ATTACHMENT A. GUIDANCE MATERIAL SUPPLEMENTARY TO AERODROME STANDARD

1. Number, siting and orientation of runways

Siting and orientation of runways

1.1 Many factors should be taken into account in the determination of the siting and orientation of runways. Without attempting to provide an exhaustive list of these factors nor an analysis of their effects, it appears useful to indicate those, which most frequently require study. These factors may be classified under four headings:

1.1.1 Type of operation. Attention should be paid in particular to whether the aerodrome is to be used in all meteorological conditions or only in visual meteorological conditions, and whether it is intended for use by day and night, or only by day.

1.1.2 Climatologically conditions. A study of the wind distribution should be made to determine the usability factor. In this regard, the following comments should be taken into account:

a) Wind statistics used for the calculation of the usability factor are normally available in ranges of speed and direction, and the accuracy of the results obtained depends, to a large extent, on the assumed distribution of observations within these ranges. In the absence of any sure information as to the true distribution, it is usual to assume a uniform distribution since, in relation to the most favourable runway orientations, this generally results in a slightly conservative for the usability factor.

b) The maximum mean cross-wind components given in Chapter 3, 3.1.2 refer to normal circumstances. There are some factors, which may require that a reduction of those maximum values be taken into account at a particular aerodrome. These include:
   1) The wide variations which may exist, in handling characteristics and maximum permissible cross-wind components, among diverse types of aeroplanes (including future types) within each of the three groups given in 3.1.2;

   2) Prevalence and nature of gusts;

   3) Prevalence and nature of turbulence;

   4) The availability of a secondary runway;

   5) The width of runways;

6) The runway surface conditions - water, snow and ice on the runway materially reduce the allowable cross-wind component; and

7) The strength of the wind associated with the limiting cross-wind component.

A study shall also be made of the occurrence of poor visibility and/or low cloud base. Account should be taken of their frequency as well as the accompanying wind direction and speed.

1.1.3 Topography of the aerodrome site, its approaches, and surroundings, particularly:

a) Compliance with the obstacle limitation surfaces;

b) Current and future land use. The orientation and layout should be selected so as to protect as far as possible the particularly sensitive areas such as residential, school and hospital zones from the discomfort caused by aircraft noise;

c) Current and future runway lengths to be provided;

d) Construction costs; and

e) Possibility of installing suitable non-visual and visual aids for approach-to-land.

1.1.4 Air traffic in the vicinity of the aerodrome, particularly:

a) Proximity of other aerodromes or ATS routes;

b) Traffic density; and

c) Air traffic control and missed approach procedures.

Number of runways in each direction

1.2 The number of runways to be provided in each direction depends on the number of aircraft movements to be catered to.

2. Clearways and stopways (See Chapter 3 Para 3.1.8.1)

3. Calculation Of Declared Distances (See chapter 2 Para 2.9.1)

4. Slopes on a runway (See Chapter 3 Para 3.1.14.1)

5. Runway surface evenness (See Chapter 3, Para 3.1.21.1)

6. Determining and expressing the friction characteristics of snow and ice-covered paved surfaces (See Chapter 2 Para 2.12.1.1)

7. Determination of friction characteristics of wet paved runways
(See Chapter 2, Para 2.11)

8. Strips (See Chapter 3,Para 3.2.5.1)

9. Runway end safety areas(See Chapter 3, Para 3.5.12)

10. Location of threshold (See Chapter 3, Para 3.1.4.1)

10.1 Displaced threshold (See To Chapter 3 Para 3.1.5.1)

11. Approach lighting systems

11.1 Types and characteristics

11.1.1 The specifications in this volume provide for the basic characteristics for simple and precision approach lighting systems. For certain aspects of these systems, some latitude is permitted, for example, in the spacing between centre line lights and crossbars. The approach lighting patterns that have been generally adopted are shown in **Figures A-5 and A-6. A** diagram of the inner 300 m of the precision approach category II and III lighting system is shown in **Figure 5-13**.

