DEPARTMENT OF THE AIR FORCE
HEADQUARTERS AIR FORCE CIVIL ENGINEER SUPPORT AGENCY

MAR 29 2004

FROM: AFCESA/CES
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SUBJECT: **Engineering Technical Letter (ETL) 04-7: C-130 and C-17 Landing Zone (LZ) Dimensional, Marking, and Lighting Criteria**

1. Purpose. This ETL provides dimensional, marking, and lighting criteria and guidance for planning, design, construction, and evaluation of landing zones used for aircrew training and contingency operations of C-130 and C-17 aircraft. These standards do not provide sufficient clearances for instrument approach and departure procedures below circling weather minimums.

This ETL supersedes ETL 98-5, *C-130 and C-17 Contingency and Training Airfield Dimensional Criteria*, 15 October 1998.

This ETL also supersedes dimensional criteria in Army Field Manual (FM) 5-430-00-02/Air Force Joint Pamphlet (AFJPAM) 32-8013, Volume 2, *Planning and Design of Roads, Airfields, and Heliports in the Theater of Operations -- Airfield and Heliport Design*, Chapter 11, "Airfield Design."

Note: The use of the name or mark of any specific manufacturer, commercial product, commodity, or service in this ETL does not imply endorsement by the Air Force.

2. Application: All Department of Defense (DOD) organizations responsible for planning, design, construction, and evaluation of LZs on property owned or controlled by the Air Force.

2.1. Authority: Air Force Policy Directive (AFPD) 32-10, *Installations and Facilities*.

2.2. Effective Date: Immediately.

2.3. Intended Users: Air Force, Army, Marine Corps, and Navy design and or construction agents responsible for planning, design, maintenance, construction, and evaluation of LZs on property owned or controlled by the Air Force.

3. Coordination:

- Air Mobility Command, vice commander (HQ AMC/CV)
- Air Force Safety Center, Aviation Safety Division (HQ AFSC/SEF)
- Air Force Flight Standards Agency, Airfield Management Division and Instrument Standards Division (HQ AFFSA/XAM/XOI)

- Air Force Chief of Safety, Issues Division (HQ USAF/SEI)
- Air Force Director of Operations and Training (HQ USAF/XOO)
- Air Force Civil Engineer (HQ USAF/ILE)

4. References:

4.1. Air Force.

- AFPD 32-10, *Installations and Facilities*, available at http://www.e-publishing.af.mil/
- Air Force Handbook (AFH) 32-7084, *AICUZ Program Manager's Guide*, available at http://www.e-publishing.af.mil/
- Air Force Instruction (AFI) 13-217, *Drop Zone and Landing Zone Operations*, available at http://www.e-publishing.af.mil/
- ETL 04-1, *Criteria and Guidance for C-17 Contingency and Training Operations on Semi-Prepared Airfields*, available at http://www.afcesa.af.mil/library/index.asp
- ETL 04-2, *Standard Airfield Pavement Marking Schemes*, available at http://www.afcesa.af.mil/library/index.asp

4.2. Joint Service.

- FM 5-430-00-02/AFJPAM 32-8013V2, *Planning and Design of Roads, Airfields, and Heliports in the Theater of Operations – Airfield and Heliport Design*, available at http://www.adtdl.army.mil/cgi-bin/atdl.dll/fm/5-430-00-2/toc.htm
- UFC 3-260-01, *Design: Airfield and Heliport Planning and Design*, available at http://65.204.17.188//report/doc_ufc.htm
- UFC 3-260-02, *Design: Pavement Design for Airfields*, available at http://65.204.17.188//report/doc_ufc.htm
- (Draft) UFC 3-535-01, *Design Standards for Visual Air Navigation Facilities*, available at http://www.lantdiv.navfac.navy.mil/pls/lantdiv/docs/FOLDER/EICO/DRAFTREVIEW/UFC_3-535-01.PDF
- (Draft) UFC 3-535-02, *Design Drawings for Visual Air Navigation Facilities*, available at http://www.lantdiv.navfac.navy.mil/pls/lantdiv/docs/FOLDER/EICO/DRAFTREVIEW/UFC+3-535-02.PDF

4.3. Federal Aviation Administration (FAA).

- FAA Advisory Circular 150/5345-44F, *Specification for Taxiway and Runway Signs*, available at http://www1.faa.gov/arp/150acs.cfm
- FAA Order 7400.2, *Procedures for Handling Airspace Matters*, available at http://www2.faa.gov/ATPubs/AIR/Index.htm

5. Definitions.

5.1. *Accident Potential Zone–Landing Zone (APZ-LZ):* A land use control area beyond the clear zone of an LZ that possesses a significant potential for accidents; therefore, land use is a concern. See Attachment 1, Figures 2 and 5.

5.2. *Airfield:* An area (including any buildings, installations, and equipment) prepared for accommodating the landing and takeoff of aircraft.

5.3. *Airspace:* The space above ground or water areas which is or is not controlled, assigned, and/or designated.

5.4. *Approach–Departure Clearance Surface:* An imaginary surface that is an inclined plane or combined inclined and horizontal planes arranged symmetrically about the extended runway centerline. Objects that penetrate this surface are considered obstructions to air navigation and should be removed, if possible; if not removed, they must be mapped, marked, and lighted as obstructions. The first segment or the beginning of the inclined plane is coincident with the ends and edges of the primary surface and the elevation of the centerline at the runway end. This surface flares outward and upward from these points. See Attachment 1, Figures 1 and 5.

5.5. *Apron:* A defined area on an LZ intended to accommodate aircraft for loading or unloading passengers or cargo, refueling, parking or maintenance. LZ aprons are sized to accommodate the mission. The runway clearance, as well as the longitudinal and transverse grades for aprons, is provided in Attachment 2, Table 4. Also see Attachment 1, Figures 2, 3, 4, and 6.

5.6. *Clear Zone-LZ:* A surface on the ground or water, beginning at the runway threshold and symmetrical about the extended runway centerline, graded to protect aircraft operations and in which only properly sited navigational aids are allowed. See Attachment 1, Figures 1, 2, and 5.

5.7. *Contingency Operations:* Typically, short-term operations conducted in support of conflicts or emergencies.

5.8. *Exclusion Area:* Exclusion areas are required for all paved and semi-prepared (unpaved) LZs. The purpose of the exclusion area is to restrict the development of facilities around the LZ. Only features required to operate the LZ are permissible in the exclusion area, such as operational surfaces (e.g., taxiways, aprons), navigational aids, aircraft and support equipment, and cargo loading and unloading areas and equipment. In addition, only properly sited facilities are allowed within this area (see Unified Facilities Criteria [UFC] 3-260-01, *Airfield and Heliport Planning and Design*, Attachment 14). The exclusion area extends the length of the runway, plus the clear zone on each end. See Attachment 1, Figures 1, 2, and 5, and Attachment 2, Table 8.

5.9. *Grade (or Gradient):* A slope expressed as a percentage. All grades may be positive or negative unless otherwise specifically noted.

5.10. *Graded Area:* An area beyond the runway shoulder where grades are controlled to prevent damage to aircraft that may depart the runway surface (see Attachment 1, Figure 6, and Attachment 2, Table 2). Culverts, headwalls, and elevated drainage structures are not allowed. Properly sited frangible navigational aids are allowed.

5.11. *Imaginary Surfaces-LZ:* Surfaces in space established around an LZ in relation to runways, helipads, or helicopter runways, and designed to define the protected airspace around the airfield. The imaginary surfaces for LZs are the primary surface and approach–departure clearance surface. See Attachment 1, Figures 1, 2, and 5, and Attachment 2, Table 7.

5.12. *Infield Area:* The area between runways and between runways and taxiways that is graded or cleared for operational safety. All obstructions must be removed from the infield area.

5.13. *Landing Zone (LZ):* A landing zone consists of a runway, a runway and taxiway, or other aircraft operational surfaces (e.g., aprons, turnarounds). It is a prepared or semi-prepared (unpaved) airfield used to conduct operations in an airfield environment similar to forward operating locations. LZ runways are typically shorter and narrower than standard runways. Because training airfields are constructed for long-term operations, semi-prepared surface structural requirements are more stringent than for contingency airfields.

5.14. *Maintained Area:* A land area, extending outward at right angles to the runway centerline and the extended runway centerline, that is outside the graded area but still within the exclusion area. This area must be free of obstructions. The maintained area is 21.5 meters (70 feet) wide for C-17 operations or 18.5 meters (60 feet) wide for C-130 operations. The grade may slope up or down to provide drainage, but may not exceed +10% nor -20% slope. See Attachment 1, Figure 6, and Attachment 2, Table 2.

5.15. *Non-Instrument Runway:* A runway intended for operating aircraft under visual flight rules (VFR).

5.16. *Obstacle:* An existing object, natural growth, or terrain, at a fixed geographical location, or which may be expected at a fixed location within a prescribed area, with reference to which vertical clearance is or must be provided during flight operations. Obstacles are not allowed if they violate grading criteria. See Attachment 2, Tables 2, 3, and 4.

5.17. *Obstruction:* A natural or man-made object that violates airfield or heliport clearances, or projects into imaginary airspace surfaces.

5.18. *Overrun:* An area the width of the runway, plus prepared shoulders, extending 91.5 meters (300 feet) from the end of the runway into the clear zone. This portion is a prolongation of the runway and is constructed to support aircraft traffic. See Attachment 1, Figure 2, and Attachment 2, Table 5.

5.19. *Parking Maximum on Ground (MOG):* The highest number of aircraft which will be allowed on the ground at any given time, based upon airfield configuration limitations and safety considerations.

5.20. *Paved Landing Zone (LZ):* A prepared and surfaced LZ designed to carry aircraft traffic, whose principal components include one of the following:

- A flexible or non-rigid pavement, or one that includes a bituminous concrete surface course designed as a structural member with weather- and abrasion-resistant properties.
- A rigid pavement, or one that contains Portland cement concrete (PCC) as an element.
- A combination of flexible and rigid pavement layers, such as an overlay, where a flexible pavement is placed over an existing rigid pavement layer to strengthen the rigid pavement layer.

Paved LZs were formerly called shortfields and later known as prepared assault landing zones (ALZ).

5.21. *Pavement (Paved Surface):* A durable weather- and abrasion-resistant surface made from a prepared or manufactured material placed on an established base. General categories of pavements are “flexible” and “rigid.”

5.22. *Primary Surface-LZ:* An imaginary surface symmetrically centered on 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 or extended runway centerline. See Attachment 1, Figures 1, 2, and 5.

5.23. *Runway:* A defined rectangular area of an airfield or heliport prepared for the landing and takeoff run of aircraft along its length.

5.24. *Runway End:* As used in this ETL, the runway end is where the normal threshold is located. When the runway has a displaced threshold, the using service will evaluate each individual situation, and, based on this evaluation, will determine the point of beginning for runway and airspace imaginary surfaces. See Attachment 1, Figure 1.

5.25. *Runway Threshold:* A line perpendicular to the runway centerline designating the beginning of that portion of a runway usable for landing. See Attachment 1, Figure 10.

5.26. *Semi-Prepared Landing Zone (LZ):* A semi-prepared LZ (formerly called a semi-prepared assault landing zone [ALZ]) refers to an unpaved LZ. The amount of engineering effort required to develop a semi-prepared LZ depends on the planned operation, the service life needed to support these operations, and the existing soil and

weather conditions. Semi-prepared construction/maintenance preparations may range from those sufficient for limited use to those required for continuous routine operations. Options for surface preparation may include stabilization, adding an aggregate course, compacting in-place soils, or matting.

5.27. *Shoulder:* A prepared (paved) or semi-prepared (unpaved) area adjacent to the edge of operational surfaces (runways, taxiways, aprons, overruns, and turnarounds). See Attachment 1, Figures 1, 2, 3, 4, and 6, and Attachment 2, Tables 2, 3, 4, and 5.

5.28. *Slope Ratio:* A slope expressed in meters (feet) as a ratio of the horizontal to the vertical distance. For example, 50:1 means 50 meters (feet) horizontal to 1 meter (foot) vertical.

5.29. *Taxiway:* A specially prepared or designated path on an airfield or heliport, other than apron areas, on which aircraft move under their own power to and from landing, service, and parking areas. Criteria for taxiways are shown in Attachment 2, Table 3, and illustrated in Attachment 1, Figure 6.

5.30. *Taxiway, Parallel:* A taxiway that parallels the runway. The curved connections to the end of the runway or overrun that permit aircraft ground movement to and from the runway and are considered part of the parallel taxiway when there are no other taxiway exits on the runway. See Attachment 1, Figure 2.

