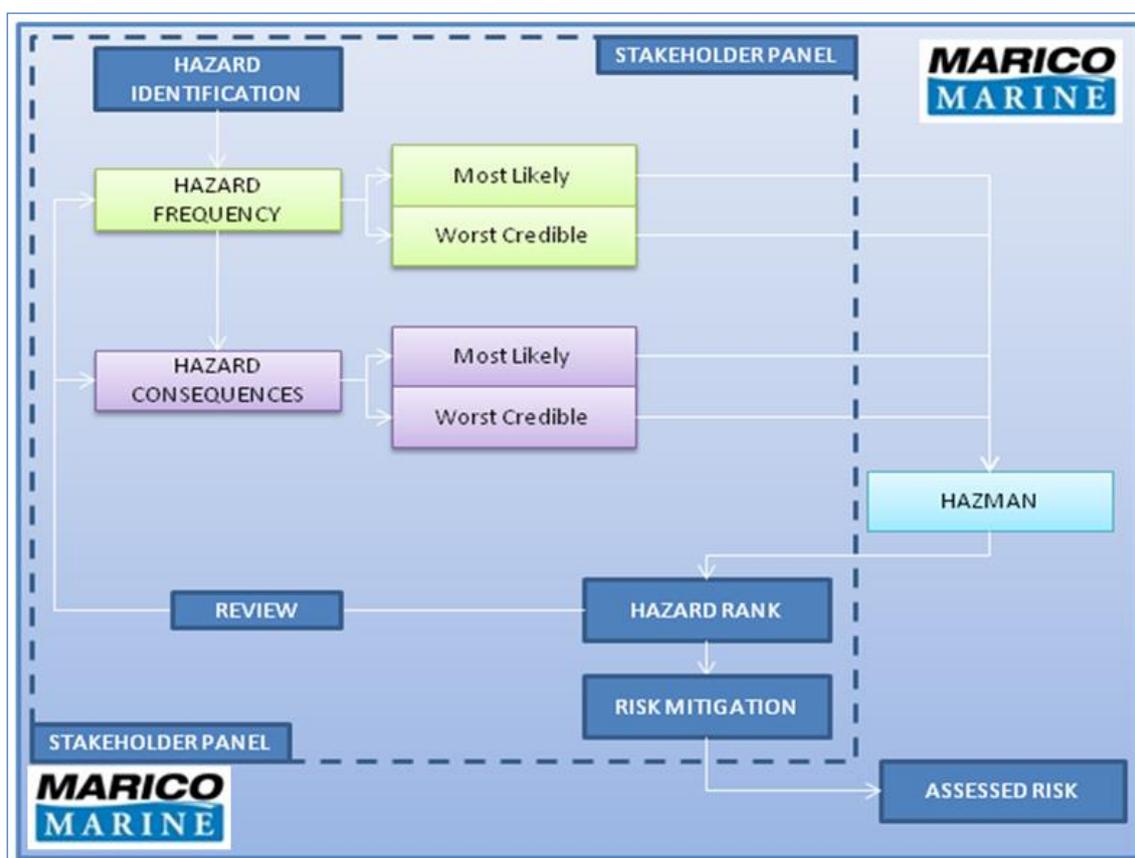


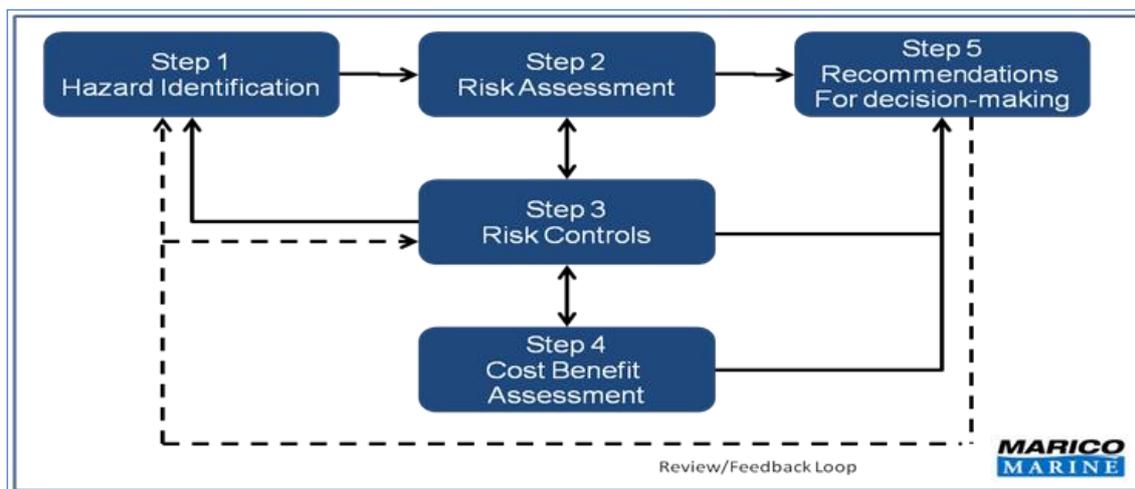
NAVIGATION RISK ASSESSMENT METHODOLOGY

The NRA will be based on the Formal Safety Assessment methodology as adopted by IMO. It will also follow the guidance set out within the MCA MGN 371 (M+F). Marico Marine will use a form of risk assessment that has been specifically adapted for navigational use. It is unique to Marico and is fundamentally based on concepts of “Most Likely” and “Worst Credible”, which reflect the range of outcomes arising from a shipping accident. This approach