The New Generation of Passenger Superyachts – SOLAS or PYC?

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ABSTRACT

November 2010 saw the introduction of the new passenger yacht code (PYC) which aims to provide a SOLAS equivalent code for yachts wishing to carry up to 36 passengers. Prior to this code, yachts wishing to carry more than 12 passengers were subject to full SOLAS and Loadline compliance. This paper investigates some of the differences in philosophy between the two compliance options and the impact they may have on large yacht design.

Where in the past international conventions have been considered unreasonable or disproportionately onerous for yachts, the PYC applies substantial equivalence to provide additional flexibility to the Naval Architect and Designers. This paper looks at some of these areas to assess the alternative design considerations that must be made or the benefits that can be achieved when applying the substantial equivalence of the PYC. Some of the topics discussed include lifeboats and lifesaving appliances (LSA), windows, doors, fire protection and interior build and construction materials.

In many matters relating to substantial equivalence the PYC calls for enhancement to damaged stability. Since 2009, under SOLAS, all passenger yachts are required to meet probabilistic damaged stability requirements. Under the PYC some categories of yacht are also required to meet an 'enhanced survivability' standard based on a 2 compartment deterministic approach. This paper also investigates the additional PYC damaged stability criteria and the impact this can have on the subdivision and arrangement of a large yacht.

1. INTRODUCTION

The PYC is a code of practice for yachts of any size which carry 13 to 36 passengers on international voyages. The philosophy of the code is to set out technical, safety and operational standards appropriate to the size and operation of the yachts using the code.

It was recognised that the requirements for commercial merchant passenger ships were "in some instances disproportionately onerous in terms of design and cost" [1] when considering the operating pattern and risk profile of a yacht. As a result the code is based on the relevant international conventions, in particular SOLAS, Loadline and STCW as amended, but applies the Conventions as equivalent standards specific to yachts where appropriate.

At the outset of a new passenger yacht project two options available are to comply with SOLAS and other Conventions in full, or to use the PYC. The decision taken will have a significant impact on the design of the vessel and will also influence cost. This paper investigates some of the differences in philosophy between full SOLAS compliance and the PYC and the impact they may have on large yacht design. Where the PYC does apply substantial equivalence this paper explains the alternative design considerations that must be made or the benefits that can be achieved when applying these equivalences.

Although this paper does provide some background to the PYC, it is assumed that the reader has a basic understanding of the origins of the code and the categories of yacht within it. With that in mind a further aim of the paper is to provide some added insight into the philosophy of the code which may not be immediately obvious from reading the code itself. Where appropriate the paper also makes some broad comparisons with the Large Yacht Code (LYC).

2. PYC BACKGROUND

The success of the LYC in its various forms is measured by the fact that it has long been the de facto standard for large-yacht construction, but the 12 passenger limit has for many been regarded as a severe limitation.

Many larger vessels have guest accommodation far in excess of 12 berths and this has often led to the question, why are we limited to 12 passengers?

The answer to this question lies in the SOLAS Convention, which defines that any ship carrying more than 12 passengers is a passenger ship and this conflicts with the statement that the Convention does not apply to pleasure vessels. Whilst the question as to which of these criteria would dominate may not have been satisfactorily addressed, most administrations, including the Red Ensign Group (REG), adopt the line that the definition of passenger ship will override the general exclusion of

pleasure vessels.

As large yachts grow in size, the 12-passenger limitation becomes more and more apparent and to tackle this, the Maritime Authority of the Cayman Islands (MACI), together with the other REG administrations, spurred on by encouragement from the industry, took on the task of developing the PYC. Creating the PYC was a challenge as it needed to satisfy the regulatory framework for passenger ships carrying up to 36 passengers, whilst retaining the necessary flexibility to ensure that the vessel can be built, to all intents and purposes, as a yacht.

The Code was developed through the REG, but has been widely publicised at various international fora, both during the development stages and after publication. The Code has also undergone a fairly wide industry consultation to test the validity of the approach adopted. This consultation was essential to ensure the acceptability of the Code when it was eventually published.