5.31. *Turnaround (or Hammerhead):* An operational surface with dimensions to allow an aircraft to execute 180-degree turns without using reverse operations. Turnarounds can provide loading/off-loading capability on LZs with a parking MOG of one. See Attachment 1, Figures 3 and 11.

5.32. *Visual Landing Zone Marker Panels (VLZMP):* Vertical, colored panels installed along runway edges to indicate the threshold location and distance remaining. See Attachment 1, Figures 7, 8, and 12.

5.33. *Visual Flight Rules (VFR):* Rules that govern the procedures for conducting flights under visual conditions. Also see *Visual Meteorological Conditions (VMC)*.

5.34. *Visual Meteorological Conditions (VMC):* Weather conditions in which visual flight rules (VFR) apply, expressed in terms of visibility, ceiling height, and aircraft clearance from clouds along the path of flight. When criteria for VMC conditions cannot be met, instrument meteorological conditions prevail and instrument flight rules must be followed. Also see *Visual Flight Rules (VFR)*.

6. Acronyms.

AC - asphalt concrete
AFPD - Air Force Policy Directive
AFJPAM - Air Force Joint Pamphlet

ALZ - assault landing zone
AMP - Airfield Marking Pattern
APZ-LZ - accident potential zone–landing zone
CANLS - contingency airfield night lighting system
DO - Director of Operations
DOD - Department of Defense
EALS - emergency airfield lighting system
ETL - Engineering Technical Letter
FAA - Federal Aviation Administration
FM - Field Manual (U.S. Army)
ICAO - International Civil Aviation Organization
IFR - instrument flight rules
IMC - instrument meteorological conditions
LZ - landing zone
MAJCOM - major command
MOG - maximum on ground
NSN - National Stock Number
NVG - night vision goggles
OPR - office of primary responsibility
PCC - Portland cement concrete
PT - point of tangency
RCR - runway condition rating
RMP - resin modified pavement
STT - Special Tactics Team
VFR - visual flight rules
VLZMP - visual landing zone marking panels
VMC - visual meteorological conditions

7. Site Planning for Landing Zones (LZ).

7.1 General. When planning the layout of an LZ that will be used for extended operations (generally defined as more than one year), site conditions beyond safety of the aircraft-related operations must be considered. These include land use compatibility with clear zones, primary surfaces, exclusion areas, and approach/departure surfaces, and with existing and future use of the areas that surround the LZ. In planning an LZ, consider the use and zoning of surrounding land for compatibility with aircraft operations. The purpose is to protect the operational capability of the LZ and prevent incompatible development, thus minimizing health and safety concerns in areas subject to high noise and accident potential resulting from frequent aircraft overflights. The minimum criteria in this ETL establish standards for a safe environment for aircraft and ground operations. Attachment 2, Table 8, Item 3, “Exclusion Area,” states: “For long-term-use LZs, restricting use of available land beyond the minimum distances contained in this ETL is highly recommended.” This will protect Air Force operational capability and enhance the potential for future mission expansion. Land use and zoning restrictions for training LZs must also comply with AFH 32-7084, *AICUZ Program Manager’s*

Handbook. The goal is to provide a landing zone environment that provides the greatest margin of safety and compatibility for personnel, equipment, and facilities.

7.1.1. Future Development (Land or Aircraft Technology). Adequate land for future aviation growth must be considered when planning an LZ. The LZ should be compatible with the existing installation plan. Potential instrument meteorological conditions/instrument flight rules (IMC/IFR) capability will require additional criteria considerations.

7.1.2. Prohibited Land Uses. LZ criteria prohibit certain land uses within the exclusion area, clear zone, and APZ. These restrictions are described in Attachment 2, Tables 6 and 8.

7.1.3. APZs not on DOD Property. APZs that are not on DOD property may require easements to control development and removal of vegetation that may violate the approach/departure clearance surface. The need must be determined on a case-by-case basis.

7.2. Siting Considerations. Site considerations include topography, vegetative cover, existing construction, weather elements, wind direction, soil conditions, flood hazard, natural and man-made obstructions, adjacent land use, availability of usable airspace, accessibility of roads and utilities, and potential for expansion capability. The potential for encroachment and effects of noise on the local community must also be considered.

7.2.1. For training LZs, it is preferred to site the runway within an airfield environment to take advantage of existing runway and taxiway clearance areas. To maximize the training environment, avoid aligning LZ runways parallel to existing runways.

7.2.2. Siting of LZs must take into account noise levels on existing facilities.

7.2.3. When a new LZ is sited, in addition to local permitting requirements, file Federal Aviation Administration (FAA) Form 7480-1, *Notice of Landing Area Proposal*, in accordance with FAA Order 7400.2, *Procedures for Handling Airspace Matters*.

7.2.4. Also consider the effects of ambient lighting for operations with night vision goggles (NVG).

7.3. Siting Training LZs within Built-Up Areas. When siting a training LZ runway within an existing built-up and occupied area, use a 304.8-meter-wide (1000-foot-wide) exclusion area rather than the 213.5-meter (700-foot) exclusion area for LZs in unoccupied areas. The 304.8-meter-wide (1000-foot-wide) exclusion zone runs from clear zone end to clear zone end, centered on the runway centerline. In addition, the APZ-LZ is widened to 304.8 meters (1000 feet) in width.

7.3.1. For siting future LZs, built-up and occupied locations are where occupied buildings/facilities exist around the potential LZ site and are not related to the LZ mission.

7.3.2. Unoccupied locations are where no buildings/facilities exist around the proposed LZ except those that are LZ mission-related.

7.3.3. The same rules apply for siting future facilities near existing LZs: If the facility and occupants are not related to the LZ mission, then the wider exclusion zone and APZ-LZ apply.

8. Dimensional Criteria.

8.1. Runway and Overrun Descriptions. Attachment 2, Tables 1, 2, and 5, provide dimensional criteria for layout and design of landing zone runways and overruns.

8.1.1. Length. Attachment 2, Table 2, provides runway lengths for C-130 LZs, and Attachment 2, Table 1, provides runway lengths for C-17 LZs. For a C-17 LZ located between sea level and 915 meters (3000 feet) pressure altitude, the minimum length requirement for C-17 operations is 1067 meters (3500 feet) with 91.5-meter (300-foot) overruns on each end. This length requirement, based upon a runway condition rating (RCR) of 20, assumes an ambient temperature of 32.2 degrees C (90 degrees F), and a landing gross weight of 202,756 kilograms (447,000 pounds). Based upon these same temperature and weight assumptions, the runway length will vary with different RCRs. Typically, paved surfaces will have RCRs of 23 dry, 12 wet, and 5 icy. Mat surfaces will have RCRs of 23 dry and 10 wet. A semi-prepared runway with stabilized soil surfaces will have RCRs of 20 dry and 10 wet. Unstabilized soil surfaces will have RCRs of 20 dry and 4 wet.

8.1.2. Width. Attachment 2, Table 2, provides the minimum width for LZ runways. The widths of these landing surfaces provide the minimum-width operating surface for the given aircraft.

8.1.3. Gradients of Operational Surfaces. Gradient constraints are based upon reverse aircraft operations conducted on hard surfaces. See Attachment 2, Tables 2, 3, 4, and 5.

8.1.4. Shoulders. Shoulders are graded and cleared of obstacles and slope downward away from the runway, where practical, to facilitate drainage. See Attachment 2, Tables 2, 3, 4, and 5.

8.1.5. Turnarounds. For C-17 LZs without parallel taxiways, turnarounds must be provided at both ends of the runway. In other cases, turnarounds may be located on overruns or taxiways, depending upon mission or terrain requirements. The shoulder, structural, gradient, and clearance requirements for a turnaround are the same as those for the overrun or taxiway area where the turnaround is constructed. Turnarounds for

C-130 aircraft should be at least 23 meters (75 feet) in diameter. Turnarounds for C-17 aircraft should be 55 meters (180 feet) long and 50.5 meters (165 feet) wide (including the overrun/taxiway width), with 45-degree fillets. The aircraft landing gear must be positioned within 3 meters (10 feet) of the runway edge prior to initiating this turn.

8.2. Clear Zones, Imaginary Surfaces, and APZ-LZs. Applicable clearances and grade controls must be established to provide a reasonable level of safety for Air Force LZs. Minimum requirements for clear zones, imaginary surfaces, and APZ-LZs and exclusion areas are provided in Attachment 2, Tables 6, 7, and 8, respectively. These areas and imaginary surfaces are shown in Attachment 1, Figures 1, 2, 5, and 6.

8.3. Operational Waivers to Criteria. The criteria in this ETL are the minimum permissible for C-17 and C-130 operations. When deviations exist or occur at a specific location, an operational waiver must be obtained before beginning flying operations. The office of primary responsibility (OPR) for the mission or exercise will initiate the waiver request. The appropriate airfield survey team will verify existing LZ dimensions and grades. The major command director of operations (MAJCOM/DO) is the approval authority for waivers of any criteria in this ETL.

8.4. Separation Distances Between Permanent Runways/Helipads and LZ Runways for Simultaneous Operations. When simultaneous operations are desired on a permanent runway or helipad and an LZ runway, minimum separation distances are required as stipulated in Attachment 2, Table 9.

8.5. Separation Between Permanent Class A or Class B Runways and LZ Runways for Non-Simultaneous Operations. At a minimum, LZ runways should be separated from permanent runways so as not to conflict with distance-remaining signs, runway edge lights, navigational aids (including glideslope signals), and other facilities associated with the runway.

9. Surface Types. Semi-prepared (unpaved) LZ surfaces may be composed of stabilized soils, aggregate surfaces, compacted native soils, or matting. Specific design guidance for semi-prepared surfaces can be found in ETL 04-1, *Criteria and Guidance for C-17 Contingency and Training Operations on Semi-Prepared Airfields*. Paved LZs may be surfaced with asphalt concrete (AC) or Portland cement concrete (PCC) pavement. On runways, taxiways, turnarounds, and aprons used by C-17 aircraft, asphalt pavement distress has been observed in areas where 90- to 180-degree turns are made; for this reason, PCC is preferred in areas where turning movements occur. Designers should consider durability and maintenance of the pavement, as well as economics, when selecting a surface type for an area associated with an LZ intended for long-term use. AC and PCC pavement structures shall be designed to support the traffic level defined in UFC 3-260-02, *Design: Pavement Design for Airfields*.

9.1. Runways and Overruns.

9.1.1. Semi-prepared Runway and Overrun Surfaces. Unpaved LZ runway and overrun surfaces shall be designed to support the anticipated aircraft type, weight, and number of planned operations. Overruns will be designed to the same standard as the runway.

9.1.2. Paved Runway and Overrun Surfaces. Paved runways and overruns may be surfaced with AC or PCC pavement. Sawcut grooving may be used to improve drainage characteristics on runways. Overruns will be designed to the same standard as the runway. Special design consideration is needed if the overrun is used as a taxiway or turnaround area.

9.1.3. Runway and Overrun Shoulders. For semi-prepared runways, the shoulder structure will be designed to the same standard as the runway. For paved runways, shoulders may be surfaced with AC or PCC pavement.

9.2. Turnarounds.

9.2.1. Semi-Prepared Turnarounds. Unpaved turnarounds will be designed to support the anticipated aircraft type, weight, and number of operations. Designers should give special consideration to stabilization for turnarounds used by C-17 aircraft because the surface can be easily damaged by the turning action of the main landing gear.

9.2.2. Paved Turnarounds. Paved turnarounds may be surfaced with AC, PCC, or resin modified pavement (RMP). Special consideration should be given to surface durability for turnarounds used by C-17 aircraft; for this reason, PCC pavement is preferred.

9.3. Taxiways.

9.3.1. Semi-Prepared Taxiways. Unpaved taxiways will be designed to support the anticipated aircraft type, weight, and number of operations. Designers should give special consideration to stabilization at taxiway turns used by C-17 aircraft because the surface can be easily damaged by the turning action of the main landing gear.

9.3.2. Paved Taxiways. Paved taxiways may be surfaced with AC, PCC, or RMP. Special consideration should be given to surface durability for taxiways used by C-17 aircraft; for this reason, PCC pavement is preferred.

9.4. Aprons.

9.4.1. Semi-Prepared Aprons. Unpaved aprons will be designed to support the anticipated aircraft type, weight, and number of operations. Designers should give special consideration to stabilization on aprons used by C-17 aircraft because the surface can be easily damaged by the turning action of the main landing gear.

9.4.2. Paved Aprons. Paved aprons may be surfaced with AC, PCC, or RMP. Special consideration should be given to surface durability and fuel resistance for aprons used by C-17 aircraft; for this reason, PCC pavement is preferred.

