A COMPARATIVE STUDY OF FAA AND ICAO OBSTACLE CLEARANCE REGULATIONS

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Research Report Number ARC-701

Prepared in cooperation with the

CENTER FOR TRANSPORTATION RESEARCH
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1.0 INTRODUCTION

The safety of aircraft operations in the vicinity of an airport is dependent on adequate clearance being provided between the aircraft and any ground obstacles. The Federal Aviation Authority (FAA) and International Civil Aviation Organization (ICAO) are two regulatory bodies that prescribe obstacle clearance standards for airports. The FAA defines U.S. standards, while ICAO defines international standards that have been adopted by a number of countries around the world.

The purpose of this paper is to provide an understanding of the differences and similarities of both the FAA and ICAO obstacle clearance regulations, through a comparison of their regulatory standards. The FAA has three sets of regulations that define obstacle clearance requirements: Code of Federal Regulation (14 CFR) Part 77 "Objects Affecting Navigable Airspace;" Advisory Circular (AC) 150/5300-13 "Runway Design;" and Terminal Instrument Procedures (TERPS) 8260.3B. By contrast, ICAO has two sets of regulations that refer to obstacle clearance: Annex 14, Volume 1, Aerodrome Design; and Procedures for Air Navigation Services (PANS-OPS) Document 8168, Volume 1. Specifically, the comparative focus of this paper is on the airport imaginary surfaces defined in CFR Part 77 and Annex 14, the obstacle-free zones defined in AC 150/5300-13 and Annex 14, and the circling and instrument landing system (ILS) obstacle clearances defined in TERPS and PANS-OPS.

To illustrate the comparative advantages and disadvantages of the FAA and ICAO regulations, the obstacle clearance surface areas prescribed by the regulations will be assessed for three different runway sizes: small, visual only runway (1000 m x 20m); medium, non-precision approach runway (1500 m x 30m); and a large, precision approach runway (2500 m x 60 m). Furthermore, to illustrate the adoption of ICAO Annex 14 obstacle clearance standards by another country, the airport imaginary surfaces as defined by the Civil Aviation Authority of New Zealand (CAA(NZ)) will also be compared to the FAA's CFR Part 77 and ICAO Annex 14 imaginary surfaces. The CAA(NZ) standards are defined in AC 139-06A "Aerodrome Design."

The report has been designed so that a reader unfamiliar with the topic can be familiarized with general terminology in Section 2, while those conversant with the topic can advance immediately to Section 3. In Section 3, the FAA's Part 77 "airport imaginary surface" standards and ICAO's Annex 14 "obstacle limitation surface" standards are compared. In Section 4, the obstacle-free zone regulations as defined in AC 150/5300-13 are contrasted to similar regulations defined by ICAO in Annex 14, and in Section 5 the circling and ILS obstacle clearance standards defined in TERPS and PANS-OPS are compared. Section 6 provides a comparative summary of the obstacle clearance surface areas for the three example runways, based on the standards defined in Sections 3 through 5.

Finally, it should be noted that System Internationale (S.I.) metric units have primarily been used for the comparison of dimensions. The factor used to convert non-S.I. units to S.I. units is: 1 ft = 0.3048m, with the result then rounded to the nearest 10m.

2.0 TERMINOLOGY AND DEFINITIONS

The FAA and ICAO have adopted a number of terms to describe the various elements associated with a runway and its airspace. In order to appreciate the discussion in the following sections, the terms used are now defined. For ease of reference, the terms are grouped into four sections: general terms; runway classification terms; obstacle-related ground terms; and obstacle related airspace terms. The definitions are taken from FAA AC 150/5300-13, 14 CFR Part 77, and ICAO Annex 14, Volume 1.

2.1 GENERAL TERMS

Some general airport terms which are utilized in this paper are defined in Table 1.

TABLE 1. GENERAL AIRPORT TERMS

Term	Definition
Airport Evaluation	Highest point on an airport's usable runway expressed in feet above mean sea level (MLS)
Airport Reference Point	Latitude and longitude of the approximate center of the airport — i.e., geometric centroid of the runway system at the airport, based upon the lengths of the runways.
Large Airplane	Airplane of more than 12,500 pounds (5,700 kg) maximum certificated takeoff weight (MCTOW)
Small Airplane	Airplane of 12,500 pounds (5,700 kg) or less MCTOW

Source: FAA Advisory Circular 150/5300-13, Chapter 1

2.2 RUNWAY CLASSIFICATION TERMS

Runways are classified in a variety of ways. In this paper the focus is on runway classification in terms of approach categories and operational capabilities. The terminology and definitions associated with approach categories and operational capabilities are detailed below.

2.2.1 Runway Approach Categories

A runway approach is defined as either visual, or non-precision, or precision approach. The definitions and associated requirements for each type of approach are detailed in Table 2.

TABLE 2. RUNWAY APPROACH CATEGORIES AND ASSOCIATED TERMS

Term	Definition
Decision Height	The lowest height above the runway where pilots make the decision to continue the landing or to abort, based on the pilot's ability to obtain guidance from visual clues on the ground rather than from instruments in the cockpit. This height only applies to precision approaches, for non-precision approaches a minimum descent altitude is defined.
Runway Visual Range (RVR)	The distance over which the high-intensity runway edge lights can be seen by pilots. It is measured and reported at the runway touchdown zone.
Visual Runway	A runway without an existing or planned straight-in instrument approach procedure, and greater than 1.5 mile (2,410 m) visibility exists.
Non-Precision Runway	A runway with an instrument approach procedure that provides only horizontal guidance for landing. The lowest minima requirements are visibility greater than 3/4 mile (1,210 m), or RVR=2,400 ft (730 m), and decision height=250 ft (80 m). A non-precision approach can be performed when the visibility is less than 3/4 mile if the runway has the necessary approach lighting system.
Precision Approach Category I (CAT I) Runway	A runway with an instrument approach procedure that provides horizontal guidance and glide slope for landing, utilizing an instrument landing system (ILS) or precision-approach radar (PAR). The guidance provides for approaches to minimum requirements of visibility greater than 1/2 mile (800 m) or RVR=2,400 ft (730 m), and decision height=200 ft (60 m). Note: The RVR minima can be reduced to 1,800 ft (550 m) if the runway has an operative touchdown zone and runway centerline lights.
Precision Approach CAT's II Runway	A runway with an instrument approach procedure that provides horizontal guidance and glide slope for landing, utilizing an ILS or PAR. The guidance provides for approaches to minimum requirements of RVR=1,200 ft (370 m), and decision height=100 ft (30 m). The aircrew needs to be CAT II certified.
Precision Approach CAT's III Runway	A runway with an instrument approach procedure that provides horizontal guidance and glide slope for landing, utilizing an ILS or PAR, for approaches to minima less than CAT II. CAT III is further subdivided into a, b, and c, and requires aircrew to be CAT III certified. CAT IIIa minimum requirements are RVR-700 ft (210 m), and decision height=0 ft, and requires aircraft with automatic landing capability. CAT IIIb minimum requirements are RVR=150 ft (50 m), and decision height=0 ft, requires aircraft with automatic landing and rollout capability. CAT IIIc minimum requirements are RVR=0 ft, and decision height=0 ft, and requires aircraft with automatic landing, rollout and taxiing capability.

Source: FAA Advisory Circular 150/533-13, Chapter 1; Horonjeff & McKelvey "Planning and Design of Airports" fourth edition, page 680.

It should be noted that while a runway may be classified as capable of providing a precision approach, an aircraft's actual approach is dependent on the on-board instrument capabilities (may only be able to decipher horizontal guidance), meteorological conditions, and current operational capabilities of the instrument landing system (system may be "down," or undergoing maintenance). Furthermore, the FAA's use of the term "precision" and "non-precision" approach is currently being replaced by the use of viability criteria, such as "visibility less than 3/4 mile."

2.2.2 Runway Operational Categories

While the FAA and ICAO both use two criteria to classify a runway in terms of its operational capabilities, the criteria used by the organizations differ slightly. The FAA classifies a runway in terms of the aircraft that it is capable of serving based on an airport reference code (ARC). The airport reference code incorporates two criteria, one of which refers to the aircraft's stall speed, and the other to itswingspan:

- aircraft approach category (AAC) — grouping of aircraft based on 1.3 times their stall speed in their landing configuration at their maximum certificated landing weight (refer Table 3).
- airplane design group (ADG) — grouping of airplanes by wingspan (refer Table 3).

For ease of comparison with ICAO standards, the wingspan width is defined in S.I. units.

TABLE 3. FAA AIRCRAFT APPROACH CATEGORY AND AIRPLANE DESIGN GROUP CLASSIFICATIONS

Aircraft Approach Category	Speed (knots)	Airplane Design Group	Wingspan (m)
Category A	speed < 91	Group I	span < 15
Category B	91 speed < 121	Group II	15 ≤ span < 24
Category C	121 ≤ speed < 141	Group III	24 ≤ span < 36
Category D	141 ≤ speed < 166	Group IV	36 ≤ span < 52
Category E	speed ≥ 166	Group V	52 ≤ span < 65
		Group VI	65 ≤ span < 80

Source: FAA Advisory Circular 150/5300-13, Chapter 1

Thus, a runway is defined, by the FAA, in terms of the maximum aircraft approach category and airplane design group that it has the capability to serve. The FAA uses this classification system to specify obstacle clearance requirements in AC 150/5300 and TERPS.

By contrast, ICAO defines a runway's capability in terms of an aerodrome reference code. The aerodrome reference code comprises two code elements which are related to the aeroplane performance characteristics and dimensions: the aeroplane reference field length; and a wingspan/outer main gear wheel span element:

- code element 1 — aeroplane reference field length (ARFL) — defines the runway length in terms of the aeroplane characteristics it has been designed to accommodate (refer Table 4).
- code element 2 — wingspan, and outer main gear wheel span — defines the greatest wingspan, or the greatest outer main gear (OMG) wheelspan, whichever gives the more demanding code letter of the aeroplane for which the runway is designed to accommodate (refer Table 4). Note, the OMG wheelspan is the distance between the outside edges of the main gear wheels. ICAO uses this classification system to specify obstacle clearance requirements in Annex 14, Volume 1, Chapter 4.

TABLE 4. ICAO AERODROME REFERENCE CODE

	Code Element 1	Code Element 2		
Code	**ARFL (m)**	**Code**	**Wingspan (m)**	**OMG Wheelspan (m)**
1	length< 800	A	span < 15	span < 4.5
2	800 ≤ length < 1,200	B	15 ≤ span < 24	4.5 ≤ span < 6
3	1,200 ≤ length < 1,800	C	24 ≤ span < 36	6 ≤ span < 9
4	length ≥ 1,800	D	36 ≤ span < 52	9 ≤ span < 14
		E	52 ≤ span < 65	9 ≤ span < 14

Source: ICAO Annex 14 - Volume 1, Chapter 1

As detailed by Horonjeff and McKelvey, there is an approximate correspondence between the FAA Airport Reference Code and the ICAO Aerodrome Reference Code. "The FAA's aircraft approach categories A, B, C, and D are approximately the same as ICAO's aeroplane reference field length code's 1, 2, 3, and 4, respectively. Similarly the FAA's airplane design groups I, II, III, IV, and V approximately correspond to ICAO's code's A, B. C, D, and E" (Ref 1).

It should be noted that in PANS-OPS, ICAO does not use the aerodrome reference code to specify obstacle clearance requirements. Instead, ICAO defines an aircraft category and relates the obstacle clearance to this category. The aircraft category is based on the speed V_{at}: the aircraft speed at threshold, which is 1.3 times stall speed at maximum certified landing mass. The aircraft categories defined by ICAO are A, B, C, D, and E. The speed V_{at} associated with the categories is identical to the speeds used to define the FAA aircraft approach category (refer Table 3), except for category E. ICAO defines "E" as an aircraft with a V_{at} greater than 166 knots and less than 210 knots, whereas the FAA defines category "E" as an aircraft with a V_{at} greater than 166 knots. For reference, the ICAO aircraft categories are defined in PANS-OPS, Part III, Chapter 1, page 3.

2.3 RUNWAY SYSTEM — IMPORTANT "GROUND" TERMINOLOGY

The purpose of this report is to compare the regulations governing obstacle clearance in the vicinity of an airport, as defined by ICAO and the FAA. However, to avoid confusion with the obstacle clearance terminology, it is important to appreciate that the aforementioned organizations also define a number of geometric specifications for ground-level aircraft safety. As an example, a number of the more ambiguous FAA terms are detailed in Table 5. For a complete listing of the geometric specifications required for a runway system, the reader is referred to FAA AC 150/5300-13, Chapter 2, or to ICAO Annex 14, and/or to Horonjeff and McKelvey, "Planning and Design of Airports," Chapter 9.

