DEPARTMENT OF THE ARMY ETL 1110-3-506
U.S. Army Corps of Engineers
CECW-CE Washington, DC 20314-1000

Technical Letter
No. 1110-3-506 1 March 2011

EXPIRES 29 February 2016
Engineering and Design
AVIATION COMPLEX PLANNING AND DESIGN CRITERIA
FOR ARMY UNMANNED AIRCRAFT SYSTEMS (UAS)

1. Purpose. This ETL provides guidance and criteria for planning and design of runways and ancillary movement areas that support operations of Army wheeled UAS that are presently fielded.

2. Applicability. All Department of Defense (DoD) / Army (DA) organizations responsible for planning and design of Army airfields and airfield pavements.

3. Distribution Statement. Approved for public release; distribution is unlimited.

4. Intended Users.

a. U.S. Army Corps of Engineers.

b. Construction contractors building and expanding DoD airfields

c. Other organizations responsible for airfield construction.

d. Organizations responsible for maintenance and operations of airfields/runways.

5. UAS Aircraft Covered in this ETL.

a. MQ-1C Grey Eagle

b. MQ-5B Hunter

c. RQ-7B Shadow 200

6. References.

a. Technical Manual (DRAFT), * TM DTM 1-1550-696-10, Operator's Manual for MQ-1C QRC Unmanned Aircraft System Block 1, 9 October 2009. Unmanned Aircraft Systems Project Office, Building 5300, ATTN: SFAE-AV-UAS, Redstone Arsenal, AL 35898.

b. Technical Manual 1-1550-692-10, Operator's Procedures for the Hunter MQ-5B Unmanned Air Vehicle System (UAS), September 2008. Unmanned Aircraft Systems Project Office, Building 5300, ATTN: SFAE-AV-UAS, Redstone Arsenal, AL 35898.

c. Technical Manual, TM 1-1550-689-10-1 and TM 1-1550-689-10-2, Operator's Manual for Shadow 200 Tactical Unmanned Aircraft System (TUAS), 1 October 2009, Unmanned Aircraft Systems Project Office, Building 5300, ATTN: SFAE-AV-UAS, Redstone Arsenal, AL 35898.

d. 3-260-01, Airfield and Heliport Planning and Design, 17 November 2008.

e. UFC 3-535-01, Visual Air Navigation Facilities, 17 November 2005.

f. UFC 3-260-05A, Marking of Army Airfield Heliport Operational and Maintenance Facilities, with Change 1, 16 January 2004.

g. UFC 3-250-18FA, General Provisions and Geometric Design for Roads, Streets, Walks and Open Storage Areas, 6 January 2006.

h. UFC 3-250-01FA, Pavement Design for Roads, Streets, Walks, and Open Storage Areas, 16 January 2004.

7. Definitions.

a. Acronyms:

(1) AICUZ – Air Installation Compatible Use Zones

(2) APZ – Accident Potential Zone

(3) DA – Density Altitude

(4) EA – Environmental Assessment

(5) EIS – Environmental Impact Statement

(6) ETL – Engineering Technical Letter

(7) CATEX – Categorical Exclusion

(8) FONSI - Finding of No Significant Impact

(9) GTOW – Gross Takeoff Weight

(10) NEPA – National Environmental Policy Act

(11) PCASE – Pavement-Transportation Computer Aided Structural Design and Evaluation Computer Programs

(12) TALS – Tactical Automated Landing System

(13) TALS-TS – Tactical Automatic Landing System – Tracking System

(14) UAS – Unmanned Aircraft System(s)

b. Terms:

(1) Pass: The movement of an aircraft over a specific spot or location on a pavement feature.

(2) Sun Screen: A cover, usually semi circular in shape to protect aircraft from the sun's ultraviolet rays

8. Implementation: This ETL is effective immediately.

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2 Appendices:
App A - Aviation Complex Planning and Design Criteria for Army Unmanned Aircraft Systems (UAS)
App B - Frangibility Requirements

APPENDIX A

Aviation Complex Planning and Design Criteria for Army Unmanned Aircraft Systems (UAS)

A-1. Aircraft Characteristics.

Table A-1. MQ-1C Grey Eagle

Wing Span (ft)	56.3
Length (ft)	28.97 (includes Angle of Attack Probe)
Height (ft)	9.8 - Level (Individual aircraft loading will affect overall height and ground clearance)
Vertical Clearance (in)	18
Tread (in)	TBD
Wheel Base (ft)	9.75
Controlling Gear	Main
180° Turn (ft)	96.6 Outside wing tip 49.4 Outside wheel
90° Turn (ft)	48.4 Outside wing tip 24.7 Outside wheel
Basic Empty Gross Weight (lbs)	2550
Basic Mission Take-Off Weight (lbs)	3200-3600
Basic Mission Landing Weight (lbs)	3200
Max Landing Gross Weight (lbs)	3200
Take-Off Distance, Ground Roll (ft)	2590
Take-Off Distance, to 50 ft	5000
Landing Distance, Ground Roll (ft)	3925
Landing Distance, from 50 ft	5400
Assembly Configuration	Single Tricycle
% of Gross Load on Assembly	95% on Main (assumed)
Tire Pressure, Nose Gear (at Max T/O weight)	32+/-5psi
Tire Pressure, Main Gear (at Max T/O weight)	75+/-5psi

Table A-2. RQ-7 Shadow 200

Wing Span (ft)	14 (-7A) (20 or 22 with re-winging -7B)
Length (ft)	11.33
Height (ft)	3.17
Vertical Clearance (in)	TBD
Tread (in)	TBD
Wheel Base (in)	39
Controlling Gear	Main
Basic Empty Gross Weight (lbs)	257
Basic Mission Take-Off Weight (lbs)	386
Basic Mission Landing Weight (lbs)	325
Max Landing Gross Weight (lbs)	386
Take-Off Distance, Ground Roll (ft)	TBD
Landing Distance, Ground Roll (ft)	Variable
Landing Distance, from 50-ft (ft)	1700
Assembly Configuration	Single Tricycle
% of Gross Load on Assembly	95% on Main (assumed)
Tire Pressure, Nose Gear (at Max T/O weight)	35 ±1psi
Tire Pressure, Main Gear (at Max T/O weight)	35 ±1psi

Table A-3. MQ-5B Hunter

Wing Span (ft)	34.25
Length (ft)	23
Height (ft)	6.1
Vertical Clearance (in)	TBD
Tread (in)	4.6
Wheel Base (ft)	6.6
Aircraft Turning Radius (ft)	97.5
Controlling Gear	Nose – NOTE: Taxiing is conducted with personnel or a tow vehicle
Basic Empty Gross Weight (lbs)	1475
Basic Mission Take-Off Weight (lbs)	1950
Basic Mission Landing Weight (lbs)	Varies
Max Landing Gross Weight (lbs)	1950
Take-Off Distance, Ground Roll (ft)	1275
Landing Distance, Ground Roll (ft)	2200
Assembly Configuration	Single Tricycle
% of Gross Load on Assembly	95% on Main (assumed)
Tire Pressure, Nose Gear (at Max T/O weight)	71 ±2psi
Tire Pressure, Main Gear (at Max T/O weight)	71 ±2psi

