

ExxonMobil DESIGN PRACTICES	PLANT ENVIRONMENTAL CONSIDERATIONS	Section	Page
		XVII	1 of 20
		February, 2004	

CONTENTS

Changes shown by ↕

Section	Page
SCOPE	2
REFERENCES	2
INTRODUCTION	3
REGULATORY ISSUES	4
General	4
Air	4
Water	5
Solid and liquid Waste	5
Site Remediation	6
Noise	6
EMISSION AND CONTAMINATION SOURCES.....	6
EMISSION REDUCTION GUIDANCE	6
GENERAL PRACTICES	6
PROCESS AND EQUIPMENT RECOMMENDATIONS.....	7
Alkylation	7
Amine Treating, Sour Water Stripping, Sulfur Recovery.....	7
Catalytic Reforming	8
Caustic Treating	9
Coking	9
Desalting.....	9
Fired Heaters.....	10
Fluid Catalytic Cracking	10
Hydrogen Manufacture	11
Ketone Dewaxing	11
MTBE.....	11
Process Contact Steam Condensate.....	12
Sewers.....	12
Tankage.....	12
TABLES	
Table 1: Approach To Manufacturing Plant Environmental Control.....	13
Table 2: References To Major Environmental DP Sections.....	14
Table 3: List Of Major Emission Sources.....	15
Table 4: Types Of Site Contamination.....	16
Table 5: Components Of An Emission Reduction Program.....	17
Table 6: Emission Control Guidance	18

REVISION MEMO

February 2004 Many minor editorial changes and updates

Section XVII	Page 2 of 20	PLANT ENVIRONMENTAL CONSIDERATIONS	 DESIGN PRACTICES
February, 2004			

SCOPE

The Plant Environmental Considerations DP provides an overview of environmental control technology, types of contamination, and environmental control recommendations for specific process units. References for additional environmental guidance, including other DP sections, are listed below.

REFERENCES

1. Highlights of New and Proposed Air Toxics Regulations, EE.3E.91.
2. Site Remediation Regulatory Review, EE.42E.92
3. MEFA: Minimum Emissions Facilities Assessment, EE.12E.92
4. MEFA: Minimum Emissions Facilities Assessment - Phase 2, EE.123E.92
5. Rittmeyer, Robert W., Waste Minimization—Part 1: Prepare an Effective Pollution Prevention Program, Chemical Engineering Progress, May 1991, 56–62.
6. Guidelines for Preparing a Cost-Effective Environmental Assessment, 88 ECS2 79, August 26, 1988
7. Responsible Waste Management Practices, Version 2, Environmental Coordinators Network Best Practice, May 15, 2003
8. No Oil to Sewer Catalog, EE.76E.2002
9. Operations Integrity Management System (OIMS) Elements 3.4, 7.2, Facilities Design and Construction
10. Onsite Process Units, Wastewater Source Load Study, Environmental Control Toolmaking Project, February 21, 1975, by F.A. Devine, et. al., Correspondence no. 50012
11. Urban, D.B, R. R. Goodrich, "Refinery Process Unit Wastewater Load Factors-Final Report," EE.086E.86, October, 1986
12. Wastewater Management- Preferred Operating Practices, EE. 99E.98
13. Waste Preferred Operating Practices, EE. 82E. 97
14. Environmental Performance Indicators, Exxon Mobil Corporation Manual, 2002 EPI Manual, November, 2002
15. Best Practice for Managing Risk with the use of Third Party Waste Disposal Facilities, Air, Water, Waste Best Net
16. Environmental Business Planning Web
<http://emcorp.na.xom.com/she/corporate/docs/EBP%20Ref%20Guide%20-%20Dec.doc>
17. Energetics, Inc. AIChE, US Dept of Energy, "Waste Reduction Priorities in Manufacturing", a DOE/CWRT Workshop, August 1, 1994
18. F. H Vaughan, J. B. Wilkinson, "Safety and Environmental Procedures for Projects", TMEE 082, EE.72E.98, Dec. 1998
19. Environmental Procedure for Processing Challenged Crudes Web
http://emre.na.xom.com/waterwst/SRADOCS_s00/ChalCrude/EnvPtc/EnvPtc.htm
20. Global Best Practice for Processing Opportunity Crudes Web
http://emre.na.xom.com/waterwst/SRADOCS_s00/ChalCrude/EnvPtc/REI.htm
21. Refining Project Systems Manual, TMEE 0112, EE.49E.2002, June 2002

