IED RELATING TO OIL AND GAS BURNERS FOR INDUSTRIAL USE

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JOINT MEETING OF THE COAL RESEARCH FORUM, (CRF), ENVIRONMENT DIVISION, THE COMBUSTION ENGINEERING ASSOCIATION, (CEA) AND THE ROYAL SOCIETY OF CHEMISTRY ENERGY SECTOR, (RSC-ES)

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HAMWORTHY
COMBUSTION

EU Directive 2010/75/EU

- EU Directive 2010/75/EU of 24th November, 2010
- Industrial Emissions Directive (IED)
- Integrated Pollution Prevention and Control (IPPC)
- Member States transpose into National Laws

DIRECTIVES

DIRECTIVE 2010/75/EU OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL

of 24 November 2010

on industrial emissions (integrated pollution prevention and control)

(Recast)

(Text with EEA relevance)

THE EUROPEAN PARLIAMENT AND THE COUNCIL OF THE EUROPEAN UNION,

Having regard to the Treaty on the Functioning of the European Union, and in particular Article 192(1) thereof,

Having regard to the proposal from the European Commission,

Having regard to the opinion of the European Economic and Social Committee (1),

Having regard to the opinion of the Committee of the Regions (2),

Acting in accordance with the ordinary legislative procedure (3),

Whereas:

(1) A number of substantial changes are to be made to Council Directive 78/176/EEC of 20 February 1978 on waste from the titanium dioxide industry (4), Council Directive 82/883/EEC of 3 December 1982 on procedures for the surveillance and monitoring of environments concerned by waste from the titanium dioxide industry (5), Council Directive 92/112/EEC of 15 December 1992 on procedures for harmonising the programmes for the reduction and eventual elimination of pollution caused by waste from the titanium dioxide industry (6), Council Directive 1999/13/EC of 11 March 1999 on the limitation of emissions of volatile organic compounds due to the use of organic solvents in certain activities and installations (7), Directive 2000/76/EC of the European Parliament and of the Council of 4 December 2000 on the incineration of waste (8), Directive 2001/80/EC of the European Parliament and of the Council of 23 October 2001 on the limitation of emissions of certain pollutants into the air from large combustion plants (9) and Directive 2008/1/EC of the European Parliament and of the Council of 15 January 2008 concerning integrated pollution prevention and control (10). In the interests of clarity, those Directives should be recast.

(2) In order to prevent, reduce and as far as possible eliminate pollution arising from industrial activities in compliance with the 'polluter pays' principle and the principle of pollution prevention, it is necessary to establish a general framework for the control of the main industrial activities, giving priority to intervention at source, ensuring prudent management of natural resources and taking into account, when necessary, the economic situation and specific local characteristics of the place in which the industrial activity is taking place.

(3) Different approaches to controlling emissions into air, water or soil separately may encourage the shifting of pollution from one environmental medium to another rather than protecting the environment as a whole. It is, therefore, appropriate to provide for an integrated approach to prevention and control of emissions into air, water and soil, to waste management, to energy efficiency and to accident prevention. Such an approach will also contribute to the achievement of a level playing field in the Union by aligning environmental performance requirements for industrial installations.

(1) OJ C 182, 4.8.2009, p. 46.
(2) OJ C 325, 19.12.2008, p. 60.
(3) Position of the European Parliament of 10 March 2009 (OJ C 87 E, 1.4.2010, p. 191) and position of the Council at first reading of 15 February 2010 (OJ C 107 E, 27.4.2010, p. 1). Position of the European Parliament of 7 July 2010 (not yet published in the Official Journal) and decision of the Council of 8 November 2010.
(4) OJ L 54, 25.2.1978, p. 19.
(5) OJ L 378, 31.12.1982, p. 1.
(6) OJ L 409, 31.12.1992, p. 11.
(7) OJ L 85, 29.3.1999, p. 1.
(8) OJ L 332, 28.12.2000, p. 91.
(9) OJ L 309, 27.11.2001, p. 1.
(10) OJ L 24, 29.1.2008, p. 8.

