# REFORM OF ICAO ANNEX 6 (HELICOPTER OPERATIONS) AND ANNEX 14 (HELIPORTS)

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**Abstract:**

The International Civil Aviation Organization, a United Nations body created in 1947 to promote safety, regularity and efficiency of international civil aviation operations, has issued a body of standards known as annexes to the Convention on International Civil Aviation (the "Chicago Convention"). These govern flight operations, aircraft airworthiness and the numerous facilities and services required in their support such as aerodromes, telecommunications, navigation aids, meteorology, air traffic services and the like. The main parts of each annex are International Standards and Recommended Practices or SARPS.

Two Annexes – 6 and 14 - address helicopter operations. Annex 6, which in 1990 became applicable to the 187 member states of ICAO, established standards and recommended practices governing helicopter flight operations; Annex 14, approved the same year, governs aerodromes. Because the bulk of these standards were determined in the early 1980s when helicopter technology was still in its infancy, they closely track standards applicable to fixed wing aircraft and, unfortunately, fail to recognize the unique operating characteristics of rotary wing aircraft. For example, Annex 6 precludes Class III single engine and light twin engine helicopter operations at night and severely limits operations over urban areas. It recommends that such helicopters should not be permitted to operate from elevated heliports or offshore helidecks. Similarly, Annex 14 mandates such large load-bearing areas for heliports (including the TLOF, FATO, Safety Area and Rejected Takeoff Area) and demanding airspace requirements that only a few heliports can meet its requirements. As a result, few states follow the strict requirements of Annexes 6 and 14.

This paper compares and contrasts applicable provisions contained within Federal Aviation Rules and Regulations (FARs), the Joint Aviation Authority Rules (JARs) and ICAO Annexes 6 and 14. For example, in the case of the FARs, the foundation for rulemaking is linked to the Category A and B rotorcraft airworthiness standards. By comparison, both ICAO and the JAA base their rulemaking on Performance Classes 1 (similar to Category A), 2 (which shares Category A and B distinctions) and 3 (similar to Category B, applicable to all single engine and most light twin engine helicopters). The presentation will discuss international efforts now underway to amend Annexes 6 and 14 and offer recommendations for needed changes to reflect reasonable safe and efficient operating practices.

## 1. Introduction/Background

Annex 6 (1) and Annex 14 (2) of the International Civil Aviation Organization (ICAO) were finalized in 1990, after considerable effort by several Helicopter Operations Panels (HELIOPS) during the period 1983 to 1988. The panels consisted of the majority of the major nations involved at that time with helicopter operations. These included Australia, Brazil, Canada, France, Germany, Italy, Japan, Netherlands, Norway, Spain, Switzerland, the then USSR and UK (the actual membership varied from meeting to meeting), but not the United States. The US, which hosts 50 percent of the world's helicopter flight operations, finally joined the HELIOPS 4 in 1988 as an Observer but failed to take an active part in the formation of ICAO Annex 6 or Annex 14. Since the annexes were issued there has been considerable debate on the applicability of such requirements, particularly in the United States and nations which follow the practice of the U.S. Federal Aviation Administration (FAA). First, the ICAO requirements apply to international operations. This leads to confusion with some observers arguing that such requirements only apply to international flights or operations from one nation to another, and not to domestic flights. While this may be technically correct, it overlooks ICAO's stated position that all contracting states should conform their own regulations, to the greatest possible extent, to those issued by ICAO. It also ignores the fact that the work of the

HELIOPS was focused on helicopter operations in general and not solely those related to international/cross border type operations. Second, the ICAO requirements are perceived by many to be more applicable to scheduled passenger type operations, with large helicopters, rather than the day-to-day operations with small and medium size helicopters. Third, the strict requirements of Annex 6 appear to many to overlook the fact that 70 to 75 percent of the world's helicopter fleet consists of single engine, performance Class 3, helicopters.

## 2. Current Requirements

The United States and nations which follow FAA practices have a very different regulatory framework from that adopted by ICAO, although both achieve the same result by different means. ICAO Annex 6 contains two parts covering International Commercial Air Transport (Section II) and International General Aviation (Section III). The annex specifically excludes what is known as Aerial Work. Aerial Work is defined by ICAO as operations *"in which an aircraft is used specifically for specialized services such as agriculture, construction, photography, surveying, observation, and patrol, search and rescue, aerial advertisement, etc. . . ."* The section dealing with International Commercial Air Transport has, since it's introduction, received most attention and observers occasionally overlook the fact that there is a separate section dealing with International General Aviation. Adding to the confusion, the definition for Commercial Transport and General Aviation varies among nations and, even when definitions are similar, the requirements are applied in a different manner.

The ICAO Annex 6 rules applicable to helicopter operations have not really been adopted in a true sense by any nation to date. In Europe the Joint Airworthiness Authority (JAA) used Annex 6 as a basis for the development of the JAR-OPS 3 standards applicable to Commercial Air Transportation. JAR-OPS 3 (3) was initially proposed to be similar to Annex 6 but as a result of amendments adopted by JAA it differs in significant ways. Even so some observers still believe JAR-OPS 3 needs to be further amended before it will be acceptable to all JAA member nations.

The European states, through the JAA, have commenced reviewing and developing General Aviation standards known as JAR-OPS 4. They are also giving considerable attention to heliport requirements along the lines of ICAO Annex 14, but here it appears that the main effort is focused on proposed changes or refinements to the current ICAO Annex 14 rather than the development of a separate JAA requirement at this stage.

Annex 14 addresses heliport design for all helicopters operating to all three performance classifications defined in Annex 6. Yet even though Class 2 and Class 3 heliport needs are discussed, most of the emphasis in Annex 14 and the associated ICAO Heliport Manual (4) is devoted to Class 1 type of operations. As a result, the Annex reflects requirements which many consider applicable to scheduled operations, rather than conventional helicopter operations. None of the approximately 5,000 heliports in the United States would meet the recommended Class 1 size requirements of Annex 14 and, as far as known, only a very few in Europe would meet the requirements. Similarly many of the elevated heliports and helidecks throughout the world fail to meet the demanding requirements for such facilities.

## 3. Annex 6/Annex 14 Revision

At the urging of several states, ICAO has now agreed to review both Annex 6 and Annex 14 in the near future. As a result, authorities, manufacturers and operators – particularly in the United States and Europe - have begun to debate what changes should be made. Since Europe has already developed JAR-OPS 3 and is working on JAR-OPS 4, it is anticipated these rules will be recommended by the European nations, including subsequent amendments issued (5, 6), as a suitable framework for the modification of Annex 6 and by implication Annex 14.