Once the Code was finalised it was presented to the IMO in the form of a Circular Letter, which essentially describes to the international community the detailed equivalence being put forward by the UK and the REG. As with most Circular Letters, this is generally dealt with by tacit acceptance, however, any Member State is free to object to the equivalence or to reject ships that are built to the equivalence. To date, there has been no such objection to the Code. Originally released in November 2010, the code is now in its 2nd Edition.

3. LIFE SAVING APPLIANCES

Historically LSA has always been a primary focus within SOLAS. For passenger ships the status has always been that lifeboats should be carried. However, a key philosophy of the PYC is to allow vessels to be designed without SOLAS lifeboat provisions, offset against an enhanced survivability of the yacht itself (enhanced resistance to fire and flooding).

The ability to dispense with lifeboats through the PYC can provide some advantages to designers and naval architects. Brightly coloured lifeboats positioned in the superstructure can have a significant impact on the styling of a yacht and also consume large areas of deck. The typical installation height of a lifeboat and davit can also be in excess of typical ‘tween deck heights therefore impacting more than one deck. The installation weight of two SOLAS compliant lifeboats and davit system will also be in the region of 50-60 tonnes depending on size (1.5% of displacement for a typical 100m motor yacht). The required lifeboat location above the waterline will also have the effect of increasing VCG and possibly require an increase in beam.

In the absence of lifeboats PYC requires LSA dry-shod evacuation equivalence in the form of davit launched life rafts (DLLR). The level of redundancy for the number of persons on board has been increased from 150% (for SOLAS) to 300% (for PYC). As an additional option the code also makes provision for the use of marine evacuation systems (MES) but not as the sole means of abandonment. MESs are still relatively new technologies and are not considered suitable for all passengers such as the elderly or infirm due to their dynamic entry. Therefore DLLR is still required. Even considering the higher level of redundancy required a typical installation of DLLR or DLLR/MES will have significantly less impact on the design of a yacht compared to the lifeboats required by full SOLAS.

Figure 3.1 – DLLR & MES

4. LOAD LINE

When developing the PYC a key philosophy was a greater adherence to the Loadline Convention compared to the LYC, except where this was found to be particularly impracticable for a yacht. This is because as passenger ships, there are greater number of persons involved and consequently a greater impact for a particular risk. Also the philosophy of the code is to promote the yacht as a safe and stable platform to justify the reduction in LSA. Hence, it was agreed that a closer compliance with the loadline standard was justified in many areas.

A key area of loadline regulation that impacts on yacht design is sill heights and windows. The PYC now makes clear the use of the ‘virtual freeboard’ concept and in conjunction with a local enhanced survivability stability assessment can provide more flexibility to the design of doors and windows compared to SOLAS.

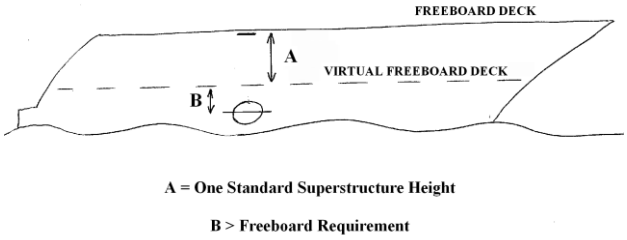

Figure 4.1 – Virtual Freeboard Concept

A typical persistent feature on large yachts is flush deck hatches. However the Loadline/SOLAS framework requires hatches to have a coaming between 450mm-600mm which is clearly not in keeping with the style and

operation of modern yachts. PYC provides equivalence for flush hatches where it can be shown that the spaces below, if flooded, can meet enhanced survivability stability requirements. Similarly, where sufficient freeboard also exists, Administrations are permitted to reduce the height of door sills from 380mm if they are satisfied the safety of the yacht will not be impaired.

