SNCR Systems to Minimize Emissions

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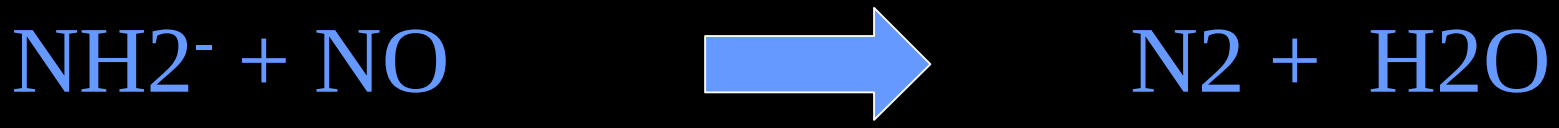
The Basic Process

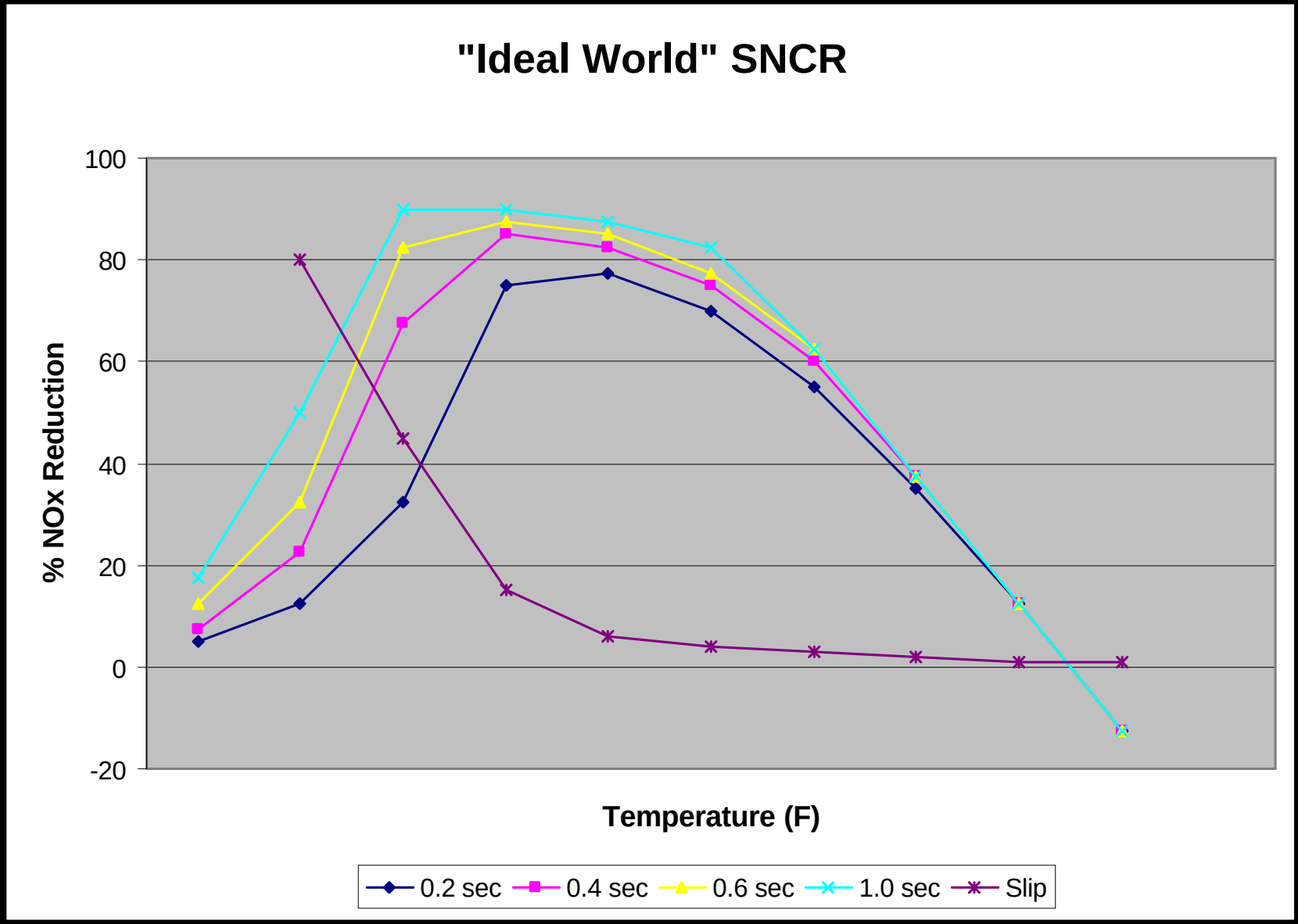
- SNCR is a gas phase reaction between ammonia radicals and NO to form N2 and water in the absence of a catalyst.



