Museum vessels: To Be or Not to Be—In Survey?

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ABSTRACT

This paper considers the challenges faced by museums that operate historic vessels. It looks at the new standards for commercial vessels and the options open to museums to propose vessel arrangements and systems that achieve equivalent safety to modern vessels. The paper also considers an alternative approach using the concept of a novel vessel that could allow operation of historic vessels under technically lower standards than for normal commercial operation subject to users understanding and accepting the increase in risk.

1. INTRODUCTION

Australia has a diverse range of historic vessels preserved in Maritime Museums around the Nation ranging from canoes, boats and yachts to large warships, cargo ships, tugs, ferries and coasters. Some of these vessels are small, some are large.

The decision as to how best to preserve a vessel is a complex one that needs to take into account a wide range of factors. Some museum vessels are stationary, either on shore or afloat, while others are operational. There are arguments for and against each option. The majority of larger vessels preserved in Australia have been kept afloat, and of these a number are operational. A major benefit to keeping a preserved vessel operational is that it allows it to be exhibited within its historical context. The carriage of members of the public on board an operational historic vessel significantly enhances the visitor experience. Keeping a vessel operational significantly expands the scope of a museum by preserving the skills of operation and maintenance, in addition to the artifact itself.

Though cherished by their owners, historic and traditional vessels are not immune from major catastrophe. The barque Marques[1] in 1984, the Pride of Baltimore[2] in 1986 and the Asgard II[3] in 2008 foundered at sea, the former two with loss of life, and fire almost destroyed the Cutty Sark[4] in 2007. Closer to home, fire consumed the paddle wheeler Golden City[5] in 2006 and the Windeward Bound[6] was involved in a serious knock-down at sea in 2004.

2. TO BE OR NOT TO BE IN SURVEY?

A number of operational Museum vessels in Australia are operated under commercial vessel survey. Statutory survey is the granting of a license to lawfully operate a vessel under legislation; usually subject to proactive third party verification to ensure that specified standards of risk management have been applied[7]. There are a number of reasons why a Museum might choose to operate a vessel under Commercial vessel survey. These include to:

a) Comply with legislation requiring the vessel to be "in survey".
b) Help fulfill Occupational Health and Safety and other general safety obligations[8]; and
c) Facilitate revenue raising by commercial operation

Legal challenges

At present, there are currently eight Marine Safety jurisdictions in Australia. Each has its own legislation with slightly differing wording as to whether a vessel must be in survey. The general rule is that carriage of members of the general public for remuneration (i.e., passengers) is commercial operation. However, the use of the vessel to carry members of the museum exclusively; or carriage of members of the general public for no charge or for a contribution to costs may lie in a grey area. For example, in NSW the Commercial Vessels Act (1979) defines commercial operation as operation in connection with a commercial purpose[9]. To what extent is the operation of a vessel by a museum a "commercial purpose"? Museums should contact the relevant

Marine Authority to determine whether the proposed operation of an historic vessel is required to be in survey under legislation.

Notwithstanding whether or not Marine Safety legislation applies; museum vessels are subject to other legal obligations contained in Occupational Health and Safety (OH&S) legislation[10] and case law. Museum vessels are likely to be work places. The Museum's operations are also subject to the law of contract[11] and the law of negligence[12]. Survey provides an objective framework that can go a long way to help fulfill these broader safety obligations. However, this latter statement needs to be tempered by the following observations:

1. OH&S legislation makes no concession for existing work places compared to new work places[13]. To a larger or lesser extent, Marine safety legislation in Australia provides for some degree of grandfathering (i.e., where different standards apply to existing vessels compared to new vessels). There is no legislative provision for grandfathering under OH&S legislation. The extent to which such concessions are applied administratively by the relevant OH&S agency is likely to be small given that OH&S is not proactively administered. This poses a significant challenge to Museum vessels.
2. NSW OH&S legislation, for example, requires that *an employer must ensure the health, safety and welfare at work of all the employees of the employer*[14]. This far-reaching requirement goes beyond the scope of marine safety legislation that only specifies a defined set of minimum required standards. Marine safety legislation may not be sufficient to "ensure the health, safety and welfare" of all employees at all times and in every circumstance. The marine safety legislation does not address every possible hazard, nor does it necessarily control all unacceptable risks. The marine safety legislation tends to focus on the more major and generic risks[15].

