

LP AMINA WAS ESTABLISHED WITH A MISSION TO SERVE AS AN INTEGRATED PLATFORM TO DEVELOP AND DEPLOY CLEAN COAL SOLUTIONS GLOBALLY

125+

Full time employees, on 3 continents

8

Locations worldwide, with activities in the US, Europe and Asia

10+

Patents, focused on coal / biomass conversion and pollution control



40+

Projects completed in last 5 years

15

Provinces and municipalities in China served to date

10GW

Of power plants retrofitted with pollution controls



Strategic partnership with Bayer to develop coal utilization technologies



The State of Wyoming co-funded LP Amina's Coal to Chemicals technology



West Virginia University participates in the research of LP Amina's CtC technology



LP Amina is a founding member and co-chair of the US-China Energy Cooperation Program (ECP)



LP Amina is a founding member of the US-China Clean Energy Research Center (CERC)

LP AMINA OFFERS A RANGE OF SOLUTIONS FOCUSED ON NO_x REDUCTION FOR COAL AND GAS POWER AS WELL AS ADVANCED COAL UTILIZATION (COAL TO CHEMICALS)

Low NO_x Burners



Shajiao Power Plant, Shenzhen

Hybrid LNB/SNCR/SCR



Yixing Power, Jiangsu

Direct Injection SCR



Jingfeng Power, Beijing

Advanced Coal Tech.



Hepo Facility, Shanxi

- LP Amina is **market leader** in pre-combustion De-NO_x solutions via in-furnace optimization in China
- **25+ Projects** at major Chinese clients including China Huaneng Group, Guangzhou Yuedian Group, Datang Group
- **Proprietary technology** developed by LP Amina
- Combines benefits of several De-NO_x technologies and brings **superior De-NO_x** results at affordable price
- Installed at multiple units at Yixing Power in Jiangsu with **80% NO_x reduction**
- **Proprietary technology** developed by LP Amina
- LP Amina was able to reduce NO_x by **over 80%** with slip below 2 ppm
- More efficient, direct injection SCR uses significantly **less energy** and is cheaper to build
- Innovative process to **co-produce** electric power and high-value chemicals
- Extraordinary **economics** and **environmental impact improvement** from systems perspective
- Piloted in Shanxi, China; to be fully operational Q4 '14

LP AMINA'S PROPRIETARY DE-NOX HYBRID: COMBINES BENEFITS OF LNB, SNCR, AND SCR TECHNOLOGIES TO BRING SUPERIOR DE-NOX RESULTS AT AFFORDABLE PRICE

Average NOx Reduction by Each Technology (%)

SNCR 25+% *Relatively low upfront cost, but ongoing operating costs (ammonia)*

LNB 45+% *Medium CapEx, no operating costs, but in many cases not enough to meet the standard. Requires boiler retrofit know-how.*

SCR 80+% *Most effective De-NOx solution, but also the most expensive due to the cost of catalyst*

Gradual NOx Reduction in LP Amina's Hybrid Approach (%)

LNB 45%

Initial NOx reduction through proprietary retrofit of burner and SOFA ports

SNCR +15%

Further NOx reduction through SNCR

SCR +20%

Final NOx reduction through in-duct SCR

80%+

The core idea behind LP Amina's Hybrid De-NOx Technology is to combine strengths of LNB, SNCR and SCR technologies, leveraging relative advantages of each

LP AMINA'S FIRST HYBRID TECHNOLOGY WAS INSTALLED ON YIXING UNION'S UNITS 5/6 IN CHINA'S JIANGSU PROVINCE, TOTAL 80% OF THE NO_x REDUCTION WAS ACHIEVED

Yixing Union Units 5 and 6 Project Overview



Units Overview:

- Power generation capacity: 2 x 50 MW
- Combustion type: T-Fired
- Fuel: Bituminous coal

Scope:

- SOFA and Low NO_x Firing Systems
- Proprietary SNCR/SCR Hybrid
- Patented coal classifiers

Results:

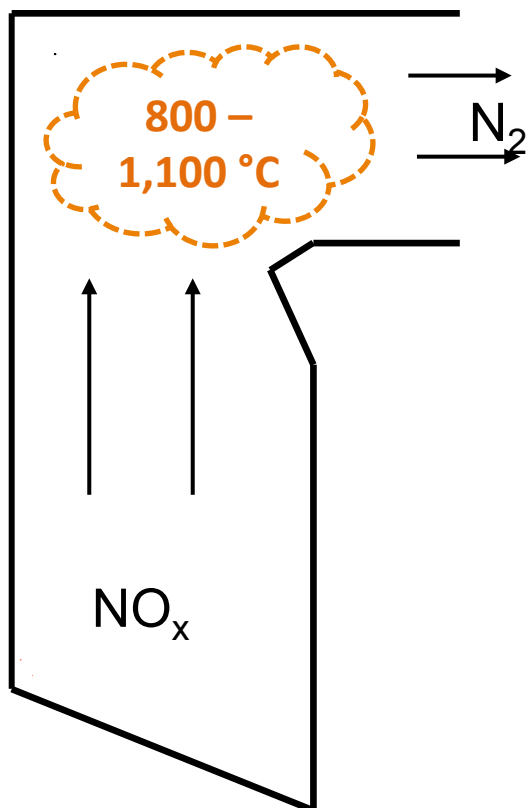
- NO_x reduced from 0.44 to 0.08 lb/MMBTu
- LOI below 1.5%
- Expanded fuel flexibility
- Increased unit efficiency
- Significant cost reduction due to the large savings in ammonia and catalysts
- Currently working on few more units for Yixing

IN HYBRID ARRANGEMENT, AMMONIA INJECTORS ARE INSTALLED IN UPPER FURNACE, AND ONE (OR MORE) IN-DUCT CATALYST INSTALLED IN BOILER REAR PASS

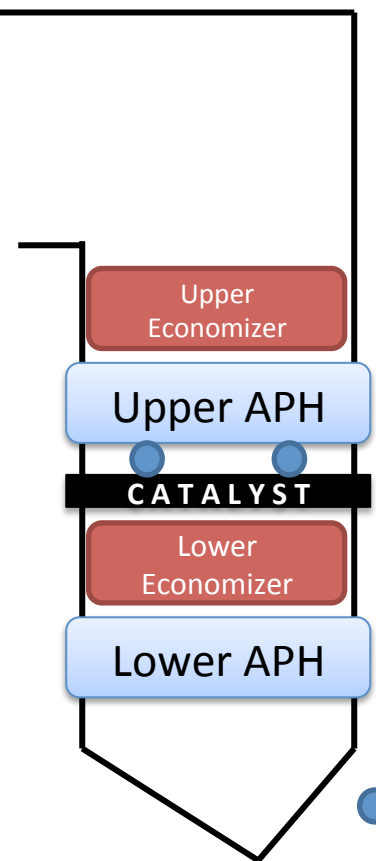
Schematical Arrangement of In-Duct SNCR & SCR

Concentrated urea reagent

Chemical Injection



Boiler Rear Pass



One or several layers of catalyst installed in-duct; each 2-3 meters thickness

300 - 400 °C

= Sonic horns, soot blowers

IN HYBRID ARRANGEMENT, AMMONIA INJECTORS ARE INSTALLED IN UPPER FURNACE, AND ONE (OR MORE) IN-DUCT CATALYST INSTALLED IN BOILER REAR PASS

Advantages

- Can achieve **significant NOx reduction**, especially when combined with LNB
- **Lower capital** cost than SCR (smaller catalyst volume, installed in-duct)
- **No significant slip** issues because catalyst cleans up excess ammonia

Constraints

- Boilers require adequate **in-duct space** for catalyst installation
- Requires **EPC with know-how** of all three technologies: LNB, SNCR, SCR