- Strong Temperature Dependence
- Requires Presence of Oxygen

The Perfect World

- In laboratory conditions (insulated tubular reactor with perfect mixing and unlimited residence time), NOx reduction greater than 90% has been demonstrated.
- Ideal Conditions – Temperature of 1800F, Residence time greater than 0.5 seconds, Well Mixed.

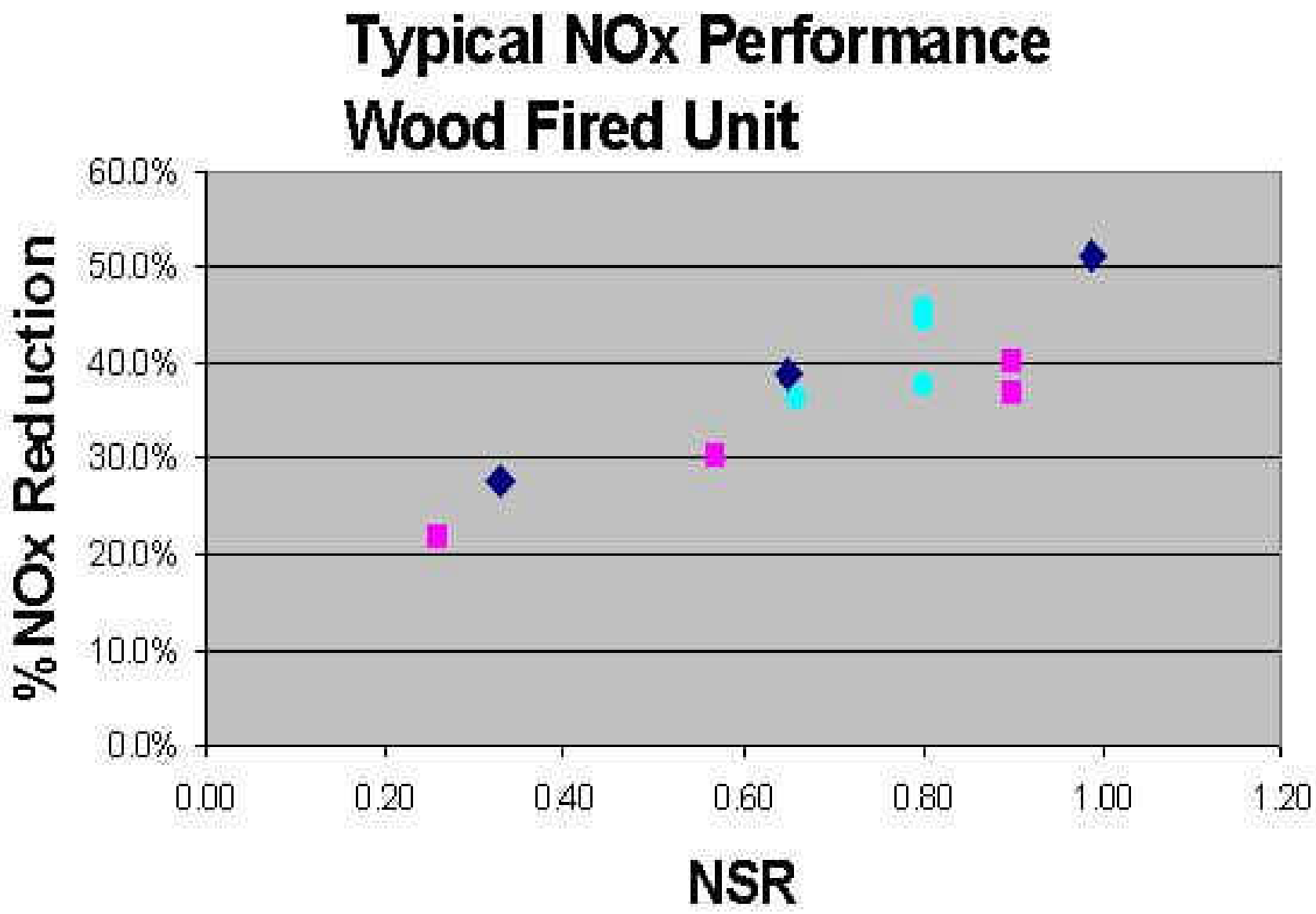

"Ideal World" SNCR
% NOx Reduction
100
80
60
40
20
0
-20
Temperature (F)
0.2 sec
0.4 sec
0.6 sec
1.0 sec
Slip