Combination of Existing Directives into IED

- Large Combustion Plant directive (LCPD);
- Integrated Pollution Prevention and Control directive (IPPCD)
- Waste Incineration directive (WID)
- Solvent Emissions directive (SED)
- Other directives relating to Titanium dioxide

UK Timetable

- Transposition into UK law by 6 January 2013
- New plant compliance from 6 January 2013
- Existing installations (but not existing LCP) comply by 6 January 2014
- Other activities not currently part of IPPC comply by 6 July 2015
- Existing LCP compliance from 1 January 2016

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Large Combustion Plant – NOx Emissions

Emission Limits - Oil Firing		
NOx in mg/Nm^3 (corrected for dry gas at 3% oxygen)		
Thermal Input	**New Plant**	**Existing Plant**
50-100 MW	300	450
100-300 MW	150	200
>500 MW	100	150

Emission Limits - Gas Firing		
NOx in mg/Nm^3 (corrected for dry gas at 3% oxygen)		
Fuel	**New Plant**	**Existing Plant**
Natural Gas	100	100
Other (includes COG and BFG)	100	200

HAMWORTHY COMBUSTION

Large Combustion Plant – Dust and CO Emissions

Particulate (dust) and CO emissions apply equally to new and existing plant

Emission Limits - Oil Firing		
dust in mg/Nm³ (corrected for dry gas at 3% oxygen)		
Thermal Input	**dust**	
50-100 MW	30	
100-300 MW	25	
>500 MW	20	

Emission Limits - Gas Firing		
dust and CO in mg/Nm³ (corrected for dry gas at 3% oxygen)		
Fuel	**dust**	**CO**
General	5	100
BFG	10	
Steel Industry Gas	30	

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Large Combustion Plant – SO_2 Emissions

SO_2 emissions apply equally to new and existing plant

Emission Limits - Oil Firing	
SO_2 in mg/Nm^3 (corrected for dry gas at 3% oxygen)	
Thermal Input	**SO_2**
50-100 MW	200
100-300 MW	200
>500 MW	150

Emission Limits - Gas Firing	
SO_2 in mg/Nm^3 (corrected for dry gas at 3% oxygen)	
Fuel	**SO_2**
General	35
LPG	5
COG	400
BFG	200

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What Can Be Achieved?

Typical Burners for Fire Tube Boilers
Individual Burners up to 25 MW

Achievable Emissions – Package Burners

Emissions in mg/Nm³
(corrected for dry gas at 3% oxygen)

Fuel	NOx	CO	SO_2	dust
Natural Gas	<80	<5	n/a	<5
Lpg	<200	<5	n/a	<5
Gas Oil	<180	<50	n/a	<20
HFO	<550	<100	1700 per 1% in fuel	<150

Above emissions are achievable without post-combustion cleaning systems, i.e. based on low NOx burner technology only

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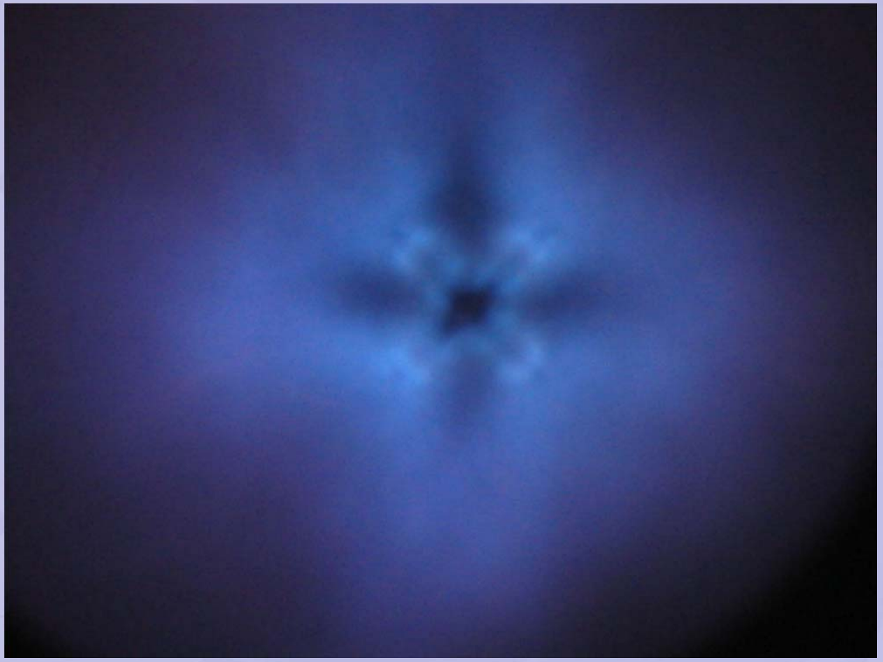
Packaged Burners for Fire Tube Boilers

- Gas, Oil and Dual Fuel Burner Sizes from 3 to 25 MW
- NOx reduction through air and/or fuel staging
- Low CO across turn-down range
- Wide turn-down range 6:1 or greater
- Excessive SO_2 and dust emissions only from HFO combustion – depend on fuel composition
- HFO NOx is higher due to N in fuel



What can be Achieved?

