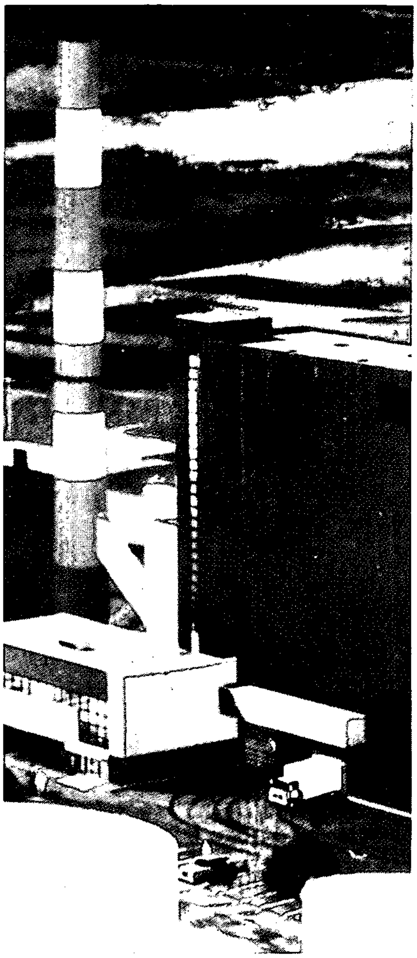
Environmental Protection Series



Environmental Codes of Practice for Steam Electric Power Generation - Operations Phase

Report EPS 1/PG/5
November 1992

anadä

Environment Canada Environnement Canada

ENVIRONMENTAL PROTECTION SERIES

Sample Number:

EPS 3 / HA / 1

- 1 — Report number with the qualifier EPS 3/HA
- HA — Subject Area Code
- 3 — Report Category
- EPS — Environmental Protection Series

Categories

1	Regulations/Guidelines/Codes of Practice
2	Problem Assessments and Control Options
3	Research and Technology Development
4	Literature Reviews
5	Surveys
6	Social, Economic and Environmental Impact Assessments
7	Surveillance
8	Policy Proposals and Statements
9	Manuals

Subject Areas

AG	Agriculture
AN	Anaerobic Technology
AP	Airborne Pollutants
AT	Aquatic Toxicity
CC	Commercial Chemicals
CE	Consumers and the Environment
CI	Chemical Industries
FA	Federal Activities
FP	Food Processing
HA	Hazardous Wastes
IC	Inorganic Chemicals
MA	Marine Pollutants
MM	Mining and Ore Processing
NR	Northern and Rural Regions
PF	Paper and Fibres
PG	Power Generation
PN	Petroleum and Natural Gas
RA	Refrigeration and Air Conditioning
RM	Reference Methods
SF	Surface Finishing
SP	Oil and Chemical Spills
SRM	Standard Reference Methods
TS	Transportation Systems
TX	Textiles
UP	Urban Pollution
WP	Wood Protection/Preservation

New subject areas and codes are introduced as they become necessary. A list of EPS reports may be obtained from Environmental Protection Publications, Conservation and Protection, Environment Canada, Ottawa, Ontario, K1A 0H3, Canada.

Printed on recycled paper

Imprimé sur du papier recyclé

Environmental Codes of Practice for Steam Electric Power Generation - Operations Phase

Industrial Programs Branch
Conservation and Protection
Environment Canada

Report EPS 1/PG/5
November 1992

CANADIAN CATALOGUING IN PUBLICATION DATA

Main entry title:

Environmental codes of practice for steam electric power generation : operations phase

(Report ; EPS 1/PG/5)
Issued also in French under title: Code de recommandations techniques pour la protection de l'environnement applicable aux centrales thermiques, phase de l'exploitation.
Fourth in a series of five documents.
Includes bibliographical references.
ISBN 0-662-20064-0
DSS cat. no. En49-9/1-5E

1. Steam power-plants -- Environmental aspects -- Canada. 2. Electric power-plants -- Environmental aspects -- Canada. I. Canada. Environmental Protection Directorate. Industrial Programs Branch. II. Canada. Environment Canada. III. Series: Report (Canada. Environment Canada) ; EPS 1/PG/5.

TD195.E4E58 1992 621.31'2132 C92-099791-0

Catalogue No. En 49-9/1-5E
ISBN 0-662-20064-0
BEAUREGARD PRINTERS LIMITED

Readers' Comments

Comments on the contents of this report should be addressed to:

Head
Electric Power Section
Industrial Programs Branch
Conservation and Protection
Environment Canada
Ottawa, Ontario
K1A 0H3

Cette publication est aussi disponible en français sous le titre *Code de recommandations techniques pour la protection de l'environnement applicable aux centrales thermiques - Phase de l'exploitation* à l'adresse ci-dessous.

Additional copies of this report are available from:

Environmental Protection Publications
Technology Development Branch
Conservation and Protection
Environment Canada
Ottawa, Ontario
K1A 0H3

Abstract

The Environmental Codes of Practice for Steam Electric Power Generation - Operations Phase is the fourth in a series of five documents developed for the steam electric power generation (SEPG) industry under Part I, Section 8 of the Canadian Environmental Protection Act. *This industry includes fossil-fuelled stations (i.e., those powered with wood, coal, oil, or gas) and nuclear powered stations. The Codes are applicable, however, only to the non-radioactive aspects of nuclear-powered stations.*

This report outlines environmental concerns associated with the operation of SEPG stations and recommends practices that are intended to:

a) mitigate the adverse environmental impacts associated with the operation of new or modified steam electric generating stations, and

b) verify the operating performance of mitigative measures through comprehensive monitoring activities that can subsequently be used as the basis for developing improved environmental protection practices.

This Code was developed by a federal-provincial-industry Working Group and was subjected to a multi-stakeholder review before its publication. It is intended as an environmental standard for governments, industry, and the public.

Résumé

Le Code de recommandations techniques pour la protection de l'environnement applicable aux centrales thermiques - Phase de l'exploitation *fait partie d'un ensemble de cinq documents élaborés à l'intention de ces centrales conformément à l'article 8 de la partie I de la* Loi canadienne sur la protection de l'environnement. *Ces guides techniques sont destinés tant aux centrales à combustible fossile (c'est-à-dire alimentées au bois, au charbon, au mazout ou au gaz) qu'aux centrales nucléaires. Toutefois, les codes s'appliquent seulement aux aspects non radioactifs des centrales nucléaires.*

Le présent code décrit des préoccupations environnementales relatives à l'exploitation des centrales thermiques et suggère des recommandations techniques qui visent à :

a) *atténuer les effets néfastes sur l'environnement de l'exploitation de centrales thermiques nouvelles ou modifiées;*

b) *vérifier l'efficacité des mesures d'atténuation à l'aide d'activités complètes de surveillance qui peuvent servir, par la suite, de base à l'élaboration de pratiques améliorées en matière de protection de l'environnement.*

Un groupe de travail formé de représentants des gouvernements fédéral et provinciaux ainsi que de l'industrie a élaboré le présent document, qu'il a soumis à divers intervenants avant de le publier. Ce code devrait servir de norme environnementale aux gouvernements, à l'industrie et au grand public.

Table of Contents

List of Tables

Glossary

The following definitions are valid for the purposes of this Code.

Approval to Construct means authorization granted by the appropriate regulatory authority for construction of a steam electric power generation station or steam electric power generation station system.

Assess or Assessment means such investigations, monitoring, surveys, testing, and other information-gathering activities that are undertaken to identify:

(i) the existence, source, nature, and extent of contamination resulting from the placement or release, or potential release, of a hazardous material or deleterious chemical substance into the environment; and

(ii) the extent of danger to the public health, safety, and welfare, and to the environment.

Background Concentration means the concentration of a chemical substance occurring in media not influenced by a steam electric power station in the same geographic area considered to be relatively unaffected by other industrial activity.

Contain or Containment means actions taken to prevent or limit the placement or release, or potential release, of a chemical substance or hazardous material into the environment so that it does not migrate or otherwise cause or threaten substantial danger to present or future public health, safety, or welfare, or the environment.

Contaminant means any solid, liquid, gas or odour, or a combination of any of them which, if released or emitted in an uncontrolled manner, may have an adverse impact on the environment.

Decommissioning is the closure of a facility taking into account the long-term protection of the environment and may include, on a site-specific basis, the removal of process equipment, buildings, and structures in an environmentally acceptable manner. Decommissioning may involve all or part of a steam electric power station. Remediation may be required to remove or contain chemical substances and hazardous materials from the environment or to render the site safe and aesthetically acceptable. Decommissioning may, but does not necessarily, result in a change of land use.

Deleterious means harmful to the health or well-being of the environment.

Disposal Area or Disposal Site is any structure, well, pit, pond, lagoon, impoundment, ditch, landfill or other place or area - excluding ambient air and surface water - where a chemical substance or hazardous material has been placed as a result of any spilling, leaking, pouring, abandoning, emitting, emptying, discharging, injecting, escaping, leaching, dumping, discarding, or disposing.

Effluent means any wastewater that is discharged to the environment.

Environment means waters, land, surface or subsurface strata, or ambient air of Canada.

First Commercial Operation means the date of the first operation of the steam electric power station or unit at which time generating capacity is electrically connected to the transmission or distribution systems for the use of tariff-paying customers.

Hazardous Material is material that, because of its quantity, concentration, chemical composition, corrosive, flammable, reactive, toxic, infectious, or radioactive characteristics, either individually or in combination with any other substance or substances, constitutes a substantial present or future threat to human health, safety or welfare, or to the environment, if improperly used, stored, treated, handled, transported, disposed of, or otherwise managed.

Maximum continuous rating (MCR) means the maximum rate of heat input (in MJ/h) at which a fossil-fired steam generating unit has been demonstrated to be capable of operating on a continuous basis.

Opacity means the degree to which emissions reduce the transmission of light and obscure the view of an object in the background.

Particulate matter is any material, other than uncombined water, that is suspended in or discharged into the atmosphere as a solid or liquid at standard conditions.

Site means any land, buildings, structures and associated pipelines, storage areas, production areas, shipping areas, and disposal areas where the generation of steam electric power is carried out.

Wastewater is any water resulting from station activities and known to contain, or potentially contain, one or more deleterious substances.

720-Hour Rolling Average means the average of the consecutive hourly mean emission rates for each pollutant, determined for the preceding 720 hours of system operation. Periods of zero emissions are not to be included in the calculation of rolling averages.

Section 1

Introduction

The Environmental Codes of Practice for Steam Electric Power Generation (SEPG) consist of a series of reports that identify good environmental protection practices for various stages of a steam electric power project. The Codes of Practice encompass the siting, design, construction, operations, and decommissioning phases of a project and deal with multi-media (air, water, and land) considerations. The Design Phase Code, however, deals only with water and land considerations; air emissions guidelines for new fossil-fuelled stations are included as an appendix in that report.

1.1 Scope

The steam electric power generation industry includes all facilities that use a steam cycle to produce electricity. This includes both fossil-fuelled (wood, coal, oil, and gas) and nuclear (CANDU) generating stations. (Utility-owned steam electric generating stations operating in Canada in 1991 are listed in Appendix A.)

The Codes of Practice outline environmental concerns and alternative methods, technologies, designs, practices, and procedures that will minimize or eliminate the adverse environmental effects associated with steam electric generating stations. They also contain recommendations that Environment Canada considers to be reasonable and practical measures to preserve the quality of the environment which is affected by these stations. These recommendations may be used by the electric power industry, regulatory agencies, and the general public as sources of technical advice and assistance in the development and implementation of environmental protection practices and requirements.

The Codes are not regulations. They are being developed under the objectives, guidelines, and codes of practice provisions of Part I, Section 8, of the *Canadian Environmental Protection Act* (CEPA). While the Codes will help to achieve the CEPA objective of protecting Canada's natural environment, consistency with them does not remove obligations to meet other federal, provincial, or municipal standards.

1.2 Development

The Operations Phase Code was developed in consultation with a federal-provincial-industry Working Group established by Environment Canada. The members of this Working Group were selected to provide appropriate expertise on SEPG operations and environmental protection practices. (Members of the Working Group are listed in Appendix B.)

1.3 Code Structure

The Operations Phase Code describes operational activities (Section 2) and related environmental concerns, such as fuel delivery and storage, the use of cooling water, atmospheric emissions, wastewater discharges, spills of hazardous materials, and solid waste disposal (Section 3). An overview of other federal environmental guidelines and standards that affect the operation of SEPG facilities is provided in Section 4. Specific recommendations regarding the mitigation of environmental impacts are presented in Section 5 and summarized in Section 7. Section 6 describes some potential options for the management of environmental programs.

For the purpose of this Code, the operations phase is considered to begin with the date of a station's first commercial operation or the date of release of this Code, whichever is later, and proceeds until the commencement of station decommissioning activities.

The Operations Phase Code applies to all on-site facilities and many off-site activities associated with the operation of steam electric generating stations. It does not, however, address the operation of off-site transmission and transportation systems or mining facilities that may be associated with the station.

This Code provides recommendations on all aspects of operating fossil-fuelled steam electric generating stations as well as the non-radioactive aspects of operating nuclear generating stations. Some recommendations however, may not apply in whole or in part to stations whose construction received regulatory approval before the promulgation of the Construction Phase Code in August, 1989. Application of the Operations Phase Code to existing stations must, therefore, be assessed by the utility company and the appropriate provincial or territorial regulatory authority on a site-specific basis.

While Code recommendations are intended to be clear and specific with respect to expected results, they nevertheless do encourage the application of alternative technologies and practices that can achieve an equivalent or better level of environmental protection. They are not intended to stifle technology, creativity, or the benefit of experience with existing methodology. Indeed, continuing research, development, and demonstration of innovative or improved environmental protection practices is strongly encouraged by Environment Canada.

The Codes are intended to be applied with some flexibility as it is recognized that specific recommendations can be interpreted to allow for site-specific conditions. However, "interpretations" of Code recommendations should be undertaken in consultation with the appropriate regulatory authorities.

