# New and Emerging Technologies and Trends

## Combustion Modification- Implementation Challenges & Impact on Boiler performance wrt Indian Context

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# NOx Control Technologies

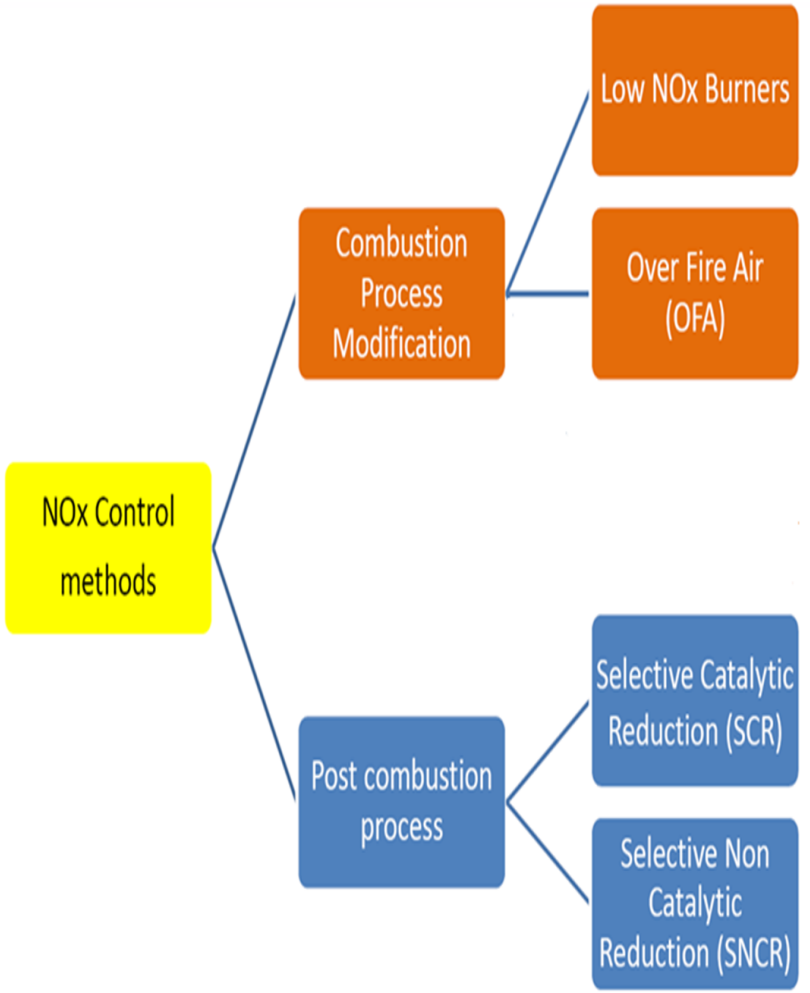


**Primary methods-Prevents the formation of NOx**

- Combustion optimization
- Boiler tuning
- Low-NOx burners
- Separate OFA system

**Secondary methods-Eliminate Primary NOx**

- Selective Non-Catalytic Reduction (SNCR)
- Selective Catalytic Reduction (SCR)
- Hybrid-SCR



# Context



- Most of the boilers installed before 31.12.2016 were designed for maximum NOx emission 260gm/GJ (750mg/NM3) as per world bank norm.
- Stringent Environmental norm notified in Dec 2015 wrt NOx
- As per new norm combustion modification will be required to get maximum NOx emission below 450 mg/NM3 level for all condition.
- NTPC envisaged around 50 boilers of 21000 MW for combustion modification. Combustion modification in around 25 boilers has already completed and implementation in balance units will be done during major overhaul of unit.
- In India, most of boilers are tangential fired (corner fired boiler).

