Environmental Impact Assessment Guidelines

Volume 4 – Electricity Generation

Version 2

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Environmental Protection Agency/Environmental Assessment Board

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1.0 Summary

This manual is a result of the joint effort of the Environmental Protection Agency (EPA) and the Environmental Assessment Board (EAB). The intention is to provide to the EPA, EAB, sector agencies, private sector, NGOs, members of the public and consultants a set of approved guidelines for the conduct and review of Environmental Impact Assessments (EIA) for Electricity Generation Projects in Guyana.

A distinction is made between Thermal and Hydro Power Projects. Thermal power has itself been sub-divided into conventional and non-conventional. Conventional plant are generally considered to be those that burn fossil fuels - coal, diesel or heavy fuel oil, or natural gas. However, biomass burning plant (which in Guyana include primarily bagasse, risk husks, and wood chips), are more appropriately termed 'non-conventional'.

As each project is different, EIAs will be customized to reflect issues that are relevant and specific to the project. While not exhaustive, the guidelines contained in this document and subsequent volumes are meant to compliment those in Section IV of the Environmental Protection Act, 1996 (EP Act). These guidelines are meant to be applied consistently to projects requiring EIAs and allows for transparent decision-making.

As our understanding and awareness of the environment improve, these guidelines will be updated to reflect new ideas or issues.

2.0 Components of an EIA

The EIA will comprise three components: Environmental Baseline Study; Environmental Assessment; and Environmental Impact Statement. The Environmental Impact Assessment may be submitted in the three components stated above or could be submitted as one document depending on the size and nature of the proposed project.

The Environmental Baseline Study will record the present quality of the environment within the area of influence before project implementation. This data will then be analysed in the environmental assessment and will be used to predict and quantify impacts.

The Environmental Assessment (EA) is basically the identification and assessment of impacts of the proposed project and of its alternatives. The EA will also consider mitigation measures to offset negative impacts and will assess the impact of implementing these measures on the environment.

The Environmental Impact Statement (EIS) is a summary of the findings of the Environmental Baseline Study and the Environmental Assessment and includes an Environmental Management Plan. For large EIAs, the EIS will be the document which decision makers and the public will use. The Environmental Baseline Study and the Environmental Assessment will then serve as reference documents to the EIS.

3.0 EIA Guidelines for Conventional and Non Conventional Thermal Power Generation

3.1 Required Expertise

A consulting team will be required with experience in the following areas:

- Environmental modeling, specifically air quality modeling, ideally in the power project context.
- Socio-economics of power projects.
- Environmental manager, team leader, industrial / technical background.

3.2 Conventional Thermal Power Generation

Key Media Issues

Conventional thermal plant usually burn oil, gas, or coal, and the issues of emissions of sulphur dioxide, oxides of nitrogen, particulates, carbon monoxide and carbon dioxide, as well as fly ash disposal, and cooling water supply and discharge are often the key environmental issues to be considered.

Water resources: thermal plants may require large volumes of cooling water, although this need not be potable water. The coolant will usually be treated to prevent biological growth and will be discharged at higher than ambient temperature. The EA must specify the origin of coolant water, examine the effect of its abstraction on the water source and on other users, and assess the impacts of the heated and potentially contaminated water when it is discharged back to the environment. A plant would usually need to demonstrate access to a secure and sufficient supply of water that can be abstracted and later discharged without compromising the interests of other users.

Air Quality: Some □ilometer urban areas in Guyana may experience high ambient levels of air pollution caused by motor vehicles,

particularly diesel and two-stroke engines. Thermal power plants located in urban areas may raise these background concentrations to levels which pose a potential health risk. The EA should predict the ground level concentrations of the major air pollutants likely to be emitted by the plant, under various operating scenarios and weather conditions, and use this information to alter the design of the plant (eg raise the height of the stack to improve dispersion, or include pollutant abatement technologies into the design).

Land Use: Although Guyana has a large land area and low population density, most of the land is rain forest and not immediately suitable for human settlement or agriculture. Apart from its site area, a power plant needs land corridors for supply roads (fuel delivery etc) and transmission lines. They may also need areas for storage of fuel, hazardous chemicals and fire-fighting equipment. Where new access corridors will be opened up in order to connect the plant site into transportation and distribution networks, consideration must be given to the land use impacts along these routes, including the potential for induced development, and unplanned settlements along these corridors. For larger plant the EA will have to show availability of sufficient suitable land for its purposes, plus areas for safety zones and any planned expansion. It must also demonstrate how the security of these areas will be maintained.

3.3 Non- Conventional Thermal Power Generation

Key Media Issues

Combustion of waste organic material such as wood chips, rice husks, bagasse etc can provide a useful energy source for generation of electricity. Biomass generation produces two dominant by-products:

- residual ash; and,
- air emissions (specifically Nox and particulate matter).

Water resources: large scale biomass plant may require large volumes of cooling water, although this need not be potable water. The coolant will usually be treated to prevent biological growth and will be discharged at higher than ambient temperature. The EA must specify the origin of cooling water, examine the effect of its abstraction on the water source and on other users, and assess the impacts of the heated, and potentially contaminated water when it is discharged back to the environment. A plant would usually need to demonstrate access to a secure and sufficient supply of water that can be abstracted and later discharged without compromising the interests of other users.

Air Quality: Biomass plant in both urban and rural areas may cause high local concentrations of pollutants, particularly of particulates. The EA should predict the ground level concentrations of the major air pollutants likely to be emitted by the plant, under various operating scenarios and weather conditions. Where high pollutant concentrations coincide with areas of human habitation, this information should be used to alter the design of the plant (eg relocate, raise the heiht of the stack to improve dispersion, or include pollution abatement technologies into the design).

Land Use: Although Guyana has a large land area and low population density, most of the land is rain forest and not immediately suitable for human settlement or agriculture. Apart from its site area, a power plant needs land corridors for supply roads (fuel delivery etc) and transmission lines. They may also need areas for storage of biomass fuel, ash and fire- fighting equipment. Where new access corridors will be opened up in order to connect the plant into transportation and distribution networks, consideration must be given to the land use impacts along these routes, including the potential for induced development, and unplanned settlements along these corridors. For larger plant the EA will have to show availability of sufficient suitable land for its purposes, plus areas for safety zones and any planned expansion. It must also demonstrate how the security of these areas will be maintained.

3.4 Environmental Baseline Study

The environmental baseline should be established in suitable detail to record the environmental conditions and seasonal variability prior to development, to permit the assessment of potential effects and to provide a baseline with which to monitor future changes. The needs will vary by project and potential environmental effects but would normally encompass the following physical, biological and socioeconomic conditions.

- ***Physical Environment***: local geology and geomorphology, topography, soils, climate and meteorology; ambient air quality; noise; surface and groundwater hydrology; water flow data for water resources to be used for supply or discharge; surface and ground water quality; seasonal changes; sediment quality; seismology; and coastal and marine parameters such as currents, bathymetry, sedimentation and erosion; ambient air quality in the airshed affected by the proposed plant; meteorological data including wind speed and direction, temperature etc.; ambient noise levels at residential and other sensitive receptors around the plant during both day and night; emissions from any major sources of pollution within the area.

- ***Biological Environment***: flora; fauna; rare and endangered species; endemic flora and fauna; and sensitive ecological habitats and ecological balance. Specific data may be required on aquatic animals, benthos species and diversity; plankton; fisheries population, use, spawning sites, mercury levels; aquatic plants, wetlands, mangroves and salt marshes; and terrestrial plants and animals (species, distribution, use, valued habitats, hunting, commercial potential).
- ***Socioeconomic Environment***: Land use including parks, reserves, protected areas, residential, commercial, agricultural and industrial; effects on future development; cultural/historic resources (archaeology); indigenous peoples; demographics, infrastructure; employment, income, skills and education; and public health.

In the collection of data it is imperative to include a Quality Assurance/Quality Control program, submit detailed protocols for all field testing procedures and use procedure generally accepted by other jurisdictions. Where secondary (ie existing) data cannot be found or where these data are inadequate or out of date, it may be necessary to collect primary data. The level of effort expended in collecting primary data should be in proportion to the scale of the project and the likely significance of the issue for which the data is required for analysis. If in doubt, developers and/or their consultants may seek advice from the EPA on the scope of survey work that will be required for analytical purposes.

In addition, where other detailed types of information are required (if significant effects on an important natural or cultural resource are anticipated, for example) there will often be studies on local areas done by international agencies. There may also be unpublished information in government departments, universities, PhD theses, or voluntary groups. These should be investigated and used where relevant, provided that the sources, and any assumptions or uncertainties in the information are documented.

3.5 Environmental Assessment

The environmental assessment will provide technical detail on the environmental effects of the project. The EA will focus on the proposed project but must also address alternatives. A summary of the data in the EA would be incorporated into the Environmental Impact Statement (see below). The EA should provide the following information and components:

1. Results of the regulatory and public participation program. These programs would normally include meetings, workshops, information brochures and should include consultation with NGOs, regulators, members of the public including indigenous peoples, etc. with the objective of identifying all issues and potential mitigation strategies.

2. Provide a brief description and assessment of possible alternatives to the project, including the 'no action' alternative. These alternatives should include alternative sites, alternative fuels, alternative technologies (eg relating to generation, cooling, waste management and reclamation). Inclusion of a prognosis of the state of the environment in each of the alternatives. Provide a comparison of the alternatives with and without the implementation of mitigation measures, including the recommended alternative (under the environmental point of view). Indication of the main reasons for selection of alternatives taking into account environmental factors. The reasons why the various alternatives considered were rejected should be documented.

3. Detailed information regarding the methods used to analyse impacts (EIA methods) and the techniques used to estimate the magnitude of the impacts (prediction techniques).

4. Identification, characterization, description and determination of magnitude and importance of the social distribution of the potential impacts in the short, medium and long term. Analysis of impacts must include as a minimum, direct, primary and secondary, temporary and permanent, reversible and irreversible impacts on the physical, biological, social, economic and cultural components of the environment, when applicable.

5. Special emphasis should be placed on indirect impacts which may arise from project implementation.

6. Analysis of the compatibility of the proposal with the existing environmental legislation that applies to the project itself or to its area of influence. In the event that national or local environmental standards do not exist, at least two international standards must be informed.

7. Assessment of physical effects for all phases including construction, operation and closure. Estimation by type and quantity of expected contaminants, residues, and emissions (water, air and soil pollution, noise, radiation, heat) resulting from the operation of the proposed project.

- Air quality and emissions (emissions data should be used in a standard dispersion model to estimate impacts under different design assumptions). Predicted emissions (basic design data) should be in compliance with the emissions standards appended to the air quality regulations. The predicted peak ground level concentrations should be in compliance with the air quality standards appended to the air quality regulations (taking background concentrations and any cumulative impacts into account);
- Hydrology (describe any changes to the water balance which may be introduced with the power station cooling cycle and the implications that may have for other users or for security of supply);
- Water quality should describe effluent discharges from the facility and their impact on surface or ground water bodies, these will include discharge of heated cooling water to rivers or sea; as well as domestic, site run-off and other operational effluents. Reference should be made to the water quality regulations, and effluent discharge should comply with the standards therein;
- Noise emissions from the plant should be assessed with reference to the noise regulations and the ambient noise standards contained therein;

8. Identify how much of a particular resource is degraded or eliminated, and how quickly the natural system may deteriorate.

9. Assessment of the biological effects on ecosystems of all project phases (construction, operations and closure). Ecological impacts should be assessed taking account of both terrestrial and aquatic ecosystems, habitats and species of flora and fauna, the

assessment should consider issues of habitat loss, mortality, disruption to breeding, feeding or migratory patterns etc;

10. Assessment of the positive and negative impacts on land use (compatibility), future development, cultural/historic resources (archaeology), indigenous peoples, infrastructure, employment, income, skills and education, and public health. Socio-economic impacts should include an assessment of changes to demographics (including increased burdens on social services and/or existing infrastructure), water resources, economy, (include indirectly through multiplier effects.

