

THE RED ENSIGN GROUP

A CODE OF PRACTICE FOR YACHTS CARRYING 13 TO 36 PASSENGERS

(THE PASSENGER YACHT CODE)

(FIFTH EDITION – JANUARY 2015)

This Code of Practice applies to pleasure yachts of any size, in private use or engaged in trade, which carry more than 12 but not more than 36 passengers and which do not carry cargo.

ANNEX 2

**TECHNICAL STANDARDS FOR HELICOPTER LANDING AREAS AND
HELICOPTER OPERATING STANDARDS.**

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ANNEX 2

TECHNICAL STANDARDS FOR HELICOPTER LANDING AREAS AND HELICOPTER OPERATING STANDARDS.

PREAMBLE TO ANNEX 2

(This Preamble is provided for explanatory purposes and is not part of the Annex 2 or Code provisions)

1. *This updated Annex has been takes into account the nature of helicopter operations on large yachts. In general terms the development of the requirements for helicopter operations in the marine sector and in particular helidecks has largely been driven by the offshore oil and gas industry. Whilst some of the core provisions and philosophies are of course relevant in any scenario involving helicopter operations on ships, the large yacht sector does operate in quite a different environment to the offshore industry and therefore the yacht sector is better served and appropriate safety standards maintained if this is recognised with respect to the requirements for helicopter operations in this area.*
2. *Annex 6 of the LY2 Code has been used as the basis for Annex 2 of this Code but it has been modified as outlined above. Specifically, the following revisions are among those which have been made-*
 - (a) *the requirement for a landing area safety net has been omitted since this is very much a requirement which is more relevant to the offshore petroleum industry operations.*
 - (b) *the “falling gradient” provision has been removed on the basis that this is not relevant to large yacht operations; the falling gradient requirement is based on the assumption that a helicopter will approach the landing area in an athwartships direction whilst in reality however, helicopters will fly up the wake of the yacht while it is under way and will land facing fore and aft on the helideck and therefore the falling gradient is irrelevant; this angle of approach is also safer as the vessel is generally steaming into wind and sea which means there is less helideck movement and also the pilot has a far better overshoot capability with an engine failure from this approach angle;*
 - (c) *in parallel with these modifications greater emphasis has been put on risk assessment at the design stage as well as early liaison with the appropriate civil aviation authorities to ensure that all relevant aspects of the proposed operation are properly covered.*

November 2010

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1. APPLICABILITY:

- 1.1. This Annex outlines the minimum standards for helicopter landing areas, and associated facilities on board vessels within the scope of this Code where helicopter operations to or from the vessel are required. It also addresses operational considerations as related to the yacht crew.
- 1.2. This Annex does not address helicopter flight operations in any detail. It is intended as a technical standard for the landing area and associated on-board helicopter facilities. The helicopter pilot/operator is responsible for ensuring that the requirements of the Administration with which the helicopter is registered and the requirements of the Administration responsible for the airspace in which the helicopter is operating are complied with in full. The Aviation Inspection Body may provide further guidance.
- 1.3. Enquiries regarding operational (flight) limitations based on non-compliances of the landing area should be directed to the Aviation Inspection Body.

2. GENERAL CONSIDERATIONS:

- 2.1. Requirements with respect to a Helicopter Landing Area (HLA) on a vessel results from the need to ensure that helicopters are afforded sufficient space to be able to operate safely at all times in the varying conditions experienced.
- 2.2. In order to ensure safe operation it is envisaged that limitations regarding the availability of the landing area will be applied by the Aviation Inspection Body on behalf of the Administration.
- 2.3. The helicopter's performance requirements and handling techniques are contained in, and governed by, the Rotorcraft Flight Manual and/or the operator's Operations Manual.
- 2.4. In all cases, a formal and documented risk assessment of the operation should be carried out by a suitably experienced and qualified individual authorised by the ship's Flag Administration. The risk assessment should establish the hazards and resultant risks associated with the operation of each helicopter type that it is planned to utilise the HLA of the yacht concerned. This should include the physical requirements for the characteristics of the landing area.

3. HELICOPTER LANDING AREAS – PHYSICAL CHARACTERISTICS:

3.1. GENERAL:

3.1.1. This section provides information on physical requirements for the characteristics of helicopter landing areas on a yacht within the scope of the Code.

3.1.2. The risk assessment carried out as above in order to establish the adequacy of the landing area should include, for each helicopter landing area, the proposed maximum size of helicopter in terms of D-value and the proposed maximum take-off weight of the heaviest helicopter in terms of “t” value for which it is proposed each landing area is certificated with regard to size and strength.

3.1.3. The criteria which follow (see Table 1) are based on helicopter size and weight and are for guidance only.

3.1.4. In addition to the risk assessment, the following plans and particulars should be submitted to the Aviation Inspection Body, Certifying Authority and Administration (as appropriate) for approval-

- (a) Hangar general arrangement (showing dimensions and structural considerations).
- (b) Helicopter lift and movement arrangements (if appropriate).
- (c) Structural fire protection.
- (d) Fire detection and extinguishing arrangements

Table 1
D-Value and Helicopter Type Criteria (Not Exhaustive)

TYPE	D VALUE (M)	PERIMETER ‘D’ MARKING	ROTOR DIAMETER (M)	MAX. WEIGHT (KG)	‘T’ VALUE
Eurocopter EC120	11.52	12	10.00	1715	1.7
Bell 206 B3	11.96	12	10.16	1451/1519	1.5
Bell 206 L4	12.91	13	11.28	2018	2.0
Bell 407	12.61	13	10.66	2268	2.3
Eurocopter EC130	12.64	13	10.69	2400	2.4
Eurocopter AS350 B3	12.94	13	10.69	2250	2.3
Eurocopter AS355	12.94	13	10.69	2600	2.6
Eurocopter EC135	12.10	12	10.20	2720	2.7
Agusta A119	13.02	13	10.83	2720	2.7

TYPE	D VALUE (M)	PERIMETER 'D' MARKING	ROTOR DIAMETER (M)	MAX. WEIGHT (KG)	'T' VALUE
Bell 427	13.00	13	11.28	2971	3.0
Eurocopter EC145	13.03	13	11.00	3585	3.6
Agusta A109	13.04	13	11.00	2850	2.9
Agusta Grand	12.96	13	10.83	3175	3.2
Eurocopter AS365 N3	13.73	14	11.94	4300	4.3
Eurocopter EC155 B1	14.30	14	12.60	4920	4.9
Bell 430	15.29	15	12.80	4218	4.2
Sikorsky S76	16.00	16	13.40	5318	5.3
Agusta Westland 139	16.66	17	13.80	6400	6.4
Bell 412	17.10	17	14.02	5398	5.4

3.2. HELICOPTER LANDING AREA DESIGN CONSIDERATIONS – ENVIRONMENTAL EFFECTS:

Introduction

3.2.1. The safety of helicopter flight operations can be seriously degraded by environmental effects that may be present around vessels. The term “environmental effects” describes the effects of the vessel, its systems, and forces in the surrounding environment, which result in a degraded local environment in which the helicopter is expected to operate. These environmental effects are typified by structure-induced turbulence, and turbulence/thermal effects caused by exhaust emissions. Controls in the form of landing area availability restrictions may be necessary and should be imposed via the Aviation Inspection Body. Such restrictions can be minimised by careful attention to the design and layout of the vessel topsides and, in particular, the location of the helicopter landing area.

Guidance for Landing Area Design Considerations

3.2.2. Guidance for landing area design considerations are given in UK Civil Aviation Authority Paper 2004/02 (as may be amended from time to time) which should be consulted by designers of helicopter landing areas at the earliest possible stage of the design process and is available through the CAA website (www.caa.co.uk).