 DESIGN PRACTICES	PLANT ENVIRONMENTAL CONSIDERATIONS	Section XVII	Page 3 of 20
		February, 2004	

INTRODUCTION

Incorporating environmental considerations into plant operations and project design is essential due to continuously expanding regulations that affect the petroleum and petrochemical industries. Trends in regulatory requirements are moving beyond control of gross emissions and discharges, focussing more on targeted constituents and individual compounds. These regulations cover discharges to the air, water and ground, the generation of noise and odors, and the remediation of contaminated sites. Worker and community exposure, as well as impact on the environment must be evaluated as part of project planning and preparation of environmental impact assessments.

In addition to strict adherence to local environmental and health regulations, ExxonMobil has additional guidelines to assure that corporate environmental policy and operations integrity are considered. In many cases these may be more restrictive than local regulations. The effects of our plants on the environment play a major role in the public's perception of our operations. Good community relations is a valuable asset, and attention to plant discharges which may be of concern plays a major part in maintaining local support.

Good business sense suggests a stepwise approach when factoring environmental considerations into manufacturing plant expansions or new projects. The approach is summarized below, with a more complete description and examples contained in [Table 1](#).

- **Eliminate/Minimize** Sources of Emissions or Wastes by using alternative processes/equipment
- If Wastes/Emissions cannot be eliminated, **Recycle or Reduce** them
- If Wastes/Emissions cannot be reduced, **Treat** them cost-effectively
- If Wastes cannot be treated, **Dispose** of them properly

With reference to the ExxonMobil Refining Project System, environmental impacts should be identified and considered prior to Gate 1 in the business planning stage. A set of possible alternatives should be explored where environmental impacts are significant. A more extensive evaluation is needed during engineering screening studies done prior to Gate 2, as facility bases are prepared, compared and cost estimates developed.

It is important that environmental impacts are identified, and alternatives assessed in parallel with economic considerations. This early assessment within the planning process allows project management to make more-informed decisions when evaluating project alternatives and their impacts. A team of process and environmental engineers, along with regulatory compliance specialists should be consulted in the early stages of the project to identify environmental considerations.

In some cases, operating permits may need to be re-opened and re-negotiated with government authorities. In other cases, small incremental investments in low emission alternatives can result in large waste reductions or emission credits. These credits may be used with governmental authorities to gain more flexible operating permits, regulatory relief in other areas, or intangible, but important public perception credits.

Economic evaluation should consider all costs in the life cycle of the project and net environmental impacts should be identified. [Design Practices XVIII](#) through [XX](#) provide details on recommended procedures and control requirements for specific situations. This section provides an overview of the major environmental regulatory issues, a listing of emission sources and types of site contamination, and environmental considerations for specific equipment and process units.

[Table 2](#) may be used as a guide to locate sections containing information on a particular environmental control topic. Specific technology is arranged by environmental media (e.g. air, water, waste) and key contaminants.

The ExxonMobil Corporation Environmental Performance Indicators (EPI) Manual explains the EPIs that are tracked from different regions and segments of the business. Examples include effluent water discharge oil and biochemical oxygen demand (BOD5) in tonnes per year, and a number of air emissions, including VOCs, SO_x, NO_x and GHGs. These indicators and corporate targets should be considered when assessing plant environmental facility needs. The EPIs, and Emission Estimating Guide (EEG) and the guidance manual for Environmental Business Plans are tools that can be used to assess facility needs at the manufacturing plant.

