Advisory review of the Environmental Impact Statement Oil refinery Tout Lui Faut, Surinam

7th July 1994

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Advisory review
of the Environmental Impact Statement
Oil refinery Tout Lui Faut, Surinam

Advice submitted to the Minister for Development Cooperation, by a working group of the Commission for Environmental Impact Assessment in the Netherlands.

the technical secretary

A.J. Kolhoff

the chairman

J.W. Kroon

Utrecht, 7th July 1994

commission for environmental impact assessment

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your reference	your letter	our reference
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By letter dated 3rd May 1994, the Ministry of Development Cooperation has requested the Commission for Environmental Impact Assessment (EIA) to advise on a review of the Environmental Study of phase I on the Surinam Refinery Project Tout Lui Faut (project WW/9-2/850 volgnr. 11 (jrc 93-381)).

Herewith, I submit the advice prepared by a working group of the Commission for EIA.

The approach followed by the Commission deviates from the common EIA procedure for practical and efficiency reasons mainly. Because on one hand the existing environmental study contains limited and incomplete information and on the other hand supplementary documents about the design of the refinery and environmental aspects were found in Surinam during the visit. The Commission has decided to review those as part of the environmental study.

In addition, the Commission brings the following issues to your attention:

1. The "Suriname Milieu Commissie Raffinaderij Project" was established in 1989, by the Minister of Natural Resources, with the aim to advise the government concerning environmental aspects of the refinery project. The "Suriname Milieu Commissie" prepared an advice in which emission standards were recommended, in accordance with the international standards. Staatsolie used these standards as startingpoint for the design of the refinery. This Commission also makes recommendations in the field of safety, environmental care and measures to be taken in case of calamities, which fit into the international framework. The Commission for EIA has advised to adopt the advice of the "Suriname Milieu Commissie".

2. Rough calculations by the Commission for EIA show that the impact to the environment (water, soil and air) is very limited. The recommendations concerning emissions standards as made by the Suriname Commission are followed.
   - The environmental load to water is very small (with appliance of the best practical means). Due to the high discharge of the river, increase of particles is hardly measurable.

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- The soil consists of a thick layer of clay with a low permeability. Experiences show that oil percolates to a maximum depth of 30 cm. The groundwater is therefore expected not to be influenced.
- The presence of an inversion layer occurs at an altitude below 30 metres. The height of the stacks for flaring must be above 30 metres, so that the impact to the surroundings is limited to a minimum.
- Considering noise and immissions of SO_2, NO_x and soot, it is noticed that in the direct surrounding of the site a residential area is located (distance about 300 metres). If it appears that, on basis of measurements, the noise and immissions levels nearby the residential area are unacceptable according to standards, necessary provisions can be implemented.

Beyond the residential area at Tout Lui Faut other inhabited areas are not affected by emissions of the refinery and cumulation of effects does not occur due to the low background level.

3. Physical planning concerning the distinction of land use functions and the creation of buffering zones is absent in Suriname. The Commission for EIA discussed with Staatsolie the problem of possible human settling in the surrounding of the site and suggested the possibility to extend the existing site with a buffering zone of about 500 metres through acquisition of State land.

4. In the opinion of the Commission for EIA , the project phase 1 can be implemented within acceptable environmental standards. During the lifetime of the refinery (20 years) it is of great importance that operation and maintenance gets all the necessary attention. In its discussions with Staatsolie the Commission recommended the importance of the execution of environmental auditing on a regular basis by a third party (e.g. Asistencia Reciproca Petrolera Estatal Latino-Americana, this is a network of Latin American State Oil Companies).

5. In conclusion the Commission for EIA draws again your attention to the importance to be involved in the EIA procedure at a much earlier stage of a project initiative. This project showed the added value of a site visit.

Yours sincerely,

J.W. Kroon,
chairman of the working group
of the Commission for EIA

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TABLE OF CONTENTS

Appendices

MAIN POINTS OF THE ADVICE

General remarks

By letter dated 3 May 1994 (appendix 1) the Minister for Development Cooperation in the Netherlands has invited the Netherlands independent Commission for Environmental Impact Assessment to conduct an advisory review of the Environmental Impact Statement (EIS) "Environmental study of Surinam Refinery Project Tout Lui Faut". Therefore the Commission visited Surinam in the period 6 - 13 June 1994 in order to gather necessary information not provided in the EIS and finally to settle on the needed additional information to provide by Staatsolie.

