PETROLEUM REFINING

1. To this category belongs the manufacture of a range of petroleum and chemical products, fuels, lubricants, tar sand and chemical intermediates product made from crude oil. Petroleum refining is done through the following steps: (a) separation of petroleum fractions according to boiling range and end products (b) conversion of the compounds by making division, rearrangement or recombination of compounds molecular, (c) treatment to remove pollutants such as sulfur, (d) mixing of additives to products in order to meet the technical specifications.

Potential impacts on the environment

2. Impacts that represent an oil refinery on the environment are mainly due to emissions of gas, waste water discharges, solid waste, noises and odor nuisance and aesthetic or visual inconvenient it brings.

3. Air emissions are primarily responsible for the effects that the refineries are doing to the environment, particles, hydrocarbons, carbon oxide, oxides of sulfur and nitrogen being the most important. These emissions come from various sources, the catalytic cracking unit, and methods of sulfur recovery, heaters, ventilation equipment, flares and storage of products or raw materials. Pump seals and valves can be the source of fugitive emissions. The combined emanation can cause repulsive odors disturbing large areas that surrounding the refinery.

4. Petroleum refining consumes large quantities of water that are used to wash the superfluous material caused by the flow of processing, the production of water vapor and cooling and reaction processes. The main pollutants in waste water from oil refineries consist of oils and fats, ammonia, phenol compounds, sulfides, organic acids, chromium and other metals.

These pollutants can be expressed in terms of biochemical oxygen demand (BOD_5), chemical oxygen demand (COD) and total organic carbon. There is also risk that surface water, soil and groundwater are seriously polluted by leaks, spills of raw materials and various products. Drain cooling water, the flushing washing water, the flow of rainwater entering the farms and rods tank, products and treatment storage areas can also cause degradation of surface water and groundwater.

5. The refineries generate abundant amounts of solid waste that mainly consist of catalyst fines, coke fines from crackers unit, iron sulfides, filtering agents and sludge (issued by sewage tanks, separating oil and water and by waste water treatment systems).

6. Oil refining operations can cause significant noise. Compressors at high speed, control valves, pipes, turbines and engines, flares, heat exchangers for cooling air and cooling towers and ventilation systems belong to the sound sources. Noise levels generally range between 60 and 110 dB over a distance of one meter (see Table attached which present other examples of the negative effects of oil refineries on the environment and recommends measures to avoid or mitigate these impacts).

Specific issues

Risk of accidental spills

7. A serious accident like a major spill of raw materials, products or waste can have disastrous effects on the nature and especially on marine and aquatic ecosystems. Groundwater's especially, are easily contaminated by leaking tanks or pipelines that have not been detected. It would be good if the refineries are located away from areas prone to natural disasters (floods earth

quakes, storms, floods, adverse weather conditions, etc.) and away from sensitive resources that can not be protected from a risk of serious spill. It should be necessary that the design of storage and transshipment facilities provides means to control spills. Pipelines should be equipped with alarms and automatic shut-off valves which immediately respond to operational failures. Frequent inspections of tanks and pipelines to ensure that leaks do not occur should be part of the factory operation procedures.

8. A training program on safety and response to a spill should be routinely provided to personnel involved in transporting raw materials and products. It would require that local authorities in conjunction with the hospitals involved in the implementation of an intervention plan enrolling in the project. This plan should also include provision for notification of person's responsible and affected parties (eg. Downstream users, fleets, ports and marinas, tourist sites), provisions assigning devolving responsibility to undertake containment and cleaning operations, evacuation procedures, medical care and equipment and advanced materials acquisition.

Explosion and Fire risks

9. Raw materials and petroleum products are substances mainly combustible or explosive nature, the establishment of a refinery should consider these risks. The project should design each installation and set up procedures which govern in manner to limit the risk it represents. In addition, any refinery should have a fire alarm system. It should evaluate and strengthen the capacity of neighboring communities, if necessary. Refer to guidelines "Industrial risk management" for more details.