With regards to windows, and comparing with Loadline, the PYC introduces several equivalences permitting windows to be fitted in locations that would not be permitted otherwise. Where a sufficient level of excess freeboard exists windows can be fitted in the 1st tier superstructure. Additionally where the required excess freeboard cannot be fully met the Administration may still consider windows in the 1st tier subject to an equivalent level of safety being achieved (which includes the vessel meeting enhanced survivability requirements with the spaces being served flooded). Windows can also be fitted in a superstructure that is considered buoyant for stability. In this case the windows should be designed to meet the requirements of Type A side scuttles taking into account the increased panel dimensions. In terms of design, windows are an important influence on the style of a yacht and to allow as much natural light into the interior spaces as possible. It can be seen that the PYC provides additional flexibility to designers when considering the available positions for windows in the hull. The use of bonded windows and not just metal frames is also considered which is important for styling in some cases. The PYC will also, in general, permit deadlights and storm shutters for side scuttles and windows to be portable if the standard of glazing is considered sufficient. However it should be noted that when achieving equivalence there are also disadvantages to consider. Depending on the size of windows the increase in glass thicknesses can be substantial which will lead to increased weight. The additional cost and engineering required must also be considered.

5. FIRE PROTECTION & MATERIALS

A key philosophy of the PYC is that "A fully addressable fire detection and extinguishing system is required in all yachts to which the Code applies." [1] This is to be installed in all spaces on the yacht except those which "Afford no substantial fire risk such as void spaces". This requirement is an enhancement on SOLAS and has been applied to offset the reduced lifeboat carriage requirements. All categories of PYC yacht have to meet this requirement.

This in its self is not a significant departure from normal yacht practice as LYC vessels also have such fire systems. However LYC vessels are permitted to use combustible outfit materials whereas for PYC vessels, tighter controls on materials are implemented as per SOLAS. The SOLAS requirements are far more stringent than LYC and place severe limitations on the materials that can be used in the interior outfit construction and finishing. In general materials are to be non-combustible, low flame spread, not readily ignitable, of restricted fire risk, calorific value and smoke production.

This will have a specific impact on yacht interior and yard practice. The materials used in interior design for linings, decoration and coverings are of particular importance to the owners and interior architects in order to generate the desired look and feel to the interior. Yards will also have their own preferred interior construction methods, materials and suppliers. All would have to be revaluated when designing a passenger yacht.

However, compared to SOLAS, the PYC does contain some equivalences. Requirements for furniture and furnishings of exterior balconies and open decks may be relaxed where a fire hose can be directed on to the area from the deck immediately above or protected by a suitable fire detection and extinguishing system. Under certain conditions the use of non-low flame spread outfit materials in owner and guest areas not serving as escape routes can also be specifically considered under PYC. This provides some additional interior design flexibility compared to SOLAS. However, proposals have to be agreed on an individual basis with the Flag Administration.

6. ARRANGEMENTS – ESCAPE & MLC

The PYC makes no substantial equivalences for means of escape and SOLAS passenger ship requirements are applied throughout. However it should be noted that these are more onerous than that applied in the LYC and can often have a significant influence on a GA. Dead-end corridors, cabins opening on to escape routes, multiple doors in engine room bulkheads and means of escape from WT compartments are all issues that need to be overcome when developing a general arrangement. It is important to understand and consider the requirements early in the design cycle to avoid significant arrangement problems at a later stage.

The Maritime Labour Convention 2006 (MLC) is now fully ratified and will come into force on 20th August 2013. The impact of MLC crew cabin sizes has been widely researched and published in the public domain. A R&D project carried out by some of the authors can also be referred to [2]. Unlike LY3 (which has a substantial equivalence to MLC as per the work of TWG95) SOLAS vessels will be required to meet the MLC in full. Currently the PYC incorporates the design requirements of the MLC into the code. However, following the publication of LY3 the Red Ensign Group will consider the substantial equivalence agreed for the crew accommodation requirements to see how this can apply to PYC vessels and to what extent this will be included. However, equivalence aside, it should be noted that passenger ships have some advantages compared to cargo ships. Crew cabins of up to 4 persons are permitted. This can half the number of bathroom/WCs compared to a twin cabin format and therefore reduce the impact of the MLC on space. Crew cabins on passenger ships are

also permitted below the waterline providing additional flexibility for general arrangements.

7. STABILITY

All vessels under the PYC are required to comply with the intact stability requirements of IS Code 2008 in accordance with SOLAS. However it is the topic of damaged stability where the PYC contains some significant differences to SOLAS. The damaged stability requirements are multifaceted and the regulations which apply to a particular yacht are determined by whether the yacht is over/under 80m loadline length (LL), whether it will be engaged in trade (charter), whether it will have a restricted area of operation, and the number of persons on board.