10. Visual Landing Zone Marker Panels (VLZMP). Various systems are used during daytime operations to provide visual cues to pilots about the location and dimensions of the LZ runway. The type of marker panels selected depends on the mission requirements and anticipated duration of LZ use. Paragraphs 10.1 and 10.2 discuss requirements for temporary and long-term applications, respectively.

10.1. Minimum Marking Requirements for Temporary Applications.

10.1.1. LZ runways intended for short-term or temporary use should be marked with one of the four arrangements of Airfield Marking Patterns (AMP) defined in Air Force Instruction (AFI) 13-217, *Drop Zone and Landing Zone Operations*. These four patterns are designated AMP-1 through AMP-4. The Special Tactics Team (STT) will decide which arrangement of panels will be installed. AMP-1 layout is illustrated in Attachment 1, Figure 8. Refer to AFI 13-217 for other layouts.

10.1.2. Materials and Size. Temporary panels may be constructed of fabric, wood, or other materials determined to be suitable by the STT. Panel faces will be at least 1676 millimeters (66 inches) wide and 432 millimeters (17 inches) tall.

10.1.3. Orientation and Color. Marker panels should be erected upright and facing toward the aircraft approach to increase visibility to the pilot. The panels should be orange (Fluorescent Orange, Army Shade 230), cerise (Fluorescent Red, Army Shade 229), or other color acceptable to the STT. The specific color used and layout must be briefed to all participating units before operations commence.

10.1.4. Frangibility. For temporary applications, frangible marker panels and supports are preferred to avoid excessive damage if struck by an aircraft. If available, VS-17 marker panels (National Stock Number [NSN] 8345-00-174-6865, Part Number MIL-P-400-61) should be used to mark temporary LZs for daytime operations.

10.2. Marking Requirements for Long-Term Applications.

10.2.1. LZs intended for long-term use should have permanently installed panels of the type described below. Panel locations are derived from the AMP-1 layout in AFI 13-217, Figure 3.1. Panels shall be placed at each threshold and 153 meters (500 feet) from each threshold. Intermediate markers shall be at 153 meters minimum/305 meters maximum (500 feet minimum/1000 feet maximum) spacing throughout the length of the runway, as illustrated in Attachment 1, Figure 8. Spacing should be consistent through the intermediate panels. If a conflict with the panels exists on one or both sides of the LZ (e.g., at locations where a taxiway connects to the LZ), that panel should be omitted. For bi-directional operations, panels of the appropriate color should be attached to each side of the support posts. The inside edge of the panels should be a minimum of 3 meters (10 feet) from the edge of the LZ surface to reduce jet blast damage. Panels should be 1.8 meters (6 feet) apart at locations where panels are placed in pairs.

AMP-1 layout is illustrated in Attachment 1, Figure 8. Refer to AFI 13-217 for other layouts as directed by AMC/DO.

10.2.2. Materials and Size. Panel surfaces may be constructed of any lightweight yet durable material suitable for the environment. Panel surfaces will be at least 1676 millimeters (66 inches) wide and 432 millimeters (17 inches) tall.

10.2.3. Orientation and Color. Marker panels should be erected upright and facing toward the aircraft approach to increase visibility to the pilot. The panels should be covered with reflective sheeting material or painted orange (Fluorescent Orange, Army Shade 230), or cerise (Fluorescent Red, Army Shade 229), the colors indicated in Attachment 1, Figure 8. Reflective sheeting shall be 3M™ diamond grade or equivalent. Panels must be designed to withstand jet blast effects. A panel design that has been used successfully is illustrated in Attachment 1, Figure 7.

10.2.4. Foundations. A reinforced concrete foundation pad should be used to support and anchor the panel support posts. Sample details for a foundation are shown in Attachment 1, Figure 7.

10.2.5. Support Posts. Support posts are needed to hold the panels upright. Posts must be strong enough to withstand jet blast and also frangible to break away upon impact. Posts shall meet the frangibility definitions, acceptance criteria, analysis and testing requirements defined in FAA Advisory Circular AC 150/5345-44F, *Specification for Taxiway and Runway Signs*. The support shall have frangible points located 51 millimeters (2 inches) or less above the concrete pad. The frangible points shall withstand wind loads due to jet blasts of 322 kilometers per hour (200 miles per hour) but will break or give way before reaching an applied static load over the surface of the sign of 8.9 kilopascals (1.3 pounds per square inch). Two examples of post materials are described below.

10.2.5.1. Galvanized steel support posts shall include a breakaway hinge point or frangible coupling 13 millimeters (0.5 inch) above the foundation pad to make the entire panel frangible. Each frangible coupling shall be permanently marked with the manufacturer name and size of the sign for which the coupling is intended.

10.2.5.2. Polycarbonate support posts shall be resistant to impact and dimensionally stable from -34 degrees C (-30 degrees F) to 66 degrees C (150 degrees F). The top section of the post shall be orange and connected to the ground anchor with a polyurethane hinge. The hinge shall be self-recovering, have an internal memory and remain dimensionally stable from -34 degrees C (-30 degrees F) to 66 degrees C (150 degrees F). The bottom of the hinge shall be positioned 51 millimeters (2 inches) or less above the concrete foundation pad. Additional details are in Attachment 1, Figure 7.

11. LZ Lighting. Airfield lighting systems are used during nighttime operations to provide visual cues to pilots about the location and dimensions of the LZ runway. The type of lighting system installed may vary between the minimum requirements for

temporary applications and the long-term use system. Equipment selection will depend on the available equipment and mission requirements. Lights are not required if night operations are not anticipated. Lighting that is planned to be permanent should be compatible with NVG (see paragraph 11.2.1).

11.1. Minimum Lighting Requirements for Temporary Applications.

11.1.1. Lights. If available, lights should be omni-directional with a minimum output rating of 15 candela for night operations. In accordance with AFI 13-217, virtually any type of lighting system is acceptable if all participating units are briefed and concur with its use. Contingency lighting kits (emergency airfield lighting system [EALS], contingency airfield night lighting system [CANLS]) or other materials may be used as available and determined to be suitable by the STT.

11.1.2. Location. There are four types of airfield lighting patterns for LZs, designated AMP-1 through AMP-4, as defined in AFI 13-217. The STT will decide which arrangement of lights will be installed. The AMP-1 layout is illustrated in Attachment 1, Figure 9. Refer to AFI 13-217 for other layouts.

11.2. Lighting Requirements for Permanent Applications. When intended for long-term use, use permanently installed lights of the type and in the locations described below.

11.2.1. Light Fixtures. High-intensity light fixtures should be used for permanent lighting installations. Runway and taxiway edge lights should be elevated FAA Type L-861. If needed, in-pavement lights should be FAA Type L-850C (Runway, Bi-directional) or L-852C (Taxiway, Omni-directional), or an International Civil Aviation Organization (ICAO) equivalent. LZ light lens colors shall be as indicated in Attachment 1, Figure 9. Taxiway and turnaround lenses shall be blue. If the LZ runway is used for bi-directional operations, lights at the thresholds should have green/red split lenses. Five-step regulators should be installed for light intensity control that is compatible with NVG operations (steps 1 through 3 are compatible with NVG operations).

11.2.2. Elevated Light Bases. Elevated light fixtures shall be attached to full depth light bases (L-867, Class I). Light bases shall be set in concrete blocks that are a minimum of 610 millimeters (24 inches) square (or round) and 610 millimeters (24 inches) deep with a 152-millimeter (6-inch) concrete or compacted aggregate base. See (draft) UFC 3-535-02, *Design Drawings for Visual Air Navigation Facilities*, for standard details on light fixtures and bases. Light bases should be installed flush with the surrounding grade or pavement. The difference between the light base and the surrounding pavement or grade is a maximum of 76 millimeters (3 inches).

11.2.3. In-pavement Light Bases. Where needed, in-pavement light fixtures shall be attached to full depth load-bearing light bases (L-868, Class I). Light bases should be set in concrete blocks that are a minimum of 610 millimeters (24 inches) square (or round) and 610 millimeters (24 inches) deep with a 152-millimeter (6-inch) concrete or compacted aggregate base or set in some other manner to prevent movement. Light

fixtures must be level and the top of the fixture edge must be flush with the pavement top or 1.6 millimeters (0.0625 inch) or less below the pavement top. See (draft) UFC 3-535-02 for standard details on light fixtures and bases.

11.3. Light Locations.

11.3.1. LZ Lights. Light locations and colors are derived from the AMP-1 configuration in AFI 13-217, Figure 3.2. Lights shall be placed at each threshold and at 152 meters from each threshold. Intermediate lights shall be 152 meters minimum/305 meters maximum (500 feet minimum/1000 feet maximum) spacing throughout the length of the runway, as illustrated in Attachment 1, Figure 9. Spacing should be consistent through the intermediate lights. If a conflict with the lights exists on one or both sides of the LZ (e.g., at locations where a taxiway connects to the LZ), that light should be an in-pavement light. Light fixtures shall be installed a maximum of 2.4 meters (8 feet) from the edge of the LZ surface (i.e., within the shoulder pavement). Where lights are installed in pairs, lights should be 1.8 meters (6 feet) apart.

11.3.2. Turnaround, Taxiway, and Apron Edge Lights. All lights shall be installed a maximum of 2.4 meters (8 feet) from the edge of the load-bearing surface. On straight sections of taxiway or turnaround, lights shall be spaced evenly with a maximum of 152 meters (500 feet) and a minimum of 23 meters (75 feet) between lights. See Attachment 1, Figures 11 and 12, for typical turnaround and taxiway edge light locations. Light spacing shall be reduced to between 7.6 meters and 10.6 meters (25 feet and 35 feet) on curves and at corners or intersections. On curved sections, lights shall be evenly spaced from point of tangency (PT) to PT, with the maximum spacing between lights equal to half the taxiway width. For all corners and all curves exceeding 30 degrees of arc, there shall be a minimum of three lights. See (draft) UFC 3-535-01, *Design Standards for Visual Air Navigation Facilities*, Chapter 5, for additional edge light location details.

11.3.3. Overrun Edge Lights. Overruns do not normally require edge lights; however, for overruns used as taxiways or turnarounds, edge lights may be installed using the location criteria stated in paragraph 11.2.2. In addition, the first pair of edge lights installed on overruns should not be more than 30.5 meters (100 feet) from the runway threshold.

11.4. Light Reflector Panels (Optional). Light reflectors may be installed at the mid-point between LZ runway edge lights or taxiway edge lights. Contact the STT for information on obtaining light reflector panels.

12. Pavement Markings.

12.1. Minimum Requirements. No pavement markings are required; however, at locations where LZs are paved and will be used for the long-term, it is desirable to apply painted markings to the pavement surface as described below. See Attachment 1, Figures 10, 11 and 12, for illustrations of LZ pavement markings.

12.2. Marking Requirements for Long-Term Use.

12.2.1. Marking Material. Use paint to apply markings to LZs, turnarounds, aprons, and taxiways. Paint should be applied at 0.305 to 0.356 millimeter (12 to 13 mils) wet film thickness for a desired dry film thickness of approximately 0.203 millimeter (8 mils). At this rate, coverage will be approximately 11 square meters (121 square feet) per gallon. For LZs that need additional reflectivity, glass beads (Type I) should be applied at a rate of approximately 3.6 kilograms to 4 kilograms (8 pounds to 9 pounds) per gallon of paint.

12.2.2. Threshold Bar. White threshold stripes may be marked at each end of the LZ runway to distinguish between the overrun and LZ runway surface. The marking should be 1.2 meters (4 feet) wide and extend from edge to edge of the LZ surface.

12.2.3. LZ Edge Stripes. White side stripes should only be painted when there is no visual distinction between the LZ runway surface and the paved shoulder (e.g., both LZ runway and shoulder are asphalt). Edge stripes should be 0.3 meter (1 foot) wide and extend along the entire length of the LZ runway.

12.2.4. Taxiway Centerline. If the LZ runway has connecting taxiways, the taxiway centerline turn radius should not be extended onto the LZ runway surface.

12.2.5. Taxiway, Apron, and Turnaround Edge Stripes. If taxiways, aprons or turnarounds have paved shoulders and there is no visual distinction between the edge of load-bearing pavement and the shoulder, the edge of full-strength pavement should be marked with two 152-millimeter-wide (6-inch-wide) yellow stripes separated by a 152-millimeter (6-inch-wide) gap.

12.2.6. Holding Position Markings. Holding position markings shall be located at the edge of the LZ runway clearance line, or 85.3 meters (280 feet) from the LZ runway centerline for C-17s, and 76.2 meters (250 feet) from the LZ centerline for C-130s. When the holding position is marked on a taxiway connecting to the overrun, the location of the marking must be adjusted to ensure it is outside of the LZ runway clear zone. For holding position marking dimensions, see ETL 04-2, *Standard Airfield Pavement Marking Schemes*.