Staatsolie Maatschappij Suriname N.V. (Staatsolie) intends the construction of 7,000 barrels per stream day (bpsd) modular refinery to process locally produced crude. The proposed refinery site is at Tout Lui Faut, located between the Sir Winston Churchill Road and the Surinam river, about 10 kilometres upstream from the main port of Paramaribo. The feedstock of the refinery will be Saramacca Crude which is produced by Staatsolie and exploited on shore in the Saramacca district.

The EIS/Environmental study for phase 1 which must be available for decision-making by the Directorate General for International Cooperation is published in 1989 and was based on a feasibility study prepared by Staatsolie (1988). Then the initiative had not yet been worked out in the feasibility study in detail, therefore the EIS contains limited information.

During the visit to Surinam the Commission discovered that more and ample information about the design of the refinery and the environmental situation was available. Having scrutinized this information, the Commission has decided to add this information to the EIS as vital for the review.

The Commission found that the terms of reference for the EIS were not adequate. Therefore, the Commission elaborated a review framework (see appendix 4) on basis of international guidelines and, emission and immission standards recommended by the "Suriname milieu commissie raffinaderij project, 1990". Next the EIS and supplemented information were reviewed based on this framework. Furthermore recommendations were made for those aspects about which essential information are missing.

The Commission noticed that the environmental study (1989) is based on an originally broader initiative and cannot be considered as an environmental impact statement, because characteristic elements of an EIS are missing.

The Commission recommends preparing a supplement to the existing environmental study. Almost all the necessary information for the preparation of a qualitatively good supplement to the EIS is already available at Staatsolie.

Under the circumstances the Commission considers it sufficient if the supplement to the EIS is limited to the main lacking points.

In this respect the Commission has made recommendations regarding the importance of the different points as well as the amount of detail to be worked out.

Recommendations for the supplement to the EIS

Legislation and policy

Investigate the possibility of establishing a buffer zone around the refinery site, in order to avoid settling of new dwellings up to 500 metres from the facilities.

Existing storage facilities

Present an alternative in which the existing storage tanks are replaced by new ones, American Petroleum Institute (API) or British Standard (BS) types, instead of revamping.

Waste water (treatment and drainage systems)

Provide information about the waste / water streams (process water, rain water, domestic waste water) as far as influenced by the intended activity (normal operation):

- the composition and quantity of the water streams (emissions of oil and grease, ammonia, suspended solids, phenolic compounds, sulphide's, organic acids, nickel and other metals). These pollutants may be expressed in terms of biochemical oxygen demand (BOD) and chemical oxygen demand (COD);
- what kind of waste water treatment (purification) system;
- what kinds of facilities are foreseen for the drainage of water during heavy rainfall or calamities (fire water);
- maximum oil spill scenarios.

Emissions to atmosphere and ground level immissions

Provide concrete information on the expected emissions and emission concentrations from the heaters, boiler and flare (SO_2, NOx, CO and particles); furthermore on the expected immission concentrations for these components and deposition of particles in the Tout Lui Faut residential area, under normal and unfavourable conditions.

Give information concerning optimal burner control systems in order to reduce the formation of soot as much as possible.

Work out an alternative in which 2 sour water strippers are used instead of 1, in order to improve redundancy and reliability.

Noise

Provide concrete information on the use of low-noise equipment, the calculated noise level in the Tout Lui Faut residential area and possible mitigating measures after start-up.

Internal environmental care/monitoring

Provide information about the environmental care system, the maintenance system and equipment inspection procedures, availability of spare parts for equipment relevant for the environment and environmental auditing in future.

Occupational health / internal safety precautions
Give further information on the Staatsolie policies and concrete measures in the design of the refinery concerning labour safety.

External safety
Give the results of maximum credible accident calculations, concerning the possible effects in the Tout Lui Faut residential area of fires/explosions.

Biotic environment
Provide the information about protection measures for sensitive areas, including closure of tidal creeks, cleaning up measures for recreational areas of sand beaches, as part of the Oil Spill Contingency Plan.