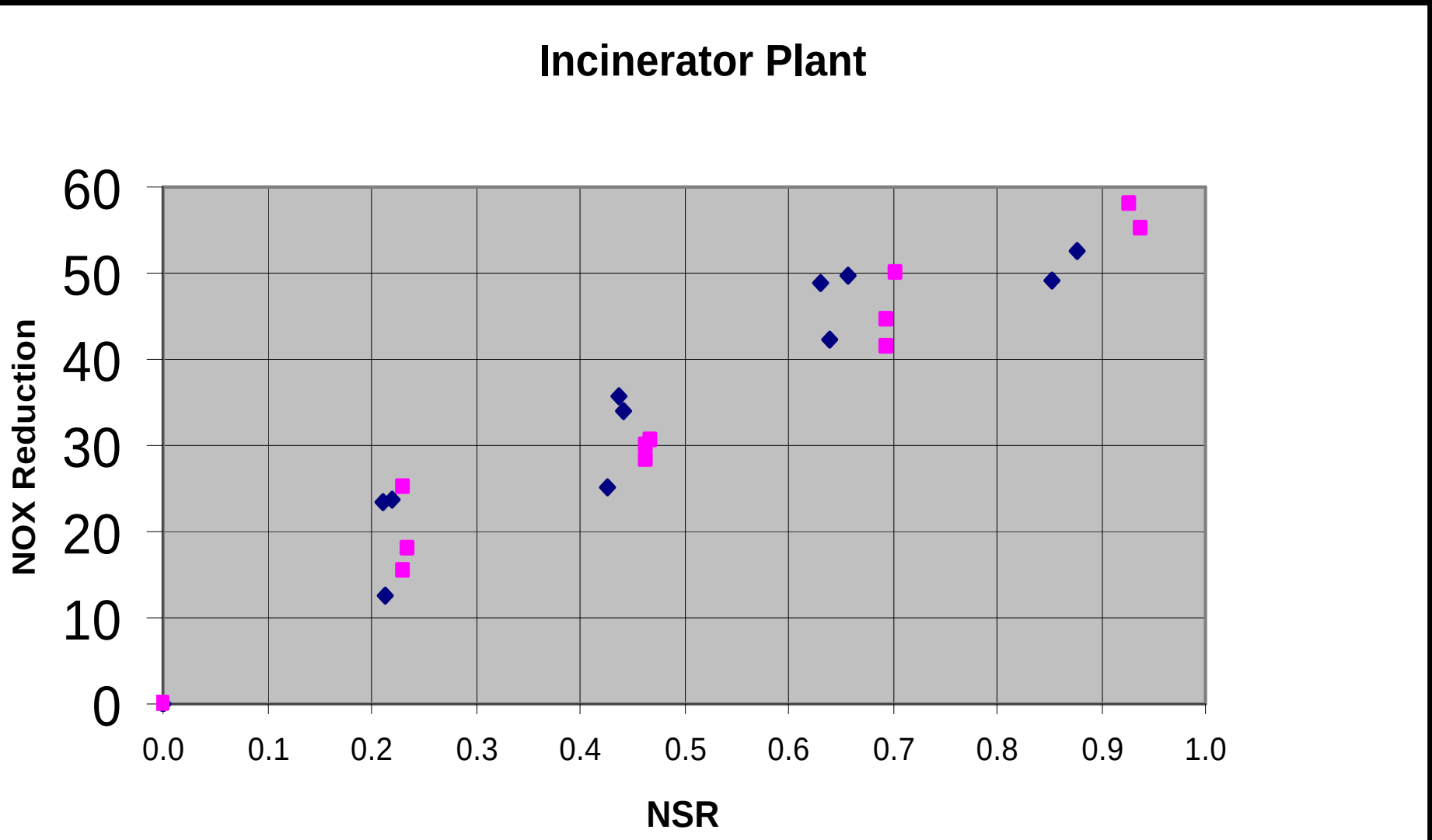
The Real World

- Access limitations
- Imperfect mixing
- Temperature and Concentrations Vary
- Operator indifference
- Carbon Monoxide
- Ammonia Slip is Important

Closest to Perfect

- Incinerators, Biomass Boilers, Cement Plants,
- Temperature, Time, Turbulence.
- Common performance is 50% reduction at NSR = 1.0 and ammonia slip L.T. 10 ppm.