This paper focuses on the main underlining issues related to the performance classification, operating limitations, and associated basic heliport ground size and airspace requirements. Reference is not made to prevailing national standards but in general to those in Europe and nations which follow the various European national standards which are being standardized under JAA. The paper, therefore, refers where appropriate to JAR-OPS 3 and European practice. Similarly reference is made to the FAA regulations and requirements. It should be noted that about half of the nations in the world follow FAA practice or similar requirements, while nearly all other nations follow European standards.

Also it should be noted that although this paper highlights differences between the practices, there are many areas where the various rules are similar or have equivalent impact. This should not be overlooked since there is a tendency to assume when addressing differences that the current FAA rules and those recommended in Annex 6 are completely different, while with one or two exceptions, this is not the case and the main differences are in the regulatory structure or framework.

Many observers contend that the Annex 6 and Annex

14 requirements closely parallel fixed-wing aircraft type practice and fail to recognize the unique operating characteristics of rotary wing aircraft. This may be partly attributed to the fact that the requirements embodied in the annexes were developed by the ICAO HELIOPS panel during the 1980s when the industry was not as mature as it is today. Also there has been a continual increase in safety standards over the years as the design of rotorcraft has improved, so that the basis on which ICAO members determined standards in the 1980s is very different from that of today. Thus it is generally agreed there is a need to amend the annexes to reflect reasonable, safe and efficient operating practices of today.

## 4. U.S. Experience

Helicopter flight operations in the United States – which has more than 5,000 heliports - are extensive. An FAA study (7) conducted in 1991 indicated that the FAA Heliport Design *"advisory circular is basically a sound and valid instrument"* and that the FAA requirements are *"very good guidance for the design of safe heliports."* The study states that for *"many of the mishaps analyzed . . . would not have occurred if the advisory design parameters had not been satisfied . . . ."* One of the few criticisms noted by the study is the lack of adequate obstacle marking. These requirements were strengthened in the subsequent Advisory Circular issued by the FAA since the 1988 version applicable at the time of the FAA study. More recently, the FAA reported at a recent HAI Heliport Committee meeting that a 1999 study by NASA and the U.S. Army (8) had concluded that there had been no accidents at US heliports in the past 30 years that were the result of heliport design deficiencies. The authors submit that this experience needs to be taken into account when assessing an update of Annex 14.

## 5. Commercial Transport/General Aviation Performance Requirements

ICAO Annex 6 is applicable to *international commercial transport* and *international general aviation*. Under ICAO commercial air transport is *". . . transport of passengers, cargo or mail for remuneration or hire."* A general aviation operation is *"an aircraft operation other than a commercial air transport operation or aerial work operation."* A similar definition is used in most of the nations in Europe. The USA defines commercial service as any operation for paid service/remuneration or hire and FAA Part 135 (9) is applied to *" aircraft having a seating capacity of less than 20 or a maximum payload . . . of less than 6,000lbs . . . OR between points entirely within any state of the United States . . . in aircraft leaving a seating capacity of 30 or less or a maximum payload . . . of 7,500 lbs or less."* It follows that fundamentally there is very little difference between the definitions. In general practice, however, the requirements are very different since there are no equivalent performance standards. In the case of a typical Part 135 operation, performance Class 1/Category A would only be considered applicable for scheduled service operations. In the 1970's the FAA applied Category A (Cat A) performance standards for scheduled helicopter air carrier operations under FAR Part 127 (10). SFAR 38-2 (11) effectively removed this requirement in 1985, but FAR Part 127 is still included in the FAA publications. Since that time the FAA has continued to require scheduled operations to be conducted under Cat A performance standards under Part 135 through the application of special provisions. The FAA have also said that such Cat A (Class 1) performance standards would be applied to proposed/future scheduled passenger operations with helicopters with nine passenger seats or more. This Cat A concept of scheduled operations appears to have general industry support.

Under the FAR Part 135, only *"over-the-top"* VFR or IFR implies use of Cat A enroute performance and multi-engine. Nevertheless SFAR 81 (12) in 1998 amended Part 135.181 to allow single engine (Cat B/Class 3) operations under IFR. This provision was introduced to enhance the safety of single engine aircraft (including helicopters) in passenger carrying operations, since inadvertent VFR/VMC flights into instrument meteorological IFR/IMC conditions was found to be a significant cause of fatal accidents in the continental United States and in particular in Alaska. It would be expected that similar improvement in safety would also result in other parts of the world if this were incorporated in Annex 6.

## 6. ICAO Annex 6 Performance Classifications

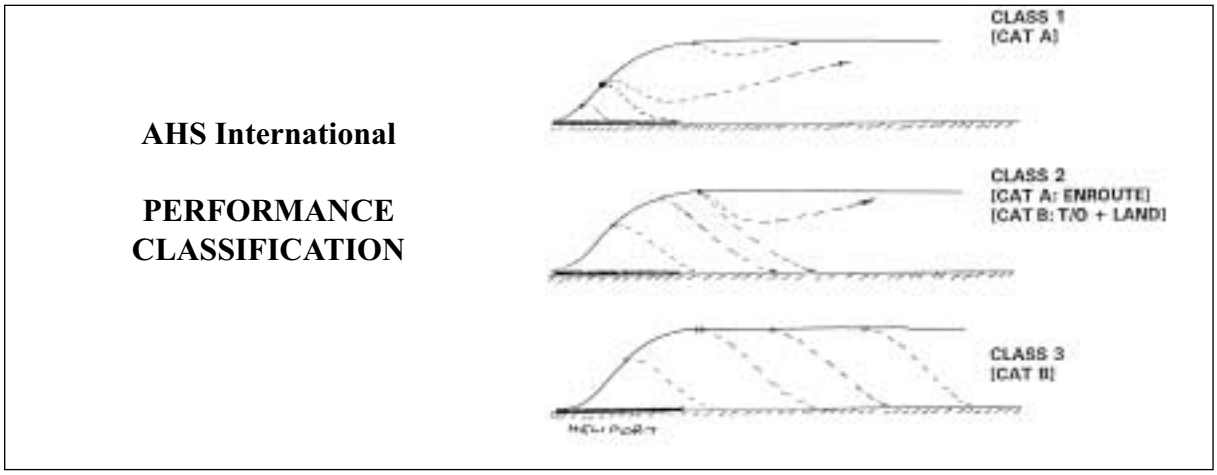
Annex 6 is based on three performance classifications: Class 1, 2 and 3. These are defined below and illustrated diagrammatically in Figure 1 where the solid line shows the normal flight path and the dashed line the flight profile resulting from an engine failure or one engine inoperative (OEI).