SOLAS now requires all passenger ships to comply with the probabilistic stability standard introduced in 2009. However, the PYC allows yachts of less than 80m LL to use the preceding 1990 deterministic stability method. This decision was taken due to lack of probabilistic data for yachts in this length range. The deterministic and probabilistic methodologies both have their own advantages and disadvantages, but for yachts of less than 80m to have the choice is a significant departure from SOLAS. The probabilistic approach certainly has some differences which naval architects may prefer to avoid. Damage to B/2 (not B/5) has to be considered. This has a significant impact on systems routing and complexity. The stability calculations themselves are also complex and require specialist software and oversight in the design process. For a more detailed introduction to probabilistic stability on large yachts refer to previous paper [2]. For yachts over 80m LL PYC requires that they must all meet the probabilistic standard in line with current SOLAS requirements but also restates the floodable length criteria, typically associated with the deterministic methodology, to address the potential for long lower holds which are possible using the probabilistic approach.

For private yachts or yachts of a very restricted range (PY2 Category) the PYC does not require any further stability assessment beyond what is described above. However for charter yachts with a longer or unlimited range (PY1 or PYU Category) the PYC applies additional stability requirements as part of the equivalence for dispensing with lifeboats. In these cases an extra deterministic 2 compartment 'Enhanced Survivability' (2CES) standard is applied. This is a key philosophy of the PYC to offset the reduction in lifeboat carriage requirements.

Yachts below 80m complying with SOLAS 90 (deterministic) will in most cases be required to meet a 1 compartment standard. Hence by applying the 2CES an increase in subdivision and an enhancement in safety is achieved. The increased subdivision will have an impact on the design. More transverse bulkheads results in more weight and more stairwells effecting the general arrangement. For yachts over 80m LL (probabilistic) the design impact of applying 2CES is not so obvious. Section 9 of this paper investigates this issue through a case study of a 105m motor yacht.

Yacht	80m LL	PYC (No Lifeboats)	SOLAS (Lifeboats)
Pleasure Vessel Unlimited Range	Under	SOLAS 1990 (Deterministic)	SOLAS 2009 (Probabilistic)
	Over	SOLAS 2009 (Probabilistic)	SOLAS 2009 (Probabilistic)
Charter Vessel PY2 Range	Under	SOLAS 1990 (Deterministic)	SOLAS 2009 (Probabilistic)
	Over	SOLAS 2009 (Probabilistic)	SOLAS 2009 (Probabilistic)
Charter Vessel PY1 Range	Under	SOLAS 1990 (Deterministic) & 2CES	SOLAS 2009 (Probabilistic)
	Over	SOLAS 2009 (Probabilistic) & 2CES	SOLAS 2009 (Probabilistic)
Charter Vessel Unlimited Range	Under	SOLAS 1990 (Deterministic) & 2CES	SOLAS 2009 (Probabilistic)
	Over	SOLAS 2009 (Probabilistic) & 2CES & 50 persons maximum	SOLAS 2009 (Probabilistic)

Figure 7.1 – Damaged Stability PYC / SOLAS

When comparing stability methods between full SOLAS and PYC it can be seen that in some cases the requirements of PYC are more onerous. The primary point to remember is that the PYC requirements are made in lieu of lifeboats where under full SOLAS lifeboats would be on board.

Another point to note is that for charter vessels of unlimited range and over 80m LL, the number of persons on board is limited to 50. This is a low complement for a yacht of this size and is a key philosophical point of the code that large yachts in this category should actually be fitted with lifeboats if they want significant numbers of people on board.

8. OTHER AREAS

Under SOLAS, vessels over 120m LL or having 3 or more main vertical zones are required to comply with the safe return to port regulations. Yachts under PYC are not required to meet this standard. This standard would have a fundamental effect on the arrangement of engine and auxiliary machinery rooms if it had to be applied.

