Government of Canada Gouvernement du Canada

CRITERIA FOR THE DEVELOPMENT OF INSTRUMENT PROCEDURES

TP 308 / GPH 209 – CHANGE 7

ANNEXES

TRANSPORT CANADA
NATIONAL DEFENSE

5 January 2017

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CRITERIA FOR THE DEVELOPMENT OF INSTRUMENT PROCEDURES

TP 308 / GPH 209 – CHANGE 7

ANNEX A

GLOSSARY

TRANSPORT CANADA
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ACRONYMS AND ABBREVIATIONS

AAF	Airway Facilities Service
AARN	Air Navigation Services and Airspace
ABM	abeam
AC	Advisory Circular
ADF	automatic direction finder
AGL	above ground level
AIM	Aeronautical Information Manual
AIS	Aeronautical Information Services
ALSF-1	approach lighting system with sequenced flashing lights (CAT I Configuration)
ALSF-2	approach lighting system with sequenced flashing lights (CAT II Configuration)
APT	Airport
APV	approach with vertical guidance (ICAO)
ARA	airborne radar approach
ARC	Airport Reference Code
ARDH	achieved reference datum height
ARP	aerodrome reference point
ARSR	air route surveillance radar
ASBL	approach surface baseline
ASL	above sea level
ASOS	automated surface observing system
ASR	airport surveillance radar
AT	Air Traffic
ATC	Air Traffic Control
ATS	Air Traffic Service
ATD	along track distance
ATRK	along track
ATS	Air Traffic Service
AVN	Aviation System Standards
AWO	all weather operations
AWOS	automated weather observation system
AWS	Aviation Weather System
BaroVNAV	Barometric vertical navigation
BAZ	back azimuth
BC	back course
BPOC	before proceeding on course
CAT	Category
CF	course to fix
CFIT	controlled flight into terrain
CG	climb gradient

CGL	circling guidance light
CIH	climb-in-hold
COP	changeover point
CP	critical point
CRM	collision risk model
CW	course width
DA	decision altitude
dB	decibel
DCG	desired climb gradient
DER	departure end of runway
DF	direct to fix
DG	descent gradient
DH	decision height
DME	distance measuring equipment
DND	Department of National Defense
DP	departure procedure
DR	dead reckoning
DRL	departure reference line
DRP	departure reference point
DTA	distance of turn anticipation
DVA	diverse vector area
EARTS	en route automated radar-tracking system
EDA	elevation differential area
ELEV	elevation
EOR	end of runway
ESA	emergency safe altitudes
ESV	expanded service volume
FAC	final approach course
FAF	final approach fix
FAP	final approach point
FAS	final approach segment
FATO	final approach and takeoff area
FAWP	final approach waypoint
FDC	Flight Data Control
FDR	Flight Data Record
FDT	fix displacement tolerance
FEP	final end point
FIFO	Flight Inspection Field Office
FMP	first maneuver point
FMPD	first maneuver point distance
FMS	flight management system
FMWP	first maneuver waypoint

FPAP	flight path alignment point
FPCP	flight path control point
FSC	final straight course
FSS	Flight Service Station
FTE	flight technical error
FTIP	foreign terminal instrument procedure
FTP	fictitious threshold point
FWP	feeder waypoint
GA	General Aviation
GCA	ground controlled approach
GH	Geoid Height
GLONASS	Global Orbiting Navigation Satellite System
GLS	GNSS Landing System
GNSS	Global Navigation Satellite System
GP	glidepath
GPA	glidepath angle
GPI	ground point of intercept
GPS	Global Positioning System
GRI	group repetition interval
GS	glide slope
HAA	height above aerodrome
HAE	height above ellipsoid
HAH	height above heliport
HAI	Helicopter Association International
HAL	height above landing area elevation
HAS	height above surface
HAT	height above touchdown zone elevation (TDZE)
HATh	height above threshold
HCH	heliport crossing height
HF	high frequency
HIRL	high intensity runway lights
HRP	heliport reference point
HUD	heads-up display
IAC	initial approach course
IAF	initial approach fix
IAP	instrument approach procedure
IAPA	instrument approach procedure automation
IAWP	initial approach waypoint
IC	intermediate course
ICA	initial climb area
ICAB	ICA baseline
ICAE	ICA end-line

ICAO	International Civil Aviation Organization
ICPS	Instrument Check Pilot School
ICWP	initial course waypoint
IDF	initial departure fix
IAF	Initial approach fix
IF	intermediate fix
IF/IAF	intermediate/initial approach fix
IFR	instrument flight rules
ILS	instrument landing system
IMC	instrument meteorological conditions
INS	inertial navigation system
IPV	instrument procedure with vertical guidance
IRU	inertial reference unit
ISA	International Standard Atmosphere
IWP	intermediate waypoint
kHz	kilohertz
KIAS	knots indicated airspeed
LAAS	Local Area Augmentation System
LAB	landing area boundary
LAHSO	land and hold short operations
LDA	landing distance available
LDIN	lead-in lighting system
LF/mf	low frequency/medium frequency
LIRL	low intensity runway lights
LNAV	lateral navigation
LPV	Lateral Precision Performance with Vertical Guidance
LOA	Letter of Agreement
LOB	lines of business
LOC	localizer
LORAN	long-range navigation system
LTP	landing threshold point
MAHWP	missed approach holding waypoint
MALS	medium intensity approach lighting system
MALSF	medium intensity approach lighting system with sequenced flashing
MALSR	medium intensity approach lighting system with runway alignment indicator lights
MAP	missed approach point
MAWP	missed approach waypoint
MCA	minimum crossing altitude
MDA	minimum descent altitude
MEA	minimum en route altitude
MHA	minimum holding altitude

MHz	megahertz
MIA	minimum IFR altitudes
MIRL	medium intensity runway lights
MLS	Microwave Landing System
MOA	military operations area
MOC	minimum obstacle clearance
MOCA	minimum obstruction clearance altitude
MOU	Memorandum of Understanding
MRA	minimum reception altitude
MSA	minimum safe/sector altitude
MSL	mean sea level
MTA	minimum turn altitude
MVAC	minimum vectoring altitude chart
NAD	North American Datum
NAVAID	navigational aid
NDB	nondirectional radio beacon
NCFIO	NAVCANADA Flight Inspection Office
NM	nautical mile
NOTAM	Notice to Airmen
NOZ	normal operating zone
NPA	nonprecision approach
NTZ	no transgression zone
OC	obstruction chart
OCA	obstacle clearance altitude
OCH	obstacle clearance height
OCL	obstacle clearance limit
OCS	obstacle clearance surface
ODALS	omnidirectional approach lighting system
OEA	obstruction evaluation area
OE/AAA	Obstruction Evaluation/Airport Airspace Analysis
OFA	object free area
OIS	obstacle identification surface
ORE	obstacle rich environment
OSAP	off-shore approach procedure
PA	precision approach
PAPI	precision approach path indicator
PAR	precision approach radar
PCG	positive course guidance
PDA	preliminary decision altitude
PFAF	precision final approach fix
PGPI	pseudo ground point of intercept
PinS	point-in-space

PLS	precision landing system
POC	point of contact
PRM	precision runway monitor
PT	procedure turn
PVG	positive vertical guidance
PVGSI	pseudo visual glide slope indicator
RA	radio altimeter
RAIL	runway alignment indicator lights
RAPCON	radar approach control
RASS	remote altimeter setting source
RCL	runway centerline
RDP	reference datum point
REIL	runway end identifier lights
RF	radius to fix
RNAV	area navigation
RNP	required navigation performance
ROC	required obstacle clearance
RPI	runway point of intercept
RRP	runway reference point
RVR	runway visual range
RWP	runway threshold waypoint
RWT	runway threshold
RWTE	runway threshold elevation
RWY	runway
SALS	short approach lighting system
SATNAV	satellite navigation
SCG	standard climb gradient
SDF	simplified directional facility
SDF	step-down fix
SER	start end of runway
SIAP	standard instrument approach procedure
SID	standard instrument departure
SM	statute mile
SSALF	short simplified approach lighting system with sequenced flashers
SSALR	short simplified approach lighting system with runway alignment indicator lights
STAR	standard terminal arrival route
STOL	short takeoff and landing
TAA	terminal arrival area
TACAN	tactical air navigational aid
TC	Transport Canada
TCH	threshold crossing height