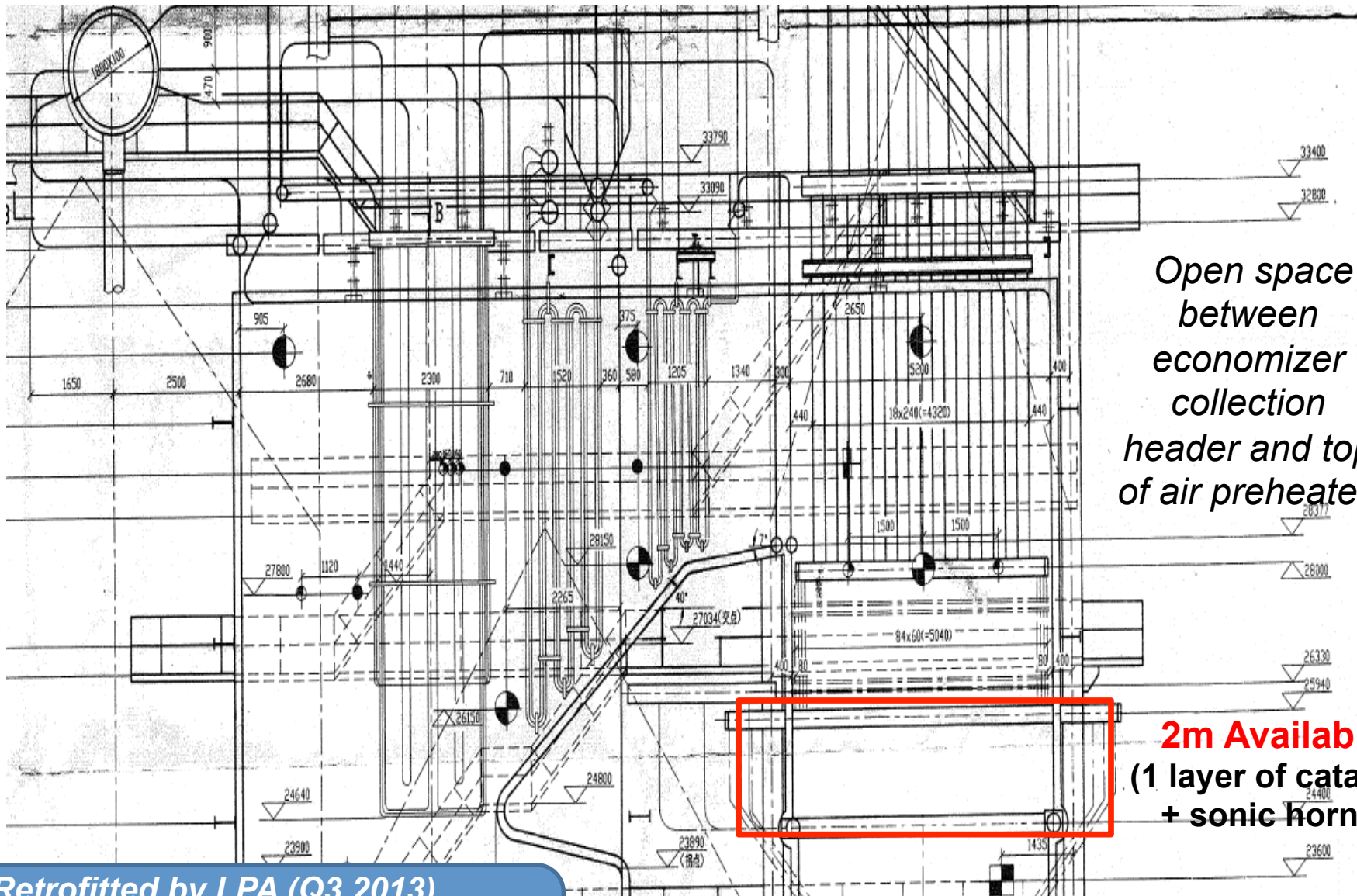
Applicability

Small Units

Medium Units (50-300 MW)