3.2.3. All new helicopter landing areas, or modifications to existing topside arrangements which could potentially have an effect on the environmental conditions due to turbulence around an existing helicopter landing area, or helicopter landing areas

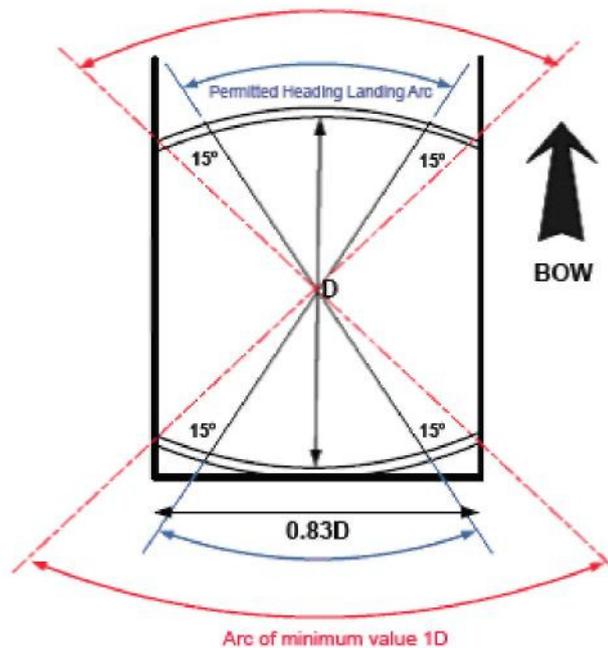
where operational experience has highlighted potential airflow problems should be subject to appropriate wind tunnel testing or Computational Fluid Dynamics (CFD) studies to establish the wind environment in which helicopters will be expected to operate. Operations to a vessel underway where the helideck will be subjected to relative rather than true wind velocity should be taken into consideration. As a guide the standard deviation of the vertical airflow velocity should be limited to 1.75m/s. This airflow velocity should be applied to the recommended approach/departure path and landing/take off phase of the aircraft. The helicopter pilot/operator and Aviation Inspection Body should be informed at the earliest opportunity of any wind conditions for which this criterion is not met in order to allow the appropriate platform availability restrictions/limitations to be defined if necessary.

- 3.2.4. Designers of helicopter landing areas should commission a survey of ambient temperature rise based on a Gaussian dispersion model and supported by wind tunnel tests or CFD studies for new build helicopter landing areas, modifications to existing topside arrangements, or for helicopter landing areas where operational experience has highlighted potential thermal problems. When the results of such modelling and/or testing indicate that there may be a rise of air temperature of more than 2°C (averaged over a 3 second time interval), the helicopter pilot/operator and Aviation Inspection Body should be consulted at the earliest opportunity so that appropriate platform availability restrictions/limitations may be applied if necessary.

Size of Landing Area and Obstacle Protected Surfaces

- 3.2.5. For any particular type of single main rotor helicopter, the helicopter landing area should, wherever possible, be sufficiently large to contain a circle of diameter D equal to the largest dimension of the helicopter when the rotors are turning. This D circle should be totally unobstructed (see Table 1 for D values). Due to the actual shape of most helicopter landing areas the D circle will be 'imaginary' but the helicopter landing area shape should be capable of accommodating such a circle within its physical boundaries. It is possible to reduce the width to a value equivalent of $0.83D$ but the longitudinal length must be at least equivalent to $1.0D$.
- 3.2.6. For operations with limited touchdown directions, the LHA should contain an area within which can be accommodated two opposing arcs of a circle with a diameter of not less than $1D$ in the helicopter's longitudinal direction. The minimum width of the landing area shall be not less than $0.83D$. In such arrangements of landing areas, the yacht will need to be manoeuvred to ensure that the relative wind is appropriate to the direction of the helicopter touchdown heading. The touchdown heading of the helicopter is limited to the angular distance subtended by the $1D$ arcs headings, minus 15° at each end of the arc. See Figure 1 below.

Figure 1



3.2.7. From any point on the periphery of the above mentioned D circle an obstacle-free approach and take-off sector should be provided which totally encompasses the safe landing area (and D circle) and which extends over a sector of at least 210° . Within this sector, from the periphery of the landing area and out to a distance that will allow for an unobstructed departure path appropriate to the helicopter that the landing area is intended to serve, only the following items may exceed the height of the landing area, but should not do so by more than 250 millimetres-

- (a) the guttering (associated with the requirements in section 3.2.13;
- (b) the lighting required by sections 4.12 to 4.21;
- (c) the foam monitors;
- (d) those handrails and other items associated with the landing area which are incapable of complete retraction or lowering for helicopter operations; and
- (e) tie down points.

3.2.8. The bisector of the 210° Obstacle Free Sector (OFS) should normally pass through the centre of the D circle. The sector may be 'swung' by up to 15° as shown in Figure 1 below. Acceptance of the 'swung' criteria will normally only be applicable to existing vessels.

3.2.9. The diagram at Figure 2 shows the extent of the two segments of the 150° Limited Obstacle Sector (LOS) and how these are measured from the centre of the (imaginary) 'D' Circle and from the perimeter of the Safe Landing Area (SLA). This

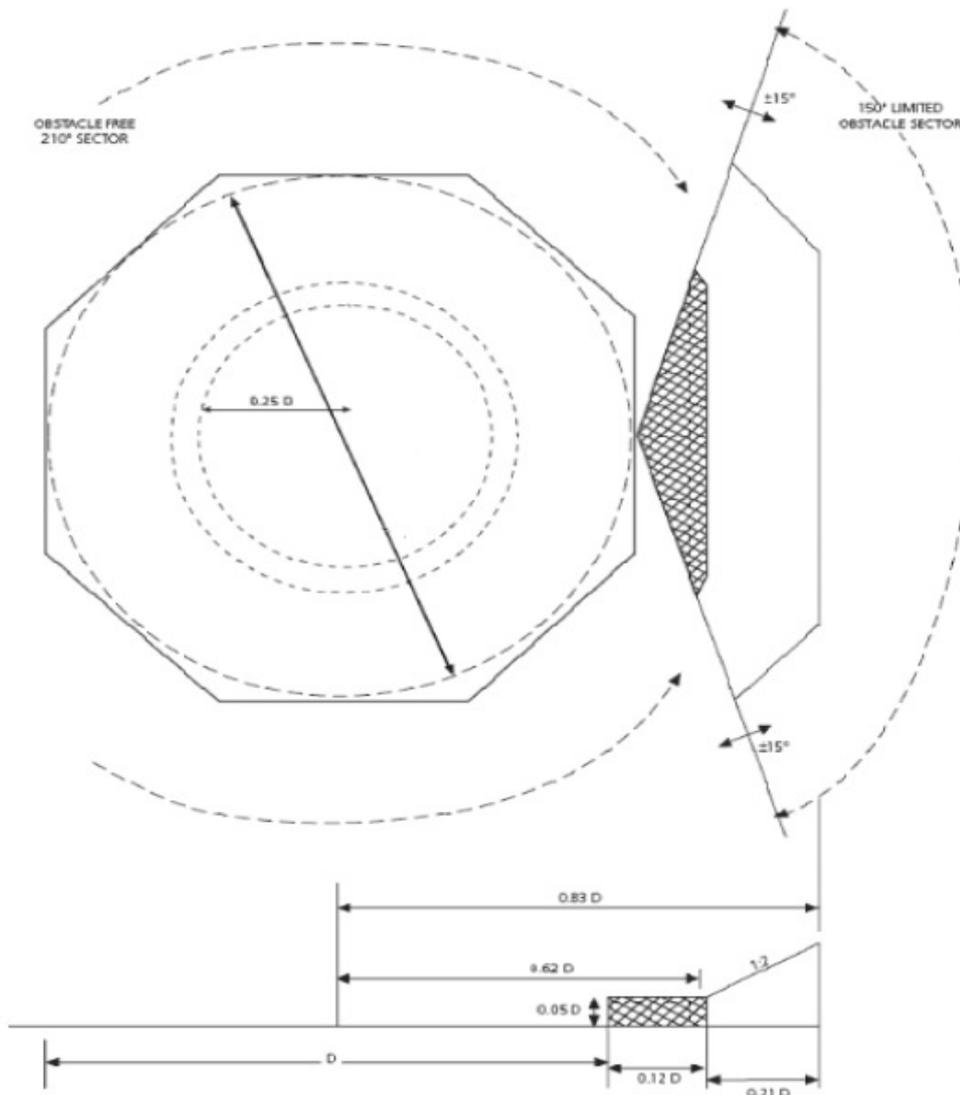
diagram assumes, since helicopter landing areas are designed to the minimum requirement of accommodating a 1 'D' Circle, that the 'D' Circle perimeter and SLA perimeter are coincidental. No objects above 0.05D are permitted in the first (hatched area in Figure 2) segment of the LOS. The first segment extends out to 0.62D from the centre of the 'D' Circle, or 0.12D from the SLA perimeter marking.