For the reader's information, the FAA dimensional standards associated with the runway OFA, RPZ, and RSA are defined in Appendix A. It should be noted that ICAO has similar regulations to the FAA's OFA and RSA. ICAO defines a "runway end safety area" which is similar to the FAA's RSA, and defines a "runway strip" which is similar to the FAA's object free area. The ICAO standards associated with the aforementioned terms are also defined in Appendix A. Furthermore, to illustrate the adoption of ICAO standards, the respective standards of CAA(NZ) have been included in Appendix A.

Figures 1 and 2 illustrate the location of the FAA's OFA and RSA, and ICAO's runway strip and runway end safety area, respectively.

2.4 OBSTACLE-RELATED "AIRSPACE" TERMINOLOGY

There are a number of regulations governing the height of ground objects in the vicinity of an airport. The regulations are designed to ensure that airborne aircraft have adequate and safe clearance from ground-obstacles, for a variety of maneuvers.

TABLE 5. SELECTED FAA GEOMETRIC SPECIFICATIONS FOR A RUNWAY SYSTEM

Term	Definition
Object	Includes, but is not limited to, above-ground structures, navigational aids, people, equipment, vehicles, natural growth, terrain, and parked aircraft.
Stopway	Defined rectangular surface beyond the end of a runway prepared or suitable for use in lieu of runway to support an airplane, without causing structural damage to the airplane, during an aborted takeoff.
Object-Free Area (OFA)	An area on the ground centered on a runway, taxiway, or taxilane centerline provided to enhance the safety of aircraft operations by having the area free of objects (including aircraft), except for objects that need to be located in the OFA for air navigation or aircraft ground-maneuvering purposes. The runway OFA begins at each runway end when a stopway is not provided; if a stopway is provided, the runway OFA begins at the stopway end.
Runway Protection Zone (RPZ)	An area off the runway end provided to enhance the protection of people and property on the ground, to achieve through airport owner control over RPZ's. The RPZ dimension for a particular runway end is a function of the type of aircraft and approach visibility minimum associated with that runway end. Unless a special application is made, RPZ begins 200 ft (60 m) beyond the runway threshold.
Runway Safety Area (RSA)	A defined surface on the round surrounding the runway prepared or suitable for reducing the risk or damage to airplanes in the event of an undershoot, overshoot, or excursion from the runway. The RSA begins at each runway end when a stopway is not provided; if a stopway is provided, the RSA begins at the stopway end.

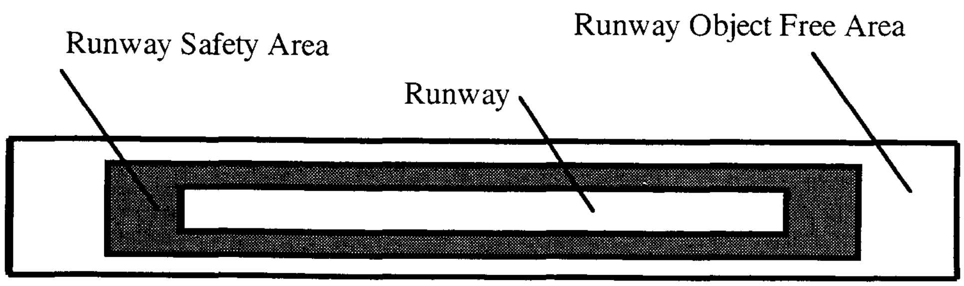

Figure 1. FAA Runway Safety Area and Runway Object Free Area Location

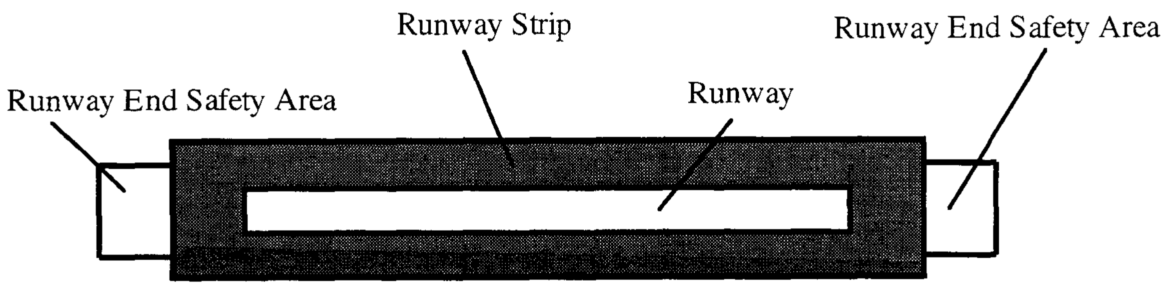

Figure 2. ICAO Runway Strip and Runway End Safety Area Location

The FAA addresses the clearance of ground objects with three specific regulations: 14 CFR Part 77, "Objects affecting navigable airspace;" AC 150/5300-13, Chapter 4, "Runway Design;" and TERP 8260.3B. The general terminology that differentiates each regulation is outlined in Table 6. The important difference to appreciate is that the OFZ and TERPS obstacle clearance requirements detail the minimum clearances required to protect the aircraft while in flight. For this reason the regulations are fairly stringent and compliance cannot easily be waived by an aeronautical study. The OFZ standards that define the minimum level of safety for precision instrument operations are determined by a collision risk model. The collision risk model is a computer program developed from observed approaches and missed approaches. The model provides the probability of an airplane passing through any given area along the flight path of the airplane. To obtain an acceptable level of safety with objects in the OFZ, operating minimum may have to be adjusted (Ref 2). By contrast to the above, the FAA Part 77, "Obstruction to air navigation" regulations merely provide a "study surface." Thus, when an object penetrates the study surface it is then identified, and studied to determine if it actually provides a hazard to safe aircraft operations. Conversely, ICAO addresses the clearance of ground objects with two regulations: Annex 14, Volume 1, Chapter 4, and PANS-OPS. In Annex 14, ICAO refers to an obstacle limitation surface which is similar to the FAA imaginary surface, and in PANS-OPS ICAO refers to obstacle clearance requirements which has the same definition as detailed under TERPS, in Table 6.

TABLE 6. OBSTACLE-RELATED "AIRSPACE" TERMINOLOGY

Regulation	Term	Definition
	Frangible NAVAID	A navigational aid (NAVAID) which retains its structural integrity and stiffness up to a designated maximum load, but on impact from a greater load yields in such a manner as to present minimum hazard to aircraft. The term NAVAID includes electrical and visual air navigational aids, lights signs and associated supporting equipment.
	Hazard to Air Navigation	An object which, as a result of an aeronautical study, the FAA determines will have an adverse effect upon the safe and efficient use of navigable airspace by aircraft, operation of navigation facilities, or existing or potential airport capacity.
AC 150/5300-13, Chapter 4	Obstacle Free Zone (OFZ)	The OFZ is defined as the airspace below 150 ft (45 m) above the established airport evaluation and along the runway and extended runway centerline that is required to be clear of all objects (including aircraft), except for frangible visual NAVAID's that need to be located in the OFZ because of their function, in order to provide clearance protection for aircraft landing or taking off from the runway, and for missed approaches. The OFZ volume of airspace is bounded by four surfaces: runway OFZ; inner-approach OFZ; inner-transitional OFZ; and Part 77 horizontal surface.
14 CFR Part 77	Obstruction to Air Navigation	Defines an object of greater height than any of the heights or surfaces defined in 14 CFR Part 77. Obstructions to air navigation are presumed to be hazards to air navigation unless an FAA aeronautical study has determined otherwise. Part 77 defines five imaginary surfaces for civil airports: horizontal surface; conical surface; primary surface; approach surface; and the transitional surface.
TERPS 8260.3B	Obstacle Clearance	This regulation defines the required obstacle clearances at airports that operate terminal instrument procedures. The regulation defines "height-above" clearances and also runway threshold approach and departure surface requirements.

Source: FAA Advisory Circular 150/5300-13, Chapter 1; 14 CFR Part 77; TERPS 8260.3B

In Section 3, the FAA Part 77, "Obstruction to Air Navigation," regulations and associated clearance requirements will be defined and compared to ICAO's Annex 14, Volume 1, Chapter 4, "Obstacle Restriction and Removal" standards. In Section 4, the FAA AC 150/5300-13, "Obstacle Free Zone," regulations will be defined and compared to similar standards in ICAO's Annex 14, Volume 1, Chapter 4 "Obstacle Restriction and Removal." In Section 5, the TERPS 8260.3B, "Obstacle Clearance," standards will be detailed and compared to the standards in PANS-OPS.

3.0 AIRPORT IMAGINARY SURFACES / OBSTACLE LIMITATION SURFACES

In this Section, the FAA airport imaginary surfaces, as defined in 14 CFR Part 77, will be compared to the ICAO obstacle limitation surfaces defined in ANNEX 14, Volume 1, Chapter 4. The FAA airport imaginary surfaces are defined in Section 3.1; the ICAO surfaces are defined in Section 3.2; and the comparison of associated dimensions is tabulated and discussed in Section 3.3.

3.1 FAA CIVIL AIRPORT IMAGINARY SURFACE DEFINITIONS

The scope of the FAA 14 CFR Part 77, "Objects Affecting Navigable Airspace," regulations covers five subparts (Ref 3):

- establishes the standards for determining obstructions in navigable airspace;
- sets forth the requirements for notice to the administrator of certain proposed construction or alteration;
- provides for aeronautical studies of obstructions to air navigation, to determine their effect on the safe and efficient use of airspace;
- provides for public hearings on the hazardous effect of proposed construction or alteration on air navigation; and
- provides for establishing antenna farm areas.

While the regulations regarding "construction or alteration requiring notice" are important, they will not be used in the comparison of FAA to ICAO standards, and therefore have been detailed in Appendix B. rather than in this section. The subpart which is of concern, and which will be compared to ICAO standards, is subpart "c," or 77.25, "Civil Airport Imaginary Surfaces."

Civil airport imaginary surfaces are established with relation to the airport and to each runway. The size of each imaginary surface is based on the category of each runway according to the type of approach available or planned for a particular runway. The slope and dimensions of the approach surface applied to each end of a runway are determined by the most precise approach existing or planned for that runway. The FAA defines five principal imaginary surfaces: horizontal surface; conical surface; primary surface; approach surface; and transitional surface. A description of each of these surfaces is detailed below (Ref 3); the surfaces are illustrated in Figure 3, and surface dimensions are detailed in Section 3.3.

- **horizontal surface**: a horizontal plane 150 ft (45 m) above the established airport elevation, the perimeter of which is constructed by swinging arcs of specified radii from the center of each end of the primary surface of each runway, and connecting the adjacent arcs by lines tangent to those arcs.
- **conical surface**: a surface extending outward and upward from the periphery of the horizontal surface at a slope of 20 to 1, for a horizontal distance of 4,000 ft (1,220 m).
- **primary surface**: a surface longitudinally centered on a runway. When the runway has a specially prepared hard surface, the primary surface extends 200 ft (60 m) beyond each end of that runway; but when the runway has no specially prepared hard surface, or planned hard surface, the primary surface ends at each end of the runway. The elevation of any point on the primary surface is the same as the elevation of the nearest point on the runway centerline. Note that the width of a primary surface is based on the most precise approach existing or planned for either end of the runway.
- **approach surface**: a surface longitudinally centered on the extended centerline and extending outward and upward from each end of the primary surface. An approach surface is applied to each end of each runway based upon the type of approach available or planned for that runway end.
- **transitional surface**: these surfaces extend outward and upward at right angles to the runway centerline and the runway centerline extended, at a slope of 7 to 1 from the sides of the primary surface up to the horizontal surface, and from the sides of the approach surfaces. With a precision approach, the transitional surface, which projects through and beyond the limits of the conical surface, extends for a distance of 5,000 ft (1,520 m) measured horizontally from the edge of the approach surface and at right angles to the runway centerline.