Recommendations that cannot be reasonably applied to existing stations are individually identified by a statement that they only apply to post-1989 stations.

Section 2

Operations Activities

This section briefly describes some of the major activities involved in the operation of steam electric generating stations. It is neither intended to be an all-inclusive list of operational activities of potential environmental significance, nor are all activities and techniques necessarily applicable to all stations. Rather, the intent is to identify the nature and scope of activities addressed in the Code with emphasis on those activities that relate to the environmental concerns and mitigative measures that are discussed later.

2.1 Cooling of Condensers and Auxiliary Equipment

Several factors affect the amount of water withdrawn and consumed by a steam electric generating station. The most notable factors are the type of station (coal, oil, gas, wood, or nuclear) and the design of the water and wastewater management systems. All plants require large quantities of cooling water, primarily for the condensation of exhaust steam from the turbine before its recirculation as water to the boiler or steam generator. Cooling water is also required for auxiliary station equipment and processes, e.g., the cooling of lubricating oil systems.

2.2 Water Treatment

Steam electric generating units operate at pressures that demand the delivery of high-quality feedwater to the steam cycle. Some stations also produce potable water for drinking and other domestic purposes. Both requirements are met by treating the raw water supply to the plant. Treatment may entail filtration, clarification, deionization, reverse osmosis, and condensate-polishing. Each of these treatment steps generates such wastewaters as filter back-washes, clarifier blowdown, and the acid-alkali wastes associated with the regeneration of demineralizer trains. The physico-chemical treatment of wastewater may also generate sludge, which subsequently becomes part of the solid waste inventory of the station.

2.3 Solid Waste Disposal

The operation of a steam electric generating station can generate considerable quantities of solid wastes, consisting primarily of the ashes associated with the combustion of fossil fuels and the by-products of flue gas desulphurization (FGD) systems. Opportunities exist to reduce these waste volumes by treating the materials as recyclable by-products. For example, several uses have been developed for coal ash, e.g., as a filler for Portland cement, and flue gas desulphurization units can produce such usable products as wallboard-grade gypsum. However, some level of waste disposal is always required and on-site disposal remains a common practice for many utility companies.

Although wet, lagoon-based ash disposal operations are still in place at a few stations, the on-site disposal of solid waste generally involves land-filling, usually with variations of either trench-and-fill or area-fill procedures. In either case, wastes are usually covered by a layer of earth, but they may also be capped with a relatively impervious layer of material to reduce the possible generation of contaminated site run-off or leachate. The control of fugitive emissions, surface and wastewater releases, and groundwater impacts are the most significant issues associated with these disposal operations.

2.4 *Oil, Fuel, and Chemical Handling and Storage*

Significant quantities of fuel, oil, and potentially hazardous materials are handled and stored at all thermal generating stations. These materials include gasoline and diesel fuel, lubricating and hydraulic oils, acids and alkalis used for resin regeneration in water treatment plants, and various other process chemicals. At fossil-fuelled plants, there is also an on-going turnover of very substantial quantities of fuel oil or coal.

These materials may be stored in centrally located bulk facilities or be scattered in small depots or underground storage tanks throughout the site. They may also be found in mobile equipment used to transfer material to the point of end use. Handling and storage facilities may also be required for waste materials, such as used lubricating oils and spent resins.

2.5 *Equipment Washing*

Trucks, conveyors, chutes, buckets, front-end loaders, spreaders, and other equipment used for the handling of coal, ash, gypsum, lime, and limestone require regular washing to remove accumulated mud, dust, and oil. Furnace (fireside) walls and air preheaters must also be washed occasionally to remove accumulated deposits, which reduce heat exchange capacity. These activities generate wastewater that may be contaminated with metallic ions, oil and grease, and suspended solids.

2.6 *Equipment Maintenance*

Equipment maintenance may involve the draining and replacement of lubricating oil, hydraulic oil, and fuel; the flushing of cooling systems; the degreasing of parts, machining, washing, welding; and painting. These activities generate waste oils and fuel, contaminated wastewater, waste cutting fluids, scrap metal, empty containers, and other miscellaneous solid and liquid wastes.

2.7 *Metal Cleaning and Surface Preparation*

The long-term operation of fossil-fuelled steam generating units may result in the buildup of excessive deposits on the waterside surfaces of boiler tubes. Removal of these deposits requires the periodic chemical cleaning of affected surfaces. The cleaning operation typically consists of the following steps:

(a) an alkaline boilout followed by a drain and rinse;

(b) an acid clean followed by a drain and rinse;

(c) an alkaline boilout to neutralize trapped acid; and

(d) a passivation rinse (this may be combined with the alkaline boilout in one step).

Boiler cleaning is also required at nuclear stations and may be undertaken with high-pressure water or chemical agents.

Periodic cleaning of condensers and other auxiliary systems takes place throughout the operating life of the station.

Spent cleaning solutions and rinses may contain caustic, acetic, sulphamic, sulphuric, citric, formic, or hydroxyacetic acids, EDTA, ammonia, silicates, sulphites, phosphates, and metal ions (particularly iron) from the cleaned surfaces .

Environmental Concerns

3.1 Withdrawal and Utilization of Cooling Water

The primary environmental concerns associated with once-through cooling water systems centre on the large volumes of water used and the potential damage to significant numbers of entrained aquatic organisms due to physical, chemical, and thermal stresses. There is also the concern of potential impact on biota in receiving water bodies due to the thermal stress induced by the thermal discharge.

In view of the infestation of the Great Lakes with zebra mussels, the periodic use of chemicals, such as chlorine, as biofouling control agents in freshwater cooling water systems is a growing concern.

3.2 Generation of Wastewater

Both fossil-fuelled and nuclear steam electric generating stations use treated water in various process streams as well as for domestic purposes. Untreated water is generally used for such services as pump seal supply, heat exchanger service water, equipment, and floor washdown, and fire protection, i.e., services where the technical specifications for water quality are not nearly as stringent as those for water used in process streams.

Coal-fired stations may require water for handling both the bottom ash from the boiler and fly ash from particulate collection equipment. Where a flue gas desulphurization system is in place, significant quantities of water are required for the saturation of flue gas, mist eliminator washes, scrubber reagent preparation, and system make-up.

The process and service water requirements for nuclear stations are similar for services common to all steam electric generating stations, but quantities are typically larger due to both the lower thermodynamic efficiency of the technology and the greater amount of waste heat rejected to the cooling water.

The characteristics of wastewaters generated by all these services depend on the initial use of the water. Some streams may contain only inert solids and require nothing more than simple clarification before reuse or discharge. Other streams may be acidic and contain dissolved heavy metals, such as iron and nickel, and require much more complex treatment before reuse or discharge.

Wastewater discharges from steam electric generating stations, like those from most industrial complexes, have the potential to have an immediate or long-term impact on the water, sediments, and biota in the receiving water body or on the quality of local groundwater. Changes in such water quality parameters as pH, dissolved oxygen, and suspended solids may adversely affect the development of some fish and other aquatic species. Toxic contaminants may accumulate in sediments near wastewater outfalls. Contamination of groundwater could adversely affect the quality of drinking water for people, livestock, and wildlife.

The behaviour and significance of wastewater contaminants discharged by steam electric power stations depends to some extent on the receiving environment. Control-at-source measures, however, can be taken to reduce or even eliminate the discharge of these contaminants and hence the resulting impact on the environment. Among the most positive of these measures are those associated with water reuse and wastewater minimization.

3.3 Solid Waste Handling and Disposal

The operation of all steam electric stations results in the generation of solid waste, which must often be disposed of on-site. Disposal operations are often viewed by plant operators as being very straightforward (as indeed they may be for some inert materials), but careful management is required regardless of the relative complexity of the operation. For example, a site approved for the disposal of domestic refuse may not be appropriate for oil-contaminated solids or wastewater sludge. Many potentially hazardous wastes, organic solvents for example, may not be approved for disposal anywhere on site. Arrangements must therefore be made for off-site disposal. These concerns are common to the operation of disposal facilities at all steam electric power stations.

The volume of solid waste generated by coal-fired generating stations introduces the additional concern of land use and site reclamation. Canadian utility companies disposed of approximately 4.3 Mt of coal ash in 1989 (Dearborn, 1989). The addition of flue gas desulphurization systems to fossil-fuelled generating stations will substantially increase the rate of solid waste production. Therefore, it will become increasingly important for plant operators not only to identify such readily recyclable and reusable wastes as wood, paper, ash, and gypsum, but also to manage these materials according to the principles of reduction, reuse, and recycling.

These wastes can be handled in an environmentally acceptable manner provided that disposal operations are conducted according to precautions taken and procedures committed to during the siting, design, and construction phases of the project. However, on-going monitoring and recordkeeping are also important elements of effective environmental protection programs.

3.4 Atmospheric Emissions

Concern for non-radioactive atmospheric emissions is largely limited to fossil-fuelled generating stations. Within the context of this Code, the parameters of primary concern are particulate matter, opacity, sulphur dioxide (SO_2), and oxides of nitrogen (NO_x). Emissions of carbon dioxide and their effect on global warming are beyond the scope of this report.

Atmospheric emissions can have an impact on local and regional airsheds, i.e., both on near-field ambient air quality and on receptors many hundreds of kilometres downwind. These impacts can be minimized by the operation of emission control devices, such as electrostatic precipitators and fabric filters for particulate matter, low-NO_x burners, and flue gas desulphurization equipment. Further measures can be taken to resolve short-term local air quality problems. In most cases, however, effective operational control of atmospheric emissions can only be assured if monitoring systems and procedures are in place that facilitate the early discovery of upset conditions and the implementation of corrective control action.

3.5 Spills of Hazardous Materials

The handling, storage, and use of large quantities of liquid fuels, oils, and chemicals at many steam electric generating stations give rise to concerns about potential leaks and spills of these materials to surface water, groundwater, and soils. Of particular significance from an operations perspective is that spills are often caused by human error.

Spills are likely to occur throughout the 30- to 40-year operating life of a typical thermal power plant, and each spill has the potential to contaminate the environment. Therefore, documented contingency plans and emergency procedures must be in place to minimize the impact of accidental releases and ensure that the affected site area is restored, as far as practically possible, to its pre-spill condition.

Overview of Applicable Federal Acts and Guidelines

4.1 *National Emission Guidelines for New Stationary Sources*

The guidelines in Thermal Power Generation Emissions - National Guidelines for New Stationary Sources (Canada Gazette, 1990) (see Appendix C) were originally promulgated under the federal *Clean Air Act* in 1981. They were incorporated, without change, into the *Canadian Environmental Protection Act* (Canada Gazette, 1988a) in 1990 and revised, in consultation with a multi-stakeholder working group, in 1992.

The emission limits embodied in the current guidelines are based on the commercial availability of demonstrated control technology. The document specifically recommends that provincial regulatory agencies adopt the guidelines as the minimum acceptable standards for new fossil-fuelled steam electric generating stations in their jurisdiction.

The guidelines indicate the maximum recommended discharge rate of particulate matter, SO_2, and NO_x from new steam electric generating stations. Limitations on stack opacity are specified as well. Guidelines are also provided for emission testing, emission monitoring, and recordkeeping, and these form the basis of the recommendations made in this Code regarding the monitoring of atmospheric emissions.

4.2 *Federal Ambient Air Quality Objectives*

The National Ambient Air Quality Objectives for Air Contaminants were formally promulgated under CEPA on July 24, 1989.

Three ranges of ambient air quality objectives were formulated in that document for 15 contaminants. The "maximum desirable level" was defined as the long-term goal for air quality and the basis for an antidegradation policy for unpolluted parts of the country. The "maximum acceptable level" is intended to provide adequate protection against deleterious effects on soil, water, vegetation, materials, and animals, as well as visibility, personal comfort, and well-being. The "maximum tolerable level" denotes the concentration beyond which, because of a diminishing margin of safety, immediate action is required to protect the health of the general population.

The range of maximum acceptable levels for sulphur dioxide, nitrogen dioxide, and suspended particulate matter forms the basis of the recommendations made in this Code regarding the monitoring and control of ambient air quality impacts.

4.3 *The Federal Fisheries Act*

The *Federal Fisheries Act* (Canada Gazette, 1988b) is administered primarily by Fisheries and Oceans Canada. However, Environment Canada shares responsibility for the application of Section 36 of the Act quoted here in part:

(3) Subject to subsection (4), no person shall deposit or permit the deposit of a deleterious substance of any type in water frequented by fish.....

(4) No person contravenes subsection (3) by depositing or permitting the deposit, in any water or place, of

(a) waste or pollutant of a type, in a quantity and under conditions authorized by regulations applicable to that water or place made by the Governor in Council under any Act other than this Act; or

(b) a deleterious substance of a class, in a quantity or concentration and under conditions authorized by or pursuant to regulations applicable to that water or place or to any work or undertaking or class thereof, made by the Governor in Council ....

It is in this context that toxicity testing is being recommended in Section 5 of this Code.

4.4 Federal Guidelines for the Management of PCB Wastes

The sale of electrical equipment containing polychlorinated biphenyls (PCBs) has been banned in Canada since 1979. Therefore, PCB management may not be an issue in most new steam electric generating stations. However, where existing stations have PCB storage facilities, they should be operated according to the Guidelines for the Management of Wastes Containing Polychlorinated Biphenyls (PCBs) (CCME, 1989).

4.5 Federal Transportation of Dangerous Goods Act (TDGA)

Large quantities of petroleum-based products and various process chemicals are shipped to, unloaded, and stored at all thermal generating stations. In addition, many station processes and maintenance practices generate waste that must ultimately be carted off-site for disposal.

All such movements of dangerous goods and hazardous wastes must be undertaken in compliance with TDGA *Transport of Dangerous Goods Regulations* SOR/85-77 (as amended).