The second segment of the LOS, in which no obstacles are permitted within a rising 1:2 slope from the upper surface of the first segment, extends out to 0.83D from the centre of the 'D' Circle, or a further 0.21D from the edge of the first segment of the LOS.

The exact point of origin of the LOS is assumed to be at the periphery of the 'D' Circle.

Figure 2 - Obstacle Limitation showing position of Aiming Circle

Drawing not to scale



3.2.10. Some helicopter landing areas are able to accommodate a SLA which covers a larger area than the declared 'D' value; a simple example being a rectangular deck with the minor dimension able to contain the 'D' Circle. In such cases it is important to ensure that the origin of the LOS (and OFS) is at the SLA perimeter as marked by the perimeter line. Any SLA perimeter should guarantee the obstacle protection afforded by both segments of the LOS. The respective measurements of $0.12D$ from the SLA perimeter line, plus a further $0.21D$ are to be applied. On these larger decks there is thus some flexibility in deciding the position of the perimeter line and SLA in order to meet the LOS requirements and when considering the position and height of fixed obstacles. Separating the origin of the LOS from the perimeter of the 'D' Circle in Figure 2 and moving it to the right of the page will demonstrate how this might apply on a rectangular SLA.

3.2.11. The extent of the LOS segments will, in all cases, be lines parallel to the SLA perimeter line and follow the boundaries of the SLA perimeter (see Figure 2 above). Only in cases where the SLA perimeter is circular will the extent be in the form of arcs to the 'D' circle. However, taking the example of an octagonal SLA as drawn at Figure 1, it would be possible to replace the angled corners of the two LOS segments with arcs of $0.12D$ and $0.33D$ centred on the two adjacent corners of the SLA; thus cutting off the angled corners of the LOS segments. If these arcs are applied they should not extend beyond the two corners of each LOS segment so that minimum clearances of $0.12D$ and $0.33D$ from the corners of the SLA are maintained. Similar geometric construction may be made to a square or rectangular SLA but care should be taken to ensure that the LOS protected surfaces minima can be satisfied from all points on the SLA perimeter.

Landing Area Surfaces

3.2.12. The landing area should have an overall coating of non-slip material and all markings on the surface of the landing area should be made with the same non-slip materials. Whilst extruded section or grid construction aluminium (or other) decks may incorporate adequate non-slip profiles in their design, it is preferable that they are also coated with a non-slip material unless adequate friction properties have been designed into the construction. It is important that the friction properties exist in all directions. Over-painting friction surfaces on such designs may compromise the friction properties. Recognised surface friction material is available commercially.

3.2.13. Helicopter landing areas should be cambered to a maximum gradient of 1:100. Any distortion of the helicopter landing area surface due to, for example, loads from a helicopter at rest should not modify the landing area drainage system to the extent of allowing spilled fuel to remain on the deck. A system of guttering should be provided around the perimeter to prevent spilled fuel from falling on to other parts of the vessel and to conduct the spillage to an appropriate drainage system.

The capacity of the drainage system should be sufficient to contain the maximum likely spillage of fuel on the deck. The calculation of the amount of spillage to be contained should be based on an analysis of helicopter type, fuel capacity, typical fuel loads and uplifts. The design of the drainage system should preclude blockage by debris. The helicopter landing area should be properly sealed so that spillage will only route into the drainage system.

3.3. HELICOPTER TIE-DOWN POINTS:

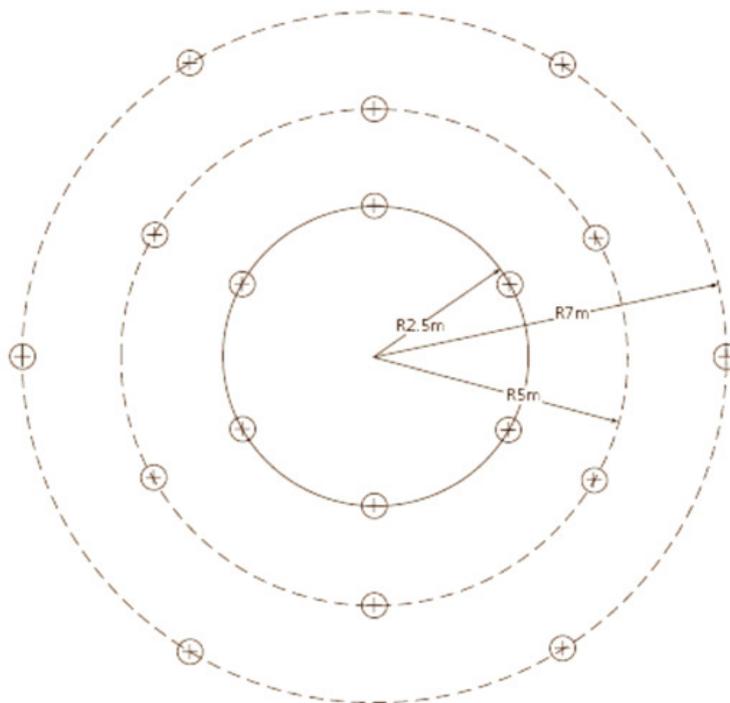
3.3.1. Sufficient flush-fitting (when not in use) or removable semi-recessed tie-down points should be provided for securing the maximum sized helicopter for which the helicopter landing area is designed. They should be so located and be of such strength and construction to secure the helicopter when subjected to expected

weather conditions. They should also take into account the inertial forces resulting from the movement of the vessel.

- 3.3.2. Tie-down rings should be compatible with the dimensions of tie-down strop attachments. Tie-down rings and strops should be of such strength and construction so as to secure the helicopter when subjected to expected weather conditions. The maximum bar diameter of the tie-down ring should be compatible with the strop hook dimension of the tie down strops carried by the helicopter operator.

An example of a suitable tie-down configuration is shown at Figure 3. The Aviation Inspection Body or helicopter operator will provide guidance on the configuration of the tie-down points for specific helicopter types.

Figure 3 – Example of Suitable Tie-Down configuration



Notes to Figure 3-

- 1. The tie-down configuration should be based on the centre of the Aiming Circle marking.*
- 2. Additional tie-downs will be required in a parking area.*
- 3. The outer circle is not required for 'D' values of less than 22.2 metres.*

3.4. SAFETY NET:

- 3.4.1. Safety nets for personnel protection should be installed around the landing area where there is a danger of personnel falling overboard. This should be looked at on an individual basis and a suitable Risk Assessment /Safety Case conducted. Where adequate structural protection against falls exists or adequate helideck procedures are in place with an appropriate risk assessment conducted by the Administration, then

safety nets may be omitted. If fitted, the netting used should be of a flexible nature, with the inboard edge fastened level, just below the edge of the helicopter landing area. The net itself should extend 1.5 metres in the horizontal plane and be arranged so that the outboard edge is not above the level of the landing area so that it has an upward and outward slope of at least 10°. It may be possible to incorporate dropped rails in place of a safety net but the dimensions and guidance above pertaining to safety net should be adhered to.

