Duke Unit Startup May 2013
MW
SCR 2-1 Inlet T
Hg lb/Tbtu
Load and SCR Inlet T
Hg lb/Tbtu
Date/Time
700
600
500
400
300
200
100
0
4
3.5
3
2.5
2
1.5
1
0.5
0
5/3/2013 19:12
5/4/2013 0:00
5/4/2013 4:48
5/4/2013 9:36
5/4/2013 14:24
5/4/2013 19:12
5/5/2013 0:00

Duke Current Plans

- Duke is awaiting final clarification on the start-up window and when it “ends.”
- Waiting for EPA response to submitted comments.
- Duke has drafted a set of guidelines for all the Plants to ensure compliance with the Rule.

SU/SD Work Practice Standards

What you should know as System Owners

- Know your emissions compliance requirement and the average duration
- Any one hour average data will calculate into the rolling average
  (even if only one hour makes up the daily average)
- Ending startup with limited operational hours before the end of the boiler operating day (one hour average can make a boiler operating day) may unfavorably impact the 30 day average.
- Operating staff shall be aware or the current 30/90 day average
- Know what value will be falling out of the average and understand the impact to the average.
- Determine a maximum emission target for the day to ensure compliance
- Determine a predicted end of day rolling average

SU/SD Work Practice Standards

What you should know

§ 63.10000 What are my general requirements for complying with this subpart?

(a) You must be in compliance with the emission limits and operating limits in this subpart. These limits apply to you at all times except during periods of startup and shutdown; however, for coal-fired, liquid oil-fired, or solid oil- derived fuel-fired EGUs, you are required to meet the work practice requirements in Table 3 to this subpart during periods of startup or shutdown.

(b) At all times you must operate and maintain any affected source, including associated air pollution control equipment and monitoring equipment, in a manner consistent with safety and good air pollution control practices for minimizing emissions.

SU/SD Work Practice Standards

Moving Forward

- Continue bench marking with peer utilities (UARG HAPS Committee meeting in Washington, DC and Fossil Networking Group)
- Stations system owners education for SU/SD requirements and controllable parameters though User's Group (Nov 2013)
- Update MATS WPS document with final reconsideration ruling (1st quarter 2014)
- Develop final reporting requirements formats (work through AIR MANAGEMENT 2nd quarter 2014)
- Annual reporting activities is responsibility of station personnel and submittal by Environmental Coordinators

Questions & Answer Time