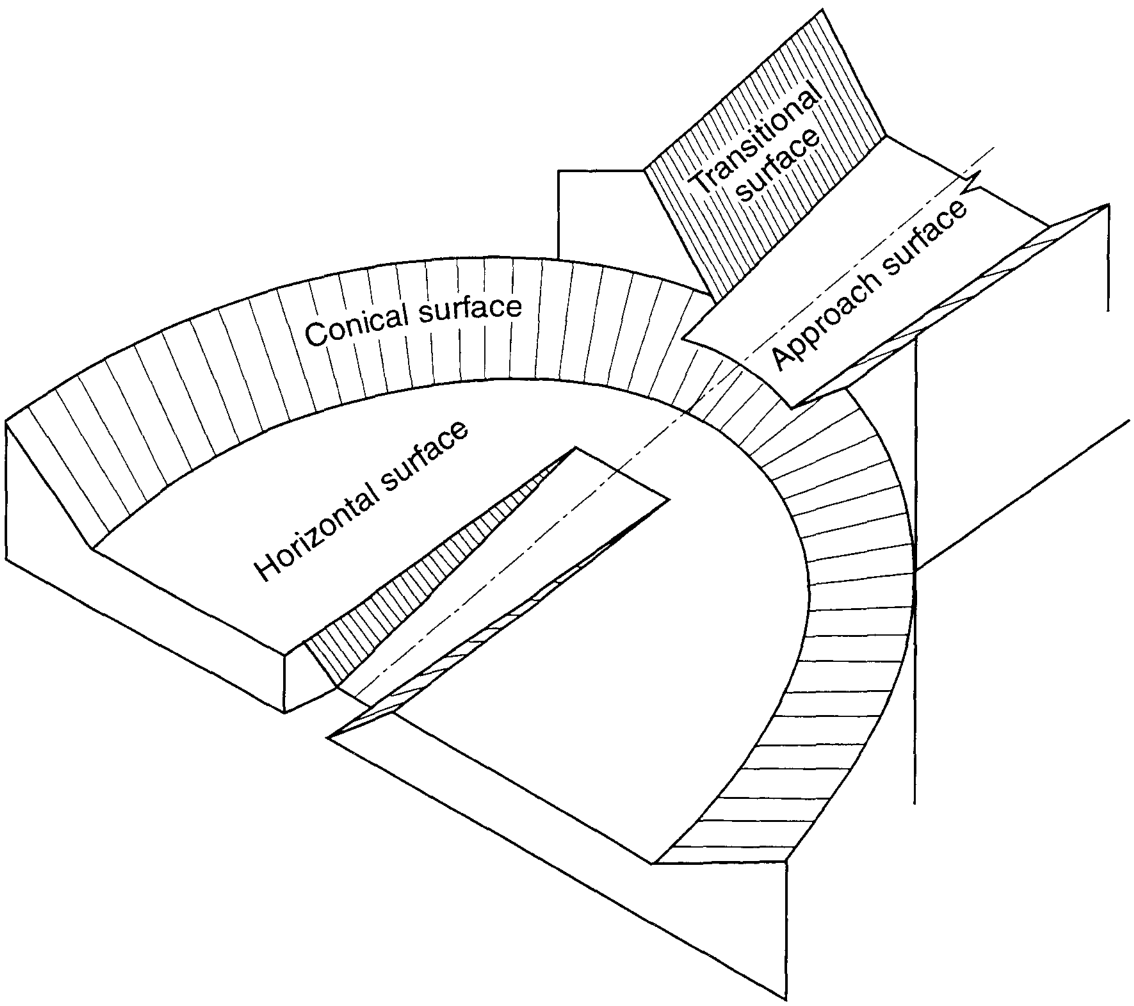

Figure 3. FAA 14 CFR Part 77 Civil Airport Imaginary Surfaces

3.2 ICAO OBSTACLE LIMITATION SURFACE DEFINITIONS

ICAO's document Annex 14, Volume 1, Chapter 4, addresses obstacle limitation surfaces. The objectives of the ICAO specifications are to "define the airspace around aerodromes to be maintained free from obstacles so as to permit the intended aeroplane operations at the aerodromes to be conducted safely and to prevent the aerodromes from becoming unusable by the growth of obstacles around the aerodromes" (Ref 5). In Chapter 4, ICAO defines nine obstacle limitation surfaces: outer horizontal surface; conical surface; inner horizontal surface; approach surface; inner approach surface; transitional surface; inner transitional surface; balked landing surface; and take-off climb surface.

Because inner approach surface, inner transitional surface, and balked landing surface are similar to the FAA's "Obstacle Free Zones" defined in FAA AC 150/5300-13, they will be discussed in Section 4. The outer horizontal surface is not applicable to the majority of runways, and therefore will not be discussed in this report. The reader is referred to ICAO's "Airport Services Manual" Part 6 for guidance on the requirements for an outer horizontal surface, and its characteristics. Thus, the ICAO obstacle limitation surfaces that will be discussed in this section are: conical surface; inner horizontal surface; approach surface; transitional surface; and take-off climb surface. These ICAO obstacle limitation surfaces are illustrated in Figure 4.

Table 7 compares the similarities and differences in the definitions of the FAA civil airport imaginary surfaces and the selected ICAO obstacle limitation surfaces. The similarities and differences in the dimensions of the FAA civil airport imaginary surfaces and the selected ICAO obstacle limitation surfaces are detailed in Section 3.3.

An interesting point that is highlighted by the comparison of the FAA "primary surface" to the ICAO "runway strip" is the different philosophy adopted by the two agencies. The FAA defines two ground surface areas that completely surround the runway, and are mandatory for runway design: runway safety area, and runway object-free area. The third ground surface area defined by the FAA, which also surrounds the runway, is the "primary surface," and it is identified as a "study surface." The width of the "primary surface" is such that it encompasses the width of both the runway object-free area and the runway safety area, reinforcing the FAA's attitude that the PART 77 imaginary surfaces are used to identify "objects that may affect the navigable airspace." By comparison, ICAO has simplified the ground surface designations by defining only one surface that completely surrounds the runway: the runway strip. The runway strip, as defined by ICAO, is not an "obstacle limitation surface," but rather a mandatory ground surface inherent to the runway

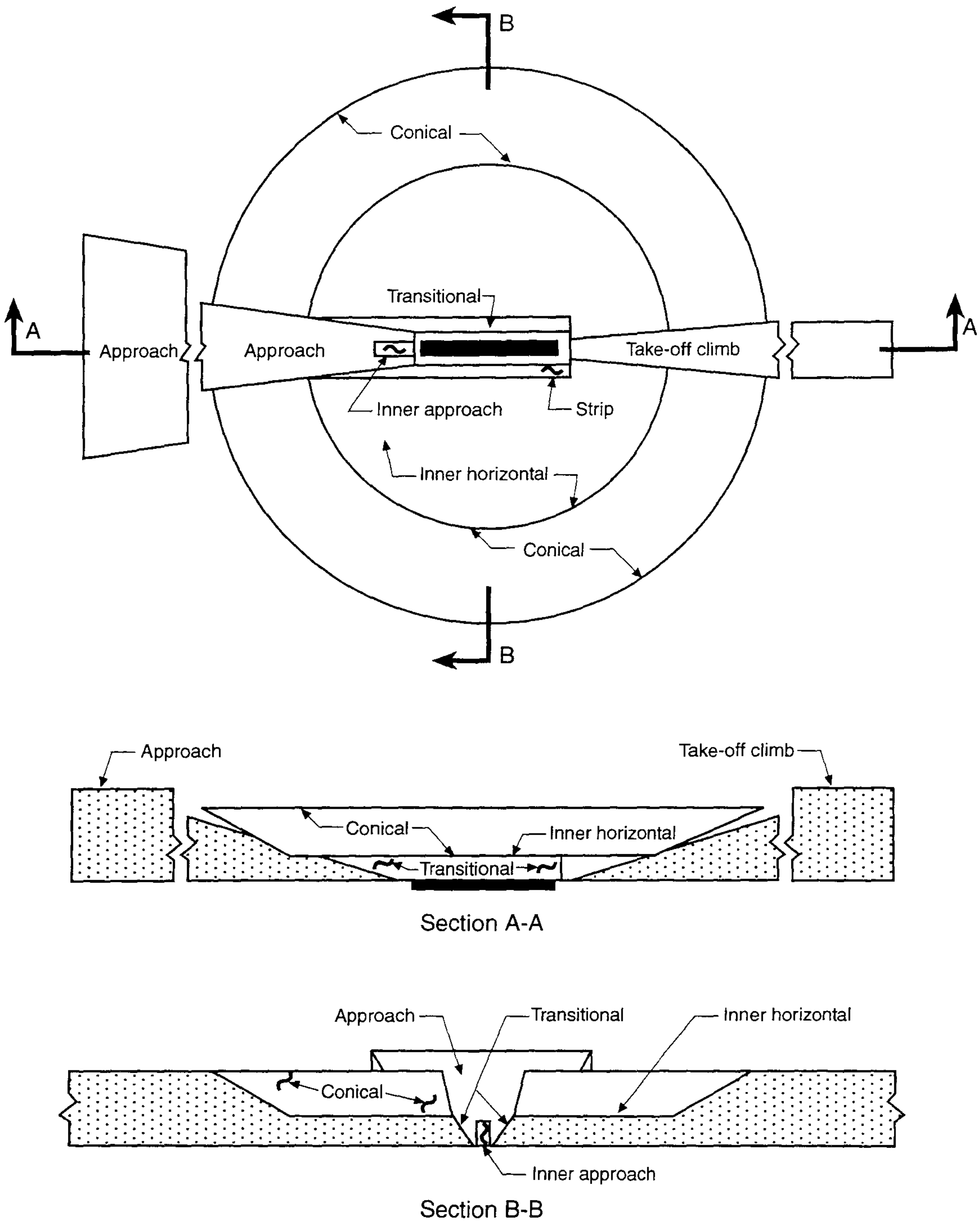

Figure 4. ICAO Obstacle Limitation Surfaces

TABLE 7. FAA CIVIL AIRPORT IMAGINARY SURFACE DEFINITIONS COMPARED WITH ICAO OBSTACLE LIMITATION SURFACE DEFINITIONS

Surface Description		
FAA Civil Airport Imaginary Surface	**ICAO Obstacle Limitation Surface**	**Differences/Similarities in Definition**
Conical Surface	Conical Surface	No difference in definition.
Horizontal Surface	Inner Horizontal Surface	The inner horizontal surface specified by ICAO is a circle whose center is at the airport reference point. The horizontal surface specified by FAA is not a circle, and the airport reference point is not used to determine the horizontal surface. However, both surfaces are located 150 ft (45 m) above the airport elevation.
Transitional Surface	Transitional Surface	The primary difference in definition is that the ICAO transitional surface extends only to the height of the inner horizontal surface (150 ft) (45 m). The FAA transitional surface extends from the sides of the approach surface, past the horizontal surface, for the complete length of the approach surface (refer to Figure 3).
Approach Surface	Approach Surface	No differences in definition.
	Take-off Climb Surface	The FAA Part 77 regulations do not differentiate between an approach surface and a take-off surface — the same regulations are applicable to the two operations. ICAO defines the take-off climb and approach operations with two different surfaces. Essentially the definition of the ICAO take-off climb surface is similar to that for the ICAO and FAA approach surface; the difference is primarily in the surface dimensions.
Primary Surface	Runway Strip	Unlike the FAA, ICAO does not define an obstacle limitation "primary" surface. However, ICAO utilizes the "runway strip" surface, as defined in Annex 14, Volume 1, Chapter 3, and discussed above in Section 2.3, for the same purpose that the FAA uses the primary surface: to locate the inner edge of the approach and transitional surfaces. As will be observed in Tables 8 through 10, the dimensions of the FAA primary surface and ICAO runway strip are very similar.

and aerodrome design. The dimensions of the runway strip width are compared to the width of the FAA runway object-free area and runway safety area in Appendix A, Table A8.

It is interesting to note that the CAA(NZ), which has primarily adopted the ICAO aerodrome design standards, has chosen to reduce the ICAO runway strip width requirements for visual approaches (refer Appendix A, Table A6). The justification for the reduced runway strip widths is that the cost of complying with the ICAO standard is prohibitive at a number of NZ domestic airports, given that the aerodromes have a proven history of being satisfactory for safe aircraft operations with the current (narrower) runway strip widths.

While the definitions of the FAA imaginary surfaces and ICAO obstacle limitation surfaces are fairly similar, the criteria used by the agencies to identify the surface dimensions are slightly different. Both agencies differentiate between non-instrument, non-precision, and precision approaches, but the FAA sub-classifies in terms of utility runways and "runways larger than utility" ("other"), and ICAO sub-classifies by aerodrome reference code element 1. In the FAA Part 77 regulations, a utility runway is defined as "a runway that is constructed for and intended to be used by propeller-driven aircraft of 12,500 pounds (5,700 kg) MCTOW and less" (Ref 3).

3.3 COMPARISON OF FAA CIVIL AIRPORT IMAGINARY SURFACE DIMENSIONS AND ICAO OBSTACLE LIMITATION SURFACE DIMENSIONS

In Tables 8 through 10, the FAA "Civil Airport Imaginary Surface" dimensions and ICAO "Obstacle Limitation Surface" dimensions are compared for non-instrument, non-precision instrument, and precision instrument runways, respectively. The surface dimensions are detailed in metric units for ease of comparison. The metric conversion factor used on FAA dimensions was 1 ft =0.3048 m. The reader is referred to FAA 14 CFR Part 77 for non-S.I. dimensions. Where significant differences between ICAO and FAA dimensions occur, the ICAO dimensions have been highlighted.

As Horonjeff and McKelvey state, "the ICAO requirements are similar to FAA Part 77 regulations, with a few exceptions" (Ref 1). As identified in Tables 8 through 10, one exception is the height of the conical surface. FAA defines a generic 4000 ft horizontal width for the conical surface which is applied to all runway scenarios. Given the 1-to-20 conical slope, the 4,000 ft horizontal width equates to a conical height of 60 m (200 ft). By comparison, the ICAO standard for conical height is not generic, and changes, depending on the aerodrome reference code (ARC), from a height of 35 m to 100 m.