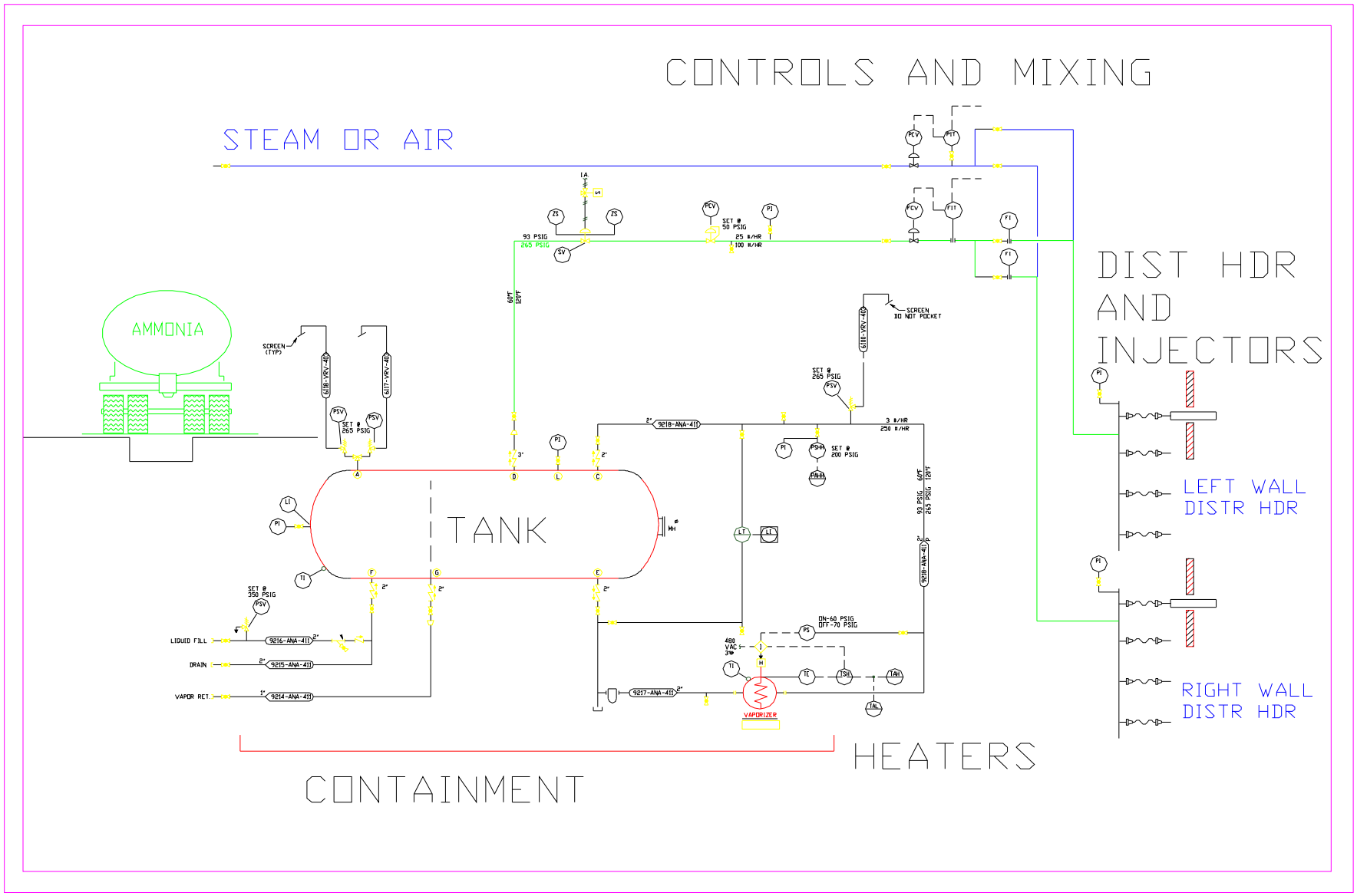

Typical NOx Performance
Wood Fired Unit
% NOx Reduction
60.0%
50.0%
40.0%
30.0%
20.0%
10.0%
0.0%
0.00
0.20
0.40
0.60
0.80
1.00
1.20
NSR


Incinerator Plant
NOX Reduction
60
50
40
30
20
10
0
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1.0