4.6 Federal Environmental Codes of Practice for Steam Electric Power Generation (SEPG)

This report, the Operations Phase Code, is the fourth in a series of Codes of Practice that identify sound environmental practices for the various phases of a steam electric power project. It has been preceded by a Siting Phase Code (Environment Canada, 1987), a Design Phase Code (Environment Canada, 1985), and a Construction Phase Code (Environment Canada, 1989).

The Operations Phase Code builds upon the recommendations of the previous reports and links them with the Decommissioning Phase Code. Collectively, the Codes represent Environment Canada's position on the environmental protection measures that should be implemented throughout the life cycle of a steam electric power generation project.

Section 5

Recommended Environmental Protection Practices

This section outlines recommended mitigative measures for activities of significant environmental concern. Rationale is presented for each recommendation and operational opportunities for application of the recommendations are identified. These are not expected to be relevant to all steam electric generating stations but are included to assist in interpretation of the Code.

Application of the recommendations to specific plants may involve practices which are not mentioned in this Code but which achieve an equivalent or better level of environmental protection. Also, municipal, provincial, or legal requirements must be taken into account and satisfied where they exist.

The previously published Design Phase Code contains three series of recommendations numbered 100, 200, and 300. The recommendations presented in the Construction Phase Code comprise series 400, and the recommendations presented in this Code comprise series 500.

5.1 Operation of Cooling Water Systems

5.1.1 Biofouling Control

RECOMMENDATION R501. For the purpose of controlling biofouling in once-through cooling water systems:

(i) chemicals should be used only when they have been demonstrated to be necessary;

(ii) when chemicals have been demonstrated to be necessary,

a) only the minimum level demonstrated to be necessary should be applied,

b) the target amount of total residual chlorine (TRC) at the outlet of the cooling water system undergoing chlorination should not exceed 0.2 mg/L,

c) chemical application should, to the extent practicable, be limited to one condenser and set of auxiliary coolers at a time; timing of the application should optimize effectiveness of treatment and degradation of residual, e.g., chemical reduction of chlorine during daylight hours;

(iii) unless continuous injection or a different point of injection have been demonstrated to be necessary (as may be the case for intake tunnels and pipes), biofouling chemicals should be applied intermittently, and the point of injection should be immediately upstream of the condensers or sets of auxiliary heat exchangers.

Rationale. Biofouling chemicals are almost certain to cause mortality or sublethal effects to entrained organisms. This recommendation minimizes the amount, concentration, and frequency of treatment. Also, residual chlorine is more readily chemically reduced in the presence of ultra-violet light.

Operational Opportunities. Biofouling control may not be required, but even if it is, then:

(i) mechanical cleaning devices (brushes, scrapers, or balls) can often be used for on-line cleaning of condenser tubes;

(ii) chemical use can be minimized by:

- injection immediately upstream of the heat exchanger in question,
- monitoring at the heat exchanger outlet as the means of controlling the rate of injection, and
- installation of test coupons to monitor the effectiveness of chemical addition; and

(iii) a dechlorination system could be operated if, for process reasons, cooling water discharges had to exceed 0.2 mg/L TRC.

5.1.2 Corrosion, Scaling, or Silting Control

RECOMMENDATION R502. For the purpose of controlling corrosion, scaling, or silting in once-through cooling systems:

(i) on-line application of chemicals should not be undertaken unless such chemicals are demonstrated to be necessary;

(ii) if on-line application of chemicals is demonstrated to be necessary the dose rates and method of application should be such that only the minimum amount of chemical necessary is used to minimize environmental damage;

(iii) off-line chemical cleaning of condensers should only be undertaken where the spent cleaning wastes can be contained and treated before discharge.

Rationale. This recommendation minimizes the release of deleterious substances to the cooling water and thereby to the receiving water body.

Operational Opportunities. Corrosion, scaling, or silting control measures may not be required, but their impact can nevertheless be minimized by:

(i) operating cathodic protection systems for corrosion control of condenser water boxes and tubesheets and at other galvanically dissimilar interfaces that are subject to corrosion;

(ii) mechanically cleaning heat exchangers; and

(iii) utilizing chemicals that have been demonstrated to be environmentally benign.

5.1.3 Minimization of Cooling Water Flow

RECOMMENDATION R503. All once-through condenser cooling water systems whose construction received regulatory approval after publication of the Environmental Codes of Practice for SEPG - Construction Phase (Environment Canada, 1989) should be operated so that:

(i) the temperature at the downstream end of each condenser is maintained as high as practically possible without causing:

a) temperature-induced mortality of entrained fish species critical to the local ecosystem or fishery, and

b) significant losses in steam cycle efficiency.

(ii) An annual temperature rule curve consistent with part (i) is established that takes into account seasonal variations in critical fish species.

Rationale. The objective of this recommendation is to minimize the volume of intake cooling water to the extent possible while ensuring that there are no significant losses in generation efficiency and that critical entrained species are not killed because of high temperatures. The establishment of an annual rule curve accounts for short-term as well as seasonal trends in species susceptibility and sensitivity. This rule curve would require agreement between the proponent and the regulatory agency regarding the establishment of an appropriate operating procedure.

Operational Opportunities.

(i) Establish seasonal aquatic biota characteristics at the location of the cooling water intake.

(ii) Determine the lethal temperatures for the different species.

(iii) Obtain concurrence of the appropriate regulatory agency on maximum allowable condenser discharge temperatures over 12 successive months.

(iv) In the absence of either data for species at a given site or agreement on which species are "critical", use an annual temperature rule that will protect the most commonly occurring freshwater species; namely a maximum of 30 °C in summer and 22 °C in winter.

5.1.4 Evaporative Recirculating Cooling Systems - Contaminants

RECOMMENDATION R504. For the purposes of controlling biofouling, corrosion, or scaling in evaporative recirculating cooling water systems:

(i) chemicals should not be used unless they have been demonstrated to be necessary;

(ii) chromium chemical additives should not be used in cooling pond recirculating systems; and

(iii) additive systems should be operated with the aim of minimizing chemical use while providing an adequate level of biofouling, corrosion, or scaling control.

Rationale. This recommendation discourages the contamination of receiving waters by deleterious substances in blowdown from evaporative cooling systems, the latter being the largest wastewater volume in stations that use such systems. Hexavalent chromium is highly toxic and may form a difficult-to-manage sludge in cooling ponds. The fundamental objective of this recommendation is to eliminate the unnecessary use of chemical additives and thereby the unnecessary discharge of deleterious substances to receiving water bodies.

Operational Opportunities. If chemical controls have been demonstrated to be necessary, their impact can be minimized by:

(i) on-line mechanical cleaning of heat exchangers or off-line chemical cleaning with waste collection and treatment before release;

(ii) operating cathodic protection systems;

(iii) operating monitoring and control systems that minimize chemical use;

(iv) using additives free of chromium; and

(v) where practicable, depressing pH as a means of effective scaling control.

Note: While Recommendation R504 strictly applies to evaporative recirculating cooling systems, some of the considerations may be applied to non-evaporative cooling systems (closed intermediate water loop heat exchanging with once-through cooling water), to recirculating ash transport systems, and to water treatment plants.

5.1.5 Evaporative Recirculating Cooling Systems - Water Use

RECOMMENDATION R505. All evaporative recirculating cooling systems whose construction received regulatory approval after the publication of the Environmental Codes of Practice for SEPG - Construction Phase (Environment Canada, 1989) should be operated:

(i) at a minimum of two cycles of concentration, i.e., such that the ratio of dissolved solids in the recirculating water to the dissolved solids in the make-up water is greater than two;

(ii) so that make-up water is introduced to the system through the auxiliary coolers where designs permit this practice.

Rationale. Because evaporative cooling systems use less water than once-through systems, there is less entrapment/ entrainment damage to aquatic life. Above two cycles of concentration, a recirculating water system will use less than 5% of the water required by a once-through system; however, water use and blowdown volumes increase substantially for fewer cycles of concentration. The introduction of make-up through the auxiliary coolers reduces the possibility of scaling in these heat exchangers and the resulting use of scaling control chemicals.

Operational Opportunities

(i) The higher the number of cycles of concentration, the lower the volume of both make-up and blowdown water. Also, the higher concentrations of dissolved and suspended solids in the blowdown make this wastewater more amenable to treatment before discharge.

(ii) An operational problem with some recirculating cooling water systems is scaling in high-temperature condenser and auxiliary heat exchanger tubes. Since the water requirements for the auxiliary coolers are much less than for the condensers, the introduction of relatively low dissolved solids make-up water reduces the probability of scaling.

5.2 Operation of Wastewater Collection and Treatment Facilities

5.2.1 Water Reuse

RECOMMENDATION R506. Wherever practicable, water use should be minimized and wastewater reused or recycled to minimize wastewater production.

Rationale. The reduction of water use and wastewater reuse are normally the first and least costly steps in a program to control wastewater discharges. Furthermore, smaller volumes of wastewater can be treated more effectively in on-site facilities.

Operational Opportunities. Numerous opportunities for cascade water management exist even in older stations. For example, treated wastewater can often be used for such relatively low-grade services as floor and equipment washdowns, ash wetting, and dust suppression. Blowdown from evaporative recirculating cooling systems could provide a relatively large volume of water of consistent quality that may be suitable for many other process uses. Clarified run-off from ash disposal areas can often be used to control fugitive dust emissions from the entire plant site. Pump seal water flows can be monitored as a means of determining the need for or frequency of seal replacement. Such practices often make good economic sense as well as enhancing environmental protection.

5.2.2 Waste Liquid Containment Sizing

RECOMMENDATION R507. All waste liquid collection and treatment facilities constructed after the date of promulgation of this Code should be sized according to Recommendation R209 of the Environmental Codes of Practice for SEPG - Design Phase (Environment Canada, 1985).

Rationale. These sizings of containment facilities are adequate for most events that may occur throughout the operating life of the station.

Operational Opportunities.

(i) Waste liquid collection and treatment facilities are added throughout the operating life of most steam electric generating stations. These additions are generally associated with the expansion of fuel storage or solid waste disposal facilities. The application of this recommendation to these facilities often requires design judgments which can be complemented by operating experience. For example, station staff will have first-hand knowledge of:

- the volume of wastewater normally in storage;
- the volume of wastewater produced in any 24-hour period; and
- the rate at which precipitated solids accumulate in sedimentation ponds.

On the basis of this knowledge, designers can, at the very least, improve upon the design assumptions made during the pre-commissioning stage and thereby optimize future operation of wastewater collection and treatment facilities.

(ii) Where the containment facility can be demonstrated to be adequate for the liquid waste volumes indicated above, the provisions of this recommendation need not be rigorously applied. For example, if an ash disposal site run-off treatment facility effectively removes suspended solids (or other relevant parameters) during a 100-year, 24-hour precipitation event, a continuous overflow may be an acceptable alternative to actual containment of the total storm run-off.

(iii) An allowance for the accumulation of solids should be included in the volume calculation, since undersizing could lead to the need for frequent clean-out to meet discharge criteria.

5.2.3 *Wastewater Treatment and Effluent Quality*

RECOMMENDATION R508.

(i) All wastewater treatment facilities whose construction received regulatory approval after the August, 1989 publication of the Environmental Codes of Practice for SEPG - Construction Phase (Environment Canada, 1989) should be operated so that the effluent quality criteria listed in Table 1 are met before discharge to cooling water, a municipal sewer, or a receiving water.

(ii) Wastewater treatment facilities whose construction received regulatory approval before August, 1989 should be operated so that the quality of their effluent is as close to satisfying the listed criteria as practically possible.

(iii) Hazardous wastewaters that cannot be effectively treated on-site should be directed only to licensed off-site disposal facilities.

Rationale. Generally, technologies capable of achieving the recommended criteria have been demonstrated or have been judged to be technically feasible. Although limits have not been prescribed for all parameters and elements of environmental concern, the application of operating practices and technologies to meet the specified effluent criteria may also reduce other contaminants of concern. Effluent criteria for other contaminants, such as arsenic, boron, selenium, and mercury may be specified on a site-specific basis by regulatory agencies. Some periodic wastewater streams may be contaminated with species that are not amenable to treatment in on-site facilities, e.g., organic solvents used in equipment cleaning or degreasing operations. These should be directed only to facilities that are approved by the appropriate regulatory authority.

Table 1 Wastewater Effluent Quality Criteria

Parameters and Elements	Recommended Effluent Criteria
pH	6.5 to 9.5
Iron (total)	1.0 mg/L
Chromium (total)	0.5 mg/L
Chromium (hexavalent)	0.05 mg/L
Copper (total)	0.5 mg/L
Nickel (total)	0.5 mg/L
Zinc (total)	0.5 mg/L
Total Suspended Solids (TSS)	25.0 mg/L
Oil and Grease	15.0 mg/L
Total Residual Chlorine (TRC)	0.2 mg/L

Notes:
1) Metal concentrations are for total dissolved and undissolved solids.
2) All values with the exception of pH refer to the average weekly concentration.
3) Background water quality should be taken into account in the development of final effluent criteria.

Operational Opportunities.

(i) Bench-scale jar tests can be conducted to optimize the physical-chemical treatment of wastewaters, particularly as it relates to the evaluation of alternative treatment chemistries and the characteristics of the waste, e.g., sludge produced by such treatment. This type of testing is also useful in evaluating the capability of an existing system to cope with different types of wastestreams.

(ii) Operations staff can mitigate the hydraulic impact of planned, large-volume, periodic wastewaters, e.g., those associated with air preheater washes, by ensuring that the operating level of containment facilities is as low as practically possible immediately before the event.

(iii) Many activities associated with the annual maintenance outage of a unit can be scheduled so as to avoid the simultaneous conduct of other activities associated with the generation of large volumes of heavily contaminated wastewaters, e.g., boiler fireside and air preheater washes.

(iv) Plant sumps as well as site containment facilities can be desludged or otherwise cleaned regularly to avoid the inadvertent contamination of influent streams or an unacceptable loss in hydraulic retention time.

(v) Temporary in-sump monitoring or adjustment of pH can assist operators with the treatment of periodic wastewater streams.