12.2.7. Touchdown Box Markings (Optional). When desired by the airfield manager, touchdown box markings may be applied. These markings consist of 0.9-meter-wide (3-foot-wide) white stripes that extend transversely across the entire width of the runway surface. The stripes are located 30.5 meters and 152 meters (100 feet and 500 feet) from the approach end threshold.

12.2.8. Runway Designation Markings (Optional). When desired by the airfield manager, runway designation numerals may be painted at each end of the runway. See ETL 04-2 for location and dimensions of the numerals.

12.2.9. Runway Centerline (Optional). When desired by the airfield manager, runway centerline stripes may be applied. Stripes are 0.5 meter to 0.9 meter wide (1.5 feet to 3 feet wide) and 30.5 meters (100 feet) long, with an 18.3-meter (60-foot) gap between stripes.

13. Point of Contact: Recommendations for improvements to this ETL are encouraged and should be furnished to: HQ AFCESA/CES, Mr. Dick Smith, DSN 523-6084, commercial (850) 283-6084, e-mail richard.smith@tyndall.af.mil.

JEFFREY L. LEPTRONE, Colonel, USAF
Director of Technical Support

Atchs
1. Figures
2. Tables
3. Distribution List

FIGURES

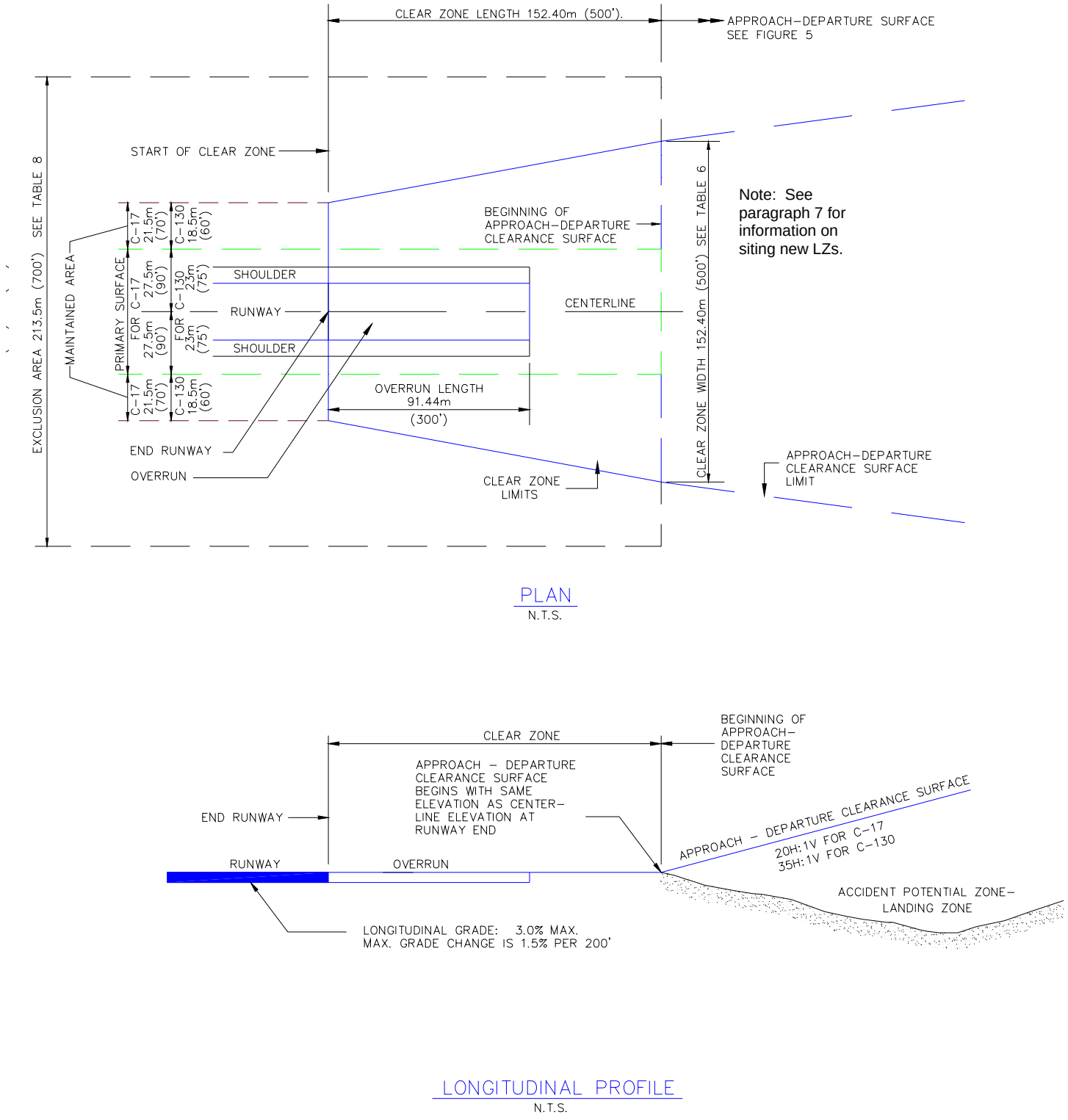
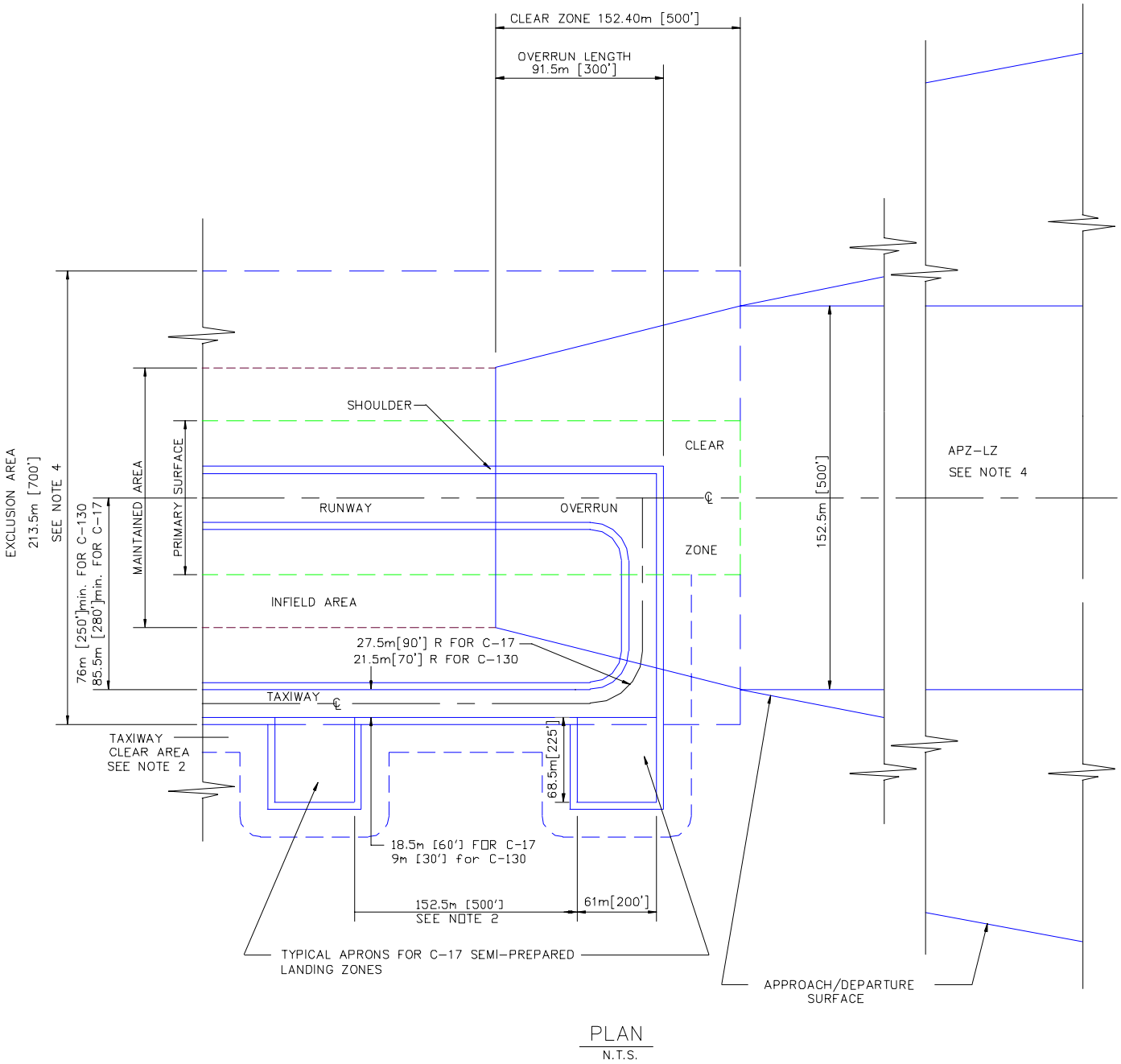


Figure 1. LZ Primary Surface End Details



PLAN
N.T.S.

NOTES

1. TAXIWAY CLEAR AREA WIDTH 33.5m [110'] FOR C-17 AND 29m [95'] FOR C-130 (FROM TAXIWAY CENTERLINE TO OBSTACLE.)

2. LOCATION AND SPACING BETWEEN MULTIPLE APRONS IS DETERMINED BY TOPOGRAPHY, MISSION, AND OBSTRUCTIONS, BUT SHALL NOT BE LESS THAN 152.5m [500'] APART.

