IALA GUIDELINE

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ENVIRONMENTAL MANAGEMENT IN AIDS TO NAVIGATION

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CONTENTS

CONTENTS

List of Figures

1. INTRODUCTION

The term environment refers to an organisation's natural and human surroundings. An organisation's environment extends from within the organisation itself to the global system, and incudes air, water, land, flora, and fauna (including people), and natural resources of all kinds.

Aids to Navigation (AtoN) play a critical role in protecting the environment by preventing maritime disasters that could have potentially catastrophic ecological impact on sensitive marine and terrestrial ecosystems and therefore the wider global environment.

Despite its role in protection of the environment, AtoN equipment and activities themselves have the potential to create significant environmental impact through waste generation, unsustainable energy use, pollution and habitat disturbance. It is essential to minimize these negative impacts so that the benefits of AtoN are not offset by unintentional negative impacts of their operation on the environment. Minimizing the impacts can be achieved by responsible environmental management and the factoring in of environmental concerns to all levels of AtoN operations; design, installation, management and maintenance.

To manage the impact of AtoN activities on the environment, an ethos of environmental protection and natural resources stewardship should be promulgated throughout an organisation. Environmental considerations should be made a part of all engineering, planning, decision-making and operational processes.

2. SCOPE

The development and implementation of environmental management tools, such as Environmental Management Systems (EMS) or Environmental Management Plans (EMP), with this Guideline has been designed as a practical guide on:

- the role of environmental management in an organisation's operations;
- compliance with the relevant environmental regulations;
- importance of identifying environmental aspects that an organisation can control, as well as those environmental aspects that it can be expected to influence;
- a focus on aspects of relevance to AtoN authorities and services providers;
- identifying and assessing any reasonable foreseeable risks associated with hazardous conditions attributable to AtoN operations and prevention or mitigation of such risks;
- environmental sustainability;
- identifying and reducing the carbon footprint;
- technical and operational considerations.

3. ENVIRONMENTAL CHALLENGES

Organisations should consider the fact that protection of the environment is a global concern and that while most impacts are localized, there is potential that the impact can be further reaching from environmental, social and political perspectives.

The increased focus on environmental responsibility requires AtoN entities to focus on sustainable practices and the identification of ways to reduce its reliance on non-sustainable energy resources, and in turn reduce their overall environmental footprint.

The impact of humans on the environment also extends beyond local, state and even national boundaries and has global repercussions. Some pollution issues are better resolved if a global perspective is adopted and

international treaties, conventions, recommendations and protocols often overlap an organisation's activities and exert some influence on the level of control which legislation specifies.

3.1. THE COMMERCIAL ASPECTS OF ENVIRONMENTAL MANAGEMENT

The impression that increasing the level of environmental controls will increase the cost of doing AtoN work, or providing AtoN services is not true. In fact, the result can be just the opposite and engineering solutions, methodologies and procedures that reduce the impact on the environment can reduce AtoN costs.

Effective environmental management strategies will allow an organisation to focus on more sustainable ways of operating, reduce wastage levels, focus on using sustainable resources and reduce reliance on un-sustainable energy resources, promote a responsible corporate image and in general, result in more efficient and cleaner operations. It reinforces an organisation's commitment in the eyes of clients, employees and members of the public.

The monetary and non-monetary costs of not pursuing an environmentally responsible approach can be much higher for an organisation. These can range from bad publicity, financial liability and increasingly, to the costs of clean-up, or actual criminal prosecution in the event of environmental incidents or disasters. The general understanding and awareness of these issues has increased dramatically in the recent past, and as a result, there is now a strong emphasis on responsible environmental stewardship, especially in marine areas. Local and global communities now have the relevant information at hand to be able to monitor the actions and impacts of authorities or service providers, putting the pressure on those entities to ensure they take their responsibilities seriously.

4. REFERENCES AND LEGISLATIVE COMPLIANCE

Protection of the environment should be of paramount importance to AtoN authorities, service providers and AtoN manufacturers. All organisations should commit themselves to comply with relevant local, national and international laws, regulations, standards and codes of practice in their area of operation. AtoN authorities and service providers should refer to their local legislation for specific compliance requirements to guide their environmental management.

Governments, intergovernmental and non-governmental organisations, major groups, the private sector and civil society, individually or collectively, have a role in environmental governance. Increased global awareness of environmental issues has meant that at the international level, multilateral environmental agreements increasingly play an important role and provide leadership. Regional organisations and bodies provide forums for policy development, environmental management implementation and information on sustainable practices. AtoN authorities and service providers should look to these as a source of information and assistance in their own environmental stewardship and, where possible, to identify environmental programs that could possibly be run parallel to their own activities.

4.1. IDENTIFICATION OF LEGISLATION AND STANDARDS

An organisation's activities may be affected by several different laws, legislations or governing standards. An organisation should identify which of these influence their environmental management and should develop and promulgate an understanding of what is required to comply and the possible consequences of non-compliance.

5. ENVIRONMENTAL MANAGEMENT

Environmental Management could be classified as a system that allows an authority to work consciously, actively and systematically towards the reducing environmental impact of its activities and improving its methods of interaction with the environment to minimize, or eliminate negative impact on the environment.

In the broader sense, environmental management consists of a series of different, but inter-related systems that, when combined, allow effective management of these environmental interactions.

Environmental management, in the broader sense, considers what aspects of an organisation's business has the potential to impact on the environment, and how organisations can achieve their environmental obligations and performance goals.

Some key drivers of environmental management include:

- environmental policies including senior management's commitment to environmental compliance;
- EMS;
- standards and legislation that dictate the level to which an organisation manages its environmental impact;
- environmental auditing and assessments;
- monitoring and measurement of environmental performance which identifies compliance issues and cost effective solutions, as well as assisting in identifying employee training needs;
- environmental reporting.

Any organisation will benefit from undertaking an initial review of the environmental aspects and impacts associated with their operations. This can provide a starting point for an organisation to identify the level of impact its activities have on the environment, what controls are currently in place and what actual levels of controls or procedures are required.

It is also a valuable tool in identifying ways to increase the sustainability of its operations and where appropriate to assess its carbon footprint and respond accordingly.

The review provides data and information that is crucial in development of policies, systems, guidelines and procedures and planning in general.

5.1. ENVIRONMENTAL MANAGEMENT POLICIES

The Environmental Policy verbalizes the organisation's commitment to be environmentally responsible. The content of the environmental policy describes the organisations aspirations, evoking the degree of commitment by top management and serving as a beacon to influence the behaviour and actions of all members of the organisation to a high level of environmental achievement.

Due to increasing complexity and understanding of environmental issues, policies may refer to specific issues, such as sustainability, waste management, habitat protection, but basically the content and direction of the policies should be dictated by the organisation.

Policies should create the basis for further development of environmental management plans, systems and any other documentation that is required to guide this aspect of an organisation's activity.

A policy should express commitment to the relevant legislation, laws, standards, or codes of practice to ensure compliance.

Environmental policies should be communicated to all employees, managers, and stakeholders. All personnel should understand their role in supporting these policies, and should receive proper training in this regard.