Figure A-1. MQ-1C Grey Eagle

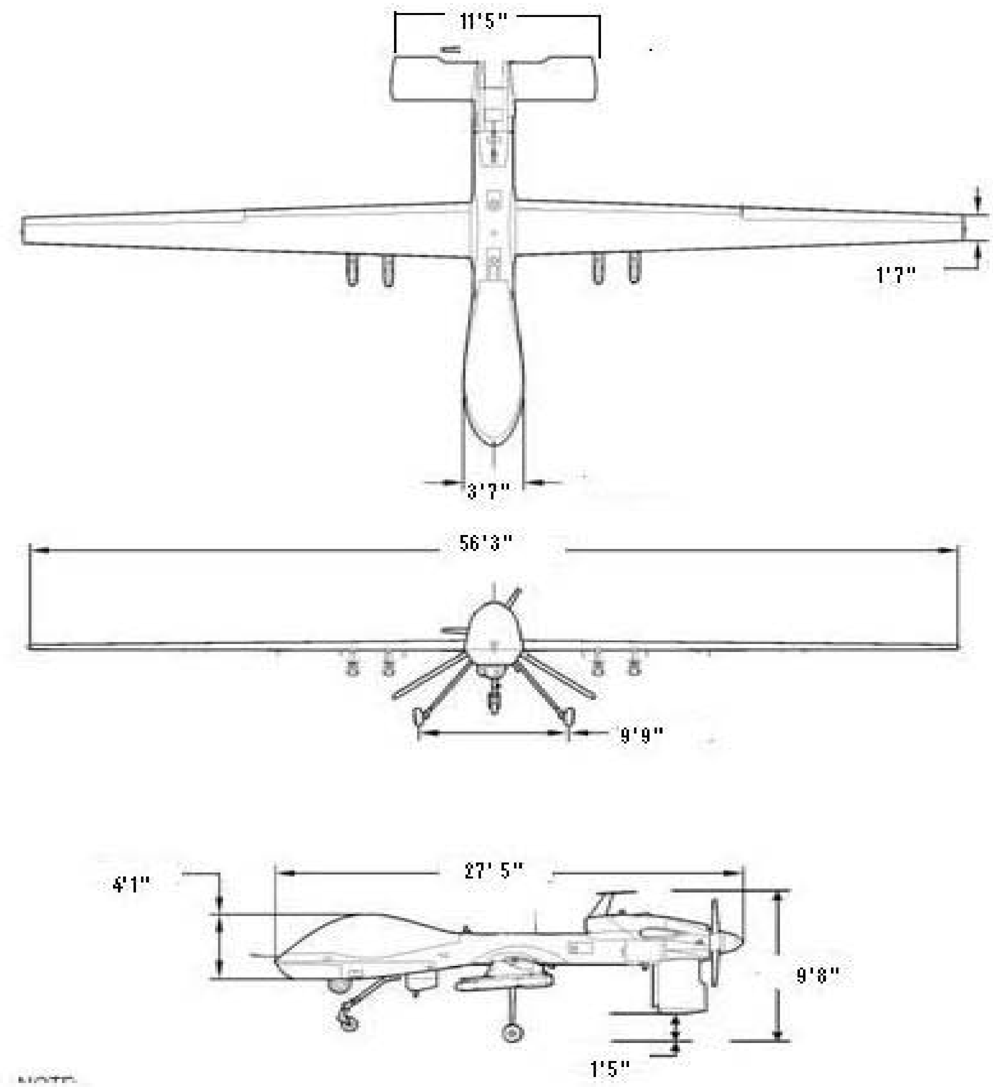


Figure A-2. Grey Eagle Turning Radius

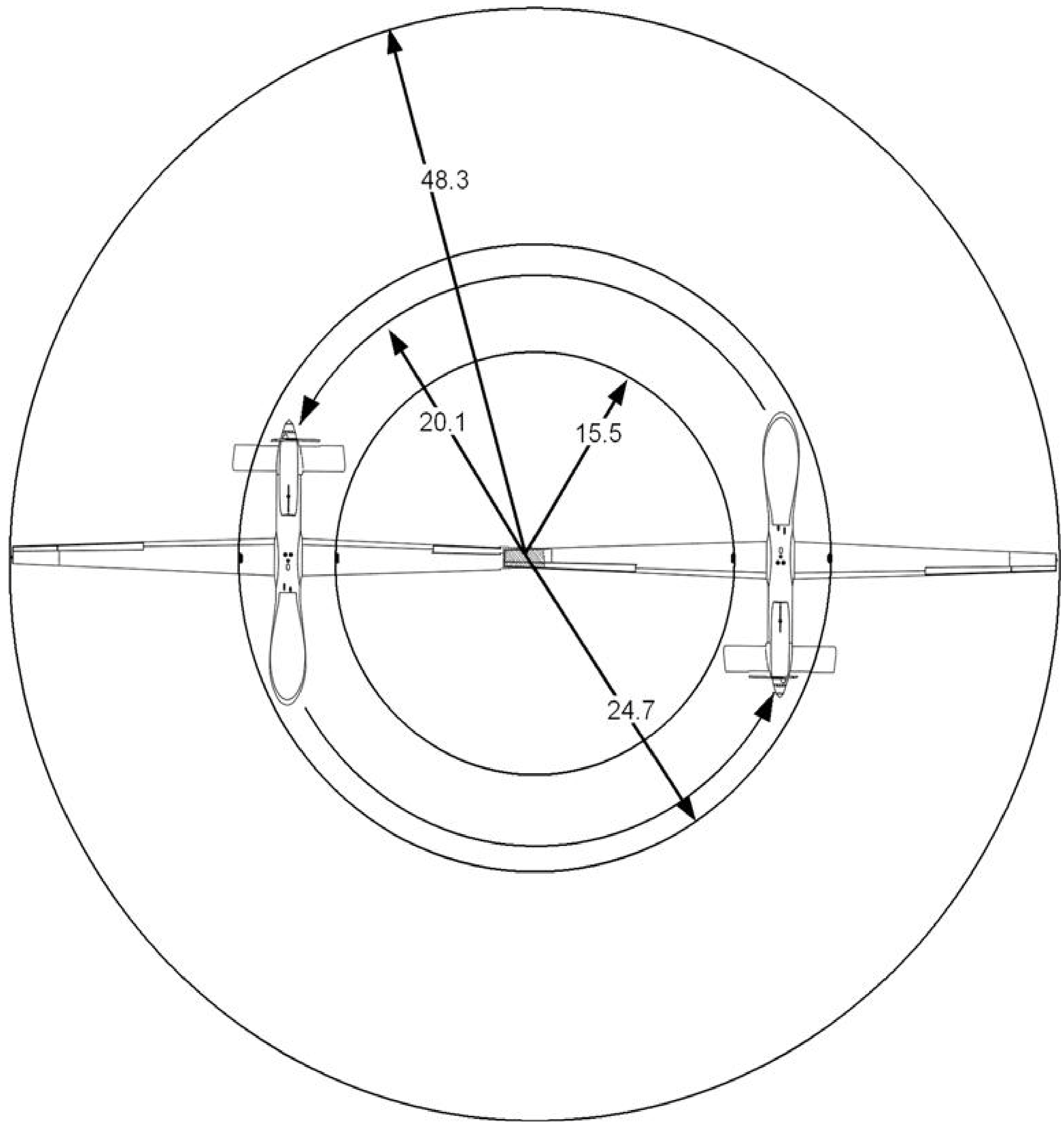


Figure A-3. RQ-7 A/B Shadow

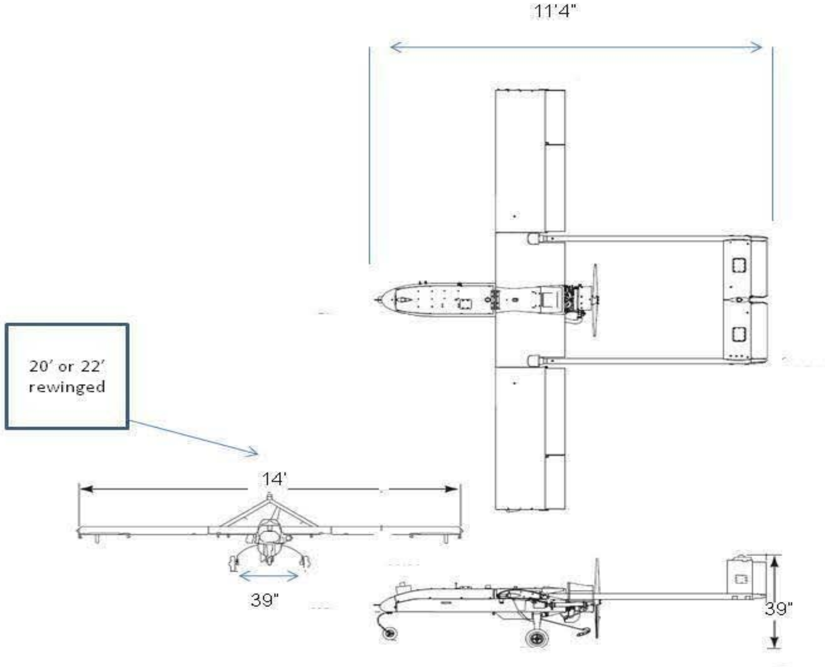
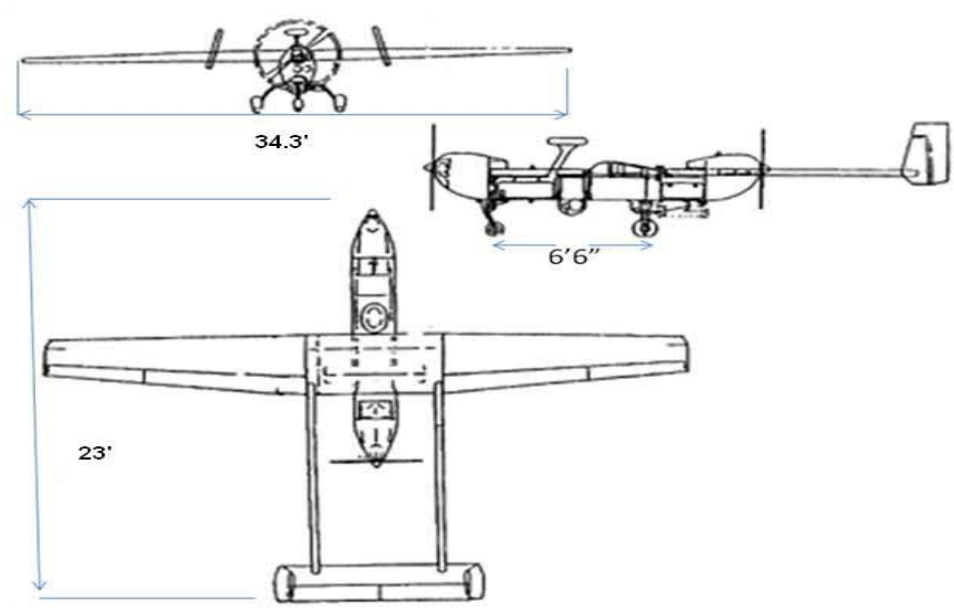


Figure A-4. MQ-5B Hunter



A-2. Land Use and Airspace Approval. When a new runway or modification is planned in addition to local permitting requirements, file FAA Form 7480-1 in accordance with FAA Order 7400.2. FAA Form 7460-1 must be submitted to the FAA at least 45 days prior to the start of construction, in accordance with Federal Aviation Regulations (FAR), Part 77, subpart B. Airspace surface penetrations will be noted. Army, ARNG, and Army Reserves process the form in accordance with Chapter 7 of AR 95-2. For DoD facilities overseas similar requirements by the host country, NATO, or ICAO may be applicable.

a. Land Use Studies. Long range land use planning is a primary strategy for protecting a facility from problems that arise from aviation generated noise and incompatible land uses. Aircraft noise can adversely affect the quality of the human environment. Federal agencies are required to work with local, regional, state, and other Federal agencies to foster compatible land uses, both on and off the boundaries of the aviation facility. The Air Installation Compatible Use Zone (AICUZ) and Installation Compatible Use Zone (ICUZ) programs promote land use compatibility through active land use planning.

b. Environmental Studies. Development of an aviation facility, including expansion of an existing aviation facility, requires compliance with a variety of laws, regulations, and policies. The National Environmental Policy Act (NEPA) requires all Federal agencies to consider the potential environmental impacts of certain proposed projects and activities, as directed by DoD Directive (DoDD) 6050.7. Implementation of these regulations is defined in these documents: Army: AR 200-1; Title 32, Code of Federal Regulations, Part 989 (32 CFR 989). Four broad categories of environmental review for a proposed action exist. The decision to conduct one study or another depends on the type of project and the potential consequences of project to various environmental categories. Criteria for determining which type of study should be undertaken are defined in the environmental directives and regulations. Environmental studies should be prepared and reviewed locally. When additional assistance or guidance is necessary, this support may be obtained through various agencies such as the Department of Army Representative to the FAA, the US Army Corps of Engineers Transportation Systems Center (USACE TSC) and the US Army Corps of Engineers District Offices.