Socio-economic environment
Provide the following information:
- prepare a land-use map of the refinery surroundings (up to 500 metres) on basis of air photos;
- assess potential hazards and pollution by refinery emissions for the human population, cultivated land and natural resources on basis of air photos;
- develop an information plan aiming to inform the residents of Tout Lui Faut;
- develop a monitoring system for ground level immissions and the quality of drinking water resources, in times piped water is not available;
- the spin off effects of the presence of a refinery in the Tout Lui Faut area (e.g. increasing employment and improvement of infrastructure).

Zero-alternative
Provide the information about the zero alternative. In case of Staatsolie this is the existing situation, which means no refinery. The existing situation and the impacts at the environment must be described and will be used as a reference situation. In particular the consequences on logistics (increase of shipped crude for export) and the air pollution (SO_2 emission) by using crude (mixed with diesel) versus the use of fuel oil by local customers must be described.

Comparison of the environmental impacts for the intended activity and its alternatives
Make a comparison between the intended activity, the different alternatives asked for and the zero alternative as explained in § 3.2.2.

Remaining gaps in knowledge and post project-evaluation
Set up an evaluation programme for the gathering of essential data asked for in the supplement which are not available in the short term. For the following aspects it is now already clear that an evaluation programme must be set up with special attention for the residential area of Tout Lui Faut:
- ground level immission of SO_2, NO_x, particles and noise hindrance;
- quality of drinking water resources in times piped water is not available.

Presentation of the EIS
- The findings of the review, as described in this report of the Commission for EIA (chapter 3), must be summarized. This summary must be part of the supplement.

- Follow the structure of appendix 4 for the set up of the supplement;
- Keep the supplement comprehensive with a maximum of 50 pages in total.

1. INTRODUCTION

1.1 The initiative: Realisation of an oil refinery at Tout Lui Faut, Surinam

Staatsolie Maatschappij Suriname N.V. (Staatsolie) intends the construction of 7,000 barrels per stream day (Bpsd) modular refinery to process locally produced crude, with an option to process imported crude in the future. The proposed refinery site is at Tout Lui Faut, located between the Sir Winston Churchill Road and the Surinam river, about 10 kilometres upstream from the main port of Paramaribo.

Staatsolie, a state owned company established in 1980, planned to start with the construction of the refinery in 1994 and with the commercial production in 1996. Since 1988 Staatsolie commissioned a series of studies on the refinery project. The original plan was to construct a refinery consisting of a crude/pre-flash unit, a visbreaker unit and a hydrocracker. This plan was not feasible in total therefore it was split up into two phases. The present initiative deals with the crude/pre-flash unit and the visbreaker only and is called the first phase. The construction of these units will be such that in a second phase a hydrocracker, a hydrogen unit and a light ends unit may be added. However, this initiative deals with the first phase and therefore the advice of the Commission will focus at this phase predominantly.

The objectives of the proposed project are as follows:
- reducing the present strong dependency on one customer, by adding new products for new customers;
- improve profit margins, by the production of higher value added products;
- decrease sensitivity towards crude oil price fluctuations.

The feedstock of the refinery will be 7,000 Bpsd Saramacca Crude. Saramacca crude is produced by Staatsolie and exploited on shore in the Saramacca district. The yield of the refinery will be respectively fuel oil 61%, heavy vacuum gas oil (HVGO) 21%, light vacuum gas oil (LVGO) 17% and asphalt 1%. Fuel oil will be used in the refinery heaters and be sold to Suralco in the bauxite sector. The intermediate product HVGO will be sold to as feedstock to refineries in the region. Surinam Electricity Company and the Surinam fishing fleet are important potential customer for LVGO. If there is no potential customer for asphalt it will be blended in the fuel oil.

The environmental impact statement (EIS) must be available for decision-making concerning the guarantee of a longterm loan for the construction of the refinery.

The Commission assumed the following points for the review:
- the construction of a refinery consisting of a crude/preflash unit and a visbreaker, which is known as the first phase;
- processing of Saramacca crude;
- standards advised by the 'Suriname Milieu commissie raffinaderij project 1990'.

