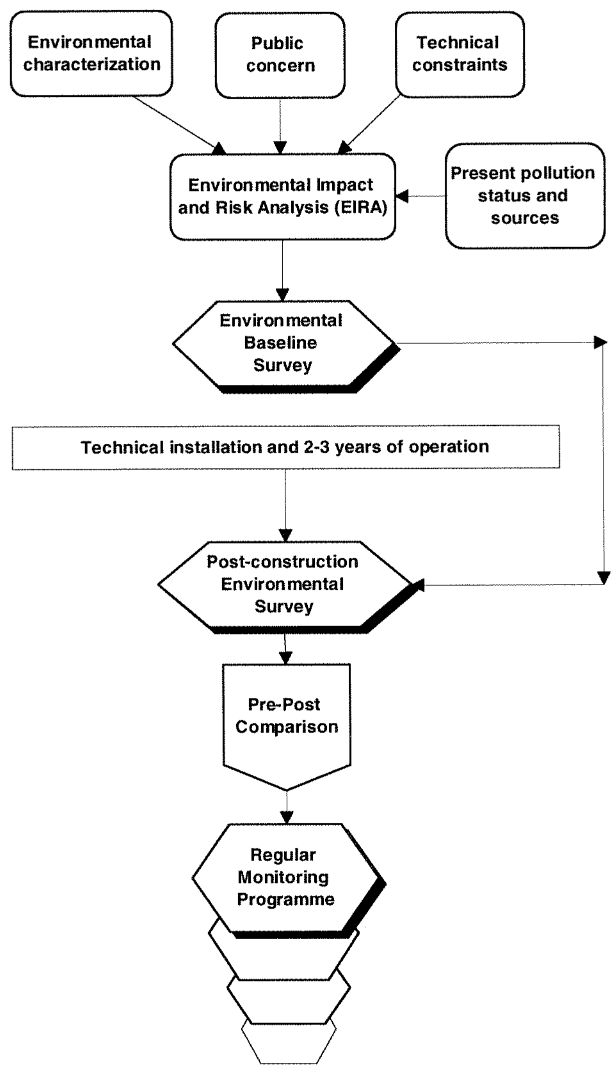
REPORT SNO 3673-97

Principles of Environmental Baseline Surveys and Monitoring of the Recipient for Effluents from Seawater Flue Gas Scrubbers

Revision 2



Norwegian Institute for Water Research

REPORT

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Abstract

The report gives a general overview of the basic principles and elements in the environmental monitoring of the marine/estuarine ecosystem receiving effluents from seawater flue gas cleaning installations (ABB SWFGD). The basic elements are a baseline survey prior to any installations, a similar survey performed after a period of regular operation of the installation, and a long term monitoring programme based on a comparison of results from the two former surveys. Preferrably these surveys should be performed by local institutions or consultants who are familiar with the local flora and fauna and other local environmental conditions, but in cooperation with an external institution with a broad experience in this kind of monitoring, to act as scientific advisor and quality assurance supervisor.

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1. Gassrensing	1. Flue gas cleaning
2. Sjøvannsskrubber	2. Seawater scrubber
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Contents

1. Introduction

ABB Environmental has requested that the Norwegian Institute for Water Research, NIVA, prepares the present document outlining some general basic principles which should be followed concerning strategy and performance of environmental monitoring in marine ecosystems receiving effluents from ABB Flakt-Hydro seawater flue gas treament plants (ABB SWFGD plants). The document is prepared on basis of the NIVA experience from several environmental impact modelling and monitoring surveys performed around ABB SWFGD installations in the Canary Islands, Spain, and in other parts of the world.

The document presents the general sequence of events proposed for the monitoring, as well as proposals on the study elements which should be included and how such studies may be organized.