3.5. ACCESS POINTS:

3.5.1. Many helicopters have passenger access on one side only and helicopter landing orientation in relation to landing area access points becomes important because it is necessary to ensure that embarking and disembarking passengers are not required to pass around the helicopter tail rotor, or under the front of the main rotor of those helicopters with a low profile rotor, should a 'rotors-running turn-round' be conducted.

3.5.2. There should be a minimum of two access/egress routes to the helicopter landing area- these should be 180° apart. The arrangements should be optimised to ensure that, in the event of an accident or incident on the helicopter landing area, personnel will be able to escape upwind of the landing area. Adequacy of the emergency escape arrangements from the helicopter landing area should be included in any evacuation, escape and rescue analysis for the vessel, and may require a third escape route to be provided.

3.5.3. Where foam monitors are co-located with access points, care should be taken to ensure that no monitor is so close to an access point as to cause injury to escaping personnel by operation of the monitor in an emergency situation.

3.5.4. Where handrails associated with landing area access/escape points exceed the height limitations given at section 3.2.7 they should be retractable, collapsible or removable. When retracted, collapsed or removed the rails should not impede access/egress. Handrails which are retractable, collapsible and removable should be painted in a contrasting colour scheme. Procedures should be in place to retract, collapse, or remove them prior to helicopter arrival. Once the helicopter has landed, and the crew has indicated that passenger movement may commence, the handrails may be raised and locked in position. The handrails should be retracted, collapsed, or removed again prior to the helicopter taking-off.

Where anti-collision lights are utilised, the helicopter crew will ensure they are switched off before the movement of passengers and/or freight takes place.

4. VISUAL AIDS:

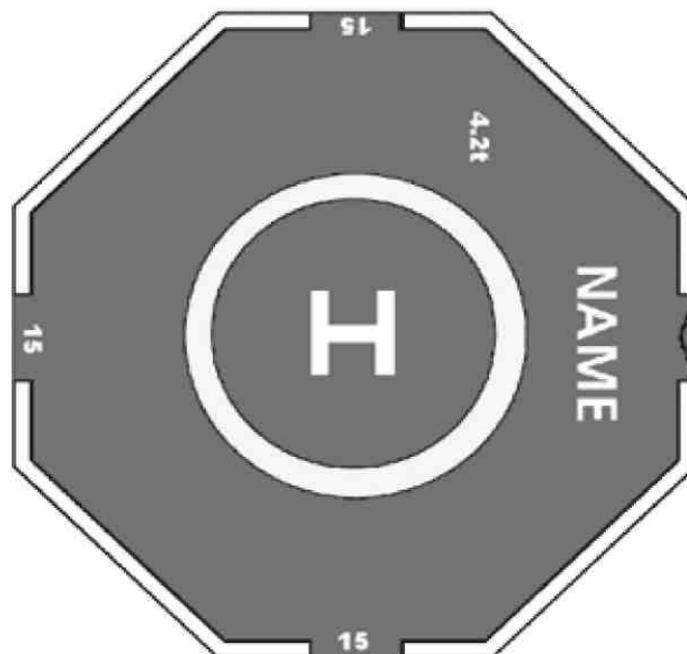
4.1. The following sections outline the requirements for helicopter landing area markings which should be permanently painted on the deck. Plans of the marking arrangements including dimensions should be submitted to the Aviation Inspection Body for approval.

- 4.2. Helicopter landing area perimeter line marking and lighting serves to identify the limits of the Safe Landing Area (SLA) for day and night operations.
- 4.3. A wind direction indicator should be provided during helicopter operations and located so as to indicate the clear area wind conditions at the vessel location. For the purposes of this regulation the wind indicator may either be a dedicated windsock or appropriate flag. It is often inappropriate to locate the indicator as close to the helicopter landing area as possible where it may compromise obstacle protected surfaces, create its own dominant obstacle or be subjected to the effects of turbulence from structures resulting in an unclear wind indication. The wind indicator should be illuminated for night operations.

Helicopter Landing Area Markings (See Figure 4 below)

- 4.4. For the smallest landing areas (typically <16metres) it may be necessary to reduce the size of the helideck markings appropriately. In such circumstances, the Aviation Inspection Body should be consulted as soon as possible.
- 4.5. The colour of the helicopter landing area should where possible be a contrasting colour to the rest of the vessel's deck. The perimeter of the SLA should be clearly marked with a painted line 0.3 metres wide in a contrasting colour to the helideck.

Figure 4 - Markings (Single Main Rotor Helicopters)

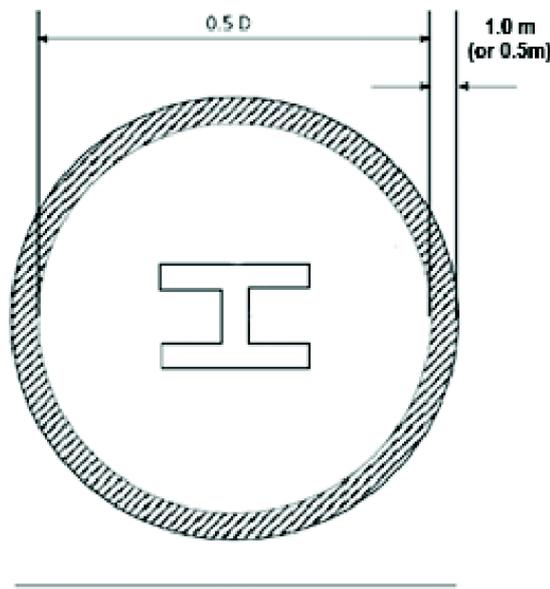


- 4.6. The light grey colour of aluminium may be acceptable in specific helicopter landing area applications where these are agreed with the Aviation Inspection Body. This should be discussed in the early design phase. In such cases the conspicuity of the helicopter landing area markings may need to be enhanced by, for example, outlining the deck marking lines and characters with a thin black line. Alternatively,

conspicuity may be enhanced by overlaying white markings on a painted black background.

- 4.7. A maximum allowable mass marking should be marked on the helicopter landing area in a position which is readable from the preferred final approach direction i.e. towards the obstacle-free sector origin. The marking should consist of a two or three digit number expressed to one decimal place rounded to the nearest 100 kg and followed by the letter 't' to indicate the allowable helicopter weight in tonnes (1000 kg). The height of the figures should be 0.9 metres with a line width of approximately 0.12 metres and be in a colour which contrasts with the helicopter landing area surface (preferably white: avoid black or grey).
- 4.8. An aiming circle (touchdown/positioning marking) for each helicopter landing area should be provided as follows: (see Figures 2, 4, 5 and 6).

Figure 5
Aiming Circle Marking



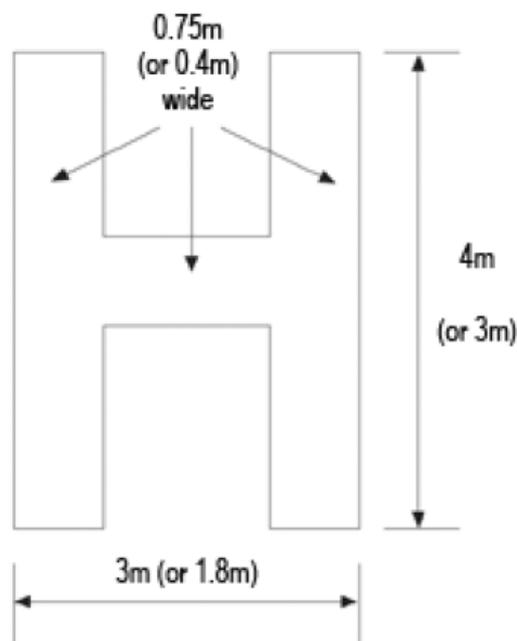
Note: On a helideck the centre of the Touch Down/Position Marking (TD/PM) circle will normally be located at the centre of the landing area, except that the marking may be offset away from the origin of the OFS by no more than 0.1D where an aeronautical study indicates such offsetting to be beneficial, provided that the offset marking does not adversely affect the safety of flight operations or ground handling issues.

