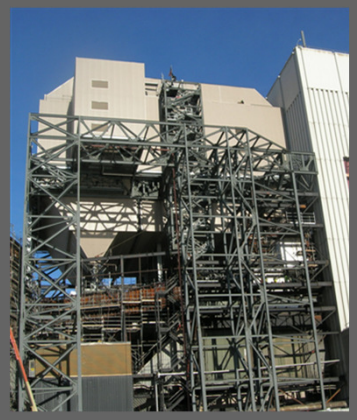
# SCR/CO/VOC Control For the McIlvaine Company

***A short overview of Emission Control Systems for Gas Tubines***

Bob McGinty, Sr. Manager, Business Development



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# PRINCIPLE OF SCR REACTION
## (DENITRIFICATION PROCESS)

Catalyst

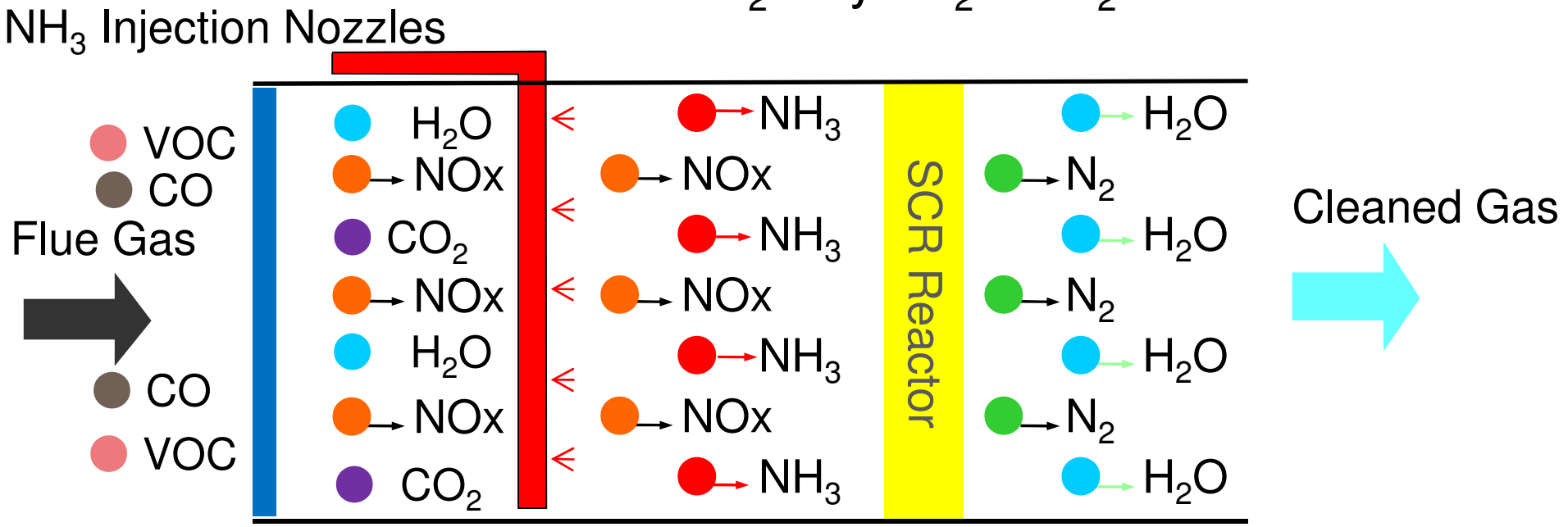
$$4NO + 4NH_3 + O_2 \rightarrow 4N_2 + 6H_2O$$