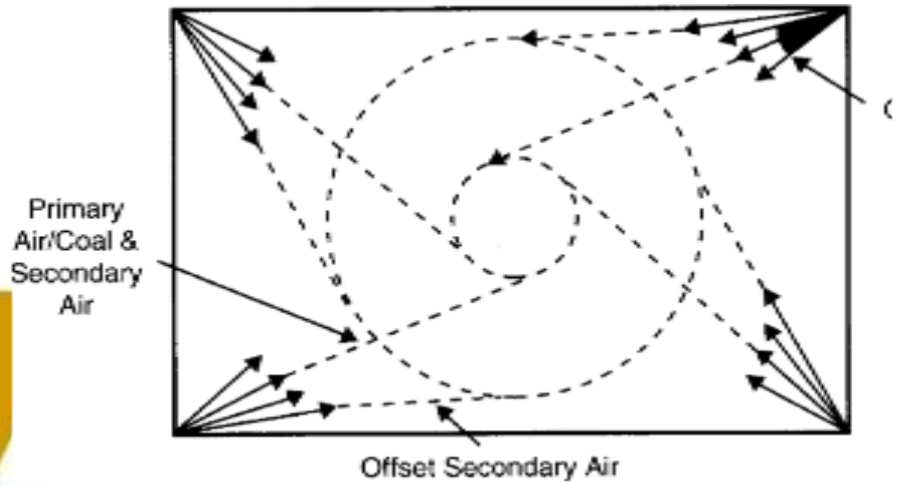
**Status of CM in NTPC as on date**

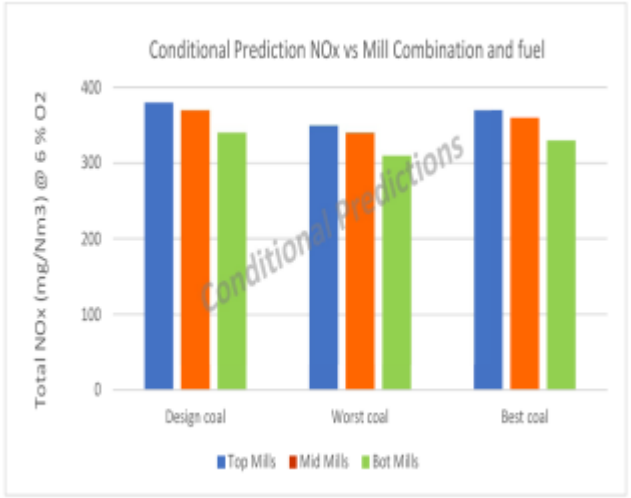
| De-NOx -CM | |
|---|---|
| **Status** | **Capacity (MW)** |
| Total Combustion Modification awarded, 50 units | 21560 |
| Combustion Modification already Implemented (28 units) | 13045 |