- 4.9. On smaller helicopter landing areas with a D value up to and including 16.00m and for bow-mounted helicopter landing areas the aiming circle should be concentric with the helicopter landing area centre to ensure maximisation of space all around for safe personnel movement and optimisation of the visual cueing environment. The marking should be a circle with an inner diameter of 0.5 times the certificated D-value of the helicopter landing area and a line width of not less than 0.5m for landing areas with a D-Value up to and including 16.00m and not less than 1.0m for landing areas with a

D-Value greater than 16.00m. The circle should be in a contrasting colour to the helideck.

- 4.10. On those decks where the aiming circle is concentric with the centre of the D circle or SLA, the need for some mitigation against concerns over tail rotor clearances should be considered; either by achieving more obstacle clearance in the 150° LOS or by adopting appropriate operational procedures (e.g. vessel to provide relative wind from beam or stern).
- 4.11. A “H” painted in a colour contrasting with the deck (preferably white) should be co-located with the aiming circle with the cross bar of the “H” lying along the bisector of the obstacle-free sector (see Figure 6). The minimum H dimensions are shown in brackets for landing areas with a D-Value up to and including 16.00 metres and without brackets for landing areas with a D-Value greater than 16.00 metres.
- 4.12. Where the obstacle-free sector has been swung in accordance with Section 3.2.8 the positioning of the aiming circle and “H” should comply with the normal unswung criteria. The “H” should, however, be orientated so that the bar is parallel to the bisector of the swung sector.

Figure 6 – Dimensions of ‘H’



Lighting

- 4.13. Night helicopter operations to a vessel underway are demanding and should be considered carefully. Providing the helicopter aircrew with the correct lighting configuration is paramount to safety. Night operations conducted inshore, in fair weather with good background lighting are considerably less challenging than those operations conducted far from the coast in heavy seas. These factors should be taken into account when determining the level of operational capability required. Deep water operations will invariably require pilot interpreted approach aid lighting.

hover and landing. Furthermore, floodlighting systems often fail to provide adequate illumination of the centre of the landing area leading to the so-called 'black-hole effect'. It is essential therefore that any floodlighting arrangements take full account of these problems.

- 4.18. The floodlighting should be arranged so as not to dazzle the pilot and, if elevated and located off the landing area clear of the LOS, the system should not present a hazard to helicopters landing and taking off from the helicopter landing area. All floodlights should be capable of being switched on and off at the pilot's request. Setting up of lights should be undertaken with care to ensure that the issues of adequate illumination and glare are properly addressed and regularly checked. Adequate shielding of 'polluting' light sources can easily be achieved early on in the design stage, but can also be implemented on existing installations using simple measures. Temporary working lights which pollute the helicopter landing area lighting environment should be switched off during helicopter operations.
- 4.19. It is important to confine the helicopter landing area lighting to the landing area, since any light overspill may cause reflections from the sea. The floodlighting controls should be accessible to, and controlled by, the officer(s) in charge of the landing area operations team(s).
- 4.20. In seeking to develop an alternative system to conventional floodlighting, it has been demonstrated that arrays of segmented point source lighting (ASPSL) in the form of encapsulated strips of light emitting diodes (LEDs) can be used to illuminate the aiming circle and landing area identification marking ('H'). This arrangement has been found to provide the visual cues required by the pilot earlier on in the approach and more effectively than by using floodlighting, and without the disadvantages associated with floodlighting such as glare. Large yacht owners are encouraged to consider appropriate systems in lieu of conventional floodlighting.
- 4.21. The quoted intensity values for lights apply to the intensity of the light emitted from the unit when fitted with all necessary filters and shades (see also paragraphs 4.24. and 4.25 below).
- 4.22. The emergency power supply of the vessel should include the helicopter landing area lighting. Any failures or outages should be reported immediately to the helicopter pilot/operator. The lighting should be fed from an Uninterrupted Power Supply (UPS) system capable of providing the required load for at least 15 minutes. This can be a standalone supply or be an additional loading requirement for the vessel's emergency power supplies.

Obstacles - Marking and Lighting

- 4.23. Fixed obstacles identified as a hazard to helicopters by the helicopter pilot/ operator, or by the Aviation Inspection Body, should be clearly defined in any operations manual (ISM procedure or Yacht Aviation File).
- 4.24. Omnidirectional red lights of at least 10 candelas intensity should be fitted at suitable locations to provide the helicopter pilot with visual information on the proximity and height of objects which are higher than the landing area and which are

close to it or to the LOS boundary. Objects which are more than 15 metres higher than the landing area should be fitted with intermediate red lights of the same intensity spaced at 10 metre intervals down to the level of the landing area (except where such lights would be obscured by other objects).

- 4.25. An omnidirectional red light of intensity 25 to 200 candelas should be fitted to the highest point of the vessel. Where this is not practicable, the light should be fitted as near to the extremity as possible.
- 4.26. Red lights should be arranged so that the location of the objects which they delineate are visible from all directions above the landing area.
- 4.27. The emergency power supply of the yacht should include all forms of obstruction lighting. Any failures or outages should be reported immediately to the helicopter pilot/ operator. The lighting should be fed from an Uninterrupted Power Supply (UPS) system capable of providing the required load for at least 15 minutes. This can be a standalone supply or be an additional loading requirement for the yacht's emergency power supplies.

5. HELICOPTER LANDING AREA (HLA) OPERATIONAL STANDARDS:

5.1. MOVEMENT OF HLA DUE TO WAVE MOTIONS AT SHIP:

- 5.1.1. Yachts experience dynamic motions due to wave action which represent a potential hazard to helicopter operations. For the helicopter operations acceleration in pitch roll and heave will provide the limiting factor. These limits are a combination of both vessel and helicopter capability. Operational limitations based on limited pitch, roll, heave, may therefore be applied to the landing area by the Aviation Inspection Body. Helicopter landing area downtime due to excessive deck motion can be minimised by careful consideration of the location of the landing area on the vessel at the design stage. Guidance on helicopter landing area location and how to assess the impact of the resulting motion on operability is presented in UK CAA Paper 2004/02 "Helideck Landing Area Design Considerations – Environmental Effects", as may be amended from time to time and which is available on the Publications section of the UK CAA website at www.caa.co.uk. Designers of helicopter landing areas should consult this paper at the earliest possible stage of the design process.
- 5.1.2. The helicopter landing area will be limited to receiving helicopters in the conditions agreed by the Aviation Inspection Body.
- 5.1.3. It is necessary for details of pitch, roll, and heave motions to be recorded on the vessel prior to, and during, all helicopter movements. Pitch and roll reports to helicopters should include values, in degrees, about both axes of the true vertical datum (i.e. relative to the true horizon) and be expressed in relation to the vessel's head. Roll should be expressed in terms of 'port' and 'starboard'; pitch should be expressed in terms of 'up' and 'down'; heave should be reported in a single figure, being the total heave motion of the helicopter landing area rounded up to the nearest metre. Heave is to be taken as the vertical difference between the highest and lowest

points of any single cycle of the helicopter landing area movement. The parameters reported should be the maximum peak levels recorded during the ten minute period prior to commencement of helicopter operations.

- 5.1.4. The helicopter pilot is concerned, in order to make vital safety decisions, with the amount of 'slope' on, and the rate of movement of, the helicopter landing area surface. It is therefore important that the roll values are only related to the true vertical and do not relate to any 'false' datum (i.e. a 'list') created, for example, by anchor patterns or displacement. There are circumstances in which a pilot can be aided by amplification of the heave measurement by reference to the time period (seconds) in terms of 'peak to peak'.