(vi) Good basic housekeeping practices, e.g., ensuring that the oil that accumulates in oil-water separators is removed regularly, can promote effective operation of treatment facilities and prevent inadvertent discharge of contaminants.

(vii) Spares for all critical components of the wastewater treatment system(s), e.g., in-line pH probes, can be stored on-site to minimize the downtime associated with component failures.

5.3 Operation of Solid Waste Disposal Sites

5.3.1 Location and Construction of Disposal Sites

RECOMMENDATION R509. Expansions to existing disposal facilities that extend beyond the spatial bounds of areas approved by the appropriate regulatory authority before the publication date of this Code should be undertaken to ensure that:

(i) the site plan is updated to clearly show the location and dimensions of the new or expanded facility;

(ii) the perimeter of the disposal area is far enough away from all watercourses* to prevent contamination by surface run-off, seepage, or fugitive emissions;

(iii) the surface drainage from off-site areas is diverted around the disposal area;

(iv) the expanded area is hidden from view by fences, berms, or buffer zones to the extent practicable; and

---

* "Watercourse" means any lake, river, pond, stream, or reservoir that may be defined as a fish habitat under the federal *Fisheries Act*.

(v) the beneficial uses of the site after closure have been considered.

Rationale. The incorporation of new or expanded disposal sites is the first step toward comprehensive and effective management of on-site solid waste disposal facilities throughout the operating life of the station. It also provides a historical record of site development that could be of value if remedial work were required later. Separation of the disposal site from watercourses and diversion of run-off reduces the probability of off-site water contamination and the volume of on-site run-off and seepage requiring collection and treatment before release. Fences, berms, and buffer zones provide an aesthetically desirable visual screening of the disposal site. Early consideration of the final use of the site will facilitate its ultimate reclamation.

Operational Opportunities. Several measures can be taken to increase the protection of the watercourse from surface run-off, seepage, and fugitive emissions. These include more extensive use of drainage diversion or collection ditches, additional berms, more stringent seepage control, and more effective windbreaks. The applicability of all such measures must be evaluated on a site-specific basis.

5.3.2 Development of Solid Waste Disposal Sites

RECOMMENDATION R510. Where possible, solid waste disposal sites should be developed according to the following practices:

(i) the disposal area should be developed in modules or cells throughout the operating life of the station;

(ii) all wastes should be so placed that they have physical and chemical stability suitable for land re-use;

(iii) contouring, capping, and reclamation of cells should be undertaken throughout the operating life of the site and should include the re-establishment of vegetation as a primary means of controlling fugitive emissions and the erosion of side slopes;

(iv) all disposal sites should be reclaimed for beneficial uses before final closure.

Rationale. The terrestrial disturbances associated with both the construction and operation of a disposal site as well as potential surface water and groundwater impacts are minimized by staged development. The properties of the placed waste should ensure, for example, that it can bear the load of heavy equipment. Proper placement of waste further ensures that physically unstable materials will not be left in the environment in perpetuity. Contouring and capping of cells minimizes the ingress of precipitation and the associated potential for contamination of groundwater. The reclamation of disposal sites minimizes surface water and groundwater contamination and enables the land to be returned to some other viable use. The main intent of this recommendation is to reduce water and land use impacts to the extent practically possible.

Operational Opportunities.

(i) The staged development of the disposal site can be carried out, at least in part, by equipment that would already be required at the site.

(ii) An option for operators of dry fly ash systems may be to market the ash for use in various cement and concrete applications and thereby realize a significant reduction in the volume of waste for disposal.

(iii) Bottom ash from oil-fired generating stations may contain sufficient vanadium to warrant its collection and sale.

(iv) Forced-oxidation lime/limestone FGD systems can produce a gypsum by-product suitable for various uses: wallboard and concrete, for example.

(v) Soil use can be greatly reduced and site reclamation facilitated if top soil is stripped, stored, and reused throughout the operating life of the disposal area.

5.3.3 Management of Solid Waste Disposal Sites

RECOMMENDATION R511. All solid waste disposal facilities should be managed throughout their operational life according to documented, site-specific solid waste management plans approved by the appropriate regulatory authority so that:

(i) solid, liquid, and hazardous wastes are disposed of only in facilities specifically designed, approved, and operated for that purpose;

(ii) access to the site is strictly controlled and all disposal activities supervised by trained personnel;

(iii) records are maintained of the types, approximate quantities, and point of origin of the wastes;

(iv) wildlife, rodents, and pests are either kept out of sanitary landfills and hazardous waste disposal areas, or otherwise controlled.

Rationale. Facilities used for the disposal of hazardous wastes are generally required to meet more stringent criteria than facilities discussed in this Code. Control of site access eliminates the inadvertent disposal of inappropriate material and permits the keeping of reliable disposal records. Such records could simplify future site restoration or provide evidence that site restoration is not necessary. Pests, if uncontrolled, could lead to both on- and off-site problems.

5.4 Seepage Control Criteria for Expanded Station Facilities

RECOMMENDATION R512. All on-site solid waste disposal or storage as well as wastewater treatment and containment facilities constructed after the promulgation of this Code should be designed and installed with seepage control barriers that, as a minimum, satisfy the requirements of Recommendation R210 of the Environmental Codes of Practice for SEPG - Design Phase (Environment Canada, 1985).

Rationale. The contamination of groundwater aquifers by seepage and leachate from waste disposal and containment sites is reduced when seepage control barriers are placed between the sites and aquifers. Seepage control criteria depend partly on the environmental concern associated with the material on the site. Provincial requirements for the disposal of industrial wastes may require more stringent criteria for seepage control.

Operational Opportunities.

(i) A hydrogeological survey may indicate the presence of naturally occurring surficial deposits that meet the permeability requirements of Recommendation R210. If not, either imported clay or till liners can be constructed or synthetic liners installed. Care should be taken, however, to maintain the integrity of these barriers during construction. A protective cover, e.g., on-site till, should be provided to minimize the potential for liner damage, particularly by mobile equipment, during operation.

(ii) A synthetic barrier material, such as high-density polyethylene (HDPE), may be an acceptable alternative to naturally occurring materials in many applications but should be evaluated in consultation with the appropriate regulatory authority. The following factors should be taken into account:

- compatibility of the material with the waste product;
- sensitivity to ultraviolet radiation, i.e., sunlight;
- need for liner protection; and
- required mechanical strength and thickness.

5.5 Control of Fugitive Emissions

RECOMMENDATION R513. All reasonable measures should be taken to control fugitive dust produced by:

(i) vehicular traffic in both paved and unpaved areas on station property;

(ii) transportation of coal to and ash from fossil-fuelled stations;

(iii) coal-handling and storage facilities;

(iv) ash-handling, storage, and disposal facilities;

(v) other significant (site-specific) sources of fugitive emissions.

Rationale. This recommendation calls for the control of all major sources of dust associated with the operation of steam electric generating stations. Appropriate measures may be selected on a site-specific basis from available alternatives.

Operational Opportunities. The options available to plant operators to control fugitive emissions depend to a great extent upon the original design of plant systems. However, the following are some suggested considerations.

(i) An excellent and cost-effective method of dust control is to preserve and enhance natural vegetation around the site to act as windbreaks.

(ii) Activities that generate large quantities of fugitive dust could be curtailed during periods of unusually high wind.

(iii) Dust rising from roads can be controlled either with water sprays or with water combined with a variety of commercially available products that improve dust suppression. In either case, it may be possible to reuse relatively low quality, treated wastewater and thereby reduce overall wastewater discharge from the station. Road sweeping can be an effective technique for paved surfaces.

(iv) Coal transfer and storage facilities may use various measures to suppress or collect dust during the operations phase, including:

a) application of water, oil or oil emulsions, or surface-crusting agents to coal piles;

b) application of vegetated topsoil or other "seed-bed" material to "dead" coal storage piles;

c) application of water sprays or other dust suppressants during coal-stacking or -reclaiming operations;

d) enclosure of transfer points on coal conveyors;

e) enclosure of the entire coal conveyor in areas exposed to high winds;

f) placement of wind guards on non-enclosed conveyors;

g) collection and filtering of air from enclosed coal conveyors and transfer points;

h) minimization of the height of coal drop during stacking operations;

i) compaction and contouring of storage piles; and

j) where ship-to-shore transfer of coal occurs, controls to avoid both overfilling of dock hoppers and wind scavenging at the point of transfer.

(v) Dust associated with the handling and disposal of dry fly ash can be suppressed by the addition of low-quality water (usually 10 to 15% by weight) to the ash as it exits the storage silo. Ash silo operations can be optimized with regard to the quantity of water added and the effective mixing of water and ash. Ash can be transported to the disposal area in covered vehicles or enclosed containers. At the disposal site itself, water sprays, chemical dust suppressants, ash compaction, modular disposal techniques, and ongoing covering/reclamation of completed cells can be used to minimize dusting. The site can be developed taking into account natural topography and wind exposure, and natural windbreaks can be left in place. Man-made windbreaks, e.g., fences, trees, and berms, can be constructed where natural windbreaks do not exist.

5.6 Control of Atmospheric Emissions

RECOMMENDATION R514.

(i) After the date of promulgation of this Code, all fossil-fired steam generating units that have been designed and built to operate in accordance with Environment Canada's *Thermal Power Generation Emissions - National Guidelines For New Stationary Sources* as amended from time to time (see Appendix C) should be maintained and operated to achieve consistency with the Guideline emission standards throughout their lifetime.

(ii) Fossil-fired steam generating stations that have not been designed and built to operate in accordance with the above-noted Guidelines should be operated with the aim of achieving consistency with the Guideline emission standards for nitrogen oxides, particulate matter, and opacity to the extent that this can be practically achieved by the adoption of sound operating practices.

Rationale. Operating so as to achieve consistency with the National Guidelines as in (i) above and operating with the aim of approaching the Guideline standards as in (ii) above will help to mitigate the impact of a station's atmospheric emissions on both local and long-range air quality. However, there is no intention to retroactively apply the Guidelines, via this recommendation, to stations that have not been designed and built to meet them. Rather, it is intended to point out that there are opportunities at all stations to optimize operating practices from an atmospheric emissions perspective, and the Guideline limits for opacity, NO_x, and particulate matter represent targets for such optimization activity. Emissions of sulphur dioxide cannot generally be impacted by operational practices and for this reason have not been referenced in R514 (ii).

Operational Opportunities.

(i) The efficiency of electrostatic precipitators (ESPs) can be optimized through regular inspection, maintenance, and cleaning of system components and by optimizing the rapping frequency.

(ii) Boilers can be operated to an optimized excess air curve to minimize NO_x production without impacting the production of unburned carbon.

(iii) Flue gas conditioning with ammonia, moisture, or sulphur trioxide can sometimes improve fly ash resistivity and thereby lead to improved ESP performance.

(iv) The use of low-sulphur fuels may be an economically viable approach to reducing SO_2 emissions at some stations, particularly if it is evaluated within the context of a corporate emission reduction strategy.

(v) The routine maintenance of efficient furnace combustion may be greatly facilitated by the operation of an on-line heat rate monitoring system.

5.7 Control of Ambient Air Quality Impacts

RECOMMENDATION R515. All steam electric generating stations should be operated so that their atmospheric emissions do not surpass the maximum acceptable level of the National Ambient Air Quality Objectives for Air Contaminants (Canada Gazette, 1989), for sulphur dioxide (SO_2), nitrogen dioxide (NO_2), and suspended particulate matter.

These are as follows:

(i) For SO_2:

a) annual arithmetic mean: 60 micrograms per cubic metre ($\mu g/m^3$);

b) average concentration over a 24-hour period: 300 $\mu g/m^3$;

c) average concentration over a 1-hour period: 900 $\mu g/m^3$.

(ii) For NO_2:

a) annual arithmetic mean: 100 μg/m^3;

b) average concentration over a 24-hour period: 200 μg/m^3;

c) average concentration over a 1-hour period: 400 μg/m^3.

(iii) For suspended particulate matter:

a) annual geometric mean: 70 μg/m^3;

b) average concentration over a 24-hour period: 120 μg/m^3.

Rationale. Consistency with these criteria should ensure that the emissions of SO_2, NO_2, and particulate matter resulting from steam electric power generation do not cause deleterious effects on soil, water, vegetation, and visibility, or on the health and well-being of animals and nearby populations.

Operational Opportunities.

(i) Utility companies can develop predictive computer models that, together with input from real-time monitoring of atmospheric conditions and such ambient air quality parameters as sulphur dioxide, can provide the basis for informed short-term emission control decisions.

(ii) Facilities for the storage of appropriate quantities of low-sulphur fuel can be maintained on site for use during adverse dispersion conditions.

(iii) Operations staff can optimize soot-blowing to avoid over-loading particulate collection equipment.

5.8 Environmental Monitoring Programs and Parameters

Operators of steam electric generating stations whose construction received regulatory approval after the August, 1989 publication of the Environmental Codes of Practice for SEPG -Construction Phase (Environment Canada, 1989) should implement environmental monitoring programs that, as a minimum, satisfy the objectives of Recommendations R516 through R522.

Details that need to be considered in the development of these monitoring programs include:

a) the availability of a background database or the feasibility of establishing one;

b) the identification of the parameters to be monitored;

c) sampling frequency;

d) definition of the procedures and protocols to be followed in sample collection, preservation, handling, shipment, and analysis;

e) development of a quality assurance/quality control program;

f) data management and reporting;

g) provision of real-time data to operators; and

h) procedures defining the action(s) to be taken when the prescribed environmental criteria have been exceeded due to station operations.

It is Environment Canada's opinion that many elements of Recommendations R516 through R522 are also applicable to stations constructed before August, 1989. However, it is recognized that the physical and operational constraints imposed by the original design of existing station systems preclude the implementation of recommended programs in their entirety. Therefore, the recommendations embodied in this Section should be considered a point of departure in assessing environmental monitoring requirements for pre-1989 stations. In other words, site-specific problems, limitations, and impacts should be documented by facility operators within the context of these recommendations and discussed with the appropriate regulatory authority early in the development of the monitoring program. This approach should facilitate the implementation of programs that are reasonably tailored to the needs and practical constraints of individual sites, yet maximize the protection of the environment.