TD	time difference
TDP	touchdown point
TDZ	touchdown zone
TDZE	touchdown zone elevation
TDZL	touchdown zone lights (system)
TERPS	terminal instrument procedures
TF	track to fix
THLD	threshold
TLOF	touchdown and life-off area
TLS	transponder landing system
TORA	takeoff runway available
TP	tangent point
TPD	tangent point distance
TRACON	terminal radar approach control facility
TWP	turn waypoint
UHF	ultra high frequency
VA	heading to altitude
VASI	visual approach slope indicator
VCA	visual climb area
VCOA	visual climb over airport
VDA	vertical descent area
VDP	visual descent point
VFR	visual flight rules
VGA	vertically guided approach
VGSI	visual glide slope indicator
VHF	very high frequency
VLF	very low frequency
VMC	visual meteorological conditions
VNAV	vertical navigation
VOR	very high frequency omnidirectional radio range
VOR/DME	very high frequency omnidirectional radio range collocated with distance measuring equipment
VORTAC	very high frequency omnidirectional radio range collocated with tactical air navigation
VPA	vertical path angle
VSDA	visual segment descent angle
VTOL	vertical take-off and landing
WAAS	Wide Area Augmentation System
WATCO	Wing Air Traffic Control Officer
WCH	wheel crossing height
WICP	wing instrument check pilot
WP	waypoint
XTRK	crosstrack

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GLOSSARY OF TERMS

Aerodrome	any area of land, water (including the frozen surface thereof) or other supporting surface used or designated, prepared, equipped or set apart for the use either in whole or in part for the arrival or departure, movement of servicing of aircraft and includes any buildings, installations and equipment in connection therewith.
Aerodrome elevation	the elevation of the highest point of the landing area measured to the nearest foot above or below mean sea level.
Aerodrome authorization for part VII operations	Where an aerodrome does not meet the full requirements for certification, an aerodrome authorization may be issued to accommodate Part VII operations. An Aerodrome Authorization is required by the aerodrome operator for each air operator applying to use the aerodrome. The requirements for issuing an Aerodrome Authorization are available from Transport Canada Aerodrome Safety in the document entitled *“Aerodrome Authorization for Part VII Operations”*.
Aerodrome operator attestation	When the aerodrome is not certified and/or does not have an Aerodrome Authorization, an Aerodrome Operator Attestation is required in order to support instrument approach procedures below 500 feet HAT. The Aerodrome Operator Attestation identifies the aerodrome physical characteristics and the obstacle environment required to support the instrument operational limits for the critical aeroplane wing span, used by operators at a specific aerodrome.
Aerodrome reference point (ARP)	The designated geographical location of an aerodrome given to the nearest second of latitude and longitude. The ARP is located as near as practicable to the geometric centre of the landing area taking into account possible future development (see Annex C, Para 13).
Altitude	The vertical distance of a level, a point or an object considered as a point, measured from mean sea level.
Angle of divergence (minimum)	The smaller of the angles formed by the intersection of two courses, radials, bearings, or combinations thereof.
Approach procedure with vertical guidance (APV)	An instrument approach procedure that utilizes lateral and vertical guidance that do not meet the requirements established for a precision approach. Minima shall be expressed as DA(H).
Approach surface baseline (ASBL)	An imaginary horizontal line at threshold elevation.
Bearing	The horizontal angle at a given point, measured clockwise from a specific reference datum, to a second point. Bearings are expressed as True, Magnetic, Relative, Astronomic, Grid, etc. according to the reference datum used.
Change over point (COP)	A point defined between navigation facilities along airway/route segments, which indicate the pilot should change over his navigation equipment to receive course guidance from the facility ahead of the aircraft instead of the one behind.

Circling approach	The visual maneuvering required, after completing an instrument approach, to bring an aircraft into position for landing on a runway that is not suitably indicated for straight-in landing.
Controlling obstacle	The obstacle on which the design of a procedure or establishment of a minimum altitude or angle is based on.
Dead reckoning	The estimating or determining of position by advancing an earlier known position by the application of direction and speed data. For example, flight based on a heading from one VORTAC azimuth and distance fix to another is dead reckoning.
Decision altitude (DA)	The DA is the barometric altitude, specified in feet above MSL, at which a missed approach shall be initiated if the required visual reference has not been established. The DA applies to approach procedures where the pilot is provided with glidepath deviation information; e.g., ILS, MLS, TLS, GLS, LNAV/VNAV, Baro VNAV, or PAR.
Decision height (DH)	The DH is the value of the DA expressed in feet above the threshold elevation. This value is also referred to as HATh.
Diverse vector	An instruction issued by a radar controller to fly a specific course, which is not a part of a predetermined radar pattern. Also referred to as a “random vector.”
DME arc	A track, indicated as a constant DME distance, around a navigation facility that provides distance information.
DME distance	The line of sight distance (slant range) from the source of the DME signal to the receiving antenna.
Elevation (Elev)	The vertical distance of a point or a level, on or affixed to the surface of the earth measured from mean sea level.
Final approach	That part of an instrument approach procedure from the time the aircraft has a. completed the last procedure turn or base turn, where one is specified; or b. crossed the final approach fix or point; or c. intercepted the last track specified for the procedure; until it reaches the missed approach point. It is in this portion of the procedure that alignment and descent for landing are accomplished.
Final approach fix (FAF)	A fix that indicates the commencement of the final approach segment of a non-precision instrument approach procedure.
Fix	A geographical location determined by means of radio aids or other navigation devices
Geographic centre of the aerodrome	The centre of the runway pattern; see Annex C for a method of determining the geometric centre of an aerodrome.
Glidepath (GP)/ glide slope (GS)	A descent profile that is electronically determined for vertical guidance during a final approach.
Glide path/ glide slope angle	The angle of the glide path/glide slope measured above the horizontal plane.

Ground point of intercept	A point in the vertical plane on the runway centerline at which it is assumed that the straight line extension of the glide slope intercepts the runway approach surface baseline.
Gradient	A slope expressed in feet per mile, or as a ratio of the horizontal to the vertical distance. For example, 40:1 means 40 feet horizontally to 1 foot vertically.
Heading	The direction in which longitudinal axis of the aircraft is pointed expressed in degrees from north (true, magnetic, compass or grid).
Height	The vertical distance of a level, a point or an object considered as a point, measured from a specified datum.
Height above aerodrome (HAA)	The height in feet of the MDA above the published aerodrome elevation. HAA will be published for all circling minima.
Height above touchdown zone elevation (HAT)	The height in feet above the touchdown zone elevation.
Height above touchdown zone elevation (HATh)	The height in feet above the threshold elevation
Holding procedure	A predetermined manoeuvre which keeps an aircraft within a specified airspace while awaiting further clearance.
Initial approach	That part of an instrument approach procedure in which the aircraft has departed an initial approach fix and is maneuvering to enter the intermediate segment of the approach.
Initial approach fix (IAF)	A fix at which an aircraft leaves the en route phase of operations in order to commence the approach.
Instrument approach procedure (IAP)	A series of predetermined maneuvers for the orderly transfer of an aircraft under instrument flight conditions from the beginning of the initial approach to a point from which a landing may be made visually.

Instrument runway	One of the following types of runways intended for the operation of aircraft using instrument approach procedures: a. Non-precision approach runway. An instrument runway served by visual aids and a non-visual navigation aid providing at least directional guidance adequate for a straight-in approach to a minimum descent height less than 500 ft above the runway threshold but not less than 250 ft above the runway threshold. b. Precision approach runway, Category I. An instrument runway served by visual and non-visual navigation aids where operations are conducted down to a decision height lower than 250 ft but not lower than 200 ft and a visibility not less than 2600 ft. c. Precision approach runway, Category II. An instrument runway served by visual and non-visual navigation aids where operations are conducted down to 100 ft decision height and a RVR not less than 1200 ft. d. Precision approach runway, Category III. An instrument runway served by non-visual guidance systems to and along the surface of the runway and: (1) CAT IIIa where operations are conducted or intended to be conducted down to an RVR not less than 600 ft (no decision height being applicable); (2) CAT IIIb where operations are conducted or intended to be conducted down to an RVR not less than 300 ft (no decision height being applicable); (3) CAT IIIc where operations are conducted or intended to be conducted with no decision height and no runway visual range limitations.
Intermediate approach	That part of an instrument approach procedure in which aircraft configuration, speed and positioning adjustments are made for entry into the final approach.
Intermediate fix (IF)	The fix at which the aircraft enters the intermediate approach segment of an instrument approach.
Landing area	That part of the movement area intended for the landing or take-off run of aircraft.
Localizer	The component of an ILS which provides lateral guidance with respect to the runway centerline.
Localizer type directional aid	A facility of comparable utility and accuracy to a LOC, but which is not part of a full ILS and may not be aligned with the runway.
Minimum descent altitude (MDA)	A specified altitude referenced to sea level for a non-precision approach below which descent must not be made until the required visual reference to continue the approach to land has been established.