$$NO + NO_2 + 2NH_3 \rightarrow 2N_2 + 3H_2O$$

Catalyst

$$2\,CO + O_2 \rightarrow 2CO_2$$

$$wVOC + xO_2 \rightarrow yCO_2 + zH_2O$$

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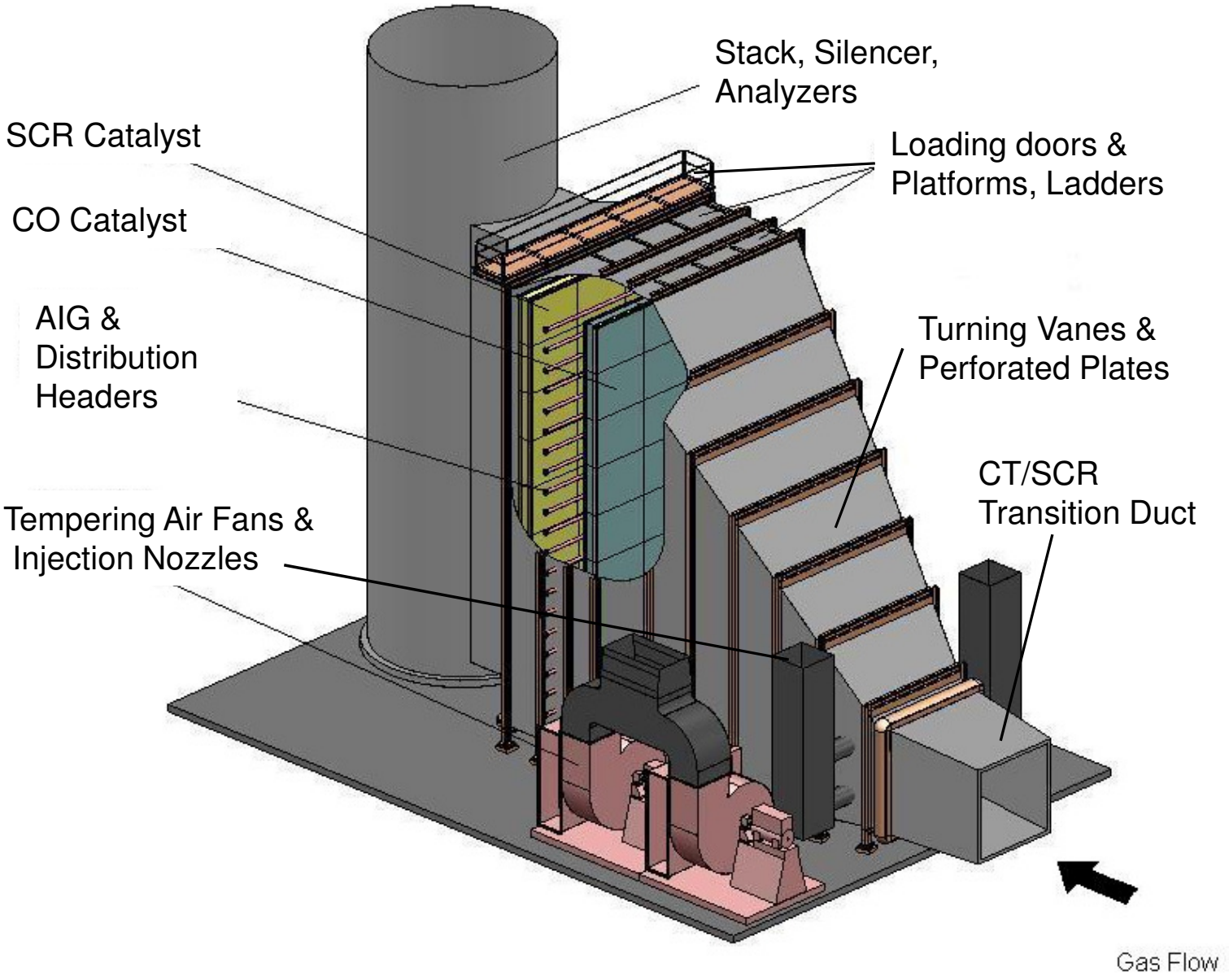
# SCR FOR SIMPLE CYCLE GT (TYPICAL SCOPE)




Add'l Scope
- AFCU
- PLC
- Tech Advisor
- Training

Options
- Ammonia Tank
- Pump Skid

Guarantee
- NOx; CO; VOC
- Utility
- dP
- Noise
- Catalyst Life

# SCR System Design

Design Considerations:

- Seismic and Wind Loads
- **Thermal Growth**
- **Catalyst Support & Sealing**
- Accessibility (Internal and external components)
- **Thermal Insulation & Liner System**
- Prefabrication – Modular - Panel - Semi Modular
- **Constructability – TIME & MONEY**
- Operation & Maintenance

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# PLANT A (MODULAR CONSTRUCTION)