Reduction, recycling and reuse of waste

10. There are two types of applicable measures in a refinery that allow to substantially reducing the volume of effluent. The first approach is to reuse water from one process to another by using, for example, purges issued by

high-pressure boilers to supply low pressure boiler or to use treated effluent as water replacement when this is possible. The second seeks to establish recycling systems that serve water each time for the same purposes; water used in cooling towers or for condensing steam could, for example, supply boilers.

11. Appropriate maintenance measures combined with good working practices will further reduce the waste stream. To test the range of products, using of vacuum or methods of dry cleaning of spills, apply means of inspection and maintenance practices to reduce leakage and separate waste streams containing features specific prior to discharge (degreasing solution, among others) are examples of ways to reduce waste.

Alternatives solution to projects

Selection of the area

12. The nature of an oil refinery is such that the effects on water quality, water resources and aesthetics require one pays particular attention to the evaluation of possible locations. Among the requirements for the establishment of a refinery, it must consider the following points:

• Quality and quantity of adequate water resources to supply the needs of the refinery and absorb the treated effluent, without impeding the desired uses or damage outfalls;

• Availability of spaces for the programmed location and extend of raw materials storage, transformation and evacuation of waste and that are sufficient for future developments;

• compatibility with adjacent land uses, in a place, for example, far enough away from residential, commercial, institutional and recreational and tourist

sites, to avoid degradation of air quality, noise or odor nuisance and the risk of explosion and fire;

• Satisfactory topography to reduce the effects of adverse weather conditions;

• Low risk of damage caused by natural accident;

• avoid areas of groundwater recharge;

• Sufficient distance from the cultural heritage that may be damaged by emissions generated by refineries.

Transportation of materials

13. Most serious oil spills are the result of accidents that occur during it transport. Each conveyance of raw materials that feed the refinery or products coming out is the risk of spillage. The magnitude of these risks depends to a large extent, geographical conditions and the state of the country's infrastructure. It is possible, in conjunction with the fragility and importance of ecological and socio-cultural resources that can be damaged, to compare them with the costs incurred by other modes of transport and their effects on the environment and thus to decide what would solutions to be adopted for a given refinery. There are cases where it is possible to reduce to acceptable levels the potential impacts of a company located in a certain place by selecting a specific method of transportation facility; for example, in a coastal region prolonged by delicate wetland area, it should be necessary to install buried pipelines or above the soil that would route to the refinery rather than resorting to tankers, barges, or means of using railway or road transport.

Changing methods of treatment

14. Changing of treatment methods environmentally beneficial and applicable to both existing and new facilities could, in most cases, include:

• Replacement by improved and more resistant catalysts whose regeneration is less frequent;

• Replacement by air cooling instead of water cooling (to reduce emissions purge), and from a recirculation procedure to system without recycling;

• Maximization of procedure based on hydrogen addition and minimization of chemical treatment procedure and carbon elimination in order to produce minimal waste as possible;

• maximum use of improved drying, smoothing and finishing methods in order to reduce the production of spent caustic soda, solid filtration and other substances requiring special evacuation measures.

Management and training

15. Effective management allowing fighting against pollution and reducing waste involves institutional support to mitigate the potentially negative effects that oil refineries have on air quality and water effects. The factory personnel should receive training on the fighting technology against pollution of water and air used. Manufacturers are usually willing, upon request, to provide training sessions explaining how to use and maintain equipment. It would be important that standard operating procedures are established for the refinery and implemented by management. Means of pollution control and monitoring air and water quality should be part of it as well as instructions for the operating personnel of the company explaining the ways to control noxious emissions; guidelines warning the authorities' of an accidental discharge of pollutants should also be implemented. Detectors, alarm devices, for example, and a special training given to operating staff will allow enhancing the handling and management of toxic and dangerous substances.

16. It is essential to provide emergency and rapid response to incidents such as a spill, fire, explosion, which pose serious threats to the environment and to the surrounding community. Insofar as the local government officials as well as local agencies and services, (medical and firefighters, etc.) Play a crucial role in this type of intervention; it would be appropriate to participate in planning process. Periodic evacuation exercises are important aspects of intervention plans (see section "Managing Industrial Risk" for more details).

17. Regulations on health and safety should be developed and implemented in the factory. These regulations should include ways to maintain exposure to noise and toxic substances within the accepted limits, a routine medical visits program and finally, provide ongoing training on issues of health and safety aspects and on environmentally maintenance practices (see guidelines on "industrial risk management").

