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International Association of Marine Aids to Navigation and Lighthouse Authorities

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On

Environmental Considerations in Aids to Navigation Engineering

(IALA Green Guidelines)

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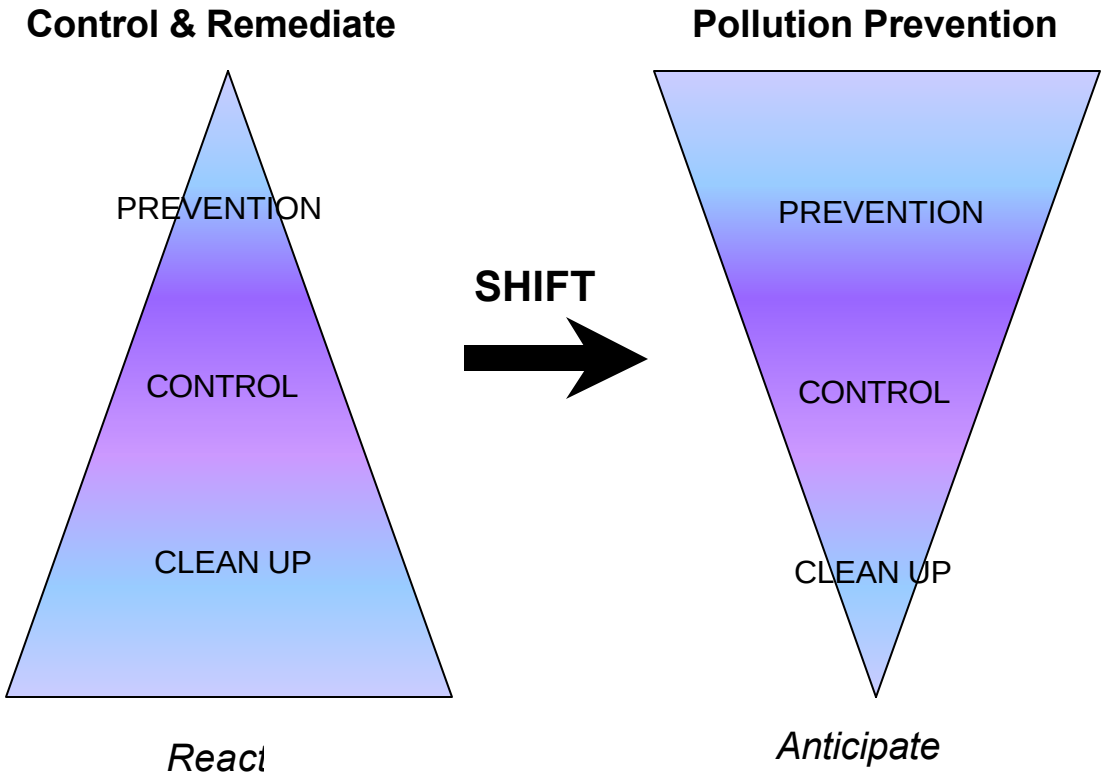
1. Introduction

Aids to Navigation (ATON) play a critical role in protecting the environment by preventing maritime disasters that could have potentially catastrophic ecological consequences at sea and on shore. However, the ATON equipment and activities themselves can create significant environmental damage through pollution, waste generation, and the disruption of ecosystems. It is essential to minimize these negative impacts so that the benefits of ATON are not outweighed by unintended harm to the environment, and to eliminate the potential for pollution and waste of the Earth's limited resources.

2. Pollution prevention

When addressing environmental issues, the traditional focus has often been on the control and remediation of waste, with less emphasis placed on prevention--a reactive approach that deals with problems after the fact. As shown in the figure below, a more effective approach is to shift the emphasis to preventing pollution through sound engineering choices at the beginning of the process. This will reduce the need for future control and clean-up. The ultimate goal should be "zero garbage"--eliminating the waste stream entirely.

