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| IALA Guideline  A number of queries and suggestions arose when this Guideline was being reformatted to the new IALA image, as shown in the comments throughout the document.  The ENG Committee is requested to respond to these queries and suggestions and submit to the Secretariat to enable completion of the reformatting. |

1049

Cost Comparison Methodology of Buoy Technologies

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Revisions to this IALA Document are to be noted in the table prior to the issue of a revised document.

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| Date | Page / Section Revised | Requirement for Revision |
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# BACKGROUND

Aids to navigation services are faced with a choice of buoy technologies. These technologies employ various materials and manufacturing methods. A change of buoy technology might allow a service to reduce its operating costs. However, the decision to change from the existing buoy technology to a different technology must be made with care.

## Scope

This paper sets out some points which should assist the decision making, and recommends the use of Net Present Value (NPV) analysis for financial evaluation.

# EXAMPLES OF DIFFERENT BUOY TECHNOLOGIES

Various materials are used for the manufacture of floating AtoN buoys. These include:

* steel;
* aluminium;
* plastics of various types (reference IALA Guideline 1006 on Plastic Buoys).

These materials may be used alone. They can also be used in combination to manufacture buoys which combine the benefits of different materials. For example:

* steel buoy hull with aluminium tower;
* rotationally moulded plastic buoy float with steel centre tube and aluminium tower;
* all plastic hull and tower, with internal metal structural members;
* aluminium buoy with plastic foam filling within the hull;
* Glass Reinforced Polyester (GRP) buoy hull with steel or aluminium tower.

These are simply a few of the possible choices. The material choices are influenced by the size of buoy required, and by the environmental conditions under which it must operate. Changing to a different technology may offer the AtoN operating authority a reduction in overall costs, via reduction in servicing/support costs or reduction in first costs. As an example, Example 1 (see section 5.1) presents technical factors relating to rotationally moulded polyethylene buoys.

This subject may also be extended to compare conventional buoys with fixed beacons (usually single pile) or spar buoys which are moored at the seabed with a universal joint or short chain. These are known by various names, including ‘spar buoys’, ‘resilient beacons’, ‘buoyant beacons’ and ‘elastic beacons’. The preferred term is ‘buoyant beacon’. This type of buoy can offer potential cost savings by reducing the frequency of mooring inspection and replacement, if local tidal regime and water depth allow the use of these alternatives. See Example 2 in section 5.2.

# PRIMARY POINTS FOR CONSIDERATION

The first step in comparing buoy technologies is determination of the level of service required. The technologies being compared should achieve the defined service level. If full compliance is not achieved, confirm if a deviation in service level is acceptable. The choice of buoy technology could affect the type of mooring hardware, signal equipment, and power systems required. The complete buoy system should be considered when conducting this analysis. In some cases, the full cost advantage may only be realised if a smaller servicing vessel can be used or if on-shore maintenance facilities can be closed. Realising these savings may require the Authority to replace the entire fleet of old buoys with new.

The following questions should be addressed when comparing different technologies.

## Existing Infrastructure

* servicing vessel capabilities;
* on-shore maintenance facilities (blasting, painting, etc.);
* on-shore logistics capabilities (storage, handling, etc.).

## AtoN signal

1. Does the new buoy provide an adequate day-mark?
2. Is it capable of carrying a lantern with the required range and other required equipment and the associated power system?
3. Is the motion of the buoy on station too rapid or of too great angular displacement for the AtoN function to be clear to the mariner (e.g. vertical divergence)?
4. Is the focal height sufficient for local sea conditions?
5. Can a suitable radar reflector be mounted?
6. In summary, how well does the new buoy meet the service requirements?

## Serviceability

1. Is it possible to connect a suitable mooring to the buoy?
2. Do the lifting and mooring eyes permit safe handling of the buoy as required by the Authority?
3. Is the buoy’s motion acceptable for maintenance personnel to work on the buoy?
4. Does the design adequately permit inspection/testing of the structural integrity of the buoy?

## Local conditions

1. Are there ice conditions will the buoy be suitable?
2. If self-coloured materials (usually plastic) are used how long will the coloured surface last in the local UV environment.
3. Extreme local conditions (temperature, wave conditions, etc.) should be taken into consideration with the choice of buoy.

## Environmental Considerations

Choice of technology should minimise the impact on the environment. Refer to IALA Guideline 1036 on Environmental Considerations in Aids to Navigation Engineering.

## Service intervals

1. At what interval must the day-mark components be replaced to retain correct signal colours?
2. What are the inspection and maintenance intervals of component parts, mooring hardware, power system and signal equipment?
3. How often must the new and existing buoys be visited to maintain the lantern, power system, mooring etc.?
4. It is important to identify the critical items that will wear out and to define the maintenance periods for the new buoy.
5. How long will the new buoy remain on station before removal ashore for major servicing is necessary and how does this compare with existing buoys?