Large Units

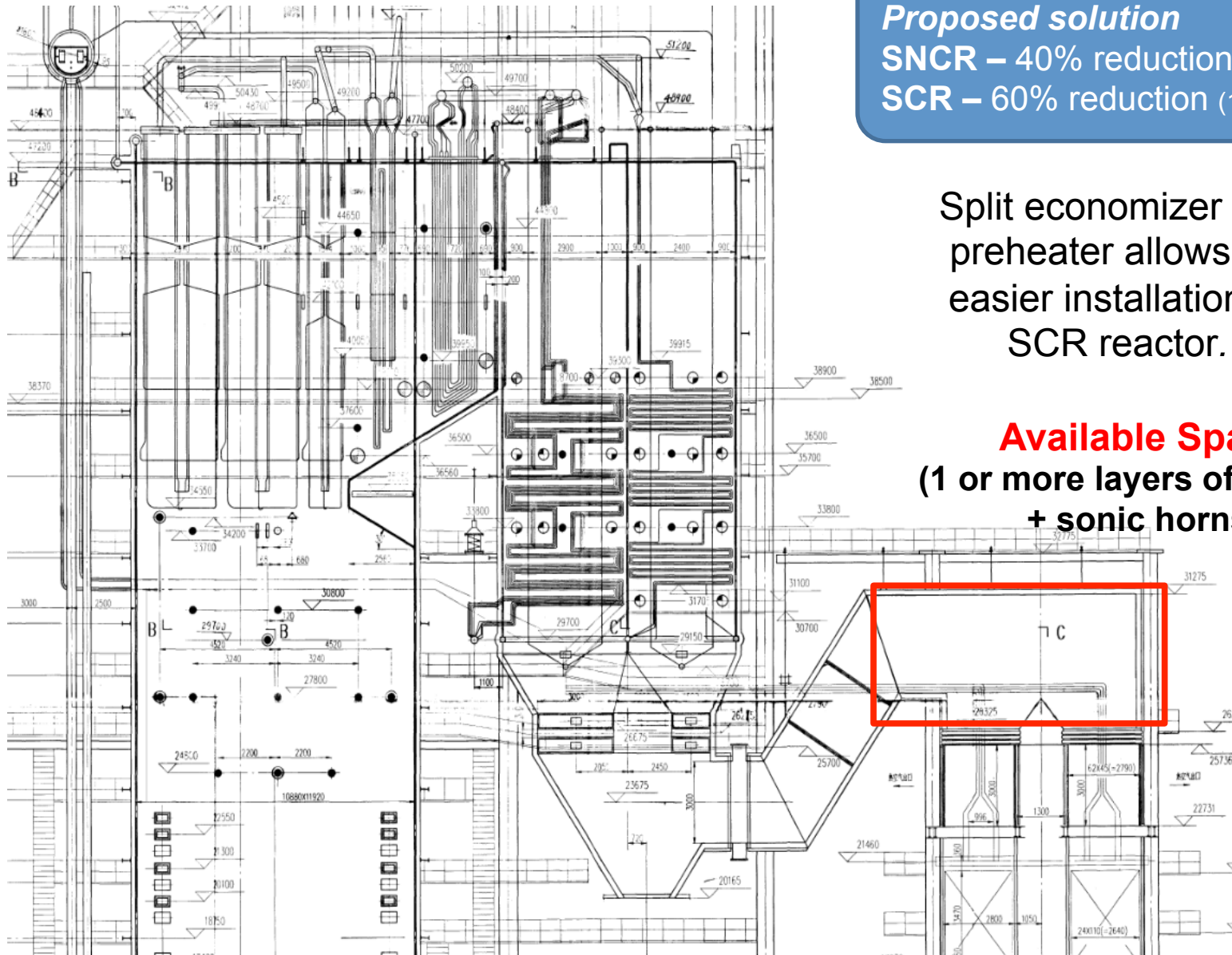
- Smaller units utilize LNB and (S)OFA, *but still need additional NOx reduction*
 - SCR too expensive/ too large for some units
 - SNCR might not provide effective NOx reduction without large amount of slip
- LNB
- SCR



Open space between economizer collection header and top of air preheater.