18. Standards for emissions and effluents applying to the factory should be guided by national regulations, if they exist, or be derived from standards preconize by the Bank. Government agencies should have at their disposal the necessary equipment, be invested and have received specialized training in monitoring and commissioning of pollution control equipment, to uphold standards and to take measures an emergency response. The environmental assessment should take into account an estimation of local capacities in relation to these issues and recommend principles of assistance needed to be included in the project.

Monitoring

19. Plans for specific follow-up of a factory and location monitoring are required and, in general, the following elements are part of the refinery monitoring:

- smoke opacity (continuous monitoring);

• Periodic inspection of chimneys by monitoring particles, sulfur oxides and nitrogen (in units of fuel combustion and catalytic cracking) and hydrogen sulfide (in the units that carry out hydro operations - desulphurization or sulfur recovery);

• On ground level concentrations at varied distances away from the location;

• Oil containing in waste water (continuous monitoring);

• Local weather station determining the weather conditions throughout the year;

• Taking of waste water samples periodically (an average sample measured over 24 hours) by monitoring the biochemical oxygen demand (BOD_5), chemical oxygen demand (COD), total organic carbon, suspended solids (TSS), oils and fats, phenol compounds, ammonia nitrogen, the sulfides, the total chromium, and their pH and their flow temperature;

• Continuous monitoring of certain parameters to quickly detect failures in the processing operations;

• Installation of observation stations and taking of groundwater samples periodically to immediately notify the water pollution caused by leaks or spills.

Table: Summary of impacts and mitigation measures

	Potential negative impacts	Mitigation measures
	Direct impacts : selection of the location	
1	Establishment of a refinery on or near sensitive habitats, such as mangroves, estuaries, wetlands and coral reefs.	• Install, if possible, the refinery in an industrial area to reduce or concentrate the pressure on environmental services in the region and to facilitate the monitoring of discharges. • Involve natural resources management agencies in the choice of location to conduct the review of alternatives.
2	Location along a watercourse that may cause degradation.	The choice of location should consider solutions having on the environment as little impact as possible and do not compromise the benefits represented by the exploitation of water bodies by following the instructions below:

		• streams with sufficient assimilative capacity • area where you can recycle waste water in agricultural and industrial activities after a minimum treatment • municipal sanitation network that can be able to receive waste water produce by the facility
3	Localization that can cause serious air pollution problems in the area.	Install the refinery in an area that does not undergo atmospheric inversions or does not collect air pollution and where the prevailing winds blow towards areas little populated.
4	Implantation that can intensify the solid waste problems facing by the community.	It would be important to assess the location of plants producing large amounts of waste from the following guidelines: • size of the field that provide an on-site elimination system or a discharge • proximity to a suitable discharge • Accessibility for public or private collection service to transport solid waste to its final destination.

Direct impacts: Exploitation of the factory

5	Water pollution caused by discharges of liquid effluents, cooling water or runoff from waste piled up which can contain: BOD, COD, total organic carbon, oil and grease, ammonia, phenol, sulfides and chromium compounds.	Reuse waste water through pretreatment technologies to source and final inspection. (a) The main measures of pretreatment at the source include: • neutralization of acidic waters • neutralization and oxidation of spent caustic (b) The final control technologies based on a set of flow equalization methods, physico-chemical processes (eg. oxidation and sludge thickeners) and biological (eg. activated sludge aeration lagoons or trickling filters)
6	Water pollution from refinery activities:	Reduce air pollutants and odorous emissions through measures to monitor the following source:
	(a) Storage Tanks - Hydrocarbons (HC)	(a) vapor recovery systems, floating roof tanks, pressure vessels, balancing vapors, tanks painted in white color