3. PARALLEL TAXIWAY, OR TURNAROUND AREAS AT BOTH ENDS OF THE RUNWAY, MUST BE PROVIDED.

4. SEE PARAGRAPH 7 FOR INFORMATION ON SITING NEW LZS.

Figure 2. LZ Details

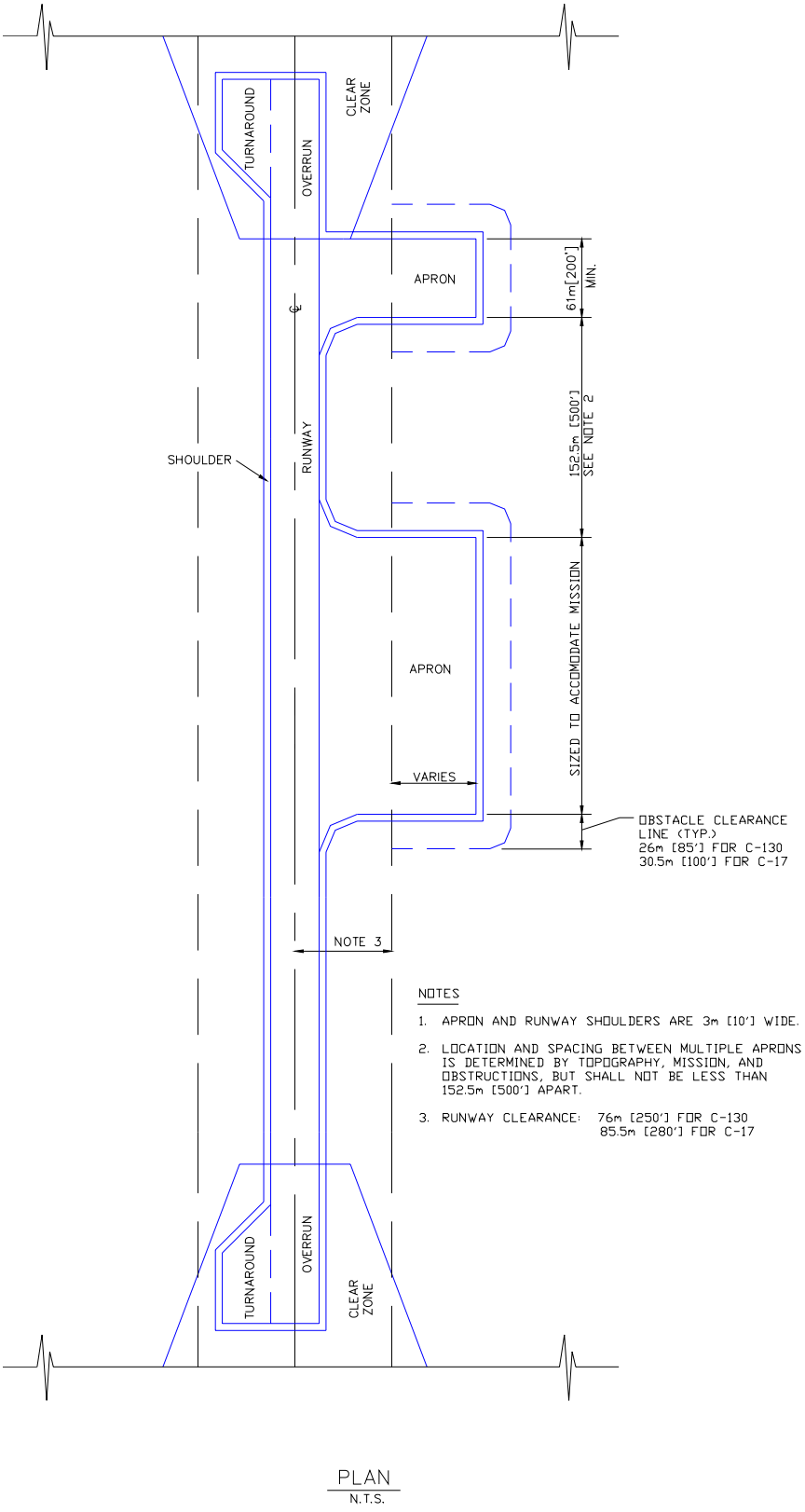
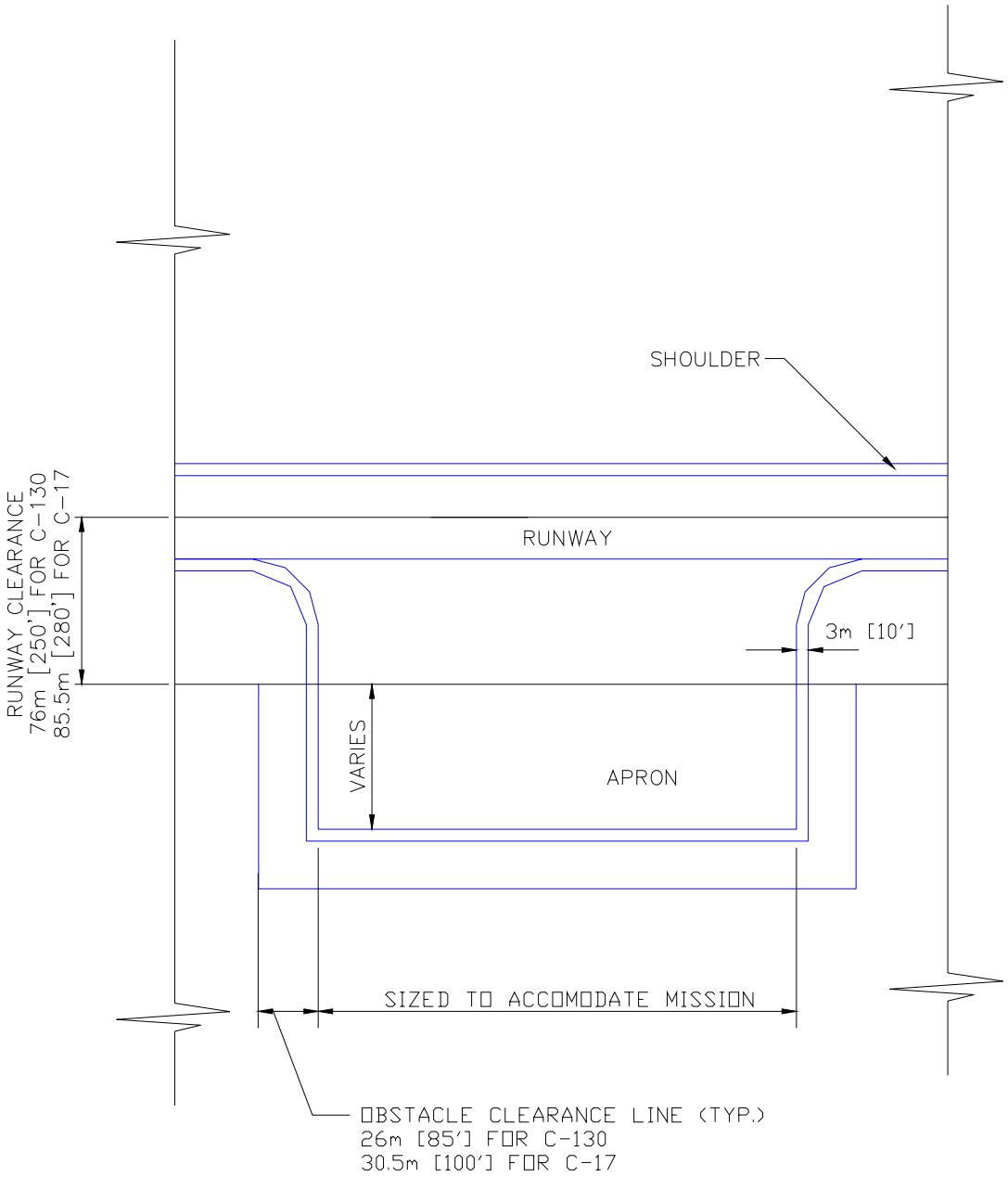


Figure 3. LZ with Contiguous Aprons and Turnarounds



PLAN
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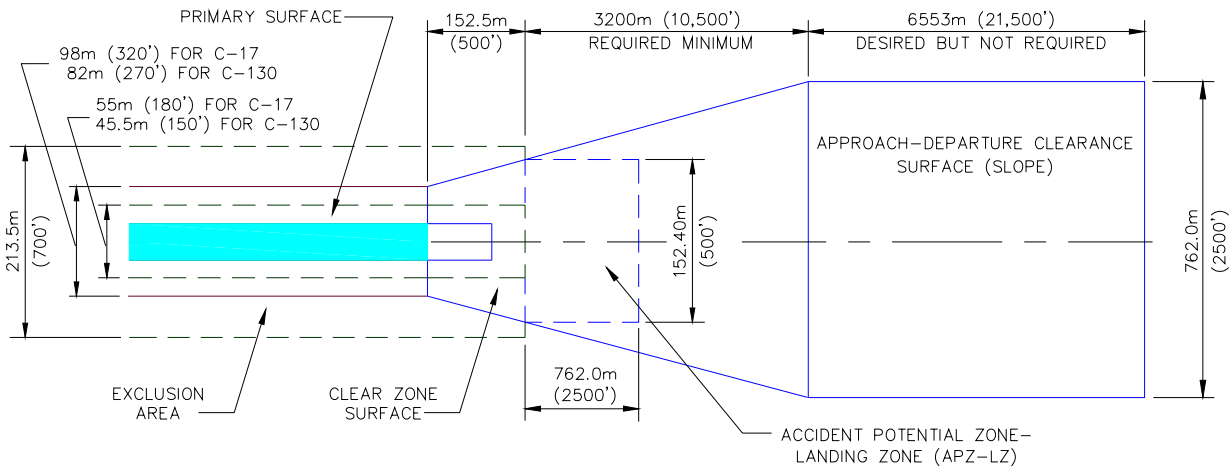
Figure 4. LZ Apron Layout Details



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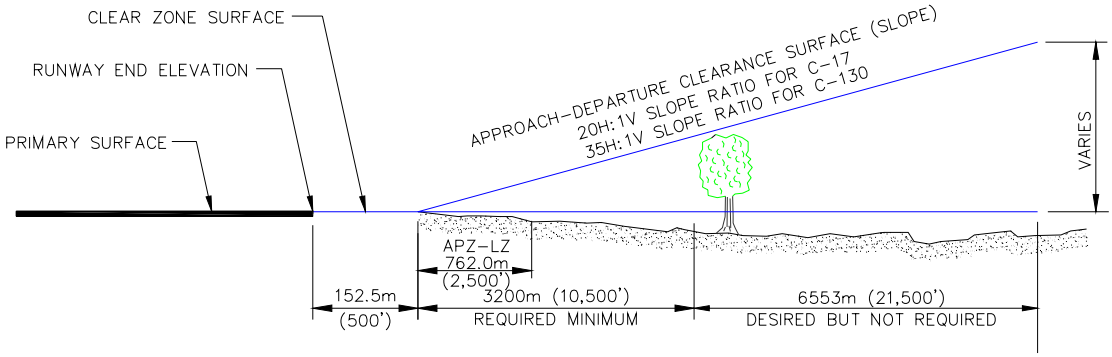
Note: See paragraph 7 for information on siting new LZs.



LONGITUDINAL SECTION
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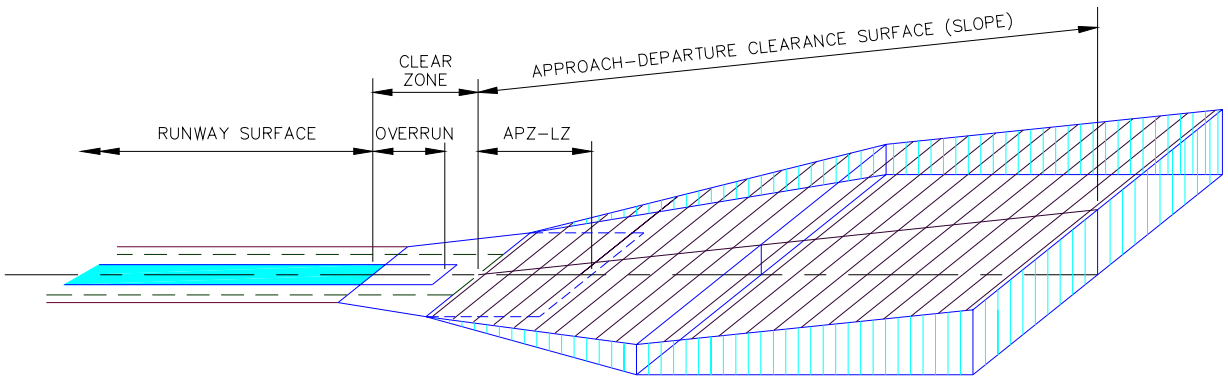

ISOMETRIC VIEW
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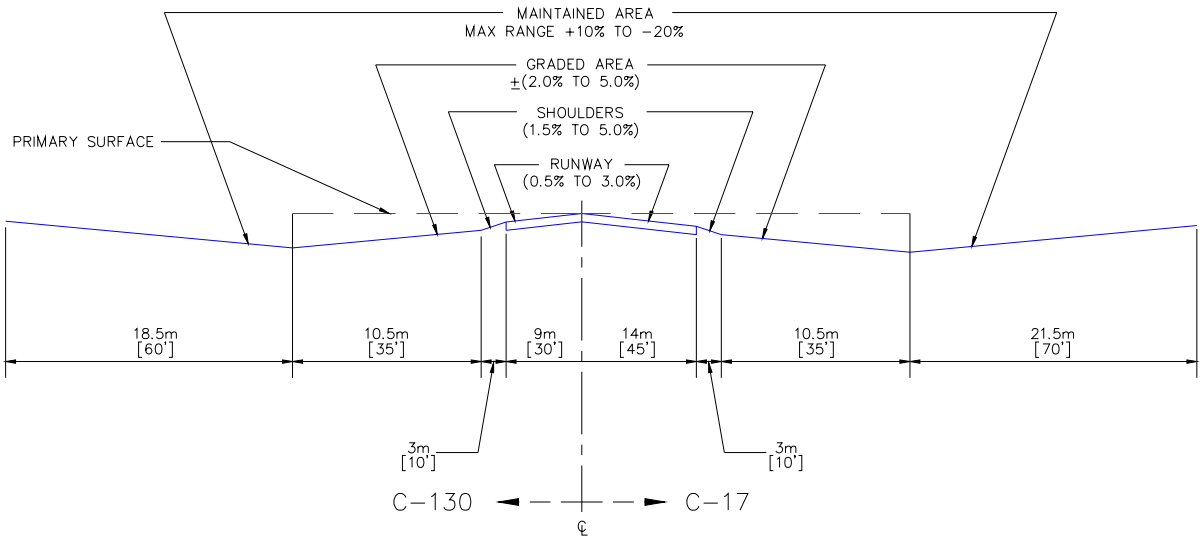
Figure 5. LZ Runway Imaginary Surfaces