Minimum sector altitude (MSA)	The lowest which will provide a minimum clearance of 1,000 feet, under conditions of standard temperature and pressure, above all obstacles located in an area contained within a defined sector of a circle of 25 nautical miles radius centred on an identified navigational facility or waypoint.
Missed approach point (MAP)	That point on the final approach track which signifies the termination of the final approach and the commencement of the missed approach. It may be: a. the intersection of an electronic glide path with a Decision Height; b. a navigational facility located on the aerodrome; c. a suitable fix (e.g., DME); d. specified distance past the facility or final approach fix, not to exceed the distance from that facility or fix to the nearest boundary of the aerodrome.
Missed approach procedure	The procedure to be followed, if for any reason, after an instrument approach, a landing is not affected.
Non-precision approach (NPA)	An instrument approach procedure which does not utilize vertical guidance. Minima shall be expressed as MDA(H).
Obstacle	An existing object, object of natural growth, or terrain at a fixed geographical location or that may be expected at a fixed location within a prescribed area, with reference to which vertical clearance is or must be provided for flight operations.
Obstacle clearance limit (OCL)	The lowest altitude that will satisfy the obstacle clearance requirement for the particular segment of an instrument approach procedure that is under consideration.
Obstacle clearance surface (OCS)	A surface above which obstacles may not penetrate if the required obstacle clearance is to be maintained.

Obstacle limitation surface (OLS).	A surface that establishes the limit to which objects may project into the airspace associated with an aerodrome so that aircraft operations at the aerodrome may be conducted safely. Obstacle limitation surfaces consist of the following: 1. Take-off/Approach surface. An incline plane beyond the end of the runway and preceding the threshold of a runway. The origin of the plane comprise: (a) An inner edge of specified length (strip width), perpendicular to and evenly divided on each side of the extended centre line of the runway, and beginning at the end of the runway strip; (b) Two sides originating at the ends of the inner edge, diverging uniformly at a specified rate in the direction of take-off; (c) The elevation of the inner edge is equal to the elevation of the threshold. 2. Transitional surface. A complex surface sloping up at a specified rate from the side of the runway strip and from part of the take-off/approach surface. The elevation of any point on the lower edge of the surface is: (a) Along the side of the take-off/approach surface, equal to the elevation of the take-off/approach surface at that point; and, (b) Along the runway strip, equal to the elevation of the centre line of the runway, perpendicular to that point.
Obstacle rich environment (ORE)	An environment is obstacle rich when it is not possible to construct an unguided discontinued approach using procedural means. Approach operations in an ORE require supplementary guidance to proceed along the published course to the missed approach point and achieve a climb to the minimum vectoring altitude or minimum IFR altitude.
Omnidirectional facility	A facility capable of receiving or transmitting in all directions. Omnidirectional facilities include VOR, TACAN, VORTAC, NDB and DME.
Operational advantage	An improvement that benefits the users of an instrument procedure without compromise to safety
Penetration turn	That part of the initial approach segment, which permits a high performance aircraft to reverse direction and to lose altitude while remaining within a limited area.
Precipitous terrain	Terrain characterized by steep or abrupt slopes.

Precision and non precision	These terms are used to differentiate between navigational facilities that provide a combined azimuth and glide slope guidance to a runway (Precision) and those that do not. The term nonprecision refers to facilities without a glide slope, and does not imply an unacceptable quality of course guidance.
Precision approach (PA)	An instrument approach procedure utilizing precision lateral and vertical guidance with minima as determined by the category of operation.
Precision approach radar (par)	Primary radar equipment used to determine the position of an aircraft during final approach, in terms of lateral and vertical deviations relating to a predetermined approach path, and in range relative to a predetermined touchdown point.
Procedure turn (PT)	A manoeuvre in which a turn is made away from a designated track, followed by a turn in the opposite direction, both turns being executed so as to permit the aircraft to intercept and proceed along the reciprocal of the designated track. **Note:** Procedure turns are designated left or right according to the direction of the initial turn.
Positive course (Track) guidance	A continuous display of navigational data which enables an aircraft to be flown along a specific course (track). **Note:** Radar vectors are considered meeting the requirements of positive course (track) guidance.
Primary area	The area within a segment in which full obstacle clearance is applied.
Radial	A bearing extending from a VOR, or TACAN facility.
Runway	A defined rectangular area, on a land aerodrome, prepared for the landing and take-off of aircraft along its length.
Runway environment	The runway threshold, lighting aids, markers or markings identifiable with the runway.
Runway visual range (RVR)	The maximum distance in the direction of take-off or landing at which the runway or specified lights or markers delineating it can be seen from a position above a specified point on its centreline at a height corresponding to the average eye-level of pilots at touchdown. **Note:** A height of 16 feet is regarded as corresponding to average eye-level of pilots at touchdown. RVR is determined from information provided by a transmissometer located near the touchdown point on a runway and where CAT II ILS is installed a second transmissometer is located near the midpoint of the runway length.

Safe altitude 100 nm	The lowest altitude that may be used that will provide a minimum clearance of 1,000 feet, under conditions of standard temperature and pressure, above all obstacles located in an area contained within a circle of 100 nautical miles radius of the geographic centre of the aerodrome.
Service volume	That volume of airspace surrounding a navigational facility within which a signal of usable strength exists and where the signal is not operationally limited by co-channel interference.
Segment	The basic functional division of an instrument approach procedure. The segment is oriented with respect to the course to be flown. Specific values for determining course alignment, obstacle clearance areas, descent gradients, and obstacle clearance requirements are associated with each segment according to its functional purpose.
Straight-in approach	An instrument approach where final approach is begun without first having executed a procedure turn. Straight-in approaches are not necessarily completed with a straight-in landing or made to straight-in landing minimums.
Straight-in landing minima	Approach minima published in association with an instrument approach procedure that conforms with specified final approach alignment and descent gradient criteria.
Strip	An area of specified dimensions enclosing a runway, intended to reduce the risk of damage to aircraft running off a runway, and to protect aircraft flying over it during take-off and landing operations.
Threshold	The beginning of that portion of the runway usable for landing.
Threshold crossing height	The height of the straight-line extension of the glide slope above the runway at the threshold.
Touchdown zone (TDZ)	The first 3,000 feet of runway, or the first one-third which ever is less, measured from the threshold in the direction of landing.
Touchdown zone elevation (TDZE)	The highest runway centreline elevation in the touchdown zone.
Track	The projection on the earth's surface of the path of an aircraft, the direction of which path at any point is usually expressed in degrees from North (true, magnetic, or grid).
Visibility	The ability, as determined by atmospheric conditions and expressed in units of distance, to see and identify prominent unlighted objects by day and prominent lighted objects by night.

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CRITERIA FOR THE DEVELOPMENT OF INSTRUMENT PROCEDURES

TP 308 / GPH 209 – CHANGE 7

ANNEX B

MINIMUM VECTORING ALTITUDE

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NATIONAL DEFENSE

5 January 2017

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MINIMUM VECTORING ALTITUDE CHARTS

1. Chart Preparation

Radar vectoring charts are developed for areas where there are numerous minimum vectoring altitudes due to variable terrain features or man-made obstacles. The responsible ATC facility shall determine whether their radar systems require vectoring charts. Procedure design specialists or WICPs shall establish the minimum altitudes by ensuring all MVA charts meet the obstacle requirements outlined within this Annex. Completed charts will be reviewed and approved in accordance with the coordination signature blocks identified on form 26-0445.

2. Areas Of Consideration

The area considered for obstacle clearance shall be based upon the maximum range of the applicable radar. This area may be subdivided into sectors to gain relief from obstacles that are clear of the area in which flight is to be conducted. There is no limit on the size, shape or orientation of the sectors; however, they must be designed with consideration to aircraft maneuvering ability, obstacle clearance requirements and air traffic flow requirements.