**Performance Class 1 Helicopter:** *"A helicopter with performance such that, in case of critical power unit-failure, it is able to land on the rejected take-off area or safely continue the flight to an appropriate landing area, depending on when the failure occurs."*

**Performance Class 2 Helicopter**: *"A helicopter with performance such that, in case of critical power-unit failure, it is able to safely continue the flight, except when the failure occurs prior to a*

*defined point after take-off or after a defined point before landing, in which case a forced landing may be performed."*

**Performance Class 3 Helicopter**: *"A helicopter with performance such that, in case of power-unit failure at any point in the flight profile, a forced landing must be performed."*




Performance Class 1 (or Class 1) is what is loosely termed Category A or Cat A and Performance Class 3 or Class 3 is termed Cat B. Class 2 is effectively Cat B on take-off and landing and Cat A enroute. It follows that performance Class 1 and 2 only applies to multi-engine helicopters. Many twin-engine helicopters can be operated as Class 1/Cat A, but more often they operate as Class 2. A single engine helicopter will always be Class 3, since an engine failure will require an immediate forced landing. A heavily-loaded twin-engine helicopter, particularly at high temperature or density altitude, will also operate in Class 3 since it cannot be operated with one engine inoperative (OEI). Since most helicopters operating throughout the world are single engine helicopters, this means that the vast majority of the current fleet have Class 3 performance.

Class 1 also assumes that an adequate rejected take-off area (RTOA) or rejected take-off distance (RTOD) is available at the heliport. If this is not the case, then technically the operation is Class 2. Similarly in the case of operations from an elevated heliport or helideck, normally without the required RTOA/RTOD, an engine failure could result in contact within the edge of the facility and thus may not fully meet the requirement for Class 1. Even so, the chance of such engine failure is remote and thus the exposure to this risk extremely small.
JAA , when developing JAR-OPS 3, added the following passenger limitation to the performance classes:

**20 or more passengers: Class 1**
**10 to 19 passengers: Class 1, 2 and 3**
**9 or less passengers: Class 1, 2 and 3**

This would appear to be a significant increase in stringency relative to Annex 6. If, however, the JAR/FAR Part 29 (13) and JAR/FAR Part 27(14) airworthiness requirements and helicopter design practice is taken into account, this the performance class/passenger limitations is a relatively good match.

The performance classification used in Annex 6 as a basis for establishing operating requirements is <u>not</u> used in FAA regulations. Nevertheless, almost identical results are achieved under FAA regulations through different means. The major concern, therefore, is not so much the performance classification framework, although some consider it inappropriate, but rather the limitations or recommendations applied in Annex 6. Here in addition to restrictions associated with the performance class, ICAO imposes limitations on operations conducted in congested areas, from elevated heliports, and helidecks at night and offshore.

## 7. <u>Annex 6 Limitations</u>

For scheduled service with 20 or more seats it is generally agreed that Class 1 standards should apply, but for 19 seats or less Class 2 is considered acceptable because of the low risk involved. For other operations, all performance classes are acceptable, although in practice most helicopter operations will be Class 2 or Class 3.

The main problem associated with Annex 6 requirements relates to the limitations imposed, or recommended, for operations with Class 3 helicopters and, to a somewhat lesser extent, Class 2 helicopters. Experience suggests that many of these limitations,

at least in non-hostile environments, are not justified and that the economic impact of applying such requirements is prohibitively high. Currently, a major segment of the industry want ICAO to reexamine the Class 3 and Class 2 related requirements and develop more suitable alternatives similar to current FAA requirements. Operational history in the United States, and particularly the Gulf of Mexico, demonstrates that an appropriate level of safety is obtained under current FAA requirements.

The main Annex 6 performance classification-related requirements which cause concern are summarized in Table 1 and Table 2 for Class 2 and Class 3 respectively. In the case of Class 3, these are related to the limitations on operations from elevated heliports and helidecks (by implication offshore) and operations at night. In the context of Annex 6 it is worth noting that in some cases actual limitations are incorporated in the requirements such as *"Only performance Class 1 helicopters shall be permitted to operate from elevated heliports in congested areas,"* while others are presented as recommendations. An example of the latter is *"Performance Class 3 helicopters should not be permitted to operate from elevated heliports or helidecks."* Some argue that "requirements" and "recommendations" are very different. Nevertheless, many observers believe that both would be treated the same in most national regulations. Thus this paper treats both requirements and recommendations as having the same impact. Table 1 and Table 2 also compares the existing US practice and whether various operations are permitted under applicable FAA regulations, Annex 6 and the new JAR-OPS 3.

## 8. Annex 6: Proposed Amendments

### 8.1 Environmental Classification/Exposure Time Concept

The use of "Hostile" and "Non-Hostile" as a discriminator for various operations was initially considered by the U.S. rotorcraft community in the early 1990s. Although these terms are not a part of U.S. rules, they are an underlying concept used by many operators to establish their own operational requirements and to select the type of helicopter and level of performance to be used. Use of the terms is generally supported by most members of the rotorcraft community and they have been incorporated into JAR-OPS 3. The original U.S. definitions for Hostile/Non-Hostile, developed by the HAI/HSAC International Operation Regulation Committee in the early 1990, are as follows:

**Non Hostile:** "An environment in which an emergency landing can be accomplished in a safe manner including consideration of *third party risks*; the aircraft occupants can be protected from the elements; and search and rescue response/capability is provided consistent with the anticipated exposure."

**Hostile:** "An environment in which an emergency landing cannot be accomplished in a safe manner because the terrain is hostile; and the occupants cannot be adequately protected from the elements; and search and rescues response/capability cannot be provided consistent with anticipated exposure or there is unacceptable *third party* risk."

These definitions effectively take into account weather, terrain, availability of search and rescue, sea state and water temperature (by implication). They also assume that if a water landing is required that the helicopter would have a suitable ditching capability and an approved flotation system.

The JAA adopted the Hostile/Non-Hostile concept but modified the Hostile Environment definition to read:

*(I) An environment in which:*
- *(A) A safe forced landing cannot be accomplished because the surface is inadequate; or*
- *(B) The helicopter occupants cannot be adequately protected from the elements; or*
- *(C) Search and rescue response/capability is not provided consistent with anticipated exposure; or*
- *(D) There is an unacceptable risk of endangering persons or property on the ground;*

*(II) In any case, the following areas shall be considered hostile:*
- *(A) For over-water operations, the open sea areas North of 45N and South of 45S designated by the Authority of the State concerned; and*
- *(B) Those parts of a congested area without adequate safe forced landing areas.*

The JAR-OPS 3 Non-Hostile definition is the opposite of the definition of Hostile.