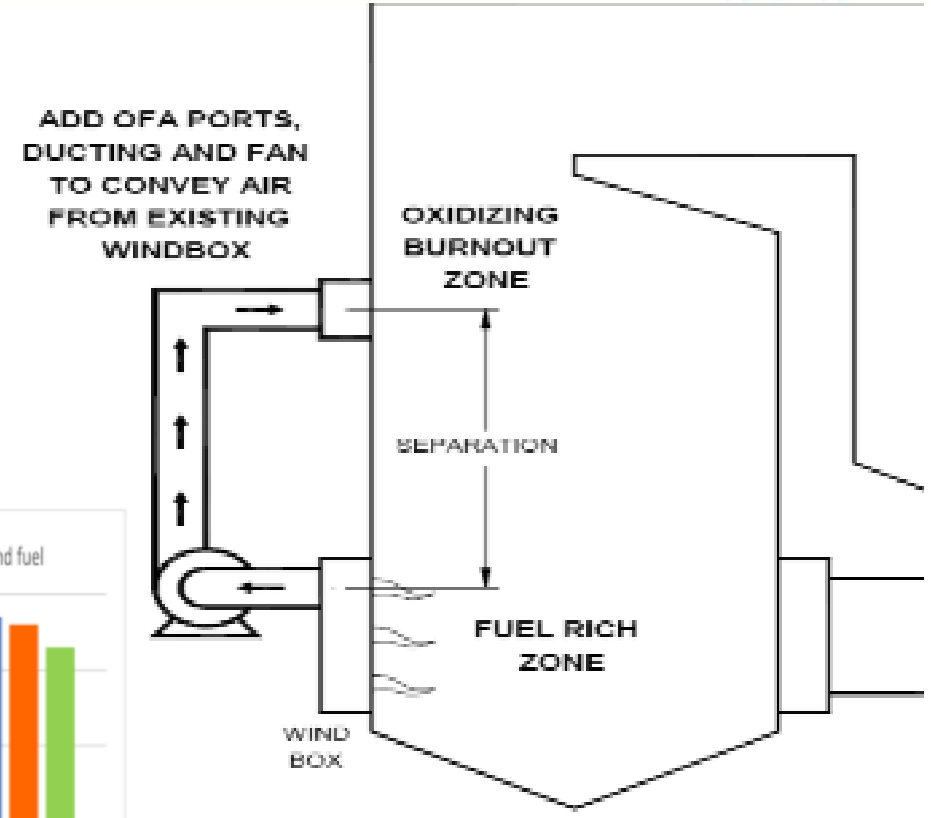
# Combustion Modification- Concept



- Precise mixing of fuel and air is used to keep the flame temperature low and to dissipate heat quickly using low excess air.
- Control the mixing of fuel and air, in effect automating low-excess-air firing or staged combustion.



# COMBUSTION MODIFICATION – Details of various Suppliers



## BHEL DESIGN FEATURE:

- Modify the existing TT burner & wind box system in the boiler.
- A "Newly developed TT burner and wind box design" along with BOFA (Bypass Over Fire Air) system introduced
- Around 30% of secondary air shall be distributed in the BOFA.
- Hot secondary air supply for BOFA system, shall be tapped from the hot secondary air duct connecting to the wind box.
- BOFA (Bottom) is placed at approx. 4-5 m above the top of wind box.

## L&T MHPS Design features

LMB will utilize the existing system / equipment as much as possible. In addition, LMB will install additional AirPort (AA-port) around 4-5 m above the existing wind box. LMB will modify / retrofit the wind box by modifying all wind box nozzle tips (coal, oil, and aux) for all four corners, using the existing coal burner body and oil gun. Necessary modification as required for boiler water wall and secondary air duct shall also be carried out.

## GE Design Features:

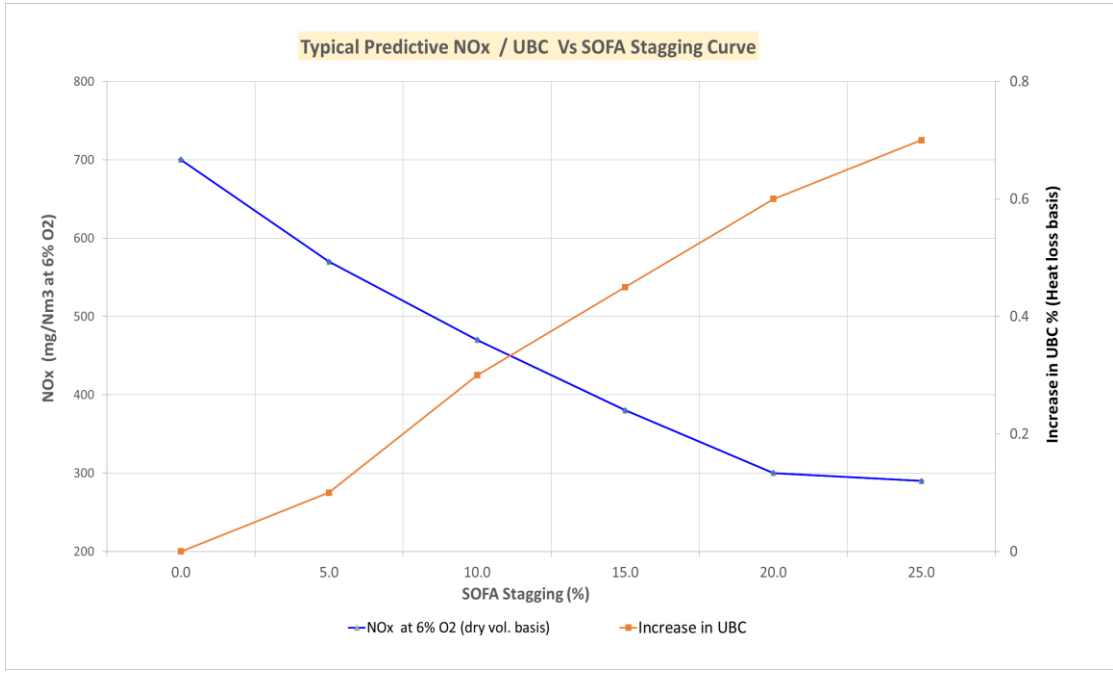
- Separated over fired Air (SOFA) dampers shall be in the range of 20% to 25% total air.
- %CCOFA shall be 10% to 12% as per the original design condition.
- SOFA wind boxes shall have 4 compartments.
- SOFA tips are designed for +/- 30 deg of vertical tilt & manually adjusted horizontal yaw of +/- 15 deg.
- SOFA wind boxes are in the corners directly above the main wind box to minimize potential formation of CO by covering maximum of furnace plan area.
- SOFA (Bottom) is placed at approx. 4-5 m above the top of wind box.
- Coal compartments will remain at their current location.