As discussed in Table 7, there is a fundamental difference in the manner in which ICAO and the FAA define the inner horizontal surface. ICAO defines the surface as a circle centered on the airport reference point, whereas the FAA defines it as a combination of arcs and tangents. Thus, it is not surprising that there is also a difference between the ICAO and FAA radius dimensions for the horizontal surface. The difference in dimensions is particularly apparent for non-instrument and non-precision instrument runways (refer Tables 8 and 9).

Another surface which displays a difference between ICAO and FAA dimensions is the approach surface for non-instrument (visual) runways. The length for ICAO ARC 3 and 4 is significantly longer than the FAA dimensions (4 km compared to 1.5 km, refer Table 8), and the slope for ICAO ARC 3 and 4 is significantly shallower than the FAA dimensions (1:30, 1:40 compared to 1:20, refer Table 8).

For non-instrument and non-precision instrument runways, there is also a difference between the ICAO and FAA transitional surface slopes. ICAO specifies a transitional slope of 1:5 for ARC Code 1 and 2, and 1:7 for codes 3 and 4. By contrast,, the FAA specifies a 1:7 slope for all possible runway scenarios (refer Tables 8 and 9).

The final significant difference is that for non-precision instrument runways, ICAO segments the approach surface for ARC Codes 3 and 4. The segments of the approach surface are defined as "first section," "second section," and "horizontal" section. The FAA does not segment the approach surface for non-precision instrument runways (refer Table 9). As a final point, it should be noted that for precision instrument runways the FAA does segment the approach surface, but it prescribes only two sloping surfaces and does not incorporate a horizontal surface. ICAO retains a three-segment approach surface for precision approach runways (refer Table 10).

3.4 AERONAUTICAL STUDY — A BRIEF REVIEW OF ALTERNATIVES

In Sections 3.1 through 3.3, the FAA imaginary surfaces and ICAO obstacle limitation surfaces that are used to identify objects that may represent an "obstruction to air navigation" were defined and the dimensions compared. When an object penetrates the aforementioned surface, or is projected to on completion of construction, an aeronautical study is required to "determine whether an object is or will be a hazard to air navigation" (Ref 3). The FAA regulations for an aeronautical study are fully outlined in Part 77 subpart D, and the reader is referred to that source for details. However, Part 77 does not identify the solutions/measures that can be taken as a result of the study.

TABLE 8. NON-INSTRUMENT (VISUAL) RUNWAY OBSTACLE LIMITATION SURFACE/CIVIL AIRPORT IMAGINARY SURFACE DIMENSIONS

		Non-Instrument (Visual) Runway					
		ICAO ARC Code Number				FAA Runway Type	
Obstacle Limitation Surface/Civil Airport Imaginary Surface and Dimensions$_a$		**1**	**2**	**3**	**4**	**Utility**	**Other**
Conical	Slope	1:20	1:20	1:20	1:20	1:20	1:20
	Height	35 m	55 m	75 m	100 m	60 m	60 m
(Inner) Horizontal	Height	45 m	45 m	45 m	45m	45m	45
	Radius$_b$	2 km	2.5 km	4 km	4 km	1.5 km	1.5 km
Approach	Length of inner edge	50 m	80m	150 m	150 m	80 m	150 m
	Distance from threshold	30 m	60 m	60 m	60 m	60 m	60 m
	Divergence (each side) $_c$	1:10	1:10	1:10	1:10	1:10	1:10
	Length	1.6 km	2.5 km	3 km	3 km	1.5 km	1.5 km
	Slope	1:20	1:25	1:30	1:40	1:20	1:20
Take-off Climb$_d$	Length of inner edge	60 m	80 m	180 m	180 m	80 m	150 m
	Distance from r/w end	30 m	60 m	60 m	60 m	60 m	60 m
	Divergence (each side)	1:10	1:10	1:8	1:8	1:10	1:10
	Final width	380 m	580 m	1.2 km$_e$	1.2 km$_e$	–	–
	Length	1.6 km	2.5 km	15 km	15 km	1.5 km	1.5 km
	Slope	1:20	1:25	1:50	1:50	1:20	1:20
Transitional	Slope	1:5	1:5	1:7	1:7	1:7	1:7
Primary/ Runway Strip	Width	90 m	90 m	150 m	150 m	80 m	150 m

Notes:
- a: All dimensions are measured horizontally unless specified otherwise; ratio is V:H.
- b: The center of the FAA and ICAO radius is different; refer Table 7.
- c: The FAA defines an outer approach width rather than divergence; the divergence defined in the table is calculated from FAA inner and outer approach widths. Refer Part 77 for outer approach width dimensions.
- d: The FAA does not define a Take-off Climb surface, and instead applies the appropriate approach surface to each end of the runway. The ICAO take-off climb surface dimensions detailed above are applicable to all runway types (i.e., visual, non-precision, and precision) and, therefore, will not be repeated in Tables 9 and 10.
- e: Final width is 1.8 km when the intended track includes changes of heading greater than 15 for operations conducted in IMC, VMC by night.
- f: This slope can vary depending on conditions; and the reader is referred to 4.2.24 in ICAO's Annex 14, Volume 1, Chapter 4.

TABLE 9. NON-PRECISION INSTRUMENT RUNWAY OBSTACLE LIMITATION SURFACE/CIVIL AIRPORT IMAGINARY SURFACE DIMENSIONS

Obstacle Limitation Surface/Civil Airport Imaginary Surface and Dimensions[a]		Non-Precision Runway: ICAO ARC Code Number 1,2	3	4	FAA Runway Type: Utility	Other Visibility > 3/4 mile	Other Visibility ≤ 3/4 mile
Conical	Slope	1:20	1:20	1:20	1:20	1:20	1:20
	Height	60 m	75 m	100 m	60 m	60 m	60 m
(Inner) Horizontal	Height	45 m	45 m	45 m	45m	45m	45 m
	Radius[b]	3.5 km	4 km	4 km	1.5 km	3 km	3 km
Approach	Length of inner edge	150 m	300 m	300 m	150 m	150 m	300 m
	Distance from threshold	60 m	60 m	60 m	60 m	60 m	60 m
	Divergence (each side)[c]	1:6.6	1:6.6	1:6.6	1:6.6	1:6.6	1:6.6
First Section	Length	2.5 km	3 km	3 km	1.5 km	3 km	3 km
	Slope	1:30	1:50	1:50	1:20	1:34	1:34
Second Section	Length	–	3.6 km[d]	3.6 km[d]	–	–	–
	Slope	–	1:40	1:40	–	–	–
Horizontal	Length	–	8.4 km[d]	8.4 km[d]	–	–	–
	Total/Length	2.5 km	15 km	15 km	1.5km	3 km	3 km
Transitional Primary/ Runway Strip	Slope	1:5	1:7	1:7	1:7	1:7	1:7
	Width	150 m	150 m	150 m	150 m	150 m	300 m

Notes:
- a: All dimensions are measured horizontally unless specified otherwise; ratio is V:H.
- b: The center of the FAA and ICAO radius is different; refer above definitions.
- c: The FAA defines an outer approach width rather than divergence; the divergence defined in the table is calculated from FAA inner and outer approach widths. Refer Part 77 for outer approach width dimensions.
- d: The FAA does not define a Take-off Climb surface, and instead applies the appropriate approach surface to each end of the runway. The ICAO take-off climb surface dimensions detailed above are applicable to all runway types (i.e., visual, non-precision, and precision) and, therefore, will not be repeated in Tables 9 and 10.

TABLE 10. PRECISION INSTRUMENT RUNWAY OBSTACLE LIMITATION SURFACE/CIVIL AIRPORT IMAGINARY SURFACE DIMENSIONS

		Precision Instrument Runway		
		ICAO ARC Code Number		**FAA Runway Type**
Obstacle Limitation Surface/Civil Airport Imaginary Surface and Dimensions$_a$		**1,2**	**3,4$_b$**	**All**
Conical	Slope	1:20	1:20	1:20
	Height	60 m	100 m	60 m
(Inner) Horizontal	Height	45 m	45 m	45m
	Radius$_b$	3.5 km	4 km	3 km
Approach	Length of inner edge	150 m	300 m	300 m
	Distance from threshold	60 m	60 m	60 m
	Divergence (each side)$_c$	1:6.6	1:6.6	1:6.6
First Section	Length	3 km	3 km	3 km
	Slope	1:40	1:50	1:50
Second Section	Length	12 km	3.6 km$_e$	12 km
	Slope	1:33	1:40	1:40
Horizontal	Length	–	8.4 km$_e$	–
	Total/Length	15 km	15 km	15 km
Transitional Primary/Runway Strip	Slope	1:7	1:7	1:7
	Width	150 m	300 m	300 m

Notes:
- a: All dimensions are measured horizontally unless specified otherwise; ratio is V:H.
- b: ICAO defines surface dimensions for both CATI and CAT III & III precision approaches for Code # 3 and 4; however, the dimensions for all three categories are identical, so they have only been detailed once in this table.
- c: The center of the FAA and ICAO radius is different; refer above definitions.
- d: The FAA defines an outer approach width rather than divergence; the divergence defined in the table is calculated from FAA inner and outer approach widths. Refer Part 77 for outer approach width dimensions.
- e: This length can vary depending on conditions; the reader is referred to 4.2.9 or 4.2.17 in ICAO's Annex 14, Volume 1, Chapter 4.

By comparison, ICAO does discuss the alternatives that are to be reviewed in an aeronautical study. The alternatives that ICAO recommends are detailed below:

- Shielding: A new object or extension of an existing object shall be permitted to penetrate an obstacle limitation surface if it will be shielded by an existing immovable object.
- Not a hazard to air navigation: When the aeronautical study determines that the object would not adversely affect the safety or significantly affect the regularity of operations of aeroplane, the object can remain but must be appropriately lighted and Vor marked.
- Hazard to air navigation: When the object penetrates an obstacle limitation surface, is not shielded by an existing immovable object, and is determined to be a hazard to air navigation, then ICAO recommends that the object be removed or reduced in height until it no longer penetrates an obstacle limitation surface.

4.0 OBSTACLE-FREE ZONES

In this Section the FAA obstacle-free zones, as defined in AC 150/5300-13, will be compared to those ICAO obstacle limitation surfaces not already discussed in Section 3. The FAA zone definitions are detailed in Section 4.1, the ICAO surfaces are defined in Section 4.2, and the comparison of associated dimensions is tabulated and discussed in Section 4.3.

4.1 FAA OBSTACLE-FREE ZONE (OFZ) DEFINITIONS

The scope of the FAA AC 150/5300-13 "Obstacle-Free Zones" regulations establishes three additional surfaces to those defined in Part 77:

- the runway obstacle-free zone surface;
- the inner-approach obstacle-free zone;
- the inner-transitional obstacle-free surface.

As detailed in Table 6, the obstacle-free zones define the volume of airspace below 150 ft (45m) above the established airport elevation and along the runway and extended runway centerline that is required to be clear of all objects, except for frangible visual navigational aids (NAVAIDS) that need to be located in the OFZ because of their function. The OFZ surfaces do not continue above the horizontal imaginary surface (as defined in Section 3.1). The definitions of the three obstacle-free zones are provided below and illustrated in Figure 5 (Ref 2). The dimensions of the surfaces are detailed in Section 4.3.

- **Runway OFZ**: The runway OFZ is a defined volume of airspace centered above the runway centerline. The runway OFZ is the airspace above a surface whose elevation at any point is the same as the elevation of the nearest point on the runway centerline. The runway OFZ extends 200 ft (60 m) beyond each end of the runway. A runway OFZ is required to be defined for all FAA runways.
- **Inner-approach OFZ**: The inner-approach OFZ is a defined volume of airspace centered on the approach area. It applies only to runways with an approach lighting system. The inner-approach OFZ begins 200 ft (60 m) from the runway threshold at the same elevation as the runway threshold, and extends 200 ft (60 m) beyond the last light unit in the approach lighting system.
- **Inner-transitional OFZ**: The inner-transitional OFZ is a defined volume of airspace along the sides of the runway OFZ and inner-approach OFZ. It applies only to runways with lower than 3/4 mile (1.2 km) approach visibility minimums. The dimension standards are different for runways serving large and small airplanes. Furthermore, the dimensions for large aircraft are sub-divided for CAT I precision approaches and CAT II/III precision approaches. For runways serving small airplanes exclusively, the inner-transitional OFZ slopes out at 3 to 1 from the edges of the runway OFZ and inner-approach OFZ to a height of 150 ft (45m) above the established airport elevation. For CAT I precision approach runways serving large aircraft, the inner-transitional OFZ begins at the edges of the runway OFZ and inner-approach OFZ, then rises vertically for a height "H," and then slopes 6 to 1 out to a height of 150 ft (45m) above the established airport elevation (refer Figure 5).

  Where:

  $$H_{meters} = 18\text{-}4 - 0\text{-}094\ (S_{meters}) - 0.003\ (E_{meters})$$

S is equal to the most demanding wingspan of the airplanes using the runway, and E is equal to the runway threshold elevation above sea level. For the CAT IImI runways serving the large airplanes, the inner-transitional surface rises vertically for a height "H," then slopes 5 to 1 out to a distance "Y" from the runway centerline, and then slopes 6 to 1 out to a height of 150 ft (45m) above the established airport elevation.