RUNWAY CROSS SECTION

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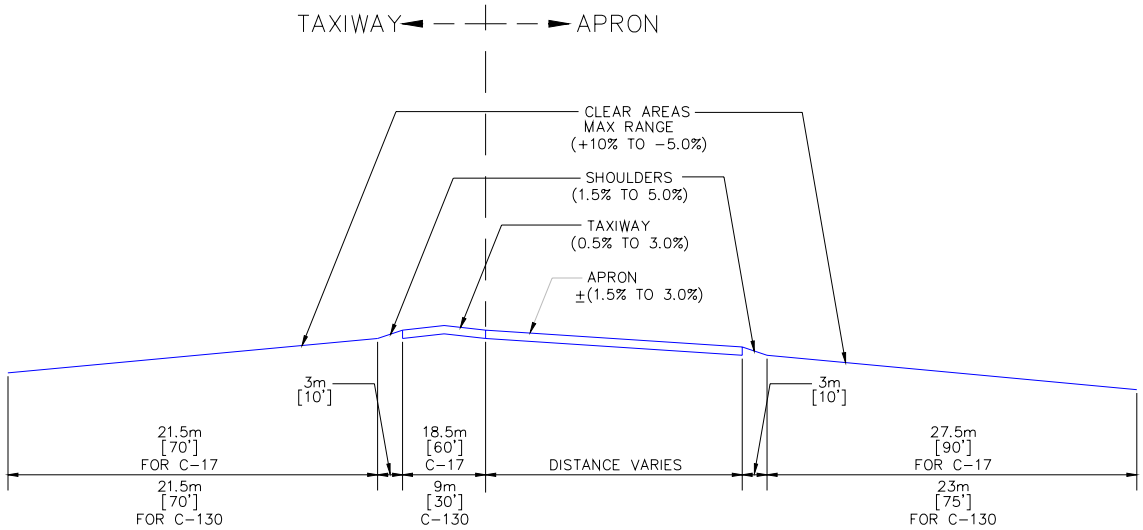


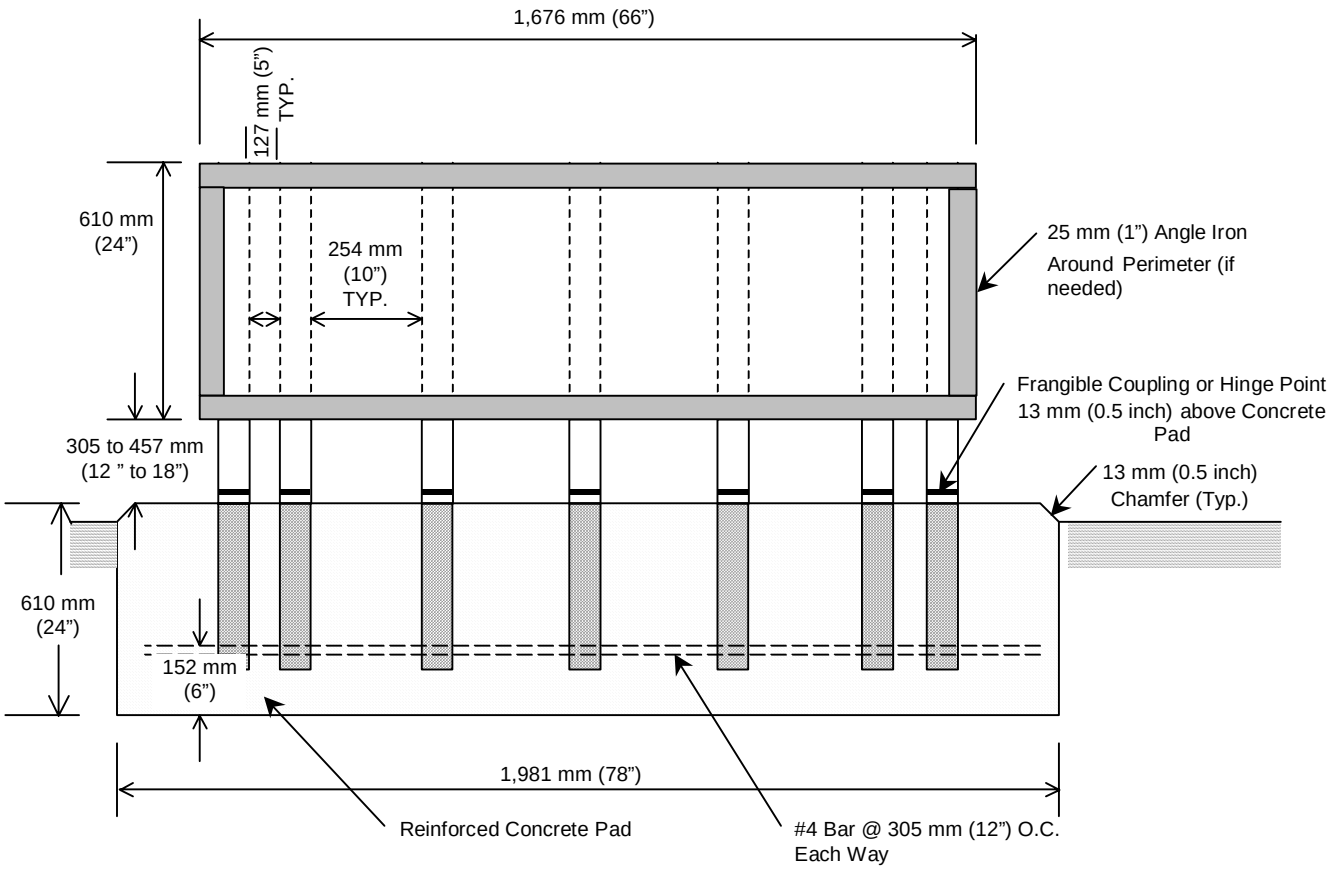
TAXIWAY/APRON CROSS SECTION

N.T.S.

NOTE:

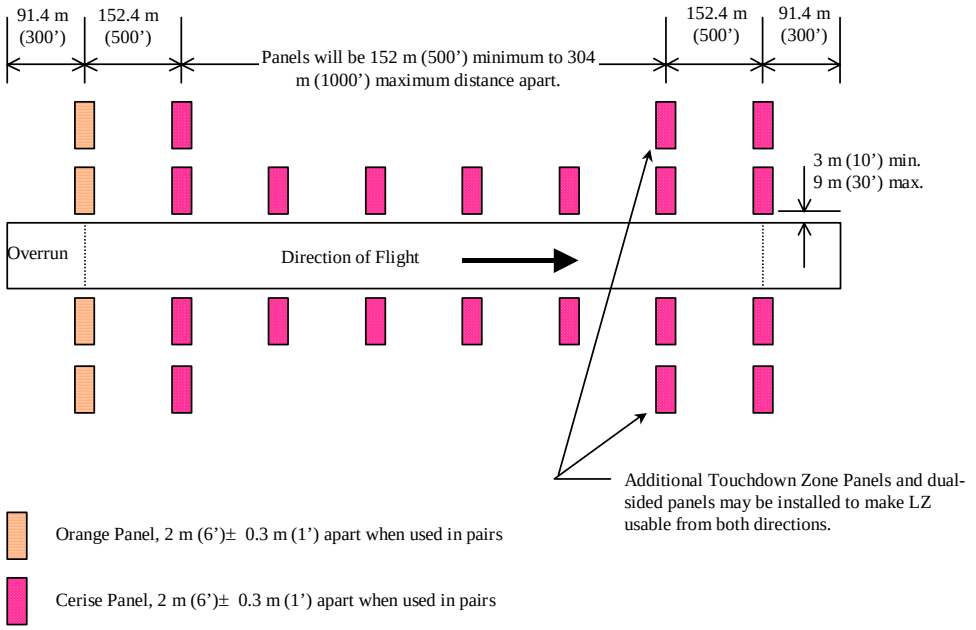
A ±(1.5% TO 5.0% GRADE MEANS THE SURFACE WILL BE SLOPED, EITHER POSITIVELY BETWEEN +1.5% AND +5.0% OR NEGATIVELY BETWEEN −1.5% AND −5.0%, BUT NOT LEVEL.

Figure 6. LZ Runway, Taxiway, and Apron Sections



Notes:
1.Example panel design. Panel minimum dimensions must be met, but panel materials, posts, and foundation can be modified by the designer.
2.Refer to Figure 8 for locations and color scheme layout.
3.Foundation width shall be a minimum 457 millimeters (18 inches). Foundation depth shall be minimum 610 millimeters (24 inches) or 152 millimeters (6 inches) deeper than the frost line.
4.Top of concrete pad shall be 13 millimeters (0.5 inch) above surrounding ground. Maximum allowable height above ground is 38 millimeters (1.5 inches). Slope concrete 6 millimeters (0.25 inch) per foot away from panel.
5.Frangible coupling or hinge point shall be located 13 millimeters (0.5 inch) above top of concrete pad.
6.Easily removable signs may be constructed by creating sleeves in the concrete base for the posts to fit into. However, the frangible coupling or hinge point in the support posts is still required for removable signs.

Figure 7. Example VLZMP on Concrete Base Detail



Note: Alternate colors may be used if all participating units are briefed and concur with the color selection. For example, all panels may be orange.