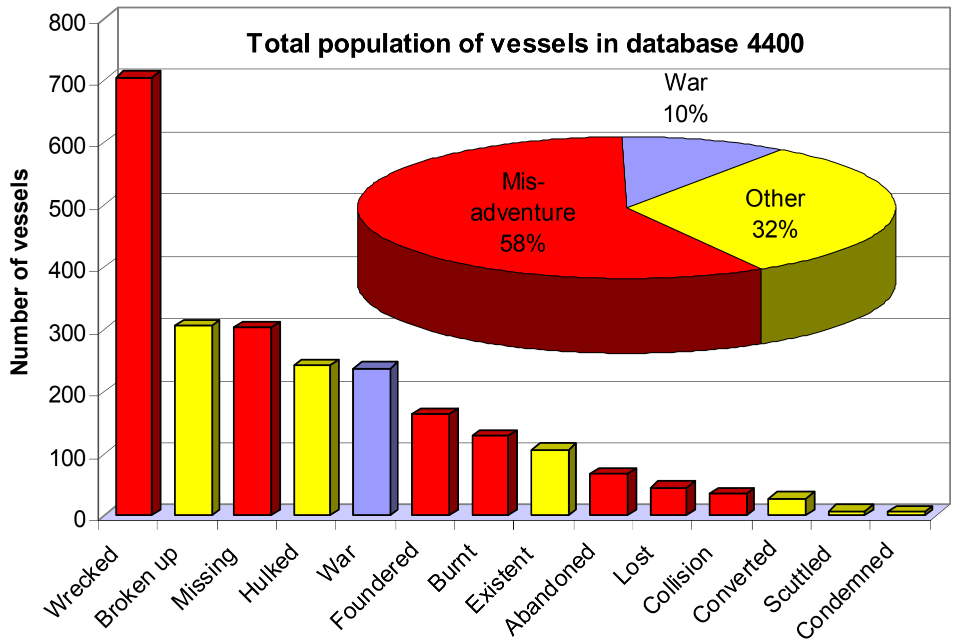

Figure 1—Fate of 2383 iron, steel and composite square rigged sailing ships between 1838 and 2000

Historical challenges

Museum vessels were built at a time of different community expectations as to safety. An analysis of the fate of vessels dating from earlier centuries shows rates of catastrophic loss far in excess of that considered acceptable today. For example, consider iron, steel and composite square rigged sailing vessels built between 1838 and 2000[16]. Of the total 4,400 so far recorded, the fate of 2,383 vessels has been determined, see Figure 1. Of these, 58% were lost through unintentional misadventure (i.e., through being wrecked, missing, foundering, burnt, abandoned, lost or collision). A further 10% were lost through war.

Current safety standards have evolved from experience gained over many thousands of tragedies. Museum vessels can predate important safety reforms. Some of these reforms are easily applied to Museum vessels operating today. Modern weather forecasting, radio communications and lifesaving equipment will go a long way towards reducing operating risks. However, there are other reforms of a more fundamental nature that may not be easily accessed by museum vessels. Minimum requirements for stability, subdivision and structural fire protection are examples of provisions that may be difficult to apply.

Technological Challenges

Modern approaches to domestic commercial vessel safety are largely concerned with creating a system that is relatively forgiving of human error. Many vessels from the past have characteristics that by today's standards are very unforgiving of human error. Examples are inboard petrol motors, crew aloft working sail in the rig of square riggers, tank boilers, and undecked vessels operating at sea. Tank boilers are subject to a strict survey regime, inboard petrol engines are prohibited as a deemed-to-satisfy solution in current commercial vessel standards, the working of sail aloft has been superseded on all but a small number of 'traditional' vessels, and the operation of open decked vessels at sea is limited under modern commercial vessel standards.

These and other "unforgiving" features may be integral to the historic character of the preserved vessel. They need to be specially considered to identify the magnitude of the risks, the extent to which the risks can be controlled and whether the risk control measures are compatible with the Museum's broader objectives (see Ethical Challenges below).

Competency Challenges

The restoration, operation and maintenance of historic vessels require skills that are rare if not unique. These skills are no longer readily available off-the-shelf. Persons who may be very competent to operate modern vessels may have difficulty operating a historic vessel safely without undergoing considerable additional training and gaining experience specific to the particular vessel. This is a problem that is increasing with the passage of time. About thirty years ago, time in steam reciprocating vessels ceased to be counted towards a marine engineer's steam endorsement. In recent years, there has been a shortage of steam qualified engineers who can operate Museum steamers. Modern requirements for revalidation of tickets have reduced the available pool even further, eliminating some retirees. The time has already arrived where Museum organizations are being forced to establish training regimes that offer restricted tickets for steam engine drivers to operate their vessels. The decision to operate a Museum vessel is also a decision to find people willing to train as crew and to establish a training regime within the Museum.

Ethical challenges

A Museum has a difficult task to balance its preservation and operation objectives with its safety obligations. Unlike the operators of most other commercial vessels, operation of a historic vessel may not be central to achieve the objectives of a Museum. Museums have broader objectives to preserve and interpret maritime heritage. Operation is but one possible means of achieving these broader objectives. A Museum must weigh the benefits of operation against the ethical costs. The following are typical of the questions that need to be considered—

1. To what extent will/should "original" fabric (i.e. material) be lost to achieve operational objectives?
2. To what extent will/should authenticity be compromised for operational safety?
3. Are the risks associated with operation consistent with levels of risk normally considered acceptable for the vessel as a museum artifact?