11.1.2 The approach lighting configuration is to be provided irrespective of the location of the threshold, i.e. whether the threshold is at the extremity of the runway or displaced from the runway extremity. In both cases, the approach lighting system should extend up to the threshold. However, in the case of a displaced threshold, inset lights are used from the runway extremity up to the threshold to obtain the specified configuration. These inset lights are designed to satisfy the structural requirements specified in Chapter 5, 5.3.1.9, and the photometric requirements specified in Appendix 2, **Figure A2-1 or A2-2.**

11.1.3 Flight path envelopes to be used in designing the lighting are shown in **Figure A-4**.

11.2 Installation tolerances

Horizontal

11.2.1 The dimensional tolerances are shown in **Figure A-6**.

11.2.2 The centre line of an approach lighting system should be as coincident as possible with the extended centre line of the runway with a maximum tolerance of ± 15'.

11.2.3 The longitudinal spacing of the centre line lights should be such that one light (or group of lights) is located in the centre of each crossbar, and the intervening centre line lights are spaced as evenly as practicable between two cross-bars or a crossbar and a threshold.

11.2.4 The crossbars and barrettes should be at right angles to the centre line of the approach lighting system with a tolerance of ±30', if the pattern in **Figure A-6 (A)** is adopted or ±2º, if **Figure A-6 (B)** is adopted.

11.2.5 When a crossbar has to be displaced from its standard position, any adjacent crossbar should, where possible, be displaced by appropriate amounts in order to reduce the differences in the crossbar spacing.

11.2.6 When a crossbar in the system shown in **Figure A-6 (A)** is displaced from its standard position, its over-all length should be adjusted so that it remains one-twentieth of the actual distance of the crossbar from the point of origin. It is not necessary, however, to adjust the standard 2.7 m spacing between the crossbar lights, but the crossbars should be kept symmetrical about the centre line of the approach lighting.

Vertical

11.2.7 The ideal arrangement is to mount all the approach lights in the horizontal plane passing through the threshold **(see Figure A-7)**, and this should be the general aim as far as local conditions permit. However, buildings, trees, etc., should not obscure the lights from the view of a pilot who is assumed to be 1º below the electronic glide path in the vicinity of the outer marker.

11.2.8 Within a stopway or clearway, and within 150 m of the end of a runway, the lights should be mounted as near to the ground as local conditions permit in order to minimize risk of damage to aeroplanes in the event of an overrun or undershoot. Beyond the stopway and clearway, it is not so necessary for the lights to be mounted close to the ground and therefore undulations in the ground contours can be compensated for by mounting the lights on poles of appropriate height.

11.2.9 It is desirable that the lights be mounted so that, as far as possible, no object within a distance of 60 m on each side of the centre line protrudes through the plane of the approach lighting system. Where a tall object exists within 60 m of the centre line and within 1 350 m from the threshold for a precision approach lighting system, or 900 m for a simple approach lighting system, it may be advisable to install the lights so that the plane of the outer half of the pattern clears the top of the object.

11.2.10 In order to avoid giving a misleading impression of the plane of the ground, the lights should not be mounted below a gradient of 1 in 66 downwards from the threshold to a point 300 m out, and below a gradient of 1 in 40 beyond the 300 m point. For a precision approach category II and III lighting system, more stringent criteria may be necessary, e.g. negative slopes not permitted within 450 m of the threshold.

11.2.11 Centre line. The gradients of the centre line in any section (including a stopway or clearway) should be as small as practicable, and the changes in gradients should be as few and small as can be arranged and should not exceed 1 in 60. Experience has shown that as one proceeds outwards from the runway, rising gradients in any section of up to 1 in 66, and falling gradients of down to 1 in 40, are acceptable.

11.2.12 Crossbars. The crossbar lights should be so arranged as to lie on a straight line passing through the associated centre line lights, and wherever possible this line should be horizontal. It is permissible, however, to mount the lights on a transverse gradient not more than 1 in 80, if this enables crossbar lights within a stopway or clearway to be mounted nearer to the ground on sites where there is a cross-fall.