In summary, environmental policy should cover some key issues:

- implementation of policy;
- review – environmental objectives and actions;
- compliance – with all relevant environmental legislation and regulations;
- awareness – promoting environmental awareness and improved performance;
- partnerships and consultation – with wider community, relevant agencies, land managers;
- communication – educating public and stakeholders.

5.2. ENVIRONMENTAL MANAGEMENT SYSTEMS (EMS)

An EMS is a set of processes and practices that enable an organisation to reduce its environmental impacts and increase its operating efficiency.

An EMP can also be an effective tool for managing environmental issues with individual projects and activities.

These types of management tools must be compliant to the relevant legislation and must be relevant to an organisation's level of environmental maturity.

A relevantly structured EMS can help an organisation to reduce its negative impacts on the environment, to state and achieve their environmental obligations and performance goals and ensure that environment management practices address local environmental concerns that impact on an organisation's social license to operate.

5.2.1. COMPONENTS OF AN EMS

Generally, an EMP/EMS provides a specific outline or policy on environmental management and what it means to an organisation, the processes and environmental controls involved, and in some cases, an outline of the monitoring of the impact and effect of an organisation's interactions with the environment.

Implementation of an EMS involves an organisation taking the following steps:

- devise a policy that articulates an organisation's commitment to uphold due process;
- adhering to relevant legislative and regulatory processes efficiently and effectively and to ensure that there is a regular review process of effects of changes in legislation, standards and regulations;
- appoint an environmental manager, or management team responsible for coordination of the EMS and identify the environmental responsibilities of all level of employees within the organisation;
- establish environmental objectives and targets;
- implement programs to achieve objectives and targets;
- responsibilities and reporting structure – assign responsibilities to achieve objectives and targets;
- identification of specific and relevant management, preventative and mitigation measures, including procedures and emergency/contingency plans;
- identify an organisation's environmental impacts, hazards and the required controls through an environmental risk assessment and record details in an Environmental Aspects Register;
- identification of key environments potentially affected by AtoN sites:
    - biological environment e.g. threatened ecological communities such as marine species, seabirds in the vicinity of AtoN;
    - socio-economic environment e.g. fisheries, Marine Parks and Reserves;
    - social environments – traditional and cultural heritage aspects.
- consultation and stakeholder engagement activities;
- undertaking informed intervention action where required;
- commitment to continually improve the effectiveness and efficiency of environmental management – review and evaluate environmental performance and correct and/or improve environmental policy, including objectives and targets, as well as organisational structures, procedures and processes;
- strategically review the continuing effectiveness of environment management within the organisation.

Commitment to compliance with applicable environmental legislation and regulations is required, along with a commitment to continual improvement – for which the EMS provides the framework.

Detailed information on how to implement an organisation-wide environmental management system is available through the International Organisation for Standardization (ISO), in their ISO 14000 family of standards.

ISO 14001:2015 is an environmental standard that focuses on the generic requirements for an environmental management system. It provides a useful framework for an organisation to follow, to develop an effective, high quality EMS and summarizes the advantage an organisation can expect from adopting these types of management tools.

5.2.2. Environmental Aspects

ISO 14001 states that an environmental aspect is an 'element or characteristic of an activity, product or service that interacts or can interact with the environment. Environmental aspects cause environmental impacts. They can have either beneficial impacts of adverse impacts and can have a direct and decisive impact on the environmental or contribute only partially or indirectly to a larger environmental change.'

An organisation needs to identify those activities and aspects that have actual and potential environmental impacts. An environmental review, or assessment, should be conducted by senior management and staff who are, or will be assigned roles in environmentally significant activities. The review can involve drawing information from several different areas such as legislation and policies, performance audits, monitoring and the assessment and management programs.

Once environmental aspects are identified, an organisation should then prioritize the high-risk activities and provide appropriate controls to mitigate any resulting impact.

5.2.3. Management measures, controls and procedures

The identification of environmental aspects will highlight critical areas of environmental management, which should be further addressed depending on the severity of impact. Written controls, procedures, instructions or other documentation outlining the approach to managing those impacts, should be provided.

5.2.4. Environmental Risk Assessment Process

Environmental risk management identifies credible environmental hazards, assessing the likelihood of occurrence and severity of the potential ecological and human health consequences, and managing the resulting level of risk.

An established program of cyclic risk reviews can be carried out throughout an organisation with significant environmental risks addressed through the EMS.

Risk management process for AtoN sites is a continuous process and an organisation should take a consultative approach with environmental managers, decision makers, industry, maintenance contractors and community stakeholders.

Ecological risk assessment involves:

- problem formulation – establishes the context for the strategic and organisational conduct of the overall assessment;
- hazard identification;
- Risk Analysis – likelihood of exposure and ecological effects;
- risk characterization;
- treatment/mitigation measures to reduce risk to acceptable levels;
- monitoring and review.

5.2.5. Objectives & targets

An organisation's EMS should state quantifiable environmental targets, that can be communicated clearly to the workforce and that can be tracked through regular monitoring. The objectives and targets should reflect an

organisations operational and environmental maturity and should be revised and changed as targets are achieved.

5.2.6. ROLES & RESPONSIBILITIES

An EMS should clearly state the roles and responsibilities of all staff relating to the environmental management framework. It should state not only the physical responsibilities, but also the responsibilities in reviewing, providing feedback and fostering a general attitude of responsible environmental stewardship.

5.2.7. COMMUNICATION

Communication and feedback from the workforce and from all personnel interacting with the EMS is a critical area and an organisation should have in place a framework whereby all levels of employees are encouraged to provide feedback, review and comments on the effectiveness of the EMS. Engaging the workforce ensures that the EMS is effective, efficient and most of all responsive. This process can take shape via a number of methods, such as awareness sessions, feedback forms, seminars, or environmental training.

5.2.8. ENVIRONMENTAL MANAGEMENT PLANS

An EMP can be an effective tool for managing environmental issues with individual projects and activities. These can be tailored to identify and control environmental risks to a project / activity level. Similar to the EMS components which is primarily an organisational approach to their activities, an EMP can be developed to incorporate information required for a specific project, or task and designed to be easily followed by personnel carrying out the activities.

5.2.9. MONITORING

An organisation should aim to conduct activities in an environmentally responsible manner and implement best practice environmental management as part of a program of continuous improvement. This commitment to continuous improvement means an organisation should review an EMS as required, at a pre-determined frequency, or in response to new information or situations. Reviews should address matters such as the overall design and effectiveness of the EMS/EMP, if works are not appropriately covered by the System/Plan, or measures are identified to improve.

These should also include a schedule which identifies what actions will be monitored, by whom, the frequency and the responsible sign-off person to confirm monitoring has been undertaken. Monitoring procedures, forms and checklists may be required and legislative requirements and licence standards/or exposure standard limits (e.g. dust emissions), if existing, listed and the metrics for measurement clearly stated. Any contingency plans, preventive or corrective action procedures should be identified and detailed in the plan to mitigate failures identified through monitoring.

Example: A simple waste schedule will allow weekly or monthly waste data (from each waste stream on site) to be recorded and compared to any targets set. The metrics for reporting should relate the amount of waste created, recycled and land filled to the amount of production e.g. total waste / unit production; recycled waste / unit production etc. This will assist in tracking the efficiency of any measures implemented to reduce or better manage waste. Monthly reporting to senior management will assist in evaluating overall progress and provide a basis for review and improvement decisions, if necessary.