To avoid excessively high MVAs within a sector, radars meeting the specifications of RAMP RADAR may isolate prominent obstacles by enclosing the obstacle within a buffer area whose boundaries are at least 3 NM from the obstacle up to and including 60 NM from the radar antenna and 5 NM from obstacle beyond 60 NM from the radar antenna. Radars not meeting RAMP RADAR specifications may isolate obstacles by 5 NM in all cases.

Rapidly rising terrain, although possibly not a factor in identifying prominent obstacles, may trigger activation of ground proximity warning devices onboard aircraft due to an aircraft descending to a MVA in these areas. Procedure designers should consider this when establishing sectors and MVAs with a view to eliminating this possibility during the development of MVA charts.

All MVAs shall be contained within controlled airspace.

3. Obstacle Clearance

Obstacle clearance shall be provided over all obstacles with all the designated vectoring areas or sectors irrespective of the minimum altitude radar coverage determined by a flight check. Selected altitudes shall provide clearance over all obstacles outside of the sector within 3 NM of the sector boundaries (5 miles beyond 60 NM from the radar antenna). In areas of overlapping radar coverage, where data from an antenna more that 60 NM away may be used, only 5 NM clearance shall be applied. Normally, 1000 feet of obstacle clearance is provided in non-mountainous areas and 1500 feet or 2000 feet, as appropriate, in areas designated as mountainous in the Designated Airspace Handbook. Chosen MVAs may be rounded off to the nearest 100 foot increment provided the required obstacle clearance within the appropriate sector is not violated.

4. Obstacle Clearance Reductions

Where lower MVAs are required in designated mountainous areas to achieve compatibility with terminal routes or to permit vectoring to an instrument approach procedure, obstacle clearances may be reduced to not less than 1000 feet when precipitous terrain is not a factor.

5. Radar Data Processing (RDP)

Radar information presented to the controller may be provided from multiple antennas. MVA charts for these facilities shall provide obstacle clearance determined by using the antenna location that is the greatest distance from the obstacle.

6. Construction

a. MVAC's should initially be drawn on an appropriately scaled aeronautical chart as per Figure B–1, Terminal Surveillance Radar (TSR), or Figure B–2, Independent Secondary Surveillance Radar (ISSR).

b. The **centre** of the chart should represent the radar antenna site, however, operations requirements may dictate otherwise. The chart may be divided into sectors as required by different obstacle clearance altitudes. The configuration of each sector, and the features to be displayed, depends upon the local terrain and operational considerations. The following guidelines should be to used when developing MVA charts:

(1) Depict each sector in relation to its magnetic bearing from the antenna site, radials from NAVAIDS, radar display range marks, or controller airspace boundaries. To facilitate a correlation between the chart and radar displays, make the sector boundaries coincide with map overlay or video map data, if possible.

(2) Make each sector large enough to permit the vectoring of aircraft within the sector. Establish the boundary of each sector at least 3 NM from the obstacle determining the minimum altitude (5 NM, if more than 60 NM from the antenna site).

(3) If there is a large sector with an excessively high altitude, due to an isolated prominent obstacle, the buffer area must have boundaries that are at least 3 NM from the obstacle (5 NM, if more than 60 NM from the antenna site).

(4) Determine and depict the minimum altitude in each sector that will provide the required obstacle clearance.

c. Complete the Minimum Vectoring Altitude Computations form, TC form 26-0445, to determine selected sector altitudes. See Figure B–3. The temperature difference, Section C.5 on the form, is calculated by finding the mean minimum temperature for each month. This temperature may be found in Environment Canada publication, "Principal Station Data," Table 1, line two, "Minimum". The lowest mean minimum temperature is then subtracted from the ICAO Standard Atmosphere (ISA) temperature for the elevation of the airport/altimeter setting source. This is the number used in Section C.5.

d. Transfer all data to the Minimum Vectoring Altitude Chart, TC form 26-0446. See Figure B–4. Complete the obstacle data for the controlling obstacle for each sector. Obtain the required signatures and retain on unit files.

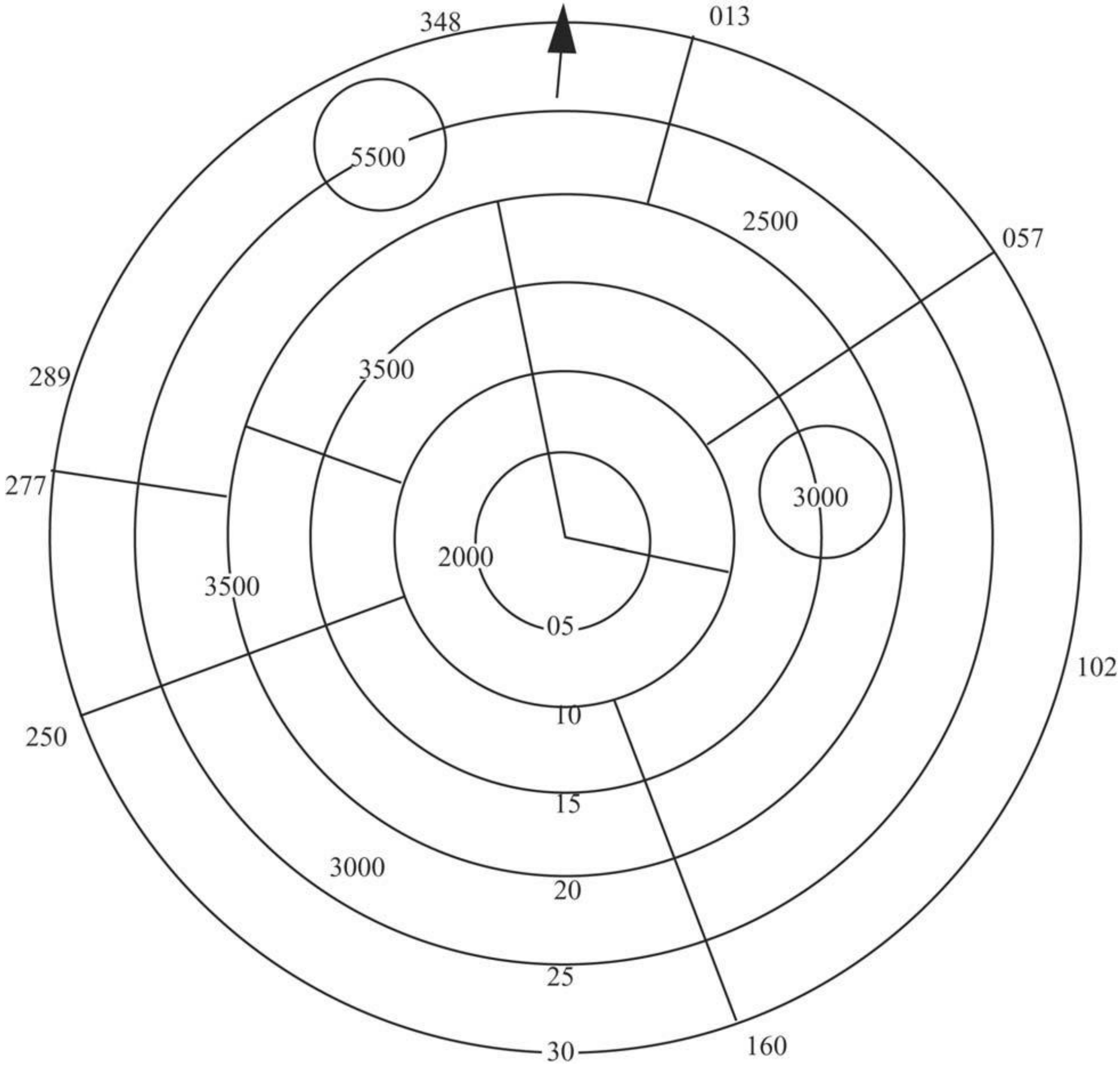

Figure B-1: Terminal Surveillance Radar (TSR)