## Purchase costs

1. What are the costs of the purchase of the existing buoys?
2. What are the costs of the purchase of the new buoys?
3. What is the anticipated life expectancy of the old versus the new buoys?
4. What are the costs of spares to cover planned maintenance and to provide breakdown cover?

## Maintenance costs

1. What time and resources are required to maintain the existing buoy – and how much does it cost?
2. What time and resources will be required to maintain the new buoy – and how much will it cost?
3. Will there be any saving in the servicing vessel costs from using a different buoy technology?
4. Will there be a saving in vessel time at each servicing visit?
5. Will the number of servicing visits be reduced?
6. Will the same vessels/facilities be used for the new buoys?
7. What there Health and Safety regulations necessary with the new technology?
8. Will the new buoy mean a reduction in mooring component costs?
9. Will the new technology require specialised staff training?

## Use of contractors

* for instance steel can be repaired ‘anywhere’;

Structural steel specialists are widely available.

* aluminium repair may be difficult away from industrial centres;
* high specification paint systems for steel and aluminium require sophisticated surface preparation and application facilities;
* repairs to some plastics may require the contractor to have special tools and skills;
* how will this affect the total costs?

# FINANCIAL ANALYSIS AND THE NPV METHOD

Financial analysis for the comparison of different buoy strategies should preferably use the Net Present Value (NPV) method. NPV analysis is an approach used in capital budgeting where the present value of cash inflow is subtracted from the present value of cash outflows. It is accepted internationally as a method of financial analysis to support decision making. For most buoy decision analysis there will be the comparison of costs, but income could arise from sales of redundant items, or from marketing ‘spare’ ship time.

Explanation of NPV theory is not given here. The reader is referred to the Internet or to textbooks, which can be found on the topic in most languages. However, the following points are important to keep in mind:

* choice of the time period of the NPV analysis;
* sensitivity of the analysis to the time period selected, discount rate chosen and other key assumptions;
* it is important to capture all of the costs during the NPV period (purchase, maintenance, disposal, etc.);
* previously-spent sums (sunk costs) should not be included in the analysis.

# EXAMPLES

Examples of the application of the above methodology are provided for reference purposes only.

## Example 1 – AMSA Australia

This example shows the use of NPV analysis for making a decision on the best buoy technology to employ.

AMSA has recently performed a cost benefit analysis of options for replacement buoys in Australia taking into consideration a number of presently available plastic alternatives to their current steel buoys. The analysis resulted in a decision to continue with steel buoys for the next five years.

Whilst the decision to stick with steel buoys is very interesting in itself, the methodology used to arrive at this decision is even more interesting for other AtoN authorities.

The approach used for evaluating the capital cost savings was as follows:

1. Select which scenarios to analyse.
2. Define any basic assumptions made for the analysis.
3. Select a timeframe for the analysis.
4. Calculate the initial replacement costs.
5. Calculate the maintenance costs each year.
6. Calculate the Net Present Value (NPV) of all costs within the selected timeframe.
7. Compare the NPV of each scenario.

### Scenarios to Analyse

The following scenarios where selected for the AMSA analysis:

* continue to use the current design of buoys of steel construction;

OR

* change to plastic construction buoys which have reduced maintenance requirements.

### Basic Assumptions

The following basic assumptions where made for the analysis:

* costs common to all scenarios can be omitted;
* maintenance cycle of steel hull buoys requires purchase of 1.5 times the number in service (spares ratio);
* maintenance cycle of plastic hull buoys requires purchase of 1.25 times the number in service.

### Time Frame

A time frame of 20 years was selected.

### Calculate Initial Replacement Costs

The following factors were taken into consideration for calculating the initial costs:

* unit cost;
* maintenance spares (proportion in store);
* installation components/fittings;
* cost of ship time for installation.

### Calculate Maintenance Costs

While calculating the maintenance costs each year, the following factors where considered:

* minor maintenance costs at intervals of 2 years;
* major maintenance costs at intervals of 4 and 6 years;
* buoy replacement costs at intervals of 10 years (buoy lifetime).

In each case the costs where split into the cost of ship time and other costs (materials and services).

### Calculate NPV

A standard methodology for calculating NPV was used.

### Compare the NPV of each Scenario

Comparing the NPV of each scenario revealed what potential capital cost savings could be obtained for each scenario relative to the present scenario.

A spreadsheet example of this basic NPV methodology is found at the end of this example.