2. General principles of the monitoring programme

An brief illustration of the sequence of events in an environmental monitoring programme is given in Figure 1. The three basic elements in a monitoring programme would normally be:
1. A baseline survey
2. A post-installation survey
3. A regular long term monitoring programme

A baseline survey is a more or less comprehensive environmental survey programme conducted before any impact has occurred in the recipient, ideally before any installation work or other disturbing activity has occurred. The purpose of the baseline survey is to describe the environmental condition of the ecosystem before any impact has occurred, including estimates of the natural variability in space and time of these conditions, and identification of any pollution or other environmental stress which is already in the area. This environmental description should be in sufficient detail so that later deviations due to significant effects from the installation can be discovered. The description should also be suitable as evidence against accusation of effects from the installation when there really are none.

The basis for selection of elements to include in the baseline survey is an *a priori* Environmental Impact and Risk Analysis (EIRA) which should identify all potential short and long term effects of the installation on the ecosystem. With these aims in mind a baseline survey will in general cover a wide range of aspects, whereas a later monitoring programme normally will focus only on a selection of these.

A post-construction survey is in general a repetition of the baseline survey. This survey is done after the installation is complete and the system has been in regular operation long enough for any effects to show up in the ecosystem. As a rule this will take 1-3 years, but should be assessed individually for each element in a programme by scientific expertise. Ideally the post-construction survey should cover the same time-span as the baseline survey. A comparison of the baseline and post-installation conditions (before-after comparison) should identify and possibly quantify any significant effects due to the construction and operation of the installation, as basis for any remedial actions and for establishing a monitoring programme.

A long term monitoring programme should therefore be planned on basis of the results from this before-after comparison. An assessment is made of the effects which are significant, and whether they are likely to increase, stabilize or decrease with time. The limits of acceptability for the effects should also be defined, in order to set the level of precision of the monitoring procedures. For instance if one defines a maximum acceptable change in a certain element of the ecosystem to be 10 %, the level of precision required to monitor this element is far higher (and costs far more) than if one accepts a 50% change before action.

Other considerations which will have to be made in establishing a monitoring programme may be national regulations requirements and other demands from the authorities regarding what shall be monitored.

3. Potential elements of a marine/estuarine baseline survey in relation to an SWFGD effluent.

In general ABB Environmental SWFGD installations at thermal power stations utilize seawater from the main cooling water system of the station both in the gas scrubber and aeration basins. Normally the SWFGD effluent is mixed with the remaining cooling water before aeration and discharge through the main cooling water outlet. On basis of numerous EIAs and other evidence from ABB SWFGD plants under construction or in operation the potential impact to the recipient from this effluent is due to:

- elevated temperature (not caused by the SWFGD plant itself)
- reduced oxygen concentration
- reduced pH
- suspended solids (ashes)
- traces of impurities in the combusted material, primarily heavy metals

Dilution and dispersion modelling linked to enviromental quality criteria (EQC) have in general showed theoretically that a dilution of the cooling water stream by 2-4 times with seawater is sufficient to eliminate most potential acute toxicity problems with these components, but the impact zone or area needed for such dilution to occur will vary from one recipient to another. Furthermore, persistent substances, such as heavy metals, may gradually accumulate in the environment, and still be a threat to the ecosystem, even though the initial dilution meets agreed EQC levels.

On basis of these considerations the elements normally included in a baseline survey outside an SWFGD plant are briefly described below.

3.1 Hydrophysical and geophysical measurements

The measurements proposed will usually cover nearshore current dynamics and salinity-temperature profiles at various seasons as inputs to improved numerical modelling of dispersion and dilution of the cooling water effluent. If the baseline survey is performed prior to the detailed engineering of the cooling water outlet arrangement, or if sufficient information is available from earlier investigations, such modelling may also be used to determine the optimal discharge arrangement (e.g. outlet site, surface or submerged outlet, technical configuration and use of diffusors). Dispersion modelling will also define the likely geographical impact zone of the effluent which is an important basis for developing the sampling design of a monitoring programme.

The hydrophysical measurements in the post-construction survey should focus on tracking the cooling water plume (temperature mesurements and use of tracers such as Rhodamine dye) to verify the dispersion modelling results.