# Limitations in Combustion Modification in existing Boilers vs New Units



- Furnace Size Restriction
- Mill Size Restriction
- Mill PF Pipe Restriction
- Fan and APH size Restriction
- Water circulation ratio

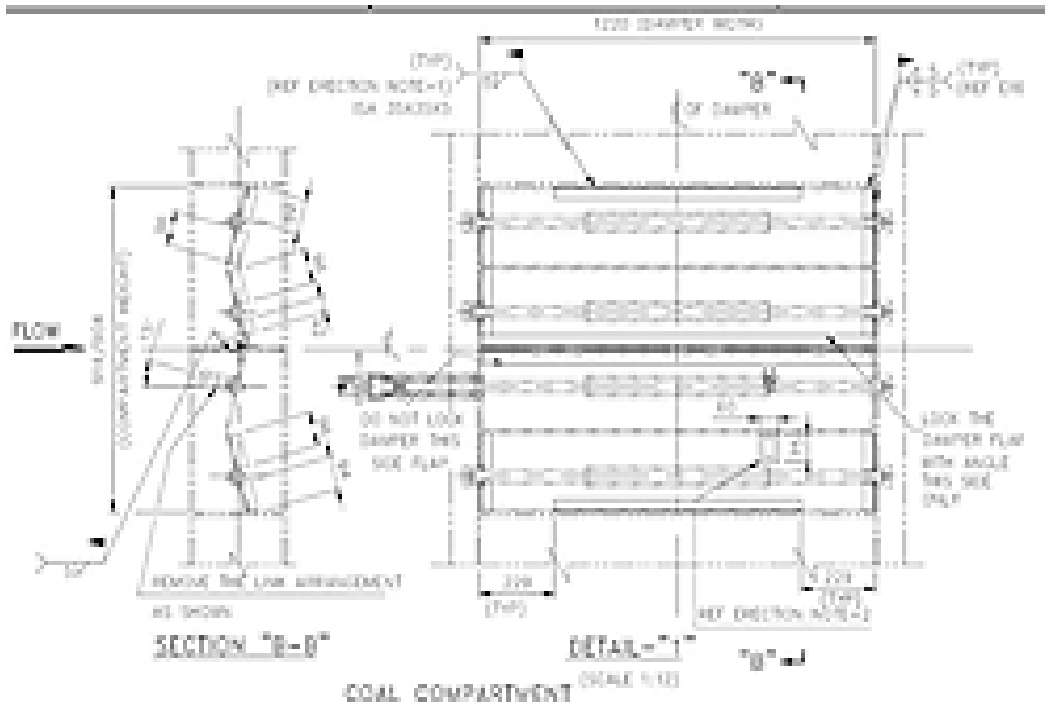
**Increase in Unburnt Carbon in existing Boilers wrt Indian Coal context**