5.3. ENVIRONMENTAL PERFORMANCE

An important part of any system is to evaluate the performance and to establish if the risks are being controlled and the goals are being met. This can be achieved by reviews, audits and performance evaluation. These aspects should be reported internally and usually external reporting is a legislative requirement.

5.3.1. AUDITS

An internal audit schedule should be developed and maintained that includes audits on an organisation's environmental performance and compliance. The general procedure should include:

- record and maintain all internal audits and the audit outcomes;
- track actions arising from internal audits until their close-out;
- facilitate audits and/or inspections by external regulations.

  The findings of external regulatory audits to be recorded and actions and/or recommendation addressed and tracked.

5.3.2. PERFORMANCE EVALUATION

Environmental performance indicators must be specific, measurable, attainable, relevant and time-framed and related to organisational practices and procedures. For example, an organisation should clearly identify in a plan or schedule its environmental objectives, what the actions are against each objective and how they will be measured.

Example 1:

- objective - continue to develop effective tools and systems to manage environmental responsibilities;
- action - maintain and continually improve an organisation's EMS;
- target - management review of EMS annually.

Example 2:

- objective - an environmentally aware and committed workforce;
- action - rolling program of targeted environmental training for staff;
- target - identify number of staff trained every year.

Some potential indicators which may be used to track significant environmental effects of an organisation include:

- environmental training – number of staff given environmental training;
- organisation's EMP – progress against objectives and targets outlined in the EMP;
- breaches of statutory instruments – total number of prosecutions and notices issued;
- greenhouse gases – net greenhouse gas emissions (net tonne CO_2 – equivalents)
- waste management – solid waste generated (tonnes); waste recycled or reused expressed as a % of solid waste generated;
- contaminated land – number of sites under control of an organisation that present a significant risk of harm as defined by legislation;
- community partnerships – value of sponsorship for community environmental projects;
- financial indictors – operating costs; overall service delivery; price of AtoN.

5.3.3. EXTERNAL REPORTING

Environmental reporting is a public record and can be considered as an 'open window' of an organisation's environmental performance on regulatory compliance, pollution control and corporate stewardship. It is also a significant tool for environmental communication to employees, stakeholders and the public in a transparent and accountable way. It conveys the major impacts an organisation has on the environment, the resources it uses, and the waste it generates.

Generally, environmental reports should be published annually, and should communicate some key elements of an organisation's environmental performance:

1 Organisational structure to reflect the size, location, number of employees and the core business of an organisation.

2 Environmental policy to show how the organisation is committed to meeting its environmental responsibilities.

3 Objectives and Targets assist an organisation to fulfil their environmental commitments stated in the environmental policy and in effect, use resources more efficiently, reduce operating costs and improve overall performance.

4 Indicators present the information on how an organisation achieves objectives and targets, and tracks inputs and outputs in a visually attractive and understandable way. They help stakeholders see right away what the major environmental impacts are, and how the organisation is working to minimize negative and encourage positive environmental effects.

5 Major Environmental Impacts indicate how the organisation's operational activities may impact on the environment. An organisation should identify the source of all pollutants and potential pollutants, the environmental factors which may be impacted and document measures to manage and/or mitigate the impacts on the environment.

6 Commitment to employees and the community details and demonstrates an organisations commitment to employees and the community.

5.4. ENVIRONMENTAL EMERGENCY RESPONSE

The objective of environmental emergency response (EER) is to ensure incident planning and response procedures are managed effectively during AtoN operational activities and to outline the general procedures for initiating an emergency response that could occur because of AtoN works, or natural causes.

In the event of changed circumstances, any planned control measures should be reviewed, risk assessed and, where appropriate and practical, amended as necessary prior to commencing new or modified activities.

An EER plan should detail:

- an organisation's security and public safety issues;
- effective spill containment and management;
- effective firefighting capabilities;
- effective response to emergencies and critical incidents;
- a single set of emergency procedures, consistent with the existing organisation's Emergency Plan, that can be scaled as appropriate for any incident or emergency;
- an incident reporting procedure which details timeframes and documentation required;

  An environmental incident should be reported as soon as practicable to an organisation's environmental representative;
- details of any further reporting required for relevant government authorities.

5.5. STAKEHOLDER ENGAGEMENT AND CONSULTATION

5.5.1. STAKEHOLDER ENGAGEMENT

Effective stakeholder engagement and consultation is a very important aspect in managing environmental requirements for AtoN services. Management of AtoN sites and activities needs to take into consideration the views of environmental stakeholders to ensure the best balance of environmental constraints and practical maintenance and construction capability.

The public participation process must provide access to all information that reasonably has, or may have the potential to influence any decision about an application, unless access to that information is protected by law and must include consultation with:

1 The competent authority.

2 Any relevant agency or department that administers a law relating to a matter affecting the environment relevant to an application for an environmental authorisation.

3 All organs of state which have jurisdiction in respect of the activity to which the application relates.

4 All potential, or, where relevant, registered interested and affected parties.

5 Communication between relevant domestic governmental departments and interested affected parties is critical. Environmental concerns can further be addressed through a structured public participation framework. It is equally important that domestic legislation be considered and impact assessment, where needed, be put in place.

5.5.2. SOCIAL RESPONSIBILITY - TRADITIONAL AND CULTURAL HERITAGE

An organisation's attitudes and environmental management practices at the operational level can have a profound effect on local traditional communities, and play an important role in shaping the relationship between an organisation and the communities in which it operates.

This is a regional issue and an authority's approach should be based on the profile of communities and/or indigenous cultures that interact in one way or another with their operations.

General, practical measures may include:

- ensuring compliance with relevant legislative framework concerned with all aspects of the protection and conservation of environmental heritage, including AtoN infrastructure, works, places or relics that are identified as of historic, scientific, cultural, social, archaeological, architectural, or have natural or aesthetic significance;
- undertaking appropriate consultation & community impact assessments for changes to existing AtoN infrastructure, applicable new infrastructure and relevant operational activities;

  Community consultation may involve a range of methodologies such as cultural mapping, oral histories, archival documentation and specific information provided by the community;
- identifying interested community groups or local traditional community;
- taking reasonable precautions to identify, protect, conserve and address traditional and cultural heritage issues arising from operational activity;
- provide appropriate mitigation or protection to sites prior to activities;
- checking that any permit requirements governing cultural heritage management are secured prior to disturbance of any known cultural heritage site and following consultation with local traditional community;
- establishing a suitable induction program to ensure relevant personnel are aware of their responsibilities concerning their operational activities at any identified cultural heritage site.

An induction program could be developed in consultation with local traditional communities and include:

- cultural awareness;
- an evaluation of significance of cultural heritage to local traditional community stakeholders;
- an insight into relevant cultural heritage legislation;
- roles and responsibilities regarding the protection and management of cultural heritage;
- a management plan or manual which identifies location of cultural heritage sites and any constraint / control plans and operation notes, details of personnel to contact if a problem occurs at a site, and a detailed description of relevant acts and legal responsibilities.

