Risk analysis and environment protection, PRA® (pollution reduction analysis) as an instrument of application of IPPC

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Abstract

Directive 96/61/CE (IPPC – Integrated Pollution Prevention and Control) has introduced the principle of pollution prevention and control by using the BAT (Best Available Techniques) and the necessity to revamp the plants according to the highest European standards. The definition and identification of what can be considered the "best available technique" for an existing plant is a very complex and difficult process. To identify environmentally critical aspects and impacts a detailed plant and process performance analysis is needed; a complete benchmarking with European and BREF performances is also needed. TRR in order to meet these requirements has developed a methodology that has been tested on several Italian plants in IPPC authorization request: PRA (Pollution Reduction Analysis). PRA will be described in this paper, showing some application examples. The PRA is a detailed process and emission parameter analysis allows one to pinpoint the instruments to meet the emission targets defined by BAT, choosing between the different alternative technologies proposed. The analysis allows one to pinpoint deviations/anomalies, causes and technical interventions that can produce useful results for the environment, for consumption reduction and an optimization of the resources used.
Keywords: environment, pollution, IPPC, best available techniques.

1 Purpose of IPPC Directive and other European environmental Directives

The purpose of IPPC Directive is to:

Art. 1

The purpose of this Directive is to achieve integrated prevention and control of pollution arising from the activities listed in Annex I. It lays down measures designed to prevent or, where that is not practicable, to reduce emissions in the air, water and land from the abovementioned activities, including measures concerning waste, in order to achieve a high level of protection of the environment taken as a whole, without prejudice to Directive 85/337/EEC and other relevant Community provisions.

Art. 3

Member States shall take the necessary measures to provide that the competent authorities ensure that installations are operated in such a way that:

(a) all the appropriate preventive measures are taken against pollution, in particular through application of the best available techniques;
(b) no significant pollution is caused;
(c) waste production is avoided in accordance with Council Directive 75/442/EEC of 15 July 1975 on waste (1); where waste is produced, it is recovered or, where that is technically and economically impossible, it is disposed of while avoiding or reducing any impact on the environment;
(d) energy is used efficiently;
(e) the necessary measures are taken to prevent accidents and limit their consequences;
(f) the necessary measures are taken upon definitive cessation of activities to avoid any pollution risk and return the site of operation to a satisfactory state.

Also the NECD Directive purpose (2001/81/CE) is to reduce total emissions of Sulphur (SOx) and Nitrogen (NOx) Oxides, volatile organic compounds (VOC) and ammonia (NH3) emitted from UE member state plants.

The Clean Air for Europe (CAFE) program leaded to the proposal of a directive defining minimum requirements for air quality.

Plants involved in an IPPC Authorization request will have to plan forward and meet all European Directives in matters of the Environment. Hence IPPC will be the instruments to reach and grant the acceptability of impacts of industrial plants.

Application of IPPC Directive is not the same in the UE member states:

- UK applies PPC principles since the 80's
- Spain has completely applied the Directive, but the way it was implemented is under critical analysis by the Commission.
- Germany and France application of the Directive has been judged inadequate by the Commission.
- Belgium and Netherlands has formally applied the Directive, reaching all of the IPPC targets and hence reducing significantly emission levels.
- Italy is vary late in applying the Directive, few authorizations has been released, and doubts about the right application of the principle of the Directive are emerging.

The commission has started the review process of the IPPC Directive and of the BREF document, and a program of recruitment and defining other requirements is expected.

2 Plant environmental analysis methodology

The methodology considers four steps:

1. Emissions and performance quantification and analysis.
2. Target definition.
3. Project alternative analysis.
4. Scheduling of changes.

2.1 Emission and performance quantification analysis

Four sub steps are considered:

- Detailed emission quantification in each media (air, water, ground, noise, etc.).
- Compliance with legislation (actual and future); respect of whole plant emission limits; compliance with special interest Directives (i.e. Large Combustion plants); compliance of emission fall out with environmental quality limits.
- Comparison between plant techniques and BREF; identification of plan feasible BAT; performance and energy efficiency benchmarking.
- Benchmarking: BREF performances, EPER and INES average emissions; local performances and special aspects.

2.2 Target definitions

Four sub steps are considered:

- Mass Flow and concentration reduction.
- Air quality limits compliance.
- BAT application.
- Performances targets (flow mass specific emissions, energy efficiency, raw material specific consumption, water consumption, etc.).