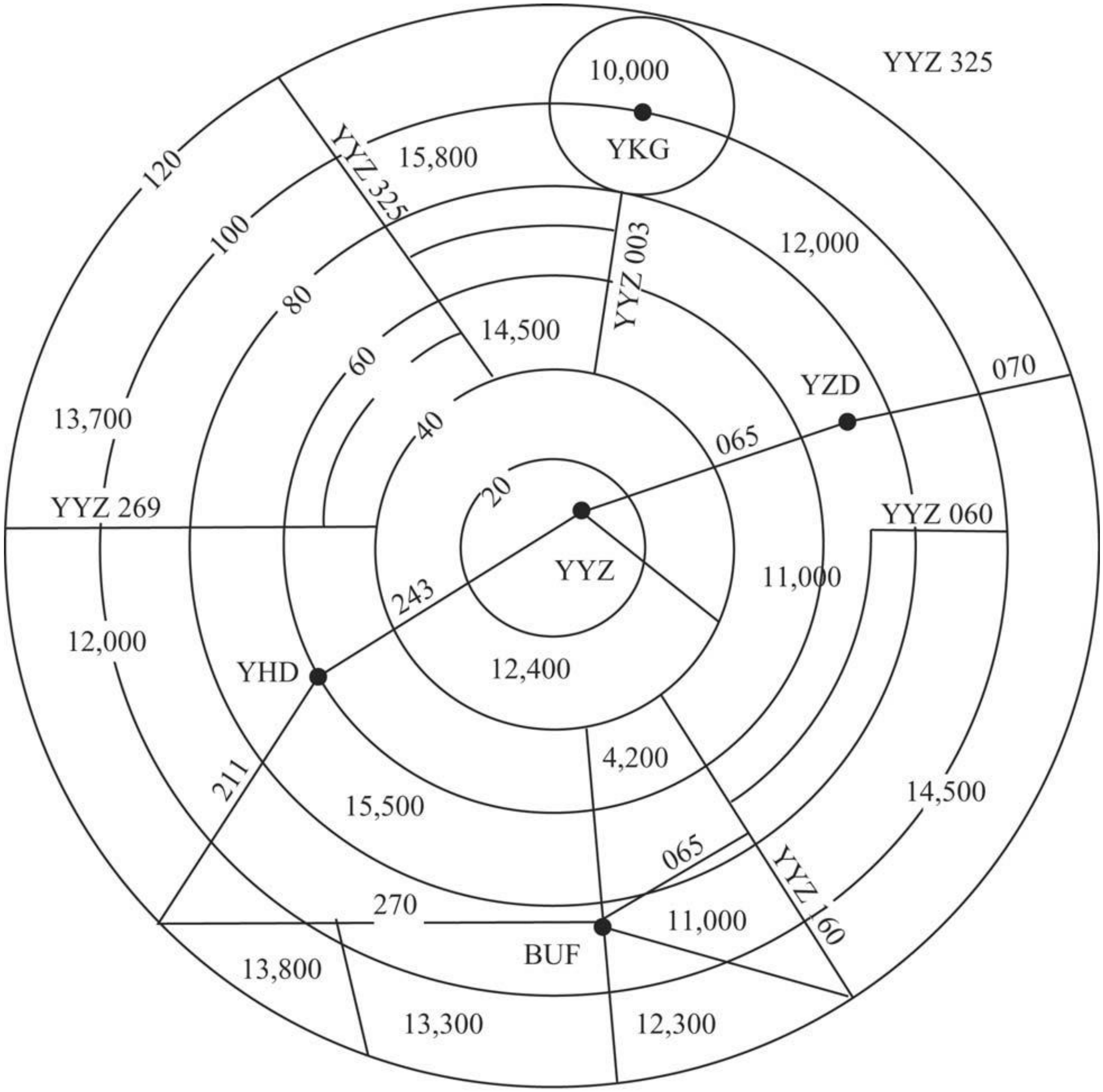

Figure B-2: Independent Secondary Surveillance Radar (ISSR)

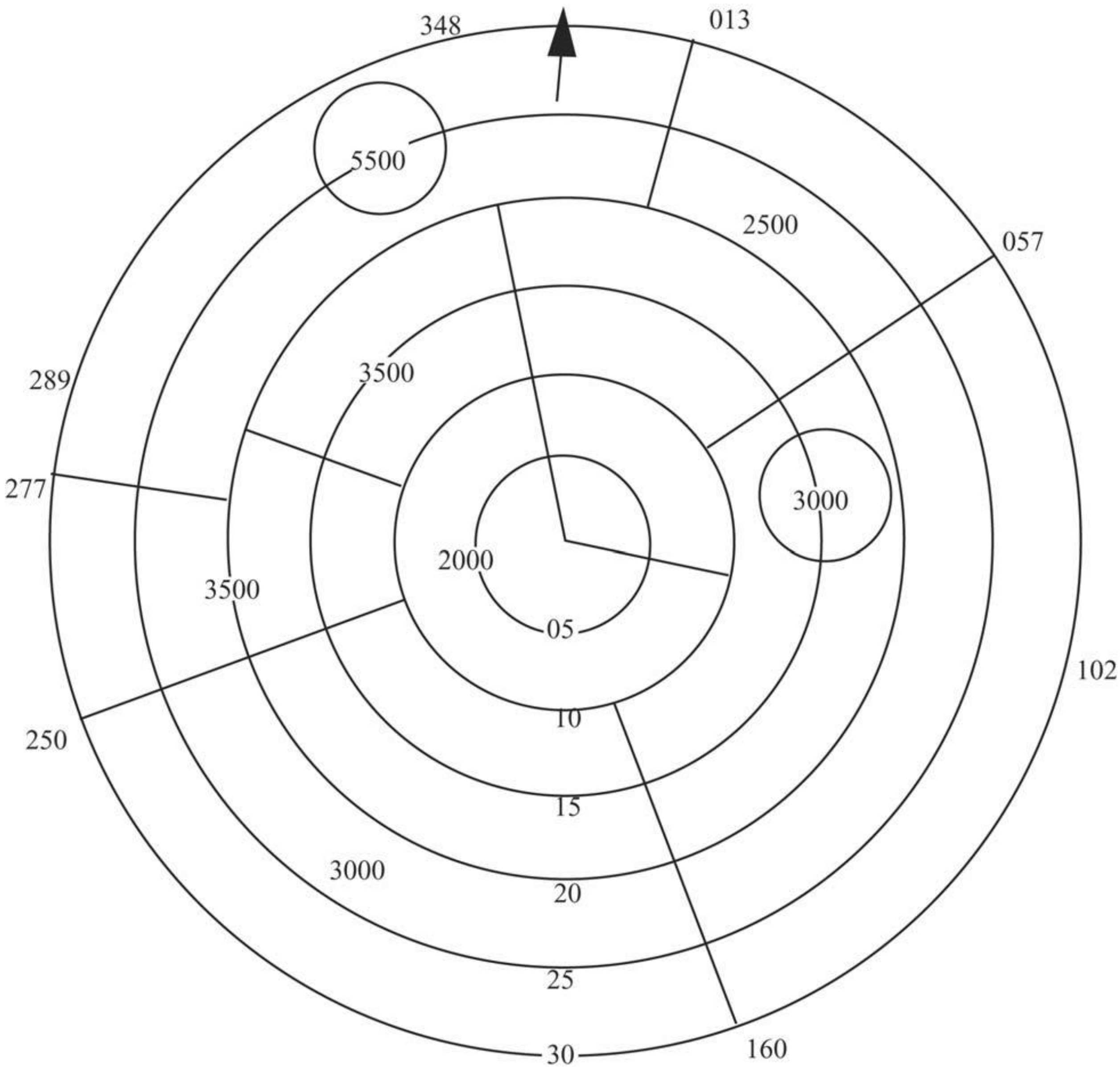

Figure B-4: Minimum Vectoring Altitude Chart.

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MINIMUM VECTORING ALTITUDE COMPUTATIONS

For completion instructions, see TP 308/GPH 209, Annex B.

Name of Facility	**>**	**Sector** _____ **of** _____
Name of Airport	**>**	

SECTOR *(Enter Description)*			
A.	**MVA Required for Terrain Obstacle Clearance**	**Buffer Area**	**Sector**
1.	Controlling obstacle *(Enter Description)*		
2.	Controlling Obstacle Height (MSL)		
3.	Required Obstacle Clearance *(Normally 1000 (1500 or 2000 mountainous Area)*	+	+
4.	ROC Adjustment (Precipitous terrain – Para 323)		
5.	Required Altitude based on Obstacle Clearance	=	=
B.	**MVA Required for Airspace**		
1.	Floor of Controlled Airspace *(AGL)(if MSL, Skip 1&2)*		
2.	Highest Terrain in Sector		+
3.	Required Altitude Based on Airspace Floor		=
C.	**MVA Required for Temperature Correction**		
1.	Required Altitude based on Obstacle Clearance (A.5)		
2.	Airport/ Altimeter Setting Source Elevation		-
3.	Elevation Differential		=
4.	Elevation Factor (C.3/1000)		
5.	Temperature Difference (Standard ____°C Winter _____°C)		
6.	Temperature Correction (C.4 x C.5 x 4)		
7.	Required Altitude based on Obstacle Clearance (A.5)		
8.	Required Altitude Based on Temperature Correction		=
D.	**Selected Sector Altitude**		
1.	For months when mean temperature is > 0°C *(Highest of A.5 or B.3 rounded as per Para 1041.a.(3))*		
2.	For months when mean temperature is ≤ 0°C *(Highest of B.3 or C.8 rounded as per Para 1041.a.(3))*		
Remarks:			

26-0445 (JAN 08)

Figure B-3: Minimum Vectoring Altitude Computations Forms.