5.6. REDUCING ENVIRONMENTAL IMPACT

5.6.1. ENVIRONMENTAL SUSTAINABILITY

An organisation should strive for sustainability in its operations. Sustainable use of resources can be achieved through several channels:

- recycling – reduction of waste by reusing and recycling to save money on costly landfill and transport services. In addition, waste reduction and recycling campaigns ensure that an organisation is contributing to a tangible sustainable future;
- managing waste streams, including paper from the administration activities, construction and demolition waste from redevelopment, and hazardous and noxious substances (HNS);
- using renewable energy – such as the use of solar panels that convert solar radiation into direct current electricity;
- developing and promoting a culture of environmental leadership, responsibility and continual improvement
- advancing and disseminating environmental knowledge and applied environmental management through training and engagement with the wider community.

5.6.2. CARBON FOOTPRINT – GREENHOUSE GAS EMISSIONS

Carbon emissions refer to the release of polluting carbon compounds into the atmosphere, most commonly attributed to human activity such as burning fossil fuels. Carbon emissions are usually measured in metric tons. A carbon footprint has historically been defined as 'the total set of greenhouse gas caused by an organisation, event, product or person.'

This issue has become an issue of global interest, due to the debate over climate change and global warming. Depending on the location, global warming has the potential to have significant impacts on AtoN sites, which are usually located in or close to the water. The impacts could include rising sea levels, more powerful storms, more powerful wind and waves, more humid climate, more clouds and less sun, heat waves and rapid temperature rises.

Organisations can consider short and long term responses and measures, including:

- structures designed to be more resistant to extreme weather and to cope with rising water levels;
- structures with robust foundations and designs;
- use of equipment appropriately designed and rated to handle extreme climate;
- methods of measuring emissions and introduction of a Greenhouse Gas Emissions Strategy including initiatives that will offset greenhouse gas emissions;
- an incentive program to take up fuel efficient fleet of cars;
- potential for greater use of fuel alternatives e.g. biofuels;
- use of renewable energy, such as solar panels that convert solar radiation into direct current electricity
- a recycled materials strategy;
- potential to increase the amount of recycled materials used for new infrastructure projects.

There is an increasing focus on organisations understanding and calculating their carbon footprint, and identifying and implementing means of reducing it. Some useful methods to calculate carbon footprint are:

- greenhouse gases – net greenhouse gas emission (net tonne CO_2 – equivalents);
- electricity consumption;

- waste management – solid waste generated (tonnes);
- waste recycled or reused expressed as a percentage of solid waste;
- CO_2 equivalent emission from authority vehicle fleet, tonnes per km travelled per annum;
- CO_2 equivalent emissions from an organisations-related air travel, tonnes per Full Time Equivalent (FTE) per annum.

This Intergovernmental Panel on Climate Change (IPCC) is a key source of information on this issue. The IPCC is the international body for assessing the science related to climate change. The IPCC was set up in 1988 by the World Meteorological Organisation (WMO) and United Nations Environment Programme (UNEP) to provide policymakers with regular assessments of the scientific basis of climate change, its impacts and future risks, and options for adaptation and mitigation. IPCC assessments provide a scientific basis for governments at all levels to develop climate related policies, and they underlie negotiations at the UN Climate Conference – the United Nations Framework Convention on Climate Change (UNFCCC). The assessments are policy-relevant but not policy-prescriptive: they may present projections of future climate change based on different scenarios and the risks that climate change poses and discuss the implications of response options, but they do not tell policymakers what actions to take. More information is available at https://www.ipcc.ch/.

6. TECHNICAL CONSIDERATIONS

As AtoN management and maintenance involves physical processes such as fabrication, maintenance, construction and the use of hazardous materials in marine environments, technical aspects are an important consideration. This section addresses specific areas of concern and potential solutions to minimize the environmental impact of AtoN equipment and activities.

6.1. MATERIAL LIFE CYCLE

Material life cycle is the life cycle of a product or service. As environmental awareness increases and community expectations grow, organisations need to move beyond compliance, to pollution prevention strategies and environmental management systems that will improve their performance. Part of the process is to manage the total material life cycle of their products and services towards more sustainable consumption and production.

Material life cycle assessment (also known as life cycle analysis, cradle-to-grave-analysis) is the environmental impact of a given product, or service throughout its lifespan, including raw material extraction, manufacture, distribution, use, pollution caused by usage (e.g. greenhouse gases, depletion of fossil fuels), ultimate product disposal and material transportation. The goal is to provide a more accurate picture of the true environmental trade-offs in product and process selection, to optimize the environmental performance of a single product, or to optimize the environmental performance of an organisation.

6.2. WASTE MANAGEMENT

In any organisation, the uncontrolled generation of waste has the potential to create environmental damage and goes directly against the principles of sustainable operations. Waste should be managed for a number of key reasons:

- to conserve resources of water, energy and raw materials;
- to minimize pollution of land, air and water;
- to enhance business performance and maintain corporate social responsibility;
- to improve Occupational Health & Safety (OSH).

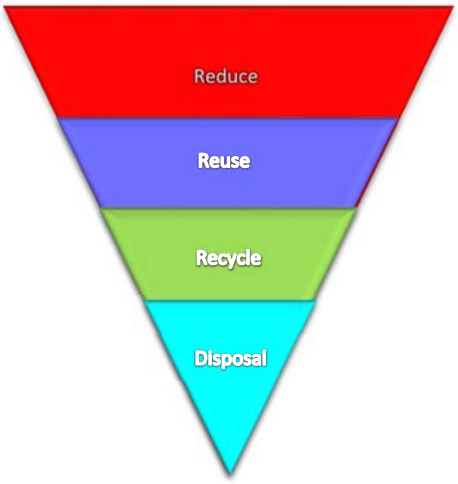

Figure 1 Waste hierarchy

6.2.1. WASTE HIERARCHY

A useful model when dealing with a waste stream originating from any source is the 'waste hierarchy' (Figure 1). It provides a tool for structuring an efficient waste management strategy. It indicates an order of preference for actions to reduce and manage waste and is usually presented in the form of a pyramid. This concept uses principles of waste avoidance/reduction to minimize the amount of waste produced and reuse/recycling to minimize the residual waste material. It thereby reduces the environmental and economic costs and ensures a consistent approach with legislative intent. It provides a tool for structuring a waste management strategy and can be used as a model for all waste management operations, including those associated with oil spill response activities. This concept of waste hierarchy uses principles as follows.

6.2.1.1. Reduction/reduce

It is the minimisation of waste at its source to minimize the quantity required to be treated and disposed of, achieved usually through better product design and/or process management.

Examples of waste reduction:

- cover storage to prevent rainwater infiltration;
- reuse equipment and personal protective equipment (PPE) where possible;
- remove beach debris before impact;
- use sorbents sparingly.

6.2.1.2. Reuse

This is the reuse of an item for its original purpose, i.e. clean-up equipment should be cleaned and reused in place of disposable items.

Examples of reuse:

- cleaning of PPE so that it can be reused e.g. rubber boots, hardhats, goggles etc.;
- ensure that no further impact is caused through the cleaning.