Section XVII	Page 4 of 20	PLANT ENVIRONMENTAL CONSIDERATIONS	 DESIGN PRACTICES
February, 2004			

REGULATORY ISSUES

General

The environmental laws and regulations which affect ExxonMobil's operations continue to become more stringent and complicated. These regulations are usually specific to a particular country, state, or province and each location will have its own unique set of requirements which need to be met. It is of primary importance to be aware of current and potential environmental laws and regulations in order to maintain compliance and to prepare for future requirements. Sometimes minor modifications of existing facilities can cause a re-opening of an existing operating permit. In some cases there is opportunity for negotiation in setting both the quantity and concentration of permitted emissions, or site clean-up/remediation requirements. A recent trend is for regulators to accept "risk-based" solutions rather than strict adherence to numerical standards. Favorable changes in the details and implementation of regulations are sometimes possible if it can be demonstrated that regulations are unnecessarily excessive based upon human health considerations, environmental risk assessment (show negative net environmental benefit), and a cost versus benefit analysis. In addition, the new trend in regulation is to provide flexibility in achieving goals. This may allow alternative approaches such as an emission 'bubble' over the entire manufacturing plant, or emissions trading with other manufacturing plants which result in similar emission reductions at reduced cost, to be considered.

The charter of most environmental regulatory agencies is to provide for the protection of the community, plant workers, and the environment. Protection levels for the surrounding community and ExxonMobil personnel are documented in government and industry standards and ExxonMobil Biomedical Sciences (EMBSI) publications. These allowable levels are periodically revised, and care should be taken in obtaining the latest limits and in their use. Consultation with the plant Industrial Hygienist (IH) is recommended to clarify appropriate long and short term personnel exposure limits. In some locations, limits on emissions or clean-up requirements are also set to preserve the "quality of life". This includes such intangibles as the effects on vegetation and animal species as well as odor and noise annoyances.

In most locations, there is a need to obtain a "permit or license" before starting construction or as a condition of being able to operate the facility. These permits usually set out the allowable emissions from the operation and may document the required equipment deemed necessary for control. Various impact analyses may be required in order to determine ambient concentrations resulting from plant emissions. The most stringent regulatory agencies are likely to require risk assessments which fully document emissions to all media and consider combined effects of different emissions on the surrounding community. These analyses involve emission estimates, dispersion modeling, water effluent estimates and population density and land use considerations (e.g. schools, health care facilities). For site remediation, clean-up requirements may be based on fixed regulatory contaminant concentrations or may be derived from a risk analysis.

Air

There are several different types of emissions to the air which may be a concern. These include the products of combustion, volatile organic compounds, hazardous air pollutants, and particulate matter. Regulation of combustion processes has historically focused on the emission quantity and concentration of oxides of sulfur and particulates based on respiratory concerns. More recently, oxides of nitrogen have received increased attention due to both acid precipitation and ozone formation. Particulate emissions have also received additional focus due to the heavy metals which may be present in the particulate phase and the potential effects of fine particulate matter. The ambient concentration of fine particulate matter (less than 2.5 micron), which is generally emitted in aerosol form from combustion operations and atmospheric interactions, is now being regulated. The other recent expansion of controls on combustion emissions relates to the so called "greenhouse" effect (global warming) and limits carbon dioxide and methane emissions (greenhouse gases).

Controls on the emissions of volatile organic compounds (VOCs) and on air toxics significantly affect facility operations. In many locations, the concentration of ozone (urban smog) is above health based standards. Although emissions from mobile sources contribute significantly to these high ozone levels, controls are focused on industrial sources of VOCs and nitrogen oxides (NOx). Addressing concerns about emissions of air toxics and other potentially hazardous releases and their effects on the surrounding community is one of the most active regulatory areas. Air emissions from fugitives (valves, pumps, etc.), tanks, waste water treating, loading operations and vents are receiving increased attention and, in some locations, controls requiring ninety percent or greater reduction in emissions are being required. Leak detection and repair programs (LDAR) are becoming prevalent, requiring measurement and

 DESIGN PRACTICES	PLANT ENVIRONMENTAL CONSIDERATIONS	Section XVII	Page 5 of 20
		February, 2004	

correction of fugitive emissions. Emissions of polynuclear aromatics (PNAs) and heavy metals on particulates from sources such as landfarms, unpaved roads and site remediation operations are also receiving increased attention.