1.2 Motive for and objectives of this review report

By letter dated 3 May 1994 (Appendix 1) the Minister for Development Cooperation in the Netherlands has invited the Netherlands independent Commission for Environmental Impact Assessment to perform an advisory review of the EIS "Environmental study of Surinam Refinery Project Tout Lui Faut" prepared by Lummus Crest B.V., 1989. If the term 'EIS' is mentioned in this report, the environmental study of 1989 is meant.

Objectives of this advice are:

- review of the EIS on the basis of specific project guidelines;
- recommendations for supplementing the EIS, as far as necessary.

The advice, which must be regarded as an independent vision on the quality of the EIS in question, has been prepared by a working group of the Commission. The composition of this working group is presented in appendix 2. The group represents the Commission and will therefore be referred to as 'the Commission'. In the Commission the following disciplines are represented: Refinery process technology, hydrology, ecology, soil science, water management and waste water treatment.

The Commission visited Surinam in the period 6 - 13 June 1994. The objective of the visit was gathering of additional information and finally to settle on the needed additional information to provide by Staatsolie.

Acknowledgements to mr Jharap and mr Waaldijk and all other personnel of Staatsolie and to mr Brands and mr Bakker of the Netherlands embassy.

1.3 Limitations encountered

In preparing the present advice the Commission has encountered certain limitations. The main limitations are:
- The Commission has not been involved in scoping and formulation of the specific project guidelines.
- The EIS was set up without adequate references to guidelines and is originally based on a broader initiative. The scope of the present initiative is limited to phase 1 whereas the EIS refers to the original initiative (including phase 2).

1.4 Justification of the approach

The EIS was published in 1989 and was based on a feasibility study prepared by Staatsolie (1988). At that time the initiative was not yet worked out in the feasibility study in detail, therefore the EIS contains limited information. Furthermore, characteristic elements of an EIS like: the prevailing condition of the environment, the autonomous development, the reference situation, design alternatives, mitigating measures and comparison of the alternatives are insufficiently worked out.

During the visit to Surinam the Commission noticed that more ample information about the design of the refinery and environmental issues were available. Therefore the Commission has decided **to incorporate in its review, besides the EIS\Environmental study, the following documents:**

[1] Staatsolie Maatschappij Suriname N.V., 1988: Surinam refinery report; Feasibility study, process scheme, site selection and preliminary economics.
[2] Parc, 1988: Staatsolie Maatschappij Suriname N.V.; Refining project - Saramacca crude pilot plant simulation of visbreaker/hydrocracking scheme.
[3] McBride Ratcliff and associates Inc. Geosciences and Materials. Engineering Services, 1989: Geotechnical Investigation Staatsolie Suriname, 7,000 bpsd refinery Tout Lui Faut, Surinam, South America.
[4] Staatsolie, 1989, 1993: Staatsolie oil spill contingency plan, different documents.
[5] Milieu commissie raffinaderij project, 1990; Advies inzake de miliestudie uitgevoerd ten behoeve van het raffinaderij project van de Staatsolie maatschappij Suriname N.V.
[6] Moret Ernst & Young, 1993; Feasibility study refinery project phase 1, Staatsolie Maatschappij Suriname N.V.
[7] Explanation by ABB Lummus Crest B.V. based on the 1993 design engineering books, Volumes 1-11.

The approach followed by the Commission consists of three steps:

1. The Commission found that the terms of reference for the EIS were not adequate. Therefore a review framework (see appendix 4) was elaborated on basis of:
   - International guidelines (World Bank, European Union, Asian Development Bank);
   - Emission and immission standards recommended by the "Suriname milieu commissie raffinaderij project,1990".
2. The EIS together with the supplementary information (the mentioned documents) was reviewed on basis of this framework.
3. Recommendations for a supplement to the EIS were made for those aspects about which essential information is missing.

It must be noticed that the above mentioned approach followed by the Commission for EIA deviates from the usual EIA procedure. The Commission decided to choose for the mentioned approach for practical and efficiency reasons mainly.

2. HEADLINES ON THE REVIEW OF THE EIS

The Commission recommends to supplement the existing EIS/Environmental study of 1989. Almost all the necessary information for the preparation of a qualitatively good supplement to this study is already available to Staatsolie.