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# PLANT B (PANEL CONSTRUCTION)

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# PLANT C (SEMI-MODULAR CONSTRUCTION)



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# KEY CONSIDERATIONS FOR GAS TURBINES SCR

| | |
|---|---|
| Service life – Hours & Years (customer requirement) | Ammonia slip |
| Exhaust gas temperature | Catalyst temperature |
| Turbine exhaust $NO_X$ , CO, VOC levels | Reactor duct configuration |
| Required $NO_X$ CO, VOC removal & stack exit | Flue gas flow/temperature distribution |
| Pressure loss allowance | SO2 to SO3 Conversion |
| Volumetric flow rate | $NH_3/NO_X$ distribution |

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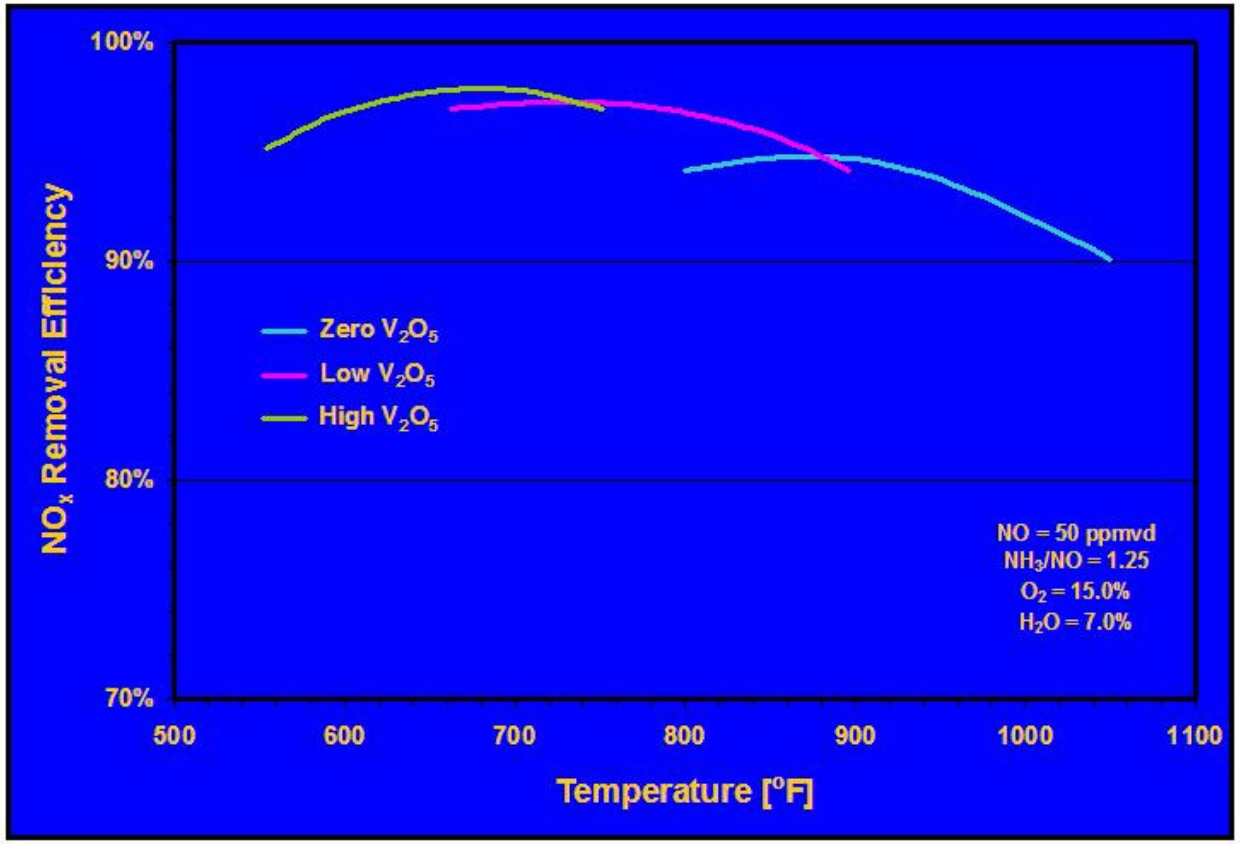
# CATALYST SELECTION: TEMPERATURE