11. A description of any hazards or dangers which may arise from the project and an assessment of the risk to the environment. Risk of major accidents or natural hazards should be assessed at a level of detail appropriate to the proposed development. Particular issues are likely to include fuel transport and storage.

12. Assessment of the project with a view to the need to protect and improve human health and living conditions and the need to preserve the stability of ecosystems as well as the diversity of species.

13. Detailed information regarding the measures which the proposed developer intends to use to mitigate any adverse effects and a statement of reasonable alternatives (if any), and reasons for their rejection.

14. An assessment of worker health and safety

15. Assessment of Mitigation Measures including cost/benefit analysis and implementation strategy. Mitigation measures in thermal power generation include:

Impact	Mitigation
Air quality	Locate facility away from sensitive receptors Cleaner fuels (eg low sulphur fuel oil) Clean technologies (eg low Nox burners, water/steam injection Higher stacks Abatement equipment (eg scrubbers for SO_x and particulates)
Increased noise and vibration	Alter site layout to minimise noise at sensitive receptors Control timing of construction/operation to least disruptive periods Acoustic treatment (enclosures, silencers, barriers) lower rated equipment
Change in surface water and groundwater quality	Treat discharges chemically or mechanically on-site Construct liners for ponds and solid waste disposal areas Dilute effluent at point of discharge
Toxic effects of chemical discharges and spills	Develop traps and containment systems and chemically treat discharges on site
Thermal shock to aquatic organisms	Use alternative heat dissipation design (e.g. closed cycle cooling) Discharge into larger receiving water body Install mechanical diffusers Cool water on site in holding pond prior to discharge Explore opportunities to use waste heat
Entertainment and impingement of aquatic organisms	Select water intake in area that avoids significant impact Install screens to eliminate entrapment and impingement
Human population displacement	Select alternative site or site layout to avoid displacement Involve affected parties in the resettlement planning and program Construct socially and culturally acceptable settlements/infrastructure development
Modification of historically or archaeologically significant structures or lands (e.g. churches, temples, mosques, cemeteries)	Select alternative site or site layout Develop and implement “chance find” procedures to recover, relocate or restore structures Fence or construct other barriers to protect structures or lands
Worker exposure to dust from ash and coal	Provide dust collector equipment Monitor for free silica content Provide dust masks when levels are exceeded
Worker exposure to toxic gases leaking from boilers	Maintain boilers properly Monitor concentrations with levels not to exceed standards

Worker exposure to excessive noise	Maintain noise levels within health standards or provide ear protection
Induced secondary development including increased demands on infrastructure	Provide infrastructure plan and consider providing financial support to help meet increased demands
Changes in demographic patterns and disruption of social and cultural values and patterns	Develop plan to educate workers on sensitive values and patterns

3.6 ENVIRONMENTAL IMPACT STATEMENT (EIS)

The EIS will provide all relevant details on the project and its effect on the environment. This document should provide a summary level of detail adequate to allow the average reader to make an informed decision on the project. This document will include a broad range of data including information on the developer, schedule, the detailed description of the project, regulatory framework, a review of alternatives, environmental management plans, socioeconomic factors, environmental impacts, mitigation, monitoring and reclamation. The EIS would be accompanied by supporting appendices, the baseline study report and the environmental assessment which will provide technical detail on specific issues, assumptions and □ilomete projections. These supporting documents would be more technical.

A typical EIS report could be organized as follows:

- *Executive summary*: Should be designed to be a consultation document and should be available in the language most used by the project stakeholders. It should contain a concise statement of the project objectives and a brief project description, in addition to a description of key project findings and recommendations for environmental management.

- *Introduction-overview of the project*; details on the developer, ownership, the resource, description of the key components with site/land use maps; and regulatory framework and requirements.

- Detailed project description including the area of influence (spatial and temporal boundaries). This section should describe the need for the project in the context of the local and national electricity supply strategy, and the effect on economic and social development goals of the locality and country. If the project is an element of an overall power development programme in the area, then a description of the other programme elements must be presented. A physical and engineering description of the project should be provided including at least the following:
- generating capacity and load profile;
- description of present land use of the project area and its immediate environs, land requirements;
- fuel type, characteristics, source, location, transport, storage;
- power cycle, boiler type, cooling cycle, water supply ans balance;
- emissions characteristics, solid and liquid waste management systems;
- hazardous wastes (generation, handling, storage, disposal).
- staffing and employment, worker health and safety;
- associated infrastructure and alternatives considered;
- activities associated with construction, operation and decommissioning.

- Economic information regarding the project, including financial statements, budgets etc. This may be submitted as a separate document to preserve confidentiality.

- Rationale for the project and its sustainability, including consideration of alternatives to the project as well as not proceeding (no-project option).

- *Existing environment* – summary of information that is provided in the baseline study report

- Summary of the public consultation programme

- A statement of the alternatives selected and the justification behind each choice.

- Summary of the environmental effects. A description of the likely significant effects of the proposed project on the environment resulting from: the existence of the project; the use of natural resources; the emission of contaminants, the creation of nuisances and the elimination of wastes.

- A statement of the degree of irreversible damage and an explanation of how it was assessed.

- A description of the best available technology.

- The Environmental Management Plan, (refer to pg. 10 for guidelines for preparing EMPs) is an essential element of the EIA. It should include details of the management initiatives to be implemented during both the construction and operational phase of the plant in order to minimise residual impacts.

- The EMP will need to account for monitoring of environmental parameters and the influence of mitigation measures on environmental impacts. For new plant greater than 10MWe in capacity, monitoring will need to be undertaken for stack emissions and cooling waters in accordance and compliance with the appropriate standards and legislation.
- In general, monitoring should also aim toward achieving the optimal operation performance as consistently as possible. This will require maintaining the combustion temperature and excess oxygen level

within the optimal band in which PM and NO_x emissions are minimised simultaneously.

- EMPs should be dynamic and subject to periodic review. As a rule, where the main environmental impacts occur during the operational rather than construction phase, as with thermal energy plant, EMPs should be regularly revised throughout the operational lifetime of the plant.

- An Emergency Response Plan for containing and cleaning up any pollution or spill of any contaminant.

- Initial plan for closure and reclamation of the environment.

- An indication of any difficulties (technical deficiencies or lack of knowledge or expertise) encountered in the EIA.

- Conclusion and Recommendations

- Annexes which include the Terms of Reference, Curriculum Vitae of the members of the EIA team, document references, field observations, etc.

4.1 EIA Guidelines for Hydro-Power Generation

4.2 Required Expertise

A consulting team will be required with experience in the following areas:

- hydrology and □ilometers□□;
- soil erosion and sedimentation;

- water quality sampling and analyses;
- agriculture, aquaculture and forestry;
- mammal, bird, fish and reptile biology and ecology; and,
- human health, sociology and socio-economics (if causing resettlement);
- environmental management of construction impacts.

4.2 Key Media Issues

The principle impacts to be considered in hydro-generation are related to dam and reservoir systems. Firstly, does the project require resettlement, and if so, who and how many people, and secondly what is the size of the land area lost due to flooding for the reservoir. From here the next most important issues are generally associated with downstream impacts, for example, the number of affected families, the length of river that may dry up, fish migrations, and the minimum dry season release regime.

Social Impacts: There is considerable scope in Guyana for identifying projects with zero or minimal human resettlement. Where resettlement is unavoidable, it is necessary to disaggregate the resettled population (`oustees') according to : proportion with land and dwelling loss, land lost but not dwelling, and partial losses. Rural oustees should weigh more than urban in decision making, and the availability of replacement land should be another factor in weighing significance. The proportion of vulnerable ethnic minorities of prime importance, as they are extremely difficult to relocate adequately. If it is the case that involuntary resettlement of such people has never been successful, then perhaps the project should not go ahead. In addition to resettlement

Environmental Impacts: The size of the flooded area is the single most relevant proxy for environmental impact. Therefore, a proposed dam should ideally, have the highest feasible ratio of power production per area inundated. There is considerable scope for selecting projects

with little or no reservoir (for example, in uninhabited rocky canyons), run-of-river, or outstream diversions, to reduce impact. For aquatic biodiversity, perhaps the simplest proxy, is the □ilometers of stream or river flooded. Generally moist forest contains more biodiversity than dry ecosystems, so hydro schemes proposed within the forest regions of Guyana, are more likely to impact a wider species range than those in the savannah regions. Intact ecosystems are more valuable (ecologically), than agriculturally modified agro-systems or barren landscapes. If part of the 'land lost' due to dam construction is a national park or affords some other kind of protect status, that would weigh very heavily in the decision making.

4.3 ENVIRONMENTAL BASELINE STUDY

The environmental baseline should be established in suitable detail to record the environmental conditions and seasonal variability prior to development, to permit the assessment of potential effects and to provide a baseline with which to monitor future changes. The needs will vary by project and potential environmental effects but would normally encompass the following physical, biological and socioeconomic conditions.

- ***Physical Environment***: geology, topography, soils, climate and meteorology; ambient air quality; noise; surface and groundwater hydrology; surface and ground water quality; water shed characteristics of the catchment area; seasonal changes; sediment quality; seismology; and coastal and marine parameters such as currents, bathymetry, sedimentation and erosion.

- ***Biological Environment***: flora; fauna; rare and endangered species; endemic flora and fauna; and sensitive ecological habitats and ecological balance. Specific data may be required on aquatic animals, benthos species and diversity; plankton; fisheries population, use, spawning sites; aquatic plants,

wetlands, mangroves and salt marshes; and terrestrial plants and animals (species, distribution, use, valued habitats, hunting, commercial potential).

- ***Socioeconomic Environment***: Surrounding land use including parks, reserves, protected areas, residential, commercial, agricultural and industrial; effects on future development; cultural/historic resources (archaeology); indigenous peoples; demographics, infrastructure; employment, income, skills and education; and public health; vectors and water borne diseases.

In the collection of data it is imperative to include a Quality Assurance/Quality Control program, submit detailed protocols for all field testing procedures and use procedure generally accepted by other jurisdictions.

Where detailed data are required (if significant effects on an important social, natural, or cultural resource are anticipated, for example) there will often be studies on local areas done by international agencies. There may also be unpublished information in government departments, universities, PhD theses, or voluntary groups. These should be investigated and used where relevant, provided that the sources, and any assumptions or uncertainties in the information are documented.

4.4 ENVIRONMENTAL ASSESSMENT

The environmental assessment will provide technical detail on the environmental effects of the project. The EA will focus on the proposed project but must also address alternatives. A summary of the data in the EA would be incorporated into the Environmental Impact Statement (see below). The EA should provide the following information and components:

1. Results of the regulatory and public participation program. These programs would normally include meetings, workshops, information brochures and should include consultation with NGOs, regulators, members of the public including indigenous peoples, etc. with the objective of identifying all issues and potential mitigation strategies.

2. Identification, description and assessment of alternatives to project/project design in relation to location, site layout, power generation technologies and selection, water supply and intake, waste discharge, management systems and reclamation. Provide a comparison of the alternatives with and without the implementation of mitigation measures, including the recommended alternative (under the environmental point of view). Indication of the main reasons for selection of alternatives taking into account environmental factors. Inclusion of a prognosis of the state of the environment in each of the alternatives.

3. Detailed information regarding the methods used to analyse impacts (EIA methods) and the techniques used to estimate the magnitude of the impacts (prediction techniques).

4. Identification, characterization, description and determination of magnitude and importance of the social distribution of the potential impacts in the short, medium and long term. Analysis of impacts must include as a minimum, direct, primary and secondary, temporary and permanent, reversible and irreversible impacts on the physical, biological, social, economic and cultural components of the environment, when applicable.

5. Special emphasis should be placed on indirect impacts which may arise from project implementation.

6. Analysis of the compatibility of the proposal with the existing environmental legislation that applies to the project itself or to its area of influence. In the event that national or local environmental standards do not exist, at least two international standards must be informed.