To limit the scope of the supplement to the main lacking points, recommendations are made considering the importance of the different aspects and the measure of detail that have to be worked out. These recommendations are defined on basis of the detailed review of the EIS and the available information, as mentioned before (see chapter 1.4).

3. REVIEW OF THE EIS ACCORDING TO THE REVIEW FRAMEWORK

In this chapter the EIS will be reviewed in detail, based on the review framework elaborated by the Commission and recommendations for supplementing are made. The recommendations are summarised into the main points of the advice.

The structure of the mentioned subjects in this chapter is as follows:

1. a detailed review on basis of the review framework (see appendix 4) of:
   - the EIS/environmental study;
   - the documents mentioned (the numbers mentioned in the text, like [1] and [2] et cetera refer to the number of the documents in § 1.4);
   - explanations given during the discussions with Staatsolie and;
   - observations made by the Commission during the visit.
2. recommendations (in the text reflected as *recommendations*) for the supplement of the EIS, as far as relevant. Mitigating and compensating measures are not described apart, but as part of the subjects.

3.1 Legislation and policy

The present legislation governing environmental quality is relatively limited and not suited for this type of projects.

For the establishment of the refinery a license is required, granted by the District Commissioner of the district of Wanica. In this license conditions can be set according to the Nuisance Act ('Hinderwet', GB 1930, no. 64), the Safety Act ('Veiligheidswet' GB 1947, no. 142) and general safety regulations. Some general requirements are indicated qualitatively. However, no standards exist. Public reaction is possible. No public participation is required.

Transport by ship is governed by the 'Havenverordening', which is enforced by the port authorities at Paramaribo. However, lack of facilities strongly reduces efficient execution of tasks.

Proposals for the Staatsolie refinery safety and fire prevention policy have been presented by a Government Commission [5]). The same commission presented some discussion concepts regarding pollution of surface water, sea water and aerial pollution.

Staatsolie is a member of the Arpel (Asistencia Reciproca Petrolera Estatal Latino-Americana) since 1985. Within this network of Latin American State Oil Companies the Staatsolie has developed a local Oil Spill Contingency Plan (OSCP) for minor spills [4]). This plan needs further extension for major oil spills. A national OSCP and Emergency plan do not exist. Such plans are considered essential in case the refinery project is developed. It is suggested that cooperation with government agencies and related companies is worked out (fire brigade, hospitals, marine, other oil companies and the port authority).

The attention of the government should be drawn regarding the importance of physical planning of the study area. Until now there is no strict separation between industrial and residential areas. Further settling of dwellings and the development of agricultural activities should be prevented up to a distance of 500 metres from the refinery site.

It is *recommended* to investigate the possibility of establishing a buffer zone around the refinery site, in order to avoid settling of new dwellings up to 500 metres from the facilities. It is suggested that Staatsolie obtains the rights on the surrounding land in order to accomplish this.

3.2 Description of the intended activity and alternatives

3.2.1 The intended activity

Location and logistics
The site for the refinery phase 1 and 2 is already determined at the existing Tout Lui Faut crude oil terminal [1]). The first activities concerning civil works have already been carried out. Therefore an alternative for the site, for instance at the exploration oil field site, is not worked out. In discussions with Staatsolie it became clear that, given the circumstances, there is no economic feasible site alternative. The chosen location is situated in an industrial area. However, the Tout Lui Faut residential area starts at about 300 metres from the refinery site.

Existing storage and jetty
Information about these facilities was obtained during a site visit. The tanks are of bolted type construction. On several places leakages occurred. Furthermore there is no instrumental safeguarding against overfilling of the tanks. Staatsolie is planning a complete revamp of these facilities together with the construction of phase 1. Furthermore the jetty is to be expanded.

It is *recommended* to work out an alternative in which the storage tanks are replaced by new type of tanks (American Petroleum Institute/API or British Standard/BS).

Raw materials and (by)products
Necessary information was provided by [6], [7] and the EIS.

Production process
Information was obtained during the site visit. Additional documents and process flow diagrams were provided [7]). Provisions are foreseen to guarantee the stability of the underground at the site where the installation wil be set up [7]).

Waste water (treatment and drainage systems)
Only a flow scheme is given from the waste water treatment facility [6]). A description of the composition of the waste water and the design parameters for the oil separator were not provided.