Large operating temperature range (350 - 1100°F)




- High temp catalyst:
  450F ~ 1,100F
- Medium temp catalyst:
  450F ~ 900F
- Medium-low temp catalyst:
  450F ~ 850F
- Standard catalyst:
  450F ~ 800F

At higher temperature, reduce V:W ratio for
- Stronger NH3 adsorption
- Lower NH3 decomp rate
- Higher DeNOx rate
- Lower sintering rate

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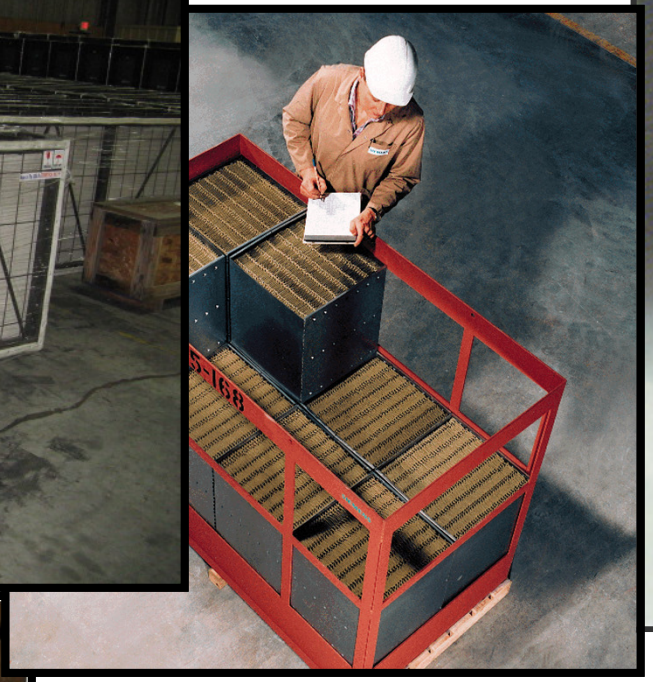
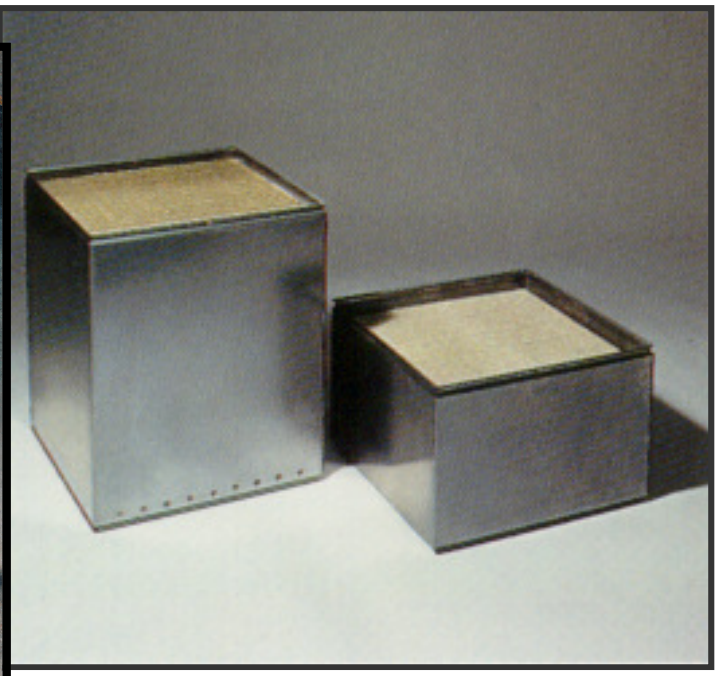
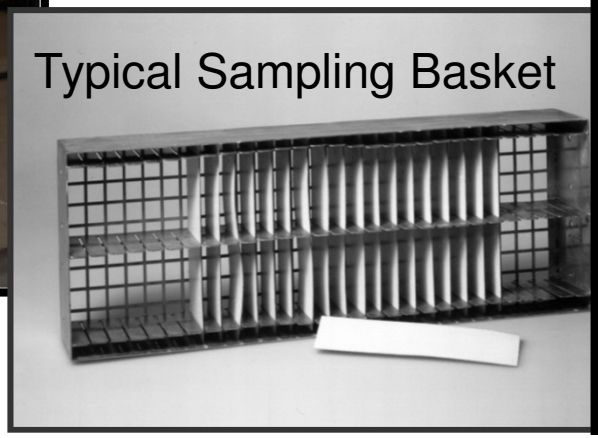
# CATALYST MODULES & TEST COUPONS/BLOCKS