6.2.1.3. Recycling/recover

It reduces the amount of waste for disposal; saves natural resources; this will be directly affected by the quality of the recovered product; i.e. highly contaminated material is less likely to be suitable for recycling.

Examples of recycling/recover:

- taking waste oil to a refinery for conversion into other usable products.
- burning of waste oils to make burner fuel (is an alternative fuel to diesel).

6.2.1.4. Disposal/refuse

Refuse is the final and least desirable option. If none of the above methods cannot be carried out for whatever reason the waste must be disposed of effectively through some means.

Examples of disposal/refuse:

- this may be the case for highly mixed wastes of oil, plastics, organic debris, water, sediments which cannot be separated.

6.3. HAZARDOUS SUBSTANCES MANAGEMENT

An organisation must identify and adequately manage environmental hazards, including wastes, or contaminants entering the immediate environment. Potentially, an organisation may have to deal with a wide range of these hazardous substances, as well as multiple hazards at individual sites. These hazards may also arise at varying times, or interact to produce several unwanted outcomes.

It is important that an organisation:

- identifies hazardous substances which present a risk to within the site and adjacent to the site;
- maintains a register of all hazardous substances being used, including the level of risk they present in the event of their release into the environment;
- ensures there are control measures or procedures in place to manage the storage and handling of hazardous substances;
- ensures that all details of the substance, the correct handling and storage controls and any emergency response requirements are communicated clearly to those personnel involved in handling those substances.

6.4. MERCURY

There is a variety of health hazards associated with mercury. These are particularly serious in the event of a fire, or for personnel engaged in mercury maintenance and clean-up operations. Sources of mercury include lantern bearing baths in lighthouses, the residual contamination in surrounding areas from these baths, or from leaking storage containers, certain electrical relays and control gear, and some types of primary batteries. The following actions can be taken to deal with issues related to mercury:

- use mercury-free batteries;
- phase out mercury-containing relays and return the ones currently in use to the manufacturer for recycling when they are no longer serviceable;
- evaluate the area to determine the presence of residual mercury;
- provide adequate fire safety signage that points out the presence of mercury;
- use licensed contractors to clean equipment and dispose of contaminated waste;
- design-out mercury bearings;
- decontaminate structures;
- store clean mercury in well- ventilated areas, use appropriate containers;
- disposal of mercury-related waste should be carried out in a timely manner and this material should not be allowed to accumulate in large quantities.

- Label mercury waste containers and store appropriately in a well-ventilated area until disposal by an authorized agent.

6.5. ASBESTOS

Asbestos has been used in AtoN facilities to varying degrees and over varying periods of time in different Authorities. The primary source of AtoN-related asbestos would be in lighthouses or associated structures. Applications can include items such as pipe lagging, shingles, roofing and guttering, floor tiles, sidings, and wall boards. Asbestos in good condition poses little hazard. However, if this material is sanded, cut, torn, or damaged, hazardous airborne fibres may be generated and remain suspended in the air for long periods of time. Inhaling these fibres can lead to chronic and deadly diseases.

The following are suggestions for dealing with asbestos:

- asbestos should never be used in new installations;
- for existing structures and equipment, surveys should be conducted to establish where asbestos and asbestos containing products have been used. Based on such surveys, a specific management plan should be introduced to label, register and control the disturbance of installed asbestos or asbestos-containing products, or to remove them under controlled conditions;
- national legislation should be implemented in relation to existing structures and equipment containing asbestos products.

6.6. BATTERIES

Batteries contain toxic and hazardous materials such as heavy metals, acids, and alkalis. Disposing of them requires special handling, and leakage of these materials could harm the environment. Batteries can enter the environment through accidental loss, vandalism, or deliberate disposal. This creates a waste remediation problem in the water or on land at an AtoN site. If different types of battery and electrolyte are used, separate storage, handling, and disposal of the different types is required.

The following are ways to minimise these problems:

- switch from primary batteries to solar power systems with rechargeable secondary batteries;

  Recycling of these batteries can often be done through the battery supplier.
- ensure that disposal of non-recyclable batteries is carried out by licensed contractors or waste disposal authorities who provide documentation of proper disposal at authorized waste facilities;
- recycling and disposal should be carried out in a timely manner;

  Batteries should not be allowed to accumulate in large quantities. Store the waste batteries in appropriate containers which are secure, ventilated, and labelled according to contents.
- implement engineering solutions to minimise the chances of battery loss through collisions or vandalism;
- use specifications and technologies that minimize power consumption and storage requirements;
- consider using the available mains (commercial power), and carefully evaluate whether backup battery systems are absolutely required.

6.7. PAINTS

Maintaining the service life of steel in a marine environment is an extreme challenge for coatings. Many systems that have been used in the past (or are still in use) are now recognized as being unfriendly to the environment - most notably, paints with lead or other heavy metals, and those high in volatile organic compounds (VOCs). Lead presents a removal hazard, a significant disposal expense, and it persists in the environment and bio-accumulates in plants and animals. Hexavalent chromium is highly toxic to humans and animals at very small doses. VOCs can

cause serious health problems for workers and contribute to air pollution in the lower and upper reaches of the atmosphere. Marine-grade paints (epoxies, polyurethanes) pose hazards to the unprotected applicator, and antifouling paints by their very nature are toxic to marine life.

6.7.1. MINIMISE THE ENVIRONMENTAL IMPACT OF PAINTS

The following solutions to minimise the environmental impact of paints involve the selection of appropriate materials and reducing the disposal of waste paint:

- select paints that have a long service life;

  This will reduce the frequency of maintenance visits required for repainting, which will in turn save fuel and minimize paint-related waste;

- avoid paints containing heavy metals such as lead, chromium, or mercury;

- select paints that are low in VOCs. Consider the use of waterborne, UV-curable, high-solids, and powder coatings rather than traditional solvent-based coatings;

- substitute other protective measures;

  Reduce the need for paint by the use of alternative construction materials (e.g., plastics, or corrosion-resistant steel, such as marine graded stainless steel), or protective mechanisms (e.g. galvanizing, cathodic protection systems) in AtoN design;

- minimize the use of antifouling paint;

  Only use this type of paint if absolutely required by the application. Explore alternatives to traditional antifouling paint, such as "release" or “slippery” (adhesive) paints to which organisms don't stick;

- paint indoors;

  Where feasible, utilize indoor painting facilities that have water collection/separation and air filtering systems to prevent fumes and particulate matter from entering the environment;

- minimize waste paint disposal;

  The best method of reducing paint waste is to carefully estimate how much product will be required for a particular application so as to have little or nothing remaining for disposal. If paint is kept in stock, attempt to use it before the storage life expiration date, and don't maintain so much inventory that it expires before use. All this requires careful procurement, stocking, and use practices, and conscientious inventory management. For example, an inventory control system with a ‘first- in- first-out’ (FIFO) policy will reduce the amount of expired materials. Require a one-for-one exchange in which workers must return an empty container to receive a new one. This will control the number of open containers, and thus reduce the risk of spills, contamination, and wasted materials. When waste paint must be disposed of, segregate and classify the material by type, since some paints have characteristics that make them more hazardous and expensive to dispose of (e.g. lead-based paints) than other ‘safer’ paints (e.g., acrylics). Label the containers according to their contents and level of hazard, and store appropriately until disposal by an authorized agent. Disposal should be carried out in a timely manner, and waste paint should not be allowed to accumulate in large quantities.