Typical Burners for Water Tube Boilers
Individual or Multi-Burner Installations
Burner Sizes from 3 to 100 MW
Multi-Burner Boilers up to 600 MW

Achievable Emissions – Power Burners

Emissions in mg/Nm^3
(corrected for dry gas at 3% oxygen)

Fuel	NOx	CO	SO_2	dust
Natural Gas	<100	<5	n/a	<5
Lpg	<100	<5	n/a	<5
Gas Oil	<100	<50	n/a	<20
HFO	<350	<100	1700 per 1% in fuel	<100

Above emissions are achievable without post-combustion cleaning systems i.e. based on low NOx burner technology only

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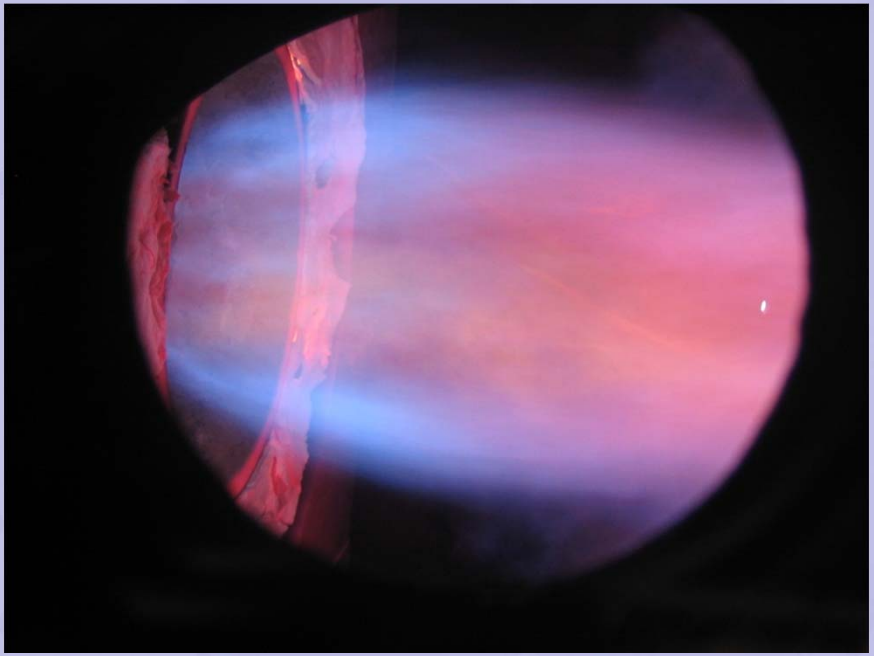
Power Burners for Water Tube Boilers

- Gas, Oil and Dual Fuel Burner Sizes from 3 to 100 MW
- NOx reduction through air and/or fuel staging. BAT is less than 20 mg/Nm^3 of NOx gas firing
- Low CO across turn-down range
- Wide turn-down range 6:1 or greater
- Excessive SO_2 and dust emissions only from HFO combustion – depends on fuel composition
- NOx from HFO depends on fuel nitrogen but can be less than 350 mg/Nm^3 with low NOx burner technology



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Factors Affecting Burner NOx Emissions

- Excess air
- Air Preheat
- Firing Intensity
  - Heat Release per Furnace Volume
- Turbulence and Mixing
- Fuel Composition