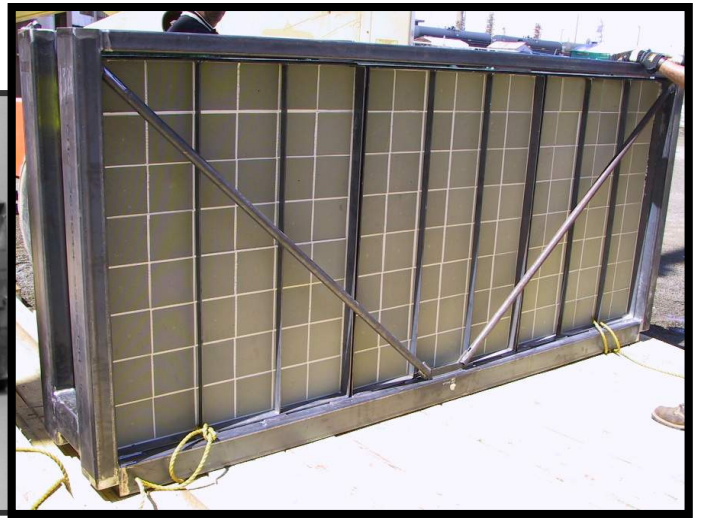




Typical Sampling Coupon

Typical Sampling Basket





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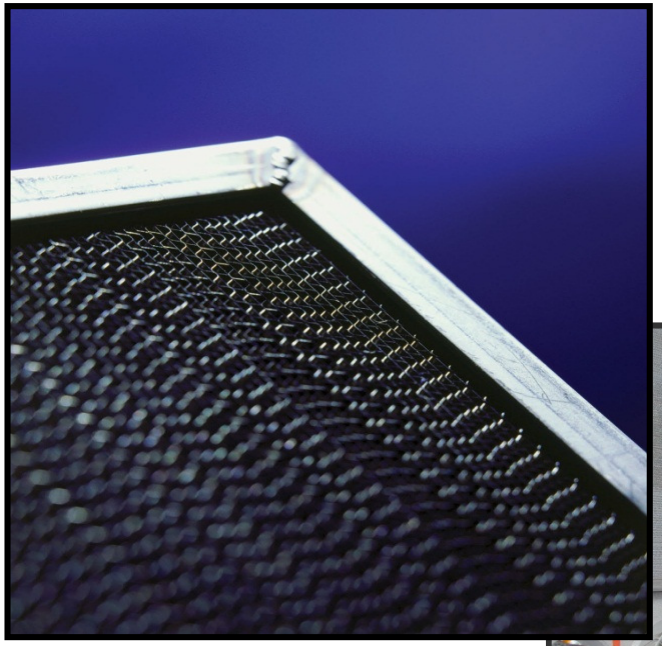
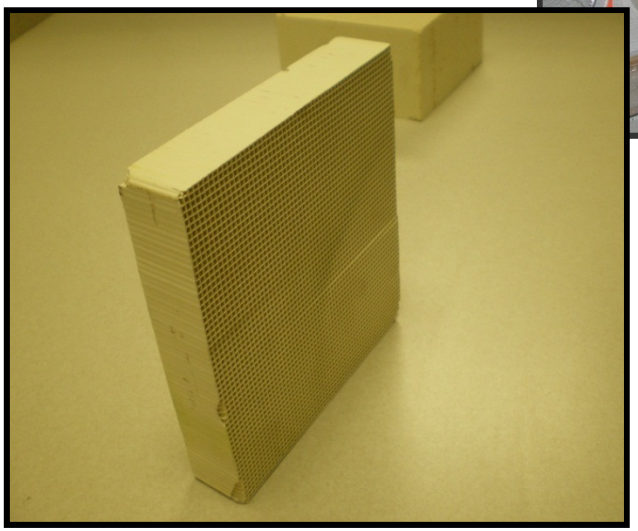
# CO & VOC CATALYST