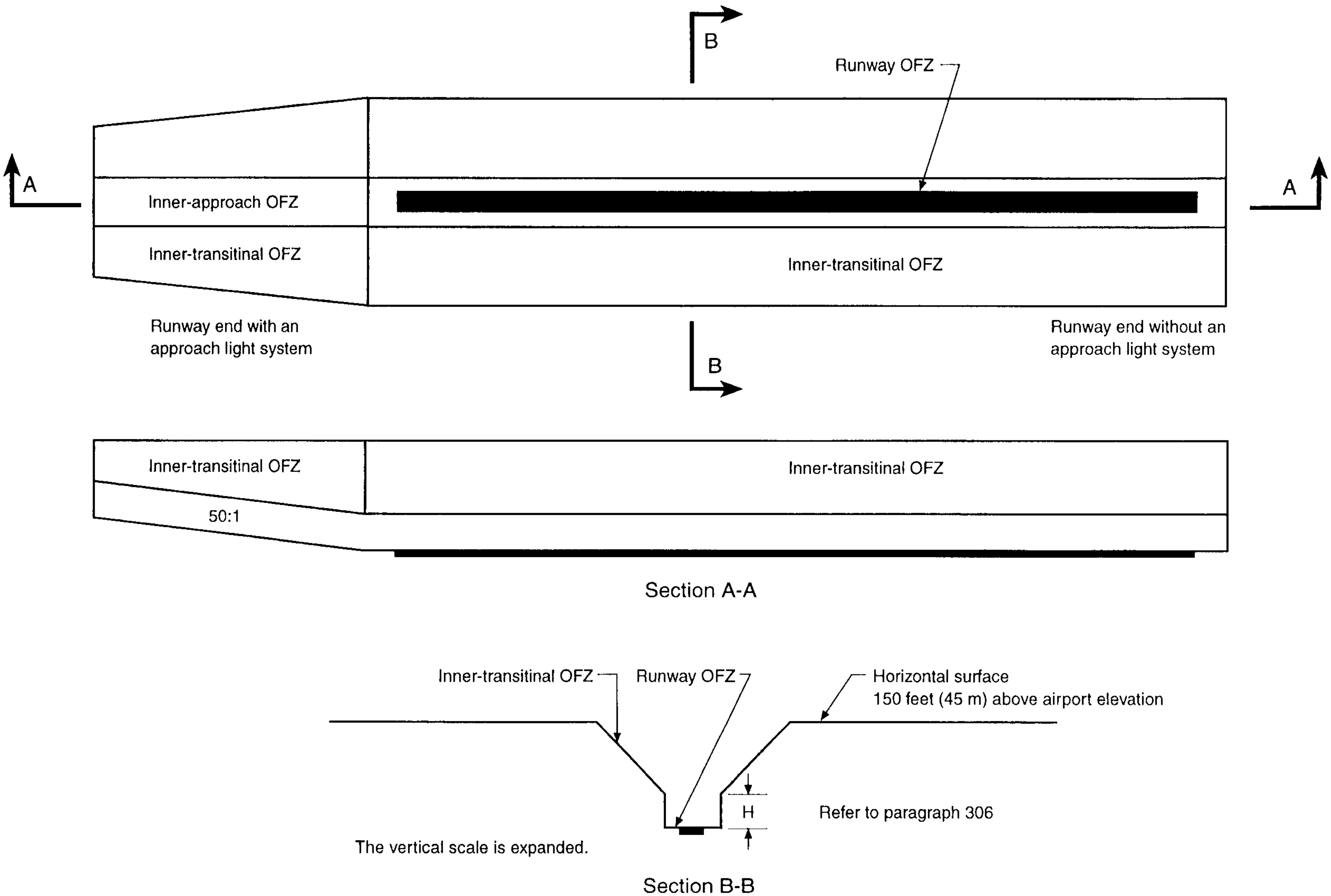

Figure 5. FAA Obstacle Free Zones

Where:

$$H_{meters} = 16 - 0\ 13\ (S_{meters}) - 0.0022\ (E_{meters})$$

$$Y_{meters} = 132 + 1\text{-}08\ (S_{meter}s) - 0.024\ (E_{meters})$$

4.2 DEFINITIONS OF ICAO OBSTACLE LIMITATION SURFACES REFERENCED TO FRANGIBLE NAVAIDS

In Section 4.2.14 of ICAO's Annex 14, Volume 1, ICAO recommends that inner-approach, inner-transitional and balled landing surfaces be established for precision approach CAT I runways, and in Section 4.2.15 states that the aforementioned surfaces shall be established for precision approach CAT IImI runways. This requirement differs from the FAA standard, which applies an inner-approach OFZ to all runways with approach lighting, and an inner-transitional OFZ to all runways with approach visibility less than 3/4 mile. The definitions of the ICAO surfaces are detailed below, Figure 6 illustrates the surfaces, and the surface dimensions are detailed in Section 4.3 (Ref 5).

- Inner-Approach Surface: A rectangular portion of the approach surface immediately preceding the runway threshold. The limits of the inner-approach surface shall comprise: an inner edge coincident with the location of the inner edge of the approach surface, but of its own specified length; two sides originating at the ends of the inner edge and extending parallel to the vertical plane containing the centerline of the runway; and an outer edge parallel to the inner edge.
- Inner-Transitional Surface: The inner-transitional surface is intended to be the controlling obstacle limitation surface for navigation aids, aircraft, and other vehicles that must be near the runway. The inner-transitional surface is not to be penetrated except by frangibly mounted objects. The ICAO transitional surface described in Section 3 is the controlling obstacle limitation surface for buildings. The limits of an inner-transitional surface are illustrated in Figure 6. The slope of the inner-transitional surface is measured in a vertical plane at right angles to the centerline of the runway.
- Babied Landing Surface is an inclined plane located at a specified distance after the runway threshold, extending between the inner-transitional surface. The limits of the balked landing surface are illustrated in Figure 6. The elevation of the inner edge is equal to the elevation of the runway centerline at the location of the inner edge. The slope of the

balked landing surface is measured in the vertical plane containing the centerline of the runway.

- It should be noted that the FAA does not include a surface similar to the ICAO balked landing surface in its obstacle-free zone requirements.

4.3 COMPARISON OF OBSTACLE FREE ZONES DIMENSIONS

In Table 11, the FAA "Obstacle-Free Zone" dimensions and ICAO "Obstacle Limitation Surface" dimensions are compared. The surface dimensions are detailed in metric units for ease of comparison. The metric conversion factor used on FAA dimensions was 1 ft = 0.3048 m. The reader is referred to FAA AC 150/5300-13 for non-S.I. dimensions.

As will be noted, the primary difference between the ICAO and FAA standards are that the FAA specifies a runway OFZ, which ICAO does not, and ICAO specifies a balked landing surface, which the FAA does not. It is interesting to observe that in defining the runway obstacle-free zone the FAA has specified a fourth surface that encompasses the runway. The four surfaces are: the runway object-free area; runway safety area; primary surface; and the runway obstacle-free zone. For clarity the dimensions of the four FAA ground surfaces are compared in Table C1 in Appendix C. By comparison, ICAO utilizes the runway strip to define the inner edges of the inner-transitional surface and the inner-approach surface. Thus, ICAO has specified only a single obstacle limitation ground surface. A final point to clarify is that the purpose of the ICAO inner-approach, inner-transitional, and balked landing surfaces is identical to that oif the FAA' s OFZs in that "fixed objects shall not be permitted above these surfaces, except for frangibly mounted objects which because of their function must be located on the runway strip. Mobile objects shall not be permitted above these surfaces during the use of the runway for landing" (Ref 5).

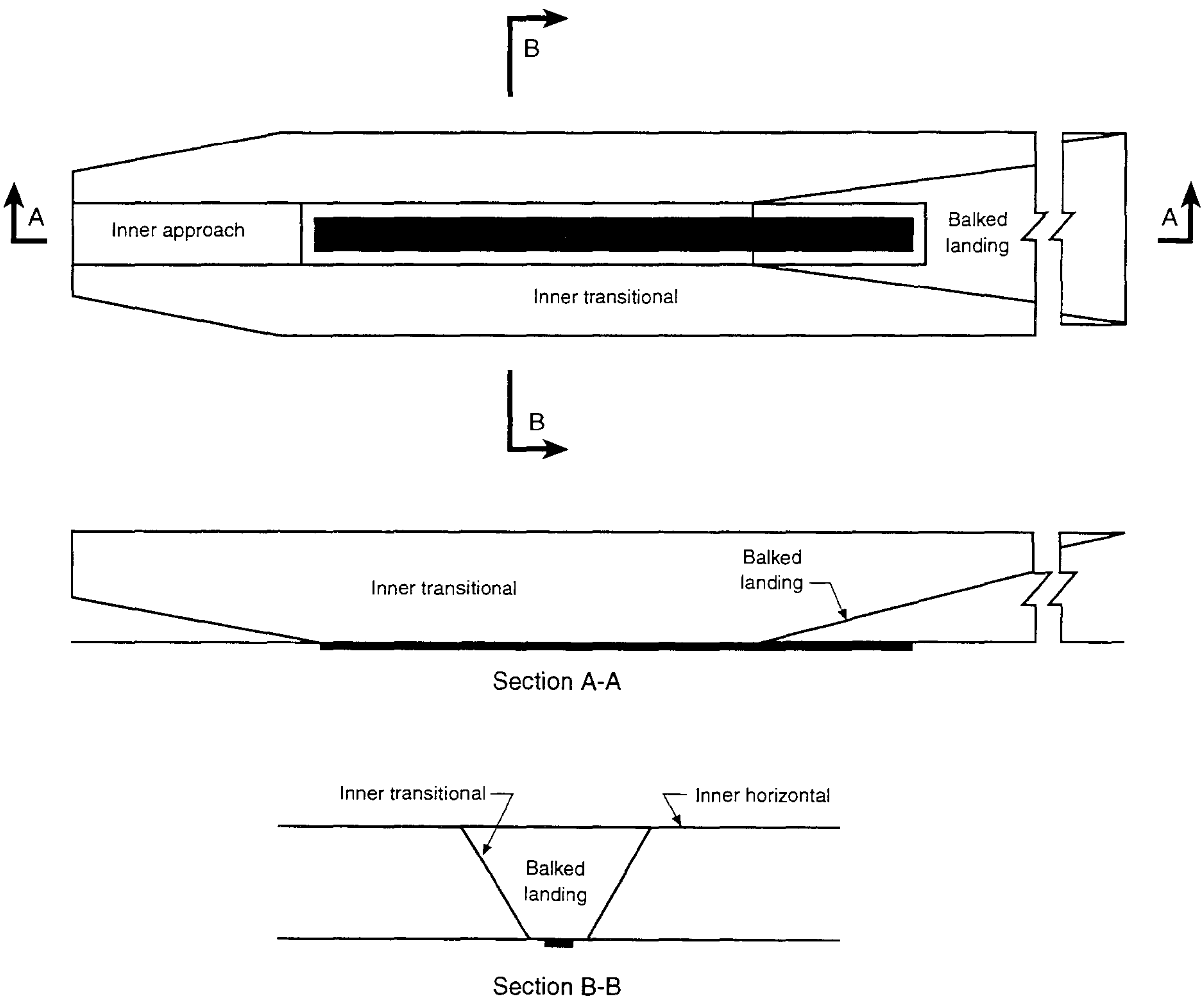

Figure 6. ICAO "Obstacle Free Zones"

TABLE 11. FAA AC 150/5300-13 "OBSTACLE-FREE ZONE" AND ICAO ANNEX 14, VOLUME 1, CHAPTER 4 "OBSTACLE LIMITATION SURFACE" DIMENSIONS

Obstacle Limitation Surface/Civil Airport Imaginary Surface and Dimensions[a]		Precision Approach Runway: ICAO ARC Code Number 1,2	ICAO ARC Code Number 3,4	FAA Classification of Runway Use: Small Aircraft Exclusively: Approach Viability < 3/4 mile (typical)	Small Aircraft Exclusively: Approach Speed ≥ 50 knots	Small Aircraft Exclusively: Approach Speed < 50 knots	Other and Large Aircraft
Runway OFZ[b]	**Distance from Runway End**	**60 m**	**60 m**	**60 m**	**60 m**	**60 m**	**60 m**
	Width	150 m	300 m	90 m	75 m	36 m	120 m
Inner-Approach OFZ and Surface[c]	Width	90 m	120 m	90 m	75 m	36 m	120 m
	Distance from threshold	60 m	60 m	60 m	60 m	60 m	60 m
	Length	900 m	900 m	–	–	–	–
	Slope	1:40	1:50	1:50	1:50	1:50	1:50
Inner-Transitional OFZ and Surface[d]	Slope	1:2.5	1:3	1:3	–	–	1:6[e]
	Height	–	–	–	–	–	Hmeters[e]
Balked Landing Surface	Length inner edge	90 m	120 m	–	–	–	–
	Distance after threshold	[f]	1.8 km[g]	–	–	–	–
	Divergence (each side	1:10	1:10	–	–	–	–
	Slope	1:25	1:30				

Notes:
a: All dimensions are measured horizontally unless specified otherwise; ratio is V:H.
b: FAA requires a runway OFZ to be defined for all runways.
c: The FAA applies inner-approach OFZ standards only to runways with an approach lighting system. Thus, theorectically, a non-reecision approach runway with a lighting system requires asn inner-approach OFZ to be defined. ICAO requires inner-approach surface for all precision approach runways.
d: FAA applies the inner-transitional OFZ standards to all runways with approach visibility less than 3/4 mile, though has different standards for runways served exclusively by small aircraft and "other" runways. ICAO requires inner-transitional surface for all precision approach runways.
e: FAA inner-transitional slope starts from the top of the vertical height H. Note that H is defined differently for CAT I and CAT II/III; refer to Section 4.1 definitions.
f: distance to the end of the runway strip
g: or end of runway, whichever is less

5.0 TERMINAL INSTRUMENT PROCEDURES

The FAA terminal instrument procedures and ICAO procedures for air navigation aircraft operations define obstacle clearances used in the design of terminal approach and departure procedures. While the documents provide obstacle clearance standards for a number of different flight procedures, only two types of approach will be assessed in this section: circling approach and ILS approach. The reader is referred to the aforementioned documents for other approach and departure obstacle clearance requirements. In Section 5.1, the ICAO and FAA circling obstacle clearance standards will be detailed, and in Section 5.2 the FAA ILS obstacle clearance standards will be summarized. Unfortunately, the ICAO obstacle clearance standards for ILS approaches are contained in the ICAO document PANS-OPS Volume II, which the author did not have access to.