7. Assessment of physical effects for all phases including construction, operation and closure; hydrology; sedimentation; water quality; downstream impacts. Estimation by type and quantity of expected contaminants, residues, and emissions (water, air and soil pollution, noise, radiation, heat) resulting from the operation of the proposed project.

8. Identify how much of a particular resource is degraded or eliminated, and how quickly the natural system may deteriorate.

9. Assessment of the biological effects on ecosystems (aquatic and terrestrial) of all project phases (construction, operations and closure).

10. Assessment of the positive and negative impacts on land use (compatibility), future development, downstream impacts; cultural/historic resources (archaeology), indigenous peoples, demographics, infrastructure, employment, income, skills and education, public health and resettlement issues. Socio-economic impacts resulting through resettlement should include assessment of changes to demographics (including increased burdens on social services and/or existing infrastructure), land

use and land use plans, water resources, economy, (include indirectly through multiplier effects), and cultural resources.

11. A description of any hazards or dangers which may arise from the project and an assessment of the risk to the environment.

12. Assessment of the project with a view to the need to protect and improve human health and living conditions and the need to preserve the stability of ecosystems as well as the diversity of species.

13. Detailed information regarding the measures which the proposed developer intends to use to mitigate any adverse effects and a statement of reasonable alternatives (if any), and reasons for their rejection. Mitigation measures in hydro generation will generally include those associated with aquatic and terrestrial biodiversity, the minimization of impacts associated with resettlement and the development of local social benefits. Relevant mitigation includes:

Construction Impacts	**Mitigation**
air and water pollution destruction of vegetation sanitary and health problems from construction camps	air and water pollution control land reclamation careful location of camps, buildings, borrow pits, quarries, spoil and disposal sites
Inundation Impacts	**Mitigation**
Dislocation of people	Relocation of people to suitable area Provision of compensation in kind for resources lost Provision of adequate health services, infrastructure and employment opportunities

Loss of land (agricultural, forest, range, wetlands)	Siting of dam to decrease losses Decrease of dam and reservoir size Protection of equal areas in region to offset losses Creation of useable land in previously unsuitable areas to offset losses
Loss of historic, cultural, aesthetic features	Siting of dam or decrease of reservoir size to avoid loss Salvage or protection of cultural properties
Loss of wildlands and wildlife habitat	Siting of dam or decease of reservoir size to avoid/minimise loss Establishment of compensatory parks or reserved areas Animal rescue and relocation
Operation Impacts	**Mitigation**
Proliferation of aquatic weeds in reservoir and downstream impairing dam discharge, irrigation systems, navigation and fisheries and increasing water loss through transpiration.	Clearance of woody vegetation from inundation zone prior to flooding (nutrient removal) Weed control measures Harvest of weeds for compost, fodder or biogas Regulation of water discharge and manipulation of water levels to discourage weed growth
Deterioration of water quality in reservoir	Clearance of woody vegetation from inundation zone prior to flooding Control of land uses, wastewater discharges, and agricultural chemical use in watershed Limit retention time of water in reservoir Provision for multi-level releases to avoid discharge of anoxic water
Sedimentation of reservoir and loss of storage capacity	Control of land use in watershed (especially prevention of conversion of forests to agriculture) Reforestation and/or soil conservation activities in watersheds (limited affect) Hydraulic removal of sediments (flushing, sluicing, release of density currents) Operation of reservoir to minimise sedimentation (entails loss of power benefits)
Formation of sediment deposits at reservoir entrance creating backwater effect and flooding and waterlogging upstream	Sediment flushing, sluicing
Scouring of riverbed below dam	Design of trap efficiency and sediment release (e.g. sediment flushing, sluicing) to increase salt content of released water
Decrease in floodplain (recession) agriculture	Regulation of dam releases to partially replicate natural flooding regime.
Salinisation of floodplain	Regulation of flow to minimise effect

lands	
Salt water intrusion in estuary and upstream	Maintenance of at least minimum flow to prevent intrusion
Disruption of riverine fisheries due to changes in flow, blocking of fish migration, and changes in water quality and limnology	Maintenance of at least minimum flow for fisheries Provision of fish ladders and other means of passage Protection of spawning grounds Aquaculture and development of reservoir fisheries in compensation
Snagging of fishing nets in submerged vegetation in reservoir	Selective clearance of vegetation before flooding
Increase in water related diseases	Design and operation of dam to decrease habitat for vector Vector control Disease prophylactics and treatment
Conflicting demands for water use	Planning and management of dam in context of regional development plans Equitable allocations of water between large and small holders and between geographic regions of valley
Social disruption and decrease in standard of living of resettled people	Maintenance of standard of living be ensuring access to resources at least equaling those lost Provision of health and social services
Environmental degradation from increased pressure on land.	Choice of resettlement site to avoid surpassing carrying capacity of the land Increase of productivity or improve management of land (agricultural, range, forestry improvements) to accommodate higher population.
Disruption/destruction of tribal/indigenous groups	Avoid dislocation of indigenous people and where not possible, relocate in area allowing them to retain lifestyle and customs
Increase in humidity and fog locall creating favourable habitat for insect disease vectors (mosquitoe	Vector control
Uncontrolled migration of people into the area made possible by access roads and transmission lines	Limitation of access, provision of rural development, and health services to try to minimise impact.

Environmental problems arising from development made possible by dam (irrigated agriculture, industries, municipal growth)	Basin-wide integrated planning to avoid overuse, misuse, and conflicting uses of water and land resources
Poor land use practices in catchment areas above reservoir resulting in increased siltation and changes in water quality	Land use planning efforts which include watershed areas above dam

14. An assessment of worker health and safety.

15. Assessment of Mitigation Measures including cost/benefit analysis and implementation strategy.

4.5 ENVIRONMENTAL IMPACT STATEMENT (EIS)

The EIS will provide all relevant details on the project and its effect on the environment. This document should provide a summary level of detail adequate to allow the average reader to make an informed decision on the project. This document will include a broad range of data including information on the developer, schedule, the detailed description of the project, regulatory framework, a review of alternatives, environmental management plans, socioeconomic factors, environmental impacts, mitigation, monitoring and reclamation. The EIS would be accompanied by supporting appendices, the baseline study report and the environmental assessment which will provide technical detail on specific issues, assumptions and □ilomete projections. These supporting documents would be more technical.
A typical EIS report could be organized as follows:

- Executive summary should be designed to be a consultation document and should be available in the language most used by the project stakeholders. It should contain a concise statement of the project objectives and a brief description in addition to a description of key project findings and recommendations for environmental management.

- Introduction-overview of the project; details on the developer, ownership, the resource, description of the key components with site/land use maps; and regulatory framework and requirements.

- Detailed project description including the area of influence (spatial and temporal boundaries), location, layout, description of present land use of the project area and the area contiguous to it, project size, land requirements, activities associated with all development stages from construction to closure, alternatives considered, staffing and employment, emission characteristics, water supply and waste disposal, environmental/waste management plans.

- Describe the need for the power in the context of the local and national electricity supply strategy, and the effect on economic and social development goals of the locality and country. If the project is an element of an overall power development programme in the area, then a description of the other programme elements must be presented.

- A physical and engineering description of the project should be provided including at least the following: river feed or storage dam descriptions; dam generation efficiency ratios related to flood area; hydrology and water quality; land use and profile; social and demographic data; worker health and safety; watershed management; power house and ancillary infrastructure; transmission line.

- Economic information regarding the project, including financial statements, budgets etc. This may be submitted as a separate document to preserve confidentiality.

- Rationale for the project and its sustainability, including consideration of alternatives to the project as well as not proceeding (no-project option).

- Existing environment – summary of information that is provided in the baseline study report

- Summary of the public consultation programme

- A statement of the alternatives selected and the justification behind each choice.

- Summary of the environmental effects. A description of the likely significant effects of the proposed project on the environment resulting from: the existence of the project; the use of natural resources; the emission of contaminants, the creation of nuisances and the elimination of wastes.

- A statement of the degree of irreversible damage and an explanation of how it was assessed.

- A description of the best available technology.

- The Environmental Management Plan (EMP), (refer to pg. 10 for guidelines for preparing EMPs). Effective environmental monitoring requires the co-operation of non government and government Agencies, and leadership by scientists with specialist knowledge in hydrology; land erosion and sedimentation; water quality sampling and analyses; agriculture and forestry; mammal, bird, fish and reptile biology and ecology; human health; sociology and socio-economics (for the

resettlement and action plan); and teachers. The range of parameters requiring frequent monitoring should be reviewed in relation to national requirements and relevant legislation.

- The results of the Environmental Monitoring Plan feed back continuously to the Environmental Management Plan as a means to validate the predicted impact assessments, and to testify to the effectiveness of the mitigation measures. Development of the Environmental Management Plan is wholly dependent on site specific surveys of and the needs for conserving wildlife; wildlife habitats; water quality; human societal needs (such as healthcare; prevention of diseases; providing employment opportunities; education infrastructure; the needs for agriculture development; sustainable land use); catchment conservation; prevention of soil erosion; rehabilitation of impacted land surface and the disposal of wastes. This list is not exhaustive, and other needs will be identified from the site surveys. Development of the Plan will necessitate close cooperation between the power station, sociologists, healthcare workers, naturalists and agriculturists.

- An Emergency Response Plan for containing and cleaning up any pollution or spill of any contaminant.

- Initial plan for closure and reclamation of the environment.

- An indication of any difficulties (technical deficiencies or lack of knowledge or expertise) encountered in the EIA.

- Conclusion and Recommendations

- Annexes which include the Terms of Reference, Curriculum Vitae of the members of the EIA team, document references, field observations, etc.

5.0 GUIDELINES FOR TRANSMISSION AND DISTRIBUTION

5.1 REQUIRED EXPERTISE

A consulting team will be required with experience in some or all of the following areas depending on the nature of the project:

- agriculture and forestry;
- terrestrial ecology;
- visual impacts;
- hydrology and hyrdogeology;
- soil erosion and sedimentation;
- environmental management of construction impacts;
- health and safety.

5.2 KEY MEDIA ISSUES

The environmental impacts of transmission and distribution systems will depend upon a) the length of the line, the size and spacing of the pylons; b) ancillary infrastructure such as access roads, switchyards and substations; and c) on the sensitivity of the environment in which the project is planned.

The environmental impact of transmission and distribution lines will generally be linear in nature, the impact on natural, social and cultural resources increasing with line length, and with the capacity of the line. High capacity lines tending to have larger pylons, carrying more lines, and able to transmit efficiently over larger distances. Distribution impacts will also depend on whether distribution networks are above or below ground.

Social Impacts: The majority of existing T & D infrastructure in Guyana is of relatively low voltage and lies within the coastal plain. The social impacts of improved or extended T & D infrastructure on these areas are largely positive in that they bring more reliable electricity to

the communities in this zone. There may however, be social issues associated with land acquisition and/or loss of crops along the ROW. Appropriate compensation will be necessary.

However, the potential development of large hydropower schemes within the forested areas could potentially bring with it negative social impacts on Amerindian communities, associated with the opening up of forested areas during the construction period, and the subsequent access corridor created by a major transmission line. Developers should take care to select a right-of-way (ROW) that avoids direct impact upon indigenous settlements. Construction workers should be carefully managed by the contractors so that they do not adversely influence or impact upon indigenous communities, and care should be taken to close construction access roads into the forest once the transmission line is operational.

Environmental Impacts: Negative environmental impacts are caused by the construction, operation and maintenance of transmission and distribution lines, and their associated infrastructure. The main environmental impacts of T & D projects are usually to do with ecology and visual impact. Vegetation must be cleared along the ROW and access must be provided for on-going maintenance. Control of vegetation along the ROW will be required which can lead to impacts on local ecology. Careful routing of the lines and locating of the pylons can help to minimise both the visual and the ecological impact.

For T&D projects traversing pristine forested areas, there is a concern that the increase in access will encourage human activity along the ROW resulting in further environmental degradation from logging and slash and burn agriculture.