Many experts consider the reference to open sea areas *"North of 45N and South of 45S"* to be an over simplification since depending on the season and actual weather and water temperature such sea areas could be hostile or non-hostile. A more general definition for Annex 6 "hostile Environment" should exclude reference to areas *"North of 45N and South of 45S."*

The ICAO Annex 6 reference to a *congested area* - and by implication a *non-congested area* – is also used in JAR-OPS 3. The definition, given below, is somewhat redundant since the features of *congested area* can be addressed as a part of Hostile/Non-Hostile definitions.

The definition for *congested Area* given in JAR-OPS 3 is *"In relation to a city, town or settlement, any area which is substantially used for residential, commercial or recreational purposes (see also definitions of hostile and non-hostile environment).* Reference to *congested areas* is also included in the FAA FAR Part 135 requirements.

The general relationship between the performance Class of Annex 6 and hostile/non-hostile definition considered applicable would be:

| | CLASS 3 | CLASS 2 | CLASS 1 |
|---|---|---|---|
| Hostile | *Not Allowed* | *Allowed with Limitations* | √ |
| Non-Hostile | √ | √ | √ |

In developing JAR-OPS 3, the JAA also included an *"exposure time"* concept. This is supported, in terms of aviation safety, since acceptance of a reasonable exposure time (to risk) reflects the extremely low probability of the loss of engine power at critical moments of flight such as on take-off. Exposure time is defined in JAR-OPS 3 as *"A period, determined on the basis of the power unit failure rate recorded for the helicopters engine type, during which probability of a power unit failure can be determined."* The maximum permitted exposure time is *"The actual period during which the performance of the helicopter with OEI (in still air) does NOT guarantee a safe forced landing area or continuation of flight."*

There is general support for amending Annexes 6 and 14 to include both the Hostile/Non-Hostile classification and exposure time concept.

**8.2 Operations**

On the surface, the JAR-OPS 3 requirements for the use of Class 3 helicopters in Non-Hostile Areas appear fundamentally different from the U.S. rules. However FAR Part 91 provides that *"An aircraft must be operated at an altitude that allows, if a power unit fails, an emergency landing to be made without undue hazard to persons or property on the surface."* Thus a helicopter can only be operated where an emergency landing can be made without undue hazard to persons or property on the surface. This is effectively the same as a requirement that Class 3 helicopters be operated only in non-hostile environments - as required by JAR-OPS 3. JAR-OPS 3 offers additional flexibility for Class 3 aircraft. For example, those parts of a *congested area* with adequate safe forced landing areas are considered Non-Hostile. JAR-OPS 3 also allows Class 3 helicopter flights in hostile areas even without safe forced landing areas provided such helicopters have six or fewer seats.

Offshore areas like the Gulf of Mexico (GOM), where the air temperature is mild and the water temperature warm, featuring adequate search and rescue capability and where offshore storms can be predicted well in advance, are Non-Hostile and thus under Annex 6 Class 2 (twin engine) helicopter operations are permitted.

Annex 6 recommends that helicopters with Class 3 performance (single engine and many light twins) should not be permitted to operate from elevated heliports or helidecks, although such operations take place on a regular basis in the United States and other parts of the world without any adverse impact. The JAA to some extent recognized the need for such operations at least to *elevated heliports* in a non-hostile environment and has recommended that such operations may be conducted with an *exposure time* until 2009, subject to the relevant approval by the appropriate authority. Under JAR-OPS 3 - and Annex 6 - such operations, however, are not allowed in a hostile environment or from helidecks. The corresponding JAR-OPS 3 requirements for helicopters with Class 2 performance allows such operations to both helidecks and elevated heliports and also such operations to be conducted in *non-congested hostile environments*.

Part of the concern here is related to the need to avoid the heliport or helideck edge in the case of one engine failure. Due to high engine reliability, this is a remote possibility. Recognition of this contributed to JAA's authorizing operations from helidecks and elevated heliports in non-hostile and non-congested hostile environments with an approved exposure time until 2009.

The restrictions associated with performance Class 3 operations in a hostile environment would appear logical but the limitation as it relates to helidecks in a non-hostile environment is not justified, at least in

the case of daytime operations. It would seem appropriate in the case of operations conducted offshore in a non-hostile environment such as in the Gulf of Mexico and many onshore locations that operations to both heliports and helidecks should be permitted for both Class 2 and 3 helicopters. In an ICAO context, the authors recommend that, rather than setting a cut-off date for any proposed rules, that there should be no limit. Instead the requirements should be re-examined at some future say, e.g., 2008, to determine if any change to the requirements are required. Experience in the Gulf of Mexico with Class 3 single engine helicopters confirms that such operations can be conducted safely. The use of Class 2 in non-congested areas and non-hostile environments given JAR-OPS 3 is also supported based on actual experience.

Annex 6 restricts the use of elevated heliports in *congested areas* to performance Class 1 helicopters. By comparison, JAR-OPS 3 allows *existing operations* to elevated heliports and helidecks with Class 2 performance helicopters to continue until 2005 if *"in accordance with approved procedures."* This is again a reflection of actual "real world" experience and that the risk associated with such operations is extremely small. This further supports a relaxation of the Annex 6 requirements. Some commentators have suggested that the cut-off dates in JAR-OPS 3 should be extended to minimize the economic impact on the operations and users of helicopter services.

Assuming that the route through the *"congested area"* is hostile, with no forced landing areas, then the *"enroute portion"* of the flight should be suitable for both Class 2 as well as Class 1. It follows that Class 1 helicopters should only be deemed essential if there is a *"congested hostile area"* within the immediate vicinity of the heliport. In most city environments, this is not the case and Class 2 and Class 3 should be acceptable providing the area under the flight path near the heliport (or in the case of Class 3 the complete route) has adequate forced landing area and hence can be considered non-hostile.

If the rules discussed above for Class 2 and Class 3 helicopters were embodied in Annex 6 to reflect today's best practices, there would not be a strong case against such ICAO regulations. If such requirements were adopted it is recommended that a detailed list be developed to categorize what is classified as Hostile and Non-Hostile. This might appear in the advisory material (green pages) of any revised Annex 6. This should give general guidance in terms of location, weather, temperature (including water temperature for over water operations), SAR capability, as well as the aircraft characteristics and performance level being considered.