5.8.1 Cooling Water

RECOMMENDATION R516. Once-through cooling water systems should be monitored as follows:

(i) continuously for total residual chlorine (TRC) at the outlet of once-through condenser cooling water systems, if and when chlorination is used for biofouling control;

(ii) continuously for the temperature of total station cooling water intake and discharge;

(iii) continuously for the temperature of condenser discharge; and

(iv) annually for total station, condenser, and auxiliary cooling water flow.

Rationale. Cooling water withdrawal volumes and their absolute and differential temperatures are of environmental concern (refer to R503, Subsection 5.1.3). The TRC of plant discharges should be monitored as part of a chlorine minimization program (refer to R501, Subsection 5.1.1).

Operational Opportunities.

(i) Several flow-monitoring techniques are available. For example, a continuous recording of pump discharge pressure or a pump motor timer together with pump characteristic curves (flow versus head) gives reasonable estimates of flow.

(ii) Pumps can be periodically calibrated through tracer techniques. This involves the injection of a tracer at a known flow rate upstream of the pump suction, and measurement of tracer concentration downstream of the pump, and calculation of pump flow.

(iii) The temperature can be measured using thermowells.

(iv) Continuous on-line TRC monitors are commercially available. These can be installed with a feedback control loop to the chlorine feed system.

5.8.2 Wastewater Discharges

RECOMMENDATION R517. All site wastewater streams discharged under normal and emergency conditions to once-through cooling water, a municipal sewer, or directly to a receiving water body should be monitored according to the following protocol.

(i) Monitoring of continuous discharges should include:

a) continuous monitoring and integration of flow rate or total volume discharged over time; expected accuracy: better than +/-15% of flow or volume;

b) continuous on-line monitoring of pH and TRC (the TRC only where the waste stream is chlorinated); and

c) weekly analysis of composite samples for iron, chromium, copper, nickel, zinc, total suspended solids (TSS), and other appropriate parameters for a period of at least one year after the station begins commercial operation (long-term analytical requirements would be based on an assessment of this data).

(ii) Monitoring of discharges associated with batch wastewater treatment processes should include:

a) determination of the volume of each batch discharged;

b) continuous monitoring of pH while the batch is being discharged; and

c) analysis of each batch discharged according to the requirements of Part i(c) of this recommendation.

(iii) Monitoring of discharges from sewage treatment facilities should include monthly analysis for biological oxygen demand (BOD).

(iv) All site wastewater discharges should be tested for toxicity within 180 days of commissioning of wastewater treatment facilities according to the following Environment Canada Reference Methods:

a) EPS 1/RM/13 for discharges to a freshwater environment (Environment Canada, 1990a); and

b) EPS 1/RM/10 for discharges to a marine environment (Environment Canada, 1990b).

The need for and frequency of future testing should be assessed on the basis of test results.

Rationale. Monitoring of contaminant discharges to the environment facilitates the evaluation of treatment systems as they relate to environmental protection.

Operational Opportunities.

(i) The intermittent nature of discharges from some run-off containment facilities, such as those located at ash disposal sites, is a recognized challenge in both designing and operating flow-monitoring and sample collection equipment. However, sequential samplers and flow monitors for open channels, e.g., weirs and flumes, are commercially available.

(ii) Manual grab samples may be adequate for wastewater streams that vary little in composition.

(iii) It may be possible to reduce or otherwise alter the number of parameters to be tested as experience is gained with the chemical characteristics of individual wastewater streams.

5.8.3 Atmospheric Emissions

RECOMMENDATION R518.

(i) Atmospheric emissions generated by fossil-fuelled steam generating units that have been designed and built to operate according to Environment Canada's Thermal Power Generation Emissions - National Guidelines for New Stationary Sources, as amended from time to time, (see Appendix C) should be monitored and tested according to the monitoring and testing provisions of the Guidelines.

(ii) Atmospheric emissions generated by fossil-fuelled steam generating units that have not been designed and built to operate according to the Guidelines in Appendix C should be monitored according to the following protocol.

a) Sulphur dioxide and nitrogen oxides emissions should be monitored on all units with a generating capacity greater than 25 MWe using a method of comparable effectiveness to continuous emission monitoring.

b) All monitoring systems should be installed, calibrated, operated, and tested according to the performance specifications established by the appropriate regulatory authority.

c) Emission monitoring data should be reported as specified by the appropriate regulatory authority.

(iii) Operators should record all equipment malfunctions and breakdowns that affect atmospheric emissions and report such occurrences as specified by the appropriate regulatory authority.

Rationale. This recommendation provides for monitoring of the atmospheric emissions from fossil-fuelled generating stations.

Operational Opportunities.

(i) Regular maintenance and calibration of instruments is basic to the reliable operation of any continuous monitoring system and is particularly important to emissions monitoring systems given the relatively harsh environments in which these instruments operate. Access to the instruments can be an added complication because of the in-stack or in-flue location of most emissions monitoring equipment. Potential access problems should be considered when the system is designed.

(ii) With the approval of the appropriate regulatory authority, emission tests conducted by in-house personnel may be an acceptable and cost-effective alternative to testing by an independent agency, provided that quality assurance/quality control protocols are followed and records maintained.

(iii) Operators of units not equipped with SO_2 emission control technology may be able to demonstrate that a system combining fuel sampling and analysis with fuel flow measurement is as effective as a continuous monitoring system for SO_2.

5.8.4 Ambient Air Quality

RECOMMENDATION R519.

(i) An ambient air quality monitoring program should be developed in consultation with the appropriate regulatory authority and implemented with the objective of enabling the operator to demonstrate that the station is being operated in a manner consistent with the National Ambient Air Quality Objectives or any other limits set by the regulatory agency.

(ii) If, in consultation with regulatory agencies, it has been determined that total suspended particulate matter needs to be measured routinely, it should, as a minimum, be measured according to the schedule of the National Air Pollution Sampling Network.

Rationale. Consistency with ambient air quality criteria is an important step in mitigating the environmental concerns associated with the operation of fossil-fuelled steam electric generating stations.

Operations Opportunities.

(i) It may be possible to demonstrate to the regulatory authority - through comprehensive fuel analyses, computer modelling, or operating experience at other stations - that routine monitoring of a particular parameter is not required. For example, ground-level monitoring of SO_2 may not be necessary near a unit firing either natural gas or low-sulphur fuel or using appropriate emission control equipment.

(ii) Where a station is located in an airshed that is potentially affected by other emission sources, utility companies may cooperate with other industries and the regulatory authority to develop an appropriate monitoring network.

5.8.5 Groundwater

RECOMMENDATION R520. A groundwater monitoring program should be developed for all solid-fuel storage and solid- or liquid-waste storage and disposal sites according to the following guidelines.

(i) A permanent system of appropriately located piezometers and wells should be provided for monitoring the quality, quantity, and flow direction of groundwater.

(ii) A program of pre-operational monitoring of groundwater regimes that may be affected by the new facilities should be initiated at least one year before operation begins.

(iii) Groundwater samples should be collected quarterly from all monitoring wells associated with the plant site during the first two years of operation and at a frequency based on the results of this test program in subsequent years.

(iv) Each groundwater sample should be analyzed for pH, total dissolved solids, and other appropriate (site-specific) parameters.

Rationale. This recommendation provides facilities with a method for monitoring the migration of contaminants in groundwater.

Operational Opportunities. The required number, location, and depth of piezometers and wells may vary with site-specific conditions and should be assessed by a qualified hydrogeologist. However, some suggested considerations for the design of groundwater monitoring systems are as follows:

a) locating at least one piezometer and well in the groundwater up-gradient of the site;

b) locating at least one piezometer and well on the site itself before the site is placed in use;

c) locating piezometers and wells in the groundwater down-gradient of the site in the expected path of the potential leachate plume;

d) protecting the monitors from tampering and vandalism; and

e) installing submersible pumps in monitoring wells to facilitate well-flushing and the collection of representative samples.

5.8.6 Noise

RECOMMENDATION R521. Within 180 days of the first commercial operation of any unit whose construction received regulatory approval after the date of promulgation of this Code, monitoring of noise levels in residential areas adjacent to the site should be undertaken to determine whether they are consistent with the following point-of-reception sound level limits:

Time	Sound level limit (Leq) at point of reception (dBA) over the specified time period
07:00 - 23:00	55
23:00 - 07:00	50
All day Sundays and Holidays	50

The need for and frequency of follow-up testing or remedial action should be assessed, in consultation with the appropriate regulatory authority, on the basis of test results.

Rationale. Noise in adjacent residential areas is normally maintained below disruptive levels. It should be noted that the noise level limitations are based on the criteria recommended in the National Guidelines for Environmental Noise Control (Health and Welfare, 1989b).

Operational Opportunities.

(i) Noise from mobile equipment operating outside the confines of a plant building can be controlled by retrofitting a better muffler and enclosing the engine.

(ii) Noisy equipment can be located as far from site boundaries as practical or enclosed to suppress noise.

(iii) Free-standing noise barriers, greenbelts, topographical features, berms, or other intervening structures can be used to shield adjacent communities from noise.

(iv) Heavy-truck movements can be planned to minimize traffic noise.

(v) Fan noise may be controlled with silencers or sections of ductwork lined with sound-absorbing material. Reducing fan speed can sometimes be a cost-effective option.

(vi) Silencers for air intakes of compressors, including rotary lobe blowers, are available and can usually be retrofitted to existing installations.

5.8.7 *Biological Monitoring*

RECOMMENDATION R522. A program of operational biological monitoring of the receiving environment should be developed and implemented in consultation with the appropriate regulatory agencies. This program should be sufficiently comprehensive to enable the operator to:

(i) measure changes in the pre-operational baseline for receiving water quality, aquatic sediments, and important aquatic and terrestrial organisms;

(ii) determine the validity and accuracy of impact predictions made during the design and construction stage of the project; and

(iii) assess the need to incorporate specific changes in the operating programs and procedures affecting the receiving environment, e.g., frequency of chlorination of once-through cooling water.

The frequency and duration of this monitoring activity should be assessed, in consultation with the appropriate regulatory authority, on the basis of test results.

Rationale. Changes in the environment due to the operation of steam electric generating stations can only be detected if the collection of monitoring data is extended into the operating life of the station.

Operational Opportunities. The required number, type, location, and frequency of collection of samples depends on the characteristics of a specific site and on the conclusions reached during the design and construction stage of the project. However, the following are some suggested considerations:

(i) The biological sampling locations and protocols established during the design and construction stage of the project can be evaluated for their applicability in the operational program.

(ii) The program can focus on the sensitive species and other areas of primary environmental concern identified during the design and construction stage of the project.

(iii) Particular attention can be paid to the assessment of impacts that were based primarily on model predictions.

(iv) The utility company could use local non-government organizations to solicit the interest and commitment of local residents in the implementation of a long-term monitoring program.

5.9 *Best Management Practices*

Best Management Practices (BMP) can generally be defined as those actions, processes, procedures, and construction activities that help to prevent the operation of a facility from damaging the environment. At the station level, they can be identified as a means of pollution abatement applicable to everyone from structural maintenance staff to the plant manager. More specifically, they pertain to the hands-on management of all aspects of plant operation with the potential to pollute the environment.

While the major elements of BMP are outlined below, some jurisdictions have specific BMP requirements. Utility companies should contact the appropriate provincial ministry to determine whether this is the case.

5.9.1 Segregation of Hazardous Materials

RECOMMENDATION R523. Separate storage and containment facilities should be provided for chemicals that can react violently with one another.

Rationale. The separation of potentially explosive chemicals or those that produce secondary hazards when mixed reduces the risk of an accidental release of energy.

Operational Opportunities. See those for Recommendation R525, Subsection 5.9.3.

5.9.2 Oil, Fuel, and Chemical Storage and Transfer

RECOMMENDATION R524. Specific sites should be designated for the bulk storage and transfer of all oil, fuel, and chemicals. These areas should be:

(i) located on material that satisfies the permeability criteria presented in R210 of the Environmental Codes of Practice - Design Phase (Environment Canada, 1985);

(ii) constructed to contain the maximum probable spill with adequate freeboard;

(iii) located so as to minimize the probability that a spill could, under any circumstances, enter a watercourse; and

(iv) protected from physical damage.

Rationale. Proper provisions for bulk storage of oil, fuel, and chemicals are necessary to prevent the discharge of these materials to the environment under any circumstance.

Operational Opportunities.

(i) Provincial regulations governing the storage of oil generally specify the required permeability and minimum containment volumes for dyked areas. As a general guide for other materials in storage, dykes or other containment facilities could be sized according to the National Fire Code of Canada (NRCC, 1990) criterion which states that "the dyked area shall be of sufficient size to contain a volume of liquid at least equal to the volume of the largest tank plus 10 percent of the aggregate volume of all the other tanks, or 10 percent larger than the volume of the largest tank, whichever is greater."

(ii) Drums containing oil, fuel, or chemicals can be stored on metal gratings underlain by metal catch basins and sheltered from precipitation. These can contain spills that may occur as a result of either material transfer operations or leaking drums. Such facilities are inexpensive and can be relocated as necessary.

(iii) Provision can be made for the regular controlled discharge of accumulated precipitation from containment facilities. This water should be sampled and analyzed before discharge if there is any doubt about it being contaminated.

(See also the Operational Opportunities of Recommendation R525.)