matches well the marine incident data that is customarily available. It is relevant that incident data often shows a high frequency of minor events, separated from a much lower frequency of “Worst Credible” events.



Marico hazard identification and risk assessment process

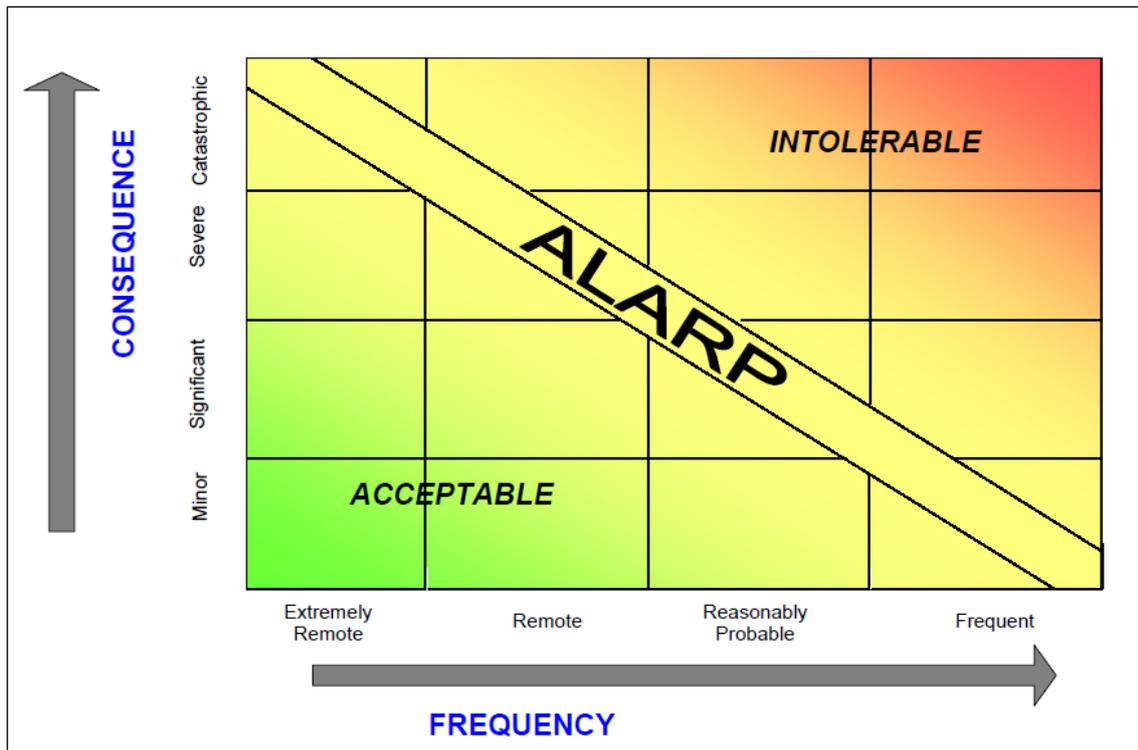
The NRA for the project will be carried out using the Marico Marine “HAZMAN II” program to provide ranked hazard reports. The data handled within “HAZMAN II” can subsequently form the basis for an on-going navigational Safety Management System (SMS).