Financial challenges

In addition to the normal financial challenges presented by return on investment and ongoing maintenance, operational museum vessels face special challenges. The first is that the technology is often relatively uneconomic in a modern context requiring larger crews, greater maintenance and/or more fuel. A second challenge is that Museum vessels have an indefinite service life. There can be no relief from addressing long term aspects of deterioration. Avoiding such work in anticipation that the vessel might be scheduled for replacement in the short to medium term is not an option.

3. STANDARDS FOR SAFETY

Commercial vessels in Australia are generally required to comply with the Uniform Shipping Laws Code (USL Code). Prior to October 2008, the USL Code was largely based on prescriptive standards that dated from the 1970s[17]. These standards represented practical safety solutions for vessels at that time. However, by 1997 it was recognized that the USL Code had become out of date and was not very suited to modern vessels that were entering the commercial vessel industry[18]. The National Marine Safety Committee was established in 1997. One of its major projects has been the revision of the USL Code to bring the standards for safety up to date. The following strategic principles[19] have been applied when reviewing these standards:

a) Incorporate recognized & relevant national & international standards
b) Encourage professional competence
c) Incorporate a performance-based approach
d) Facilitate the approval of new technologies
e) Incorporate OH&S principles
f) Encourage recognition of duty of care
g) Develop the safety system based on sound information

The first sections of the new National Standard for Commercial Vessels (NSCV)[20] that will eventually replace the USL Code were published as part of the USL Code 2008[21] and are now mandatory for new vessels, existing vessels entering survey for the first time and existing vessels upgrading survey. Given that safety standards relevant to vessels in the 1970s have been identified as being unsuited to vessels in the 2000s, how can these new standards be applied to vessels built 100 years ago or more?

The unique nature and needs of museum vessels means they do not fit in well with conventional prescriptive survey standards contained in the USL Code. Many have needed exemptions from application of the standard in order to be granted a certificate of survey.

There are important changes within the new NSCV standards that should assist with the rational safety assessment of museum vessels. These are pre-empted by the strategic principles b), c), d) and f) above. The NSCV focuses on safety outcomes rather than prescriptive solutions. The framework that allows the standards to facilitate approval of new technologies may also apply to the approval of old technologies.

Required outcomes, deemed-to-satisfy solutions and equivalent solutions

The NSCV Part B[22] establishes a new framework that combines the flexibility of a performance-based approach with the convenience of prescriptive provisions, see Figure 2. The safety outcomes specified by the ***required outcomes*** can be achieved in two ways, the first is by using the prescriptive ***deemed-to-satisfy solution*** prescribed within the standard, and the second is by using a performance based ***equivalent solution*** that is formulated and specified by the proponent. The key characteristic of equivalent solutions is that they must provide safety outcomes at least ‘equivalent’ to the deemed-to-satisfy solution prescribed within the standard. However, as we shall see, this does not necessarily mean that they have to be measured directly against the deemed-to-satisfy solution. An equivalent solution may be either ***generic*** or ***local***.

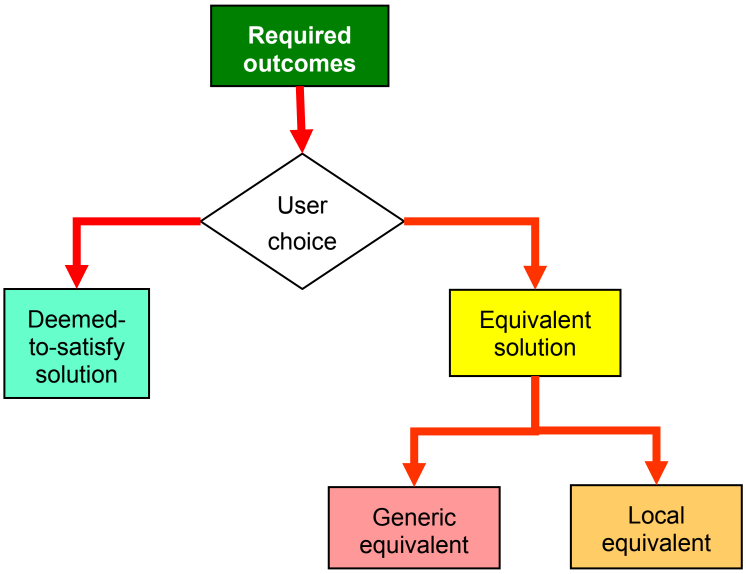

Figure 2—Solution options within the NSCV

4. THE MEANING OF RISK AND ACCEPTABLE RISK

The application of equivalent solutions requires that the proponent has an appreciation of the meaning of "risk". Part B of the NSCV defines risk as *the chance that one or more hazards will cause something to happen that will have a detrimental impact upon safety. It is measured in terms of the* ***likelihood*** *and* ***consequences*** *of injury, illness or environmental damage.*

Part B Annex C of the NSCV provides guidance on acceptable risk. The Annex establishes systems of grading for both likelihood (Table 1) and consequence (Table 2) that can be used for assessing the relative risk associated with a specific hazard.