5.2.1 The EA Study and Report

An EA report (the EIS) will need to be based upon the following sections:

Executive summary

1. Introduction
2. Policy, Legal, and Administrative Framework
3. Project Objectives and Description
4. Baseline Data
5. Consultation Programme
6. Analysis of Alternatives
7. Environmental Impacts
8. Mitigation
9. Environmental Management Plan

Executive Summary:	Should be designed to be a consultation document and should be available in the language most used by the project stakeholders. It should contain a concise statement of the project objectives and a brief project description, in addition to a description of key project findings and recommendations for environmental management.
Policy, Legal, and Administrative Framework:	See EPA Permitting System. Summaries of the requirements of any co-financing institutions should also be included Tables should be used to list applicable standards and note which authorities are responsible for their application.
Project Objectives and Description:	This section should describe the need for the power in the context of the local and national electricity supply strategy, and the effect on economic and social development goals of the locality and country. If the project is an element of an overall power development programme in the area, then a description of the other programme elements must be presented. A physical and engineering description of the project should be provided including at least the following: • capacity and length of the proposed T&D infrastructure • details of proposed transmission line route(s) • details of tower design, stringing configuration, clearance heights and widths etc; • details of all ancillary infrastructure, such as temporary and permanent access roads, substations and switchyards; • activities during construction, operation and decommissioning; and

- timeframe for construction and operation.

Baseline Data:

The key categories of data needed for a transmission and distribution infrastructure EA should include the following:

- land use;
- socio-economic, demographic and cultural data;
- terrestrial (and possibly aquatic) flora and fauna;
- soil characteristics;
- natural, protected or heritage areas;
- visual characteristics of affected area.

Where detailed data are required (if significant effects on an important social, natural, or cultural resource are anticipated, for example) there may be studies on local areas done by international agencies. There may also be unpublished information in government departments, universities, PhD theses, or voluntary groups. These should be investigated and used where relevant, provided that the sources, and any assumptions or uncertainties in the information are documented.

Consultation Programme:

Although it forms a separate component within the EIS, consultation is an iterative process and should be undertaken throughout the EIA. Consultation should be recorded and included within the EIS, and should follow the requirements set out in the Rules and Procedures for Conducting and Reviewing EIA (EPA 2000).

Analysis of Alternatives:

This section should provide a brief description of possible alternatives to the project/project design (including the 'no action' alternative). These may include alternative ancillary structure location, ROW layout, and management systems.

The reasons why the various alternatives considered were rejected should be documented.

Environmental Impacts:

A prediction of the changes in the environment resulting from project construction and operation should be considered, and an assessment of the effect on the surrounding physical, biological, and human systems, should be presented. The assessment should pay particular attention to :

- resettlement or disruption issues (including socioeconomics and cultural heritage issues);
- runoff, erosion and sedimentation from grading for access roads and ancillary structures, and the alteration of hydrological patterns due to maintenance access roads.
- increased access to populations and wildlands;
- chemical contamination from maintenance techniques;
- avian hazards from lines and towers;
- visual impacts;
- land use changes resulting from induced secondary developments;

- biodiversity (aquatic and terrestrial)

Socio-economic impacts should include an assessment of changes to demographics (including increased burdens on social services and/or existing infrastructure), land use and land use plans, water resources, economy, (include indirectly through multiplier effects), and cultural resources.

Mitigation

Mitigation measures in transmission and distribution will generally include those associated with terrestrial (and aquatic) ecology and biodiversity, minimisation of visual impacts and the impacts associated with increased access. Relevant mitigation measures are outlined in table 5.1.

Table 5.1 Proposed Mitigation Measures for T&D projects

Feature	Mitigation Measures
Land use and agriculture	• Pylons located to avoid interference with existing land uses and agricultural activities as far as practicable. • Fencing provided to prevent incursion of vehicles or workers into surrounding crops, or otherwise sensitive areas, during construction of pylon sites. • Construction to avoid key planting/harvesting periods wherever possible. • Replacement tree planting.
Soils and geology	• Construction undertaken during dry season to minimise the potential for run-off induced erosion. • On hillsides or other places prone to erosion, terracing, cribbing or protection of the surface using embedded stones will reduce the risk of soil erosion. • Construction workers and vehicles will be restricted to the pylon construction sites only.
Aquatic environment and hydrogeology	See soils and geology above

Feature	Mitigation Measures
Flora and Fauna	• Route alignment to minimise loss of habitat or biodiversity • Habitat loss kept to the minimum necessary for the works. • Removal of habitat supporting nesting birds during the breeding bird season should be avoided. • Avoid Incursion into adjacent habitat by construction workers and vehicles through fencing of adjacent habitat, warning signs and training of staff. • If species of importance are identified on site during construction, appropriate mitigation measures should be identified and implemented. • Vegetation under the transmission lines cut back by mechanical means alone, chemical herbicides or sprays should be avoided. • Soil reinstated and allowed to return naturally to its previous state or land use. • Replacement tree planting.
Traffic and transport	• Where temporary closure of a road or track is required provision should be made for alternative access to properties through the use of diversions around the ROW using the existing road network, which should be clearly signed. • Where possible, access to pylon construction sites should be achieved through the use of the local road network. Opening of new access roads should be avoided. • Where new access roads cannot be avoided (eg for projects within forested areas) they should be temporary, and the land reinstated and replanted after closure of the access road.
Landscape and visual impact	• Route alignment away from visually sensitive areas. • Construction corridors kept as narrow as practicable. • Replacement tree planting
EMF	• Where possible transmission line routes should be routed away from residential properties.

Feature	Mitigation Measures
Atmospheric emissions	• All vehicles delivering dusty construction materials to the pylon construction sites or removing spoil should be enclosed and covered to prevent escape of dust. • Speed limits applied to all vehicles accessing construction sites along unpaved roads, tracks and temporary access roads.
Noise and vibration	• Construction work should be carried out in daylight hours. • Construction plant sited away from residential properties where possible..
Archaeology and cultural impacts	• Construction works should be monitored by the contractor to ensure that in the event of a chance find the relevant authorities are informed and appropriate action is taken to evaluate and if necessary remove or protect the find.
Socio-economic and socio-cultural effects	• Appropriate compensation to be paid, in cash or in kind, to owners of land required for the pylon footprints (including the 2m band around the footprint). Compensation should also be paid to farmers for lost revenues caused by any temporary or permanent disturbance to crop production, or other means of livelihood, both around pylon bases and along the transmission line routes.
Accident hazards	• Risks to the general public, during construction, should be reduced by public education and by physical measures, such as warning signs attached to each pylon. • Once the stringing works are complete, permanent anti-climbing devices should be installed on all faces of pylons to avoid unauthorised access. • The operation start date and safety information should be publicised in advance.

6.0 Guidelines for Preparing Environmental Management Plans

6.1 Generic Guidelines

Environmental Management Plans (EMP) are necessary to ensure that the proposed procedures, actions and measures identified as part of alleviating environmental impacts of a project are not just a statement of goodwill by the company/developer but that they will be effectively implemented.

The EMP should identify feasible and cost effective measures that may reduce potentially significant adverse environmental impacts to acceptable levels. It should also involve operational procedures needed to avoid environmental risks during everyday and maintenance operations, as well as emergency and contingency plans in case of accidents, where applicable.

Each EMP must clearly state the company's commitment and policy on the environment. There must also be a clear statement committing the company to integrate environmental management and specifically the EMP into its operation.

The preparation of an Environmental Management Plan (EMP) involves the following:

1. Environmental Policy of the company

2. Specific objectives of the plan.

3. Identification and description of the potential adverse impacts and environmental risks associated with implementation of the proposed/existing project.

4. Detailed description of the appropriate mitigation and compensatory measures together with designs, equipments

description and operational procedures (as appropriate) to respond to these impacts or to avoid or reduce risks.

5. Determination of requirements for ensuring that responses to predicted impacts are made effectively and an implementation schedule (timing) for mitigation measures that must be carried out as part of the project.

6. Development of a programme to monitor the impacts arising out of the project operational activities and the effectiveness of the proposed mitigation measures. The monitoring plan should detail as a minimum, impact indicators, location and frequency of sampling, analytical methods to be used and criteria for evaluation. Such information enables the developer and the EPA to evaluate the success of mitigation and allows corrective actions to be taken when needed. This programme should also include regular audits of the implementation of the EMP.

7. Identification of persons within the company responsible for executing the EMP

8. Identification of necessary funds (including budget) to implement mitigation measures.

9. Emergency Response Plan in cases where the project uses or produces substances know to have a deleterious effect on the environment.

The decision to proceed with a project is based in part on the expectation that the EMP will be executed effectively. Consequently, the EPA expects the plan to be specific in its description of the individual mitigation and monitoring measures which must be integrated into the project's overall planning, design, budget and implementation. Such integration is achieved by establishing the EMP within the project

so that the plan will receive funding and supervision along with the other project components.

The Environmental Protection Agency encourages companies to move towards ISO 14000 certification. ISO 14000 is an internationally accredited set of environmental standards which allow companies to achieve an Environmental Management System.

6.2 Environmental Management and Best Practices in the Electricity Sector

Planning for Best Practice in Thermal Power Generation

This section outlines some of the most common approaches to improved environmental performance within the thermal power generation industry. It includes monitoring and management techniques as well as technologies that are applicable to both conventional and non-conventional generation options.

Monitoring and Reporting

Maintaining combustion temperatures and excess oxygen levels within the optimal band in which Particulate Matter (PM) and NO_x emissions are minimised simultaneously ensures the greatest energy efficiency and the most economic plant operation.

Monitoring of operational parameters can therefore assist in achieving the optimal performance as consistently as possible.

Monitoring Air Emissions

If monitoring air emissions, they can be determined either through the installation of continuous monitoring systems (where the costs are appropriate), or more cheaply, through surrogate performance monitoring based on calibration. In surrogate monitoring emission levels are determined by:

- **Particulate Matter**: Ash (and heavy metal) content of fuel; maximum flue gas flow rate; minimum power supply to Electrostatic Precipitator or minimum pressure drop across baghouse; and minimum combustion temperature, and minimum excess oxygen level.
- **Sulphur Dioxide:** Sulphur content of fuel.
- **Nitrogen Oxides:** Maximum combustion temperature and maximum excess oxygen level.

In surrogate monitoring, direct measurements of the above in samples of flue gases should be performed initially and then annually to validate surrogate monitoring results.

Near sensitive areas (eg residential areas or sensitive ecosystems) where emission limits are expected to be exceeded, for instance in areas prone to temperature inversions, ambient monitoring may also be a requirement to assess the need for changes in operating practices.

Monitoring Water Emissions

If effluent needs to be monitored, it will normally include pH and temperature, suspended solids, oil and grease, residual chlorine, and heavy metals.

Records and Recording

Data should be analysed and reviewed with reference to operating standards on a regular basis. All records of monitoring results should be kept in an acceptable/logical format. The objective is to ensure compliance with relevant standards and limit values. These are based on sound operation and can be agreed with EPA from the outset. Exceedance should stimulate mitigatory action. Exceedence levels may also be reviewed with EPA in-light of good faith efforts of a company.

Management

Techniques

Before adopting expensive control technologies (that can substantially increase the levels of solid waste produced), there are a number of options for reducing emissions and effluents. Below are some standard practices that when implemented can lead to operational compliance, and reduced ash residue.

These include:

- recirculating cooling systems;

- choice of cleanest fuel, particularly for solid waste reductions (gas is preferable to oil, which is preferable to diesel or heavy fuel oil, which is preferable to washed coal, which is preferable to coal);
- select the best technology for the chosen fuel to balance economic and environmental benefits;
- For pollution control consider the following:
    - prevention of PM smaller than 10 microns in size are the most important from a health perspective, and removal can be achieved at low cost;
    - consider cost-effective technologies such as pre-ESP sorbent injection along with coal washing before in-stack SO_2 removal;
    - NO_x reduction can be achieved by low NO_x burners and other combustion modifications.