Reporting Format

- 5.1.5. A standard radio message should be passed to the helicopter which contains the information on helicopter landing area movement in an unambiguous format. This will, in most cases, be sufficient to enable the helicopter crew to make safety decisions. Should the helicopter crew require other motion information or amplification of the standard message, the crew will request it (for example, yaw and heading information).

Standard Report example:

Situation: The maximum vessel movement (over the preceding ten minute period) about the roll axis is 1° to port and 3° to starboard (i.e. this vessel may have a permanent list of 1° to starboard and is rolling a further 2° either side of this 'false' datum). The maximum vessel movement (over the preceding ten minute period) about the pitch axis is 2° up and 2° down. The maximum recorded heave amplitude over a single cycle (over the preceding ten minute period) is 1.5 metres.

Report: 'Roll 1° left and 3° right; Pitch 2° up and 2° down; heave two metres'.

- 5.1.6. It is important to ensure that the deck motions reported to the helicopter pilot relate to the motion at the helicopter landing area. Very often pitch, roll and heave measurements are taken from a source far removed from the helicopter landing area location. If this source should happen to be midships and the helicopter landing area is located, for example, high up on the bow, the actual heave (and, in future accelerations,) at the helicopter landing area are likely to be far in excess of the source measurement. Software packages are available to provide helicopter landing area location corrected movement data from a source at a different location. Ideally, deck motion measuring equipment should be located at (attached to the underside of) the helicopter landing area.

5.2. AIRCRAFT OPERATIONAL DATA – REPORTING AND RECORDING:

- 5.2.1. In addition to the data covered by section 5.1.5 above, it is essential that yachts are provided with means of ascertaining and reporting at any time-

- (a) the wind speed and direction using aviation approved equipment to ICAO standard;
- (b) the air temperature;
- (c) the barometric pressure using aviation approved equipment to ICAO standard;
- (d) the visibility, cloud base and cover; and
- (e) the sea state.

5.2.2. Air temperature and barometric pressure should be measured by conventional instruments approved to ICAO standards. An indication of wind speed and direction will be provided visually to the pilot by the provision of a windsock coloured so as to give maximum contrast with the background. However, for recording purposes, an anemometer positioned in an unrestricted airflow is required. A second anemometer, located at a suitable height and position can give useful information on wind velocity at hover height over the helicopter landing area in the event of turbulent or deflected airflows over the deck. Visibility, cloud conditions, and sea state will normally be assessed by visual observations.

5.2.3. Measuring instruments used to provide the data listed in sections 5.2.1 and 5.2.2 above should be periodically calibrated in accordance with the manufacturer's recommendations in order to provide continuing accuracy.

5.3. HLA OPERATIONS MANUAL AND GENERAL REQUIREMENTS:

The maximum helicopter weight and 'D' value for which the helicopter landing area has been designed and the maximum size and weight of helicopter for which the vessel is certificated should be included in the Helicopter Landing Area Operations Manual and Landing Area Certificate. The extent of the obstacle-free area should also be stated and reference made to any helicopter landing area operating limitation imposed by helicopter operators or the Aviation Inspection Body as a result of non-compliances. Details of non-compliances themselves should also be listed.

5.4. HELICOPTER OPERATIONS SUPPORT EQUIPMENT:

5.4.1. Provision should be made for equipment needed for use in connection with helicopter operations including-

- (a) chocks and tie-down strops;
- (b) a suitable power source for starting helicopters if helicopter shut-down is seen as an operational requirement; and
- (c) equipment for clearing the helicopter landing area of snow and ice and other contaminants.

5.4.2. Chocks should be compatible with helicopter undercarriage/ wheel configurations. Helicopter operating experience has shown that the most effective chock for use on

helicopter landing areas is the 'rubber triangular' or 'single piece fore and aft' type chocks may be used as long as they are suited to all helicopters likely to operate to the helicopter landing area.

5.4.3. For securing helicopters to the helicopter landing area only adjustable tie-down strops should be used.

5.5. RADIO COMMUNICATIONS EQUIPMENT:

5.5.1. At least one aeronautical frequency radio licensed by the Administration responsible for the airspace in which the helicopter is intended to operate when approaching the vessel should be fitted on board the vessel.

5.5.2. Radio operators of offshore aeronautical radio stations are required to hold a Certificate of Competence. Further information can be found in CAA Publication CAP 452 'Aeronautical Radio Station Operator's Guide'.

5.6. RISK ASSESSMENT:

5.6.1. A full risk assessment should be carried out addressing all the operations anticipated with helicopter operations on board a yacht. This should include-

- (a) Landing and securing
- (b) Preparing for take off and taking off
- (c) Unloading passengers, baggage and stores
- (d) Refuelling
- (e) Securing
- (f) Safe movement of personnel

5.6.2. The risk assessment should be submitted to the Administration. The risk assessment to address the safe movement of personnel on the helicopter landing area should also be submitted for approval by the Aviation Inspection Body to demonstrate that safe passenger movement may take place without endangering the safety of the helicopter or the life of personnel on-board.

5.7. CREW TRAINING:

5.7.1. The yacht crew, as appropriate, should be trained to deal with normal helicopter movements as well as abnormal and emergency situations. The training should include dealing with fires and other possible emergency scenarios.

5.7.2. Specific training should be provided to the Helicopter Landing Officer (HLO) by an appropriate training provider. Where there are refuelling facilities on board, at least one member of crew should be trained in the handling of aviation (Jet A1) fuel and associated quality control procedures.

5.7.3. Training of crewmembers and the HLO should include both practical and theoretical sessions and, wherever possible, practical training should be carried out on board.

5.7.4. The crew should practice dealing with the possible emergency scenarios through regular drills on board with an annual inspection by an external auditor.

5.7.5. The emergency scenarios should be addressed in the yacht's contingency plans and similar documents.

6. EXAMPLE INSTRUCTION CHECKLIST:

6.1. GENERAL:

The following checklist indicates in general terms the minimum number of helicopter landing area physical characteristics which the Administration considers should be examined during initial inspection and periodic surveys carried out by the Aviation Inspection Body to confirm that there has been no alteration or deterioration in condition.

6.2. HELICOPTER LANDING AREA DIMENSIONS:

This shall include-

- (a) D-value as measured;
- (b) Declared D-value;
- (c) deck shape; and
- (d) scale drawings of deck arrangement.

6.3. HELICOPTER LANDING AREA CONDITIONS:

This shall include-

- (a) type of surface, condition, friction, contaminant free;
- (b) fuel retention;
- (c) deck landing area net;
- (d) perimeter safety netting; and
- (e) tie-down points.

6.4. ENVIRONMENT:

This shall include-

- (a) machinery exhausts;
- (b) hot and cold gas emissions; and
- (c) presence of turbulence.

6.5. OBSTACLE PROTECTED SURFACES (MINIMA):

This shall include-

- (a) Obstacle Free Sector (210°);
- (b) Limited Obstacle Sector (150°); and
- (c) Note if (a) above is swung from normal axis.

6.6. VISUAL AIDS:

This shall include-

- (a) deck surface;
- (b) general condition of painted markings;
- (c) location of H;
- (d) Aiming Circle;
- (e) maximum allowable weight marking;
- (f) conspicuity of painted markings;
- (g) wind indicator;
- (h) perimeter lighting;
- (i) floodlighting;
- (j) obstruction lighting;
- (k) marking of dominant obstacles; and
- (l) shielding of working lights (helicopter landing area light pollution).

6.7. FUEL SYSTEMS:

This shall include-

- (a) principal agent;
- (b) complementary media;
- (c) rescue equipment; and
- (d) personal protective equipment.

6.8. RESCUE AND FIRE FIGHTING FACILITIES:

This shall include-

- (a) principal agent
- (b) complementary media
- (c) rescue equipment
- (d) personal protective equipment

6.9. CREW TRAINING CERTIFICATION:

This shall include qualifications and Training Records for the crew concerned.