- extend paint shelf life;

  With regard to expired paint, it is better to use it, if possible, than to dispose of it as waste. Most two-part epoxies can be properly stored in ambient temperature conditions and remain functional for up to 10 years. Water-based paint and oil-based paint can be stored at ambient conditions for three to five years. Previously opened cans of water-based and oil-based paints are usually not suitable if stored for longer than one year. Previously opened cans of unmixed two-part epoxy paint in good condition may still be good after three to four years in storage. However, it is important to consult the paint supplier to ensure a given product will remain functional before extending the shelf life in this manner.

- prevent and contain spills;

  Use appropriate paint storage containers that are labelled correctly, and monitor for leaks. While transporting vats and pails, make sure provisions have been made to catch spillages. Provide ditches, bunds, or other measures in work and storage areas to contain any leakage or spillage.

- after cleaning up spills, store the waste paint, clean-up rags, and other materials in properly labelled containers prior to disposal by an authorized agent.

6.7.2. LEAD BASED PAINTS

Prior to 1970, lead was the major ingredient in paint and was used as a base, as a drying agent, as colouring (often white, red, orange, yellow and scarlet) and to protect steel and iron from corrosion. Lead-based paints were used both inside and outside of buildings and as protective coatings on plant and equipment and were widely used on AtoN structures. The removal of lead-based paint from buildings, structures, plant and equipment can result in harm to those workers carrying out the removal work and the environment if not captured, handled and disposed of appropriately.

Containment or full encapsulation may be required to capture the paint being removed so it is not released into the environment. Countries will usually have a legislative requirement for managing lead-based paints, detailing the safety and environmental controls required for removal, containment transport and disposal.

For paint removal, the following activities and equipment may be required:

- Containment;

  The scale of paint removal required will indicate the amount of containment required to effectively capture the contaminated paint. Containment methods for different scale of works include:

  - ✓ localized paint removal - heavy duty plastic drop sheeting in the immediate area of localized paint removal; polyethylene ground sheets to seal off work areas including floor, soil and vegetation for the sufficient collection of falling paint debris and dust and prevent contamination;
  - ✓ outside work – extend two meters of polyethylene ground sheets from the base of the building or structure and an additional meter for each storey. Edges of the sheets should be turned by at least 100mm to contain any liquid discharge. For a scaffold, tie a sheet underneath to catch falling paint debris;
  - ✓ inside work - install polyethylene ground sheets with the edges sealed using heavy-duty tape;
  - ✓ maintain all sheets and replace immediately, if torn;
  - ✓ avoid working in wet or windy conditions, as lead dust and paint might be washed, or blown off the plastic sheeting and away from the work area.

  - large scale paint removal - full encapsulation of the structure at a negative pressure with dust extraction filters.

- Cleaning;

  Ensure that the methods used to clean a lead process area do not spread the contamination of lead dust and debris off site. Shovelling or sweeping should be minimized. Blowing down with compressed air is generally prohibited, except within ventilated containments – blow-down of surface dust should be starting at the highest point of the structure within the containment and working downwards to the bottom of the structure.

  - High Efficiency Particulate Air (HEPA) filter:
    - ✓ HEPA type filter fitted to a suitable commercial vacuum cleaner for particulate removal, or a liquid vacuum cleaner for liquid waste removal;
    - ✓ vacuuming is considered to be the most reliable method of cleaning surfaces on which dust accumulates.

- clean heavy duty plastic bags – polyethylene:
  - ✓ polyethylene bags 150 L bags or 200 L drums with ties for lead paint debris and disposable items.

6.8. SOLVENTS

Problems with the use of solvents include the release of VOCs into the atmosphere, and the disposal of waste material.

These issues can be addressed as follows:

- reuse solvents;

  This reduces the amount of new solvent that must be purchased and the amount of hazardous waste that must be disposed of. One option is to utilize distilling equipment to recycle dirty solvents for continuous reuse. Commercially available self-contained recycling units can recover 85% or more of waste solvent and make it into reusable solvent, with the remainder being waste sludge that must be disposed of. However, this sludge is a significantly smaller quantity of waste than would be the case with having to dispose of entire barrels of waste solvent. Even without distilling equipment, recycling of solvent is possible. When cleaning spray guns and lines, store the dirty solvent for several days to allow the pigment and resin to settle out, then separate the paint fines by pouring off the solvent for reuse. Solvents used for final wash during equipment cleaning can also be reused as paint thinner.

- pre-clean parts;

  Wipe parts with rags or blow compressed air before applying liquid or vapour degreasing solvents. This can reduce the amount of solvent required and extend the life of degreasing solutions. Cold cleaning with mineral spirits can also help reduce solvents by removing grease before vapour degreasing.

- cover degreasing baths when not in use to reduce solvent losses to the air;

  Substitute water-based solvents when possible to replace organic solvents.

- prevent and contain spills;

  Use appropriate solvent storage containers that are labelled correctly, and monitor for leaks. While transporting vats and pails, make sure provisions have been made to catch spillages. Provide ditches or other measures in work and storage areas to contain any leakage or spillage. After cleaning up spills, store the waste solvent, clean-up rags, and other materials in properly labelled containers prior to disposal by an authorized agent.

- disposal should be carried out in a timely manner, and solvents should not be allowed to accumulate in large quantities.

  Label the waste solvent containers and store appropriately until disposal by an authorized agent.

6.9. FUEL

The most common type of fuel in the AtoN field is diesel, which is used in vessels and generators. This material can accidentally spill and require clean-up. It can become contaminated and require disposal. Its fumes pollute the air, and its exhaust contains sooty emissions. Similar problems can also be encountered with other types of fuel (e.g. gasoline).

The following are measures that can be taken to minimize these problems:

- switch to solar, commercial power, or other renewable energy sources (e.g., wind) whenever possible;
- when using continuously operating diesel generators, consider converting these to cycling generators which charge batteries as the main source of power;
- implement measures to prevent and contain spills;

Tank leakage may lead to costly soil clean-up operations. Generally, it is better to place tanks above ground than to bury them underground, since leaks in underground tanks are more difficult to observe. The space beneath the above-ground tank should be designed in such a way that leaking fuel will flow to a collection and containment area. A commonly used protection against leakage is the double tank.

- use of drip trays is a simple, effect and cost efficient way of containing any small leaks during filling or transfer;

  Leak detectors can be installed on the outer tank to detect leaks in the inner tank. Tanks and other systems related to fuel storage should be inspected at appropriate intervals. Containers for transporting the diesel fuel should be strong enough to withstand a reasonable amount of mishandling.

- tank filling must be done carefully;

  Electric overfill detectors are commonly used to automatically stop filling before overfilling occurs. The equipment should be designed for ease of use to avoid spilling. If the diesel fuel is very cold, the tank should not be filled up completely, since the diesel will expand when it warms up.

- have spillage handling procedures in place;

  For high-risk areas, consider keeping spillage absorbent material (spill kits) on site.