2.3 Project alternatives analysis

Three aspects are considered:

- Cost effectiveness.
- Feasibility.
- Timing for design and construction of changes.

2.4 Schemes

See schemes in figures 1 and 2.

3 Example: mineral oil refinery

3.1 Refinery brief description

- Medium size refinery: throughput: 5 M tonns/year
- Total electrical energy required 800 GJ/year @ 25 MWe
- Total thermal energy required 8000 GJ/year @ 250 MWt
- Fuel Need:
  - Fuel Gas @ 1000 ppmw S content 200.000 tonns/year
  - Fuel Oil @ 1,8%w S content 50.000 tonns/year
- Energy efficiency: EII = 105
- Complex refinery with Fluidized bed Catalytic Cracking plant (FCC)
  - Flue Gas @ 0,2%v S Content 700.000.000 Nm^3/year
- Simple (two stages) sulphur recovery plant
  - Efficiency of sulphur recovery 95%

3.2 Bottom-up analysis Δ1 (DELTA 1)

- Sulphur recovery Plant
  - Three stages recovery
  - Tail gas clean-up
  - Efficiency of sulphur recovery 99% minimum
- FCC Plant
  - Flue gas @ max 500 ppmv S content
  - Use deSOx catalyst
  - Desulphurization of FCC feed
- Burners
  - Use Low-Nox Burners on Fuel Gas burners

3.3 Top-down analysis

Emissive figure

Total SOX emissions: 6.778 tonns/year

- SOx from Fuel Gas 400 tonns/year
- SOx from Fuel Oil 1.800 tonns/year

• SOx from FCC	4.000 tonns/year
• SOx from Sulphur plant	580 tonns/year
• SOX Refinery Bubble	1.653 mg/Nm^3
Total NOX emissions:	1.688 tonns/year
• NOx from Fuel Gas	980 tonns/year
• NOx from Fuel Oil	280 tonns/year
• NOx from FCC	420 tonns/year
• NOx Refinery Bubble	412 mg/Nm^3

Top-Down Analysis Δ2 (DELTA 2)

• Energy efficiency:	EII = 90 max
• SOx emissions:	
o Use clean Fuel Gas	max 200 ppmw S content
o Use Low S Fuel Oil	max 1%w S Content

Compliance with actual and future legislation analysis and target identification

• SOX Emission limits	
o Actual	1.700 mg/Nm^3
o Future (2008)	1.200 mg/Nm^3
o Future (2012)	800 mg/Nm^3
• NOX Emission limits	
o Actual	500 mg/Nm^3
o Future (2008)	450 mg/Nm^3
o Future (2012)	300 mg/Nm^3

3.4 Impact analysis Δ3 (DELTA 3)

Air quality analysis

The air quality in areas surrounding the Refinery for a 4 km radius shows critical overcoming of air quality limits for about 30 days per year.

Fall-out evaluation

Emissions (SOx, NOX and particulate) fall-out has been evaluated with EPA model ISC III, with hourly meteorological data.

Simulations show that the contribution of Refinery emissions to air quality is very relevant, reaching 40% of pollutant ground concentration.

Emission reduction is needed also to reduce the contribution of refinery emissions to air quality.

4 Target identification

Relevant SOx and NOx emission reduction is needed to respect future emission limits and to reduce impacts on air quality. Reduction is also needed to meet LCP directive requirements.

Selected targets to be reached within 2012 are:

- Improve energy efficiency up to EII = 90
- Reduce SOx emissions:
  - Total mass flux from 6.800 tonns/year to 1.600 (85% red.)
  - SOx Bubble concentration from 1.600 mg/Nm^3 to 400
- Reduce NOx emissions:
  - Total mass flux from 1.700 tonns/year to 850 (50% red.)
  - NOx Bubble concentration from 400 mg/Nm^3 to 200

Many techniques are available to reach the targets. Below are described the selected techniques to be realized within 2012 with their effects on emission levels.

- Fuel Gas
  - Increase fuel gas cleaning reduction S content from 1000 ppmw to 200 ppmw → **red. of about 300 t/y SOx**
- Fuel Oil
  - Reduce Fuel Oil S content from 1,8%w → **red. of about 800 t/y SOx**
- Sulphur recovery plant
  - Changes installing 3rd stadium and tail gas clean up unit, increasing S recovery efficiency from 95% to 99,9 Reduce Fuel Oil S content from 1,8%w → **red. of about 580 t/y SOx**
- FCC plant
  - Install FCC feed desulphurization unit, reducing emission of about 90% → **red. of about 3.600 t/y SOx**
- Burners
  - Install Low-NOx an all gas burners, reducing NOx emission from 350 mg/Nm^3 to 50 → **red. of about 840 t/y NOx**

Cross media effects

Low-NOx burners will marginally increase particulate emissions (PM10).