c. Environmental Assessment (EA). The EA serves to analyze and document the extent of the environmental consequences of a proposed action. It evaluates issues such as existing and future noise, land use, water quality, air quality, and cultural and natural resources. The conclusion of the assessment will result in either a Finding of No Significant Impact (FONSI), or, if the consequences are significant and cannot be mitigated to insignificance, the decision to conduct an Environmental Impact Statement (EIS). This decision is typically made by the authority approving the study.

d. Environmental Impact Statement (EIS). An EIS is the document that identifies the type and extent of environmental consequences created if the proposed project is undertaken. The primary purpose of the EIS is to ensure that NEPA policies and goals are incorporated into the actions of the Federal government. The EIS defines the impact and details what measures will be taken to minimize, offset, mitigate, or avoid any adverse effects on the existing environmental condition. Upon completion of an EIS, the decision maker will file a Record of Decision (ROD), which finalizes the environmental investigation and establishes consent to either abandon or complete the project within the scope of measures outlined in the EIS.

e. Categorical Exclusion (CATEX). A CATEX is defined as a category of proposed action(s) that do not individually or cumulatively have the potential for significant effect on the environment and do not, therefore, require further environmental analysis in an EA or EIS. A list of actions that are categorically excluded is contained in the regulatory directives for each service.

f. Exemption By Law and Emergencies. In specific situations, Congress may exempt the DoD from compliance with NEPA for particular actions. Emergency situations do not exempt the DoD from complying with NEPA but do allow emergency response while complying with NEPA.

g. Aircraft Noise Studies. AICUZ and ICUZ are programs initiated to implement Federal laws concerning land compatibility from the perspective of environmental noise impacts. The ICUZ program is the Army's extension of the AICUZ program, which was initiated by the DoD. Studies under these programs establish noise abatement measures that help to eliminate or reduce the intensity of noise from its sources, and provide land use management measures for areas near the noise source.

h. Noise Contour Maps. Noise levels generated from the activities of fixed- and rotary wing operations are identified using contours that delineate areas of equal sound pressure impact on the areas surrounding the source of the noise. Noise levels are expressed in Ldn (day/night average noise level), and noise contours provide a quantified diagram of the noise levels. Noise contours are illustrated on airfield general site plans, installation land use compatibility plans. Noise contours from other sources, such as firing ranges, should also be shown on noise contour maps. In addition, noise contour maps should show the imaginary airspace, such as the runway primary surface, clear zone, APZ I, and APZ II. Establishing noise contour maps identifies potential noise sensitive areas on and off the aviation facility.

i. Requirement for Analysis of Noise Impact. An EIS is required to analyze a noise impact. An EA is required when: (1) a project or facility is proposed within a noise-sensitive area; (2) there is a change in flight operational procedures; or (3) the quality of the human environment is significantly affected by a change in aircraft noise.

A-3. Runway.

a. Runway Location. Runway location and orientation are paramount to airport safety, efficiency, economics, practicality, and environmental impact. The degree of concern given to each factor influencing runway location depends greatly on meteorological conditions, adjacent land use and land availability, airspace availability, runway type, environmental factors, terrain features/topography, and obstructions to air navigation.

b. Obstructions to Air Navigation. The runway must have approaches that are free and clear of obstructions. Runways must be planned so that the ultimate development of the airport provides unobstructed navigation. A survey of obstructions will be undertaken to identify those objects that may affect aircraft operations. Protection of airspace may be accomplished through purchase, easement, zoning coordination, and application of appropriate Army directives.

c. Runway Orientation. Wind direction and velocity is a major consideration for siting runways. To be functional, efficient, and safe, the runway should be oriented in alignment with the prevailing winds, to the greatest extent practical, to provide favorable wind coverage. Wind data, obtained from local sources, for a period of not less than five years, should be used as a basis for developing the wind rose to be shown on the airfield general site plan. UFC 3-260-1, Appendix B, Section 4, provides guidance for the research, assessment, and application of wind data

A-4. Airfield Dimensional Criteria.

a. The dimensions for airfield facilities, airfield lateral safety clearances, and airspace imaginary surfaces are provided in this document.

b. Army Airfields used by manned aircraft will use the criteria contained in UFC 3-260-01.

(1) Permissible Deviations From Design Criteria. This paragraph provides siting information for UAS support facilities that do not conform to the airfield clearance and airspace surface criteria elsewhere in this ETL. The TALS-TS shall be sited the maximum distance from the runway centerline allowed by operational requirements but not less 250 feet. When the TALS is required to be sited within 250 feet it must meet frangibility requirements and have waiver approval from USAASA. Under no conditions will the TALS be sited closer than 150 feet from the runway centerline. If line-of-sight is the basis of the waiver request then the waiver request will have a line of sight analysis justifying the operational distance from the runway centerline. Additionally, if the TALS-TS will be required to remain in service for more than 30 days, the equipment should be installed on a small concrete foundation. No part of the TALS-TS foundation and any remaining structure attached to it will extend 3 inches or more above grade after the frangible connections fail. For frangibility requirements see Appendix A.

c. UAS runway co-located with an active Army airfield. Table A-4 lists the separation criteria between manned and unmanned runways.

Table A-4 Separation Distance

Separation Distance Between Manned and Unmanned Runways	
Min. 700 ft	Non-simultaneous VFR operations.
Min. 1000 ft	Simultaneous VFR operations
Min. 2500 ft	IFR/VFR using simultaneous operations (depart-depart) (depart-approach).

d. UAS only runways: This section presents design considerations for UAS only runways. These criteria are provided as a supplement to the criteria given in UFC 3-260-01, *Airfield and Heliport Planning and Design.*

(1) Runway Designation. The UAS only runway will be designated with a U above the runway number, since these airfields are not built structurally to support standard fixed wing or rotary aircraft operations. Runway weight bearing capability will be based on the heaviest vehicle that would traverse the runway.

Table A-5

Item		UAS Runway			Remarks
No.	Description	MQ-1C	RQ-7B	MQ-5B	
1	Length (ft)	5000	800	2500	MQ-1C At 9000' elevation runway length is 5500'
2	Width (ft)	100	50	50	
3	Width of shoulders(ft)	10	5	10	Shoulder may be paved or unpaved
4	Longitudinal grades of runway and shoulders	Grades may be both positive and negative but must not exceed the limit specified in UFC 3-260-1. Grade restrictions are exclusive of other pavements and shoulders. Where other pavements tie into runways, comply with grading requirements for tow ways, taxiways, or aprons as applicable, but hold grade changes to the minimum practicable to facilitate drainage.			
5	Longitudinal runway grade changes	No grade change is to occur less than 1,000 ft from the runway end	No grade change is to occur less than 100 ft from the runway end	No grade change is to occur less than 300 ft from the runway end	Where economically feasible, the runway will have a constant centerline gradient from end to end. Where terrain dictates the need for centerline grade changes, the distance between two successive points of intersection (PI) will be not less than 1,000 ft (MQ-1C),100 ft (RQ-7B) and 300 ft (MQ-5B) and two successive distances between PIs will not be the same.
6	Rate of longitudinal runway grade changes	Maximum rate of longitudinal grade change is produced by vertical curves having 180-m (600-ft) lengths for each percent of algebraic difference between the two grades.			