### 8.3 Day-Night Operations

Annex 6 states that *"Performance Class 3 helicopters shall only be operated in conditions of weather and light . . . that permit a safe forced landing to be executed in the case of an engine failure."* It also states that this should apply to performance Class 2 helicopters *"prior to the defined point of take-off and after the defined point on landing."* This, to some extent, appears logical. Appendix A of Annex 6, however, states that Class 3 helicopters may not conduct operations at night or when cloud ceilings are less than 180 meters (600 feet). In addition, Appendix A requires minimum visibility for Class 2 and 3 of 1000 meters (3280 feet) and 1,500meters (4,920 feet), respectively.

This is a complex issue. A radically different perspective is usually taken by individuals living in Europe and those living in the United States on this topic. In the United States, unless a storm front is *passing through*, the typical night over much of the U.S. is clear with good visibility. This is in contrast to Europe where the night periods are often overcast, cloudy, with little or no visibility. Thus in the U.S. it is easy to conduct VFR flights safely at night in a Performance Class 3 aircraft, and indeed this is regular practice on-shore as detailed in Table 2. In contrast, nighttime operations are not common offshore in the United States because of difficulties associated with search and rescue and the associated difficulties of landing on water without the visual cues available on land. Ideally the standards for what is termed *"night operations"* should still be related to *"visibility,"* but it is customary to define standards in terms of day operations and night operations and it is unlikely that this will change. Even so for on-shore operations at night over routes with known adequate forced landing areas, it would seem reasonable to consider this as non-hostile. Thus, if instead of Day/Night, the Hostile/Non-Hostile definition were applied to set the Class 3 operating limits, this issue could easily be resolved. Unfortunately, many nations will not find this acceptable, even though Class 3 helicopter operations at night can be conducted safely. One suggestion is that such operations can be conducted over routes featuring adequate forced landing areas which have been specifically approved for night VFR operations. Here it is assumed that such routes may be different from those used for day VFR operations, or covered under the general route provision of, for example, FAR Part 91. Clearly this is an issue which needs further consideration, since on a clear night with adequate forced landing areas under the route and the remote possibility of the need to conduct an emergency landing such operations can be safely conducted. This similarly applies to Class 2 helicopters in the vicinity of

heliports prior to the *defined point* on take-off and after the *defined point* on landing.

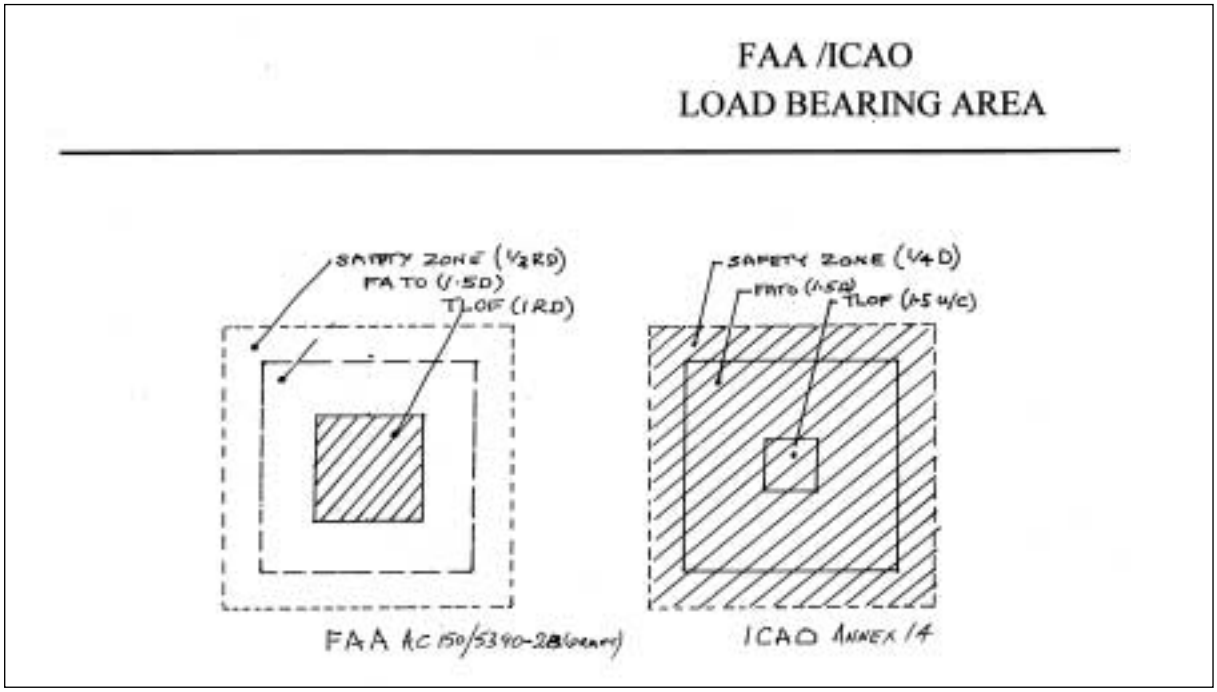
## 9. Heliport Design

There is considerable variation in the numerous heliport design standards or guidelines published around the world and in particular between Annex 14 and U.S. guidelines embodied in Advisory Circular (AC) 150/5390-2A (15). The ICAO framework is defined in terms of the Performance Class structure given in Annex 6. By comparison, FAA requirements are related to type of service provided by the heliport, e.g., Private Use or Prior Permission Required (PPR), General Aviation, Hospital, and Transport. Under the existing Advisory Circular, each of these are treated separately. Under a proposed revision to the Advisory Circular (16), however, Private Use/PPR is combined with General Aviation, with separate provisions where appropriate. A Transport Heliport under FAA requirements is essentially for scheduled operations and thus is broadly similar to a heliport for a performance Class 1 type operation. The other FAA heliport designations would each accommodate both Performance Class 2 and Class 3 operations. Annex 14 similarly groups the provisions for performance Class 2 and Class 3 helicopters together.

### 9.1 Annex 14 Design Philosophy

Annex 14 addresses heliports for all Performance Class helicopters and covers both ground space and airspace. In addition to basic ground level or surface level heliports, it addresses elevated heliports, offshore helidecks, and shipboard heliports. Much of the focus of this document and the corresponding Heliport Manual is, however, related to heliports for Class 1 operations and heliports located on airports. Thus it is more applicable to scheduled service type operations or large heliport facilities rather than typical heliports used around the world.