11.3 Clearance of obstacles

11.3.1 An area, hereinafter referred to as the light plane, has been established for obstacle clearance purposes, and all lights of the system are in this plane. This plane is rectangular in shape and symmetrically located about the approach lighting system's centre line. It starts at the threshold and extends 60 m beyond the approach end of the system, and is 120 m wide.

11.3.2 No objects are permitted to exist within the boundaries of the light plane which are higher than the light plane except as designated herein. All roads and highways are considered as obstacles extending 4.8 m above the crown of the road, except aerodrome service roads where all vehicular traffic is under control of the aerodrome authorities and coordinated with the aerodrome traffic control tower. Railroads, regardless of the amount of traffic, are considered as obstacles extending 5.4 m above the top of the rails.

11.3.3 It is recognized that some components of electronic landing aids systems, such as reflectors, antennas, monitors, etc., must be installed above the light plane. Every effort should be made to relocate such components outside the boundaries of the light plane. In the case of reflectors and monitors, this can be done in many instances.

11.3.4 Where an ILS localizer is installed within the light plane boundaries, it is recognized that the localizer, or screen if used, must extend above the light plane. In such cases the **height of these structures should be held to a minimum and they should be located as far from the threshold as possible**. In general the rule regarding **permissible heights is 15 cm for each 30 m** the structure is located from the threshold. As an example, **if the localizer is located 300 m from the threshold**, the screen will be permitted to extend above the plane of the approach lighting system by 10 x 15 = 150 cm maximum, but preferably should be kept as low as possible consistent with proper operation of the ILS.

11.3.5 In locating an MLS azimuth antenna the guidance contained in Annex 10, Volume I, Attachment G should be followed. This material, which also provides guidance on collocating an MLS azimuth antenna with an ILS localizer antenna, suggests that the MLS azimuth antenna may be sited within the light plane boundaries where it is not possible or practical to locate it beyond the outer end of the approach lighting for the opposite direction of approach. If the MLS azimuth antenna is located on the extended centre line of the runway, it should be as far as possible from the closest light position to the MLS azimuth antenna in the direction of the runway end. Furthermore, the MLS azimuth antenna phase centre should be at least 0.3 m above the light centre of the light position closest to the MLS azimuth antenna in the direction of the runway end. (This could be relaxed to 0.15 m if the site is otherwise free of significant multipath problems.) Compliance with this requirement, which is intended to ensure that the MLS signal quality, is not affected by the approach lighting system, could result in the partial obstruction of the lighting system by the MLS azimuth antenna. To ensure that the resulting obstruction does not degrade visual guidance beyond an acceptable level, the MLS azimuth antenna should not be located closer to the runway end than 300 m and the preferred location is 25 m beyond the 300 m crossbar (this would place the antenna 5 m behind the light position 330 m from the runway end). Where an MLS azimuth antenna is so located, a central part of the 300 m crossbar of the approach lighting
system would alone be partially obstructed. Nevertheless, it is important to ensure that the unobstructed lights of the crossbar remain serviceable all the time.

11.3.6 Objects existing within the boundaries of the light plane, requiring the light plane to be raised in order to meet the criteria contained herein, should be removed, lowered or relocated where this can be accomplished more economically than raising the light plane.

11.3.7 In some instances objects may exist which cannot be removed, lowered or relocated economically. These objects may be located so close to the threshold that they can not be cleared by the 2 per cent slope. Where such conditions exist and no alternative is possible, the 2 per cent slope may be exceeded or a “stair step” resorted to in order to keep the approach lights above the objects such “step” or increase gradients should be resorted to only when it is impracticable to follow standard slope criteria, and they should be held to the absolute minimum. Under this criterion no negative slope is permitted in the outermost portion of the system.

11.4 Consideration of the effects of reduced lengths

11.4.1 The need for an adequate approach lighting system to support precision approaches where the pilot is required to acquire visual references prior to landing, cannot be stressed too strongly. The safety and regularity of such operations is dependent on this visual acquisition. The height above runway threshold at which the pilot decides there are sufficient visual cues to continue the precision approach and land will vary, depending on the type of approach being conducted and other factors such as meteorological conditions, ground and airborne equipment, etc. The required length of approach lighting system which will support all the variations of such approaches is 900 m, and this shall always be provided whenever possible.