Table 1 – Grading for hazard likelihood (NSCV Part B Annex C)

Level of Likelihood	Descriptive frequency	Probability per hour
1. Frequent	Likely to occur often during the operational life of a particular vessel.	$>10^{-3}$
2. Reasonably probable	Unlikely to occur often but which may occur several times during the total operational life of a particular vessel	$<10^{-3}$ & $> 10^{-5}$
3. Remote	Unlikely to occur to every vessel but may occur to a few vessels of a type over the total operational life of a number of vessels of the same type	$<10^{-5}$ & $>10^{-7}$
4. Very remote	Unlikely to occur when considering the total operational life of a number of vessels of the type, but nevertheless should be considered as being possible	$<10^{-7}$ & $>10^{-9}$
5. Improbable	Occurrence is so extremely remote that it should not be considered as possible to occur	$<10^{-9}$

Table 2 – Grading for hazard consequence (NSCV Part B Annex C)

Level of Consequence	Description
1. Minor	An effect which can be readily compensated for by the operating crew
2. Major	Significant increase in operational duties. Significant degradation in handling characteristics, etc
3. Hazardous	Dangerous increase in the operational duties of the crew; dangerous degradation of handling or strength characteristics; marginal or actual conditions for, or injury to, occupants; need for outside rescue operations.
4.Catastrophic	An effect which results in the loss of the vessel and/or fatalities

The combination of hazard likelihood and hazard consequence is the key parameter that determines whether a particular risk is acceptable. The table of acceptable risk shown in Table 3 comes from NSCV Part B Annex C and is based on allowable risk levels applied to aircraft and high speed vessels.

Table 3 – Table of acceptable risk (NSCV Part B Annex C)

		Hazard likelihood				
		Improbable	**Very Remote**	**Remote**	**Reasonably Probable**	**Frequent**
Hazard consequence	**Minor**	Negligible	Negligible	Negligible	Tolerable	Tolerable
	Major	Negligible	Negligible	Tolerable	Tolerable	**Intolerable**
	Hazardous	Negligible	Tolerable	**Intolerable**	**Intolerable**	**Intolerable**
	Catastrophic	Tolerable	**Intolerable**	***Intolerable***	**Intolerable**	**Intolerable**

Looking at this table, a remote hazard with catastrophic consequences would amount to an intolerable risk which would be unacceptable. Figure 3 illustrates the principles contained in Table 1 to Table 3 assuming 24 hours per day operation. A frequent occurrence would occur on average within 42 days, a reasonably probable occurrence would occur between 42 days and 11.4 years, and so on. The tolerable frequency for catastrophic consequence occurs not less than 114,000 continuous years of vessel operation. This seems incredulous, but compare against the likelihood of winning Lotto playing four games per week. The frequency of winning all six numbers would take an average 39,000 years. Given that the tolerable average frequency for catastrophic loss from any one hazard is 114,000 years, it does not take very many different hazards before the tolerable likelihood of being involved in a catastrophic incident on a commercial vessel exceeds the likelihood of winning Lotto.