Formal Safety Assessment Risk Assessment Process

IMO Guidelines define a hazard as “*something with the potential to cause harm, loss or injury*”, the realisation of which results in an accident. The potential for a hazard to be realised can be combined with an estimate or known consequence of outcome. This combination is termed “risk”. Risk is therefore a measure of the frequency and consequence of a particular hazard. One way to compare risk levels is to use a matrix approach as illustrated. At the lowest end of the scale, frequency is extremely remote, consequence insignificant such that a risk can be said to be negligible. At the high end, where hazards are defined as frequent and the consequence catastrophic, then risk is termed intolerable. Between the two lies an area known “As Low As Reasonably Practicable” (ALARP).

The IMO guidelines allow the selection of definitions of frequency and consequence to be made by the organisation carrying out the risk assessment. This is important, as it allows risk to be applied in a qualitative and comparative way. To identify high risk levels in the traditional mathematical way would require a large volume of casualty data, which is rarely available in the maritime context. ALARP can be accepted as being “Tolerable”, if the further reduction of the risk is impracticable, or if the cost of such reduction would obviously be highly disproportionate to the improvement. It can also be considered “Tolerable”, if the cost of reducing the risk is greater than any improvement gained.



Frequency / Consequence Chart.

The NRA will use accident categories to organise hazards for assessment. The hazard categories identified as relevant to this study are likely to be:

- Collision;
- Grounding
- Obstruction;
- Fire;
- Contact; and
- Personal injury.

To undertake the NRA, the OFD will be considered as a number of geographical areas, each with its own particular hazards.

Each hazard will be reviewed with respect to cause and effect. Frequencies are then derived for notional “most likely” and “worst credible” hazard events in each case, using the frequency bands defined below.

Frequency criteria

Scale	Description	Operational Interpretation
F5	Frequent	One or more times in 1 year
F4	Likely	One or more times in 10 years 1 - 9 years
F3	Possible	One or more times in 100 years 10 – 99 years
F2	Unlikely	One or more times in 1,000 years 100 – 999 years
F1	Remote	More than 1,000 years

Using the assessed notional frequency for the “most likely” and “worst credible” scenarios for each hazard, the probable consequences associated with each were assessed in terms of damage to:

People - Personal injury, fatality etc.;

Property – OFD and third party;

Environment - Oil pollution etc.; and

Business - Reputation, financial loss, public relations etc.

The magnitude of each is then assessed using the consequence categories as shown in the table below. These have been set such that the consequences in respect of property, environment and business have similar monetary equivalent outcomes.