NSR

Ammonia Process

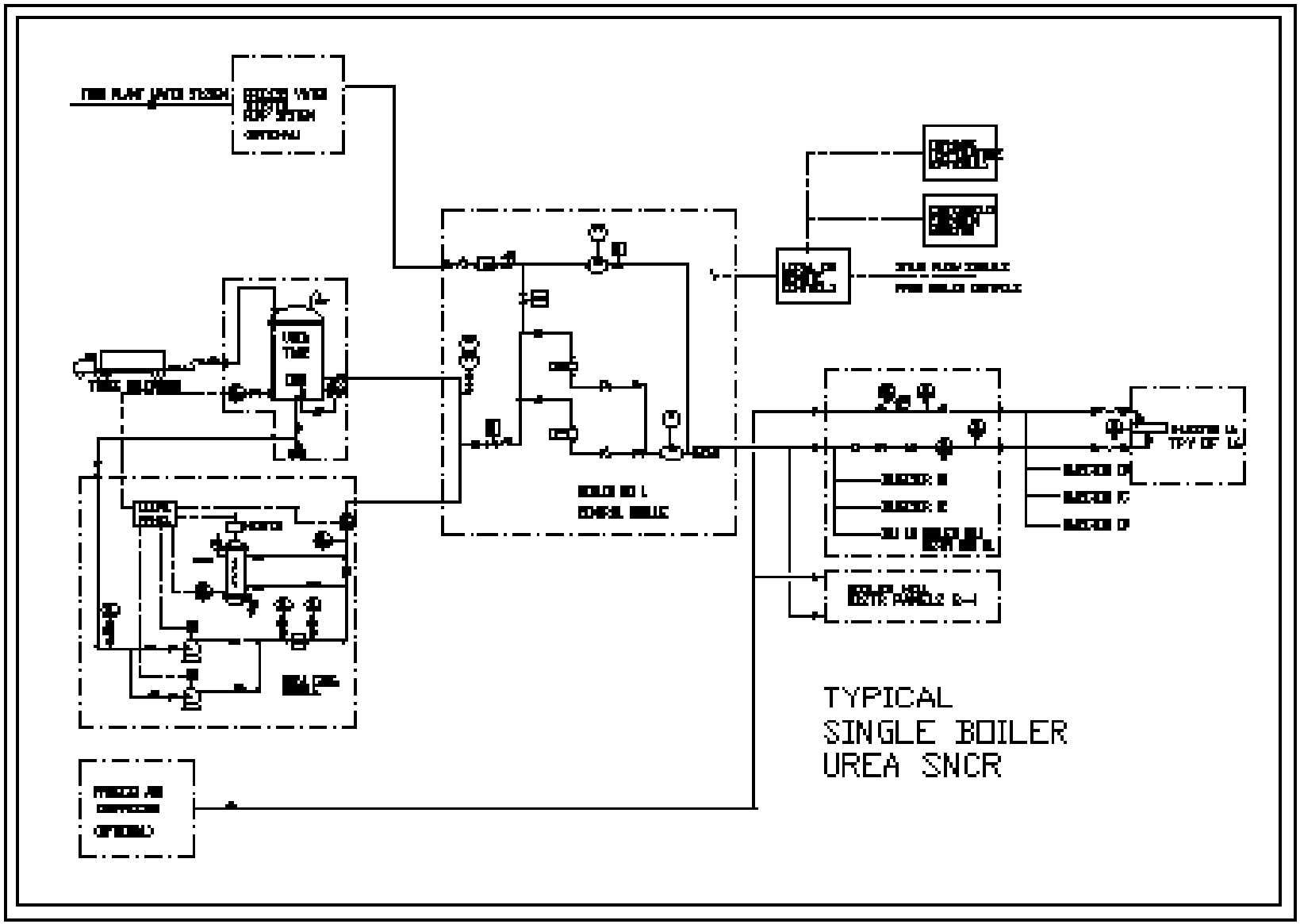
- Simplest and least expensive* approach.
- Gaseous injection.
- Anhydrous ammonia has lowest delivered cost.
- Storage and Handling issues.
- Lowest boiler corrosion risk.