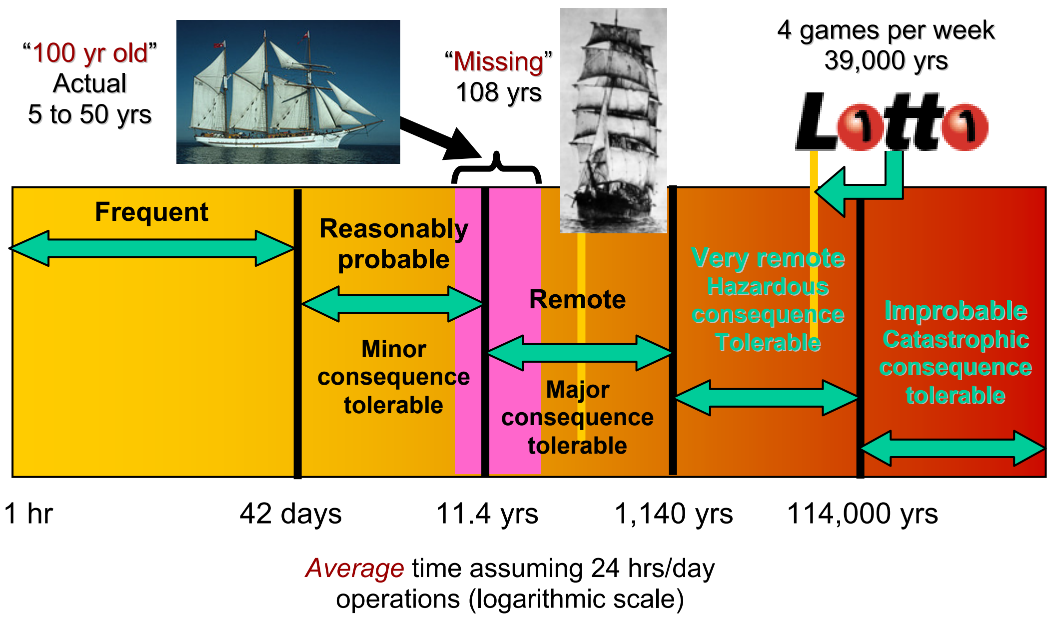

Figure 3—Tolerable consequences for varying event likelihoods

The figure also shows an estimate for the historical probability of an iron, steel or composite sailing vessel going missing from the analysis of data referred to earlier[23]. This estimate suggests that on average, one such vessel would go missing for every 108 years of operation. Clearly, lying in the remote likelihood range, such levels of catastrophic risk are not acceptable by today's standards.

It has often been said that because an old vessel has survived to be 100 years old, this is proof enough that the vessel is safe. The fallacy of this argument becomes clear when the exposure of 100 year old vessel is plotted in the figure. A 100 year old vessel will probably have actually operated only between 5 years and 50 years, depending upon whether it is recreational or commercial. That total exposure after 100 years of existence, when compared against the exposure needed to establish whether hazardous or catastrophic risks are tolerable, is insufficient to establish a pattern let alone lead to any conclusions. This should be of no surprise: many a vessel may contain latent defects that are never actually tested during the vessel's life.

5. METHODS TO REDUCE RISK

An equivalent solution applicable to a historic vessel must find alternative means to manage risk. Table 3 provides an insight into possible ways of modifying risk.

Option 1: Modifying likelihood of exposure to hazards

Starting with the earlier example of an intolerable risk that arises from a remote hazard with catastrophic consequences, the risk can be made tolerable by reducing the likelihood of exposure to the hazard to a level that is improbable, see Table 4. Some possible measures that may reduce the likelihood of exposure are listed as follows:

a) Limits on area of operation (no more Cape Horn!)
b) Limits on weather and sea conditions
c) Optimised operating displacement
d) Modern navigation equipment
e) Modern communication equipment
f) Modern weather forecasting
g) Crew having special knowledge of hazards
h) Safety management systems
i) Reduced operation

The last listed suggestion of reduced operation can reduce exposure to hazards by a factor of 100 or more. Very occasional operation of an otherwise riskier than usual museum vessel under controlled conditions could possibly be considered acceptable in the same way that New Years Eve fireworks are acceptable notwithstanding the increased potential fire risk. An example of such operation is the occasional sailing of the large iron barque Star of India in San Diego; a vessel that is not mechanically propelled and has minimal unauthentic structural alterations.

Table 4 – Modifying risk by changing likelihood of exposure to hazard

		Hazard likelihood				
		Improbable	**Very Remote**	**Remote**	**Reasonably Probable**	**Frequent**
Hazard consequence	**Minor**	Negligible	Negligible	Negligible	Tolerable	Tolerable
	Major	Negligible	Negligible	Tolerable	Tolerable	**Intolerable**
	Hazardous	Negligible	Tolerable	**Intolerable**	**Intolerable**	**Intolerable**
	Catastrophic	*Tolerable*	**Intolerable**	**Intolerable**	**Intolerable**	**Intolerable**

Option 2: Modifying the consequences of exposure to hazards

Another approach is to reduce the consequences of exposure to a hazard. Taking the earlier example of an intolerable risk that arises from a remote hazard with catastrophic consequences, the risk can be made tolerable by reducing the consequences of exposure to the hazard to a level that is major, see Table 5. Some possible measures that may reduce the consequences of exposure are listed as follows:

a) Systems forgiving of human error
b) Auxiliary machinery
c) Additional bilge pumps
d) Subdivision
e) Emergency preparedness
f) Comprehensive life saving equipment
g) Comprehensive fire suppression equipment

Table 5 – Modifying risk by changing consequence of exposure to hazard

		Hazard likelihood				
		Improbable	**Very Remote**	**Remote**	**Reasonably Probable**	**Frequent**
Hazard consequence	**Minor**	Negligible	Negligible	Negligible	Tolerable	Tolerable
	Major	Negligible	Negligible	*Tolerable*	Tolerable	**Intolerable**
	Hazardous	Negligible	Tolerable	**Intolerable**	**Intolerable**	**Intolerable**
	Catastrophic	Tolerable	**Intolerable**	**Intolerable**	**Intolerable**	**Intolerable**

Option 3: Modifying both likelihood and consequence of exposure to hazards

A reduction in exposure to a hazard by a factor exceeding 100 (a grade of two or more); or a reduction in consequence by a grade of two or more; are in practise difficult to achieve. Another method to reduce risk is to use a composite approach that reduces both likelihood and consequence concurrently. In the example of the remote hazard with catastrophic consequences, tolerable risk can be achieved by reducing likelihood from remote to very remote, and consequence from catastrophic to hazardous, see Table 6.