It is *recommended* to describe the waste / water streams (process water, rain water, domestic waste water) as far as influenced by the intended activity during normal conditions:
- the composition and quantity of the water streams (emissions of oil and grease, ammonia, suspended solids, phenolic compounds, sulphides, organic acids, nickel and other metals). These pollutants may be expressed in terms of biochemical oxygen demand (BOD) and chemical oxygen demand (COD);
- what kind of waste water treatment (purification) system;
- what kind of facilities are foreseen for the drainage of water during heavy rainfall or calamities (fire water);
- maximum oil spill scenarios.

Emissions to soil and groundwater
The EIS does not present information. Facilities (dikes) for the catch of oil due to spills and other calamities are foreseen in the design of the installation [7]). The Commission noticed that if there is any emission to the soil, the groundwater will not be affected due to the presence of heavy clays in the soil [3]). The upper layer of the soil, up to 30 cm depth, can become polluted due to spills.

Emissions to atmosphere and ground level immissions
The EIS gives an overview of the international standards on emissions-/immissions. In appendix 12 of the EIS standards are recommended by Lummus Crest B.V. (Lummus).

In the advice of the "Milieu Commissie Raffinaderij Project, 1990" these standards are evaluated and more stringent standards are proposed [5]). These proposed standards are close to the existing standards in Western-Europe (Western-European standards are more stringent than international standards). During the discussions with Staatsolie and Lummus it was stated that these proposed standards will be reached and that they will be guaranteed by Lummus to Staatsolie.

SO_2

The EIS does not contain SO_2 emission/immission data. The SO_2 outlet concentration and emission from the heaters and the boiler is directly related to the sulphur content of the used fuels (fuel gas ,naphtha, fuel oil, asphalt). According the given specification of maximal 0,6 % sulphur in the Saramacca crude [2]), the sulphur contents of these fuels will be relatively low. The quaranteed emission concentration (by Lummus) is 2000 mg/nm^3. This is the existing standard for refineries in The Netherlands. The expected real concentration is about 1000 mg/nm^3 according to Lummus [7]).

It is *recommended* to make such data available, especially including maximal calculated SO_2 immission concentration in the Tout Lui Faut residence during unfavourable weather conditions (inversion). Furthermore after start -up SO_2 monitoring should be executed by Staatsolie [1].

NO_x

The emission standard quaranteed by Lummus to Staatsolie is 450 mg/nm^3. However it is expected that the real concentration will be lower because of the standard low-NO_x design of heater manufacturers, thus bringing the NO_x emission in line with European standards.

Particles (soot)

The EIS does not contain information on emission/immission levels of soot, nor about the measures to limit the emission. The quaranteed emission concentration by Lummus is 80 mg/nm^3. The burner design and burning conditions are important to limit the emission of soot. Hence proper operation and control is crucial. Stack concentrations could be monitored continuously on opacity.

It is *recommended* that calculations are made on the maximal soot deposition in the Tout Lui Faut residential area, under unfavourable weather conditions. Furthermore information is needed concerning effective burner operation and instrumental control. Furthermore, after start-up, soot deposition monitoring should be carried out by Staatsolie.

Hydrocarbons/odours

According to the presented design in the EIS there will be no venting of hydrocarbons to atmosphere during normal operation. The waste gases are burned in 3 independent burner locations and occasionally sent to flare.

Attention should be paid to possible emissions caused by disruptions in the process, especially the waste gas (fuel gas) system and the sour water stripper. According to the observations during the site visits the odour potential of Saramacca crude is low.

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1 If in future crudes from elsewhere, for instance Venezuela, are imported the SO_2 emission could increase, due to higher sulphur concentrations. It was stated by Staatsolie that in this case the installations will be modified.

It is *recommended* to work out an alternative of 2 instead of 1 sour water stripper, thus improving redundancy and reliability, and it offers the possibility of keeping one stripper available while the other is shut-down for maintenance or cleaning.

Noise
No levels of noise hindrance for the Tout Lui Faut residential area are given in the EIS. The design is aimed at a level lower than 50 dB(A) [7]). Staatsolie mentioned that calculations can be made after concrete information is received from the equipment suppliers. During a visit to the Tout Lui Faut residential area it became clear that existing noise levels are very low.