Shifting the Emphasis



Examples of activities that can reduce or prevent pollution include:

- Developing and incorporating new technology, materials, and methods which have a reduced impact on the environment.
- Working with suppliers to identify ways of minimizing waste through rework, reuse, and recycling, rather than disposal.
- Identifying materials that are hazardous, and substituting less-hazardous or non-hazardous materials for hazardous ones.
- Limiting the quantities of hazardous materials that are bought and stored; controlling the quantity issued to workers to reduce the amount of leftover material; and properly managing inventory to reduce the amount which must be discarded through expiration of the shelf life.

Specific areas of concern are addressed in detail in Section 5 of these Guidelines.

3. Cost versus benefit of "greening" ATON

There is a false impression that increasing environmental "friendliness" will always increase the cost of doing ATON work. In fact, the result can be just the opposite--engineering solutions that reduce the impact on the environment can actually reduce ATON costs. Here are some examples:

- Converting from primary batteries to solar power systems generates considerable savings through the increased reliability of the aids, the decrease in required servicing visits, and the reduction of hazardous waste disposal.
- Distilling and reusing solvents saves money by reducing the amount of new solvent that must be purchased and the amount of hazardous waste that must be disposed of.
- Switching from high-VOC paints to more robust low-VOC paints on buoys enhances their performance on station by extending the life of the signal color, and thus decreases the need for costly and time-consuming repainting on station.

The monetary and non-monetary costs of not pursuing "green" alternatives can be much higher for an organization. These can range from bad publicity, to financial liability, to criminal prosecution. In particular, waste remediation and clean-up of a contaminated site is a lengthy and expensive process. Even after a site has been restored, it may be necessary to continue monitoring it on a long-term basis to ensure there is no continued threat to the environment.

4. Environmental management

In order to truly "green" ATON activities, an ethic of environmental protection and natural resources stewardship should be promulgated throughout the organization. Environmental considerations should be made a part of all engineering, planning, and decision-making. 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. Detailed information on

how to implement an organization-wide environmental management system is available through the International Organization for Standardization (ISO), in their ISO 14000 family of standards. When procuring products and services, Authorities are encouraged to utilize suppliers that comply with ISO 14000 requirements.

5. Technical considerations

This section addresses specific areas of concern and potential solutions to minimize the environmental impact of ATON equipment and activities.

5.1 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 minimize 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 minimize 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.

5.2 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. The following solutions to minimizing 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) or protective mechanisms (e.g., galvanizing, spray moralizing, 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" (abhesive) 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 in order 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 labeled 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-labeled containers prior to disposal by an authorized agent.

5.3 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 vapor 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 vapor 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 labeled 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-labeled 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.

5.4 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 aluminum 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.

5.5 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 cleanup. 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 cleanup 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. 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 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.

5.6 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.

5.7 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 also require special handling and disposal. Here 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 as incandescent lamps, so relamping 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.

5.8 Mercury

There are 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 the waste containers and store appropriately in a well-ventilated area until disposal by an authorized agent.

5.9 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, siding, and wall board. When it is intact, asbestos in good condition poses little hazard. However, if this material is sanded, cut, torn, or damaged, hazardous airborne fibers may be generated and remain suspended in the air for long periods of time. Inhaling these fibers can lead to chronic and deadly diseases. Here 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 register and control the disturbance of installed asbestos or asbestos-containing products or to remove them under controlled conditions.

5.10 Electric and electronic devices

Authorities are encouraged to classify and separate the waste (including used wires) in a selective way to facilitate recycling and disposal through an authorized agent (e.g., separate copper, aluminum, plastics, etc.).

5.11 Noise pollution

The primary source of ATON-related noise pollution comes from electric 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, plug the foghorn to focus the sound in one direction, 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 neighbors, and use the most quiet system available.

5.12 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.

5.13 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. Batteries are sometimes 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 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.

5.14 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 organizations 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 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 in order to determine likely contaminants.
- The order in which the Authority conducts restoration and cleanup 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 cleanup or restoration; an ongoing condition with unknown, but potentially serious health consequences unless action is taken; and legally-binding agreements with regulatory agencies.