TSR/ISSR Magnetic Variation:	

Obstacle Data			
Sector	**Controlling Obstacle No.**	**Elevation MSL**	**LAT / LONG**
Remarks			

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Figure B-4: Minimum Vectoring Altitude Chart (continued).

CRITERIA FOR THE DEVELOPMENT OF INSTRUMENT PROCEDURES

TP 308 / GPH 209 – CHANGE 7

ANNEX C

PROCEDURES

TRANSPORT CANADA
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PROCEDURES

1. Administrative – Reserved
2. General Provisions – Reserved
3. Enroute Procedures – Reserved
4. Terminal Procedures – Reserved

4.1. General.

This section contains supplementary guidance for the development of RNAV instrument procedures. RTCA DO-201A, Standards for Aeronautical Information, has established operational requirements and standards that aviation authorities, procedure designers, and airspace planners must consider when developing en route, arrival, approach, departure, and aerodrome environments. This guidance provides a standardized method of processing RNAV instrument procedures using information from this RTCA document.

4.2. RNAV Approach Procedure Design.

a. The RNAV procedure should, **whenever** and wherever possible, match the ILS at the same runway in the following respects: final and intermediate segment procedure ground track, missed approach, altitudes, fix locations/names, glidepath angles (GPAs), and threshold crossing heights (TCHs). Nothing in this policy requires an RNAV procedure to emulate a procedure turn used on an underlying ILS procedure.

b. Establish an LNAV FAF for all new RNAV procedures at a location that will support a collocated PFAF for future RNP, LNAV/VNAV, and/or WAAS/LAAS procedures.

c. RNAV RNP procedures may be designed to support minimums with different RNP values in the final approach segment. The largest RNP value is the one that will be coded into the avionics database (pilots will have the ability to enter the lower values if their equipment permits).

d. ILS and/or LOC procedures may be combined with RNAV (GPS) procedures. This will permit use of an ILS/LOC with the same ground track as the RNAV (GPS) procedure. When combining procedures, consideration must be given to the number of lines of minima that are possible and the potential human factors implications.

e. Remote Altimeter Setting for Baro-VNAV is not authorized. When the primary altimeter source is from a remote location, LNAV/VNAV is not authorized to be flown using Baro-VNAV. When the primary altimeter source is local and a secondary altimeter source is remote, LNAV/VNAV minimums must be noted as not authorized (NA) to be flown with Baro-VNAV when the secondary altimeter is in use.

f. **Critical Temperature.** Temperature limits above and below which Baro-VNAV operations are not authorized are published on RNAV instrument approach procedures. Current RNAV criteria standards provides the formulas to compute the critical temperatures for the airport of intended landing based on a given deviation from International Standard Atmosphere (ISA) for the airport elevation. Maximum temperature published must not exceed 54°C (130°F).

g. **Due to limited WAAS coverage at certain locations**, a restriction may be required on procedures where WAAS can be used for vertical navigation on a procedure containing LNAV/VNAV minima. This restriction must be portrayed on the instrument procedure chart to signify WAAS signal outages may occur daily and that these outages will not be NOTAM'd. At locations where LNAV/VNAV minima are published and it has been determined that there is no WAAS coverage whatsoever, the chart must be annotated to indicate that the use of WAAS for VNAV is not authorized.

4.3. RNAV (RNP)

a. **As part of the minima box for RNAV (RNP) procedures**, enter "Authorization Required" in the title line.

b. **Document the RNP value** (e.g., RNP 1.0 or RNP 0.15) used for each segment (except the final segment). Additionally, when the RNP for feeder, initial and/or intermediate segments are less than standard (RNP 2.0 for feeder, RNP 1.0 for initial and/or intermediate), a chart note must be placed adjacent to the feeder fix or IAF stating the required RNP value.

c. **RNAV (RNP) speed restrictions** [see Order 8260.58, Volume 5] must be noted on the chart. For a missed approach RF turn, specify the point where the restriction starts and the point at which the restriction is no longer required.

d. **Certain RNP-equipped aircraft may not be capable of flying procedures that contain RF turns**, so the entire procedure or segment of the procedure must be annotated to alert the pilot of this limitation.

e. **RNP criteria require a wing (semi) span value** for narrow and wide body aircraft to be used when calculating the Vertical Error Budget (VEB). When the narrow body value is used, a note must be placed on the approach chart to alert the pilot of this limitation.

5. Airspace – Reserved

6. Military Procedures – Reserved

7. Planning – Reserved

8. Instrument Approach Procedure Data Transmittal System – Reserved

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CRITERIA FOR THE DEVELOPMENT OF INSTRUMENT PROCEDURES

TP 308 / GPH 209 – CHANGE 7

ANNEX D

OLS VS OCS

TRANSPORT CANADA
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NOTE ON THE DISTINCTION BETWEEN OBSTACLE LIMITATION SURFACES AND OBSTACLE CLEARANCE SURFACES

Care should be taken to distinguish between Obstacle Limitation Surfaces (OLS) dealt with in TP 312/CETO C-98-001-003/MS-022, and Obstacle Clearance Surfaces (OCS) dealt with in TP308/GPH209, as their purpose is different.

a. Obstacle Limitation Surface (Take-off/Approach, Transitional, and Outer Surface) define the volume of airspace that should ideally be kept free from obstacles in order to minimize the dangers presented by obstacles to an aircraft, either during an entirely visual approach or during the visual segment of an instrument approach (see Figure F-1). The Obstacle Limitation Surfaces are intended to be of a permanent nature Values are fixed in relation to the proposed airport use and therefore they form the basis for an enactment of Zoning Regulations.[1]

b. Obstacle Clearance Surfaces are intended to be used by instrument procedure specialists for the construction of instrument flight procedures and for specifying minimum safe altitudes for each segment of the procedure. Obstacle Clearance Surfaces are designed to meet the needs of a particular runway environment based on the location and height of existing obstacles, aeroplane speed, the navigational aid being used and in some cases the equipment fitted to the aeroplane. Rarely would two sets of OCSs be the same for the same type on instrument approach at different runways.

The standards for Obstacle Limitation Surface described in TP 312/CETO C-98-001-003/MS-022 determine whether an aerodrome can be certified and whether a runway can be authorized as an instrument runway or non-instrument runway. Once Obstacle Limitation Surfaces are in place, it is possible to exercise some discretion on what to do when they are penetrated. TP 312/CETO C-98-001-003/MS-022 Para 4.1.2 states, "New objects or extensions of existing objects shall not be permitted...except when in the opinion of the certifying authority, the new object or extension would be shielded by an existing immoveable object."

In the case of Obstacle Clearance Surfaces, the Minimum Vertical Clearance is always based on existing obstacles. If a new obstacle appears, the entire instrument approach procedure must be reviewed.

In summary, TP 308/GPH 209 (OCS) specifies the size and dimensions of the obstacle-free airspace needed for an instrument approach, a missed approach initiated at or above the Obstacle Clearance Altitude and for the visual maneuvering (circling) procedure. Aeroplanes continuing their descent below the specified Obstacle Clearance Altitude, and therefore having visual confirmation that they are properly aligned, are protected by TP 312/CETO C-98-001-003/MS-022 (OLS) and related obstacle limitations and marking/lighting requirements.

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[1] "Registered Zoning Regulations" is defined as the enactment of Registered Zoning Regulations pursuant to the *Aeronautics Act*, Part 1, Sections 5.4 to 5.8, for the protection of approach and departure paths surrounding an aerodrome. In normal Canadian practice a Registered Zoning Regulation forbids penetration of runway Take-off/Approach, Transitional, and Outer Surfaces as described in TP312/CETO C-98-001-003/MS-022.