Also, **for turbine and engine driven processes** using diesel oil or heavy fuel oil operational modification parameters will include:

- exhaust gases:
- load profile
- ambient conditions
- fuel quality
- auxiliary equipment, eg cooling properties

- NO_x emissions:

    - fuel injection (timing, □ilometers□, duration)
    - combustion air (valve timing, charge air cooling etc)
    - air and fuel mix, compression ration

- Sox emissions:

    - sulphur content of fuel

- Particulate Matter:

- engine condition (maintenance, fuel injection)
- ash content of fuel

For Non-Conventional Generation plant using Biomass systems incomplete combustion gives rise to smoke emissions and excessive quantities of ash, and thereby increases the environmental impact of the plant as well as reducing the proportion of energy that can be recovered.

In achieving the optimal band in which Particulate Matter (PM) and NO_x emissions are minimised simultaneously the combustion equipment therefore needs to be carefully designed to ensure complete combustion of the feed material.

It is often not possible to achieve complete combustion of biomass materials in furnaces designed for burning normal fuels such as coal. A number of processes have been designed to achieve complete combustion of biomass materials. This includes a two stage process in which the material is first partially burned and volatile matter given off as smoke, the volatile matter is then burned in a second combustion chamber to recover the remaining calorific energy so eliminating the smoke. In other systems chipped feed material is mixed with combustion air in a cyclone system to promote complete combustion.

In a well designed and operated system the ash quantity will often be no more than 3% of the feed material. This will often be in a light friable form that could give rise to dust problems if not carefully managed. Well designed combusters will incorporate a mechanism for discharging ash to suitable containers and / or for damping down with water. In many cases good quality ash which does not contain residual organic material can be used as a valuable constituent for brick or concrete block manufacture.

Technologies

There is a wide variety of control technology options. As usual, these should be considered after an adequate assessment of broader management techniques, which will reduce all by-products, and particularly solid waste.

Abatement of Particulate Matter

The options for removing particulates from exhaust gases are cyclones, baghouses (fabric filters), and ESPs. Cyclones may be adequate as pre-cleaning devices, with an overall removal efficiency of less than 90% for all particulate matter and considerably lower for PM_{10} . Baghouses can achieve removal efficiencies of 99.9% or better for particulate matter (of all sizes) and they have the potential to enhance the removal of SO_x when sorbent injection, dry-scrubbing, or spray dryer absorption systems are used. ESPs are available in a broad range of sizes for power plants and can also achieve removal efficiencies of 99.9% or better for particulate matter (of all sizes).

The choice between a baghouse or an ESP will depend upon fuel and ash characteristics as well as operating and environmental factors. ESPs can be less sensitive to plant upsets than fabric filters, because their operating effectiveness is not as sensitive to maximum temperatures and they have a low pressure drop. On the other hand, ESP performance can also be affected by fuel characteristics. Modern baghouses can be designed to achieve very high removal efficiencies for PM_{10} at a capital cost that is comparable to that for ESPs, but it is necessary to ensure appropriate training of operating and maintenance staff.

Abatement of Sulphur Oxides

The most cost-effective way to control sulphur oxides in the exhaust gases is to minimise the sulphur content of the fuel.

The range of end-of-pipe options and removal efficiencies of SO_x controls is wide. Pre-ESP sorbent injection can remove from 30-70% of

SO_x. Post-ESP sorbent injection can achieve 70-90%. Wet and semi-dry FGD units consisting of dedicated SO_x absorbers can remove 70-95. The operating costs of most FGDs are substantial because of the power consumed (of the order of 1-2% of the electricity generated), chemicals used, and disposal of residues. Estimates made by the International Energy Agency (IEA) suggest that the extra levelised annual cost for adding an FGD designed to remove 90% of SO_x to a coal fired power plant amounts to 10-14% depending on capacity □ilometers□.

An “integrated pollution management” approach should be adopted that does not involve switching one form of pollution to another. For example, FGD scrubber wastes when improperly managed can lead to contamination of the water supply, and such SO_2 removal systems could lead to greater emissions of particulate matter from materials handling and windblown dust. This suggests the need for careful benefit-cost analysis of the types and extent of sulphur dioxide abatement.

Abatement of Nitrogen Oxides

The main options for controlling NO_x emissions are combustion modifications – low NO_x burners with or without over fire air or reburning, water/steam injection, and selective catalytic or non-catalytic reduction (SNCR/SCR). Combustion modifications can remove 30-70% of NO_x. SNCR systems can remove 30 to 70% of NO_x. However, plugging of pre-heater from the formation of ammonium bisulphate may pose some problems. SCR units can remove 70-90% of NO_x. Moreover, SCR may require low sulphur fuels (less than 1.5% sulphur content) because the catalyst elements are sensitive to the SO_2 content in the flue gas.

Fly Ash Handling

Fly ash handling systems may be generally □ilometers□ as dry or wet, even though the dry handling system involves wetting the ash to 10-20% moisture to improve handling characteristics and to mitigate the

dust generated during disposal. In wet systems the ash is mixed with water to produce a liquid slurry with 5-10% solids by weight. This is discharged to settling ponds – often with bottom ash and FGD sludges as well. These ponds may be used as the final disposal site, the settled solids may be dredged and removed for final disposal in a landfill. Wherever feasible, decanted water from ash disposal ponds should be recycled to formulate ash slurry. Where there are heavy metals present in ash residues of FGD sludges, care must be taken to monitor and treat leachates and overflows from settling ponds in addition to disposal in lined places to avoid contamination of water bodies. In some cases, ash residues are being used for building materials and in road construction. Gradual reclamation of ash ponds should be □ilometer.

Water Use

It is possible to reduce the fresh water intake for cooling systems by installing evaporative recirculating cooling systems. While such systems require a greater capital investment, they may use only 5% of the water volume required for once through cooling systems. Where once through cooling systems are used, the volume of water required and the impact of its discharge can be reduced by the careful siting of intakes and outfalls, by □ilometers the use of biocides and anti-corrosion in cooling with water systems), and by controlling discharge temperatures and thermal plumes. Wastewaters from other processes (including broiler blowdown, demineraliser backwash, and resin regenerator wastewater) can be recycled, but again this requires careful management and treatment for reuse. Water use can also be reduced in certain circumstances through the use of air cooled □ilometers.

Waste Handling

Inert and domestic waste should be managed according to a specific plan of collection, containment, and disposal off site at a designated landfill site. Special waste including oily and hazardous waste require different treatment. Oily wastes should be collected, drummed and stored on site, (or at cooperative storage sites shared by several users)

until such time as an environmentally sustainable disposal method is identified.

At decommissioning, all asbestos should be removed and disposed of safely. This will require the intervention of specialist experts to remove the materials and contain it. Asbestos waste should be double bagged and placed in a sealed skip. It can then be buried in specially designed landfills. If no adequate facilities exist in Guyana, the waste asbestos should be shipped overseas to a country which is able to dispose of the waste safely.

Waste transformer oils, potentially containing PCBs, should be drummed and stored in designated secure areas prior to disposal in a sanitary landfill that has been designed to accept hazardous waste. If no adequate facilities exist in Guyana, the waste transformer oils should be shipped overseas to a country which is able to dispose of the waste safely.

Best Practice Guidelines for Hydro Power Generation

This section outlines some of the most common approaches to improved environmental performance within the hydro power generation industry.

It includes monitoring and management techniques aimed at the reduction of environmental and social impacts commonly associated with large scale flood plains. However, many measures and approaches are equally applicable to smaller scale flood plain developments, and 'run-of-river' plant.

MITIGATION, MONITORING AND REPORTING

Mitigation

The principle impacts to be considered in hydro-generation are related to dam and reservoir systems. Firstly, does the project require

resettlement, and if so, who and how many people, and secondly what is the size of the land area lost due to filling the reservoir. From here the next most important issues are generally associated with downstream impacts, for example, the number of affected families, the length of river that will dry up, fish migrations, and the minimum dry season release regime.

Environmental Management During Construction

During construction the EMP should aim to ensure :

- preservation of constant adequate river flow down stream from the dam and up to the confluence of the tail race outflow; and maintenance of an adequate flow downstream of the tail race during the wet season;

- preservation of a viable aquatic plant and animal community in the rivers downstream of the dam and tail race outlet;

- vegetation clearance is carried out in a systematic and gradual manner, within well defined consecutive plots – so that clearance within any one plot is completed before work begins with an adjacent plot;

- clearance proceeds with minimum threat from conflagration by burning wood;

- activities that disturb or are harmful to wildlife are minimised;

- animals are able to move out of disturbed areas safely and without prejudice from humans;

- medical provision is provided to the relocated and host communities;

- the resettlement action plan is adequate to meet the needs and aspirations of the resettled and host communities.

Environmental Management During Commissioning

Environmental management during commissioning should aim to ensure that:

- adequate water flow is preserved downstream of the dam, to maintain viable aquatic plant and animal communities;

- wildlife are able to move away from rising waster levels, without threat from the construction force or other ancillary workers;

Environmental Management During Operation

- adequate water flow is preserved downstream of the dam, and the continuation of a viable aquatic plant and animal community within the river;

- the aims and aspirations of the resettlement action plan are achieved;

- policies provided for the protection of wildlife and wildlife habitats in the catchment and the resettlement areas are complied with;

- adequate health and medical services, as well as a range of occupations and educational opportunities are provided to the relocated people in accordance with the resettlement action plan terms of reference;

- prevention, control and migration of endemic diseases in the catchment and the resettlement areas;

- afforestation and land rehabilitation measures are adequately carried out; and

- activities carried out on the surface of the reservoir such as fish farming, and draw-down area such as agriculture comply with reservoir operation procedures.

Environmental Management During Decommissioning

Environmental management during the decommissioning phase should aim to ensure:

- the dam infrastructure is disposed in a manner that does not conflict with human, wildlife and habitat interests;
- disposal complies with national and regional legislation;
- adequate flood prevention measures are installed; and
- adequate rehabilitation of all impacted land surfaces.

Monitoring

The EMP will need to account for monitoring of environmental parameters and the influence of mitigation measures on environmental impacts. It will also need to specify who is responsible for monitoring, the costs, and what other inputs (such as training) are required. In this respect an environmental monitoring plan will also need to be prepared which will feed into the EMP. The monitoring will need to include a variety of parameters at each stage of the project (pre-construction, construction, commissioning, operation, and de-commissioning).

The following text describes the range of parameters that can require monitoring and management within all stages of hydro developments. However, the precise range of parameters requiring frequent monitoring should be reviewed in relation to Guyana's national requirements and relevant legislation.

Environmental Monitoring During Construction

Environmental monitoring during construction should aim to ensure that:

- wildlife and plants are surveyed during logging and woodland clearing;
- water samples are collected from the catchment rivers for analyses;
- a database of water quality parameters is established;
- a database recording the health characteristics of the relocated and host
- adequate surveys of the resettlement sites for human resettlement are carried out.

Environmental Monitoring During Commissioning

Monitoring during commissioning should aim to ensure:

- water samples are taken from pre-arranged locations within the impoundment area, and upstream of the reservoir; and,

- analysed water samples are recorded in a retrievable database for future reference and comparisons of subsequent results.

Environmental Monitoring During Operations

Monitoring during the operations phase should aim to ensure:

- maintenance of the water quality sampling and analyses programme in the reservoir and its upstream rivers;

- rates of sediment accumulation in the reservoir are measured annually or seasonally;

- soil erosion in the catchment and suspended sediment loads in river flow and run-off is measured periodically;

- sediment is sampled for analyses of chemical parameters (e.g. heavy metals);

- maintenance of the sediment and water quality record database; and,

Recording

Data should be analysed and reviewed with reference to operating standards on a regular basis. All records of monitoring results should be kept in an acceptable/logical format. The results of the Environmental Monitoring Plan feed back continuously to the Environmental Management Plan as a means to validate the predicted impact assessments, and to testify to the effectiveness of the mitigation measures. Development of the Environmental Management Plan is wholly dependent on site specific surveys of and the needs for conserving wildlife; wildlife habitats; water quality; human societal needs (such as healthcare; prevention of diseases; providing employment opportunities; education infrastructure; the needs for agriculture development; sustainable land use); catchment conservation; prevention of soil erosion; rehabilitation of impacted land surface and the disposal of wastes. This list is not exhaustive, and other needs will be identified from the site surveys.