Item		UAS Runway			Remarks
No.	Description	MQ-1C	RQ-7B	MQ-5B	
7	Longitudinal sight distance	Any two points 8 ft above the pavement must be mutually visible (visible by each other) for 5000 ft. Proportionally reduce height above runway for runways shorter than 5,000 ft...			
8	Transverse grade of runway	Runway pavements will be centerline crowned. Slope pavement downwards from centerline of runway. 1.5 percent slope is optimum transverse grade of runway			
9	Transverse grade of paved shoulder	Slope downward from runway pavement. Reversals are not allowed.			
10	Runway lateral clearance zone (ft)	250	60	250	The runway lateral clearance limits coincide with the limits of the primary surface. The ends of the lateral clearance zone coincide with the runway ends plus overruns. The ground surface within this area must be clear of fixed or mobile objects, and graded to the requirements of UFC 3-260-1, Table 3-2, items 13 and 14. The zone width is measured perpendicularly from the centerline of the runway and begins at the runway centerline. (1) Fixed obstacles include man-made or natural features such as buildings, trees, rocks, terrain irregularities and any other features constituting possible hazards to moving aircraft (2) Mobile obstacles include parked aircraft, parked and moving vehicles, railroad cars, and similar equipment. Taxiing aircraft, emergency vehicles, and authorized maintenance

Item		UAS Runway			Remarks
No.	Description	MQ-1C	RQ-7B	MQ-5B	
					vehicles are exempt. (3) Parallel taxiway (exclusive of shoulder width) will be located in excess of the lateral clearance distances (primary surface). (4) Above ground drainage structures, including head wall, are not permitted within 150'(60' for RQ-7) of the runway centerline
11	Longitudinal grades within runway lateral clearance zone	Exclusive of pavement, shoulders, and cover over drainage structures. Slopes are to be as gradual as practicable. Avoid abrupt changes or sudden reversals. Rough grade to the extent necessary to minimize damage to aircraft.			
12	Transverse grades within runway lateral clearance zone (in direction of surface drainage)	Exclusive of pavement, shoulders, and cover over drainage structures. Slopes are to be as gradual as practicable. Avoid abrupt changes or sudden reversals. Rough grade to the extent necessary to minimize damage to aircraft.			
13	Width of mandatory frangibility zone (MFZ) (ft)	300	NA*	300*	Centered on the runway centerline. All items sited within this area must be frangible (see UFC 3-260-01Appendix B, Section 13).
14	Length of MFZ	Extends the entire length of the runway plus clearzone. Items that must be sited there due to their function must be made frangible to the maximum extent possible (see UFC 3-260-1, Appendix B, Section 13).			

***** For the RQ-7 runway no objects except for the arresting system and barrier net may be placed within the primary surface. For the MQ-5B runway no objects except the arresting system may be placed within the primary surface and the MFZ.