5.9.3 Spill Control Planning and Procedures

RECOMMENDATION R525. Appropriate measures should be taken to ensure that oil, fuel, and chemicals used or stored at the station do not contaminate the environment. These measures should include:

(i) development of procedures for the handling, use, and storage of petroleum products, fuel, and chemicals on site;

(ii) development of a detailed contingency plan for response to any foreseeable situation that would permit the release of oil, fuel, or chemicals to the environment;

(iii) development of a detailed emergency response plan for the station;

(iv) maintenance of an awareness among employees and contractors that all individuals on site and off are required to comply with environmental procedures;

(v) routine inspection of the handling and storage facilities for oil, fuel, and chemicals;

(vi) routine checks of consistency with environmental procedures in general and the contingency and emergency response plans in particular;

(vii) training of personnel in spill response and cleanup;

(viii) maintenance of access to the resources required to deal with a spill;

(ix) designation of a point of first contact in the event of a spill; and

(x) carrying out a plant-wide assessment of all areas where such materials are handled or stored to ensure the compatibility of:

- the container being stored with the contained material;
- different chemicals upon mixing in the same container or containment area; and
- the container with its environment.

Rationale. The intent of this Recommendation is to minimize, to the extent practically possible, the probability of an accidental release of environmental contaminants or, in the event that such a release should occur, to minimize its impact.

Operational Opportunities.

(i) All elements of Recommendations R523, R524, and R525 could be documented in a single BMP plan for each station.

(ii) Responsibility for developing and implementing the BMP Plan could be assigned to a station BMP Committee that would function similarly to the Fire Prevention and Safety Committees in a typical plant environment.

(iii) Firefighting, occupational health and safety, and chemical control personnel may have expertise in handling hazardous materials and in spill control and may therefore be candidates for emergency response responsibilities.

(iv) Designated persons with spill control responsibilities reporting directly to the station manager could help ensure compliance with spill control procedures.

(v) Well developed and documented spill control procedures will promote prompt and appropriate action in the event of a spill. These procedures should include a list of emergency contacts who are available 24 hours a day, 7 days a week. Some organizations supplement this part of the procedure by distributing a wallet-sized Emergency Call Card.

(vi) Where a complete inventory of spill control equipment cannot be maintained on site, pre-arranged access to off-site equipment and services can facilitate a speedy response to emergencies.

(vii) The spill control plan could be tested regularly, e.g., annually, to ensure that the required resources and contact people are still available and in a state of readiness.

Section 6

Potential Options for the Management of Environmental Programs

The day-to-day management of the environmental issues and programs associated with the operation of a steam electric power station, including the development and implementation of company-specific protocols to address regulatory requirements, is the responsibility of the utility company.

Among Environment Canada's responsibilities is the promotion of progressive approaches to the management of environmental issues and programs. In this Section, three examples are given of what Environment Canada considers to be elements of a positive corporate approach to environmental management.

6.1 Environmental Auditing

Environmental audits are internal evaluations undertaken by companies to identify compliance problems, weaknesses in management systems, and areas of risk. The findings are documented in a written report for follow-up by the company's managers. Environmental audits are conducted voluntarily and are usually carried out by individuals from outside the work unit being audited. The utility company may use the services of an external consultant, a central corporate group, or some other combination.

Environment Canada recognizes the effectiveness of environmental auditing as an internal management tool and therefore does not request audit reports during routine compliance inspections. Environment Canada would encourage provincial regulatory agencies to adopt the same position as a means of encouraging the voluntary conduct of environmental auditing.

Periodic, internal environmental audits conducted throughout the operating life of the station provide a means of assessing environmental risk, ensuring consistency with regulatory or corporate requirements, and identifying or implementing opportunities for improving the environmental performance of the station.

In summary, internal audits help the utility to ensure that the environmental requirements of each station are being met, that management is informed, and that appropriate corrective actions are identified and taken to protect the environment. The Canadian Electrical Association has produced an "Environmental Audit Manual for Canadian Electric Utilities" (Canadian Electrical Association, 1989), which could be used in the development of a company-specific environmental auditing program.

6.2 Communications

Many utility companies have developed and implemented a communications strategy to facilitate the provision of information on station operations to both employees and the public. The regular issuance of information on station operations helps to educate employees about corporate environmental issues and programs and can do much to alleviate public concern in the event of an unavoidable operational upset.

Examples of such communications opportunities include:

- conducting plant tours to provide employees and the public with an understanding and appreciation of the complexity of plant operations in general and environmental control systems in particular;
- developing and circulating a synopsis of the station's environmental performance in a State-of-the-Environment report;
- notifying local residents in advance of planned, abnormal activities, such as steam blows, dye-testing of CW pump flows, or unusual trucking activity; and
- having plant staff conduct site visits to address environmental concerns from within the community.

6.3 Hiring of Contractors

Contractors' adherence to all applicable environmental protection practices, standards, approvals, and permits is an important consideration in the conduct of many station operations, particularly in light of the growing number and complexity of utility commitments in this regard.

One approach to dealing with this concern is to stipulate adherence to specific environmental requirements as a condition of tenders and contracts for on-site construction work, the operation of environmental monitoring and control equipment, and the disposal of waste material.

Clearly stated environmental requirements will prevent misunderstandings between plant managers, contractors, and regulatory agencies about the utility company's commitment to environmentally responsible operations and help to ensure that the contractor is aware of these requirements before undertaking any on-site work.

Section 7

SUMMARY OF RECOMMENDATIONS

A summary of the recommendations for the Operations Phase Code is presented in Table 2 as an overview for the reader. The full text of the Recommendations, as presented in Section 5, should be consulted for greater detail.

Table 2 Summary of Recommendations

Number	Subject	Summary of Recommendation	Section
R501	**Operation of Cooling Water Systems** - Biofouling Control	i) Avoid chemical use if possible. ii) If chemicals are necessary, minimize frequency and concentration of application. iii) Chemicals should be applied intermittently immediately upstream of the condensers, unless other practices have been found necessary.	5.1.1
R502	**Operation of Cooling Water Systems** - Corrosion, Scaling, or Silting Control	i) Avoid chemical use if possible. ii) If chemicals are necessary, minimize their use and select environmentally innocuous types. iii) Contain and treat off-line cleaning wastes.	5.1.2
R503	**Operation of Cooling Water Systems** - Minimization of Cooling Water Flow	i) Maintain downstream temperature of condenser as high as possible without causing temperature-induced mortality of entrained species or major losses in steam cycle efficiency. ii) Establish an annual temperature rule curve and operate within maximum defined discharge temperature.	5.1.3
R504	**Operation of Cooling Water Systems** - Contaminants in Evaporative Recirculating Cooling Systems	i) Avoid chemical use if possible. ii) If chemicals are necessary, minimize frequency and concentration of application, and do not use chromium-based additives.	5.1.4

Table 2 Summary of Recommendations (Cont.)

Number	Subject	Summary of Recommendation	Section
R505	**Operation of Cooling Water Systems** - Evaporative Recirculating Cooling Systems; Water Use	Post-1989 systems should be operated at a minimum of two cycles of concentration, so that make-up is introduced through auxiliary coolers where designs permit.	5.1.5
R506	**Operation of Wastewater Collection and Treatment Facilities** - Water Reuse	Reuse/recycle water and wastewater wherever practicable.	5.2.1
R507	**Operation of Wastewater Collection and Treatment Facilities** - Waste Liquid Containment Sizing	Develop new containments according to R209 of the Design Phase Code.	5.2.2
R508	**Operation of Wastewater Collection and Treatment Facilities** - Wastewater Treatment and Effluent Quality	i) Operate post-1989 treatment facilities so that wastewater contaminants do not exceed the following criteria: pH 6.5 to 9.5 Fe 1.0 mg/L Cr, Cu, Ni, Zn 0.5 mg/L Cr (hexavalent) 0.05 mg/L TSS 25.0 mg/L Oil & Grease 15 mg/L TRC 0.2 mg/L ii) Operate older stations so that effluent quality is as close as practically possible to the listed criteria. iii) Direct wastewaters, which cannot be effectively treated on site, only to licensed off-site facilities.	5.2.3
R509	**Operation of Solid Waste Disposal Sites** - Location and Construction	Expansions to existing disposal facilities should be undertaken so as to ensure that: i) the station site plan is updated; ii) the site perimeter is located a sufficient distance from watercourses to prevent contamination; iii) off-site surface drainage is diverted around the disposal area; iv) the site is screened from view; and v) beneficial uses after closure have been considered.	5.3.1

Table 2 Summary of Recommendations (Cont.)

Number	Subject	Summary of Recommendation	Section
R510	**Operation of Solid Waste Disposal Sites** - Site Development	i) Develop the site in modules or cells. ii) Ensure wastes have physical and chemical stability. iii) Contour, cap, and reclaim cells throughout the operating life of the site. iv) Reclaim site for beneficial use before final closure.	5.3.2
R511	**Operation of Solid Waste Disposal Sites** - Site Management	i) Dispose of liquid and hazardous wastes in approved facilities. ii) Control site access and supervise disposal activities. iii) Maintain disposal records. iv) Control wildlife and pests.	5.3.3
R512	**Seepage Control Criteria for Expanded Station Facilities**	Develop new solid waste storage and disposal, and wastewater treatment & containment facilities according to R210 of the Design Phase Code.	5.4
R513	**Control of Fugitive Emissions**	All reasonable measures should be taken to control fugitive dust emissions from: i) vehicular traffic; ii) transportation of coal and ash; iii) coal transfer and storage facilities; iv) ash handling and disposal facilities; and v) other significant (site-specific) sources.	5.5
R514	**Control of Atmospheric Emissions**	i) After the date of promulgation of this Code, all fossil-fuelled steam generating units that are designed and built to operate in accordance with the National Emission Guidelines should be maintained and operated to achieve consistency with the Guideline emission standards throughout their lifetime.	5.6

Table 2 Summary of Recommendations (Cont.)

Number	Subject	Summary of Recommendation	Section
R514	**Control of Atmospheric Emissions (Cont.)**	ii) Stations that have not been designed and built to operate in accordance with the Guidelines should be operated to achieve consistency with the Guideline's emission standards - for NO_x, particulate matter, and opacity to the extent that this can be achieved through sound operating practices.	
R515	**Control of Ambient Air Quality Impacts**	Stations should be operated so that their atmospheric emissions do not result in exceeding the maximum acceptable levels of SO_2 , NO_x, and particulate matter prescribed by the National Ambient Air Quality Objectives.	5.7
R516	**Environmental Monitoring Programs and Parameters** - Cooling Water	Monitoring of once-through cooling water systems should include: i) continuous TRC if chlorine is used; ii) continuous temperature monitoring of cooling water intake and discharge; iii) continuous temperature monitoring of condenser discharge; and iv) annual flow monitoring of total station, condenser, and auxiliary cooling water.	5.8.1
R517	**Environmental Monitoring Programs and Parameters** - Wastewater Discharges	i) Monitoring of continuous wastewater streams should include: a) continuous flow monitoring; b) continuous pH and TRC monitoring; and c) weekly analysis of composite samples for Fe, Cd, Cu, Ni, Zn, TSS, and other appropriate parameters for at least 1 year. ii) Monitoring of batch wastewater discharges should include: a) determination of volume of each batch; b) continuous monitoring of pH during discharge; and c) analysis of each batch as described in Part i(c).	5.8.2

Table 2 Summary of Recommendations (Cont.)

Number	Subject	Summary of Recommendation	Section
R517	**Environmental Monitoring Programs and parameters** - Wastewater Discharges (Cont.)	iii) Monitoring of discharges from sewage treatment facilities should include monthly analysis for BOD. iv) All site wastewater discharges should be tested for toxicity within 180 days of commissioning of wastewater treatment facilities.	
R518	**Environmental Monitoring Programs and Parameters** - Atmospheric Emissions	i) Monitoring of atmospheric emissions from fossil-fuelled stations required to satisfy the requirements of the National Emission Guidelines should be monitored and tested according to the monitoring and testing provisions of the Guidelines. ii) Plants not required to meet the Guidelines should: a) monitor SO_2 and NO_x on units >25 MWe by a method of comparable effectiveness to continuous emission monitoring; b) install, calibrate, operate, and test monitoring systems according to regulatory requirements; and c) report data as specified by regulatory authorities. iii) All plants should maintain records of all equipment malfunctions and breakdowns that affect atmospheric emissions.	5.8.3
R519	**Environmental Monitoring Programs and Parameters** - Ambient Air Quality	i) An ambient air quality program should be developed and implemented in consultation with the appropriate regulatory authority. ii) Monitoring of suspended particulate matter should be undertaken according to the schedule of the National Air Pollution Sampling Network.	5.8.4
R520	**Environmental Monitoring Programs and Parameters** - Groundwater	A groundwater monitoring program should be implemented that includes: i) a permanent system of piezometers and wells;	5.8.5

Table 2 Summary of Recommendations (Cont.)

Number	Subject	Summary of Recommendation	Section
R520	**Environmental Monitoring Programs and Parameters** - Groundwater (Cont.)	ii) monitoring of groundwater regimes starting at least one year before the operation of new facilities; iii) sample collection at least quarterly during the first two years of operation; and iv) sample analysis for pH, TDS, and other appropriate parameters.	
R521	**Environmental Monitoring Programs and Parameters** - Noise	Noise monitoring should be undertaken in residential areas adjacent to the plant site to determine if noise levels are consistent with: i) 55 dBA during the day (07:00-19:00) ii) 50 dBA at night (23:00-07:00) and all day Sundays and Holidays.	5.8.6
R522	**Environmental Monitoring Programs and Parameters** - Biota	Operational biological monitoring of the receiving environment should be sufficiently comprehensive to enable the operator to: i) measure changes in the preoperational background; ii) determine the validity and accuracy of impact predictions made during the design and construction stage; and iii) assess the need to incorporate changes in operations affecting the receiving environment.	5.8.7
R523	**Best Management Practices** - Segregation of Hazardous Materials	Separate storage and containment facilities should be provided for chemicals that can react violently with one another.	5.9.1
R524	**Best Management Practices** - Oil, Fuel, and Chemical Storage and Transfer	Specific sites should be designated for the storage and transfer of oil, fuel, and chemicals that are: i) located on material of low permeability; ii) constructed to contain the maximum spill; iii) located to minimize the probability of watercourse contamination; and iv) protected from physical damage.	5.9.2

Table 2 Summary of Recommendations (Cont.)