5.1 CIRCLING OBSTACLE CLEARANCE STANDARDS

In TERPS 8260.3B, the FAA circling approach area is defined as the "obstacle clearance area which shall be considered for aircraft maneuvering to land on a runway which is not aligned with the final approach course of the approach procedure" (Ref 4). The size of the circling area varies with the approach category of the aircraft, and the limits of the circling area are defined by drawing an arc from the center of the end of the each usable runway and joining the extremity of the adjacent arcs with lines drawn tangent to the arcs. The size of the arc radius is dependent on the aircraft approach category. A minimum 300 ft (90 m) of obstacle clearance is required within the circling approach area. The FAA standard circling minimums are detailed in Table 12.

In PANS-OPS (Doc 8168), Volume 1, ICAO defines "visual maneuvering" or circling as "the visual phase of flight after completing an instrument approach, to bring an aircraft into position for landing on a runway which is not suitably located for a straight-in approach" (Ref 6). Like the FAA, ICAO defines the circling area by drawing arcs centered on the end of the runway and joining those arcs with tangent lines. However, in contrast to the FAA, ICAO defines the arc radius in terms of the aircraft category, aircraft speed, wind speed (46 km/h, 25 knots throughout the turn), and the bank angle (3° per second). The standard circling minimums as defined by ICAO are detailed in Table 12. Figure 7 illustrates a visual maneuvering (circling approach) area as defined by the FAA and ICAO.

TABLE 12. CIRCLING APPROACH AREA DIMENSIONS FOR OBSTACLE CLEARANCE

Aircraft Approach Category	Regulatory Body	Obstacle Clearance Dimensions: Radius (km)	Height Above Airport Elevation (m)	Visibility (km)
A	FAA	2.1	110	1.6
	ICAO	3.1	120	1.9
B	FAA	2.4	140	1.6
	ICAO	4.9	150	2.8
C	FAA	2.7	140	2.4
	ICAO	7.9	180	3.7
D	FAA	3.7	170	3.2
	ICAO	9.8	210	4.6
E	FAA	7.2	170	3.2
	ICAO	12.8	240	6.5

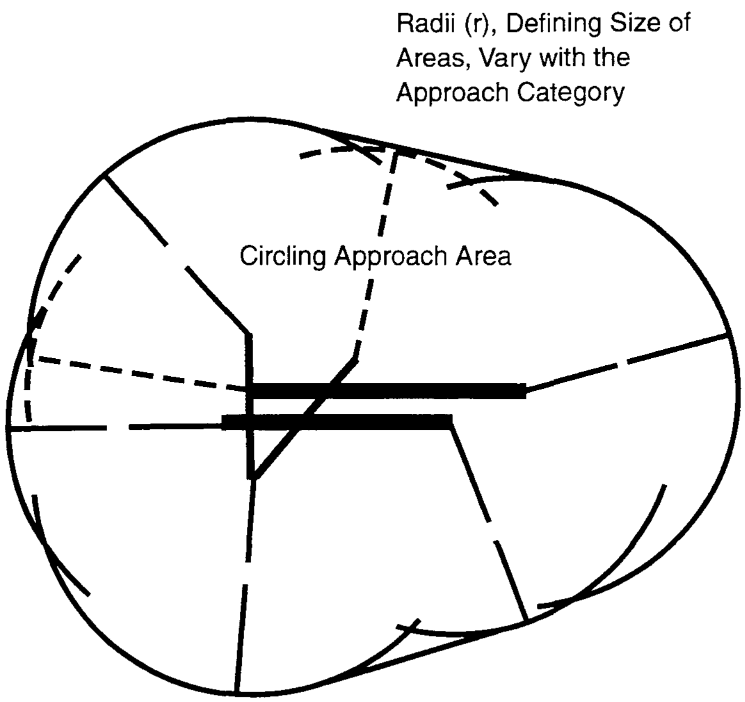

Figure 7. Circling Approach Obstacle Clearance Area

In comparing the obstacle clearance dimensions in Table 12, it is apparent that for all aircraft approach categories the ICAO standards are more stringent than the FAA standards. As the author does not consider herself qualified to comment on the appropriateness of the dimensions, a discussion on which standards are "better/ more realistic" will not be incorporated in this report. The circling approach regulations were introduced simply to make the reader aware that in addition to the imaginary surfaces and airport design standards (OFZ's) there is a third set of obstacle clearance regulations that specifically pertain to terminal instrument procedures.

5.2 ILS APPROACH OBSTACLE CLEARANCE STANDARDS

In TERPS 8260.3B, the FAA defines approach procedures pertaining to five types of Instrument Landing System (ILS): ILS Category I; ILS Category II; ILS Category m; Localizer and LDA; and simultaneous ILS. In this paper the obstacle clearance standards for ILS Category I approach will be discussed. The reader is directed to TERPS 8260.3B, Chapter 9, for clearance standards for the other four ILS approach types. The ILS Category I allows for an ILS approach procedure to a decision height of not less than 200 ft.

Focusing on the final approach segment of the ILS Category I approach, the regulations require an obstacle clearance area to be defined. The obstacle clearance area consists of a final approach area and transitional surfaces. The final approach obstacle surface is an inclined plane which originates at the runway threshold elevation 975 ft (300 m) outward from glide path indicator. The surface is divided into two sections: an inner 10,000 ft (3,050 m) and an outer 40,000 ft (12,200 m). The gradient of the obstacle clearance surfaces is dependent on the glide slope adopted. Table 13 defines applicable glide slopes and respective gradients. The recommendation is to use a 2.5 degree glide slope unless another slope is required to ensure clearance over existing obstacles. The transitional surfaces for ILS Category I are inclined planes with a slope of 7 to 1 which extend outward and upward from the edge of the final approach area, starting at the height of the final approach surface and extending for a lateral distance of 5,000 ft (1,520 m).

The FAA specifies in TERPS that "if an obstacle penetrates the ILS Category I final approach and transitional obstacle clearance surfaces, consideration should be given to the removal of the obstacle or relocation of the landing threshold" (Ref 4). For comparison, the Part 77 approach surface slope and AC 150/5300 inner-approach OFZ slope, for precision approaches, have been included in Table 13.

TABLE 13. ILS CATEGORY I OBSTACLE CLEARANCE SURFACE SLOPES AND GLIDE SLOPE ANGLES

Glide Slope Angle (degrees)	Approximate Slope of Inner Section (H to V) length=3,050 m	Approximate Slope of Outer Section (H to V) length=12,200 m	Part 77 Approach Surface Slope (precision approach)	AC 150/5300 Inner-Approach Surface Slope (Precision approach)
2	96.5 to 1	61.5 to 1	50 to 1 (3 km); 40 to 1 (12 km)	50 to 1 (2.25 km)
2.25	66 to 1	48.5 to 1	50 to 1 (3 km); 40 to 1 (12 km)	50 to 1 (2.25 km)
2.5	50 to 1	40 to 1	50 to 1 (3 km); 40 to 1 (12 km)	50 to 1 (2.25 km)
2.75	40.5 to 1	34 to 1	50 to 1 (3 km); 40 to 1 (12 km)	50 to 1 (2.25 km)
3	34 to 1	29.5 to 1	50 to 1 (3 km); 40 to 1 (12 km)	50 to 1 (2.25 km)

It should be remembered that the Part 77 approach surface slope defines a study surface and the inner-approach and ILS obstacle clearance slopes define an area that needs to be retained free of obstacle penetrations. From Table 13, it is apparent that the three slopes are identical for a precision approach with a 2.5 degree glide slope.

6.0 OBSTACLE CLEARANCE SURFACE AREAS FOR EXAMPLE RUNWAYS

To provide an example of the impact of the ICAO and FAA obstacle clearance regulations, the obstacle clearance surface areas for three example runways were calculated. The example runways were: 1000 m x 20 m visual approach runway; 1500 m x 30 m non-precision approach runway; and a 2500 m x 60 m precision approach runway. In the estimation of the surface areas, only the horizontally projected areas were calculated; thus the approach slopes were not incorporated in the calculations. The purpose of the exercise is to provide an easy comparison of how the ICAO and FAA standards can impact an airport and the surrounding community.

The dimensions used to calculate the surface areas are taken from tables incorporated in Sections 3 through 5 and Appendix A. The results of the surface area calculations for the three example runways are detailed in Table 14. It should be recalled that the OFZ is actually a volume of airspace bounded by the three OFZ surfaces and the horizontal imaginary surface. In Table 14 only the surface areas of the OFZ boundary surfaces have been calculated.

The results clearly indicate that the ICAO and FAA standards can affect the airspace and ground objects, in the vicinity of a runway, very differently. In particular the ICAO requirements are more conservative than the FAA regulations for the horizontal imaginary surface, the runway OFZ/runway strip, and the TERPS/PANS-OPS circling approach clearance surface. It is interesting to note that the FAA standards are more stringent than ICAO's for the inner-approach OFZ and the inner-transitional OFZ. However, the simple comparison of ICAO and FAA dimensions for these two OFZ surfaces should be tempered by the fact that the ICAO runway strip is much larger than the FAA runway OFZ therefore the ICAO inner-transitional and inner-approach surfaces start much further out from the runway.

As stated previously, the authors does not consider themselves qualified to comment on whether the FAA standards are better or worse than the ICAO standards; rather, their intention is to make the reader aware of the standards' differences and similarities.

TABLE 14. COMPARISON OF OBSTACLE CLEARANCE SURFACE AREAS FOR DIFFERENT RUNWAYS AND STANDARDS

	Surface Area (km^2) Unless Otherwise Stated					
	1000 x 20 m, Visual Runway		1500 m x 30 m, Non-Precision Runway		2500 m x 60 m, Precision Runway	
Surface Type$_a$	**FAA**	**ICAO**	**FAA**	**ICAO**	**FAA**	**ICAO**
Ground Surface						
Airport/Aerodrome Ref. Code	A/B-I	1-A	A/B - III	2-C	C/D-VI	4-E
Runway	0.020	0.020	0.045	0.045	0.150	0.150
Runway Safety Area	0.041		0.167		0.465	
Runway Object-Free Area	0.137		0.445		0.744	
Runway Protection Zone	0.063		0.231		0.393	
Runway End Safety Area		0.006		0.011		0.016
Runway Strip		0.101		0.243		0.786
Imaginary Surfaces						
Runway Classification/Reference Field Length	Utility	1	other	2	other	4
Conical (width in meters)	1220 m	700 m	1220 m	1200 m	1220 m	2000 m
(Inner) Horizontal	10.069	12.566	37.274	38.484	43.274	50.265
Approach	0.690	0.704	3.627	2.644	77.182	77.182
Transitional (width in meters)	315 m	225 m	315 m	225 m	315 m	315 m
Primary Surface/Runway Strip	0.089	0.101	0.243	0.243	0.786	0.786
Obstacle-Free Zone						
Runway OFZ/Runway Strip	0.084	0.101	0.146	0.243	0.314	0.786
Inner-Approach OFZ			0.405		0.540	0.216
Inner-Transitional OFZ (width in meters)					205 m$_b$	135 m
Balked Landing Surface						0.036$_c$
TERPS/PANS-OPS						
Aircraft Approach Category	A	A	C	C	E	E
Circling	18.054	36.391	30.702	219.76 7	198.860	578.718

Note: a: Runway safety area, runway OFA, runway OFZ, primary surface, and runway strip areas include the area of the runway.
b: S=80 m; E=0 m; H=10.88 m; slope=6 to 1
c: assume landing from other ends of the runway

7.0 CONCLUSION

The aim of this report was to introduce the reader to the FAA's and ICAO's obstacle clearance regulations, as they pertain to runways, and to promote understanding of the differences and similarities between the two sets of regulations.