7. HELICOPTER HANGAR FACILITIES:***General***

- 7.1. Helicopter hangar arrangements on board should be in accordance with requirements for helicopter refuelling and hangar facilities contained within SOLAS II-2. Helicopter fuelling facilities on board should be in accordance with requirements for helicopter refuelling and hangar facilities in SOLAS II-2. In addition, the applicable requirements outlined in this Annex to the Code should be complied with in full unless a safety case is made to, and approved by, the Administration, based on an alternative arrangement according to Classification Society Rules or guidance from the Aviation or Petro-Chemical industries. The requirements in this section are based upon the use of helicopters run on Jet A1 fuel. When developing hangar arrangements, consideration should be given to the type of fuel on which the helicopter to be stowed is run.
- 7.2. The following plans and particulars are to be submitted to the Classification Society and Administration for approval-
 - (a) hangar general arrangement and structure;
 - (b) helicopter lift, hoist, and movement arrangements (if appropriate);
 - (c) structural fire protection;
 - (d) fire detection and extinguishing arrangements; and
 - (e) ventilation arrangements.

Hangar Design Considerations

- 7.3. Helicopter hangar(s) on board should be positioned, as far as is practicable, so as to preclude excessive movement and acceleration forces. Guidance on this should be sought from the helicopter manufacturer / operator. Where possible, the positioning of

hangar(s) should be determined through the use of computer modelling and/or wind tunnel testing (refer also to Section 3.2.3).

- 7.4. The perimeter of hangar(s) and any associated entrance or hatchway inclusive of helicopter lift arrangements should provide a stowage / maintenance box allowing for a minimum 0.5m clearance at any point around the helicopter and rotors when the helicopter is in its stowed condition.
- 7.5. Where appropriate CCTV should be used to ensure visibility of the aircraft at all times.

8. HELICOPTER FUELLING FACILITIES:

8.1. GENERAL:

- 8.1.1. This section outlines the requirements for the storage and transfer of Jet A1 fuel. When developing fuelling arrangements, consideration should be given to the type of fuel on which the helicopter to be operated is run. In addition, all facilities for the storage and handling of aviation fuels on board should be grade identified using the appropriate American Petroleum Industry (API) markings for the grade of fuel used. Aviation fuel facilities should also be fully segregated from any other fuel system.
- 8.1.2. Refuelling and defueling operational considerations should be agreed with the helicopter pilot / operator and Aviation Inspection Body.
- 8.1.3. The following plans and particulars are to be submitted to the Aviation Inspection Body and Classification Society for approval-
- (a) description of fuel with statement of minimum flash point (closed cup test);
 - (b) arrangements of fuel storage and piping;
 - (c) arrangements for drainage, ventilation and sounding of spaces adjacent to storage tanks;
 - (d) details and approval certification of pumping units;
 - (e) structural fire protection arrangements of all spaces to contain aviation fuel;
 - (f) fire detection and extinguishing arrangements; and
 - (g) ventilation arrangements.
- 8.1.4. When developing operational procedures for the movement of aviation fuel onboard, the restricted use of radio frequency equipment including portable phones with regard to transmission sparks should be considered.

8.2. STORAGE OF AVIATION FUEL:

- 8.2.1. Fuel storage tanks should be of baffle-free, stainless steel, cylindrical construction, located in a designated area as remote as practicable from machinery and

accommodation spaces, and be suitably isolated from areas where there are sources of ignition.

- 8.2.2. Fuel storage tanks should be provided with an intrinsically safe level indicator fitted through the top of the tank, and a ¾ inch sampling valve at the bottom of the tank (low end) to allow for samples to be taken as per paragraph 8.5.3. The minimum slope of the tank to the sampling point should be 1:30.
- 8.2.3. The storage and handling area should be permanently marked. Instructions for filling fuel and, if appropriate, emptying fuel, should be posted in the vicinity of the filling area.
- 8.2.4. Tank ventilation (breather) pipes should be fitted with an approved vent head with pressure-vacuum valve, flame arrester, and desiccant. The vent outlet should be located no less than 2.3m above the weather deck in a safe position away from accommodation spaces, ventilation intakes and equipment that may constitute an ignition hazard. Particular attention should also be directed to the height of the tank vent and overflow with respect to the design head of the tank.
- 8.2.5. High level alarm arrangements should be provided to indicate when fuel storage tanks are close to being filled in excess of maximum operating levels. Alternative arrangements for tank venting may be accepted subject to approval from the Administration.
- 8.2.6. A coaming surrounding the fuel storage tanks, associated piping and the pumping unit should be provided. The height of this coaming should be at least 150 mm, so as to contain fuel spillage as well as fire extinguishing agents. Where the pumping unit is situated at a remote distance from the fuel storage tank, a separate coaming of the same minimum height should be provided around the pumping unit. For tanks forming an integral part of the vessel's structure, cofferdams with permanently fitted gas detectors should be provided as necessary to contain leakage and prevent contamination of the fuel. Also, it should be ensured that there is no common boundary between the fuel storage tank and accommodation or high fire risk spaces.
- 8.2.7. Arrangements for drainage from within the coaming area described in section 8.2.6 above should be as follows-
- (a) permanent piping and a suitable holding (waste) tank (compliant with sections 8.2.1 and 8.2.2 of this Annex) should be fitted so that drainage can be either led to the holding tank (for draining fuel) or discharged overboard (for draining water) through a three-way valve. No other valve should be permitted in the drain piping. The holding tank should be clearly labelled to distinguish between itself and the main storage tank.
 - (b) the cross sectional area of the drain pipe should be twice that of the storage tank outlet pipe.
 - (c) the area within the coaming should be sloped towards the drain pipe.

- 8.2.8. Drainage of cofferdam spaces should be entirely separate from the machinery space drainage arrangements. As far as is practicable, fuel sampling points should be low points on piping and should provide a “closed sampling” visi-jar system fitted with arrangements to prevent the spring-loaded valve from being locked in an open position.
- 8.2.9. Air pipes for the cofferdam space should be led to a point at least 2.3m above the weather deck through a safe space and fitted with an approved air pipe head fit for purpose and having a wire gauze diaphragm of corrosion resistant material.
- 8.2.10. Access to each cofferdam should be provided by at least two manholes from the open deck, each fitted with gas-tight manhole covers. Cofferdams should be cleaned prior to opening manhole covers, using an induced draught certified safe ventilation fan for a minimum of 20 minutes. A notice to this effect should be fitted to each manhole.

8.3. FUEL PUMPING AND STORAGE TANK FILLING:

- 8.3.1. All tank outlet valves and filling valves should be mounted directly onto the tank and be capable of being closed from a remote location outside the compartment in the event of a fire in the compartment. Ball valves are to be of the stainless steel, anti-static, fire tested type.
- 8.3.2. If more than one storage tank is fitted then fuel should be pumped through suitable filtration if it is to be transferred from one tank to another.
- 8.3.3. Filling arrangements for fuel tanks should be through closed piping systems with outlet ends configured to reduce turbulence and foaming of the fuel. If the storage tank(s) are filled from the top, the filler pipe should pass through the tank to the bottom and terminate with a 90 degree bend so that fuel flows over the bottom of the tank to reduce the possibility of a build-up of static charge.
- 8.3.4. Pumping units should be easily accessible and capable of being controlled from both the fuel station and a position remote from the fuel station. The device to prevent over-pressurisation as required by SOLAS 2-II should be fitted with a relief valve to discharge either to the suction side of the pump(s) or to a holding tank complying with the arrangements of section 8.2.7.
- 8.3.5. When not in use, fuel filling equipment should be stowed in a locker that is well ventilated and drained.
- 8.3.6. Suitable filtration arrangements in accordance with appropriate American Petroleum Industry (API) and British Energy Institute (or equivalent) standards should be provided to reduce the level of water and particulate contamination of the fuel to within the limits specified by the helicopter manufacturer. The minimum requirements are; delivery into storage through a filter water separator (FWS), filtration out of storage through filter water separator (FWS), filtration at the point of filling (e.g. on the helicopter landing area), via a filter monitor (FM). Filter vessels should be fitted with a differential pressure gauge and automatic air eliminator.