- Platinum or other PGM promotes CO to $CO_2$ oxidation.
- Brazed joint corrugated metallic foils, stacked corrugated foil or ceramic cells to provide high surface area per cu.ft. of catalyst
- Oxidation occurs on “surface” of catalyst.
- Pressure drop is directly dependent on catalyst depth and compactness





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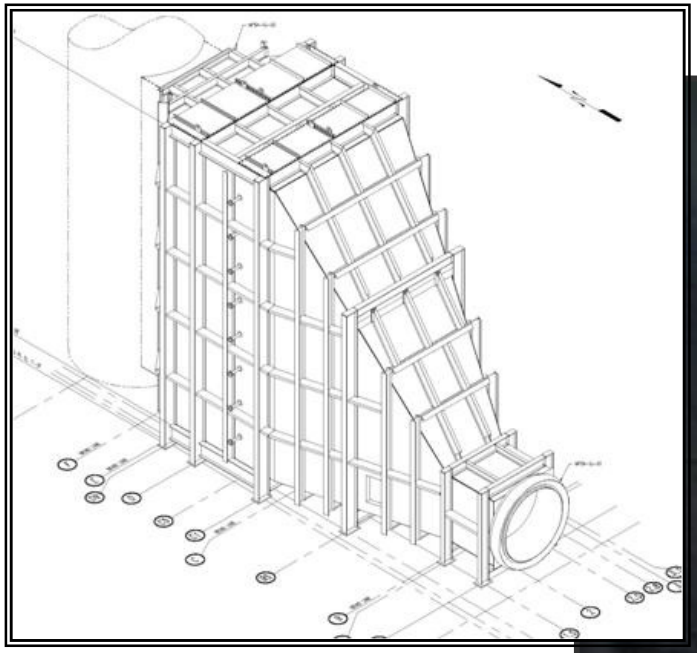
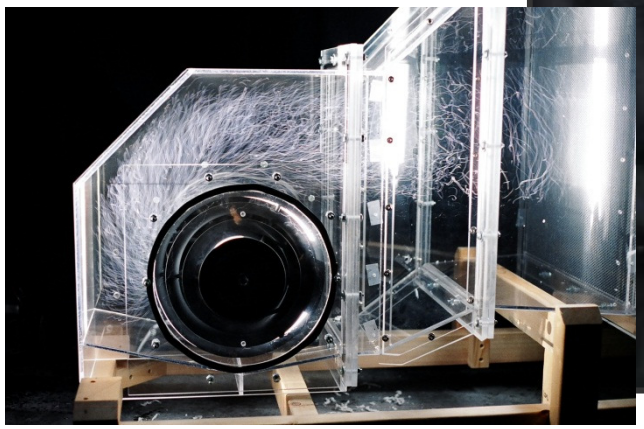
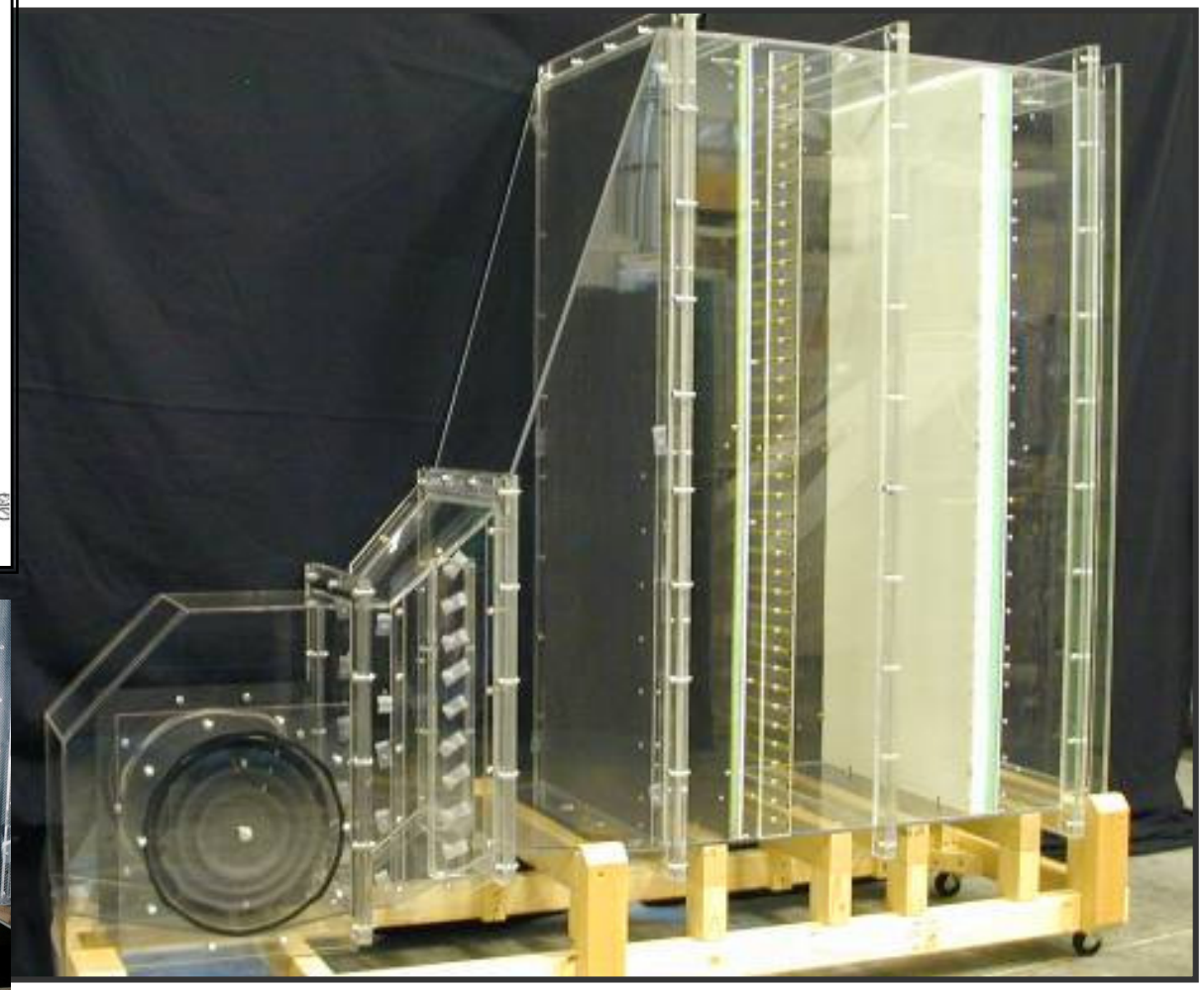
# Catalyst Poisoning & Degradation Mechanism