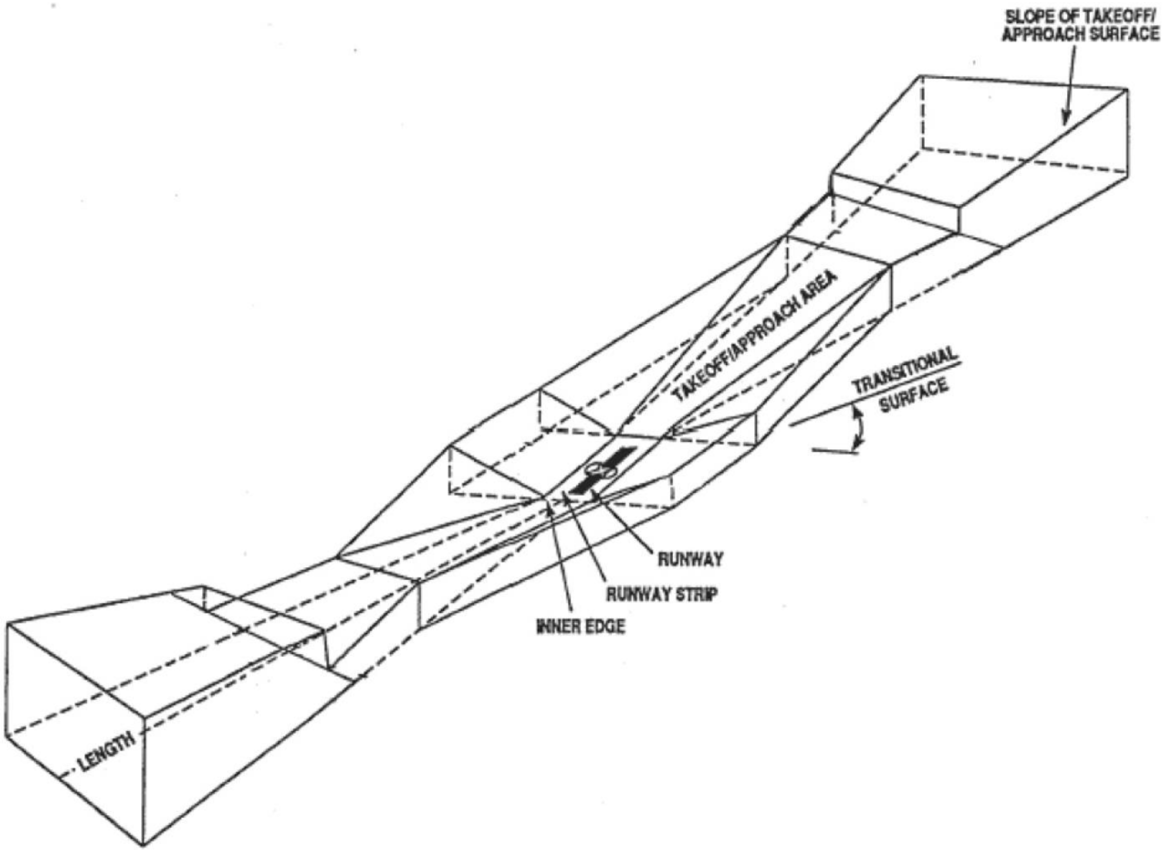

Figure F-1: Obstacle Limitation Surface

An example may serve to further clarify the above distinction. If a new object were to penetrate the Take-off/Approach Surface of an unzoned, precision approach runway, remedial options to be considered could include the following:

(1) Removal of the object,

(2) Displacing the threshold to retain a 2% gradient,

(3) Downgrading the level of operations to non-precision or non-instrument, or

(4) Marking the obstacle with a suitable hazard beacon.

(Although raising the glide path angle is another possibility, the size of the acceptable change - from the normal 3° to a maximum of 3.2° - is almost invariably too small to make this a practical option). If an Instrument Procedures Specialist determined that the obstruction would not affect landing minima, the certifying authority could chose to implement any of the above options. For example, if the object were a long way from threshold, and penetration were minimal, merely marking or lighting the obstruction could satisfy safety requirements. However, if the application of the Minimum Vertical Clearance to the penetration results in unacceptably higher minima, the certifying authority would have only the option of arranging removal of the obstruction or downgrading the level of operations. Of these, the one that least disrupted safety and regularity would be chosen.

Note: A Registered Zoning Regulation relates to lands "adjacent to or in the vicinity of airports", therefore it has no force with regard to lands inside the airport boundary. However, any penetration of an OLS inside the boundary would be sanctioned only if the object had to be so located for navigation or guidance purposes.

Note: Obstacles existing at the time a Registered Zoning Regulation comes into force are not affected by such Regulation. Removal of such an obstacle by legal means can only be done by acquiring the property under the Expropriation Act or payment of compensation.

Definitions:

Obstacle Limitation Surface (OLS). A surface that establishes the limit to which objects may project into the airspace associated with an aerodrome so that aircraft operations at the aerodrome may be conducted safely. Obstacle limitation surfaces consist of the following:

(1) Take-off/Approach surface. An incline plane beyond the end of the runway and preceding the threshold of a runway. The origin of the plane comprise:

- (a) An inner edge of specified length (strip width), perpendicular to and evenly divided on each side of the extended centre line of the runway, and beginning at the end of the runway strip;
- (b) Two sides originating at the ends of the inner edge, diverging uniformly at a specified rate in the direction of take-off;
- (c) The elevation of the inner edge is equal to the elevation of the threshold.

(2) Transitional surface. A complex surface sloping up at a specified rate from the side of the runway strip and from part of the take-off/approach surface. The elevation of any point on the lower edge of the surface is:

- (a) Along the side of the take-off/approach surface, equal to the elevation of the take-off/approach surface at that point; and,
- (b) Along the runway strip, equal to the elevation of the center line of the runway, perpendicular to that point.

Strip: An area of specified dimensions enclosing a runway, intended to reduce the risk of damage to aircraft running off a runway, and to protect aircraft flying over it during take-off and landing operations.

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CRITERIA FOR THE DEVELOPMENT OF INSTRUMENT PROCEDURES

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ANNEX E

TERRAIN AND OBSTACLE DATA (TOD)

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TERRAIN AND OBSTACLE DATA (TOD)

1.0. General

The primary purpose of obstacle evaluation is to determine how an obstacle will affect instrument flight procedures. The evaluations provide accurate, consistent, and meaningful results only if procedure specialists apply the same rules, criteria, and processes during development, revision, and cyclical review. This annex establishes the minimum accuracy standards for obstacle data and its application in the development, revision, and cyclical review of instrument procedures. The minimum standards, regardless of the data source, are to be applied by instrument procedure specialists in all instrument procedure obstacle evaluations.

1.1. Obstacle Data Accuracy Standards

This paragraph identifies the MINIMUM requirement for accuracy of obstacle data used in the development of minimum vectoring altitudes (MVA) and instrument procedures; providing the minimum accuracy standards for each.

a. Concept. Obstacle data accuracy is not absolute, and the accuracy depends on the data source, different sources of data will have different accuracies. The magnitude of the inaccuracy does not preclude its use, provided it is identified, accounted for and documented. In some cases, upgrading obstacle accuracy can provide relief from operational restrictions in an instrument procedure. In no case, will the application of obstacle data accuracy preempt the requirement for the flight check of an instrument procedure for discrepancies.

b. Standards. The minimum accuracy standards in this annex are for use in the development, revision, and cyclical review of instrument procedures. They must be applied to all new procedures and to existing procedures at the next revision or cyclical review, whichever occurs first. The minimum accuracy standards are listed below. ADJUST the location/elevation data of the segment-controlling obstacle by the actual horizontal and vertical accuracy values, only if the specified accuracy value does not meet or exceed the following standards.

(1) ±20 ft horizontal and ±3 ft vertical accuracy: Precision and APV final and missed approach segments.

(2) ±50 ft horizontal and ±20 ft vertical accuracy: Non precision final segments; missed approach 40:1 surface evaluation; circling areas; and the Obstruction Evaluation Area (OEA) for a climb to 400 ft above DER on all departure procedures.

(3) ±250 ft horizontal and ±50 ft vertical accuracy: Intermediate segment. All areas outside of OEA for a climb to 400 ft above DER.