Of greatest interest to the operating community, at least in the United States, are the Annex 14 requirements for Performance Class 2 and Class 3 helicopter operations. The minimum Final Approach and Take-Off Area (FATO) dimension associated with these heliports in Annex 14 is identical to those in most national regulations, including those of the FAA. All define the FATO as 1.5D where D (D-factor) is the overall length of the longest helicopter to use the heliport. However, Annex 14 requires that the load bearing area must encompass both FATO and safety area which is approximately 2D in size. The FAA requirements for General Aviation heliports, by comparison, only require the touchdown and lift-off area (TLOF) of one rotor diameter (1RD) in size to be load bearing. This is a considerable difference in size of the load bearing area as illustrated in Figure 2. It has a major impact on cost of heliport design since this area has to be capable of withstanding the dynamic loads. It is also of interest to note that although the definition of TLOF is essentially the same in Annex 14 and the FAA Heliport Design AC, Annex 14 only requires the TLOF to be 1.5 times the maximum of the undercarriage width or length (1.5U/C). This is the same as for Private Use, or what is currently being termed PPR heliports in the U.S., under the existing FAA Heliport Design AC, but this is being changed under a current revision to 1RD for all heliports in the new AC being



developed. A *touchdown pad area* of 2 U/C is being retained to ground level PPR heliports and being proposed by industry for rooftop PPR heliports if a 1RD *ground effect area* is available.

The basic safety area requirements for VMC/VFR operations in Annex 14 are 0.25D which is, for all practical purposes, the same as the FAA requirements of 1/3 RD. The FAA, however, has set a minimum value of 10 feet (3 meters), 20 feet (6 meters), or 30 feet (9 meters) depending on the type of heliport, while the Annex 14 requires 3 meters (10 feet).

### 9.2 Acceleration Distances/Clearways

In addition to the basic FATO and Safety dimensions, Annex 14 recommends or implies the use of a clearway and in the associated Heliport Manual it is recommended an area should be provided *"over which the helicopter can accelerate safety to its climbing speed before leaving ground effect".* The recommendation for the *acceleration distance* is included in the Heliport Manual under 'site selection' and in Annex 14 listed in the chapter dealing with the physical characteristics. In another section of the Heliport Manual, the need *"to accelerate in level flight close to the ground"* is discussed under the section dealing with *helicopter clearways*. This adds to the difficulty of interpreting Annex 14 intent and suggests, therefore, that it should be revised. Clearway and acceleration distance is also discussed in connection with Performance Class 1 helicopters. In this case, the authors agree it is generally appropriate.

The FAA Advisory Circular provides in the case of General Aviation heliports for a protection zone of 280 feet (85 meters) and this can be considered equivalent to the clearway. For a Transport Heliport a 400 foot (122 meter) protection zone is recommended. The Heliport Manual includes a table of acceleration distances, which suggests that the heliport clearway should be 118 to 400meters (387 to 1312 feet).

### 9.3 Performance Class 1/Class 2 Helicopters

In the case of heliport design for Performance Class 1 helicopter operations, Annex 14 requires that the RTOA/RTOD and clearway be taken into account. Inclusion of the RTOA/RTOD would result in a very long heliport since with reasonable payloads and operational temperatures the RTOA can be as large as 1500 feet (450 meters) and the clearway can add an additional length up to 400 meters (1312 feet). The authors would suggest that these requirements, however, are only needed for scheduled service operations with helicopters with more than 19 seats.

The FAA Advisory Circular, in the case of Transport Heliports, requires a minimum FATO of 200 feet (61meters) but it recommends *"a larger FATO (which) can provide increase safety margin and greater operational flexibility."* There is little direct experience of such operations in the US, but in the case of scheduled operations conducted in the past one Transport Heliport was 400 feet long and featured an additional clearway and two others used *"water"* to provide an adequate RTOA/RTOD and clearway. It follows that the take-off weight had to be adjusted to the available RTOA/RTOD (RTODAH). The US recommendations in the Advisory Circular apply to scheduled, or unscheduled operations with large helicopters. It is generally agreed that scheduled operations with helicopters having 20 seats or more should be conducted to Cat A or Class 1 performance standards and hence require an adequate RTOA/RTOD. In this context it should be noted that with the advent of helicopters with higher levels of installed power (and in some cases three engines) the RTOA/RTOD may be substantially reduced in size. For scheduled operations with helicopters with 19 or less seats, as discussed previously, performance Class 2 helicopters are considered acceptable. For such heliports an extended FATO is suggested as recommended by the FAA for a Transport Heliport.

### 9.4 Non-Scheduled Class 2/Class 3

Here the size of the *load bearing area* and the size of the required clearway or protection zone (if any) is of particular interest. First, it seems reasonable to assume that Private or PRR heliports should be a national issue and NOT covered by Annex 14. Thus, the focus should be on General Aviation operations with performance Class 2 and Class 3 helicopters. Similarly special requirements are needed for heliports for Emergency Medical Service (EMS or HEMS) operations, or hospital heliports, since for such operations each nation must balance the level of safety desired against operating efficiency and the needs of society and the costs involved. Thus it has been suggested that the requirements for such facilities not be addressed by Annex 14. Instead, these should be established on a national or regional basis. Alternatively if such requirements were to be included, the special need for such operations must be taken into account.

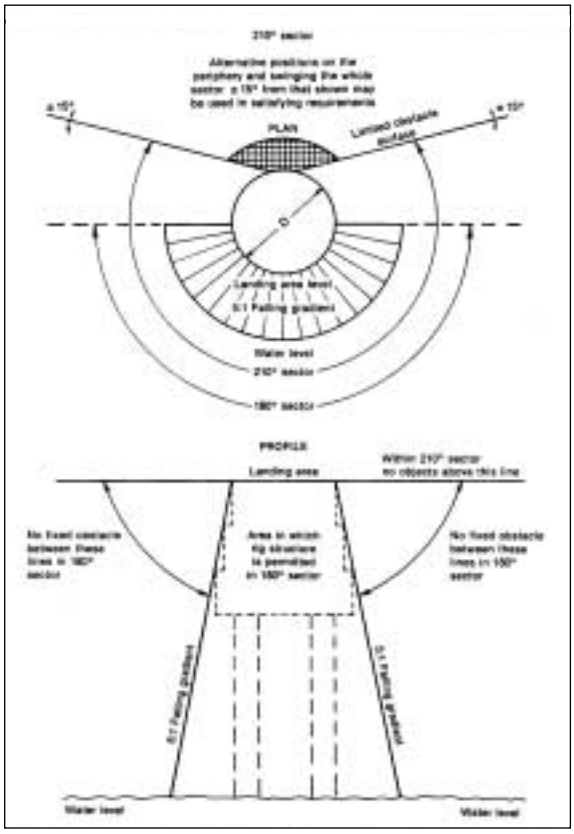
It could be argued that the *load bearing a*rea and clearway (or protection zone) size requirements should be a function of environment in which they are located - with *hostile areas* requiring larger areas. This concept has already been adopted by International Maritime Organization (IMO) for helidecks (17) located on mobile offshore drilling

units (MODUs) and is being proposed for other offshore facilities. Specific proposals related to *Hostile/Non*-Hostile areas for heliports for use with performance Class 2 and Class 3 helicopters have not been developed, but it is recommended this concept be examined as a part of the revision of Annex 14.