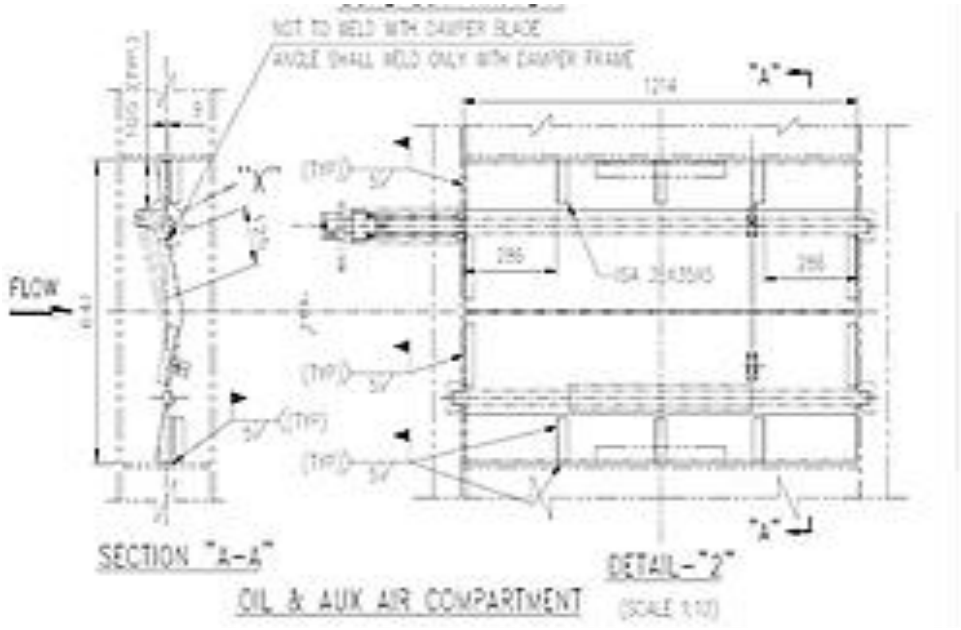


# Operational Challenges



- Difficult to maintain various parameters and performance at the level of pre modification- Like Windbox DP, Opening of Aux air dampers



# CASE STUDY FOR ANALYSING PERFORMANCE AFTER COMBUSTION MODIFICATION



## Before Modification- Base line Test

| Description / Load | 50% TMCR | TMCR | TMCR | 50% TMCR |
|---|---|---|---|---|
| Mill combination | D-E-F-G (Top) | A to F (Bottom) | D to J (Top) | A-B-C-D (Bottom) |
| UBC heat loss in BA in % | 0.39 | 0.16 | 0.08 | 0.06 |
| UBC heat loss in FA in % | 0.71 | 0.36 | 0.36 | 0.24 |
| Total UBC heat Loss in % | **1.10** | **0.52** | **0.44** | **0.30** |
| SH Spray in T/Hr | 103..8 | 3.2 | 28.2 | 1.8 |
| RH Spray in T/Hr | 0.0 | 0.0 | 0.0 | 0.0 |
| NOX in Mg/NM3 | Below 750 mg/NM3 for all conditions | | | |

## After Modification- PG Test

| Description | 50% Top | 100% Bottom | 100% Top | 50% Bot |
|---|---|---|---|---|
| UBC heat loss in BA in % | 0.43 | 0.47 | 0.40 | 0.51 |
| UBC heat loss in FA in % | 0.38 | 0.45 | 0.39 | 0.50 |
| Total UBC heat Loss in % | 0.82 | 0.91 | 0.79 | 1.01 |
| Increase in UBC loss in % from baseline | -0.28 | 0.39 | 0.35 | 0.71 |
| SH Spray in T/Hr | 87.2 | 11.6 | 47.9 | 22.9 |
| Increase in SH spray in T/hr from Base line | -16.6 | 8.4 | 19.7 | 21.1 |
| RH Spray in T/Hr | 0.0 | 0.0 | 0.0 | 0.0 |
| NOX in Mg/NM3 | Below 400 mg/NM3 for all conditions | | | |

# Impact of Combustion Modification on Boiler Parameters: Conclusion



- NOx Reduction
- Unburnt Carbon Loss
- SH & RH Spray Variation
- Waterwall Corrosion
- Impact on other parameters

# Thank You

*For discussions/suggestions/queries email: www.indiasmartgrid.org*
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