The standard of 50 dB(A), used in for instance the Netherlands, includes other noises like traffic. If phase 1 of the refinery causes the total load of 50 dB(A) any additional industrial activity /traffic, including the extension of the intended activity with a hydrocracker in phase 2, would mean an increase of the accepted maximal level.

Therefore it is suggested to install low-noise equipment, especially for air fin coolers, burners and flare, in order to reach a level well below 50 dB(A). If needed further noise reduction measures, like the installation of screens and confinement of burners, could be retrofitted.

It is *recommended* to provide concrete information on the use of low-noise equipment, the calculated noise level in the Tout Lui Faut residence area and possible mitigating measures after start-up. After start-up noise level measurements should be executed (monitoring).

Light
The designed flare dimensions is 8 inch diameter [7]). No data were available on expected flaring times. However under normal circumstances there will be no vent gas stream to the flare because there appears to be sufficient independent outlets for waste gas incineration (heaters/boilers).

Waste
It was stated by Staatsolie that there is no generation of waste from the process. Tank sludges, separator oil and oils catched in pigging operations are blended in the process streams. Furthermore there is no usage of catalysts.

Internal environmental care / monitoring
Staatsolie gave a presentation of their existing organisation, including the safety and environment department which will be adapted for the refinery project. During the first year of operation extensive training of Staatsolie operators will take place by Lummus. Keeping the installation to standard by proper maintenance and keeping a high grade of operator quality over the years, must be considered of paramount importance. Furthermore monitoring inside the facilities (stack emission, water treatment) as well as outside the plant (Tout Lui Faut) has to be regarded as part of the Staatsolie environmental care system.

In this respect the cooperation of Staatsolie in "Arpel" can play a significant role, for instance the execution of environmental audits by Arpel members. Furthermore a post project evaluation is considered necessary.

It is *recommended* to describe:
- the environmental care system (good house keeping, periodic training, monitoring and safety procedures);
- the maintenance system and equipment inspection procedures;
- availability of spare parts for equipment relevant for the environment;
- environmental auditing.

Occupational health / internal safety precautions
The Staatsolie organisation for occupational health was explained. It is not clear which specific measures will be taken in the design of the refinery and the revamp of the storage facilities.

It is *recommended* to provide further information on the Staatsolie policies and concrete measures in the design of the refinery concerning labour safety.

External safety
The Saramacca crude does not contain large quantities of light volatile hydrocarbons [2]). In phase 1 only a limited conversion to lighter products takes place. Therefore the production and storage of light flammable hydrocarbons (naphtha and LPG) is very small. The effects of fires/explosions are therefore relatively small. However no information on this is given in the EIS or other documents.

It is *recommended* to work out a worst case scenario (maximum credible accident calculation) for fire/explosion of naphtha and LPG, with establishing possible effects on the Tout Lui Faut residential area. Risk reducing measures, like containment in case of spills, should be mentioned.

3.2.2 Alternatives

Alternatives of the design
Some alternatives were briefly discussed in the EIS. It was agreed that Staatsolie will study the alternative of two sour water strippers instead of one. Other alternatives will be considered during procurement of process equipment.

Zero alternative or existing situation
The zero alternative was not discussed in the EIS.

It is *recommended* to work out the zero alternative. In case of Staatsolie this is the existing situation, which means no refinery. The existing situation and the impacts at the environment must be described and will be used as a reference situation. In particular the consequences on logistics (increase of shipped crude for export) and the air pollution (SO_2 emission) by the use of crude (mixed with diesel) versus the use of fuel oil by local customers must be described.

3.3 Description of the prevailing condition, autonomous development and impacts on the environment

Climatology and air quality
Meteorological information was obtained from the meteorological service. No air quality measurements data are available. It is suggested to make use of the data gathered at the "Zorg en Hoop" meteo station being closest to the plant site (about 5 km).

Hydrography, hydrology and surface water quality
In the plan atlas of Surinam (1988) a description is given about the hydrography and the hydrology of the Surinam river. The water of the Surinam river is not used for drinking purposes. In the hydrological annual report of Surinam a quality of several rivers is given. In general the temperature of the surface water is about 28° C so the biological activity is very high. The present quality of the river is hardly influenced by human activities.