2m Available
(1 layer of catalyst + sonic horns)

Retrofitted by LPA (Q3 2013)
LNB – 40% reduction (200 mg/Nm³)
SNCR – 30% reduction (200 mg/Nm³)
SCR – 50% reduction (100 mg/Nm³)



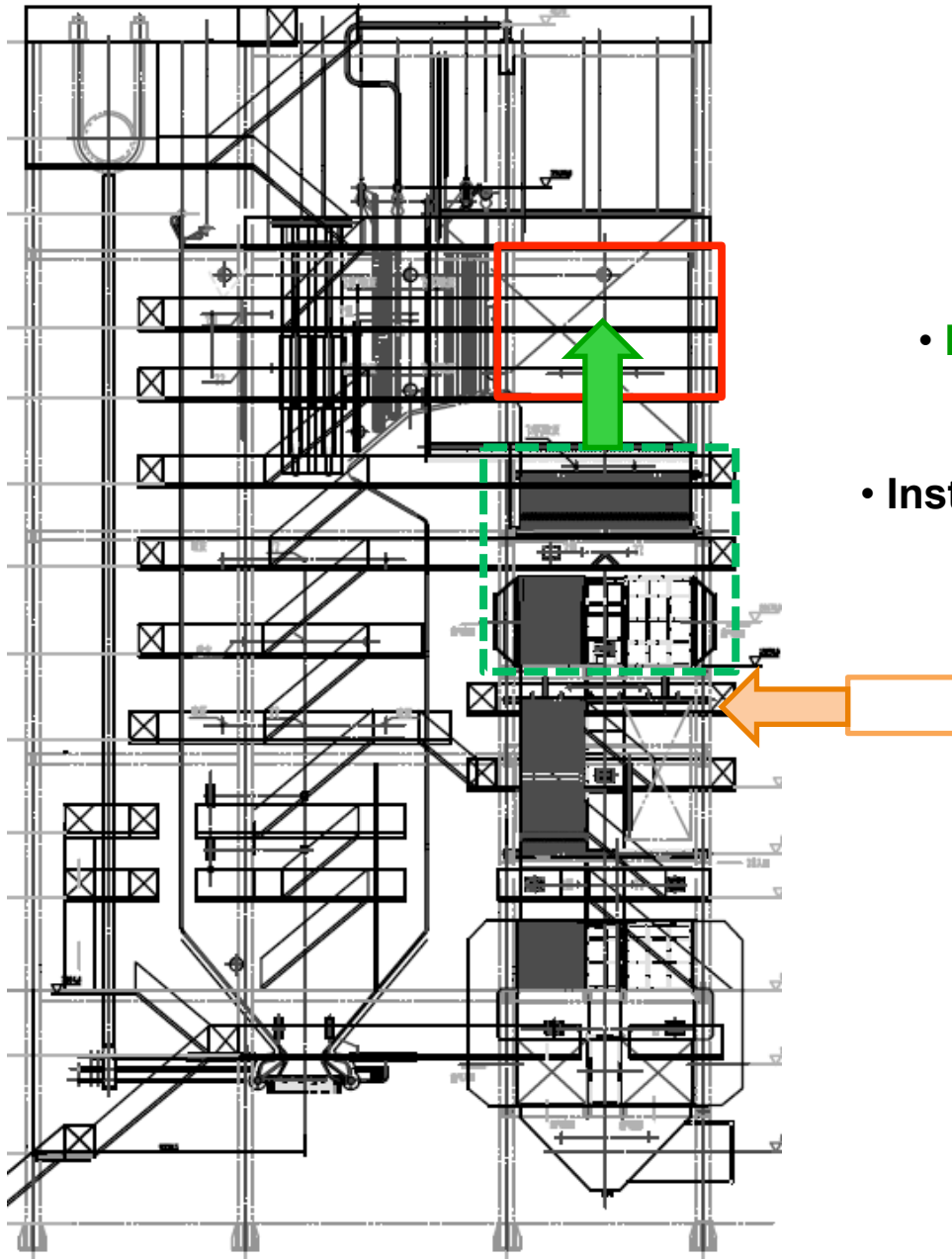
Proposed solution

SNCR – 40% reduction (250 mg/Nm^3)

SCR – 60% reduction (100 mg/Nm^3)

Split economizer / air preheater allows for easier installation of SCR reactor.

Available Space
(1 or more layers of catalyst + sonic horns)



Proposed solution

SNCR – 40% reduction (166 mg/Nm³)

SCR – 40% reduction (100 mg/Nm³)

Available Space **TOO HOT**

- **Move economizer, APH upwards.**
- **Create new space below in correct temperature zone.**
- **Install 1 layer of catalyst + sonic horns**

Harder installation than other examples because of lack of space in correct temperature zone.