MANAGEMENT TECHNIQUES

The size of the flooded area is the single most relevant proxy for environmental impact. Therefore, a proposed dam should ideally, have the highest feasible ration of power production per area inundated. There is therefore great scope for selecting projects with little or no reservoir (for example, in uninhabited rocky canyons), run-of-river, or outstream diversions, to reduce impact. For aquatic biodiversity, perhaps the simplest proxy, is the □ilometers of stream or river flooded. Generally moist forest contains more biodiversity than dry ecosystems, so plant proposed within the forest regions of Guyana, are more likely to impact a wider species range than those in the savannah regions. Intact ecosystems are more valuable (in terms of environmental

protection), than agriculturally modified agro-systems or barren landscapes. If part of the ‘land lost’ due to dam construction is a national park or affords some other kind of protect status, that would weigh very heavily in the decision making.

6.3 Framework for Environmental Monitoring

Activity	Requirement for Existing Installations	Requirement for New Installations
Monitoring of gaseous emissions		
Detailed design of monitoring programme Data reporting and compliance checking	All plants regardless of output within three years of the enactment of the Air quality Regulations 2000 Less than 15 year lifetime; Spot checks for particulates and complaints monitoring taking into account plant age and size. More than 15 year lifetime and more than 10 MWe output regular monitoring of air emissions reports (taking into account plant age and size) for parameters in the First Schedule, within 5 years of the commencement of Air Quality Regulations 2000 Reporting of data to EPA within five years of the enactment of Air Quality Regulations 2000.	Detailed design of monitoring programme for submission to EPA. Regular monitoring of air emissions (parameters) mentioned in First Schedule, reporting of data to EPA.
0.5 – 10 MWe	Monitoring of particulates and complaints monitoring	
Less than 0.5 MWe	Complaints monitoring	Complaints monitoring

MONITORING OF EFFLUENT DISCHARGE		
More than 0.5 MWe using a water-cooled system discharging significant volumes of cooling water, water treatment wastes, boiler blowdown, contaminated stormwater	Less than fifteen years old requires spot checks and complaints monitoring taking into account plant age and size. More than fifteen years old requires full discharge monitoring ; spot checks and complaints monitoring, taking into account plant age and size.	Full discharge monitoring regime for parameters mentioned in Second Schedule; spot checks and complaints monitoring
More than 0.5 MWe using other than a water-cooled sytem	Less than fifteen years old requires spot checks and complaints monitoring More than fifteen years old requires a monitoring system for stormwater and domestic sewage within five years after the commencement of these Regulations; spot checks and complaints monitoring	Monitoring system for contaminated stormwater stormwater and domestic sewage; spot checks and complaints monitoring
Less than 0.5 MWe	Complaints monitoring	Complaints monitoring

Monitoring of Wastes		
Oily wastes, hydrocarbons, emulsions	Less than 3 years old requires complaints monitoring More than 3 years old requires full monitoring regime documenting transport, storage and disposal including volumes, spillages; spot checks and complaints monitoring. Environmental Management plan to include adequate measures for disposing of waste oils.	Where EIA required, environmental permit require sampling, analysis and reporting. Full monitoring regime, documenting transport, storage and disposal, including volumes and accidental spillages, spot checks and complaints monitoring. Environmental Management plan to include adequate measures for disposing of waste oils.
Asbestos	Containment of asbestos in place until decommissioning, leading to safe disposal overseas. Prohibit the use of asbestos.	Prohibit the use of asbestos
PCBs	Document the age, maintenance and disposal of units using PCB-based transformer oils, spot checks. Use of PCB's prohibited.	Prohibit the use of PCBs in any form
Ash(Bagasse, rice hulls)	Less than 3 years old requires complaints monitoring More than 3 years old requires monitoring of volumes produced and means of disposal, spot checks and complaints monitoring	Monitoring of volumes produced and means of disposal, spot checks and complaints monitoring

7.0 Environmental Audit Protocol

7.1 Introduction

Before undertaking an audit, it is important to clearly define the scope and objectives of the audit, as well as how the results will be used. In Guyana, existing plants may require an environmental audit to form a baseline against which an Environmental Management Plan can be prepared, and in some cases, to define a programme to meet environmental standards.

There are four general types of audit:

- Liability and Risk
- Health and Safety
- Monitoring and Compliance
- Environmental Management Plan or System

7.2 General Scope

An audit of the environmental conditions at an existing plant should:

- Review the actual operating and environmental performance of the plant, relative to its original design parameters or, if this is not applicable, then relative to best practice, regulatory standards or targets set for improvement.
- Examine the reasons for poor performance to identify opportunities for technical improvement
- Assess the scope for making improvements to general housekeeping and management practices
- Evaluate the capacity of the plants emergency procedures and management systems
- Examine the plants record with respect to worker health and safety.

The environmental audit report should also provide recommendations on the measures required to rectify any significant problems that were identified during the study, and should be sufficient to provide the basis for an Environmental Management Plan (EMP). Recommendations should be accompanied by the appropriate estimates of the cost (both capital and operating) that would be involved and an indication of the

actions that should be taken either to implement the recommendations or evaluate alternative options. Responsibilities should be clearly defined for each action.

7.3 Protocol

Guidance and Standards

This audit protocol is intended to serve as an *aide memoire* for auditors visiting the site. It is not intended to comprehensively detail findings from the visit and should not be used as the sole basis from which conclusions to the audit have been drawn.

Guidance in this protocol is limited to the nature of the regulation for each of the topics covered, but reference is also made to standards of international relevance and corporate policy requirements.

Guidance is also given on the implications of answers given during the compilation of the audit protocol. This is intended to prompt the auditor into asking the questions of most relevance to the site, in order to establish level of site awareness and degree of compliance.

Using the Protocol

Compliance is the benchmark addressed by this protocol. Establishing compliance can be achieved in a number of ways, including:

- Establishing the level of awareness – of legislation, corporate requirements (if applicable), emissions, discharges and risks associated with principal operations at the site(s) and the likely impact on the site and its personnel;
- Establishing control/abatement technologies in use – and assessing whether they are effective in controlling pollutants and meeting relevant regulations or standards;
- Establishing the procedures and management systems in place – to reduce the overall environmental impact of operations including responsibility of specific personnel, the presence and adequacy of written procedures and reporting structures;
- Establishment of upgrade programmes and performance targets (EMP) – these relate to the efficiency of EHS work and help to establish whether the site is seeking preventative, rather than

reactive, solutions to EHS issues.

*Throughout the protocol, the annotation * follows a number of questions. This indicates that the auditor should review (and if necessary obtain copies of) relevant documentation relating to the issue. It may, for example, refer to environmental permits, documented procedures or correspondence with third parties.*

1. GENERAL SITE DETAILS

This section gathers introductory information regarding the site. Its chief importance is to record which personnel were involved in the audit process and to establish a general description of the site and its activities. This information is of use when following up/verifying audit findings and if necessary, contacting authorities for further information (as they will need basic information regarding the site).

1.1 Site Name: _____

1.2 Full Postal Address: _____

_____

_____

_____

1.3 Telephone Number: _____

1.4 Fax Number: _____

1.5 Principal Contact Name and Position: _____

1.6 Other Site Contacts and Positions: _____

_____

_____

_____

2. SITE ACTIVITIES

2.1 Briefly describe activities carried out on-site, including types of products/chemicals/materials handled. **Obtain a flow schematic if possible.**

2.2 Number of Employees:

Full-time: _____

Part-time: _____

Temporary/Seasonal: _____

Maximum no. of people on site at any time: _____

2.3 Typical Hours of Operation: _____

Number of Shifts: _____

Days per Week: _____

Weeks per Year: _____

Scheduled plant shut-down: _____

2.4 Detail the main sources of energy at the site:

Gas	Yes/No
Electricity	Yes/No
Oil	Yes/No
Other	Yes/No

2.5 Are any significant construction projects or process/manufacturing or utility changes planned in the next 5 years which will require environmental review, action or modification? **Give details as to any environmental impacts or specific planning/development requirements.**

3. SITE DESCRIPTION

This section is intended to gather information on site setting and environmental receptors on, adjacent or close to the site.

3.1 What is the total site area: _____

What area of the site is covered by buildings (%): _____

3.2 Is the site owned or leased? Owned/Leased

If leased, who is the landlord?* _____

3.3 Is a site plan available?* Yes/No

3.4 Are there any other parties on site as tenants or sub-tenants? Yes/No

If yes, identify those parties: _____

3.5 Describe surrounding land use (residential, industrial, rural etc.) and identify neighbouring facilities and types of industry.

North: _____

_____

South: _____

_____

East: _____

_____

West: _____

_____

3.6 Describe the topography of the area (flat terrain, rolling hills, mountains, by a large body of water, vegetation etc.).

3.7 State the size and location of the nearest residential communities.

3.8 Are there any sensitive habitats nearby, such as nature reserves, national parks, wetlands or sites of special scientific interest?

3.9 Are there any important cultural or archaeological sites nearby?

4. SITE GEOLOGY AND HYDROGEOLOGY

The information collected in this section should allow an assessment of site hydrogeological sensitivity, particularly in relation to the potential impacts associated with polluting activities at or near to the ground surface.

4.1 Define and describe geology of the site and surrounding area from surface down to bedrock. (*Give details of any borings ever taken for geotechnical or site contamination purposes*)

4.2 Based upon information contained within reports detailed above or other published information which may be held at the site describe the hydrogeological site setting of the site and its immediate environs. *Give details of depth to and direction of flow of shallow groundwater and usable uppermost aquifer and if possible the quality of groundwater.*

4.3 What is the location of the nearest surface water courses? **Official classifications of water quality should be established if possible, rather than subjective judgements.**

Water course:
Location:
Use:
Classification:

Water course:
Location:
Use:
Classification:

4.4 Are there any boreholes/wells or natural springs either on the site or in the surrounding area? **Describe groundwater use in surrounding area (e.g. municipal or residential drinking water, commercial or industrial,** agricultural)

Well, Borehole or Spring:
Location:
Use:

Well, Borehole or Spring:
Location:
Use:

4.5 From the information gathered, a classification of hydrogeological sensitivity should be possible:

- High Sensitivity
- Moderate Sensitivity
- Low Sensitivity

5. SITE HISTORY

Information on site history will assist in identifying whether past land use may have caused ground contamination at the site. Details of historical land use on neighbouring land can also provide useful information. Historical maps and aerial photographs may be available.

5.1 Describe the dates, ownership and past uses of the site as far back as possible prior to the date of acquisition or lease.

5.2 Have there been any major changes in operations carried out at the site in the last 10 years? (*If so, describe*)

5.3 Have any polluting activities been carried out in the vicinity of the site in the past?

6. OPERATING PERMITS

Details of Environment, Health & Safety and Operating permits should be obtained in this section of the protocol.

6.1 Is the facility subject to any integrated operating permits for environmental, health and safety matters?* Yes / No

If yes;

6.2 What are the National laws/regulations applicable?

6.3 What are the particular processes/activities or quantities of chemicals stored at the site which attract this permitting requirement?

6.4 Who is the regulatory/enforcing authority that granted the permit?

6.5 When was the permit granted?

6.6 How long is the permit valid and on what date will it require renewal?

6.7 How frequently do the regulatory authorities visit to check that the site is operating in accordance with the permit conditions?