Figure 8. Airfield Marking Panel 1 (AMP-1) Layout

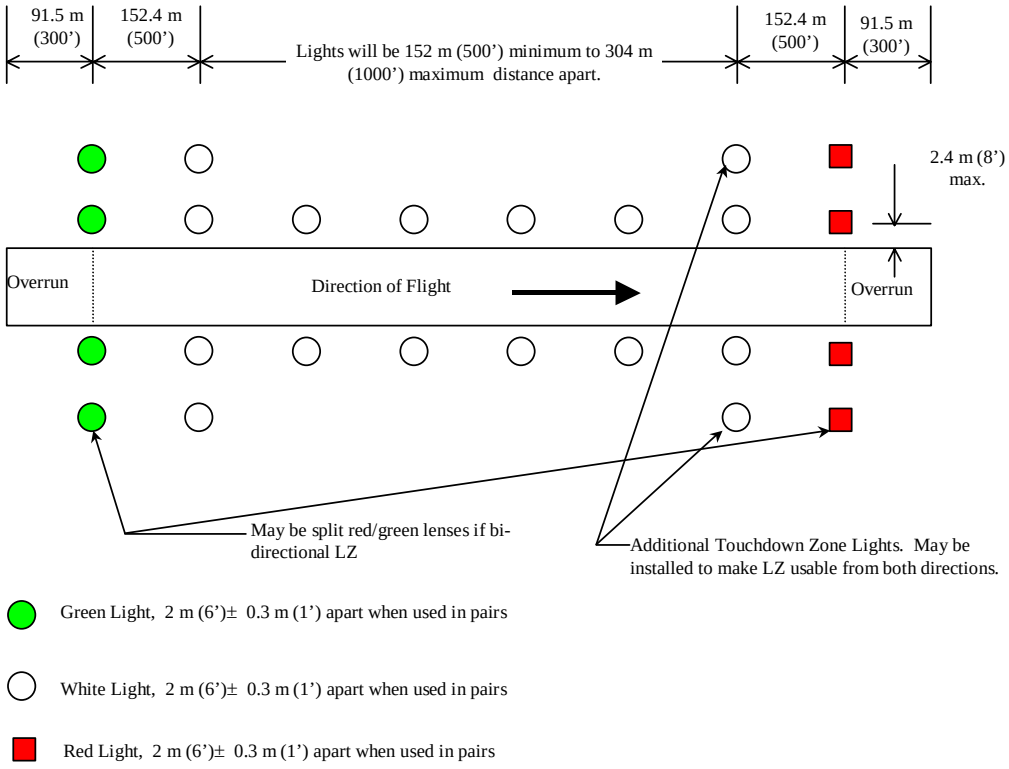


Figure 9. Airfield Lighting Layout

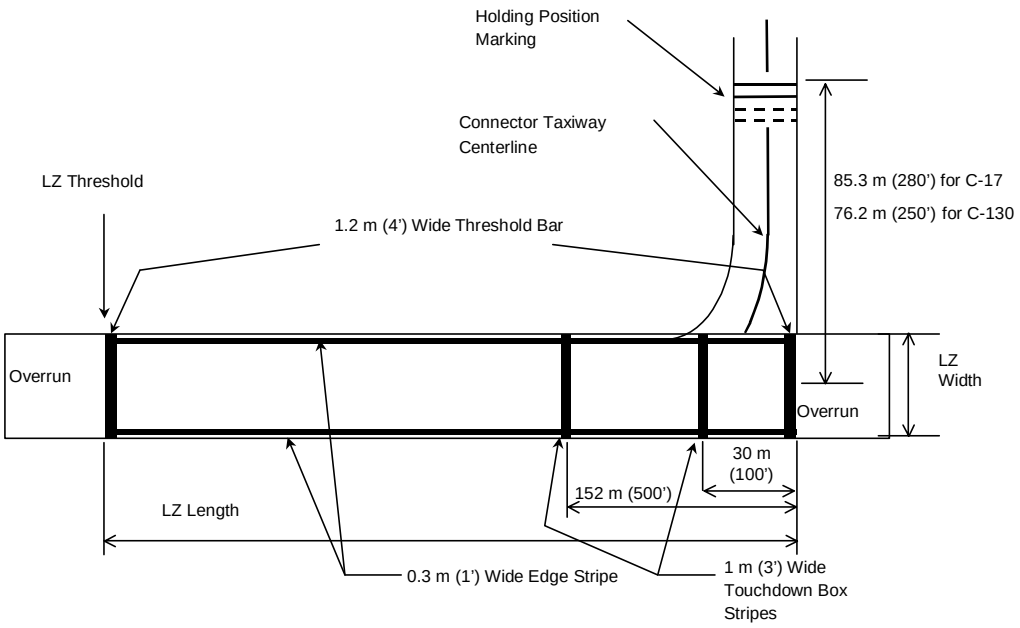


Figure 10. Airfield Marking Layout

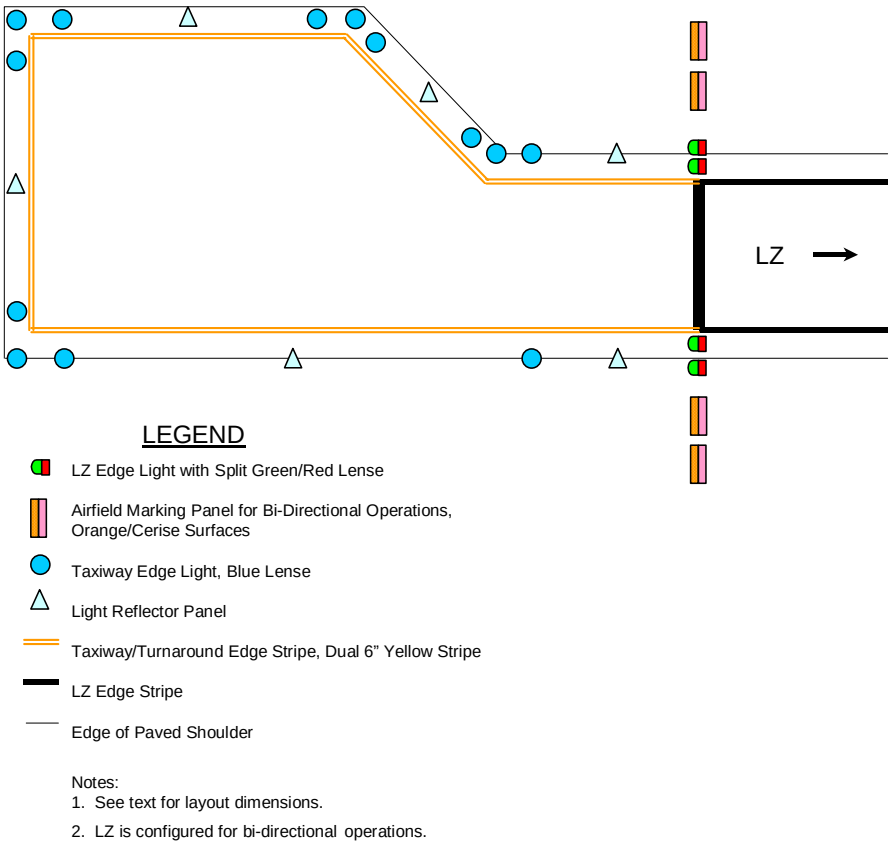
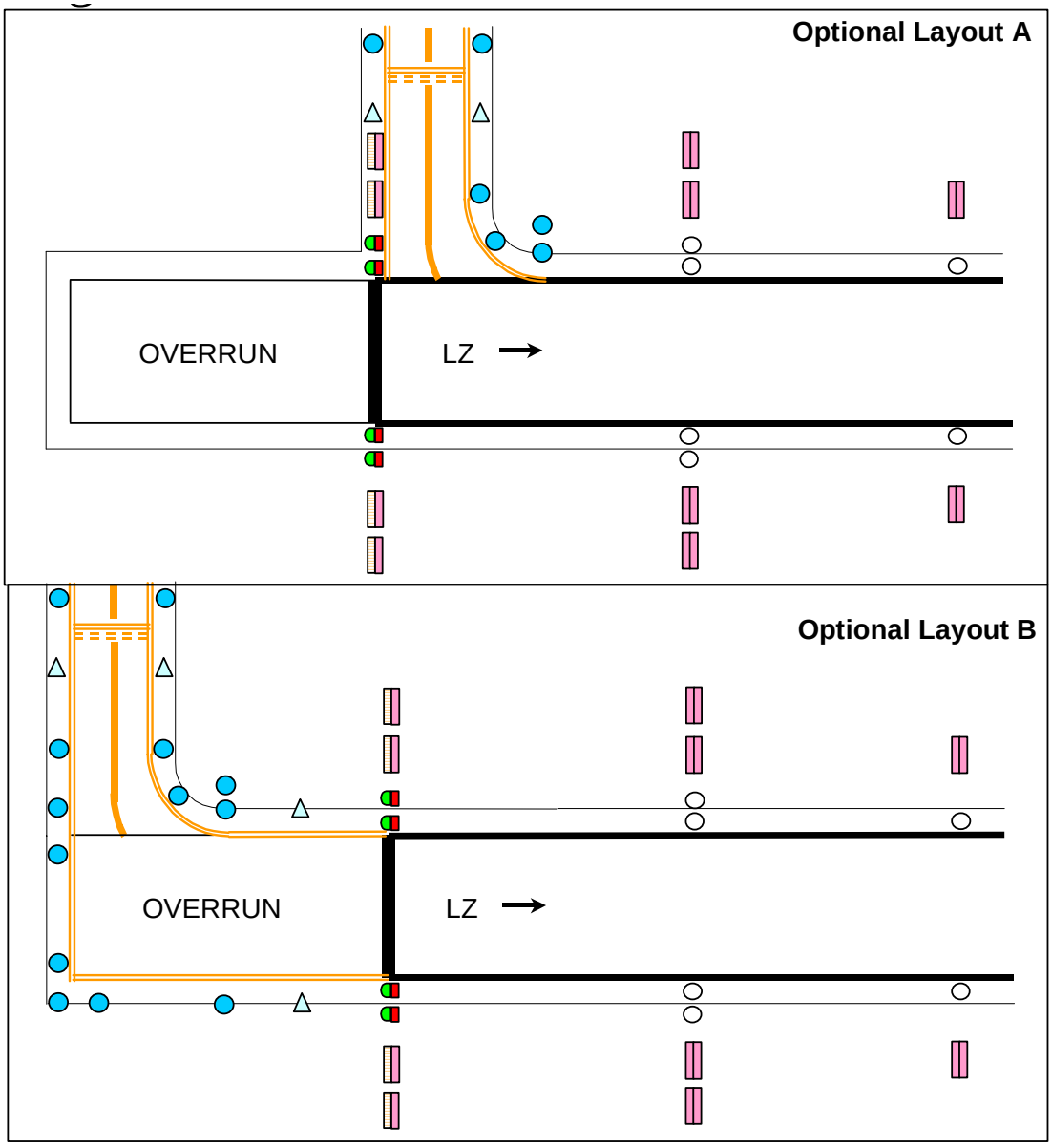


Figure 11. Typical Turnaround Marking and Lighting Layout



LEGEND

- LZ Edge Light with Split Green/Red Lense
- LZ Edge Light with White Lense
- Airfield Marking Panel for Bi-Directional Operations, Orange/Cerise Surfaces
- Airfield Marking Panel for Bi-Directional Operations, Cerise/Cerise Surfaces
- Taxiway Edge Light, Blue Lense
- Light Reflector Panel
- Taxiway/Turnaround Edge Stripe, Dual 6" Yellow Stripe
- Taxiway Centerline Stripe
- LZ Edge Stripe
- Edge of Paved Shoulder

Notes:
1. See text for layout dimensions.
2. LZ is marked and lighted for bi-directional operations.

Figure 12. Typical Bi-Directional Runway/Taxiway Marking and Lighting Layout

TABLES

Table 1. C-17 LZ Runway Lengths

202,756 KG (447,000 LB): MAX WEIGHT FOR SOIL SURFACED LZs		
RCR	Pressure Altitude (Meters [Feet])	Runway Length (Meters [Feet])
20	0 to 914 (3000)	1067 (3500)
	915 (3001) to 1829 (6000)	1219 (4000)
16	0 to 609 (2000)	1219 (4000)
	610 (2001) to 1829 (6000)	1372 (4500)
12	0 to 609 (2000)	1372 (4500)
	610 (2001) to 1524 (5000)	1524 (5000)
	1525 (5001) to 1829 (6000)	1676 (5500)
8	0 to 609 (2000)	1676 (5500)
	610 (2001) to 1219 (4000)	1829 (6000)
	1220 (4001) to 1829 (6000)	1981 (6500)
4	0 to 609 (2000)	2134 (7000)
	610 (2001) to 1524 (5000)	2286 (7500)
	1525 (5001) to 1829 (6000)	2438 (8000)
227,703 KG (502,000 LB): MAX WEIGHT FOR CONTINGENCY OPERATIONS ON PAVED LZs		
RCR	Pressure Altitude (Meters [Feet])	Runway Length (Meters [Feet])
23	0 to 914 (3000)	1067 (3500)
	915 (3001) to 1829 (6000)	1219 (4000)
16	0 to 304 (1000)	1372 (4500)
	305 (1001) to 1219 (4000)	1524 (5000)
	1220 (4001) to 1829 (6000)	1676 (5500)
12	0 to 914 (3000)	1676 (5500)
	915 (3001) to 1829 (6000)	1981 (6500)
8	0 to 609 (2000)	1981 (6500)
	610 (2001) to 1219 (4000)	2134 (7000)
	1220 (4001) to 1829 (6000)	2438 (8000)
5	0 to 304 (1000)	2134 (7000)
	305 (1001) to 1219 (4000)	2438 (8000)
	1220 (4001) to 1829 (6000)	2744 (9000)

Note: Runway lengths **do not** include overruns.

Table 2. Runways for LZs

Item No.	Item Description	Paved		Semi-Prepared (Unpaved)		Remarks
		C-130	C-17	C-130	C-17	
1	Length	Min. 914 m (3000 ft)	Min. 1067 m (3500 ft) See Remarks	Min. 914 m (3000 ft)	Min. 1067 m (3500 ft) See Remarks	See paragraph 8.1.1. for LZ length requirements for the C-17. For lengths less than 1067 m (3500 ft), an Air Force MAJCOM/DO waiver is required prior to initiating flying operations (see paragraph 8.3)
2	Width	18.5 m (60 ft)	27.5 m (90 ft)	18.5 m (60 ft)	27.5 m (90 ft)	See Note.
3	Width of Shoulders	Min. 3 m (10 ft)				Remove all tree stumps and loose rocks in shoulder areas. Shoulders for paved LZs shall be paved. Shoulders for semi-prepared LZs should be stabilized to prevent erosion by jet blast. Where adequate sod cover cannot be established, the shoulders should be chemically stabilized.
4	Longitudinal Grades of Runway and Shoulders	Max. 3%				Hold to minimum practicable. Grades may be both positive and negative but must not exceed the limit specified.
5	Longitudinal Runway Grade Change	Max. 1.5% per 61 m (200 ft)				Grade changes should be held to a minimum and should be gradual. Minimum distance between grade changes is 61 m (200 ft). Grade changes cannot exceed 1.5% measured at 61 m (200 ft) intervals.
6	Transverse Grade of Runway	0.5% Min. 3.0% Max.				Transverse grades should slope down from the runway centerline. The intent of the transverse grade limit is to provide adequate cross slope to facilitate drainage without adversely affecting aircraft operations.
7	Transverse Grade of Runway Shoulders	1.5% Min. 5.0% Max.				Transverse grades should slope down from the runway edge. The intent of the transverse grade limit is to facilitate drainage.
8	Width of Graded Area	10.5 m (35 ft)				Cut trees flush with the ground and remove rocks larger than 100 mm (4 in) in diameter. Remove vegetation (excluding grass) to within 150 mm (6 in) of the ground. Jet blast may cause erosion of the graded area. For paved LZs where adequate vegetation cannot be established to prevent erosion, the graded area can be covered with a thin 38 mm to 51 mm (1.5 in to 2.0 in) asphalt layer.
9	Transverse Grade of Graded Area	2.0% Min. 5.0% Max.				Grades may slope up or down to provide drainage, but may not penetrate the primary surface.
10	Width of Maintained Area	18.5 m (60 ft)	21.5 m (70 ft)	18.5 m (60 ft)	21.5 m (70 ft)	Remove obstructions; cut trees flush with ground. Remove rocks that project more than 150 mm (6 in) above grade. Remove vegetation (excluding grass) to within 150 mm (6 in) of the ground.
11	Maintained Area: Transverse Grade	Maximum range: +10.0% to -20.0%				Grades may slope up or down to provide drainage, but may not exceed +10.0% nor -20.0% slope.