5 Conclusions

The proposed methodology allows one to find the best solution to reduce emissions, that is the solutions with greatest benefits at lower costs.

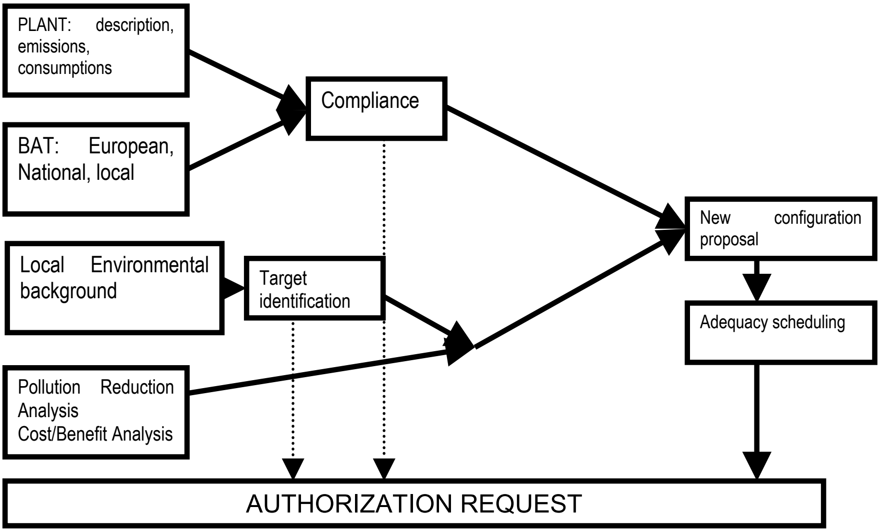

Figure 1: Permitting process.

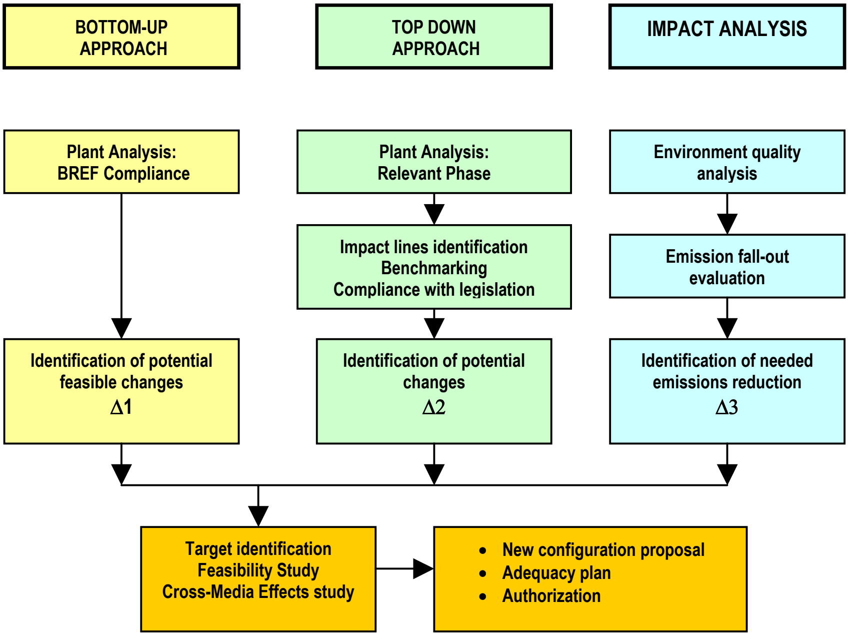

Figure 2: IPPC approaches.

It starts from a very detailed plant environmental analysis, that is also the first step to realize an Environmental management system, that gives to plant managers the opportunity to have a complete landscape on environmental aspects and issues both in a detailed view and in an overseeing way.

It shows which are the most critical aspects in terms of actual plant configuration and future development, and a method to find a feasible way to design interventions.

It also allows one to define long term plans (five to ten years) to reach the expectations of both actual and incoming legislation, and to be prepared to meet more stringent emission limits.

As shown, this methodology completely satisfies IPPC Directive expectations, and gives to authorities a complete screening of the plant, helping them in permitting procedures.

References

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