Soil and groundwater quality
The upper 20-30 meter of the underground consists of a predominantly soft to medium clay, overlying either a very stiff, compact clay, or fine to medium sand. Groundwater movement was monitored for some period and variations appeared to be very small [3]). The groundwater level in the upper clay deposits is not related to the one of the sandy deposit, thus illustrating the very slow permeability of the clay.

The upper part of the original soil surface at the site has been removed and a landfill of medium sand has been constructed. Observation on oil spills near the existing tanks indicate that oil pollution enters no deeper than 30 cm into the clay soil.

Pollution of the soil and the groundwater as well as eventual aquifers is considered very unlikely. Pollution may, however, percolate through the upper landfill and flow laterally to the edges where it may contribute to the surface water pollution. The resulting pollution is expected to be minor.

Noise
No data on the prevailing noise levels in the Tout Lui Faut residential areas are available. The Commission observed a low background level.

Biotic environment
The Staatsolie Oil Spill Contingency Plan [4]) (OSCP) includes maps and descriptions of sensitive areas and objects as: mangrove forests, feeding and breeding areas of coastal birds, turtles, fishes and shrimps.

The natural values (vegetation types, mammals, birds, herpetofauna, foodfish) are adequately described in the Report of the "Milieu commissie raffinaderij project, 1990" (chapters Fishery and Nature Conservation) [5]).

It is *recommended* to extend the OSCP with protection measures for sensitive areas, including closure of tidal creeks, cleaning up measures for recreational areas of sand beaches.

Socio-economic environment
The EIS mentioned most impacts of emissions and immissions on human health in general, but it is not specified for the residential area of Tout Lui Faut .

The Staatsolie Oil Spill Contingency Plan [4]) (OSCP) includes maps and descriptions of sensitive areas and objects as: industrial and commercial areas, harbours, piers, cooling water intakes, recreational and fishery areas. Protection measures are given in case of oil spills.

The land-use in the area surrounding the refinery site is not mapped and insufficiently described in the Report of the Suriname Milieu commissie (chapter Nature Conservation) [5]).

No description is given of the environmental impact of (worst case) air pollution (including odour, noise and light), surface water-, soil- and groundwater pollution, caused by the refinery process, by transportation of raw materials and products on the natural ecosystems on the natural ecosystems, the cultivated land and the human society of the study area.

No data are given on the availability of piped drinking water in residential areas and on alternative sources used in times piped water is not available.

It is *recommended* to:
- prepare a land-use map of the refinery surroundings (up to 500 m) based on air photos;
- assess potential hazards and pollution by refinery emissions for the human population, cultivated land and natural resources based on air photos ;
- develop an information plan aiming to inform the residents of Tout Lui Faut;
- develop a monitoring system for ground level immissions and the quality of drinking water resources in times piped water is not available;
- describe the spin off effects of the presence of a refinery in the Tout Lui Faut area (e.g. increasing employment and improvement of infrastructure).

3.4 Comparison of the environmental impacts for the intended activity and its alternatives

Because alternatives were not worked out in the EIS a comparison was not possible.

It is *recommended* to make a comparison between the intended activity, the different alternatives asked for in this review report and the zero alternative as explained in § 3.2.2.

3.5 Remaining gaps in knowledge and post-project evaluation

No inventory of gaps was provided in the EIS and the set up of an evaluation programme was not presented.

It is *recommended* to set up an evaluation programme for the gathering of essential data asked for in the supplement which are not available in the short term. It is now already clear that an evaluation programme must be set up with special attention for the residential area of Tout Lui Faut for the following aspects :

- ground level immission of SO_2, NO_x, particles and noise hindrance;
- quality of drinking water resources in times piped water is not available.

3.6 Presentation of the EIS

As indicated before the Environmental study and the provided documents can not be considered as a complete EIS.

It is *recommended* to:

- prepare a summary of the review, as described in the report of the Commission for EIA (chapter 3). This summary must be part of the supplement;
- follow the structure of appendix 4 for the set up of the supplement;
- keep the supplement comprehensive with a maximum of 50 pages in total.

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