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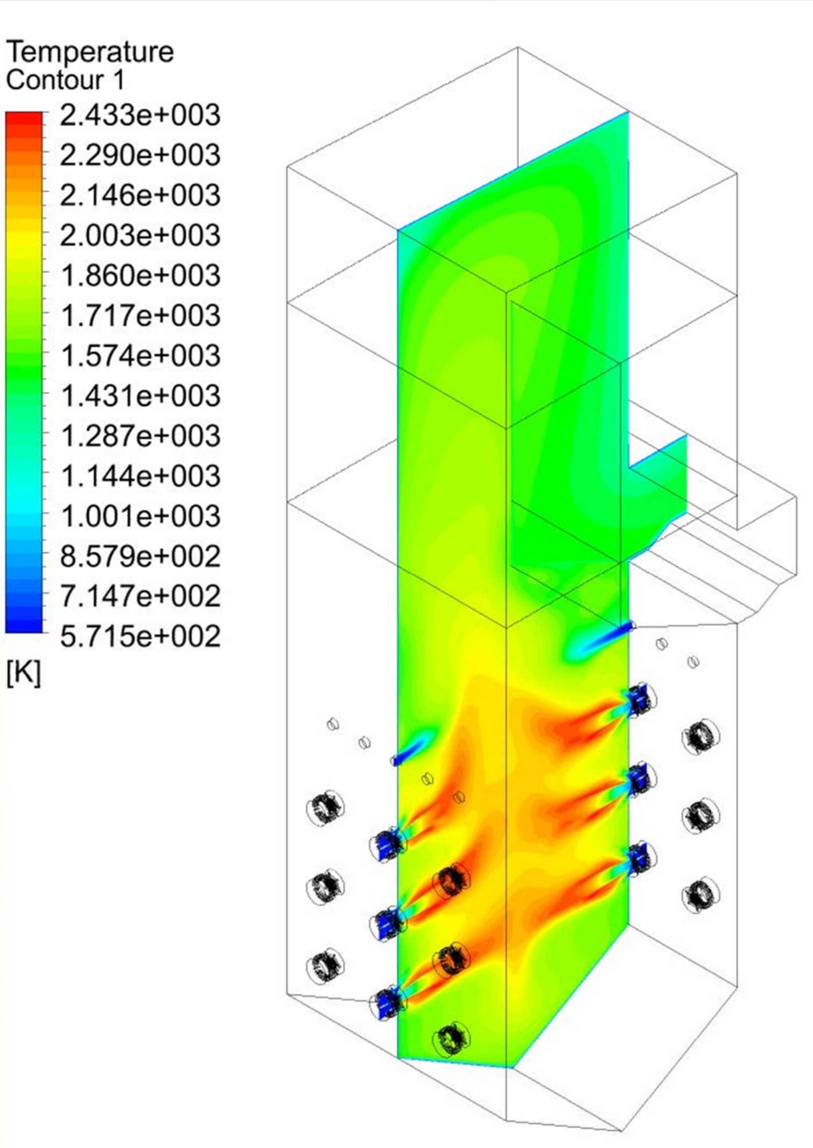
Post Combustion Emissions Reduction

- Costly systems applicable mainly for larger plant i.e. high pressure steam boilers
- In-furnace NOx reduction
- Flue Gas Acid Gas Scrubbing
- Dust Removal Systems

In-Furnace Systems

- Flue Gas Recirculation (FGR)
  - NOx reduction up to 75%
  - Some burners can use 30% or more FGR
  - Additional or larger fan required – increased electricity use
  - Increases mass flow
- Water Injection through Burner
  - NOx reduction up to 20%
  - Increases mass flow
  - Reduces efficiency
- Steam injection in (Gaseous) Fuel
  - NOx reduction up to 40%
  - Can use low pressure 'waste' steam
  - up to 0.5 kg / kg of fuel
- Steam injection in Air
  - NOx reduction up to 25 %