| Degradation Source | Mechanism |
|---|---|
| High Temperature > 930F | Decreases available surface area by thermal sintering of ceramic material |
| Fine particulate | Reduces available surface area by masking surface and preventing diffusion into pre structure |
| Ammonia-sulfur compounds | Plugs pores and prevents diffusion |
| Alkaline metals, Na, K | Ion exchange with active sites |
| Alkaline earth metals, Ca, Mg | Typically in form of sulfates, bond with acid sites reducing the ability of catalyst to absorb $NH_3$ I.e. formation of $CaSO_4$ |
| Halogen | May react with and volatilize active metal sites |
| Arsenic | Gaseous arsenic diffuses into catalyst and covers active sites, preventing further reaction |
| V, Pt, Cr and Family | Deposit onto catalyst, increasing $NH_3$ to NO and/or $SO_2$ to $SO_3$ |

# Flue Gas Path Management ($NH_3$ Mixing - Cold Flow Model)







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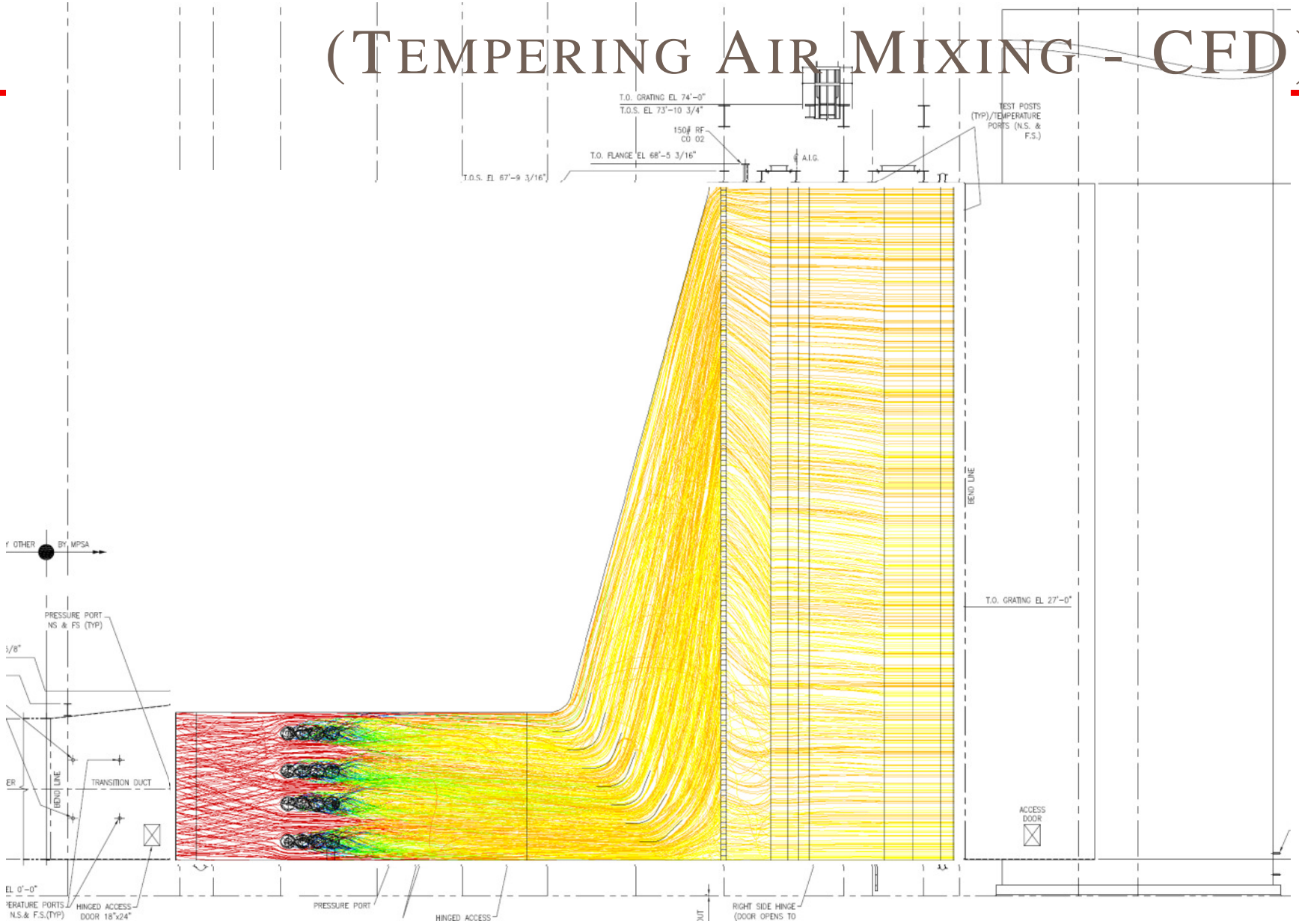
Simple Cycle Physical 1/12th Scale Model

# Flue Gas Path Management (Tempering Air Mixing - CFD)




Simple Cycle CFD Model

# SCR FOR SIMPLE CYCLE GT
# NRG MARSH LANDING

## Project Features

- Frame SCGT x 4 units
- Max operating temp: ~1150F
- Tempering Air
- Outlet NOx:  2.5 ppmvd
- Completed April 2013

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# SUMMARY

- MPSA has established SCR design considerations for gas turbine fired applications and can ensure long-term and continuous system operation on gas or liquid fuels.

- Mitsubishi has supplied SCR systems for combined cycle and simple cycle gas turbines globally, and is a "Proven" technology provider with over 600 SCR systems worldwide.

- MPSA has a team of qualified experts in Newport Beach and Lake Mary Office with access to more experts at MHI Nagasaki and MHI R&D. We can offer support with feasibility studies, with project execution, and with long term maintenance of your valuable investment.

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