Figure A-5 MQ-1C Grey Eagle

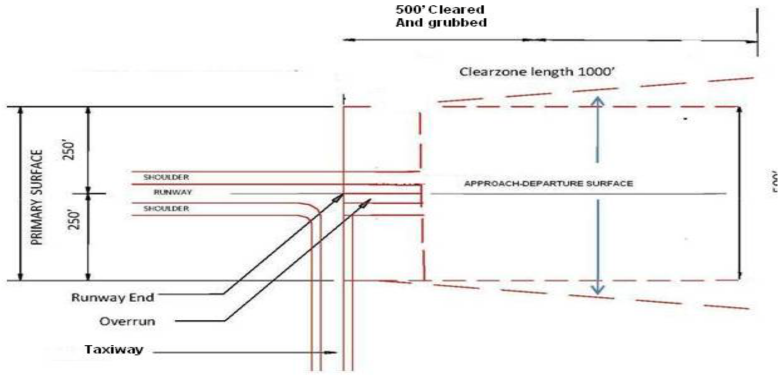


Figure A-6 RQ-7B Shadow

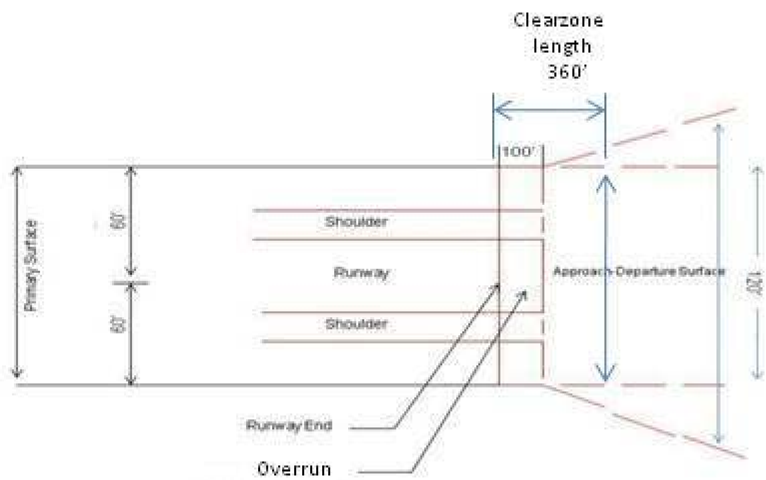


Figure A-7 MQ-5B Hunter

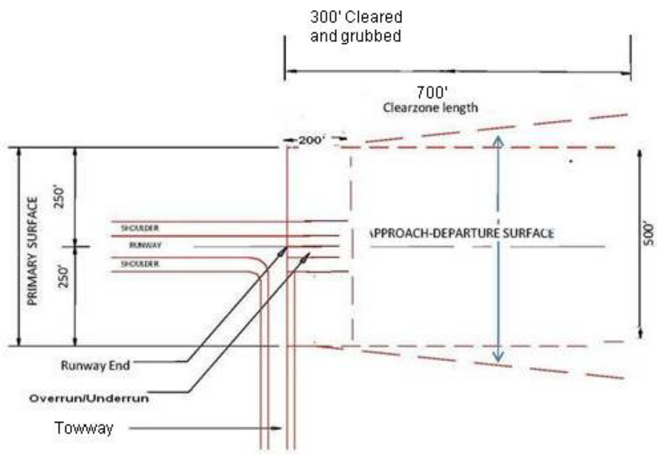


Figure A-8 MQ-1C Grey Eagle

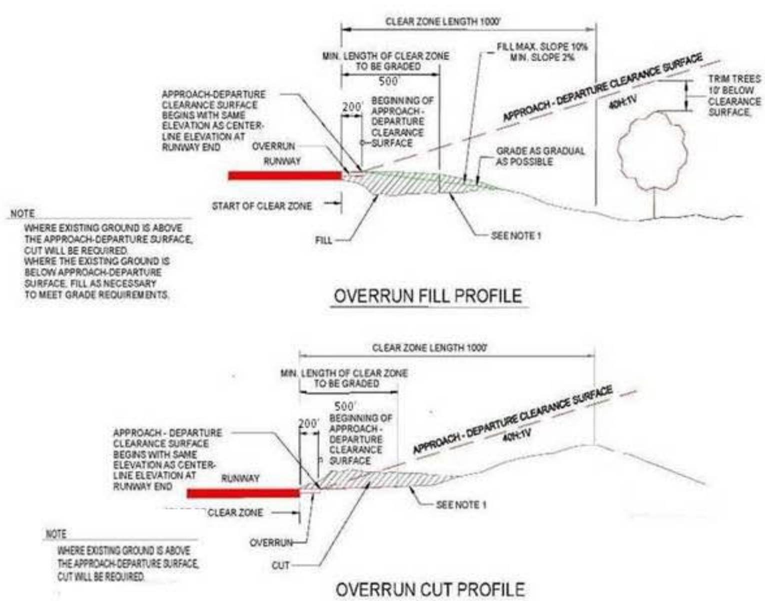


Figure A-9 RQ-7A/B Shadow

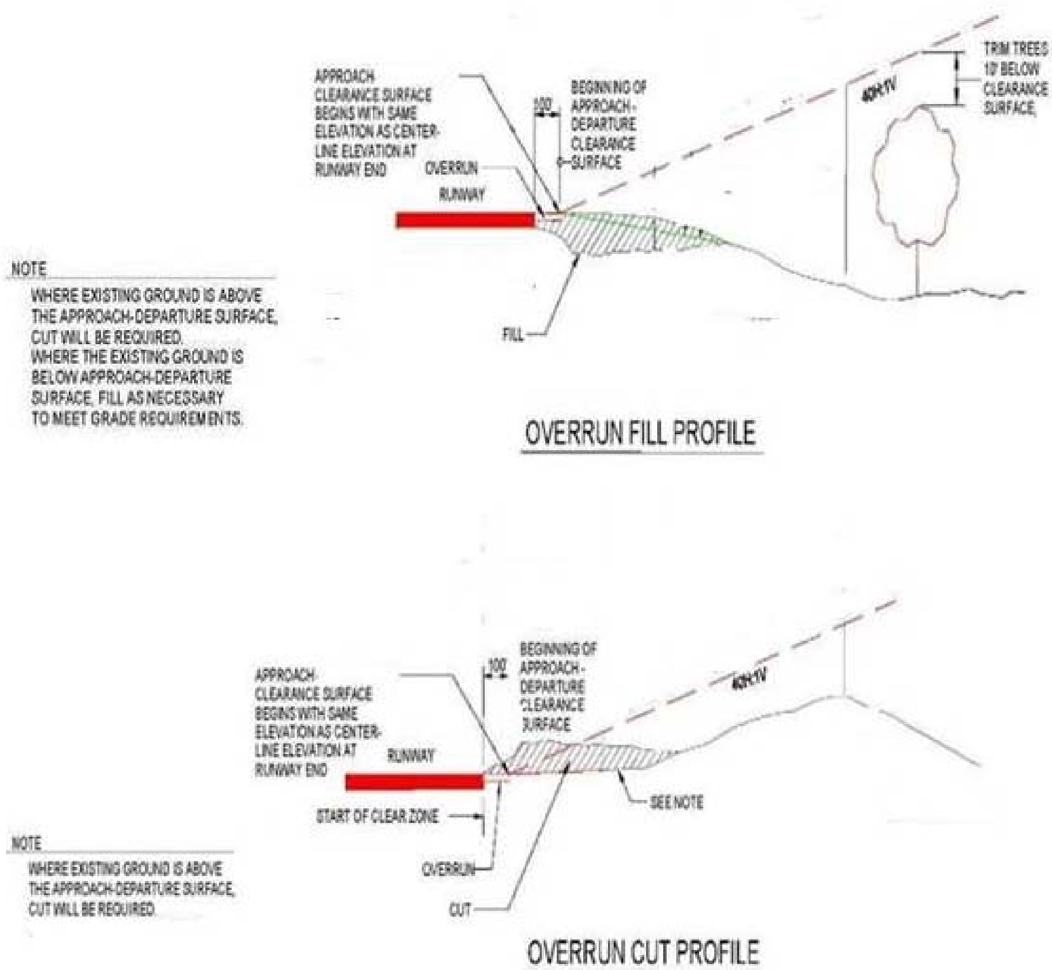
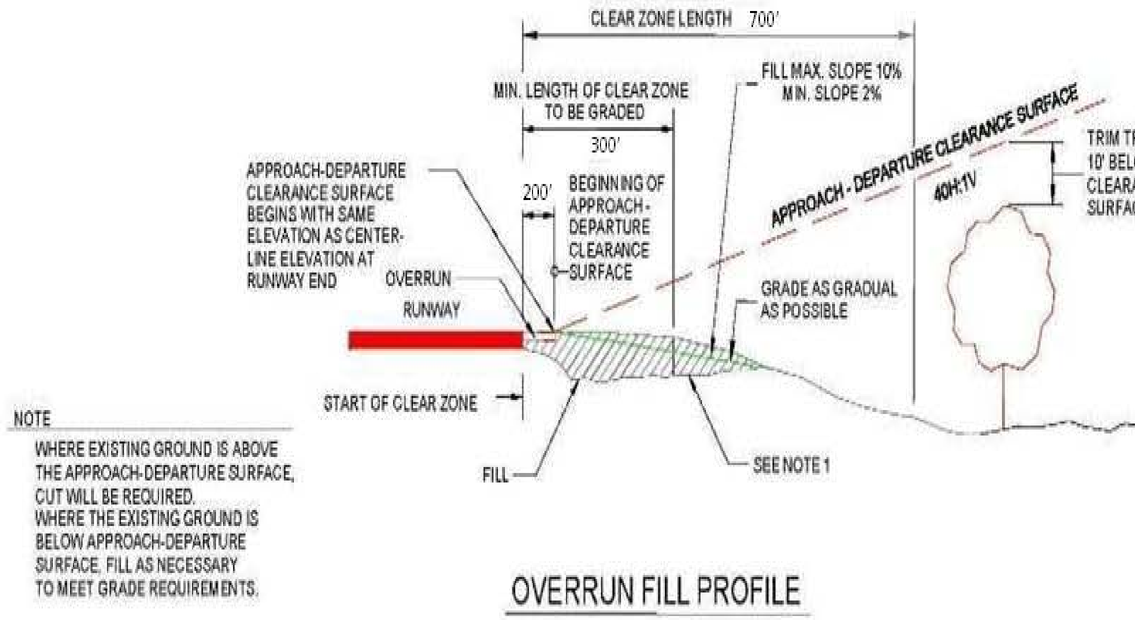