- attach a filter to the engine exhaust to reduce the particulate emissions;

  Check whether cleaner fuel is available in your region.

- service engines regularly;

- disposal of residual waste (e.g., absorbents, filters, fuel containers, waste oil) should be carried out in a timely manner, and this material should not be allowed to accumulate in large quantities.

  Label the waste containers and store appropriately until disposal by an authorized agent.

6.10. SYNTHETIC BUOYS AND MOORINGS

Some synthetic buoy materials do not lend themselves to recycling, or may be mixed together in a way that makes it impossible to separate them for recycling at the end of their useful life. Materials of this type must be disposed of as industrial waste. This creates extra cost, and most of these materials will not degrade after they have been deposited in the landfill. Some materials create toxic air emissions when they are cut up or burned. Old synthetic moorings that are discarded on site could present a tangling hazard to marine life, or foul the propellers of passing vessels.

Solutions to these issues would include the following:

- utilize buoys and moorings made from materials that are fully recyclable;

  Pay attention to the fact that materials that are perfectly recyclable by themselves may become impossible to recycle if they are joined in an inseparable way (e.g., a polyethylene buoy shell with tightly adhering polyurethane foam filling).

- consider the availability of recycling options before selecting a product;

  Ask the manufacturer about ‘cradle-to-grave’ support for their products; i.e., whether they are willing to take back old products for proper disposal or recycling.

- select buoys that can be refurbished;

  Too often, synthetic buoys are considered a disposable commodity. More durable buoys that can be refurbished instead of discarded lead to less frequent replacement and therefore a smaller waste stream.

- install and utilize equipment on servicing vessels to recover synthetic moorings rather than disposing of them on site.

6.11. LAMPS

Marine lamps may contain elements that are dangerous to the environment, and thus create problems when lost or disposed of. Sodium and neon lamps are not ozone friendly and require special handling and disposal.

The following are suggestions for minimizing these issues:

- use lamps that are made of inert materials (e.g., krypton gas with tungsten filaments) that can be disposed of as standard waste;
- select lamps with a longer service life;

  As an example, metal halide lamps provide 45 times the lumen hours than incandescent lamps, so re-lamping and lamp disposal can be performed less often. LED light sources are another option to be considered.
- recycle;

  Lamps can often be recycled, or disposed of through the manufacturer, or a licensed contractor.

6.12. BLAST CLEANING

This process can have negative environmental impacts in terms of solid waste (paint residue, used blast grit) and air emissions (dust from blasting).

The following measures can help mitigate these problems:

- switch to recyclable blasting media;

  Material like sand and coal slag generate considerable solid waste and airborne dust, and are normally "one-time use" grits that are not recyclable. By contrast, abrasives such as aluminium oxide, garnet, and cast iron can usually be recycled five to seven times. Steel grit can be recycled up to twenty times.
- blast indoors;

  Where feasible, utilize an enclosed, indoor steel grit blasting system in which the grit is continuously recycled. The only waste generated is the relatively small amount of paint chips and other debris that is automatically filtered out through a separator for disposal, and airborne dust is contained within the facility.
- use containment when blasting outdoors;

  When blasting must be done outdoors, such as when work is done on a lighthouse, build scaffolding around the parts to be blasted and cover with a containment barrier from top to bottom. This will keep most of the harmful dust in, after which it can be swept up and disposed of in a proper manner. Consider using portable blasters which have a grit recycling capability.
- disposal of blast waste should be carried out in a timely manner, and this material should not be allowed to accumulate in large quantities.

  Label the waste containers and store appropriately until disposal by an authorized agent.

6.13. NOISE POLLUTION

The primary source of AtoN-related noise pollution comes from fog horns, which can disturb nearby residents if left running continuously in all visibility conditions. Diesel and wind generators can also be a disturbing noise source.

The following are ways to address these problems:

- install fog detectors to turn on the fog horns only when visibility falls below a predetermined threshold;
- if possible, configure the foghorn to focus the sound in one direction (directional), and thus minimize noise to the surrounding areas;

- erect a baffling system around the horn;
- to reduce the noise from diesel generators, install acoustic isolation around the engine shelter and use improved muffler systems;
- for wind generators, address the problem through proper site selection to reduce the noise impact on neighbours, and use the quietest system available.

6.14. LIGHT POLLUTION

This is a problem that sometimes occurs with lighthouses when the light disturbs surrounding residents. It can be dealt with by 'Blacking out' the lantern panes that face toward shore, either through painting them black, or installing black panels.

6.15. IMPACT ON MARINE LIFE AND HABITATS

AtoN equipment and maintenance activities can generate pollution in marine habitats, and can interfere with, or harm animals, plants, and birdlife. In the past, some batteries were disposed of on-site. Synthetic line sometimes gets abandoned instead of recovered. Different types of spills occur (e.g. diesel fuel, sewage, concrete while building lighthouse foundations on site). Biocide-based antifouling paint on buoys is toxic to marine life. Migratory birds nest on some stations, making it problematic to service the AtoN without disturbing the nests.

Servicing vessels may hurt marine animals while working in their habitat. Deploying and retrieving submarine cable and buoy moorings, and installing AtoN structures, can disturb the seafloor or impact sensitive environments. AtoN may be situated in areas where rare or protected flora and fauna are found. It is sometimes necessary to clear trees and brush when AtoN structures become obscured.

The following are ways to minimize the environmental impact of AtoN activities:

- when an AtoN is required in protected or especially sensitive areas, consult with environmental stakeholders and develop compatible solutions;

  For example, an AtoN structure could be designed to also serve as a bird observatory.
- extend the maintenance intervals to the greatest extent possible through engineering design solutions, or changes in policy;

  This will minimize the frequency of intrusive servicing visits in marine habitats.
- schedule maintenance visits to avoid nesting, spawning, and mating periods;
- shut down wind generators and switch to secondary power systems on the days of extensive bird migration;
- implement measures to discourage nesting on AtoN equipment;

  For example, build separate, higher nesting platforms on AtoN structures or add extensions on lantern stands to keep birds from nesting on the signal equipment itself.
- choose AtoN equipment that has less potential for environmental damage; e.g., use solar power versus primary batteries, diesel, or submarine cable;
- minimize the impact of the servicing boat's presence: limit the speed to reduce the wake, pay attention to where you anchor, don't leave the engine running;
- reduce the application of antifouling paint, or use non-biocide alternatives;
- seek out access roads and methods that have the least impact on the environment;

  Leave nothing behind. Bring back old batteries, broken AtoN equipment, partial cans of paint, etc. Clean up spills immediately.
- perform concrete work at a yard on shore if possible, rather than pouring on site;

- know the environment you'll be working in.

  Understanding the habitat will help to avoid harmful mistakes during the planning and execution of AtoN activities. If appropriate, rehabilitate the project site after work is complete. Pay particular attention to restoring the correct vegetation; i.e., indigenous versus invasive plants. Some countries have a practice of conserving part of the original vegetation in a nursery during project execution, for replanting after the work is done.

6.16. VESSEL OPERATIONS IN CORAL HABITATS

Many AtoN activities are carried out in the vicinity of marine, coastal and riverine habitats.