In general, under PYC, the requirements for hull construction and installation of machinery and electrical systems must all comply with SOLAS as written. When considering Class, ship rules also become applicable. Naval architects and engineers previously experienced in LYC type yachts should be aware of the impact of moving to the more prescriptive ship rules as there can be a significant increase in complexity and weight. Un-

manned machinery spaces are also not permitted for passenger yachts. Machinery spaces can still be designed to UMS notation but manning of the machinery rooms is still required whether under charter or private use.

The introduction of the PYC has provided owners and operators with an interesting dilemma. Unlike standard SOLAS, PYC offers a range of categories to which a yacht can be designed and built. The choice of which category is most suitable is not a trivial decision. Apart from the design aspects, other areas such as charter operating profiles and re-sale value also need to be considered.

9. ENHANCED SURVIVABILITY – IMPACT ON DESIGN

Under the PYC, yachts greater than 80m LL (probabilistic) with a PY1 or PYU notation must also meet the two compartment enhanced survivability (2CES) standard if they do not carry lifeboats. This Section discusses a case study for a 105m motor yacht. It has been assessed to both the probabilistic stability standard (SOLAS 2009 Regulation 7) and the PYC deterministic 2CES standard. As a result, the impact of having no lifeboats on the subdivision of a large yacht could be determined.

9.1 PROBABILISTIC VS DETERMINISTIC (2CES)

Despite very different formulations the probabilistic and 2CES methodologies are not completely dissimilar. Both standards work by studying the vessel's ability to withstand a specific set of damage cases through the assessment of the vessel's equilibrium particulars and GZ curve characteristics after damage.

The set of damage cases defined for the probabilistic study is also not far removed from that defined for a 2 compartment deterministic study. It could be argued that the depth of damage penetration differs (B/5 vs B/2); however on a typical yacht the difference it makes to the space actually flooded is limited only to specific areas designed with longitudinal subdivision (such as tankage in the double bottom).

Also, when assessing the vessel to the probabilistic standard, the damage zones tend to be defined to match the vessel's main transverse watertight boundaries (at least at preliminary design stage). In such cases, the contributions to the attained index become very small for damage cases that would include 3 or more adjacent damage zones so that most contribution to the attained index is in practice from damaged cases of up to 2 compartments long.

Finally, if the probabilistic study requires the assessment of every single damage case possible, the 2CES methodology also requires the study of "any damage of lesser extent that would result in a more severe condition". In practice the naval architect would use his judgement to discard any damage cases that would not be critical. This is not allowed under the probabilistic methodology but the outcome of the study is still led by the worst case scenario that would normally be defined for a deterministic study.

Therefore the fundamental difference between both standards does not reside in the way the study is performed but in the interpretation of the results. Unlike the 2CES methodology, the probabilistic standard does not require the vessel to pass all damage cases studied as long as it achieves an "overall" level of safety deemed to be satisfactory.

In other words, if the 2CES methodology requires the same minimum level of safety across the entire length of the vessel, the probabilistic standard only requires that the minimum level of safety be achieved "on average".

As a consequence, the probabilistic standard allows the design of local areas with low subdivision density if elsewhere the vessel exhibits a higher than average ability to withstand damages.

Hence by applying the 2CES a minimum level of safety is imposed across the entire vessel length and an enhancement in safety is achieved. The actual impact on the subdivision is discussed in the following text.

9.2 METHODOLOGY

The subdivision layout of the 105m yacht was developed to comply with both the probabilistic standard and the 2CES as required for a PY1 or PYU yacht (i.e. no lifeboats). This was the basis subdivision arrangement.

On the assumption that the vessel will now carry lifeboats the basis subdivision layout was modified to take advantage of the flexibility offered by the probabilistic stability method when not constrained by the additional deterministic 2CES standard.

9.3 ALTERNATIVE LAYOUTS & RESULTS

Basis Layout

The basis layout passes the 2CES standard and the probabilistic requirements. The margin on the Attained Index ('A') is 26%.

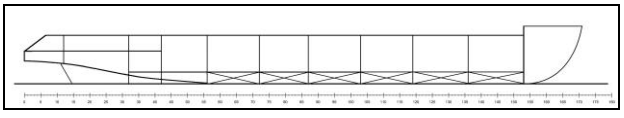

Figure 9.1 – Simplified Illustration of the Basis Layout

Alternative Layout 1

For this iteration, one bulkhead forward of the engine room was removed and the remaining bulkheads were equally spaced between the forward engine room bulkhead and the collision bulkhead.