8.3.7. In general, all piping systems should be located clear of accommodation spaces, escape routes, embarkation stations and ventilation openings and should not pass through category A machinery spaces. However, where arrangements are such that piping has to pass through accommodation spaces, service spaces, escape routes, or embarkation stations double skinned piping is to be used or pipes should be enclosed in a cofferdam.

8.3.8. Means should be provided for keeping deck spills away from accommodation and service areas.

8.3.9. Drip trays for collecting replenishment oil residues in pipelines and hoses should be provided beneath pipe and hose connections in the manifold area.

8.3.10. It is recommended that a “Y” strainer should be fitted on the pump suction to protect the pump itself.

8.4. REFUELLING AND DEFUELLING HELICOPTERS:

8.4.1. Refuelling and defueling hoses should be of one continuous length, smooth bore, synthetic rubber construction, and semi-conducting, conforming to EN1361 type C or API standards. A hose end pressure controller should also be provided for fuelling hoses to prevent the possibility of the helicopter fuel tanks being subject to excessive pressure. Delivery nozzles should be fitted with minimum 100 mesh strainer element, and in the case of gravity over-wing nozzles, they should be situated in the spout. Trigger mechanisms should not have hold-open ratchets.

8.4.2. Provision should be made to electrically bond the helicopter to the vessel prior to commencement, and throughout the process of, any refuelling and defueling procedures. The maximum resistance of such bonding systems should be less than 0.5 ohms.

8.4.3. Where appropriate CCTV should be used to ensure full view from the bridge of all helicopter refuelling activities that would normally be hidden from view.

8.5. PREVENTION OF FUEL CONTAMINATION:

8.5.1. Materials and/or their surface treatment used for the storage and distribution of fuel should be selected such that they do not introduce contamination or modify the properties of the fuel. The use of copper or zinc compounds in fuel piping systems where they may come into contact with fuel is not permitted. Copper-nickel materials are permissible but should be limited to positions after filtration and water absorption equipment.

8.5.2. The location and arrangement of air pipes for fuel tanks are to be such that in the event of a broken vent pipe, this does not directly lead to ingress of seawater or rain water.

8.5.3. Fuel samples should be taken on a daily basis throughout the fuel handling, storage, and distribution process from the tank in use, all filter vessels, and at the hose end. Fuel samples should be recorded and kept for 24 hours in a 1 US Gallon glass jar then disposed of in the aviation fuel waste/holding tank referred to in section 8.2.7. A record should be kept of all fuel movements on board. Guidance on how to take fuel samples and record fuel movements may be obtained from Chapter 4 of UK CAA CAP 748 which is accessible via the UK CAA website www.caa.co.uk. Fuel in the holding tank may be passed to the main tank provided that suitable filtration is fitted in accordance with section 8.3.6 to the satisfaction of the aviation inspection body.

8.5.4. At least one member of crew on-board the vessel should be trained in the handling of aviation (JetA1) fuel and associated quality control procedures. This person(s) should oversee all operations involving the movement of aviation fuel on-board. Further guidance on such training may be obtained from the fuel supplier and marine aviation consultants.

8.6. FUEL PUMPING SPACES AND COMPARTMENTS:

8.6.1. Where it is intended to install fuel transfer pumps for handling aviation fuel in a separate compartment, the pump room(s); should be totally enclosed and have no direct communication through, e.g. bilge piping systems and ventilation systems, with machinery spaces; should be situated adjacent to the fuel storage tanks; and should be provided with ready means of access from the weather deck.

8.6.2. Alarms and safety arrangements should be provided as indicated in section 8.6.3 and Table 3, below-

Table 3 – Alarms

ITEM	ALARM	NOTE
Bulkhead Gland Temperature	High (See Note 1)	Any Machinery Item
Pump Bearing and Casing Temperature	High (See Note 1)	Any Machinery Item
Bilge Level	High	---
Hydrocarbon Concentration	High (See Note 2)	> 10% LEL

Notes:

1. The alarm signal is to trigger continuous visual and audible alarms in the pump room or the pump control station.
2. This alarm signal is to trigger a continuous audible and visual alarm in the pump room, pump control station and machinery control room.

8.6.3. A system for continuously monitoring the concentrations of hydrocarbon gases within the pump room should be fitted. Monitoring points are to be located in positions where potentially dangerous concentrations may be readily detected.

8.7. VENTILATION:

- 8.7.1. Fuel pump room(s), fuel storage room(s) and other closed spaces which contain fuel handling equipment, and to which regular access is required during stores handling operations, are to be provided with permanent ventilation system(s) of the mechanical extraction type.
- 8.7.2. The ventilation system(s) should be capable of being operated from outside the compartment being ventilated and a notice should be fixed near the entrance stating that no person is to enter the space until the ventilation system has been in operation for at least 15 minutes.
- 8.7.3. The ventilation system(s) should be capable of 20 air changes per hour, based on the gross volume of the pump room or space.
- 8.7.4. Protection screens of not more than 13 millimetres square mesh should be fitted in outside openings of ventilation ducts, and ventilation intakes should be so arranged as to minimise the possibility of re-cycling hazardous vapours from any ventilation discharge opening. Vent exits are to be arranged to discharge upwards.
- 8.7.5. The ventilation should be interlocked to the lighting system (except emergency lighting) such that the pump room lighting may only come on when the ventilation is in operation. Failure of the ventilation system is not to cause the lighting to go out and failure of the lighting system is not to cause loss of the ventilation system.

8.8. NON-SPARKING FANS FOR HAZARDOUS AREAS:

- 8.8.1. The air gap between impeller and housing of ventilation fans should be not less than 0.1 of the impeller shaft bearing diameter or 2 millimetres whichever is the larger, subject also to compliance with section 8.8.2(e) below. Generally, however, the air gap need be no more than 13 millimetres.
- 8.8.2. The following combinations of materials are permissible for the impeller and the housing in way of the impeller-
- (a) impellers and/or housings of non-metallic material, due regard being paid to the elimination of static electricity;
 - (b) impellers and housings of non-ferrous metals;
 - (c) impellers and housings of austenitic stainless steel;
 - (d) impellers of aluminium alloys or magnesium alloys and a ferrous housing provided that a ring of suitable thickness of non-ferrous material is fitted in way of the impeller;
 - (e) any combination of ferrous impellers and housings with not less than 13 millimetre tip clearance; and
 - (f) any combination of materials for the impeller and housing which are demonstrated as being spark proof by appropriate rubbing tests.

8.8.3. The following combinations of materials for impellers and housing are not considered spark proof and should not be permitted-

- (a) impellers of an aluminium alloy or magnesium alloy and a ferrous housing, irrespective of tip clearance;
- (b) impellers of a ferrous material and housings made of an aluminium alloy, irrespective of tip clearance; and
- (c) any combination of ferrous impeller and housing with less than 13 millimetres tip clearance, other than permitted by section 8.8.2(b) above.

8.8.4. Electrostatic charges both in the rotating body and the casing should be prevented by the use of antistatic materials (i.e. materials having an electrical resistance between 5×10^4 ohms and 10^8 ohms), or special means should be provided to avoid dangerous electrical charges on the surface of the material.

8.8.5. Type approval tests on the complete fan should be carried out to the satisfaction of the Classification Society.

8.8.6. Protection screens of not more than 13 mm square mesh should be fitted in the inlet and outlet of ventilation ducts to prevent the entry of objects into the fan housing.

8.8.7. The installation of the ventilation units on board should be such as to ensure the safe bonding to the hull of the units themselves.

END