## 10. Helidecks

Annex 14 also addresses helidecks and shipboard facilities. This differs from most national regulations, including those in the United States, where helidecks are covered by separate rules. As discussed previously, it is proposed that such facilities, providing they are located it is in a Non-Hostile environment, should be available for use by all performance classes of helicopters and only in Hostile areas should the operations be limited to Class 1 and 2 helicopters. It is recommended that Hostile/Non-Hostile be used as the basis of a revision to the Annex 14 helideck requirements.

The size of the FATO/TLOF for helidecks, which are assumed to be coincidental, are in most regulations smaller than the values associated to heliports. This is partly attributed to the fact that whereas a heliport typically has only one or two approach and departure paths, helidecks have a wide-angle *obstacle free sector* and such operations are conducted to high standards with the pilots trained to operate into the specific helidecks used. Experience has shown over the years that the current standards are acceptable with practically no accidents attributed to the helideck dimensions. Annex 14 recommends that the FATO/TLOF should be 1D with a clear section 210° in a horizontal plane plus 180° with 5.1 *downward slope* shown in Figure 3. This is supported for Hostile environments, but for Non-Hostile environments, as currently embodied in the IMO requirements and recommended by the Gulf of Mexico operators through the Helicopter Safety Advisory Conference (HSAC) - 1RD (0.84D) for most helicopters with a 210° obstacle free horizontal sector should be acceptable. HSAC have also proposed that facilities with a 360° obstacle free horizontal sector need only to be 0.63D (but no less than 27ft/8.25m). These proposals are based on the large number of operations conducted by HSAC members in the Gulf of Mexico. These requirements are recommended for inclusion in Annex 14.




## 11. Elevated Heliports

Annex 14 treats elevated heliports in a similar manner to helidecks in recommending that the FATO and TLOF be considered coincidental. It further recommends that the FATO/TLOF should, as for ground level heliports, be 1.5D for use by performance Class 2 or 3 helicopters. The US experience is that although 1.5D is reasonable for the FATO, there is no need for the TLOF to be any larger than 1RD and the FATO can - if required - be *"in space"*. Annex 14 requirements may be reasonable for a Hostile Environments, but they are not supported for heliports located in areas which are typically Non-Hostile. Thus for such heliports the current FAA requirements/US practice is considered acceptable. In the U.S. special consideration is given to what can be described as *rooftop heliports.* Here although the heliport is above ground level and hence elevated, the area surrounding the heliport - the roof - provides similar *ground cushion* or *ground effect area* as if the heliport was located on the ground. Here it is proposed, for at least PPR/Private Use facilities, that the TLOF should be 2 U/C, provided a *ground effect area* surrounding the TLOF of 1RD is available. Such proposals have, however, not been accepted by the FAA.

## 12. Non-Precision/Precision IFR Heliports

In addition to the basic requirements for heliports for use under VFR or VMC (visual meteorological conditions), additional requirements are recommended in Annex 14 for heliports for use under IFR/IMC (instrument meteorological conditions) but Annex 14 does not distinguish between Non-Precision and Precision IFR facilities. The main difference between Annex 14 requirements for VFR/VMC and

IFR/IMC facilities is the safety area which is increased in size for IFR/IMC facilities. In the US, Non-Precision and Precision facilities are treated separately and requirements for full Precision IFR facilities involve considerable increases in both to the size of the FATO and safety area (15, 16). For Non-Precision IFR facilities, there is no specific guidance but most interest in the U.S. is in connection with Non-Precision IFR (IMC) Point-in-Space approaches (P-in-S) which makes use of the standards for VFR/VMC facilities. The philosophy is that the *final visual segment* of a Non-Precision/P-in-S IFR approach is similar to a VFR/VMC approach and thus no change is required to the heliport design. Also there is considerable work currently taking place in the US in connection with the development of TERPS/airspace requirements by the FAA. This in general assumes no change to the heliport design for Non-Precision IFR operations. Further work is required to ascertain the details for Precision IFR facilities, but a discussion of such issues are considered to be outside the scope of this paper.

## 13. Airspace

Annex 14 contains airspace requirements for visual (VFR/VMC) operations, Non-Precision IFR, and Precision IFR. Take-off and Approach are addressed separately, two approach angles 3° and 6° are considered, and requirements for performance Class 1, 2 and 3 helicopter operations are defined. In addition the airspace is considered in three segments or sections. Day and night operations are also treated separately and some of the dimensions associated with the airspace are dependent on the rotor diameter of the helicopter considered. Thus the Annex 14 requirements are extremely complex and difficult to follow. They are, in fact, so complex that they are practically impossible to apply for a typical heliport. Some observers have suggested that since they were developed in the mid-1980s, they are also out of step with other ICAO airspace requirements. It follows that the airspace requirements clearly need to be re-evaluated as a part of the proposed revision of Annex 14. Further discussion of the IFR/IMC requirements is beyond the scope of this paper. It is, however, of interest to note that approximately 150 Non-Precision P-in-S IFR approaches have been established at heliports in the US, although they have been treated as *"special procedures"* rather than public procedures.

### 13.1 Visual Operating Conditions (VFR/VMC) Airspace

Annex 14, as mentioned above, provides different requirements for performance Class 1, 2 and 3. The differences are more a function of the helicopter rotor size, however, than true performance except in the case of take-off for performance Class 1 (which considers OEI operations). The FAA has adopted a somewhat different format and has a single *approach/departure (take-off)* surface. The logic behind this is that at most heliports the approach flight path is also used as the departure flight path. Also in the case of a facility with two flight paths they will, depending on the wind direction, both be used for landing and take-off. Under the FAA requirements, although two flight paths are strongly recommended, a single flight path is allowed for Private Use (PPR) and Hospital Heliports.