The FAA has three sets of regulations that address obstacle clearance in the vicinity of an airport: 14 CFR Part 77, "Objects affecting navigable airspace;" AC 150/5300-13, "Runway Design;" and TERPS 8260.3B. The important point to recall is that the Part 77 imaginary surfaces merely define a study surface. When an object penetrates the surface it is then subject to an aeronautical study to determine whether it constitutes a hazard to aircraft maneuvers. Not ad objects that penetrate a Part 77 surface are deemed obstacles to air navigation. In comparison, the obstacle free zone surfaces defined in AC 150/5300 define a volume of airspace above the runway that can only be penetrated by frangible navigational aids. Objects that penetrate these surfaces need to be removed. Finally, the TERPS procedures define obstacle clearance requirements for terminal instrument maneuvers. While only the circling and ILS approach obstacle clearances have been discussed in this report, it is important to be aware that the TERPS standards define the minimum obstacle clearance requirements needed for safe aircraft approach and departure operations.

ICAO's regulations are similar to the FAA's in that both study surfaces and mandatory surfaces are defined. The ICAO study surfaces are detailed in Annex 14, Chapter 4. In many respects these surfaces are similar in definition to the FAA Part 77 surfaces; however, a major difference is that ICAO defines both approach and take-off surfaces, while the FAA defines only an approach surface. The primary difference between ICAO and FAA imaginary surface dimensions is in relation to the conical surface and the (inner) horizontal surface (refer Table 14). With regards to mandatory surfaces ICAO does define surfaces similar to the FAA' s obstacle free zones, however the surfaces are incorporated in Annex 14, Chapter 4. Furthermore, ICAO's equivalent obstacle-free zones apply only to precision approach runways, whereas the FAA's use of an obstacle-free zone surface is determined by the presence of an approach lighting system and/or approach visibility less than 3/4 mile. It is important to note that the "obstacle-free zone surfaces" as defined by ICAO and the FAA result in very different surface areas being defined, though in a similar volume of airspace. Finally, ICAO's obstacle clearance standards for terminal instrument procedures are contained in document 8168 PANS-OPS. Like the FAA's TERPS, the obstacle clearance standards incorporated in PANS-OPS are minimum requirements for safe aircraft operations. In terms of the obstacle clearance standards for visual circling approach, the ICAO standards are far more conservative than the FAA's (refer Table 14).

In summary, the impression is that the ICAO standards are generally similar to the FAA's, and, where they differ, ICAO's standards are more conservative than the FAA's. While a number of countries are adopting the ICAO standards, it is interesting that in some instances the standards have been modified when they are considered to be overly conservative, as was the case with the CAA(NZ) modification of the runway strip width for visual approach runways.

REFERENCES

1. Horonjeff and McKelvey, *Planning and Design of Airports*, 1994.
2. FAA, "Runway Design," AC 150/5300-13.
3. FAA, "Objects Affecting Navigable Airspace," 14 CFR Part 77.
4. FAA, "Terminal Instrument Procedures," TERPS 8260.3B.
5. ICAO, "Obstacle Limitation Surfaces," Annex 14, Chapter 4.
6. ICAO, PANS-OPS Document 8168, Volume 1.
7. CAA (NZ), "Aerodrome Design," AC 139-06.

APPENDIX A

A.1 RUNWAY PROTECTION ZONE (RPZ)

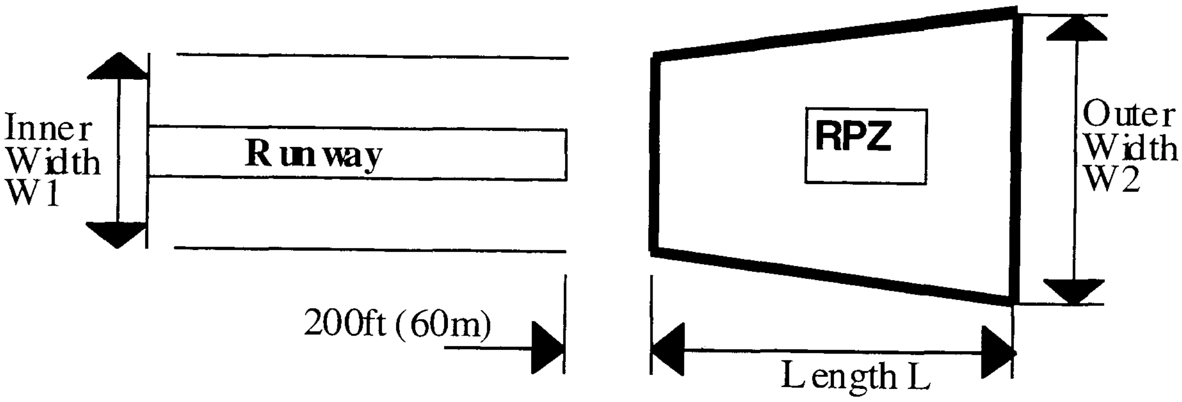

Figure A1. Runway Protection Zone Location

TABLE A.1. RUNWAY PROTECTION ZONE DIMENSIONS

		Dimensions			
Approach Visibility Minimums	Runway Design	L ft (m)	W1 ft (m)	W2 ft (m)	RPZ acres
Visual Approach:	Small aircraft	1,000 (300)	250 (75)	450 (135)	8.035
Visibility > 1 mile (1,600 m)					
	AAC=A & B	1,000 (300)	500 (150)	700 (210)	13.770
	AAC= C & D	1,700 (500)	500 (150)	1,010 (303)	29.465
Non-precision Approach:	All aircraft	1,700	1,000	1,510	48.978
Visibility > 3/4 mile (1,200 m)		(500	(300)	(453)	
Precision Approach:	All aircraft	2,500	1,000	2,750	78.914
Visibility < 3/4 mile (1,200 m)		(750)	(300)	(525)	

Note 1: AAC=aircraft approach category; refer Section 2.2.2
Note 2: The departure RPZ dimensional standards are equal to or less than the approach RPZ dimensional standards detailed above.
Source: FAA AC 150/5300-13, Chapter 3

A.1 FAA RUNWAY SAFETY AREA AND RUNWAY OBJECT-FREE AREA DESIGN STANDARDS

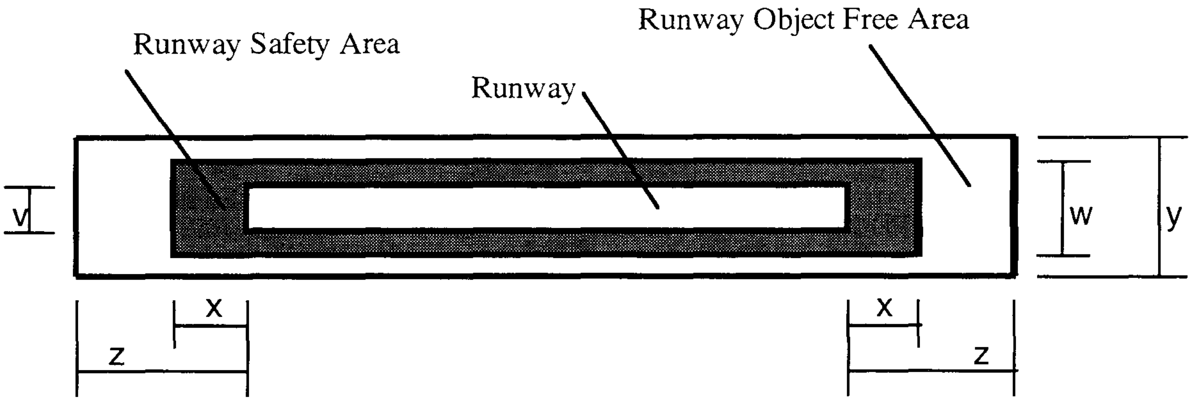

Figure A2: RSA and Runway OFA Location

For "v", "w", "x", "y", and "z" dimensions refer following two tables.

TABLE A2: FAA DESIGN STANDARDS FOR AIRCRAFT APPROACH CATEGORIES A & B

Item	Ref	Airplane Design Group				
		I_b	I	II	III	IV
Design standards for aircraft approach categories A & B visual and non-precision runways						
runway width	v	60 ft (18 m)	60 ft (18 m)	75 ft (23 m)	100 ft (30 m)	150 ft (45 m)
RSA width	w	120 ft (36 m)	120 ft (36 m)	150 ft (45 m)	300 ft (90 m)	500 ft (150 m)
RSA length$_a$	x	240 ft (72 m)	240 ft (72 m)	300 ft (90 m)	600 ft (180 m)	1000 ft (300 m)
R/w OFA width	y	250 ft (75 m)	400 ft (120 m)	500 ft (150 m)	800 ft (240 m)	800 ft (240 m)
R/w OFA length$_a$	z	240 ft (72m)	240 ft (72m)	300 ft (90 m)	600 ft (180 m)	1000 ft (300 m)
Design standards for aircraft approach categories A & B precision runways						
runway width	v	75 ft (23m)	100 ft (30 m)	100 ft (30 m)	100 ft (30 m)	150 ft (45 m)
RSA width	w	300 ft (90 m)	300 ft (90 m)	300 ft (90 m)	400 ft (120 m)	500 ft (150 m)
RSA length$_a$	x	600 ft (180 m)	600 ft (180 m)	600 ft (180 m)	800 ft (240 m)	1,000 ft (300 m)
R/w OFA width	y	800 ft (240 m)	800 ft (240 m)	800 ft (240 m)	800 ft (240 m)	800 ft (240 m)
R/w OFA length$_a$	z	600 ft (180 m)	600 ft (180 m)	600 ft (180 m)	800 ft (240 m)	1,000 ft (300 m)

Note : a - RSA and runway OFA lengths begin at each runway end when stopway is not provided, if a stopway is provided the lengths begin at the end of the stopway.
b - dimensional standards for exclusive small airplane facilities

Source: FAA AC 150/5300-13, Chapter 3

TABLE A3: FAA DESIGN STANDARDS FOR AIRCRAFT APPROACH CATEGORIES C & D

Item	Ref	Airplane Design Group					
		I	II	III	IV	V	VI
Runway width	v	100 ft (30 m)	100 ft (30 m)	100 ft_b (30 $m)_b$	150 ft (45 m)	150 ft (45 m)	200 ft (60 m)
RSA $width_c$	w	500 ft (150 m)	500 ft (150 m)	500 ft (150 m)	500 ft (150 m)	500 ft (150 m)	500 ft (150 m)
RSA $length_a$	x	1,000 ft (300 m)	1,000 ft (300 m)	1,000 ft (300 m)	1,000 ft (300 m)	1,000 ft (300 m)	1,000 ft (300 m)
R/w OFA width	y	800 ft (240 m)	800 ft (240 m)	800 ft (240 m)	800 ft (240 m)	800 ft (240 m)	800 ft (240 m)
R/w OFA $length_a$	z	1,000 ft (300 m)	1,000 ft (300 m)	1,000 ft (300 m)	1,000 ft (300 m)	1,000 ft (300 m)	1,000 ft (300 m)

Note : a - RSA and runway OFA lengths begin at each runway end when stopway is not provided, if a stopway is provided the lengths begin at the end of the stopway.

b - airplanes with MCTOW > 150,000 pounds (68,100 kg) the standard runway width is 150 ft (45 m).

c - for airport reference code C-I and C-II a RSA width of 400 ft (120 m) is permissible

Source:FAA AC 150/5300-13, Chapter 3

TABLE A4: COMPARISON OF FAA AND ICAO MINIMUM RUNWAY WIDTH REQUIREMENTS

FAA Aircraft Approach Category (A-D)/ ICAO Aerodrome Reference Code Elemenmt1 (1-4)		FAA Airplane Design Group (I-V)/ ICAO Aerodrome Reference Code Element 2 (A-E)				
		I	II	III	IV	V
		A	B	C	D	E
	1	18 m	18 m	23 m	-	-
A :visual and non-precision		18 m	23 m	30 m	45 m	-
A :precision		30 m	30 m	30 m	45 m	-
	2	23 m	23 m	30 m	-	-
B :visual and non-precision		18 m	23 m	30 m	45 m	-
B :precision		30 m	30 m	30 m	45 m	-
C	3	30 m	30 m	30 m_a	45 m	45 $m_{FAA\ only}$
D	4	30 $m_{FAA\ only}$	30 $m_{FAA\ only}$	45 m_a	45 m	45 m

Note: CAA (NZ) have adopted the ICAO standards for runway width.