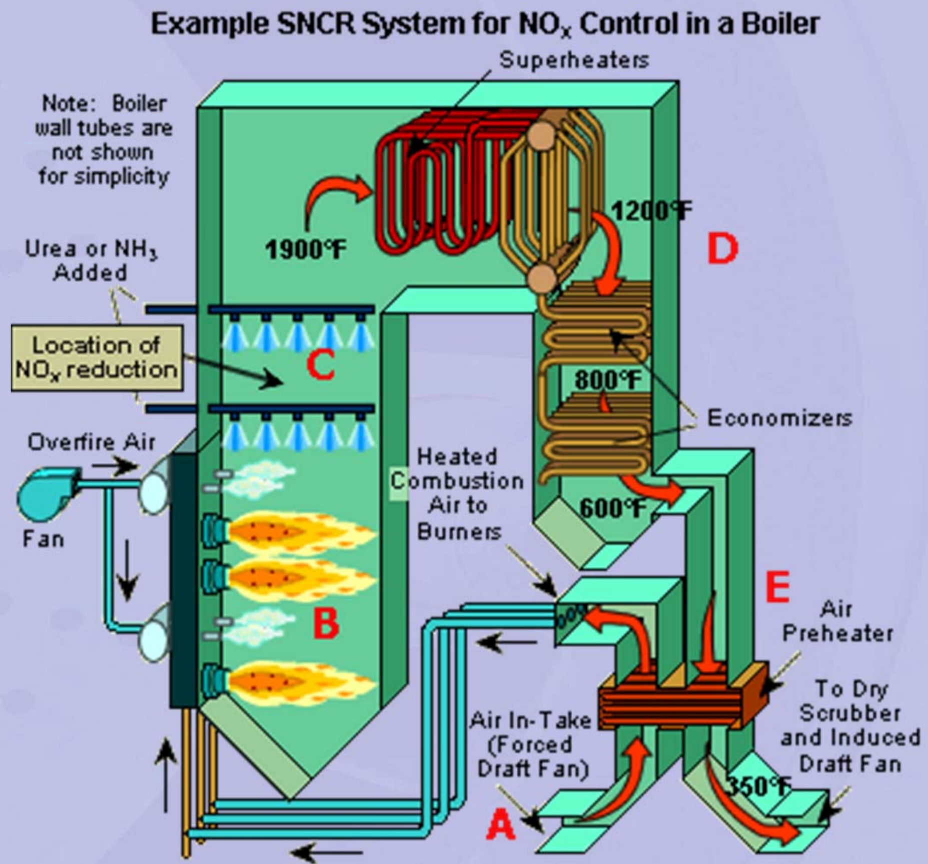
In-Furnace Systems, *Continued*



- Over-fire Air (OFA) or After Burner Air (AAP)
  - Applicable for multi-burner systems
  - Air Ports above top row of burners
  - Burners operate sub-stoichiometrically
  - Use CFD to aid design
  - NOx reduction up to 40%
- Row Staging
  - Lower Burners operate sub-stoichiometrically
  - Higher burners operate with higher excess air
  - NOx reduction up to 10%

In-Furnace Systems, *Continued*

- Selective Non-Catalytic Reduction (SNCR)
  - In-furnace injection of ammonia or urea
  - Limited temperature window (900 to 1000 °C)
  - Not suitable for all applications
  - NOx reduction 40 to 80%
  - Risk of ammonia ‘slip’
  - Ammonia emission limit <5 mg/Nm^3
- Re-burn
  - Similar to OFA but with additional gas burning downstream in furnace



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Post Combustion Gas Cleaning

- SO2 Removal
  - Wet scrubbing
    - Packed bed or venturi
  - Dry scrubbing
    - Lime injection in bag house
  - Efficiency >95% is possible
- Dust Removal
  - Bag House
  - ESP
  - Efficiency > 95% is possible

Post Combustion Gas Cleaning

NOX Reduction

- Selective Catalytic Reduction (SCR)
  - Injection of ammonia or urea
  - Catalyst bed to achieve efficiency
  - Capable of operating at low temperature
  - Suitable for installation after boiler and heat recovery
  - NOx reduction >90%
  - Ammonia emission limit
    <5 mg/Nm^3

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Terms and Conditions

- For retrofit applications, specific limits may not always be achievable due to furnace shape and firing intensity
- SO_2 and particulate emissions depend on fuel composition
- 1% S → 1700 mg/Nm3 of SO_2
- Ash in fuel is unchanged by combustion process

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How Can NOx Limits Be Achieved?

Emission Limits - Oil Firing			
NOx in mg/Nm³ (corrected for dry gas at 3% oxygen)			
Thermal Input	**New Plant**	**Existing Plant**	
50-100 MW	300	450	Can be achieved on some fire-tube boilers with gas oil and HFO firing and in-furnace techniques
100-300 MW	150	200	) Requires SNCR or SCR systems for HFO) combustion, low NOx burner technology for gas) oil combustion
>500 MW	100	150	

Emission Limits - Gas Firing			
NOx in mg/Nm³ (corrected for dry gas at 3% oxygen)			
Fuel	**New Plant**	**Existing Plant**	
Natural Gas	100	100	) Achievable with low NOx burner technology in all) applications)
Other (includes COG and BFG)	100	200	

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Summary

- Gas Firing Emission limits can generally be achieved with low NOx burner technology only - for most commercially available fuels
- Where fuels contain sulphur, ash or nitrogen (e.g. HFO) post combustion gas cleaning systems are almost certainly required
- Oil firing NOx emissions can generally be achieved with a combination of low NOx technology and in-furnace techniques
- Consideration of furnace and burner design together for new installations will be important for minimisation of emissions