Number	Subject	Summary of Recommendation	Section
R525	**Best Management Practices** - Spill Control Planning and Procedures	Site management should designate one or more persons whose responsibilities include: i) developing handling and storage procedures for oil, fuel, and chemicals; ii) developing a detailed spill contingency plan; iii) developing an emergency response plan; iv) liaising with contractors about site environmental procedures; v) inspecting oil, fuel, and chemical handling and storage facilities; vi) routinely checking consistency with environmental procedures; vii) training personnel in spill response and cleanup; viii) maintaining access to resources required to deal with a spill; ix) designating a point of first contact in the event of a spill; and x) undertaking a plant-wide assessment of compatibility of materials .	5.9.3

References

Canadian Council of Ministers of the Environment (CCME), "Guidelines for the Management of Wastes Containing Polychlorinated Biphenyls (PCBs), Report CCME-TS/WM-TRE008 (1989).

Canadian Electrical Association (CEA), "Environmental Audit Manual for Canadian Electrical Utilities" (1989).

Dearborn Environmental Consulting Group, "Development of a Combustion Waste Inventory" (1989).

Environment Canada, "Environmental Codes of Practice for Steam Electric Power Generation - Design Phase", Conservation and Protection, Ottawa, Ontario, Report EPS 1/PG/1 (1985).

Environment Canada, "Environmental Codes of Practice for Steam Electric Power Generation - Siting Phase", Conservation and Protection, Ottawa, Ontario, Report EPS 1/PG/2 (1987).

Environment Canada, "Environmental Codes of Practice for Steam Electric Power Generation - Construction Phase", Conservation and Protection, Ottawa, Ontario, Report EPS 1/PG/3 (1989).

Environment Canada, "Biological Test Method: Reference Method for Determining Acute Lethality of Effluents to Rainbow Trout", Conservation and Protection, Ottawa, Ontario, Report EPS 1/RM/13 (1990a).

Environment Canada, "Biological Test Method: Acute Lethality Test Using Threespine Stickleback (*Gasterosteus aculeatus*), Conservation and Protection, Ottawa, Ontario, Report EPS 1/RM/10 (1990b).

Environment Canada, "Biological Test Method: Reference Method for Determining Acute Lethality of Effluents to *Daphnia magna*", Conservation and Protection, Ottawa, Ontario, Report EPS 1/RM/14 (1990c).

Canada Gazette, "Canadian Environmental Protection Act", S.C. (1988), C.22, Ottawa, Ontario (1988a).

Canada Gazette, "Fisheries Act R.S., c. F-14, s. 1", Ottawa, Ontario (as amended December 12, 1988) (1988b).

Canada Gazette, Department of the Environment, "National Ambient Air Quality Objectives for Air Contaminants", Part I, Ottawa, Ontario (August 12, 1989).

Canada Gazette, Department of the Environment, "Thermal Power Generation Emissions - National Guidelines for New Stationary Sources", Part I, Ottawa, Ontario (March 3, 1990).

Canada Gazette, "Transportation of Dangerous Goods Act - Transport of Dangerous Goods Regulations", SOR/85-77 (as amended) Ottawa, Ontario.

Health and Welfare Canada, "Guidelines for Canadian Drinking Water Quality, Fourth Edition", Ottawa, Ontario, (1989a).

Health and Welfare Canada, Federal-Provincial Advisory Committee on Environmental and Occupational Health, "National Guidelines for Environmental Noise Control - Procedures and Concepts for the Drafting of Environmental Noise Regulations/Bylaws in Canada", Ottawa, Ontario, (1989b).

National Research Council of Canada (NRCC), "National Fire Code", Ottawa, Ontario, (1990).

Bibliography

Canadian Chemical Producers Association, "Codes of Practice Commitment Package" (undated).

Canadian Electrical Association (CEA), "Water Use/Reuse Practices & Wastewater Management Practices at Selected Canadian Coal Fired Generating Stations - Volume I" (1984).

Canadian Manufacturers Association, "A Simplified Guide to Emergency Planning" (1990).

Environment Canada and the Canadian Electrical Association, "Environmental Aspects of Operating Thermal Generating Stations - Summary and Proceedings" (1989).

Environment Canada, "Water and Wastewater Management Practices for Coal-fuelled Power Generating Stations Equipped with Flue Gas Desulphurization", Conservation and Protection, Ottawa, Ontario, Report EPS 2/PG/1 (1985).

Environment Canada, "National Guidelines for the Landfilling of Hazardous Waste", Conservation and Protection, Ottawa, Ontario (1990).

Environment Canada, "An Overview of Environmental Policy in Canadian Industry", Ottawa, Ontario (1991).

Environment Canada, "Interim Recommended Practices for the Management of Solid Residues from Circulating Fluidized Bed Combustion (CFBC), Conservation and Protection, Ottawa, Ontario, Report EPS 1/PG/4 (1992).

Canada Gazette, Department of the Environment, "Canadian Environmental Protection Act - Enforcement and Compliance Policy" (1988).

New Brunswick Department of the Environment, "Design Guidelines for Sanitary Landfill Sites" (1988).

Ontario Ministry of the Environment, "The Development Document for the Effluent Monitoring Regulation for the Electric Power Generation Sector" (1990).

Appendix A

Canadian Steam Electric Power Generating Stations as of 1991

Table A-1 Canadian Oil-fired Thermal Generating Units (1991)

Station & Unit No.	Operating Utility	Capacity (MW)	Start Date
Holyrood 1	Nfld. & Lab. Hydro	175	1970
Holyrood 2	Nfld. & Lab. Hydro	175	1971
Holyrood 3	Nfld. & Lab. Hydro	150	1979
St. John's 1	Nfld. Light & Power	10	1957
St. John's 2	Nfld. Light & Power	20	1959
Charlottetown 5	Maritime Electric	5	1948
Charlottetown 6	Maritime Electric	7	1955
Charlottetown 7	Maritime Electric	7	1960
Charlottetown 8	Maritime Electric	10	1963
Charlottetown 9	Maritime Electric	20	1968
Point Tupper 1	Nova Scotia Power	80	1969
Tufts Cove 1	Nova Scotia Power	100	1965
Tufts Cove 2	Nova Scotia Power	100	1972
Tufts Cove 3	Nova Scotia Power	150	1976
Coleson Cove 1	New Brunswick Power	350	1976
Coleson Cove 2	New Brunswick Power	350	1976
Coleson Cove 3	New Brunswick Power	350	1977
Courtenay Bay 1	New Brunswick Power	45	1961
Courtenay Bay 2	New Brunswick Power	13	1964
Courtenay Bay 3	New Brunswick Power	100	1966
Courtenay Bay 4	New Brunswick Power	100	1967
Dalhousie 1	New Brunswick Power	100	1969
Tracy 1	Hydro Quebec	150	1964
Tracy 2	Hydro Quebec	150	1965
Tracy 3	Hydro Quebec	150	1967
Tracy 4	Hydro Quebec	150	1968
Lennox 1	Ontario Hydro	550	1976
Lennox 2	Ontario Hydro	550	1976
Lennox 3	Ontario Hydro	550	1976
Lennox 4	Ontario Hydro	550	1977
Total Units: 30	Total Utilities: 7	Total Capacity: 5 217 MW	

Table A-2 Canadian Gas-fired Thermal Generating Units (1991)

Station & Unit No.	Operating Utility	Capacity (MW)	Start Date
R.L. Hearn 1	Ontario Hydro	96	1951
R.L. Hearn 2	Ontario Hydro	96	1952
R.L. Hearn 3	Ontario Hydro	96	1952
R.L. Hearn 4	Ontario Hydro	96	1953
R.L. Hearn 5*	Ontario Hydro	191	1961
R.L. Hearn 6*	Ontario Hydro	191	1960
R.L. Hearn 7*	Ontario Hydro	191	1961
R.L. Hearn 8*	Ontario Hydro	191	1961
Queen Elizabeth 1**	SaskPower	62	1959
Queen Elizabeth 2**	SaskPower	62	1959
Queen Elizabeth 3	SaskPower	92	1971
Medicine Hat 3	City of Medicine Hat	15	1974
Medicine Hat 4	City of Medicine Hat	3	1929
Medicine Hat 6	City of Medicine Hat	5	1947
Medicine Hat 7	City of Medicine Hat	32	1953
Clover Bar 1	Edmonton Power	162	1970
Clover Bar 2	Edmonton Power	162	1973
Clover Bar 3	Edmonton Power	167	1976
Clover Bar 4	Edmonton Power	167	1979
Rossdale 2	Edmonton Power	10	1944
Rossdale 3	Edmonton Power	26	1949
Rossdale 4	Edmonton Power	27	1953
Rossdale 5	Edmonton Power	28	1955
Rossdale 8	Edmonton Power	67	1960
Rossdale 9	Edmonton Power	71	1963
Rossdale 10	Edmonton Power	71	1966
Burrard 1	BC Hydro	150	1966
Burrard 2	BC Hydro	150	1963
Burrard 3	BC Hydro	150	1962
Burrard 4	BC Hydro	150	1967
Burrard 5	BC Hydro	150	1968
Burrard 6	BC Hydro	162	1975

Total units: 32 Total Utilities: 5 Total Capacity: 3 289 MW

* These units are also capable of coal-fired operation.
** These units are also capable of oil- and coal-fired operation.

Table A-3 Canadian Coal-fired Thermal Generating Units (1991)

Station & Unit No.	Operating Utility	Capacity (MW)	Start Date
Glace Bay 3	Nova Scotia Power	15	1951
Glace Bay 4	Nova Scotia Power	15	1954
Glace Bay 5	Nova Scotia Power	15	1955
Glace Bay 6	Nova Scotia Power	15	1959
Glace Bay 7	Nova Scotia Power	36	1967
Lingan 1	Nova Scotia Power	150	1979
Lingan 2	Nova Scotia Power	150	1980
Lingan 3	Nova Scotia Power	150	1983
Lingan 4	Nova Scotia Power	150	1984
Maccan	Nova Scotia Power	15	1949
Point Aconi 1	Nova Scotia Power	180	1993
Point Tupper 2	Nova Scotia Power	150	1973
Trenton 3	Nova Scotia Power	20	1953
Trenton 4	Nova Scotia Power	20	1959
Trenton 5	Nova Scotia Power	150	1969
Trenton 6	Nova Scotia Power	150	1991
Belledune 2	New Brunswick Power	450	1993
Chatham 1	New Brunswick Power	10	1948
Chatham 2	New Brunswick Power	22	1956
Chatham 3	New Brunswick Power	22	1987
Dalhousie 2	New Brunswick Power	200	1979
Grand Lake 5	New Brunswick Power	5	1951
Grand Lake 6	New Brunswick Power	5	1952
Grand Lake 7	New Brunswick Power	13	1953
Grand Lake 8	New Brunswick Power	60	1963
Atikokan 1	Ontario Hydro	215	1985
J. Clark Keith 1	Ontario Hydro	64	1952
J. Clark Keith 2	Ontario Hydro	64	1952
J. Clark Keith 3	Ontario Hydro	64	1953
J. Clark Keith 4	Ontario Hydro	64	1953
Lakeview 1	Ontario Hydro	262	1962
Lakeview 2	Ontario Hydro	262	1963
Lakeview 3	Ontario Hydro	284	1965
Lakeview 4	Ontario Hydro	284	1965
Lakeview 5	Ontario Hydro	266	1967
Lakeview 6	Ontario Hydro	266	1969
Lakeview 7	Ontario Hydro	285	1969
Lakeview 8	Ontario Hydro	285	1969
Lambton 1	Ontario Hydro	495	1970
Lambton 2	Ontario Hydro	495	1970
Lambton 3	Ontario Hydro	495	1970
Lambton 4	Ontario Hydro	495	1970
Nanticoke 1	Ontario Hydro	497	1973
Nanticoke 2	Ontario Hydro	497	1973

Table A-3 Canadian Coal-fired Thermal Generating Units (1991) (continued)

Station & Unit No.	Operating Utility	Capacity (MW)	Start Date
Nanticoke 3	Ontario Hydro	497	1973
Nanticoke 4	Ontario Hydro	497	1974
Nanticoke 5	Ontario Hydro	497	1975
Nanticoke 6	Ontario Hydro	497	1977
Nanticoke 7	Ontario Hydro	497	1978
Nanticoke 8	Ontario Hydro	497	1978
Thunder Bay 1	Ontario Hydro	88	1963
Thunder Bay 2	Ontario Hydro	155	1981
Thunder Bay 3	Ontario Hydro	155	1982
Brandon 1	Manitoba Hydro	33	1958
Brandon 2	Manitoba Hydro	33	1959
Brandon 3	Manitoba Hydro	33	1959
Brandon 4	Manitoba Hydro	33	1959
Brandon 5	Manitoba Hydro	105	1969
Selkirk 1	Manitoba Hydro	66	1960
Selkirk 2	Manitoba Hydro	66	1960
Boundary Dam 1	SaskPower	62	1959
Boundary Dam 2	SaskPower	60	1960
Boundary Dam 3	SaskPower	142	1969
Boundary Dam 4	SaskPower	142	1970
Boundary Dam 5	SaskPower	142	1973
Boundary Dam 6	SaskPower	280	1977
Poplar River 1	Saskpower	278	1980
Poplar River 2	Saskpower	280	1982
Estevan 2	Saskpower	15	1950
Estevan 3	Saskpower	19	1953
Estevan 4	Saskpower	29	1957
Battle River 1	Alberta Power Limited	28	1956
Battle River 2	Alberta Power Limited	28	1964
Battle River 3	Alberta Power Limited	148	1969
Battle River 4	Alberta Power Limited	148	1975
Battle River 5	Alberta Power Limited	370	1981
H.R. Milner 1	Alberta Power Limited	145	1972
Sheerness 1	Alberta Power/TransAlta	380	1986
Sheerness 2	Alberta Power/TransAlta	380	1990
Genesee 1	Edmonton Power	386	1989
Genesee 2	Edmonton Power	386	1994
Keephills 1	TransAlta Utilities	383	1983
Keephills 2	TransAlta Utilities	383	1984
Sundance 1	TransAlta Utilities	280	1970
Sundance 2	TransAlta Utilities	280	1973