Note: a:FAA requires 45 m for runways serving airplane design group III airplanes with MCTOW greater than 150,000 pounds (68,100 kg) otherwise C-III & D-III runway width of 30 m is allowed

Source: ICAO Annex 14 -Volume 1; CAA(NZ) AC 139-01; FAA AC 150/5300-13

A.3 COMPARISON OF FAA MINIMUM RUNWAY SAFETY AREA AND ICAO MINIMUM RUNWAY END SAFETY AREA

TABLE A5: RUNWAY SAFETY AREA AND RUNWAY END SAFETY AREA WIDTH DIMENSIONS

FAA Aircraft Approach Category (A-D)/ ICAO Aerodrome Reference Code Elemenmt1 (1-4)		FAA Airplane Design Group (I-V)/ ICAO Aerodrome Reference Code Element 2 (A-E)				
		I A	II B	III C	IV D	V E
	1	36 m	36 m	46 m	-	-
A :visual and non-precision		36 m	45 m	90 m	150 m	-
A :precision		90 m	90 m	120 m	150 m	-
	2	46 m	46 m	60 m	-	-
B :visual and non-precision		36 m	45 m	90 m	150 m	-
B :precision		90 m	90 m	120 m	150 m	-
	3	60 m	60 m	60 m	90 m	-
C_a		150 m	150 m	150 m	150 m	150 m
	4	-	-	90 m	90 m	90 m
D_b		150 m	150 m	150 m	150 m	150 m

Note: CAA (NZ) have adopted the ICAO standards for runway width.
a: for airport reference code C-I and C-II, a 120 m runway safety area width is permissible.
b: for runways designed after 28 February 1983 the runway safety area width increases 6 m (20 ft) for each 300 m (1,000 ft) of airport elevation above MSL.
Note: ICAO and CAA (NZ) only require the width of the runway end safety area to be at least twice that of the associated runway.
Source: ICAO Annex 14 -Volume 1; CAA(NZ) AC 139-01; FAA AC 150/5300-13

FAA Minimum Runway Safety Area Length, and ICAO and CAA(NZ) Minimum Runway End Safety Area Length Dimensions

The only requirement that ICAO and CAA(NZ) place on the runway end safety area (RESA) length is: "if provided the runway end safety area should extend from the end of the **runway strip** for as great a distance as practicable, but at least 90 m". In comparison, the FAA require the runway safety area to extend beyond the end of a **runway** for a length of 72 m (airport reference code A-I) to 300 m (aircraft approach code C and D). The reader is referred to the above FAA tables for exact runway safety area lengths for the different airport reference codes.

The following diagram is provided to clarify the ICAO and CAA(NZ) runway layout system, in terms of runway, runway strip and runway end safety area locations. In the diagram: dimension "z" refers to the RESA width as a minimum of twice the width of the runway; dimension "x" refers to the RESA length as a minimum of 90 m from the end of the runway strip; and dimension "y" refers to the runway strip dimensions which are detailed in the following table and discussion.

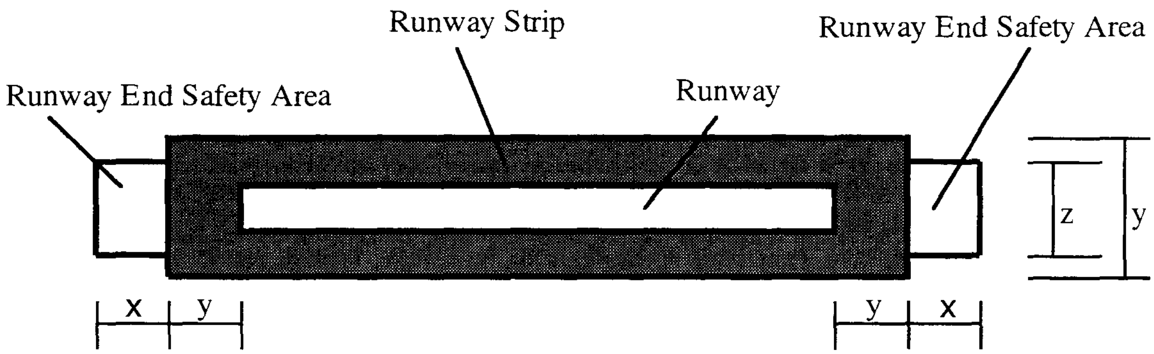

Figure A3: ICAO & CAA(NZ) Runway Strip and Runway End Safety Area Location

A.4: ICAO and CAA(NZ) Minimum Runway Strip

ICAO and the CAA(NZ) define the width of the runway strip as extending laterally on each side of the runway centerline and extended centerline throughout the length of the strip. The strip widths defined in the table below are total widths, half the width extends to the left of the centerline and half to the right.

TABLE A.6: ICAO AND CAA(NZ) MINIMUM RUNWAY STRIP WIDTH REQUIREMENTS

Runway Type Based On:		Aerodrome Reference Code Element 1			
Airport Type	Approach Type	1	2	3	4
international	precision	-	-	300 m	300 m
	non-precision	-	-	150 m	150 m
domestic	precision	**150 m**$_{\mathbf{CAA(NZ)}}$	**150 m**$_{\mathbf{CAA(NZ)}}$	220 m	220 m
	non-precision	150 m	150 m	150 m	150 m
	visual	**60 m**$_{\mathbf{CAA(NZ)}}$	**80 m**$_{\mathbf{CAA(NZ)}}$	150 m	150 m
	visual day only	**60 m**$_{\mathbf{CAA(NZ)}}$	**80 m**$_{\mathbf{CAA(NZ)}}$	**90 m**$_{\mathbf{CAA(NZ)}}$	**90 m**$_{\mathbf{CAA(NZ)}}$
	& aircraft less than 22700kgs MCTOW	**90 m** $_{\mathbf{ICAO}}$	**90 m** $_{\mathbf{ICAO}}$	**150 m** $_{\mathbf{ICAO}}$	**150 m** $_{\mathbf{ICAO}}$

Note: the differences between the ICAO and CAA(NZ) domestic airport runway strip widths is attributed to corrigendum 2 to CAA(NZ) AC 139-06A. While AC 139-06A adopts the ICAO system of runway coding, the ICAO specifications introduce significant changes to some dimensions and slopes by comparison to specifications in the NZ Aerodrome Standards Manual. Because the runway strip width standards of the NZ Aerodrome Standards Manual at domestic aerodromes have a proven history of being satisfactory, for the safety of aircraft operations, they have been retained. Furthermore, the cost associated with complying with ICAO standards is considered prohibitive at a number of NZ domestic airports.
Source: CAA(NZ) AC 139-06A; Corrigendum 2 to AC 139-06A; ICAO Annex 14 - Volume 1

ICAO and the CAA(NZ) define the length of the runway strip from the runway threshold and beyond the end of the runway or stopway for a minimum distance as per the following table.

TABLE A7: ICAO AND CAA(NZ) MINIMUM RUNWAY STRIP LENGTH REQUIREMENTS

	ICAO Aerodrome Reference Code Element 1			
Approach Type	1	2	3	4
Instrument (Precision & Non-Precision)	60 m	60 m	60 m	60 m
Non-Instrument (Visual)	30 m	60 m	60 m	60 m

A.5: Comparison of FAA Runway Object Free Area and Runway safety Area dimensions, to ICAO Runway Strip Requirements

An exact comparison between ICAO runway strip dimensions and the FAA runway object free area and runway safety area dimensions, is difficult due to the fact that the two organizations use different criteria to define their dimensions. Nonetheless, a rough comparison is detailed in the following table. It should be noted that to provide a "fair" comparison to the FAA's runway object free area length and runway safety area length, the requirements for ICAO runway strip length and ICAO RESA length have been added. The comparison is done in metric units for convenience, and the reader is referred to the above tables for non S.I. dimensions. Due to the fact that the CAA(NZ) has primarily adopted ICAO standards, except as detailed above, only a comparison of FAA and ICAO standards has been tabulated.

TABLE A8: COMPARISON OF FAA RUNWAY OFA, AND RSA DIMENSIONS TO ICAO RUNWAY STRIP DIMENSIONS

FAA Airport Reference Code AAC / ICAO Aerodrome Reference Code Element 1								
FAA AAC[a]		A		B		C		D
ICAO Code Element 1	1		2		3		4	
Length:[b] FAA=OFA ICAO=R/w strip + RESA	120 m - 150 m	72 m - 300 m	150 m	72 m - 300 m	150 m	300 m	150 m	300 m
Length:[b] FAA=RSA ICAO=R/w strip + RESA	120 m - 150 m	72 m - 300 m	150 m	72 m - 300 m	150 m	300 m	150 m	300 m
Width: FAA=OFA ICAO=R/w strip	90 m - 150 m	75 m - 240 m	90 m - 150 m	75 m - 240 m	150 m - 300 m	240m	150 m - 300 m	240 m
Width: FAA=RSA ICAO=R/w strip	90 m - 150 m	36 m - 150 m	90 m - 150 m	36 m - 150 m	150 m - 300 m	150 m	150 m - 300 m	150 m

Note: a: AAC=aircraft approach category.
b: Length is measured from end of runway for FAA, and from runway threshold for ICAO

APPENDIX B

APPENDIX B

In Subpart C, section 77.25 of FAA regulation 14 CFR Part 77, the FAA defines the civil airport imaginary surfaces. These surfaces are fully described and defined in Section 3.0 above. However, included in Subpart C is section 77.23 “Standards for determining obstructions”. These additional standards are now briefly discussed.

The FAA states that “an existing object, including a mobile object, is, and a future object would be, an obstruction to air navigation if it is of greater height than any of the following heights or surfaces”:

- a height of 500 ft (150 m) above ground level at the site of the object;
- a height that is 200 ft (60 m) above ground level or above the established airport elevation, whichever is higher, within 3 nautical miles of the established reference point of an airport, with its longest runway more than 3,200 ft (975 m) in actual length, and that height increases in the proportion of 100 ft (30 m) for each additional nautical mile of distance from the airport up to a maximum of 500 ft (150 m).
- a height within a terminal obstacle clearance area, including an initial approach segment, a departure area, and a circling approach area, which would result in the vertical distance between any point on the object and an established minimum instrument flight altitude within that area or segment to be less than the required obstacle clearance.
- a height within an enroute obstacle clearance area, including turn and termination areas, of a Federal airway or approved off-airway route, that would increase the minimum obstacle clearance altitude.
- the surface of a takeoff and landing area of an airport or any imaginary surface (refer Section 3.1 above).
- a height 17 ft (5.2 m) above an interstate highway. • a height 15 ft (4.6 m) above any public roadway, other than interstate.
- a height 10 ft (3.0 m) above a private road, or the height of the highest mobile object that would normally traverse the road whichever is greatest.
- a height 23 ft (7 m) above a railroad.
- for a waterway or any other traverse way not previously mentioned, an amount equal to the height of the highest mobile object that would normally traverse it.

Annex 14, Volume 1, Chapter 4, ICAO also refers to the consideration of objects that are outside the obstacle limitation surface. ICAO's recommendations are fairly general and encompass the consideration of objects: that may adversely affect the optimum sitting or performance of visual or non-visual aids; and isolated objects in the vicinity of an aerodrome. The only dimensioned recommendation is that "in areas beyond the limits of the obstacle limitation surfaces, at least those objects which extend to a height of 150 m or more above ground elevation should be regarded as obstacles, unless a special aeronautical study indicates that they do not constitute a hazard to aeroplane" (Ref 5).

APPENDIX C

APPENDIX C:

For comparison simplification the four surfaces have only been compared for the approach scenario of visibility less than 3/4 mile. The reader is referred to AC 150/5300-13 and 14 CFR Part 77 for the dimensions of other scenarios.

TABLE C1: COMPARISON OF FAA RUNWAY OFA, RSA, PRIMARY SURFACE AND OFZ DIMENSIONS

FAA Ground Surface Dimensions and Surface Specification		Approach Visibility < 3/4 mile : Precision Approach Runway — FAA Aircraft Approach Category (AAC) A	B	C	D
Length beyond runway end	OFA	180 m - 300 m	180 m - 300 m	300 m	300 m
	RSA	180 m - 300 m	180 m - 300 m	300 m	300 m
	$Primary_a$	60 m	60 m	60 m	60 m
	OFZ_b	60 m	60 m	60 m	60 m
Width	OFA	240 m	240 m	240 m	240 m
	RSA	90 m - 150 m	90 m - 150 m	150 m	150 m
	$Primary_a$	300 m	300 m	300 m	300 m
	OFZ_b	36 m - 90 m	36 m - 90 m	120 m	120 m

Note a: the FAA actually classifies the primary surface dimensions in terms of runway type (ie. utility runway, "other than utility"). In this table the dimensions utilized are "precision instrument other than utility runway".

b: the FAA actually classifies the runway OFZ dimensions in terms of "small airplane" and "large airplane". In this table a "small" airplane has been categorized as AAC "A" or "B", and "large airplane" as ACC "C" or "D".