Geophysical characterization should be an element of the baseline survey, and should determine the distribution pattern of bottom types in the area. This may be done on basis of topographical analysis (avaliable maps and echo soundings) and analysis of particle size distribution at selected sites. The purpose will be to map the distribution of solid rock, erosion, transport and accumulation bottoms within the impact zone, and with focus on accumulation areas.

3.2 Hydrochemical and geochemical measurements

Baseline and post-construction surveys will normally cover a limited hydrochemical and geochemical programme to define the normal range and variability in elements such as oxygen concentrations, pH, and suspended solids in the water masses, and the present levels in sediments of relevant heavy metals, possibly also organic micropollutants such as PAH (polycyclic aromatic hydrocarbons). The focus of the geochemical characterization should be on areas with fine bottom sediments (silt and clay) where any contaminants from the effluent probably will accumulate.

3.3 Contaminants in organisms

This will normally focus on determining the baseline concentrations of heavy metals in selected organisms. The organisms should be species known to be good indicators of heavy metal accumulation and/or locally harvested species of fish or shellfish. The latter should be included also to provide evidence on how the effluent may affect the quality for consumption by humans. The before-after comparison of these analyses will show if the effluent to any extent may affect the quality of local seafood, and the geographical extent of such an impact.

3.4 Damage to ecological communities

The description of the ecological status within the impact zone should focus on those communities which most likely may be affected by the effluent, i.e. the nearshore biotopes on hard and soft bottom. These communities are fixed to the bottom and hence more chronically exposed to the effluent than organisms in the free waters. Long term effects are therefore more likely here than in pelagic microalgal and zooplankton communities. Furthermore, the communities of the free waters are highly dynamic in time and may be transported in and out of an impact zone too frequently for any effects to be manifested and detected.

The depth distribution of communities to be described should be determined by the effluent dispersion modelling, but will normally be from the shoreline to about 20-30 m depth.

The ecosystem description should also give priority to any particularly rare or valuable biotopes and populations in the area, such as mangroves or coral reefs.

The community description should focus on quantitative analysis covering species number and individual abundances, species composition, biodiversity and dominance indexes, geographical gradients in community structure, and variability in structure over time. The basic principles of such analyses will be the same for hard and soft bottom communities, although the sampling procedures will be different. The available statistical tools to perform similarity and multivariate analysis of quantitative community data in connection with environmental data, are highly developed today, and have in many cases shown to be very sensitive to community changes over time.

4. Survey and monitoring procedures

In general the procedures recommended for baseline and follow up surveys should be according to internationally accepted guidelines. For all the elements outlined above such guidelines have been prepared or are under preparation by international organizations such as the International Council for Exploration of the Seas (ICES), Oslo-Paris Commission (OSPARCOM) or other multinational commissions. In case any national or relevant international guidelines have been ratified in the country where the surveys shall be done, these should be followed. Timing of the surveys will depend on local conditions, but a general principle is to avoid periods of rapid and erratic hydrophysical and biological changes such as e.g. flood periods due to heavy rainfall, and periods of intense recruitment of animal larvae to the bottom. Timing relative to season should be determined before the baseline survey is initiated, and should be the same for the baseline survey, post-installation survey and subsequent monitoring surveys to facilitate comparison of results.

5. Performance, quality assurance, and organization

The monitoring around SWFGD plants should be performed as much as possible by local scientific institutes or consultants. This will ensure first hand scientific knowledge of the local environmental, climatic and other conditions, ecological communities, species of algae and animals, harvested fish and shellfish, endangered species, and sites of particular scientific or public interest. It is also proposed that a cooperation is established with an external consultant, such as NIVA, with a solid international experience and expertise in this kind of work, in order to harmonize the performance to what is internationally accepted. This will also facilitate comparison with other SWFGD monitoring studies. A model which has been used is that the external consultant acts as a general advisor and a quality assurance supervisor for the studies, forms a link to other laboratories internationally, and takes necessary initiatives with respect to intercomparison of analytical procedures and performance.