Table 6 – Modifying risk by changing likelihood and consequence of exposure to hazard

		Hazard likelihood				
		Improbable	**Very Remote**	**Remote**	**Reasonably Probable**	**Frequent**
Hazard consequence	**Minor**	Negligible	Negligible	Negligible	Tolerable	Tolerable
	Major	Negligible	Negligible	Tolerable	Tolerable	**Intolerable**
	Hazardous	Negligible	*Tolerable*	**Intolerable**	**Intolerable**	**Intolerable**
	Catastrophic	Tolerable	**Intolerable**	**Intolerable**	**Intolerable**	**Intolerable**

The composite approach is essentially an application of defence-in-depth. As already mentioned, some traditional technologies are relatively unforgiving of human error. Defence-in-depth acknowledges that no one defence is likely to be sufficient to convert an intolerable risk to a tolerable one. This is because a single defence places all risk control eggs in the one basket, a single defence is unlikely to be applicable to every situation, and the reliability of any risk control measure is limited (lucky if 99% effective). That is why the carriage of life-saving equipment alone is not a sufficient risk control measure.

Defence-in-depth forms the basis of the deemed-to-satisfy provisions contained within the NSCV. For example consider the provisions that apply to control the risk of flooding in Table 7. The navigation requirements and watertight and weathertight integrity requirements go toward reducing the likelihood of exposure to flooding. The subdivision requirements and requirements for evacuation to save life reduce the consequences of exposure to flooding. An equivalent solution must achieve equivalent safety by alternative means.

Table 7 – Deemed-to-satisfy defence-in-depth provisions for flooding

General area	Specific requirements
Navigation requirements	Navigation competencies, navigation lights, navigation equipment, communication equipment, field of vision from helm
Watertight and weathertight integrity requirements	Structural strength, hull fittings, bilge and seawater systems, deck accessways, loadline and freeboard
Subdivision requirements	Bulkheads, buoyancy, double bottoms, alarms, flooded stability
Requirements for evacuation to save life	Lifesaving equipment, communication equipment, escapes and evacuation paths, emergency preparedness

Risk control measures are not created equal

A key measure of the effectiveness of a risk control measure is its reliability. One can easily anticipate where a risk control measure that fails to work at time of need can be worse than not having the risk control measure at all. Some methods of risk control are more reliable than others. Table 8 specifies a hierarchy of risk control measures. As a general rule, risk control measures that require an element of human intervention in order to work are less reliable compared to other measures and so are less favoured. It stands to reason that measures intended to forgive human error are somewhat compromised where they rely on human intervention. Hence, after *Option 3: Modifying both likelihood and consequence of exposure to hazards* that has the benefits of defence-in-depth, *Option 1: Modifying likelihood of exposure to hazards* is preferred before *Option 2: Modifying the consequences of exposure to hazards*.

Table 8 – Hierarchy of risk control measures

Most reliable	**A. Eliminate the hazard**
↑	**B. Control the risk** ▪ Substitute with something safer ▪ Modify the design ▪ Isolate the hazardous aspect ▪ Apply engineering controls
Least reliable	**C. Reduce the risk** ▪ Administrative controls ▪ Safe work practices ▪ Personal protective equipment

6. SPECIAL FACTORS THAT CAN INCREASE RISK ON MUSEUM VESSELS

The majority of museum vessels were never built to carry passengers. They would probably have not met standards required for passenger service at the time they were built, let alone today. Use of such vessels to carry passengers is effectively an upgrade of service that normally invalidates any grandfathering that might have been otherwise applicable.

Modern materials and/or systems can give rise to new risks. Auxiliary machinery gives rise to additional fire risks. Modern high strength sail cloth and running rigging may eliminate what was a weak link that protected the vessel whenever sails blew out in a gust.

The characteristics of a historic vessel may fall outside modern experience or expectations. The delay when reversing a steam engine via a command on the telegraph is different from direct control of an engine using a throttle. Both unfamiliar operators and other waterway users have been known to underestimate the limited manoeuvrability of a museum vessel compared to that of modern harbour craft.