11.4.2 However, there are some runway locations where it is impossible to provide the 900 m length of approach lighting system to support precision approaches.

11.4.3 In such cases, every effort should be made to provide as much approach lighting system as possible. The appropriate authority may impose restrictions on operations to runways equipped with reduced lengths of lighting. There are many factors, which determine at what height the pilot must have decided to continue the approach to land or execute a missed approach. It must be understood that the pilot does not make an instantaneous judgment upon reaching a specified height. The actual decision to continue the approach and landing sequence is an accumulative process, which is only concluded at the specified height. Unless lights are available prior to reaching the decision point, the visual assessment process is impaired and the likelihood of missed approaches will increase substantially. There are many operational considerations, which must be taken into account by the appropriate authorities in deciding if any restrictions are necessary to any precision approach and these are detailed in Annex-6.

12. Priority of installation of visual approach slope indicator systems

12.1 It has been found impracticable to develop guidance material that will permit a completely objective analysis to be made of which runway on an aerodrome should receive first priority for the installation of a visual approach slope indicator system. However, factors that must be considered when making such a decision are:

a) Frequency of use;
b) Seriousness of the hazard;
c) Presence of other visual and non-visual aids;
d) Type of aeroplanes using the runway; and
e) Frequency and type of adverse weather conditions under which the runway will be used.

12.2 With respect to the seriousness of the hazard, the order given in the application specifications for a visual approach slope indicator system**, 5.3.5.1 b) to e**) of Chapter 5 may be used as a general guide. These may be summarized as:

a) Inadequate visual guidance because of:

1) Approaches over water or featureless terrain, or absence of sufficient extraneous light in the approach area by night;
2) Deceptive surrounding terrain;

b) Serious hazard in approach;
c) Serious hazard if aeroplanes undershoot or overrun; and
d) Unusual turbulence.

12.3 The presence of other visual or non-visual aids is a very important factor. Runways equipped with ILS or MLS would generally receive the lowest priority for a visual approach slope indicator system installation. It must be remembered, though, that visual approach slope indicator systems are visual approach aids in their own right and can supplement electronic aids. When serious hazards exist and/or a substantial number of aeroplanes not equipped for ILS or MLS use a runway, priority might be given to installing a visual approach slope indicator on this runway.

12.4 Priority should be given to runways used by turbo- jet aeroplanes.

13 Lighting of unserviceable areas. (See Chapter 7, Para 7.4.2.1)

14. Rapid exit taxiway indicator lights

14.1 Rapid exit taxiway indicator lights (RETILs) comprise a set of yellow unidirectional lights installed in the runway adjacent to the center line. The lights are positioned in a 3-2-1 sequence at 100 m intervals prior to the point of tangency of the rapid exit taxiway center line. They are intended to give an indication to pilots of the location of the next available rapid exit taxiway.

14.2 In low visibility conditions, RETILs provide useful situational awareness cues while allowing the pilot to concentrate on keeping the aircraft on the runway center line.

14.3 Following a landing, runway occupancy time has a significant effect on achievable runway capacity. RETILs allow pilots to maintain a good roll-out speed until it is necessary to decelerate to an appropriate speed for the turn into a rapid exit turn-off. A roll-out speed of 60 knots until the first RETIL (three-light barrette) is reached is seen as the optimum.

15. Intensity control of approach and runway lights

15.1 The conspicuity of a light depends on the impression received of contrast between the light and its background. If a light is to be useful to a pilot by day when on approach, **it must have an intensity of at least 2 000 or 3 000 cd**, and in the case of approach lights an intensity of the order of 20 000 cd is desirable. In conditions of very bright daylight fog it may not be possible to provide lights of sufficient intensity to be effective. On the other hand, in clear weather on a dark night, intensity of the order of 100 cd for approach lights and 50 cd for the runway edge lights may be found suitable. Even then, owing to the closer range at which they are viewed, pilots have sometimes complained that the runway edge lights seemed unduly bright.