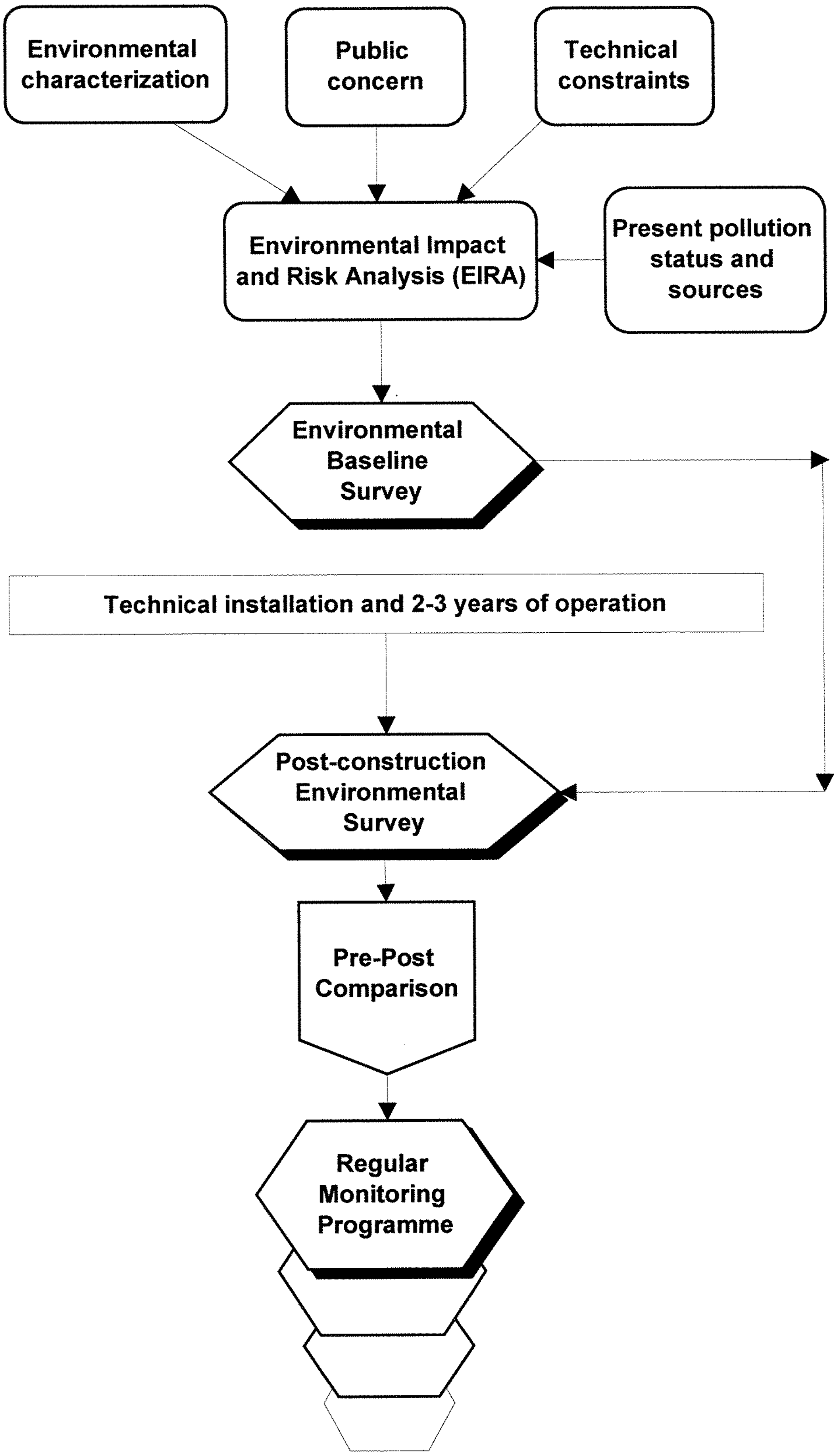

Figure 1. General sequence of actions in an overall impact assessment and monitoring strategy of a large technical installation.

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