Museum vessels may be subject to increased risk from potential latent defects caused by the effects of time and wear. The properties of materials may change over long periods of time. Timber may become waterlogged, moving components may fatigue, and structural components may become brittle.

Each of these potential risks if relevant should be addressed as part of a proposal for an equivalent solution.

7. LOCAL EQUIVALENT SOLUTIONS

Museum vessels are well suited to the application of local equivalent solutions. They are normally intended for operation within a limited area.

A local equivalent solution is defined in NSCV Part B Clause 2.7.2.2 as follows:

> *Local equivalent solutions are solutions that are specifically customised for the circumstances of a particular locality or operation within a locality. Local equivalent solutions shall fulfill the applicable required outcomes while the vessel is operating within the particular locality or operation. Information and controls shall be provided to ensure that the effectiveness of the safety system is reassessed prior to the vessel being used in another locality or for an operation where the same special circumstances no longer apply. Additional measures to control risk shall be provided if, upon reassessment, the standard of safety falls below that specified in this National Standard.*

Hence, a local equivalent solution can take into account the specific circumstances of the vessel's intended operation. An example of a local equivalent solution might be the certification of a vessel to carry special personnel[24] in addition to the crew subject to the vessel only operating on specified waters with known and controlled hazards.

8. THE ASSESSEMENT OF EQUIVALENT SOLUTIONS

The benefit of flexibility provided by equivalent solutions is accompanied with a burden of proof[25]. The proponent is responsible for developing an equivalent solution and proving that it provides equivalent safety. There is more than one means of assessing an equivalent solution. Clause 2.7.3 of Part B states:

> *The following assessment methods, or any combination of them, may be used to determine whether a solution complies with the required outcomes:*
>
> *a) Evidence to support that the use of a material, form of construction, design or system of work meets a deemed-to-satisfy solution.*
>
> *b) Evidence to support that the use of a material, form of construction, design, or system of work meets the applicable required outcomes.*
>
> *c) Quantitative comparison with the deemed-to-satisfy solution.*
>
> *d) Quantitative risk analysis.*
>
> *e) Expert judgment with or without qualitative risk analysis.*

The content of the Clause 2.7.3 provides a range of potential methodologies for proving equivalence. Note in particular that a combination of these methods may also apply. Such combinations may help to significantly improve confidence in the conclusions of the assessment.

9. NOVEL VESSELS

Not all museum vessels can be accommodated by equivalent solutions. Some vessels have features that make them inherently more dangerous. Shallow-draft, hard-chine scows were prone to capsize and may pose unacceptable risks[26]. The explosive characteristics of vessels with inboard petrol engines are quite unforgiving[27].

While a surveyor is obliged to accept solutions that provide equivalent safety to the deemed-to-satisfy standard as being equivalent, the surveyor is unable to accept as equivalent solutions that fall below the safety outcomes of the deemed-to-satisfy solution.

The Authority is still normally able to exempt vessels that fall outside legislated standards using its power of exemption under the enabling legislation. Such powers are rarely unfettered and tend not to be exercised lightly. However, the NSCV may still be able to provide an alternative approach. Part F of the NSCV deals with Special Vessels. These are vessels that have hazards and risks that cannot be adequately or appropriately addressed by the requirements for conventional vessels contained in Parts B to E of the NSCV. Special Vessels include Fast Craft, Hire and Drive Vessels, Novel Vessels and Special Purpose Vessels. Part F Section 3 of the NSCV will deal with Novel Vessels; i.e., vessels for which the hazards and risks are not adequately addressed by the other sections of the standard. Part F Section 3 has not yet been written but will likely be based on a *safety case*[28] approach where the risks are assessed for the particular vessel in the context of its particular operation.

While the safety case concept is rather open-ended and vague, provisions contained within air safety legislation may provide some guidance for a possible approach that could be applicable to operating museum vessels. The Civil Aviation Safety Regulations[29] provide for Limited Category Aircraft that do not comply with the full airworthiness codes. The category permits otherwise ineligible aircraft to be certificated for special purposes that include operating historic or ex-military aircraft. Conditions of Limited Category Certification include:

a) Not more than 6 people
b) Some aircraft are restricted in where they can fly
c) The aircraft must be airworthy and maintained
d) A satisfactory history of operations…etc

A key characteristic that differentiates Limited Category Certification is that it requires persons to be warned of the additional risks of flying on the aircraft prior to doing so. The legislation specifies the provision of warning signs, explanations, special briefings and acceptance in writing. The warning sign is to be of the form shown in Figure 4.

Figure 4—Warning sign for aircraft with Limited Category Certification

The Civil Aviation Safety Regulations take an interesting approach by attempting to change the expectations of users as to what is an acceptable level of risk. This is consistent with other real life choices in other pursuits such as wilderness bushwalking or surfing. However, there are at least three constraints on the approach. The first is that OH&S still requires a safe workplace. The second is that third parties (such as bystanders), not being persons on board a vessel, should not be exposed to additional danger. The third is that there are statutory implied warranties associated with the supply of services that cannot be contracted out[30].