15.2 In fog the amount of light scattered is high. At night this scattered light increases the brightness of the fog over the approach area and runway to the extent that little increase in the visual range of the lights can be obtained by increasing their intensity beyond 2 000 or 3 000 cd. In an endeavour to increase the range at which lights would first be sighted at night, their intensity must not be raised to an extent that a pilot might find excessively dazzling at diminished range.

15.3 From the foregoing will be evident the importance of adjusting the intensity of the lights of an aerodrome lighting system according to the prevailing conditions, so as to obtain the best results without excessive dazzle that would disconcert the pilot. The appropriate intensity setting on any particular occasion will depend both on the conditions of background brightness and the visibility. Detailed guidance material on selecting intensity setting for different conditions is given in the Aerodrome Design Manual, Part 4.

16. Signal area

16.1 A signal area need be provided only when it is intended to use visual ground signals to communicate with aircraft in flight. Such signals may be needed when the aerodrome does not have an aerodrome control tower or an aerodrome flight information service unit, or when the aerodrome is used by aeroplanes not equipped with radio. Visual ground signals may also be useful in the case of failure of two-way radio communication with aircraft. It should be recognized, however, that the type of information which may be conveyed by visual ground signals should normally be available in AIPs or NOTAM. The potential need for visual ground signals should therefore be evaluated before deciding to provide a signal area.

17. Rescue and fire fighting services

17.1 Administration

17.1.1 The rescue and fire fighting service at an aerodrome should be under the administrative control of the aerodrome management, which should also be responsible for ensuring that the service provided is organized, equipped, staffed, trained and operated in such a manner as to fulfill its proper functions.

17.1.2 In drawing up the detailed plan for the conduct of search and rescue operations in accordance with 4.2.1 of Annex 12, the aerodrome management should co-ordinate its plans with the relevant rescue co-ordination centers to ensure that the respective limits of their responsibilities for an aircraft accident within the vicinity of an aerodrome are clearly delineated.

17.1.3 Co-ordination between the rescue and fire fighting service at an aerodrome and public protective agencies, such as local fire brigade, police force, coast guard and hospitals, should be achieved by prior agreement for assistance in dealing with an aircraft accident.

17.1.4 A grid map of the aerodrome and its immediate vicinity should be provided for the use of the aerodrome services concerned. Information concerning topography, access roads and location of water supplies should be indicated. This map shall be conspicuously posted in the control tower and fire station, and available on the rescue and fire fighting vehicles and such other supporting vehicles required to respond to an aircraft accident or incident. Copies should also be distributed to public protective agencies as desirable.

17.1.5 Co-ordinated instructions should be drawn up detailing the responsibilities of all concerned and the action to be taken in dealing with emergencies. The appropriate authority should ensure that such instructions are promulgated and observed.

17.2 Training

17.2.1 The training curriculum should include initial and recurrent instruction in at least the following areas:

a) Airport familiarization;

b) Aircraft familiarization;

c) Rescue and fire fighting personnel safety;

d) Emergency communications systems on the aerodrome, including aircraft fire related alarms;

e) Use of the fire hoses, nozzles, turrets and other appliances required for compliance with Chapter 9, 9.2;

f) Application of the types of extinguishing agents required for compliance with Chapter 9, 9.2;

g) Emergency aircraft evacuation assistance;

h) fire fighting operations;

i) Adaptation and use of structural rescue and fire fighting equipment for aircraft rescue and fire fighting;

j) Dangerous goods;

k) Familiarization with fire fighters' duties under the aerodrome emergency plan; and

l) Protective clothing and respiratory protection.

17.3 Level of protection to be provided

17.3.1 In accordance with Chapter 9, 9.2 aerodromes should be categorized for rescue and fire fighting purposes and the level of protection provided should be appropriate to the aerodrome category.

17.3.2 However, Chapter 9, 9.2.3 permits a lower level of protection to be provided for a limited period where the number of movements of the aeroplanes in the highest category normally using the aerodrome is less than 700 in the busiest consecutive three months. It is important to note that the concession included in 9.2.3 is applicable only where there is a wide range of difference between the dimensions of the aeroplanes included in reaching 700 movements.