_____ Every 6 months _____ Every 2 years

_____ Yearly _____ Not done

6.8 When did they last visit?

6.9 Did any enforcement actions or improvement requirements result from the last visit?* Yes/No/NA

Describe

6.10 What data/studies were required to be submitted to the authorities under the permit application process?*

6.11	If site operations change, will a new permit application be necessary? Describe the nature of such changes	Yes/No
6.12	Are any such changes planned in the next 5 years which will require a new permit or existing permit modification? Describe	Yes/No

7. ENVIRONMENTAL MANAGEMENT

Environmental, health and safety issues must be effectively managed if regulatory compliance is to be consistently achieved. This section seeks to establish the overall structure for EHS management at the site - questions relating to the management of specific EHS issues are integrated into the relevant sections.

7.1	Does the site have an environmental policy?*	Yes/No
7.2	Does the site have an environmental management manual*?	Yes/No
7.3	Are there any written environmental procedures*? (e.g. spill prevention, drum handling etc.)	Yes/No
7.4	Who has responsibility for environmental issues at the site? *(Specify who reports to whom and indicate who has ultimate responsibility)*	
7.5	Is there an environmental committee?	Yes/No
	If yes, how often does it meet and who sits on the committee?	
7.6	Are environmental audits ever carried out?	Yes/No
	How frequently are audits undertaken?	
	Who carries out the audits?	
7.7	Are environmental issues incorporated as part of employee training programmes?	Yes/No
	Does the site participate in any environmental management schemes, e.g. ISO 14001?	Yes/No
	Does the site support any local/national environmental projects?	Yes/No

8. AIR EMISSIONS

Significant emissions to air are subject to regulatory control. Failure to comply with the terms of regulation/license may result in improvement notices, fines or in extreme cases, plant closure. Good practice dictates that operating sites not only comply with regulatory requirements regarding air emissions where applicable, but also undertake preventative maintenance programmes, establish relevant management procedures and where feasible harness 'advanced technology' to minimise polluting emissions.

8.1 Has an air emission inventory been completed? *(If yes attach a copy)*

If No, identify all air emissions on the attached inventory, giving details of all known sources of release (heating, combustion, manufacturing related etc.) and nature of emissions (toxic gases, particulates, odours or steam)

8.2 What is the total number of plant emission sources (stacks and vents)?

8.3 Is the facility subject to any licenses for atmospheric emissions? *(Identify any National air emission laws/regulations and describe those processes/point sources which are licensed)*

8.4 List air emission permits and expiry dates.

8.5 Describe frequency of EPA inspections, date of most recent visit and any problems noted

8.6 Are there any boilers on site? *(Give details of capacities and fuel source)*

8.7 Are any materials incinerated on site? *(Describe nature of incinerator including material burned, process used and registration details)*

8.8 Describe (briefly) any air emission control devices employed.

8.9 Is there a preventative maintenance programme/cleaning schedule for the emission control devices employed? *(Give details of frequency)*

8.10 Has any monitoring of stack emissions been carried out? *(Describe locations, frequency and scope, whether required by law or voluntary, and body undertaking monitoring)*

- Is stack emission monitoring undertaken on a routine basis?

8.11 Has any monitoring/assessment of fugitive releases been carried out? *(Describe as above)*

- Is fugitive release monitoring/assessment undertaken on a routine basis?

8.12 Has any ambient atmospheric monitoring been carried out? (e.g. at the site boundary). *(Describe as above)*

- Is ambient monitoring undertaken on a routine basis?

8.13 Has the facility been in compliance with allowable air emission standards? *(Give details, including permitted standards)*

8.14 Describe the nature of any fugitive emissions on site and any steps to control these.

8.15 Describe the presence of detectable odours, solid particulates, liquid droplets or mist in the air:

- Within buildings

- Outside buildings, but within site property limits

- Outside plant boundary

8.16 Have there been any abnormal emission incidents?

8.17 Are there any other potential sources of air pollution from neighbouring sites? *(Give details of distance, location, pollutants and prevailing wind direction)*

8.18 How many air related complaints have been received by the facility during the past 5 years? *(Give details and dates)*

8.19 Has the facility been prosecuted for any atmospheric emission incidents in the past 5 years? *(Give details and dates of past violations and regulatory actions)*

8.20 Are there any pending regulatory enforcement actions regarding atmospheric emissions?

8.21 Are any additions or major modifications to air emission sources envisaged or likely to be required in the near future? *(If yes, detail and provide an estimate of capital expenditure)*

EMISSIONS INVENTORY

List all air emissions and control devices (e.g. wet/dry scrubber, cyclone, fume incinerator, filters etc.)

Emission Source	Pollutants	Quantity Emitted	Stack / Vent Location	Control Devices	Frequency of monitoring	Emission Regulated (Y / N?)

9. WATER SUPPLY

9.1 Describe water supply sources and site usage. **Identify site usage for each (e.g. process, utility (boilers/cooling towers), sanitary/domestic, drinking, fire water etc.)**

Source	**Use**	**Quantity per annum**
Municipal water system		
Wells / boreholes		
River / canal / lake		
Other		

9.2 What authority/organisation(s) is involved in water supply to the site?

9.3 Does the facility undertake any pre-treatment of water prior to site usage? (e.g. softening, chlorination, de-ionising etc.)

9.4 Are there any boreholes or wells currently in use or disused on site? *(Give details of age, depth, volumes of water extracted and abstraction licences)*

Detail the source of any surface water abstractions and licenses held.

9.5 Is there any analysis of water supplied to the site? Yes/No

Is analysis required/necessary? Yes/No

Give details as to whether water is sampled and tested by a certified laboratory, frequency of testing and analytical parameters.*

9.6 Are test results compared to appropriate Governmental standards? Yes/No

Is there potential for back-flow from plant process into the drinking water supply?

10. WASTEWATER

Discharge of trade effluent is typically subject to some form of regulation e.g. via a discharge consent or license. The terms of this license - and the facility's compliance to these terms - needs to be verified. Discharges to surface waters may also require consents.

Good practice dictates that operating sites not only comply with regulatory requirements regarding wastewater discharge, but also undertake preventative maintenance programmes, establish relevant management procedures and where feasible harness 'advanced technology' to minimise polluting discharges.

All wastewater discharges should be identified on the attached inventory, giving details of source, make-up streams, quantities discharged and treatment methods.

10.1 Which of the following types and/or sources of wastewaters are generated at the facility?

- Process wastewater Yes/No
  (i.e. water that comes into contact with the process or product)
- Non-contact water Yes/No
  (i.e. heat exchanged cooling water)
- Sanitary wastewater Yes/No
  (i.e. domestic wastewater)
- Surface water Yes/No
  (i.e. storm water run-off)

10.2 Do separate site drainage systems exist for the following?

- Surface water Yes/No
- Foul/sanitary effluent Yes/No
- Process effluent Yes/No

10.3 Are there any interceptors, effluent pits, sumps, lagoons, septic tanks or soakaways on-site? *(Give details of locations, capacities and frequency of cleaning)*

10.4 Is any specific wastewater treatment undertaken on-site? *(Briefly describe locations, make-up streams and effluent treatment process)*

10.5 Are any discharges subject to permit/consent by local or state authorities? *(Identify any National water laws/regulations)*

Identify all discharge points

EFFLUENT/WASTEWATER INVENTORY

	Discharge [1]	**Make-up Streams** [2]	**Quantity Discharged**	**Treatment Methods** [3]	**Discharge Point**	**Monitoring** [4]	**Consented (Y? N?)**
1							
2							
3							
4							
5							
6							
7							
8							

[1] Discharges (e.g. surface/storm water run-off to river, process wastewaters to municipal sewer, sanitary/domestic wastewater to septic tanks etc.)
[2] Make-up streams (e.g. process areas, boiler blow-down, vehicle wash, surface run-off, sanitary/domestic, laundry, laboratory etc.)
[3] Treatment methods (e.g. organic or oil separation, biological ETP, chemical treatment, settling pond, aeration/filtration/neutralisation etc.)
[4] Monitoring (e.g. who by and how often?)

10.6 Describe frequency of EPA inspections, date of most recent visit and any problems noted

- List wastewater permit numbers and expiry dates

10.7 How frequently does the facility monitor wastewater discharges? *(Give details of frequency, technique, parameters measured and typical composition)*

10.8 Does the regulatory authority undertake independent analysis of wastewater discharges (additional to the facilities own monitoring)? *(Give details as above)*

10.9 Has the facility been in compliance with allowable wastewater discharge standards? *(Give details, including permitted standards)*

10.10 List all complaints, prosecutions, improvement notices and fines relating to water discharges over the past 5 years.

10.11 Are any additions or major modifications relating to effluent discharge or on site treatment envisaged or likely to be required in the next year? *(Describe, including estimate of capital cost)*

10.12 Are site management aware of any plans for the municipality to revise local effluent discharge laws, requirements or facility permits/licenses? (e.g. in terms of stricter discharge standards, increased water use charges, fines for non-compliance etc., or contributions to new municipal treatment plant construction costs)

11. CHEMICAL HANDLING AND STORAGE

There are widely accepted good practice codes in relation to handling and storage, particularly with bulk storage, spill containment and segregation of incompatible materials. Often, inspectors may wish to inspect chemical storage facilities prior to awarding licenses or certificates. The audit should therefore include a detailed visual inspection and a review of all associated documentation.

GENERAL DETAILS

11.1 Material inventory lists, including quantities and locations available? *(If yes, how often are these inventories updated?)*

11.2 Has the facility produced a separate hazardous substance inventory?

11.3 Have there ever been any incidents or accidents (spills, fires, injuries etc.) involving any of these materials? *(Provide details)*

11.4 How are materials received (rail, truck etc.) and stored on site (drums, tanks, carboys, bags, silos, cisterns, vaults, cylinders)?

11.5 Is the storage of materials subject to any licenses, permits or consents from local or state authorities (e.g. EC Seveso Directive type or US SPCC Plans etc.)? *(Identify applicable national, regional or local laws/regulations and quantity of material(s) attracting licence)*

- List licence numbers and expiry dates

11.6 What regulatory authorities are regularly involved in the licensing of chemical storage at the site? *(Describe frequency and date of most recent inspection)*

11.7 Are personnel involved in the handling and storage of hazardous materials adequately trained? *(Provide details of any documented procedures)*

11.8 Has the facility been subject to any public complaints, or any prosecutions by local or national regulatory authorities relating to the storage of hazardous materials?

BULK STORAGE

Identify all bulk storage tanks and their contents on the attached inventory.

11.9 Describe bulk tank storage arrangements. *(Identify separation distance from boundaries and buildings, spillage containment, floor material, bund capacity and sumps/interceptors)*

11.10 Describe bulk tank filling and distribution arrangements (e.g. tanker delivery, above/underground pipelines).

11.11 Describe hours and frequency of unloading operations.

11.12	Are bulk storage tanks fitted with low or high level alarms and are vent pumps fitted and protected against electrostatic hazards (for flammable materials)?	Yes/No
	Are bulk tanks fitted with dedicated vents or vapour balance lines?	Yes/No
11.13	What is the condition of bund walls and floors?	
11.14	What procedures are there for removing rain water from bunds? *(Describe whether rainwater is checked for contamination before draining)*	
11.15	What maintenance and inspection procedures are undertaken for bulk storage tanks and bund walls?	
11.16	Are non-destructive tests and examinations undertaken for all underground tanks and pipelines? *(Describe frequency, dates of last inspection and details of any integrity test failures)*	
11.17	Are there any disused underground storage tanks? *(Give details of age, location and previous contents)*	
	Have disused underground tanks been removed or otherwise secured (e.g. concrete, sand etc.)?	

BULK STORAGE OF OILS/CHEMICALS

No. of tanks	Contents	Ages (yrs)	Capacity	Location	Above of Below Ground	Bunded (Y/N)	Level Alarm (Y/N)	Annual Throughput

DRUMMED STORAGE

11.18 Identify all drummed materials storage areas (i.e. those in portable containers such as drums, cans, tins, barrels, carboys etc.)