Planning for and mitigating the effects of accidental releases of hazardous vapors has been a major focus of recent regulation. New dispersion models are used to determine the potential affected areas in the result of a spill and also to evaluate the effectiveness of various controls. Incidental releases of VOCs and toxics are often the cause of community odor complaints which are sometimes regulated to protect the "quality of life."

There is an increasing trend toward international agreements to address air pollution concerns since in many cases the effects of emissions are evident large distances from the sources. Reduction of acid precipitation was part of an agreement between Canada and the United States. More recently, the Montreal Protocol, an international agreement to halt production of certain chlorofluorocarbons, was negotiated to mitigate the depletion of stratospheric ozone.

Water

Quality requirements for industrial wastewater effluents have changed significantly worldwide since the passing of the Clean Water Act in the United States in 1975. Past regulations focused on conventional contaminants such as oil and grease, biochemical oxygen demand (BOD5) and suspended solids (TSS). In many locations, regulatory authorities are continuing to reduce the allowable concentrations and mass limits of these indicator parameters of pollution. In these regulations and many others worldwide, additional emphasis is on the control of toxic compounds. Specific effluent concentration and/or quantity limits are being imposed on industrial facilities for compounds such as phenolics, benzene, and metals. In many locations regulatory agencies are placing limits on nutrient (nitrogen and phosphorus) discharges which may cause uncontrolled algae or vegetative growth (eutrification) in receiving bodies of water. The vegetative growth, if escalated to an undesirable stage, can reduce the intended uses of the water resource, negatively impact wildlife, change the aesthetic appearance or quality, or increase the cost of pretreating the water for industrial, domestic or agricultural uses. Regulatory limits for acute and chronic toxicity to aquatic organisms has become more common, and can affect the selection of WWTP equipment considered in plant design.

Many environmental agencies are requiring more consistent compliance and more frequent monitoring and reporting for established effluent limits. The capability of new analytical methods to measure very low concentrations is creating the need for increased emphasis on reducing toxic contaminants. In locations that require maximum water reuse, concerns focus on avoiding excessive concentration of the contaminants that need to be treated prior to discharge. Also, new projects are changing the types and quantities of compounds entering the wastewater system. The need for more consistent compliance has introduced other challenges to the WWTP operation. Sparing philosophy has to be considered since there will likely be no scheduled WWTP turnaround for a significant period of time, much longer than typical refinery petroleum process equipment. Therefore, all WWTP equipment has to be designed for removal from service with part or all of the facility in operation, while continuing to meet all discharge requirements.

New regulations are starting to consider the tendency of certain compounds to bio-accumulate in aquatic organisms. The protection of larger systems, such as watersheds, is also under regulatory consideration and may require extensive sampling, analysis and modeling of wastewater effluent discharges into these water bodies.

An understanding of current and projected air emission requirements at the WWTP is essential, as it will impact treatment plant equipment selection, since certain types of equipment are not amenable to retrofitting to meet more stringent air emission standards.

Solid and liquid Waste

Until the mid 1970s, solid and liquid waste disposal consisted mainly of biological treatment via landfarms and burial in landfills. Increasing concerns over protection of human health and the environment have led many countries to place restrictions on the disposal of these "hazardous" wastes. New regulations have been enacted to protect the quality of ground and surface waters, the air, and land from contamination by solid waste. Today, in many countries, biomass is classified as "hazardous or dangerous" waste.