For the standard VFR heliport, the U.S. requirements dictate an 8:1 (12.5 degree) slope for a distance of 4000 feet (1220 meters). Under the revised FAA requirements to be embodied in the new Heliport Design Advisory Circular, the 8:1 surface starts from the edge of the safety area for General Aviation and Transport Heliports and from the edge of the FATO in the case of PPR and Hospital Heliports. The surface is 500 feet (152 meters) wide at 4,000 feet (1220 meters). The 8:1 surface is somewhat *"steeper"* - at least initially - near the heliport than, for example, the corresponding Annex 14 *approach (day) slope* which for the initial section is 8 degrees (12.5:1) for 245 meters (805 feet) followed by a variable length section of 12.5 degrees (8:1) and finally a 15 degree (6.7:1) segment of 790 meters (2,600 feet). For take-off, the corresponding slopes in Annex 14 for performance Class 2 and 3 are 8 degrees (12.5:1), 15 degrees (6.7:1) and 15 degrees (6.7:1) for each of the three segments. Shallower surfaces are recommended for performance Class 1 operations of 4.5% (22:1) for the first two segments.

The authors do not propose to discuss the airspace requirements in depth in this paper, although some general observations can be made. The philosophy behind the values quoted in Annex 14, and some of the requirements in Annex 6 and JAR-OPS 3, is that the Height-Velocity (H-V) diagram (or HV chart) should not be infringed or the *"avoid region"* should not be penetrated on take-off. There appears to be considerable difference of opinion on the implications of the H-V diagram. For all helicopters except those certificated under FAR/JAR Part 29 with a take-off weight of 20,000 lbs (9074 kgs) or less and 10 passengers seats or more, the H-V diagram is performance information and is not a limitation. The H-V diagram is advisory in nature and is provided for pilot planning purposes. This applies to the vast majority of helicopters and, in particular, performance Class 3 single engine and most of the performance Class 2 helicopters. The H-V diagram requirement has been, over the years, *"softened"* for most FAR/JAR Part 29 multi-engine helicopters. It is also

generally accepted that the H-V diagrams are conservative, since they are normally developed from the results of tests performed at high density altitudes and gross weights. The H-V diagram does not apply in the case of helicopters certificated to Category A and hence those operated to performance Class 1. Even for the FAR/JAR Part 29 helicopters for which the H-V diagram is a limitation, it is generally accepted that the H-V diagram is a safety guideline rather than a precise performance indicator. It has also been shown that piloting techniques can be varied to avoid the H-V diagram and 8:1 surfaces. The 8:1 approach/departure surfaces have been applied in the U.S. since, at least, 1969 (18). In this context it is also of interest to note that, in connection with operations to/from elevated heliports and helidecks using performance Class 2 and 3 helicopters as stated in NPA-OPS 8 (5), that H-V diagrams may be infringed in order to enable procedures which minimize the deck edge collision risk. Another section of JAR-OPS 3 also allows *". . . momentary flight through the height velocity (H-V) envelope . . ."* Also it is generally agreed that the avoid region of the H-V diagram may be penetrated for a short period without any adverse impact. This can be effectively viewed as an *exposure risk period* and as such it should be addressed in any revision of Annex 14 when considering performance Class 2 and Class 3 (Category B) operations.

## 14. Concluding Remarks

Annex 6 and Annex 14 address many other topics not discussed in this paper. Some are equally important to the long term viability of the rotorcraft industry and thus they will need to be taken into consideration when revision to the ICAO documents is commenced. The points reviewed in this paper are considered most important. The authors would urge that the unacceptable features of both Annex 6 and Annex 14 should be modified if acceptable worldwide regulations and recommended practices are to be established. Many of the current requirements which cause difficulty can be resolved by the application and acceptance of the *Hostile/Non-Hostile environment* framework and *exposure time* concept. Also there is a clear need to consider the unique operating characteristics of rotary wing aircraft rather than fixed-wing practice or thinking which appears to have influenced some of the current requirements in the annexes. Both in Annex 6 and Annex 14 it is also important to separate requirements for scheduled airline type operations from those which apply to the majority of onshore and offshore operations. With this approach the overall safety standards can be enhanced. At the same time the helicopter industry can be stimulated to provide an even more important aviation role transporting passengers and freights. This is particularly important as the aviation industry faces major difficulties in many parts of the world as a result of airport and airspace congestion.

The current Annex 6 and Annex 14 provides an excellent basis for developing such broad based international standards and recommended practices which can be adopted as a basis for international and domestic requirements by all nations with helicopter operations.

## Acknowledgement

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## TABLE 1: CLASS 3 LIMITATIONS/PRACTICE

| | US PRACTICE | FAA RULES | ICAO ANNEX 6 | JAA JAR OPS3 |
|---|---|---|---|---|
| Night – Offshore | NO (1) | YES | NO | NO |
| - Onshore | YES | YES | NO | NO |
| Helidecks | YES | YES | NO | NO |
| Offshore-Hostile | NO (2) | YES | NO | 10 MIN. LIMIT |
| Onshore - Non-Hostile | YES | YES | YES | YES |
| - Hostile | YES (3) | NO/YES (3) | NO | NO/YES (4) |
| Elevated Heliports – Non-Hostile | YES | YES | NO | NO/YES (5) |
| Hostile | YES | YES | NO | NO/YES (5) |
| IMC (Passengers) | YES | NO/YES (6) | NO | NO |
| IMC (Cargo) | YES | YES | NO | NO |

**(1)** **HSAC Information - Passenger Carrying -Some Limited GOM Operations**
**(2)** **GOM Non-Hostile**
**(3)** **Forced Landing Area Required**
**(4)** **With Approved *Exposure Time* Until 2009**
**(5)** **Turbine Engine Helicopters 6 Seats or Less - Outside Congested Area: Safe Forced Landing Area NOT Available**
**(6)** **SEIFR/SFAR 81**

## TABLE 2: CLASS 2 LIMITATIONS, PRACTICE

| | US PRACTICE | FAA RULES | ICAO ANNEX 6 | JAA JAR OPS3 |
|---|---|---|---|---|
| Elevated Heliport | | | | |
| Night | YES | YES | NO | NO |
| Hostile | YES | YES | ?? | NO/YES (1) |
| Elevated Heliport | | | | |
| Non-Hostile | YES | YES | ?? | NO/YES (1) |
| Non-Congested/Hostile | YES (2) | YES | ?? | NO/YES (1) |
| Congested/Hostile | YES (2 | YES | NO | NO |
| Helideck | YES | YES | ?? | NO/YES (1) |

**(1)** **Until 2005 AND with Approved *Exposure Time* Until 2009**
**(2)** **Route Non-Hostile**