11.19 Describe drum storage areas. *(Give details of store construction, spill containment, fire protection and where possible the type, size, packaging and no. of portable containers)*

11.20 Describe provision (and use) of drip trays and other secondary containment measures applied. *(Give details of any spillage clean-up equipment)*

Are any nearby drains protected? Yes/No/NA

11.21 What is the condition of containers and are these adequately labelled?

11.22 Have incompatible materials been adequately segregated? *(Describe)*

11.23 Are any surface water drains located near to drum storage and unloading areas?

12 EMERGENCY PLANS

12.1 Is there a documented fire and environmental protection plan covering emergencies?*

Yes/No

12.2 What are the main site emergencies to have been foreseen in the site emergency plans?

- Fires and smoke
- Explosions
- Toxic Releases
- Other (describe)

12.3 Identify the issues addressed by the plan *(Is the storage and handling of chemicals covered?)*

12.4 How is the plan updated and when was the last revision?

12.5 Describe emergency/spillage procedures. *(Include emergency contacts and provision of clean-up equipment, personal protective equipment and first aid measures)*

12.6 What training is given to emergency response team members?

12.7 State all past instances of spills, explosions, fires and substances released *(How were these brought under control and which required plan implementation and/or off-site assistance?)*

12.8 Do spill drains feed to surface or foul water drainage?

12.9 What arrangements are made for on-site containment of potentially contaminated surface water following a major spillage incident or fire? (e.g. Sandoz basin)

12.10 Have any emergency practice drills been undertaken and are joint drills ever carried out with off-site teams? *(Describe giving frequency and date of last drill)*

12.11 Does the facility have an evacuation plan?

12.12 Identify agencies and authorities aware of these emergency procedures and facility operations.

13 WASTE MANAGEMENT

Identify all waste materials produced (solid and liquid), quantities and disposal methods on the attached inventory. Identify which of these waste materials are classified as hazardous.

13.1	Does the facility have a formal waste management plan?*	Yes/No
	Is the facility subject to any licenses for waste handling, storage, treatment or disposal? *(Identify any national, regional or local laws/regulations and describe the activities which are licensed)*	Yes/No
13.2	Describe frequency of EPA inspections, date of most recent visit and any problems noted	
13.3	Describe the nature of record keeping for disposal of wastes. *(Have all necessary statutory waste consignment documents been completed?)*	
13.4	Describe on-site storage arrangements for waste *(Describe whether waste materials are adequately segregated, locations of storage areas, condition of containers, spillage containment etc.)*	
13.5	What waste disposal contractors are used?	
13.6	How do these waste disposal facilities treat/dispose of the waste? *(Are any wastes transported for disposal abroad?)*	
13.7	Have all waste carriers and disposal contractors been licensed/approved by the regulatory authorities?	
13.8	Are copies of these licenses held on site?	Yes/No
13.9	Have final waste disposal destinations been verified by site personnel?	
13.10	Are wastes treated in any way on site (e.g. incineration, burning, on-site lagoons) and/or have these activities been carried out in the past? *(Describe)*	
13.11	Are wastes dumped on site and/or has on-site dumping taken place in the past? *(Give details on the nature of wastes, quantities disposed and length of time on-site disposal has been carried out)*	
13.12	Does the on-site disposal facility accept waste from other sources?	Yes/No
13.13	Does the facility have a licence for on-site waste treatment/disposal?	Yes/No
	If yes, provide details	
13.14	What wastes, if any, are recycled and by whom?	
13.15	Are there any initiatives to minimise waste on the site?	

13.16 List all complaints, prosecutions, improvement notices and fines relating to the mishandling or incorrect disposal of wastes.

13.17 What is the remaining available capacity (i.e. the current life expectancy) of any landfill sites used for waste disposal? *(If life expectancy is less than 5 years, have alternative plans been prepared by facility management?)*

WASTE INVENTORY

Description	Source	Quantity Generated	Storage Location and Container	Frequency of Collection	Contractor	Final Destination and Method of Disposal

14 ASBESTOS

Exposure to asbestos fibres has been linked with diseases such as asbestosis, mesothelioma and bronchial carcinoma. Good practice dictates that all asbestos on site should be identified, labelled and in a good condition (i.e. not in a fibre releasing state). Management plans should exist for suitable arrangements to be taken in event of asbestos disturbance (e.g. due to building refurbishment). In most countries, asbestos has to be removed and disposed of by specialist/licensed contractors.

14.1 Has an asbestos survey ever been carried out? Yes/No

If yes, when was this carried out and by whom?

14.2 Identify asbestos containing materials present within the building structure at the site? **Auditor should establish condition of material during walkthrough inspection and assess condition of asbestos material; A - Good, B - Fair (minor deterioration), C - Poor**

Description	**Location**	**Quantity (m^2/m)**	**Condition**
Asbestos cement sheet roofing/cladding			A / B / C
Sprayed insulation on structural steelwork			A / B / C
Sprayed insulation between walls/floors			A / B / C
Pipework/boiler insulation			A / B / C
Asbestos panels/boards or partition walls			A / B / C
Ceiling tiles			A / B / C
Other			A / B / C

14.3 Has any asbestos containing material been covered or otherwise secured on site? *(Describe)*

14.4 Have there been any demolition or removal operations involving asbestos containing materials? *(Describe date, removal process, fate and quantity of materials, contractor used)*

14.5 Are asbestos materials used or handled for other purposes at the facility (e.g. gaskets, flanges, brake pads)?

Yes/No

15 NOISE

This section relates to environmental noise, as opposed to workplace noise which is normally covered under health and safety. EPA have promulgated ambient noise standards in order to reduce the likelihood of industrial noise causing nuisance.

15.1 Is the facility subject to any boundary noise standards? *(Identify any National, regional or local environmental noise laws/regulations and permits applicable)*

15.2 What are the noise standards which must be met at the site boundary?

During the day: _____

At night: _____

Has a boundary noise survey been carried out? Yes/No

If yes, when and by whom?

15.3 Does the facility meet the noise level requirements? *(Describe actual noise levels measured)*

15.4 Describe the source of high level noise at the site and any steps to control this *(Describe existing and planned noise attenuation measures)*

15.5 Describe frequency of EPA inspections, date of most recent visit and any problems noted

15.6 How frequently are noise measurements taken? *(Identify who carries out these measurements)*

15.7 How many noise related complaints (e.g. from statutory authorities, neighbours or public) have been received by the facility during the past 5 years? *(Give details and dates)*

15.8 Has the facility been prosecuted for any noise incident in the past 5 years? *(Give details, including past violations and pending regulatory actions)*

16 PCBS

Polychlorinated biphenyls (PCBs) can contain highly toxic impurities such as chlorobenzodioxins and polychlorodibenzofurans. PCBs are resistant to chemical and biochemical degradation and persist in the environment. They accumulate in the fatty tissues of living organisms and in particular, are known to accumulate up the aquatic food chain. Their manufacture has now been banned in almost all countries, although they remain present in existing equipment (primarily electrical, including old transformers). If not required legally, good practice dictates that presence of PCBs should be established and any source labelled and monitored accordingly. In addition, removal and disposal must be carefully controlled.

16.1 Approximate the number of power transformers, capacitors, lighting ballasts, hydraulic equipment and heat transfer systems on site *(Identify locations, types and ages)*

16.2 Has a survey been made to determine the presence or absence of PCB or PCB contaminated oil in these units?

16.3 Has any unit ever leaked? *(If yes, give details including nature of underlying ground)*

16.4 Are there any PCB containing items presently out of service, abandoned or in storage at the site? *(Describe)*

Have any PCB containing units ever been stored on-site in the past? Yes/No

If yes, detail when and where:

If PCBs have been removed from transformers or capacitors, how were they disposed of?

16.5 Identify any national or local regulations/laws regarding the special requirements for handling, use and disposal of PCBs.

17 OZONE DEPLETING CHEMICALS

Manufacture and sale of ozone depleting compounds (ODCs) - particularly chlorofluorocarbons (CFCs) - are regulated internationally through the Montreal Protocol, to which most countries are signatories. Specific compounds have individual phase out dates. Fire extinguishing systems, refrigerants for chillers and chlorinated solvent degreasers are three common areas utilising ODCs.

Identify ODCs used at the site:

Substance	**Site usage / Application**	**Comments**
CFC-11		
CFC-12		
CFC-22		
CFC-500		
Halon 1211		
Halon 1301		
Carbon tetrachloride		
1,1,1- trichloroethane		
Methyl bromide		
HCFCs		
HBFCs		

17.1 Are there any halon fire blanketing systems or hand-held halon (e.g. BCF, Halon 1301) fire extinguishers on site?

Are non-release test procedures utilised?

Is there a halon replacement programme in place?

17.2 Are there any refrigeration or air conditioning systems on-site?

Detail the equipment and refrigerant used **(is it regulated by the Montreal Protocol?)**

Is there a refrigerant replacement programme in place?

17.3 Are any solvents used on site regulated by the Montreal Protocol?

If so, is there a replacement programme in place? **Solvents of note include 1,1,1-trichloroethane (Genklene), methyl chloroform and carbon tetrachloride.**

17.4 Is there a site policy with regard to purchase of 'ozone friendly' aerosols and equipment?

Is there a CFC replacement programme underway? Yes/No

If yes, what alternatives/substitutes are being considered?

18 SOIL AND GROUNDWATER CONTAMINATION

18.1 Is there any evidence of soil/groundwater contamination on-site? *(Give details of any studies carried out)*

18.2 Has fill been brought to the site in order to alter site topography? *(Describe source and type of fill brought to the site and fill location)*

18.3 Have any parts of the site historically been used for chemical, oil or waste materials storage and processing activities (i.e. those areas no longer used for that purpose)?

18.4 Has any on site dumping of waste materials taken place? *(Describe locations and history of materials dumped, including nature of materials)*

18.5 Have any soil/groundwater samples been taken? *(Give dates, analytical laboratory used and results of any analyses)*

18.6 Is there any evidence to suggest off-site migration of contaminants from the site? *(Give details)*

18.7 Is there any evidence to suggest on-site migration of contaminants from neighbouring pollutant sources? *(Describe)*

18.8 Are regulatory authorities aware of any contamination? *(Give details, including past or pending regulatory actions)*

18.9 Has the facility carried out (or are there plans to undertake) any site remediation or clean-up programme? *(Describe and provide an estimate of capital expenditure associated with the project)*

19. EKEEPING

Good housekeeping practices minimises the risk of both environmental (e.g. spillage) and health and safety (e.g. tripping) incidents taking place. This section of the protocol is designed for the auditor to make notes from visual observation, rather than through interview. Good housekeeping generally indicates that environmental management issues are being effectively addressed.

19.1 Is there evidence of new and waste drums scattered throughout the site (more than for immediate use), without secondary containment? *(Describe)*

19.2 Are drums in poor condition (e.g. rusty, blown ends, leaking) and are they correctly labelled? *(Give details)*

19.3 Is there evidence of solids and liquids spills on paved and unpaved areas? *(Describe nature and extent)*

19.4 Is there evidence of burning on paved or unpaved areas? *(Describe)*

19.5 Is there evidence of redundant equipment and rubbish lying around inside and outside the facility buildings? *(Describe)*

19.6 Provide a brief statement to summarise the status of housekeeping at the facility.

20. COMPLAINTS AND PUBLIC RELATIONS

20.1 Have neighbours or the public complained about nuisance/visual impact from any of the following: *(Give details, including number of complaints per year)*

Site aesthetics	Yes/No
Lighting at night	Yes/No
Litter	Yes/No
Waste materials storage	Yes/No
Dust	Yes/No
Vehicle movements	Yes/No
Other (describe)	Yes/No

20.2 How are complaints processed?

20.3 Are there any regulatory enforcement actions or prosecutions outstanding which relate to the above? *(Give details)*

20.4 Does the facility try to portray itself to the public as a good neighbour? *(Give examples of specific initiatives)*