In many cases, due to the nature of the AtoN, they are in areas where pristine or ecologically sensitive habitats have been identified. It is therefore important that there is a full understanding of all sites where an AtoN entity may operate, including any site specific environmental issues, the full scope of activities and their impacts and the mitigation controls required to reduce environmental impact to an acceptable level. Environmental issues related to working in marine habitats are many and varied.

Following are some examples and considerations:

- AtoN entities should ensure that they are aware of the environmental status of all areas they operate in, whether this be through consultation with local stakeholders, appropriate government organisations, or non-governmental organisations (NGOs);

  Where possible, appropriate assessments should be undertaken to assess the ecological, social and general environmental value of the site. Assessment of a site will allow the entity to develop and implement appropriate environmental management and monitoring controls.

- reconnaissance of regular anchorages to choose the most appropriate anchorages, with priority given on placing anchors in areas of low ecological value, such as a sandy or muddy seabed;
- use of appropriately designed moorings wherever possible, to avoid the use of anchors;
- reconnaissance of transit routes and identification of alternatives;
- reconnaissance and identification of access routes between shore and land, to avoid disturbance to near-shore and foreshore marine habitats;
- appropriate choice of weather for movement of vessels and construction platforms.

6.17. CONTAMINATED LAND

Environmental restoration refers to a comprehensive effort to identify and remediate past hazardous waste sites at AtoN locations. These properties could have contaminated groundwater, surface water, soil or air. The contamination could have come from numerous sources, including operations, or processes carried out by the Authority currently, or in the past; operations or processes carried out by previous property owners, such as military organisations or industrial concerns; or from the property of adjacent landowners. In addition to the largely invisible contaminants, there could be an issue with larger items of junk, which are not only an eyesore but may be leaching contaminants such as printed circuit boards (PCBs), lead, or hydrocarbons into the ground and ground water.

Here are ways to handle land contamination:

- avoid contamination legacies by taking preventive measures now;

  Identify past activities to determine likely contaminants.

- the order in which the Authority conducts restoration and clean-up activities may be based on a ‘worst-first’ scenario that assigns the highest and most immediate priority to those facilities representing the greatest hazard to the environment and to public health and welfare.

Some of the criteria used to assign priority could be: imminent and substantial danger to public health or welfare; anticipated danger in the near-term from potential accident, deterioration or failure of safeguards while attempting clean-up or restoration; an ongoing condition with unknown, but potentially serious health consequences unless action is taken; and legally-binding agreements with regulatory agencies.

6.18. EROSION MANAGEMENT

Erosion management includes prevention, mitigation and remediation of soil erosion at AtoN sites.

A suite of erosion management measures may include:

- careful site selection, taking into account site hydrology, soil conditions and weather conditions;
- selection of the most appropriate structure or AtoN type;
- prevention – reduce the likelihood of erosion initiating by increasing awareness of erosion processes, causes, impacts and treatment options;

  For example, restricting vehicle movements during wet conditions.
- remediation – reduce the on-site and off-site impacts of erosion through remediation of active erosion sites e.g. re-vegetation, earthworks and structures;
- co-ordinate, monitor and evaluate plan implementation and achievements;
- minimise on-site and off-site impacts of erosion at times of natural disturbance: fire, flood, drought, cyclones and earth quakes;
- communication – educate personnel on the causes and impacts of erosion on-site and off-site.

Installation of erosion and sediment control measures should take into account site conditions including:

- soil type and erodibility potential;
- slope;
- rainfall frequency and intensity;
- catchment size and therefore required capacity and co-ordination of control structures;
- vegetation cover;
- proximity to sensitive environments.

6.19. HABITAT PROTECTION / PROTECTION OF FLORA AND FAUNA

As part of responsible environmental stewardship, an organisation should take into account habitat protection, or biodiversity conservation, including terrestrial and marine ecosystems, and flora and fauna communities which may be affected by AtoN infrastructure or operational activities.

Terrestrial ecosystems are generally recognized by the characteristic vegetation they support, for example; type of grasslands, forests, heathlands, inland waters and coasts.

Marine ecosystems are the combination of the animals and plants which depend on each other in some way that make up marine communities, and the physical environment that supports them.

Several conservation and sustainable environmental practices may be implemented:

- ensure compliance with relevant government legislative framework and policies and any international agreements or treaties on protection of native plant and animal species;
- provide a risk assessment and mitigation strategies for existing flora and fauna;
- establish a baseline inventory of present flora and fauna and any threatened species;

- identify sites regarded as significant breeding and nesting sites for year-round resident birds or migratory birds or marine creatures where special care must be taken at sensitive times to not disturb nesting and foraging;
- consider any quarantine management measures imposed by regulatory authorities and how they impact on AtoN procedures, specifications, roles and responsibilities of personnel;

  Identify changes to operational activities or processes that could have an impact on quarantine, and define and implement measures to minimise quarantine risks
- ensure an appropriate policy is in place for managing established or introduced weeds.

6.20. PREVENTION OF INTRODUCTION OF NON-ENDEMIC SPECIES AND DISEASES

Maintenance and construction activities can be conducted in areas of environmental significance and the introduction of non-endemic species and diseases could have a detrimental effect on the ecosystem.

Non-endemic species and diseases can be transferred from site to site by the means of human interaction during AtoN maintenance and construction activities. Species and diseases can be transferred to site on equipment, tools, materials, machinery and workers' personal protective clothing. One of the common causes of transfer is within dirt.

Typical issues are the transfer of:

- weeds;
- rodents;
- insects;
- diseases.

Likely controls are:

- inspection prior to mobilizing or entry to site:
  - construction and maintenance materials inspection;
  - cools and equipment inspections.
- cleaning and sanitization prior to mobilizing or entry to site:
  - washing down all equipment and machinery;
  - washing and cleaning workers' tools and personal protective clothing (especially boots).

7. DEFINITIONS

The definitions of terms used in this Guideline can be found in the International Dictionary of Marine Aids to Navigation (IALA Dictionary) at http://www.iala-aism.org/wiki/dictionary and were checked as correct at the time of going to print. Where conflict arises, the IALA Dictionary should be considered as the authoritative source of definitions used in IALA documents.

8. ACRONYMS

AtoN	Aid(s) to Navigation
CO_2	Carbon Dioxide
EER	Environmental Emergency Response
EMP	Environmental Management Plan(s)

EMS	Environmental Management System(s)
FIFO	First in First Out
FTE	Full time equivalent
HEPA	High Efficiency Particulate Air Filter
HNS	Hazardous & Noxious Substances
IALA	International Association of Marine Aids to Navigation and Lighthouse Authorities - AISM
IPCC	Intergovernmental Panel on Climate Change
ISO	International Organization for Standardization
LED	Light-Emitting Diode(s)
NGO	Non-Governmental Organization(s)
OSH	Occupational Health & Safety
PCB	Polychlorinated Biphenyls
PPE	Personal Protective Equipment
UNFCCC	United Nations Framework Convention on Climate Change
UV	Ultra Violet (light) (10 – 380 nm)
VOC	Volatile Organic Compounds (paints and solvents)
WMO	World Meteorological Organization