Consequence Categories and Criteria

Cat.	People	Property	Environment	Business
C1	Negligible Possible very minor injury (e.g. bruising)	Negligible Costs <10k	Negligible No effect of note. Tier1 <u>may</u> be declared but criteria not necessarily met. Costs <10k	Negligible Costs <10k
C2	Minor (single minor injury)	Minor Minor damage Costs 10k – 100k	Minor Tier 1 – Tier 2 criteria reached. Small operational (oil) spill with little effect on environmental amenity Costs 10K – 100k	Minor Bad local publicity and/or short-term loss of revenue Costs 10k – 100k
C3	Moderate Multiple minor or single major injury	Moderate Moderate damage Costs 100k - 1M	Moderate Tier 2 spill criteria reached but capable of being limited to immediate area within site Costs 100k - 1M	Moderate Bad widespread publicity Temporary suspension of operations or prolonged restrictions Costs 100k - 1M
C4	Major Multiple major injuries or single fatality	Major Major damage Costs 1M - 10M	Major Tier 3 criteria reached with pollution requiring national support. Chemical spillage or small gas release Costs 1M - 10M	Major National publicity, Temporary closure Costs 1M - 10M
C5	Catastrophic Multiple fatalities	Catastrophic Catastrophic damage Costs >10M	Catastrophic Tier 3 oil spill criteria reached. International support required. Widespread shoreline contamination. Serious chemical or gas release. Significant threat to environmental amenity. Costs >10M	Catastrophic International media publicity. Operations and revenue seriously disrupted for more than two days. Ensuing loss of revenue. Costs >10M

Project Risk Matrix

Consequences	Cat 5	5.1	5.9	7.0	8.3	10.0
	Cat 4	4.1	4.9	5.9	7.4	9.4
	Cat 3	2.9	3.5	4.4	5.9	8.3
	Cat 2	1.5	1.8	2.4	3.5	5.9
	Cat 1	0	0	0	0	0
Frequency	>1,000 years	100-1,000 years	10-100 years	1 to 10 years	Yearly	

Navigation hazards will be identified by the project team, and scored for “frequency”) and “consequence” and in terms of a “most likely” (ML) and “worst credible” (WC) outcome, with results documented in a “Hazard Log”.

Risk is then calculated, for each consequence category (e.g. people, property, environment and business) based on the scores in the hazard log, using a risk matrix. Risk scores are calculated for each hazard under the “most likely” and “worst credible” scenarios for each of the consequence criteria. This generates eight individual risk scores per hazard. These risk scores are documented in the “Ranked Hazard Lists”, and are combined, using a propriety algorithm, to derive an overall risk score. From the overall baseline risk scores, a ranked hazard list is generated documenting the individual category risk scores in more detail.

Risk bands

Matrix Outcome	Risk Definition	Action Taken
0 & 1	Negligible Risk	A level where operational safety is unaffected.
2 & 3	Low risk	A level where operational safety is assumed.
4 ,5 and 6	As Low as Reasonably Practicable (ALARP)	A level defined by study at which risk control in place is reviewed. It should be kept under review in the ensuing Safety Management System (SMS).
7 & 8	Significant Risk	A level where existing risk control is automatically reviewed and suggestions made where additional risk control could be applied if appropriate. Significant risk can occur in the average case or in individual categories. New risk controls identified should be introduced in a timescale of two years.
9 & 10	High Risk	A level requiring immediate mitigation.

All risk scores, whether individual per consequence category, or overall for a hazard are scored on a scale of 0 (low risk) to 10 (high risk).

A basic set of hazards will be identified for each of the three phases of the project, namely construction, operation and de-commissioning. These will then be reviewed, expanded and subsequently scored in accordance with above the procedures. Where the resultant risk levels cannot be considered as tolerable or as lying within the ALARP range, possible risk mitigation measures will be identified. Stakeholder consultation will be invited throughout the risk assessment process. The first draft of the NRA report will then be prepared.

Risk Treatment Criteria

Risk scores for each hazard under the ‘most likely’ and ‘worst credible’ scenarios provide eight risk scores per hazard when each of the consequence criteria are considered. These can be combined to derive the overall risk score.

From the overall risk score, criteria can be applied for risk diagnosis. The scale used is 0 (low risk) to 10 (high risk) as shown below.

Risk Factor Matrix Used for the Assessment

Where:	0 & 1	equates to Negligible Risk
	2 & 3	equates to Low Risk
	4, 5, 6	assessed to be in the ALARP region
	7, 8 & 9	equates to Heightened Risk
	10	equates to Significant Risk

Hazard Review and Risk Control Options

A basic set of hazards are constructed for each of the four phases of the project. These are then reviewed, expanded and subsequently scored in accordance with the procedures outlined above. Risk control options are suggested against the risk outcome.