17.4 Rescue equipment for difficult environments

17.4.1 Suitable rescue equipment and services should be available at an aerodrome where the area to be covered by the service includes water, swampy areas or other difficult environment that cannot be fully served by conventional wheeled vehicles. This is particularly important where a significant portion of approach/departure operations takes place over these areas.

17.4.2 The rescue equipment should be carried on boats or other vehicles such as helicopters and amphibious or air cushion vehicles, capable of operating in the area concerned. The vehicles should be so located that they can be brought into action quickly to respond to the areas covered by the service.

17.4.3 At an aerodrome bordering the water, the boats or other vehicles should preferably be located on the aerodrome, and convenient launching or docking sites provided. If these vehicles are located off the aerodrome, they should preferably be under the control of the aerodrome rescue and fire fighting service or, if this is not practicable, under the control of another competent public or private organization working in close co-ordination with the aerodrome rescue and fire fighting service (such as police, military services, harbour patrol or coast guard).

17.4.4 Boats or other vehicles should have as high a speed as practicable so as to reach an accident site in minimum time. To reduce the possibility of injury during rescue operations, water jet-driven boats are preferred to water propeller-driven boats unless the propellers of the latter boats are ducted. Should the water areas to be covered by the service be frozen for a significant period of the year, the equipment should be selected accordingly.
Vehicles used in this service should be equipped with life rafts and life preservers related to the requirements of the larger aircraft normally using the aerodrome, with two-way radio communication, and with floodlights for night operations. If aircraft operations during periods of low visibility are expected, it may be necessary to provide guidance for the responding emergency vehicles.

17.4.5 The personnel designated to operate the equipment should be adequately trained and drilled for rescue services in the appropriate environment.

17.5 Facilities

17.5.1 The provision of special telephone, two-way radio communication and general alarm systems for the rescue and fire fighting service is desirable to ensure the dependable transmission of essential emergency and routine information. Consistent with the individual requirements of each aerodrome, these facilities serve the following purposes:

a) Direct communication between the activating authority and the aerodrome fire station in order to ensure the prompt alerting and dispatch of rescue and fire fighting vehicles and personnel in the event of an aircraft accident or incident;

b) Emergency signals to ensure the immediate summoning of designated personnel not on standby duty;

c) As necessary, summoning essential related services on or off the aerodrome; and

d) Maintaining communication by means of two-way radio with the rescue and fire fighting vehicles in attendance at an aircraft accident or incident.

17.5.2 The availability of ambulance and medical facilities for the removal and after-care of casualties arising from an aircraft accident should receive the careful consideration of the appropriate authority and should form part of the over-all emergency plan established to deal with such emergencies.

18. Operators of vehicles

18.1 The authorities responsible for the operation of vehicles on the movement area should ensure that the operators are properly qualified. This may include, as appropriate to the driver's function, knowledge of:

a) The geography of the aerodrome;

b) Aerodrome signs, markings and lights;

c) Radiotelephone operating procedures;

d) Terms and phrases used in aerodrome control including the ICAO spelling alphabet;

e) Rules of air traffic services as they relate to ground operations;

f) Airport rules and procedures; and

g) Specialist functions as required, for example, in rescue and fire fighting.

18.2 The operator should be able to demonstrate competency, as appropriate, in:

a) The operation or use of vehicle transmit/receive equipment;

b) Understanding and complying with air traffic control and local procedures;

c) Vehicle navigation on the aerodrome; and

d) Special skills required for the particular function.

In addition, as required for any specialist function, the operator should be the holder of the State driver's licence, the State radio operator's licence or other licences.

18.3 The above should be applied as is appropriate to the function to be performed by the operator and it is not necessary that all operators be trained to the same level, for example, operators whose functions are restricted to the apron.

18.4 If special procedures apply for operations in low visibility conditions, it is desirable to verify an operator's knowledge of the procedures through periodic checks.