* - Assumes typical tank/containment.


CONTROLS AND MIXING
STEAM OR AIR
AMMONIA
TANK
DIST HDR
AND
INJECTORS
LEFT WALL
DISTR HDR
RIGHT WALL
DISTR HDR
HEATERS
CONTAINMENT
VAPORIZER
LIQUID FILL
DRAIN
VAPOR RET
SCREEN
DO NOT POCKET
SET @
265 PSIG
SET @
350 PSIG
SET @
200 PSIG
SET @
50 PSIG
93 PSIG
265 PSIG
3 #/HR
250 #/HR
25 #/HR
100 #/HR
ON-60 PSIG
OFF-70 PSIG
480
VAC
3Ø

Urea and Aqua Ammonia Process

- Liquid Reagent, sprayed in as droplet.
- Higher reagent costs, but friendlier chemical.
- Equivalent performance and stoichiometry.
- More difficult to distribute reagent equally.


TYPICAL
SINGLE BOILER
UREA SNCR

Design Considerations

- Temperature / Velocity Profile
- Uncontrolled NOX Concentration
- Equipment Arrangement/ Injector Location
- Injector Number, Location, and Sizing
- Controls

Economic Summary

- Installed Cost – Utility scale $5-10/kW
- Installed Cost – Industrial $10-15 /kW
- Negligible Outage Costs
- Operating Cost - $300-500 per ton NOx removed