Just as it is better practise in general to avoid the likelihood of exposure to hazards, it is better for any relative deficiency inherent in a novel vessel that might apply the above approach to be in measures designed to reduce the consequences of exposure to hazards.

10. CONCLUSIONS

The operation of Museum vessels poses special challenges. The decision on whether a Museum vessel should be operational needs to balance ethical and practical needs against the obligation to provide for safety. Operating a vessel under survey can have a number of benefits that include the proactive application of a safety system, the ability to greatly enhance the visitor experience and as a means of raising funds.

The National Standard for Commercial Vessels permits flexibility in the methods used to achieve safety outcomes. In those areas where a historic vessel may fail to comply with modern deemed-to-satisfy safety standards, equivalent solutions may be devised that creatively achieve the same outcomes using risk-based methods. The benchmark for equivalence is the level of safety provided by the deemed-to-satisfy provisions contained within the standard. Such equivalent solutions can use means other than the deemed-to-satisfy solution to reduce either the likelihood or consequences of exposure to hazards, or a combination of both.

Not all issues arising from the operation of historic vessels will be suited to resolution by equivalent solutions. The National Standard for Commercial Vessels will provide another avenue for consideration in its provisions for "novel vessels". An approach used by regulators of civil aviation may be worthy of consideration in the context of novel vessels. So-called Limited Category Certification permits operation of certain aircraft (including historic aircraft) that would otherwise be incapable of certification. This apparent allowable reduction in the minimum standards for safety is on the basis that user expectations for safety can be modified.

11. NOTES AND REFERENCES

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[7] For example: Commercial Vessels Act (NSW) 1979 Section 7 http://www.austlii.edu.au/au/legis/nsw/consol_act/cva1979197/
[8] See the National Standard for Commercial Vessels Part A Safety Obligations for guidance http://www.nmsc.gov.au/documents/NSCV/PARTA.PDF
[9] Commercial Vessels Act (NSW) 1979 Section 4A
[10] For example: Occupational Health and Safety Act (NSW) 2000 http://www.austlii.edu.au/au/legis/nsw/consol_act/ohasa2000273/
[11] Limited liability of shipowners http://www.infrastructure.gov.au/maritime/liability/limitation.aspx
[12] Wikipedia. Australian tort law. http://en.wikipedia.org/wiki/Australian_tort_law
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[22] Australian Transport Council. National Standard for Commercial Vessels Part B—General Requirements. 2005. National Marine Safety Committee Inc. Sydney. http://www.nmsc.gov.au/documents/NSCV/PARTB.PDF
[23] Based on 303 missing vessels of total 2383 of known fate using an estimated average working life for all vessels in database of 20 years, 250 days operation at 24 hours per day.
[24] NSCV Part B Clause 1.8 defines special personnel as all persons who: a) have knowledge of safety procedures and handling of safety equipment on board; b) are not passengers, or members of the crew, or children under one year of age; c) are carried on board in connection with the special purpose of that vessel, or because of special work being carried out aboard that vessel; and d) are able bodied.

[25] Flapan, Mori. Equivalent Solutions—How do they work? Presented at the Marine Safety 2008 Conference. Adelaide. 26-29 May 2008. http://www.nmsc.gov.au/documents/Equivalent%20solutions%20-%20How%20do%20they%20work.pdf

[26] Vessels that carry sail having a range of stability less than 70 degrees are not deemed-to-satisfy; see NSCV Part C Subsection 6A—Intact Stability Criteria; Chapter 6A Criteria. http://www.nmsc.gov.au/documents/NSCV/NSCV%206A%20-%20V3.7%20%20Final%20Draft%20-%20Post%20Edit%2008%2004%20Amended%20-%203.pdf

[27] There is no deemed-to-satisfy solution for inboard petrol engines under the NSCV. See NSCV Part C Subsection 5A—Machinery; Clauses 2.14.2, 2.14.3. http://www.nmsc.gov.au/documents/NSCV/PARTC5A.PDF

[28] Safety case: A document body of evidence that provides a demonstrable and valid argument that a system is adequately safe for a given application and environment over its lifetime. Adelard, at http://www.adelard.com/web/hnav/resources/ascad/index.html

[29] Civil Aviation Safety Regulations (Cth) 1998. Regulation 21.189. http://www.austlii.edu.au/au/legis/cth/consol_reg/casr1998333/s21.189.html

[30] Trade Practises Act (Cth) 1974 Sections 68 and 74. http://www.austlii.edu.au/au/legis/cth/consol_act/tpa1974149/