Figure A-10 MQ-5B Hunter



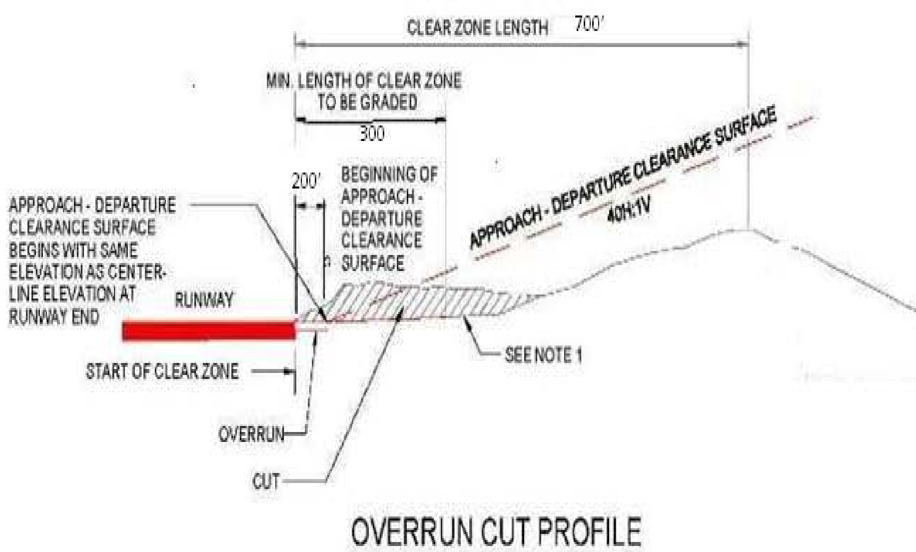
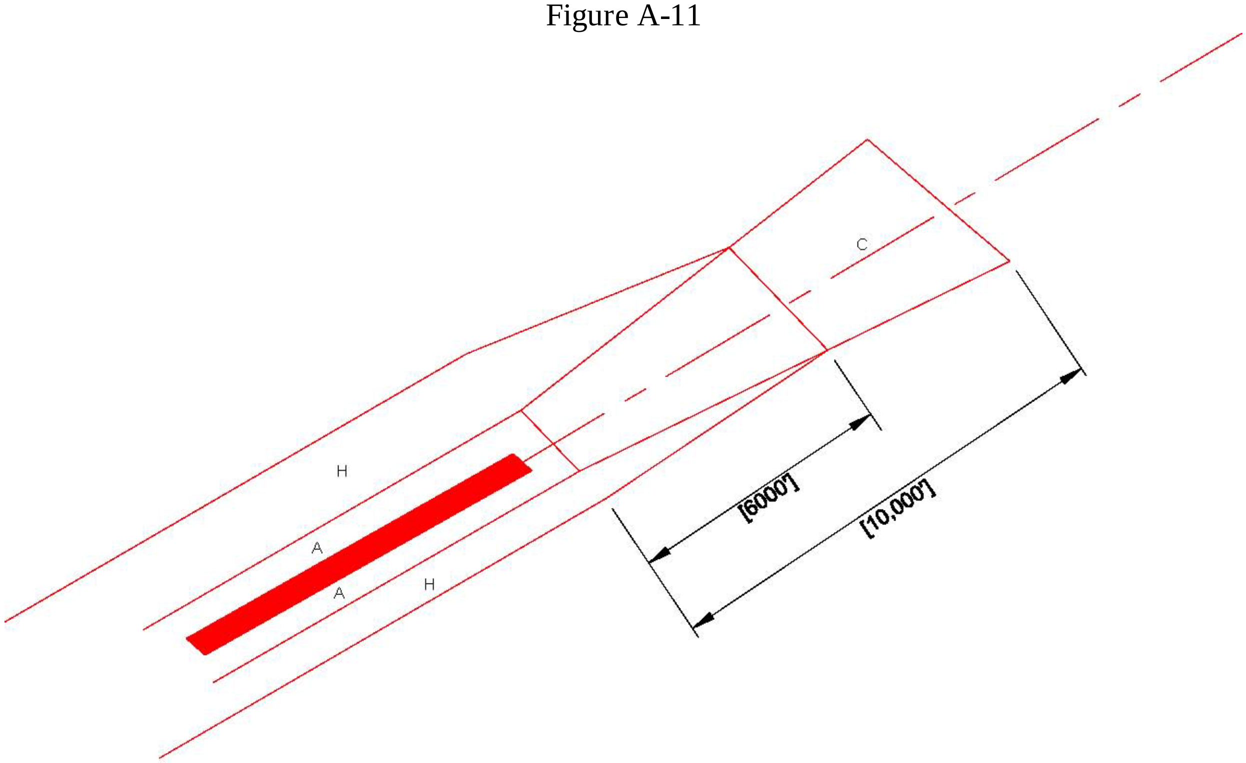