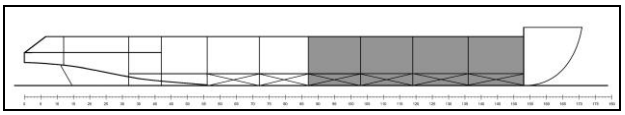

Figure 9.2 –Area Modified for the Alternative Layout 1

This Arrangement still passes the probabilistic stability requirements with 13% margin on 'A' but now does not comply with the 2CES requirements.

Alternative Layout 2

For this iteration, the aft beach club / tender bay area was extended through to the next watertight compartment by removing one bulkhead above the lower deck only.

This Arrangement also passes the probabilistic requirements with 18.5% margin on 'A' but also does not comply with the 2CES requirements.

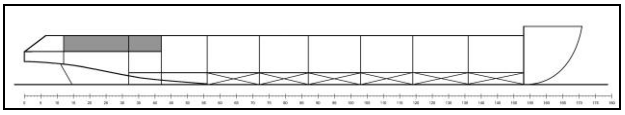

Figure 9.3 –Area Modified for the Alternative Layout 2

Alternative Layout 3

For this iteration, the modifications to the basis design considered for Iteration 1 and 2 are applied at the same time. This Arrangement still passes the probabilistic requirements with 4.9% margin on 'A' but fails the 2CES requirements.

These modifications affect different parts of the ship, so that there is no interaction between the two modifications. As a consequence, the attained index simply decreases by the sum of the Attained Index drop in value experienced in Iteration 1 and 2. If there was a cross-over between the damage cases of Iteration 1 and 2 the drop in the final Attained Index would be more severe.

9.4 SUMMARY OF FINDINGS

Through the evaluation of the three alternative layouts the impact on subdivision of applying the 2CES standard has been demonstrated. It is clear that the 2CES standard requires more subdivision than probabilistic and therefore enforces an additional level of safety in lieu of lifeboats. It has also been shown that if lifeboats were to be carried the reduction in subdivision possible can provided additional benefits. Fewer bulkheads in the forward half of the ship (and therefore fewer stairwells and vertical escapes) or a larger beach club / tender bay can be of significant importance on a yacht and will provide more flexibility to designers. It could also reduce the construction complexity and cost.

The subdivision layouts studied are just examples of what can be achieved. Another advantage of the probabilistic standard is that arrangements can be optimised to accommodate special features requested by an owner.

Finally, it should be remembered that the SOLAS 2009 stability assessment is not just limited to a probabilistic study (Regulation 7), but also the minor damage requirements (Regulation 8) apply and could in some cases be a design driver.

10. CONCLUSIONS & THE FUTURE

The Code has been well received by industry and a number of projects being built in accordance with the Code are in progress. It is recognised that this is a dynamic standard and regular updates are envisaged for the first five years of operation.

It is clear that the PYC offers much substantial equivalence to SOLAS providing added flexibility to designers and naval architects. It is worth remembering that where the full SOLAS route is taken, any deviation from the regulations requires approval of any equivalence to be granted by the Flag State Administration on a case by case basis adding more inertia to the design process in way of 'red tape'. PYC can offer a more convenient route to compliance.

With the introduction of the PYC and the various categories of yacht within it, the decision of which option to take is no longer a trivial one. The LYC has now also had removed the 3000 GRT limitation (LY3), further adding to the complexity. There is a balance to be considered in terms of design, operation and cost. A good understanding of the regulations and their impact is essential.

Finally, it must be emphasised that the regulatory framework for passenger yachts is a significant step change in philosophy and complexity compared to the LYC (cargo ship framework). However, compared to full SOLAS, the PYC makes significant progress in integrating yachts into the territory of passenger ships.

11. REFERENCES

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12. AUTHORS' BIOGRAPHIES

Alex Meredith Hardy is a Naval Architect at BMT Nigel Gee. He has worked on a wide range of commercial and yacht projects including concept designs, refits and new builds and is currently on the design team for several large yacht projects. He has more recently specialised in the design of passenger yachts.

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