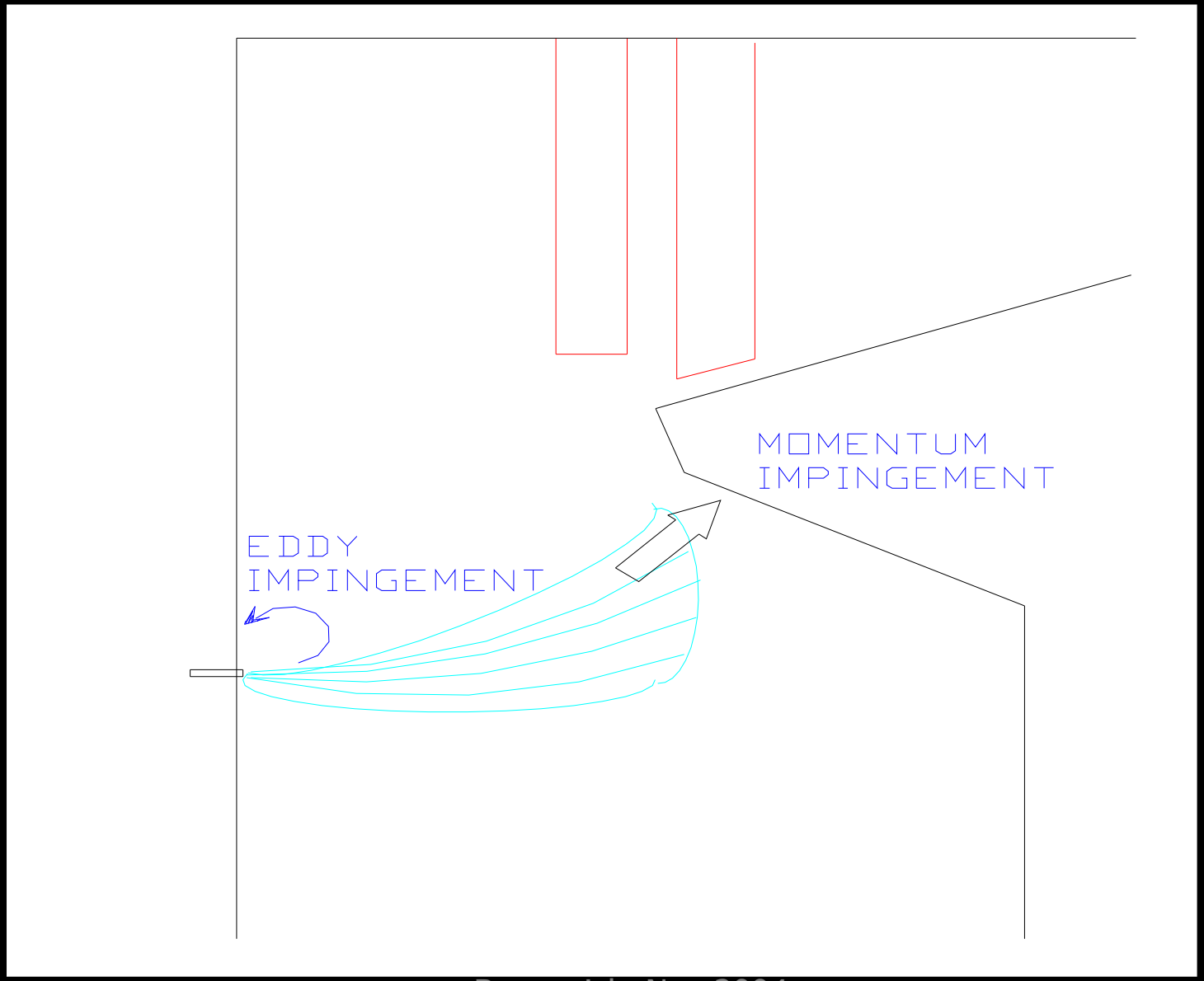
Operational Issues

- Localized Corrosion
- Detached Plume Formation
- Air Heater Fouling
- Nozzle Failure

Corrosion

- Localized corrosion at liquid injected SNCR facilities is an issue.
- Generally located in immediate vicinity of injector ports, or on opposite walls of narrow boilers.
- Especially problematic for gas with high chloride and sulfur.

LOCALIZED CORROSION



Plume Issue

- Common in non-scrubbed flue gas
- Detached from the stack
- Caused by condensation/combination at lower temperatures.
- Ammonium chloride, ammonium bisulfate, +?