(4) ±500 ft horizontal and ±125 ft vertical accuracy: (1,000 ft ROC) Initial segments, feeder segments, en route areas, missed approach holding/level surface evaluation; MSA, Safe Altitude 100 NM and the level route portion for SIDs.

(5) ±1,000 ft horizontal and ±250 ft vertical accuracy: (1,500/ 2,000 ft ROC) Feeder segments, en route areas, Safe Altitude 100 NM, MVA and the level route portion for SIDs.

Note: The above values are assumed accuracy. If the data used does not meet that minimum value of accuracy, the obstacle data must be adjusted by the actual value of the accuracy data. If the data used meets the value of accuracy, the data can be used as is. By "meets that minimum value of accuracy" it is meant that the accuracy value is within that specified. (i.e ±5 ft meets a requirement of ±20 ft and as such that data could be used, but ±25 ft does not meet a requirement of ±20 ft and as such the ±25 ft would have to be used to adjust the obstacle data in this example)

1.2. Accuracy Standards Application

a. Determine the segment-controlling obstacle using raw obstacle data only (i.e., accuracy adjustments not applied) then, if required under paragraph 1.1.b., add the actual horizontal and/or vertical accuracy adjustments to the raw obstacle data to determine the obstacle's most adverse location and elevation.

b. For any one segment the controlling obstacle needs to be determined using the raw obstacle data only (as if no accuracy data were available). Once that obstacle has been identified and determined not to meet the minimum requirement for accuracy, the accuracy data for only that one obstacle needs to be applied in the most adverse location and elevation (i.e. the location and elevation that will be most penalizing). For example if the controlling obstacle has a raw height of 250 feet and an accuracy of ±15 feet, that obstacle (and only that obstacle in that segment) would be considered to have a height of 265 feet.

c. Accuracy adjustments are not applied to obstacles evaluated relative to TP 308, volume 1, paragraph 289.

Examples:

1) **Non Precision Final Approach Segment** (±50 ft H, ±20 ft V Required Accuracy)
   - Controlling Obstacle: 175 ft with ±55 ft horizontal and ±20 ft vertical accuracy
   - Conclusion(s): Horizontal standard NOT met, vertical standard met.
   - Action(s): Adjust horizontal obstacle location data by 55 feet horizontally. No vertical adjustment is required.

   Note: This example is for a case where the minimum accuracy value (as stated in Annex E section 1.1) is not met (in fact for this example only the horizontal minimum accuracy value is not met, while the vertical minimum accuracy value is in fact met).

2) **Precision Final Approach Segment** (±20 ft H, ±3 ft V Required Accuracy)
   - Controlling Obstacle: 112 ft with ±20 ft horizontal and ±2 ft vertical accuracy
   - Conclusion(s): Both horizontal and vertical standards are met.
   - Action(s): Nil (no adjustment required)

   Note: This example is for the case where the minimum accuracy value (as stated in Annex E section 1.1) is met. In both examples the way to implement Annex E is provided.

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CRITERIA FOR THE DEVELOPMENT OF INSTRUMENT PROCEDURES

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ANNEX F

PRECIPITOUS TERRAIN CALCULATIONS

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PRECIPITOUS TERRAIN CALCULATIONS

1.0. General

Precipitous Terrain Equations, Parameters, Interests, Weights, and Adjustment Values. A digital terrain data base (100 m or 3 arcsecond separation density or better) must be used for the determination of precipitous terrain. The precipitous terrain area will contain the prescribed segment (both primary and secondary, if applicable) and a 2 NM buffer surrounding that segment. For segments that are comprised of multiple legs, each leg should be evaluated separately. The digital terrain data within that defined area will be analyzed electronically to determine the values of five specific parameters [g(1) through g(5)], which will be transformed into interest values [I(1) through I(5)], weighted [W(1) through W(5)] and combined to determine the base precipitous adjustment,

a. Step 1. The equations, minimum and maximum thresholds, and weight values for each parameter are:

Average elevation

$$g(1) = \Sigma \frac{h(x,y)}{n}$$

min(1) = 600 $meters$

max(1) = 3000 $meters$

(1) = 0.05

98th percentile – 2nd percentile height differential

$$g(2) = h_{98percentile} - h_{2percentile}$$

min(2) = 250 $meters$

max(2) = 2500 $meters$

(2) = 0.30

Slope gradient

$$g(3) = \sqrt{\left(\frac{D_a}{D}\right)^2 + \left(\frac{D_b}{D}\right)^2}$$

min(3) = 0.015

max(3) = 0.060

(3) = 0.10

Standard deviation from plane of best fit

$$g(4) = \sqrt{\frac{\Sigma\left[h(x,y) - \left(\frac{D_a \times x}{D} + \frac{D_b \times y}{D} + \frac{D_c}{D}\right)\right]^2}{n}}$$

$min(4) = 40 \text{ meters}$

(4) = 200 meters

(4) = 0.35

98th percentile max - min height differential within 0.50 NM of each terrain posting

$g(5) = (h_{max} - h_{min})_{98percentile}$

(5) = 100 meters

(5) = 1000 meters

(5) = 0.20

b. **Step 2.** The interest values are based on the parameter thresholds and are found via this piecewise function:

$g(i)$ < $min(i)$:

(i) = 0

(i) ≤ (i) ≤ max(i):

$$I(i) = \frac{g(i) - min(i)}{max(i) - min(i)}$$

(i) > max(i):

(i) = 1

c. **Step 3.** The combined interest (CI) is computed as follows:

$CI = W(1) \times I(1) + W(2) \times I(2) + W(3) \times I(3) + W(4) \times I(4) + W(5) \times I(5)$

d. **Step 4.** The base precipitous adjustment (BA) is also a piecewise function with a minimum threshold of 0.20 and a maximum of 0.60.

$CI < 0.20$:

$BA = 0$

$0.20 \leq CI \leq 0.60$:

$BA = 500 \times CI - 50$

$CI > 0.60$:

$BA = 250$

e. **Step 5.** Finally, BA is applied and rounded varyingly depending on the evaluated segment to derive the actual adjustment (A) [see Note 1].

Rounded to the next higher 1 foot increment:

Precision and APV finals [see Note 2]

$A = 0.10 \times HAT$

Rounded to the next higher 10 foot increment:

Non precision finals

$A = BA$

Intermediate

$A = 1.25 \times BA$

Initial, holding, & missed approach level surface

$A = 1.5 \times BA$

Note 1: Precipitous terrain evaluation is not required for departures and the sloping portion of missed approach. Where precipitous terrain evaluation is required, refer to additional guidance provided by criteria.

Note 2: When BA>0, use the HAT output based on final and missed approach assessment, excluding remote altimeter adjustments.

Explanation of variables:

$h(x,y)$ = height (meters) of the selected terrain posting

x = x coordinate of the selected terrain posting

y = y coordinate of the selected terrain posting

n = number of terrain postings in the area

$h_{98percentile}$= height (meters) of the 98th percentile terrain posting

$h_{2percentile}$ = height (meters) of the 2nd percentile terrain posting

h_{max}=height (meters) of the highest terrain posting within 0.50 NM of the selected post

h_{min}=height (meters) of the lowest terrain posting within 0.50 NM of the selected post

$$D = \begin{vmatrix} \sum x^2 & \sum x \times y & \sum x \\ \sum x \times y & \sum y^2 & \sum y \\ \sum x & \sum y & n \end{vmatrix}$$

$$D_a = \begin{vmatrix} \sum x \times h(x,y) & \sum x \times y & \sum x \\ \sum y \times h(x,y) & \sum y^2 & \sum y \\ \sum h(x,y) & \sum y & n \end{vmatrix}$$

$$D_b = \begin{vmatrix} \sum x^2 & \sum x \times h(x,y) & \sum x \\ \sum x \times y & \sum y \times h(x,y) & \sum y \\ \sum x & \sum h(x,y) & n \end{vmatrix}$$

$$D_c = \begin{vmatrix} \sum x^2 & \sum x \times y & \sum x \times h(x,y) \\ \sum x \times y & \sum y^2 & \sum y \times h(x,y) \\ \sum x & \sum y & \sum h(x,y) \end{vmatrix}$$

To compute the determinant, use the following:

$$\text{Matrix} = \begin{vmatrix} A & B & C \\ D & E & F \\ G & H & I \end{vmatrix}$$

$$D = A \times E \times I + B \times F \times G + C \times D \times H - A \times F \times H - B \times D \times I - C \times E \times G$$