(b) a refinery transforming gas - hydrogen sulfide (H_2S)	(b) absorption of ethanolamine, sulfur recovery
régénérateurs catalytiques – particules, oxyde de carbone (CO) (c) catalytic regenerators - particles, carbon oxide (CO)	cyclone-rushing on the area, CO combustion, CO's boiler, water cyclones scrubber, multi cyclones, electrostatic dust collectors, bag house,
(d) Prises d'air des accumulateurs – HC	(b) Recovery and vapor incineration
(e) Pompes et compresseurs – HC	(c) joints plans, vapor recovery, oil sealing gland, maintenance
(f) Ejectors – HC	(d) vapor incineration
(g) valves – HC	(e) inspection and maintenance
(h) depressurization valves – HC	(f) Recovery and incineration of vapor, rupture of discs, inspection and maintenance
(i) Liquid waste evacuation – HC	(g) formwork scrubbers, fluid valves in the flow channels
(j) Unloading materials installations - HC	(h) sensing of vapor with recovery or incineration, filling by immersion or

	by the bottom
(k) Treatment with acid - HC , sulfide , mercaptan	(i) continuous-type agitator with mechanical mixing, replacement by catalytic hydrogenation units, incineration of all discharged gases, stopping the combustion of the sludge
(l) Storage and transport of acid sludge - HC	(j) cf. (k)
(m) Handling of residual caustic soda - sulfide , mercaptan	(k) vapor purifying, incineration by neutralization, closed circuit
(n) softening Procedures– HC	(l) washing with vapor water solutions to plombite exhausted to recover hydrocarbons before discharge into the atmosphere, treatment unit replacement by more acceptable facilities
(o) Treatment with acid water - ammonia (NH_3)	(m) make use of oxidizing acid water, gas incineration and conversion into ammonia and ammonium sulfate
(p) Elimination of mercaptan	(n) processing bisulphide, adding it to the load of catalytic cracking, incineration, use of substances in form of organic synthesis

	(q) Blowing of asphalt -HC	(o) incineration, washing with water (not in closed circuit)
	(r) decommissioning, complete review of the industrial unit	(p) depressurizing and draining for vapor recovery
	(s) Boilers and radiators - SOx, NOx , particles	(q) hydrodesulphurization of fuel and chimney gas desulphurization
	(t) sulfur recovery unit (Claus) - SO_2	(r) treatment of tail gas, start the replacement unit when the main is not working
	(u) solvents (hydrocarbons, amines)	(s) providing recovery units at closed circuit
7	Noises emissions	• Enclose equipment or noisy processes in structures that mitigate the potential noise. • Use noise reduction procedures.
8	Accidentally spill of raw materials, ends products, potentially dangerous solvents,	• Inspect and maintain storage areas and disposal to prevent accidental spills.

	chemicals, acids and alkalis.	• Install alarms, stop valves and provide confinement systems (containment, storage bowl) accidental spills as well as equipment to reduce impacts and emergency plans.
9	Risk of surface water and groundwater pollution due to runoff and infiltration of compounds, raw materials and from treatment facilities and transfer points.	• Apply appropriate regulations of percolation and rainwater runoff for the transport of raw materials or products that can be controlled using tarps or containment system. • It would be important that the dikes are sealed and of sufficient size to contain an average rainfall of 24 hours.
Indirect impacts		
10	Health Risks of workers caused by the manipulation of materials or manufacturing	The facility must develop a comprehensive health and safety program designed to identify, assess , monitor and control risks to the health and

	processes and exposed to fugitive dust and noise.	safety of employees to meet the dangers they face and put in place protection measures comprising one or all of the following aspects : • Characterization and analysis of the site • Control of the location • training • health surveillance and monitoring of clinical records • controlling of engineering work , working methods and personnel protection equipment • monitoring • information programs • handling of raw materials and processed products • intervention measures in case of emergency • lighting • sanitation system in permanent and temporary units
11	Regional solid waste problem intensified by inadequate elimination system.	Provide for the appropriate elimination areas on the site by assuming that the characteristics of dangerous leachates are known.

12	12 Disruption of transit circuits, appearance of noise and traffic, increasing of accidents risk pedestrians by walkers caused by the comings and goings of trucks carrying raw materials.	• The choice of location can mitigate a number of these problems. • It should be good to conduct, during the feasibility study of the project, studies on transport to determine the safest routes.
13	Risk of land degradation and surface water aggravated by routing pipelines of new products or materials.	• Locate the pipeline in manner to reduce risks to the environment. • Develop a periodic pipelines monitoring program .