Plume Suppression

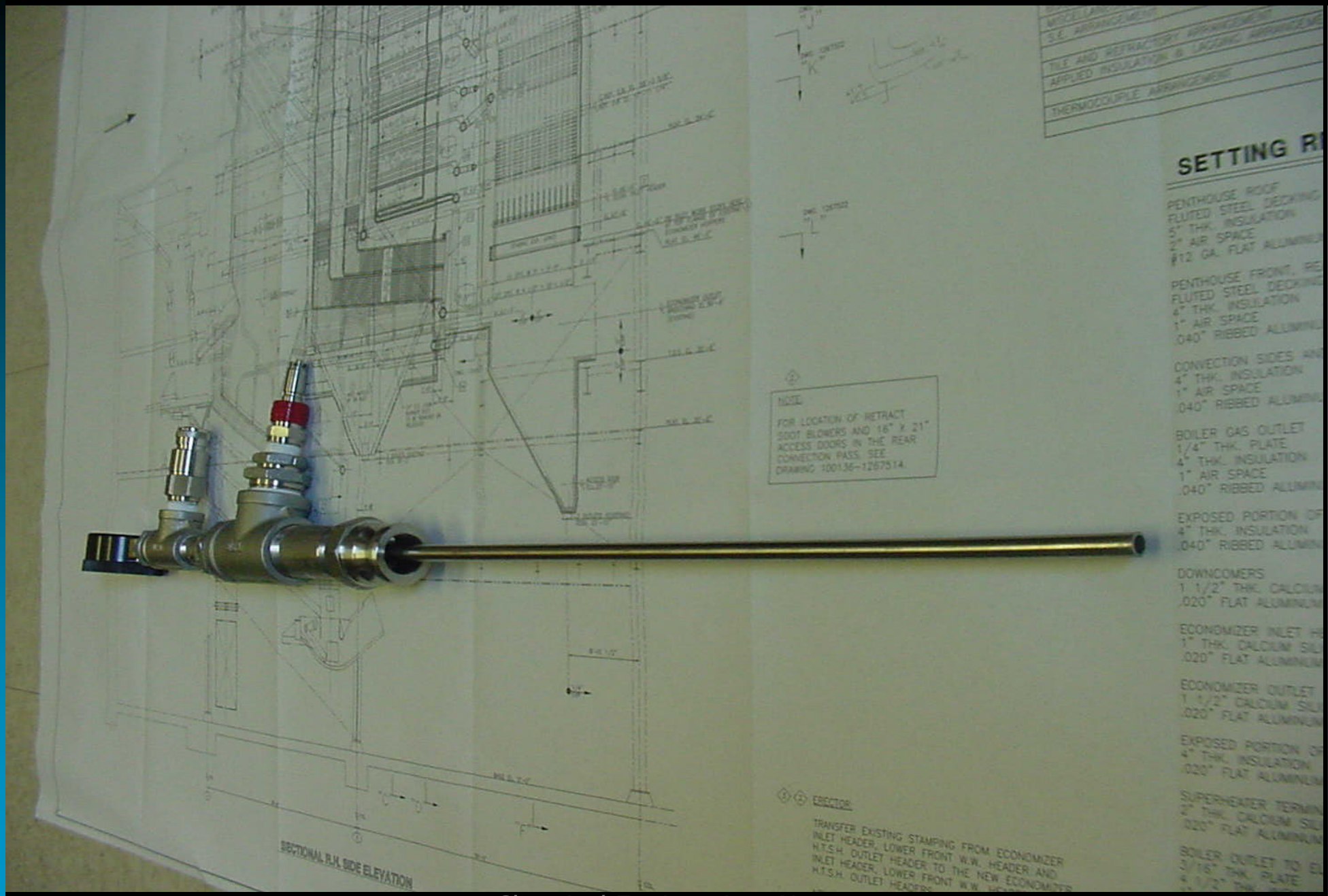
- Slip reduction – keep less than 10 ppm
- Nozzle orientation/operation key.
- Get good stack and operational data.

Air Heater Plugging/Corrosion

- Ammonium Bisulfate is a liquid above 300F
- Sticky material - difficult to remove.
- Not a problem with low sulfur fuels
- Again, minimize slip

Injector Burn-out

- High Temperature Corrosion
- Erosion
- High alloy with heavy wall thickness
- Interchangable lances


SETTING R
SECTIONAL P.H. SIDE ELEVATION

Combination Technologies

- SNCR very compatible with combustion controls.
  - Low NOx Burners
  - OFA Injection
  - Gas Reburning
- NOx reduction approaching that of SCR at lower capital cost

SNCR Summary

- Mature Technology
- Fuel Indifferent
- Low cost alternative for first 50% NOX reduction.
- Easily retrofitted
- Compatible with combustion modifications for High NOx removal