The above mentioned factors can more or less be characterized as direct cost drivers. In addition to these there may be a number of indirect cost drivers such as workshop facilities that may be affected the alternative scenarios.

(Information provided courtesy of AMSA (Alan Crossing and Gary Prosser))

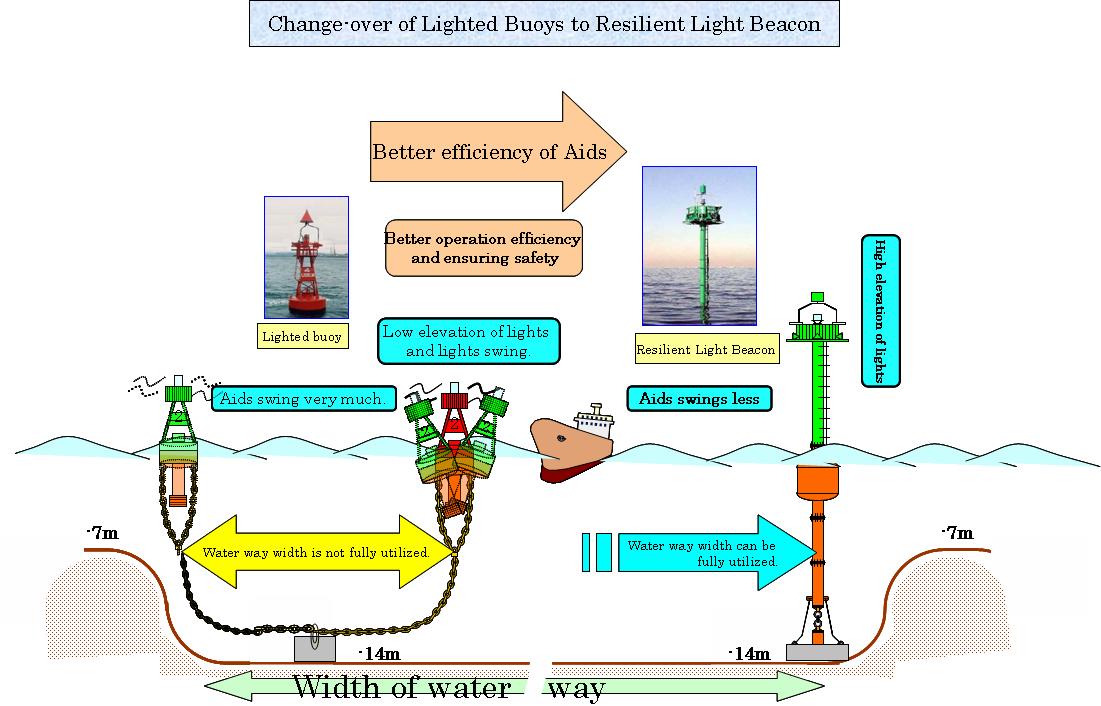
1. Spread Sheet example

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Item** | **Current Steel Buoy** | **Buoy A** | **Buoy B** | **Buoy C** | **Buoy D** |
| **Initial Costs** |  |  |  |  |  |
| Unit Cost | 9600 | 9700 | 14000 | 25000 | 55000 |
| Maintenance Spares (proportion in store) | 0,5 | 0,25 | 0,25 | 0 | 0 |
| Installation components/fittings | 6300 | 6300 | 6300 | 1800 | 1800 |
| Ship time for installation (days) | 0,5 | 0,5 | 0,5 | 2 | 2 |
| Installation costs | 2550 | 2550 | 2550 | 10200 | 10200 |
|  |  |  |  |  |  |
| Daily Ship Cost | 5100 |  |  |  |  |
| **Maintenance Costs** |  |  |  |  |  |
| Minor maintenance costs at interval of:- (years) | 2 | 2 | 2 | 2 | 2 |
| Ship Time (days) | 0,5 | 0,5 | 0,5 | 0,5 | 0,5 |
| Ship Cost | 2550 | 2550 | 2550 | 2550 | 2550 |
| Other Costs (materials & services) | 2700 | 2700 | 2700 | 1500 | 1500 |
|  |  |  |  |  |  |
| Major maintenance costs at interval of:- (years) | 4 | 4 | 4 | 6 | 6 |
| Ship Time (days) | 0,5 | 0,5 | 0,5 | 1 | 1 |
| Ship Cost | 2550 | 2550 | 2550 | 5100 | 5100 |
| Other Costs (materials & services) | 3000 | 2400 | 2400 | 3000 | 3000 |
|  |  |  |  |  |  |
| Buoy Changeout costs at interval of:- (years) |  |  |  | 10 | 10 |
| Ship Time (days) |  |  |  | 2 | 2 |
| Ship Cost |  |  |  | 10200 | 10200 |
| Other Costs (materials & services) |  |  |  | 6000 | 9000 |
| **Year** | **Current** | **Buoy A** | **Buoy B** | **Buoy C** | **Buoy D** |
| **0** | -23250 | -20975 | -26350 | -37000 | -67000 |
| **1** | 0 | 0 | 0 | 0 | 0 |
| **2** | -5250 | -5250 | -5250 | -4050 | -4050 |
| **3** | 0 | 0 | 0 | 0 | 0 |
| **4** | -5550 | -4950 | -4950 | -4050 | -4050 |
| **5** | 0 | 0 | 0 | 0 | 0 |
| **6** | -5250 | -5250 | -5250 | -8100 | -8100 |
| **7** | 0 | 0 | 0 | 0 | 0 |
| **8** | -5550 | -4950 | -4950 | -4050 | -4050 |