A solid or liquid waste may be deemed hazardous based on its quantity, concentration, physical or chemical properties. Wastes may be classified as hazardous if they may cause, or significantly contribute to, a substantial present or potential hazard to human health or the environment when improperly treated, stored, transported, or disposed. A solid waste is usually classified as hazardous when it exhibits characteristics of ignitability, corrosivity, reactivity, or toxicity. In many locations, specific manufacturing by-products or process streams have been classified as hazardous. The definition of hazardous may differ between states, provinces, or countries.

The trend in solid/hazardous waste regulation focuses on the "cradle to grave" concept of hazardous waste management. This approach involves comprehensive tracking procedures and full documentation of waste

Section XVII	Page 6 of 20	PLANT ENVIRONMENTAL CONSIDERATIONS	 DESIGN PRACTICES
February, 2004			

generation, shipment, storage, treatment and disposal. Several regulatory bodies now limit the transport of hazardous wastes to other jurisdictions for disposal. ExxonMobil regions and operating affiliates have plans for managing wastes properly to meet company and government needs. This approach is clearly communicated in OIMS 6.5, which requires a system be in place to track emissions and wastes, to evaluate pollution prevention steps, and to control emissions and wastes consistent with policy, regulatory requirements, and business objectives. ExxonMobil maintains a list of Approved Hazardous Waste Sites, which are periodically audited to ensure that potential liability to the company is minimized (refer to ExxonMobil Waste Disposal Site Audit List). If certain wastes cannot be accepted at these audited sites, treatment facilities may need to be installed on-site.

Site Remediation

Regulations covering the remediation of contaminated sites are focused on reducing the volume, toxicity and/or mobility of the contaminants. These regulations are often focused on protecting groundwater quality. Historically, regulations have addressed clean-up of current or recent contamination. More recently, regulations mandate the remediation of older spills, leaks and disposal sites.

Clean-up levels are often fixed by regulation, but may be negotiated based on general guidelines and risk assessments of site specific conditions. Separate surface and sub-surface clean-up levels may be used, reflecting different exposure pathways and potential health risks. In most locations, remediation requirements are based on specific contaminants of concern as well as general parameters such as the total hydrocarbon present. There is a trend toward setting levels based on risk to humans and ecological receptors. Since many of ExxonMobil manufacturing facilities have been in operation for over 50 years, project planners need to factor in the cost of contaminated soil handling and disposal during the construction of new projects or revamp of existing facilities where soil excavation and removal is planned.

Noise

Regulations to control noise are based on protection from hearing damage as well as mitigating annoyance to preserve "quality of life." In addition, limits are sometimes set to ensure clear communications in control rooms. Standards for worker safety have been established and appropriate noise levels for industrial, commercial and residential areas need to be checked for the particular local jurisdiction. Currently, there are workplace and community noise limits in most countries.

Noise sources which may be regulated include blowers, gas turbines, fired heaters, construction equipment, motors and engines as well as intermittent noise sources such as flares, safety relief valves, and other flow induced noise. Options for controlling the generation of noise and thus mitigating its effects include purchasing low-noise equipment and installing noise control devices such as enclosures, pipe insulation and silencers.

EMISSION AND CONTAMINATION SOURCES

Table 2 lists the major sources of plant emissions along with the pollutants usually associated with each source. Table 3 lists the types of site contamination. Air emissions estimating procedures are included in the ExxonMobil manual at the following website: http://emre.na.xom.com/tmee046/contents_sra/tmee046.htm

EMISSION REDUCTION GUIDANCE

GENERAL PRACTICES

There are usually a number of ways in which emissions of various pollutants can be reduced. In some cases there are technical limitations, but most often cost is the major consideration. The first part of this section is focused on reducing the generation of wastes rather than treating or controlling them with "end of pipe" methods. These activities have been referred to as "pollution prevention" or "source control". The second part of this section provides specific recommendations for emissions reduction in manufacturing plant operations. A key activity to evaluate emissions and potential reduction is to prepare a flow sheet and material balance on the particular facility or project under consideration. Air Emission estimating tools are on the SHE website (<http://emcorp.na.xom.com/she/>) and in the Emission Estimating Guide and water/wastewater estimation guidance can be found in the Environmental Design Practices.