Note: For C-17 LZs without parallel taxiways, turnarounds must be provided at both ends of the runway. Turnarounds for C-17 aircraft should be 55 m (180 ft) long and 50.5 m (165 ft) wide (including the overrun/taxiway width), with 45-degree fillets. The aircraft must be positioned within 3 m (10 ft) of the runway edge prior to initiating this turn. If provided, turnarounds for C-130 aircraft should be at least 23 m (75 ft) in diameter.

Table 3. Taxiways for LZs

Item No.	Item Description	Paved		Semi-Prepared (Unpaved)		Remarks
		C-130	C-17	C-130	C-17	
1	Width	9 m (30 ft)	18.5 m (60 ft)	9 m (30 ft)	18.5 m (60 ft)	
2	Turning Radii	21.5 m (70 ft)	27.5 m (90 ft) See Remarks	21.5 m (70 ft)	27.5 m (90 ft) See Remarks	C-17 aircraft can execute "star turns" which require forward and reverse taxi within 27.5 m (90 ft). However, for normal 180-degree turn maneuvers, the C-17 turn radius is 35 m (116 ft).
3	Shoulder Width	3 m (10 ft)				Shoulders for paved LZs should be paved. Shoulders for semi-prepared LZs should be stabilized to prevent erosion by jet blast. Where adequate sod cover cannot be established, the shoulder should be chemically stabilized. Remove all tree stumps and loose rocks.
4	Longitudinal Grade	Maximum 3.0%				Hold to minimum practicable. Grades may be both positive and negative.
5	Rate of Longitudinal Grade Change	Maximum 2.0% per 30 m (100 ft)				Grade changes should be held to a minimum and should be gradual. Minimum distance between grade changes is 30 m (100 ft). Grade changes cannot exceed 2.0% measured at 30 m (100 ft) intervals.
6	Transverse Grade of Taxiway	0.5% to 3.0%				Transverse grades should slope down from the taxiway centerline. The intent of the transverse grade limitation is to provide adequate cross slope to facilitate drainage without adversely affecting aircraft operations. The surfaces should slope so that the centerline of the taxiway is crowned.
7	Transverse Grade of Taxiway Shoulder	1.5% to 5.0%				Transverse grades should slope down from the taxiway edge. The intent of the transverse grade limit is to facilitate drainage.
8	Runway Clearance	76 m (250 ft)	85.5 m (280 ft)	76 m (250 ft)	85.5 m (280 ft)	Measured from the runway centerline to near edge of the taxiway.
9	Infield Area					All areas located between the runway and taxiways must be cleared of obstructions
10	Clearance to Fixed or Mobile Obstacles	29 m (95 ft)	33.5 m (110 ft)	29 m (95 ft)	33.5 m (110 ft)	Measured from the taxiway centerline. Required to provide minimum 7.5 m (25 ft) wingtip clearance.
11	Taxiway Clear Area – Width	21.5 m (70 ft)				Measured from the outer edge of the taxiway shoulder to obstacle clearance line. Remove rocks that project more than 150 mm (6 in) above grade. Cut tree stumps, brush, and other vegetation (excluding grass) to within 150 mm (6 in) of the ground.
12	Taxiway Clear Area – Grade	Maximum range: +10.0% to -5.0%				Transverse grades may slope up or down to provide drainage, but may not exceed a +10% nor -5% slope.

Table 4. Aprons for LZs

Item No.	Item Description	Paved		Semi-Prepared (Unpaved)		Remarks
		C-130	C-17	C-130	C-17	
1	Apron size	See Remarks			See Note	Sized to accommodate mission. Maximum visibility must be maintained at all times. As a minimum, the pilot must be able to clearly see all parked aircraft when taxiing. On paved aprons, clearance between wing tips of parked aircraft should be minimum 7.5 m (25 ft). Clearance between wing tips of taxiing aircraft and parked aircraft should be minimum 7.5 m (25 ft) for paved aprons and 15 m (50 ft) for semi-prepared aprons.
2	Apron Grades in the Direction of Drainage	1.5 to 3.0%				
3	Width of Apron Shoulder	3 m (10 ft)				Apron shoulders for paved LZs should be paved. Shoulders for semi-prepared LZs should be stabilized to prevent erosion by jet blast. Where adequate sod cover cannot be established, the shoulders should be chemically stabilized.
4	Transverse Grade of Shoulder Away from the Apron Edge	1.5 to 5.0%				Apron shoulder should be graded to carry storm water away from the apron. In shoulder areas, remove all tree stumps and loose rocks.
5	Runway Clearance	76 m (250 ft)	85.5 m (280 ft)	76 m (250 ft)	85.5 m (280 ft)	Measured from the runway centerline to the near edge of the parking apron. Aprons may be contiguous with the runway, but parked aircraft and vehicles must be behind this line.
6	Clearance from Edge of Apron to Fixed or Mobile Obstacles	26 m (85 ft)	30.5 m (100 ft)	26 m (85 ft)	30.5 m (100 ft)	Measured from the outer edge of the apron to obstacle clearance line. Remove rocks that project more than 150 mm (6 in) above grade. Cut tree stumps, brush, and other vegetation (excluding grass) to within 150 mm (6 in) of the ground.
7	Apron Clear Area Grade	Maximum range: +10.0% to -5.0%				Grades may slope up or down to provide drainage, but may not exceed a +10% nor -5% slope. Centerline of drainage ditches must be established away from apron shoulders to prevent water from backing up onto the shoulder area.

Note: To eliminate the potential for foreign object damage (FOD) created by jet blast to parked and taxiing aircraft, individual parking aprons should be provided for each C-17 aircraft on semi-prepared LZs (other than AM-2 mat surfaced). Each apron should be minimum 61 m (200 ft) wide and 68.5 m (225 ft) long. Topography, mission, and obstructions determine the location and spacing between multiple aprons, but the aprons shall not be located less than 152.5 m (500 ft) apart. All loose material must be stabilized or removed before the aprons can be operational.

Table 5. Overruns for LZs

Item No.	Item Description	Paved		Semi-Prepared (Unpaved)		Remarks
		C-130	C-17	C-130	C-17	
1	Overrun Length	91.5 m (300 ft)				The overruns must be constructed to the same standards as the runway. Overruns for mat surfaced runways must also be mat.
2	Overrun Width	18.5 m (60 ft)	27.5 m (90 ft)	18.5 m (60 ft)	27.5 m (90 ft)	
3	Longitudinal Grade of Overruns	Maximum 3%				
4	Transverse Grade of Overruns	0.5% Min. 3.0% Max.				Grades should slope downward from overrun centerline.
5	Width of Overrun Shoulder	3m (10 ft)				Overrun shoulders for paved LZs should be paved. Shoulders for semi-prepared LZs should be stabilized to prevent erosion by jet blast. Where adequate sod cover cannot be established, the shoulders should be chemically stabilized.
6	Transverse Grade of Overrun Shoulders	1.5% Min. 5.0% Max.				Transverse grades should slope down from the overrun edge. The intent of the transverse grade limit is to facilitate drainage.

Table 6. Runway End Clear Zone for LZs

Item No.	Item Description	Paved		Semi-Prepared (Unpaved)		Remarks
		C-130	C-17	C-130	C-17	
1	Length	152.5 m (500 ft)				Measured along the extended runway centerline; begins at the runway threshold.
2	Width at Inner Edge	82.5 (270 ft)	98 m (320 ft)	82.5 (270 ft)	98 m (320 ft)	
3	Width at Outer Edge	152.5 m (500 ft)				
4	Longitudinal and Transverse Grade of Surface	Maximum 5.0%				Grades are exclusive for clear zone and are not part of the overrun but are shaped into the overrun grade. Grades may slope up or down to provide drainage. Exception: Essential drainage ditches may be sloped up to 10% in the clear zones. Do not locate these ditches within 23 m (75 ft) of a C-130 runway centerline or within 27.5 m (90 ft) of a C-17 runway centerline. Such ditches should be essentially parallel with the runway. Remove or embed rocks larger than 100 mm (4 in) in diameter. Cut tree stumps, brush, and other vegetation (excluding grass) to within 150 mm (6 in) of the ground.

Table 7. Imaginary Surfaces for LZs

Item No.	Item Description	Paved		Semi-Prepared (Unpaved)		Remarks
		C-130	C-17	C-130	C-17	
1	Primary Surface Length	Runway length plus 305 m (1000 ft)				Centered on the runway. (Includes lengths of clear zones.)
2	Primary Surface Width	45.5 m (150 ft)	55 m (180 ft)	45.5 m (150 ft)	55 m (180 ft)	Centered on the runway.
3	Primary Surface Elevation					The elevation of the primary surface is the same as the elevation of the nearest point on the runway centerline, or extended runway centerline.
4	Approach-Departure Clearance Surface -- Inner Edge	152.5 m (500 ft)				Measured from runway end.
5	Width at Inner Edge	152.5 m (500 ft)				
6	Slope	35H:1V	20H:1V	35H:1V	20H:1V	Remains constant throughout length.
7	Slope Length	Minimum 3200 m (10,500 ft)				The desired slope length is 9733 m (32,000 ft).
8	Width at Outer Edge	762 m (2500 ft) at 3200 m (10,500 ft) from inner edge				Width of approach–departure clearance surface is constant from 3200 m (10,500 ft) to 9753 m (32,000 ft) from the inner edge.

Table 8. Accident Potential Zones (APZ) and Exclusion Areas for LZs

Item No.	Item Description	Paved		Semi-Prepared (Unpaved)		Remarks
		C-130	C-17	C-130	C-17	
1	APZ-LZ Length	762 m (2500 ft)				Limit the following, where possible, within the APZ-LZ: • Actions that release any substances into the air that would impair visibility or otherwise interfere with operating aircraft, such as steam, dust, and smoke. • Actions that produce electrical emissions that would interfere with aircraft and/or communications or navigational aid systems. • Actions that produce light emissions, direct or indirect (reflective), that might interfere with pilot vision.
2	APZ-LZ Width	Unoccupied Area: 152.5 m (500 ft) Occupied and Built-Up Area: 305 m (1000 ft)				• Items that unnecessarily attract birds or waterfowl, such as sanitary landfills, feeding stations, or certain types of crops or vegetation. • Explosive facilities or activities. • Troop concentrations, such as housing areas, dining or medical facilities, and recreational fields that include spectators. • For cases where a training LZ may be sited near permanently occupied facilities or where new facilities may be sited near an LZ, use a 305 m (1000-foot) wide APZ-LZ. See paragraphs 7.1 through 7.3 for all necessary modifications and considerations.
3	Exclusion Area	Unoccupied Area: 213.5 m (700 ft) Occupied and Built-Up Area: 305 m (1000 ft)				Exclusion areas are required for all paved and semi-prepared LZs. The purpose of the exclusion area is to restrict development of facilities around the LZ. Only features required to operate the LZ, such as operational surfaces (e.g., taxiways, aprons), navigational aids, aircraft and support equipment, and cargo loading and unloading areas and equipment, are permissible in the exclusion area. Security forces, roads, parking lots, storage areas, etc., are excluded from this area. The exclusion area is centered on the runway, and extends the length of the runway plus clear zone at each end. For long-term use LZs, restricting use of available land beyond the minimum distances contained in this ETL is highly recommended. The goal is to provide the greatest margin of safety for personnel, equipment, and facilities. For cases where a training LZ may be sited near permanently occupied facilities or where new facilities may be sited near an LZ, use a 304.8 m (1000-foot) wide Exclusion Area. See paragraph 7.3 for a clarification of built-up and occupied areas.

Table 9. Runway Separation for Simultaneous Operations

Item No.	Item Description	Requirement	Remarks
1	Distance between centerlines of parallel runways	762 m (2500 ft)	IFR using simultaneous operation (Depart–Depart) (Depart–Arrival).
		1310.6 m (4300 ft)	IFR using simultaneous approaches.
2	Distance from the Centerline of a Fixed-Wing Runway to the Centerline of a Parallel Rotary-Wing Runway, Helipad, or Landing Lane	Min 213.4 m (700 ft)	Simultaneous VFR operations for Class A Runway and Army Class B Runway.
		Min. 304.8 m (1000 ft)	Simultaneous VFR operations for Class B Runway for Air Force, Navy and Marine Corps.
		Min 213.4 m (700 ft)	Non-simultaneous operations. Distance may be reduced to 60.96 m (200 ft); however, waiver is required and must be based on wake-turbulence and jet blast. In locating the helipad, consideration must be given to hold position marking. Rotary-wing aircraft must be located on the apron side of the hold position markings (away from the runway) during runway operations.
		Min. 762 m (2500 ft)	IFR using simultaneous operations (Depart–Depart) (Depart–Approach).
		Min. 1310.6 m (4300 ft)	IFR using simultaneous approaches.

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