Table A-3 Canadian Coal-fired Thermal Generating Units (1991) (continued)

Station & Unit No.	Operating Utility	Capacity (MW)	Start Date
Sundance 3	TransAlta Utilities	355	1976
Sundance 4	TransAlta Utilities	355	1977
Sundance 5	TransAlta Utilities	355	1978
Sundance 6	TransAlta Utilities	365	1980
Wabamun 1	TransAlta Utilities	64	1958
Wabamun 2	TransAlta Utilities	64	1956
Wabamun 3	TransAlta Utilities	140	1962
Wabamun 4	TransAlta Utilities	280	1968

Total Units: 93 Total Utilities: 8 Total Capacity: 18 204 MW

Table A-4 Canadian Nuclear Generating Units (1991)

Station & Unit No.	Operating Utility	Capacity (MW)	Start Date
Point Lepreau 1	New Brunswick Power	635	1983
Gentilly 2	Hydro Quebec	638	1983
Bruce A-1	Ontario Hydro	904	1977
Bruce A-2	Ontario Hydro	904	1977
Bruce A-3	Ontario Hydro	904	1978
Bruce A-4	Ontario Hydro	904	1979
Bruce B-5	Ontario Hydro	915	1985
Bruce B-6	Ontario Hydro	915	1984
Bruce B-7	Ontario Hydro	915	1986
Bruce B-8	Ontario Hydro	915	1987
Darlington 1	Ontario Hydro	935	1988
Darlington 2	Ontario Hydro	935	1990
Darlington 3	Ontario Hydro	935	1991
Pickering A-1	Ontario Hydro	542	1971
Pickering A-2	Ontario Hydro	542	1971
Pickering A-3	Ontario Hydro	542	1972
Pickering A-4	Ontario Hydro	542	1973
Pickering B-5	Ontario Hydro	540	1983
Pickering B-6	Ontario Hydro	540	1984
Pickering B-7	Ontario Hydro	540	1985
Pickering B-8	Ontario Hydro	540	1986
Total Units: 21	Total Utilities: 3	Total Capacity: 16 617 MW	

Appendix B

Working Group 14
Operations Phase
Environmental Codes of Practice for Steam Electric Power Generation

David Briggs
Operating Practice and
Fluidized Bed Engineer
Nova Scotia Power Corp.
P.O. Box 910
Halifax, Nova Scotia
B3J 2W5

Chris Doiron*
Senior Programs Advisor
Industrial Programs Branch
Environment Canada
Ottawa, Ontario
K1A 0H3

John Ell
Operating Superintendent
Sheerness Generating Station
Alberta Power Limited
Box 1540
Hanna, Alberta
T0J 1P0

Wendy Gowans
Technical Superintendent
Environmental Audit
Ontario Hydro
700 University Avenue
Toronto, Ontario
M5G 1X6

Bill Lawrysyn
Water Quality Branch
Saskatchewan Environment
and Public Safety
3085 Albert Street
Regina, Saskatchewan
S4S 0B1

Dave MacRae
Industrial Programs Branch
New Brunswick Department
of the Environment
P.O. Box 6000
Fredericton, New Brunswick
E3B 5H1

Anne Maria Pennanen
Industrial Approvals Section
Ontario Ministry of the Environment
250 Davisville Avenue
Toronto, Ontario
M4S 1H2

Geoff Ross **
A/Head, Electric Power Section
Industrial Programs Branch
Environment Canada
Ottawa, Ontario
K1A 0H3

* Coordinator

** Chairperson

Appendix C

Thermal Power Generation Emissions - National Guidelines for New Stationary Sources

THERMAL POWER GENERATION EMISSIONS

NATIONAL GUIDELINES FOR NEW STATIONARY SOURCES

Foreword

1. (1) During the development of the annexed Guidelines, representatives of the federal and provincial governments, environmental non-government organizations and technical personnel from industry were consulted regarding control strategies and technologies for the air pollutants addressed in the Guidelines.

(2) The Minister of the Environment recommends that provincial and territorial air pollution control agencies adopt the annexed Guidelines as minimum standards for new fossil fuel-fired steam generating units within their jurisdiction. However, local conditions, such as density of industrial development, topography and other environmental considerations, may necessitate the adoption of more stringent requirements than those suggested in these Guidelines.

(3) Provincial and territorial regulatory agencies may wish to encourage efficiency in energy conversion systems by specifying emission limits for electric power generation per unit of total useful energy output. It is not intended that these Guidelines constrain the use of such an approach where it can be shown to result in superior benefit to the environment.

Scope

2. (1) The annexed Guidelines indicate the quantities and concentrations above which nitrogen oxides, particulate matter and sulphur dioxide should not be emitted from fossil fuel-fired steam-driven electricity generating units, operated in whole or in part for the purpose of the sale of electricity to industry, commerce, or the public.

(2) The Guidelines are intended to apply to new units only. However, it is recognized that opportunities to reduce nitrogen oxides may arise during major alterations to an existing fossil fuel-fired steam generating unit. It is therefore recommended that an assessment of the feasibility of nitrogen oxides reduction measures be completed prior to commencing such alterations. This assessment should be undertaken by the owner of the unit in close consultation with the appropriate provincial regulatory authority, and improved nitrogen oxides control measures should be implemented wherever feasible.

(3) The Guidelines are part of continuing efforts to diminish the emissions of air-polluting discharges to the atmosphere, and will contribute to that end by restricting such discharges from future additions to electric generating system capacity. The emission limits recommended herein are achievable using control methods now available to the industry for the abatement of the specified air pollutants.

Interpretation

3. In this document,

"averaging period" means a period for determining emission rates based on 720 operating hours which is further defined below; (*période de prise de la moyenne*)

"continuous monitoring system" means the complete equipment for sampling, conditioning and analysing emissions or process parameters and for recording data; (*dispositif de surveillance en continu*)

"first commercial operation" means the date of the first operation of a steam generating unit at which time electric generating capacity is electrically connected to the transmission and/or distribution systems for the use of tariff-paying customers; (*début de l'exploitation commerciale*)

"fossil fuel" means natural gas, petroleum, coal, and any form of gaseous, liquid or solid fuel derived from such for the purpose of creating useful heat; (*combustible fossile*)

"fossil fuel-fired steam generating unit" means a combustion device used for the purpose of burning fossil fuel, at a rate in excess of 73 megajoules per second heat input, for the purpose of producing steam for utility electric generation; (*générateur de vapeur alimenté au combustible fossile*)

"maximum continuous rating" means the maximum rate of heat input, in megajoules per hour, at which a fossil fuel-fired steam generating unit has been demonstrated to be capable of operating on a continuous; (*capacité maximum en service continu*)

"mg/m^3" means milligrams per cubic metre on a dry basis at a temperature of 298 degrees K and pressure of 101.3 kilopascals; (mg/m^3)

"ng/J" means nanograms per joule; (ng/J)

"new fossil fuel-fired steam generating unit" means any fossil fuel-fired steam generating unit, including a unit which replaces an existing fossil fuel-fired steam generating unit with equivalent technology or with any other steam generating technology which is based on fossil fuel combustion, for which first commercial operation commences after May 1, 1981; (*nouveau générateur de vapeur alimenté au combustible fossile*)

"nitrogen oxides" means all oxides of nitrogen except nitrous oxide, collectively expressed as nitrogen dioxide; (*oxydes d'azote*)

"opacity" means the degree to which emissions reduce the transmission of light and obscure the view of an object in the background; (*opacité*)

"original projected date of first commercial operation" means the anticipated date of first commercial operation which is referenced in the first approvals issued by the provincial or territorial regulatory authority for the construction or operation of the steam generating unit; (*date originalement prévue du début de l'exploitation commerciale*)

"720 hour rolling average" means for each pollutant, the average of the consecutive hourly mean emission rates, determined for the preceding 720 hours of system operation. Intervals of zero emissions are not to be included in the calculation of rolling averages. (*moyenne mobile sur 720 heures*)

Emission Guidelines

4. The hourly mean rate of discharge of air contaminants emitted into the ambient air from new fossil fuel-fired utility steam generating units should not exceed the following, when determined over successive averaging periods as previously defined:

(1) For Sulphur Dioxide: Generating units emitting more than 258 ng/J of heat input, when uncontrolled:

(a) Those units emitting between 258 ng/J and 2580 ng/J of heat input should be controlled such that the final emission does not exceed 258 ng/J of heat input;

(b) Units emitting more than 2580 ng/J of heat input should be controlled so that a minimum of 90% of the uncontrolled emission is captured before release to the atmosphere.

(2) For Nitrogen Oxides expressed as NO_2:

(a) For new units for which the original projected date of first commercial operation is prior to January 1, 1995:

   (i) 258 ng/J of heat input, when fired with solid fossil fuel;

   (ii) 129 ng/J of heat input, when fired with liquid fossil fuel;

   (iii) 86 ng/J of heat input, when fired with gaseous fuel.

(b) New units for which the original projected date of first commercial operation is January 1, 1995, or later, should meet a tonne/hour emission limit, calculated for each unit based on the following emission rates at maximum continuous rating:

   (i) 170 ng/J of heat input, when fired with solid fossil fuel;

   (ii) 110 ng/J of heat input, when fired with liquid fossil fuel;

   (iii) 50 ng/J of heat input, when fired with gaseous fuel.

5. The rate of discharge of particulate matter emitted into the ambient air from new fossil fuel-fired utility steam generating units should not exceed 160 mg/m^3 corrected to 3% oxygen in the flue gas, when fired with solid fossil fuel or liquid fossil fuel.

Opacity

6. All new sources fired with solid fossil fuel or liquid fossil fuel should not emit visible emissions with opacity greater than 20%, except that the opacity may increase to 40% for not more than six (6) minutes in any sixty (60) minute period.

Compliance

7. (1) Natural variations in coal constituents can cause emissions to vary and make enforcement on an hourly or daily basis impractical. However, calculating the 720 hour rolling average allows the regulatory agency to be informed daily, for each unit, of the maximum average emission rate in the previous 24 hours, since the rolling average must be calculated hourly, on the previous 720 hours' emission values.

(2) It is recognized that the emission guidelines suggested in paragraphs 4,5 and 6 may be exceeded:

(a) in the event of malfunction or breakdown in air pollution control equipment; and

(b) in the event of start-up or shutdown in the operation of the source.

These events should be minimized, both as to frequency of occurrence and duration of each event.

Emission Testing

8. (1) For the purposes of sections 4, 5 and 6, emission tests should be conducted and a written report of results submitted within 180 days from first commercial operation of a fossil fuel-fired steam generating unit and at such other times as the appropriate regulatory agency may require.

(2) Emission tests required under paragraph 8(1) should be carried out in the following manner for:

(a) nitrogen oxides in accordance with Environment Canada report "Protocols and Performance Specifications for Continuous Monitoring of Gaseous Emissions from Thermal Power Generation", as amended from time to time;

(b) particulate matter in accordance with the reference method specified in the Department of the Environment Report EPS 1-AP-74-1, "Standard Reference Methods for Source Testing: Measurement of Emissions of Particulates from Stationary Sources", as amended from time to time;

(c) sulphur dioxide in accordance with Environment Canada report "Protocols and Performance Specifications for Continuous Monitoring of Gaseous Emissions from Thermal Power Generation", as amended from time to time;

(d) visible emissions should be measured in accordance with the reference method specified in the Department of the Environment Report EPS 1-AP-75-2, "Standard Reference Methods for Source Testing: Measurement of Opacity of Emissions from Stationary Sources", as amended from time to time.

Emission Monitoring

9. (1) A continuous monitoring system for measuring the opacity of emissions should be installed on each new source fired with solid fossil fuel or liquid fossil fuel. The installation and operation of the system should be in accordance with the performance specification for transmissometer systems established by the appropriate regulatory agency.

(2) A continuous system for measuring sulphur dioxide should be installed on each new source fired with solid fossil fuel or liquid fossil fuel. The installation and operation of the system should be in accordance with Environment Canada report "Protocols and Performance Specifications for Continuous Monitoring of Gaseous Emissions from Thermal Power Generation", as amended from time to time.

(3) A continuous monitoring system for measuring nitrogen oxides should be installed on each new source. The installation and operation of the system should be in accordance with Environment Canada report "Protocols and Performance Specifications for Continuous Monitoring of Gaseous Emissions from Thermal Power Generation", as amended from time to time.

(4) All continuous monitoring systems should be installed, calibrated and operating prior to the emission tests required under

paragraph 8(1). During the emission tests or within 30 days thereafter, and at such other times as may be required, an evaluation of the performance of the continuous monitoring systems should be conducted in accordance with the requirements and procedures set out in Environment Canada report "Protocols and Performance Specifications for Continuous Monitoring of Gaseous Emissions from Thermal Power Generation", as amended from time to time. A written report of the results should be prepared and submitted, within sixty (60) days of the evaluation, to the appropriate regulatory agency.

Notification and Record Keeping

10. (1) The emission rates for each pollutant included in these Guidelines, determined by rolling averages, should be sent to the regulatory authority at least every calendar quarter.

(2) Operators should keep records of malfunction and breakdowns and should report each occurrence, at least every calendar quarter, to the appropriate regulatory agency.

(3) The appropriate regulatory authority should be furnished with the following written notifications for sources subject to the provisions of these Guidelines:

(a) notification of the proposed construction, replacement or major modification of a fossil fuel-fired steam generating unit;

(b) notification of the anticipated date of first commercial operation of the source, postmarked not less than 30 days prior to such date; and

(c) notification of the date of any performance tests and evaluations of continuous monitoring system performance, postmarked not less than 30 days prior to such date.