19. The ACN-PCN method of reporting pavement strength " Overload operations" (**See Chapter 2,Para 2.7)**

ATTACHMENT B. OBSTACLE LIMITATION SURFACES

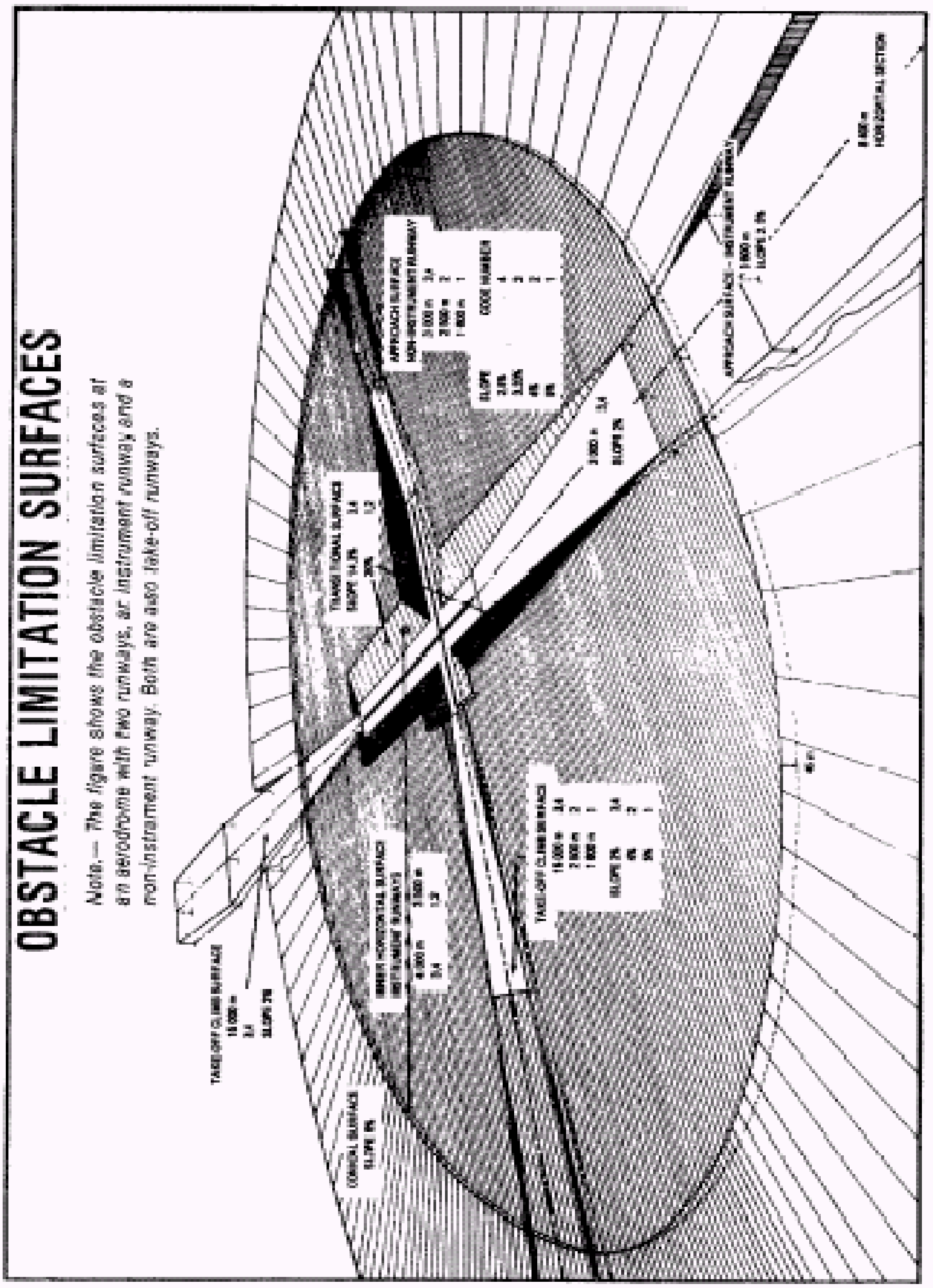

Figure B-1

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