| **9** | 0 | 0 | 0 | 0 | 0 |
| **10** | -5250 | -5250 | -5250 | -16200 | -19200 |
| **11** | 0 | 0 | 0 | 0 | 0 |
| **12** | -5550 | -4950 | -4950 | -8100 | -8100 |
| **13** | 0 | 0 | 0 | 0 | 0 |
| **14** | -5250 | -5250 | -5250 | -4050 | -4050 |
| **15** | 0 | 0 | 0 | 0 | 0 |
| **16** | -5550 | -4950 | -4950 | -4050 | -4050 |
| **17** | 0 | 0 | 0 | 0 | 0 |
| **18** | -5250 | -5250 | -5250 | -8100 | -8100 |
| **19** | 0 | 0 | 0 | 0 | 0 |
| **20** | -5550 | -4950 | -4950 | -16200 | -19200 |
| **Total** | -77250 | -71975 | -77350 | -113950 | -149950 |
| **NPV at** |  |  |  |  |  |
| **5%** | **-56.033** | **-52.023** | **-57.398** | **-80.619** | **-113.591** |
| **10%** | **-45.084** | **-41.709** | **-47.084** | **-64.214** | **-95.817** |

Note - The figures shown are indicative of the figures obtained by AMSA but for commercial reasons are not the actual figures used.

## Example 2 - JCG Japan

This shows an alternative method of financial analysis in the comparison of buoys and resilient beacons.

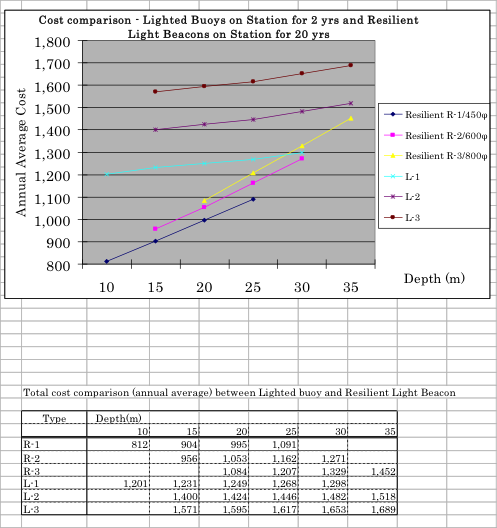


1. Changeover of lighted buoys to resilient light beacon
3. Lighted buoy types L-1, L-2 & L-3



1. Resilient Light beacon types R-1, R-2 & R-3





1. Cost comparison between Lighted Buoys and Resilient Lighted Beacons
2. Total cost comparison (annual average) between Lighted Buoy and Resilient Lighted Beacon

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Type | Depth (m) | | | | | |
|  | 10 | 15 | 20 | 25 | 30 | 35 |
| R-1 | 812 | 904 | 995 | 1,091 |  |  |
| R-2 |  | 956 | 1,053 | 1,162 | 1,271 |  |
| R-3 |  |  | 1,084 | 1,207 | 1,329 | 1,452 |
| L-1 | 1,201 | 1,231 | 1,249 | 1,268 | 1,298 |  |
| L-2 |  | 1,400 | 1,424 | 1,446 | 1,482 | 1,518 |
| L-3 |  | 1,571 | 1,595 | 1,617 | 1,653 | 1,689 |

# DEFINITIONS

The definition 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>.

# ACRONYMS

AMSA Australian Maritime Safety Authority

AtoN Aid(s) to Navigation

GRP Glass Reinforced Plastic (fibreglass)

IALA International Association of Marine Aids to Navigation and Lighthouse Authorities - AISM

JCG Japan Coast Guard

m metre(s)

NPV Net Present Value

nm nanometres

UV Ultra Violet (light) (10 – 380 nm)