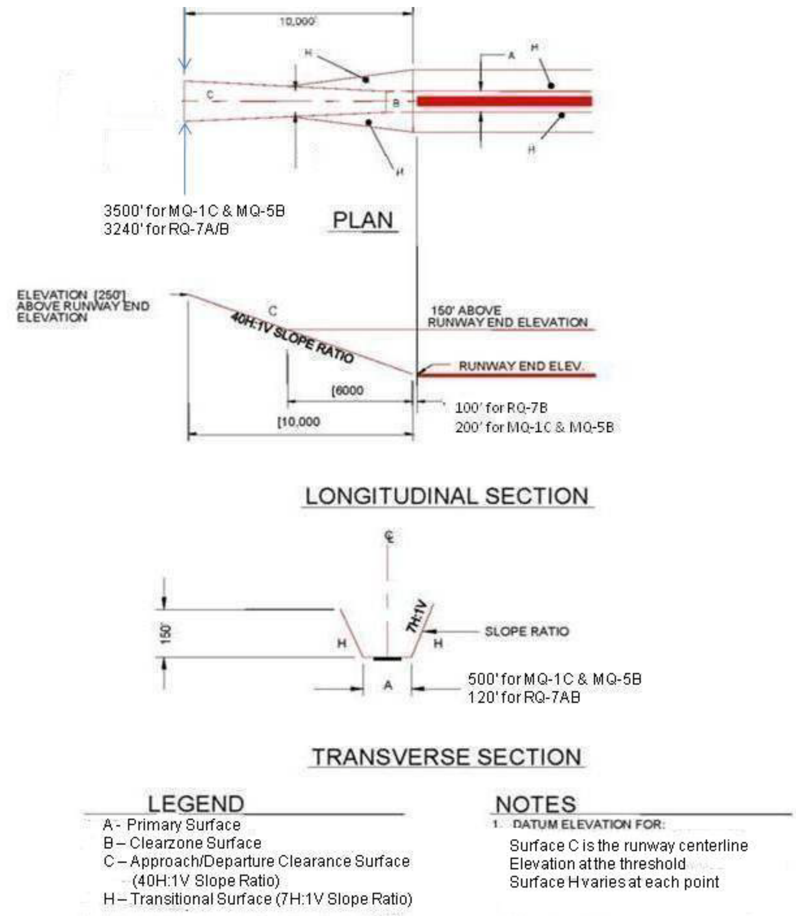
Figure A-11



LEGEND

A PRIMARY SURFACE
B CLEAR ZONE SURFACE (NOT SHOWN)
C APPROACH-DEPARTURE CLEARANCE SURFACE (40H:1V SLOPE RATIO)
D APPROACH-DEPARTURE CLEARANCE SURFACE (HORIZONTAL)(NOT REQUIRED)
E INNER HORIZONTAL SURFACE (NOT REQUIRED)
F CONICAL SURFACE (NOT REQUIRED)
G OUTER HORIZONTAL SURFACE (NOT REQUIRED)
H TRANSITIONAL SURFACE (7H:1V SLOPE RATIO)
I NOT USED

Figure A-12



e. Runway Overruns. Runway overruns keep the probability of serious damage to an aircraft to a minimum in the event that the aircraft runs off the runway end during a takeoff or landing, or lands short during a landing. Overruns are required for the landing and takeoff area.

Table A-6

Overruns					
Item		MQ-1C	RQ-7B	MQ-5B	Remarks
No.	Description	Requirement			
1	Length paved (ft)	200	Optional 100	200	
	Length unpaved (ft)	NA	100	NA	

Overruns					
Item		MQ-1C	RQ-7B	MQ-5B	Remarks
No.	Description	Requirement			
2	Total width of overrun (paved and unpaved)	Sum of runway and shoulders			The outside edges of the overrun, equal in width to the runway shoulder, are graded but not paved.
3	Paved/unpaved overrun width	Same as width of runway			Center on runway centerline extended
4	Longitudinal centerline grade	Same as last 1,000' of runway	NA	Same as last 800' of runway	To avoid abrupt changes in grade between the first 300 ft and remainder of overrun the maximum change of grade is 2.0 percent per 100 linear ft.
5	Transverse grade	Min 2.0 percent Max 3.0 percent 1.5 in drop-off at edge of paved overrun +/- 0.5 in			From centerline of overrun. Transition from the runway and runway shoulder grades to the overrun grades to be made within the first 50ft of overrun.

f. Runway Clear Zones. Runway clear zones are areas on the ground, located at the ends of each runway. They possess a high potential for accidents, and their use is restricted to be compatible with aircraft operations. Hence, they are treated as “exclusion zones” and not merely restricted access. Runway clear zones are required for the runway and should be owned or protected under a long-term lease.

(1) Treatment of Clear Zones. The clear zone consists of two distinctly different areas, the graded area (for length of the graded area, see Table A-9, item 4) and the land use control area. The graded area of the clear zone is prepared and maintained as an aircraft safety area. Preparation of the graded area must comply with the criteria given in this document. The remainder of the clear zone is a land use control or exclusion area intended to protect people on the ground. DODI 4165.57 and UFC 3-260-1, Appendix B, Section 3.

(2) Clear Zone Mandatory Frangibility Zone (MFZ). The MFZ extends through the graded area. Items that must be sited there due to their function must be made frangible to the maximum extent possible (see UFC 3-260-1, Appendix B, Section 13).

(3) Prohibited Land Uses. Criteria prohibits certain land uses within the clear zone and APZs (APZ I and APZ II). These land uses include storage and handling of munitions and hazardous materials, and live fire weapons ranges. See DODI 4165.57 for more information.

Table A-7

Clear Zones					
Item		MQ-1C	RQ-7B	MQ-5B	Remarks
No.	Description	Requirement			
1	Length (ft)	1000	360	700	Measured along the extended runway centerline beginning at the runway end. For grading requirements, see items 4 and 5.
2	Width at start of clear zone (adjacent to the runway) (ft)	500	120	500	Centered on the runway center line extended
3	Clear zone surface (graded area) (ft)	500	120	300	Graded area only. For land use outside the graded area of the clear zone, apply AICUZ standards
4	Width at end of clear zone (ft)	500	120	500	Centered on the runway center line extended
5	Longitudinal grade of area to be graded	Max 10.0 percent	NA	Max 7.0 percent	The area to be graded is 500 ft (MQ-1C), 300 ft (MQ-5B) and 100 ft (RQ-7B) in length by the established width of the primary surface. Grades are exclusive of the overrun, but are to be shaped into the overrun grade. The maximum longitudinal grade change cannot exceed ± 2.0 percent per 100 ft. Grade restrictions are also exclusive of other pavements and shoulders. Where other pavements cross the graded area, comply with grading requirements for the specific pavement design (tow ways, taxiways, or aprons as applicable), but hold grade changes to the minimum practicable to facilitate drainage.

					The graded area is to be cleared and grubbed of stumps and free of abrupt surface irregularities, ditches, and ponding areas. No aboveground structures , objects, or roadways (except air traffic control controlled service roads to arresting gear are permitted in the area to be graded, but gentle swales, subsurface drainage, covered culverts and underground structures are permissible. The transition from the graded area to the remainder of the clear zone is to be as gradual as feasible. For policy regarding permissible facilities, geographical features, and land use in the remainder of the clear zone, refer to guidance furnished by the DoD AICUZ guidelines for clear zones and accident potential zones. (See UFC 3-260-1, Appendix B, Section 3.)
6	Transverse grade of area to be graded (in direction of surface drain-age prior to channelization)	Min 2.0 percent Max 10.0 percent			
7	Width of MFZ (ft)	300	120	300	Centered on the extended runway centerline. All items sited within the MFZ in the graded area of the clear zone must be frangible. Items located beyond the Graded Area of the clear zone but within the MFZ must be constructed to be frangible, low impact resistant structures, or semi-frangible (see UFC 3-260-1, Appendix B, Section 13).
8	Length of MFZ (ft)	500	100	300	Starts at end of runway and extends through the graded area

Table A-8

Accident Potential Zones					
Item		MQ-1C	RQ-7B	MQ-5B	Remarks
No.	Description	Requirement			
1	APZ I length (ft)	1500	1500	1500	APZ I starts at the end of the clear zone, and is centered and measured on the extended centerline. Modifications will be considered if: - The runway is infrequently used. - Prevailing wind conditions are such that a large percentage (that is, over 80 percent) of the operations are in one direction. - Local accident history indicates consideration of different areas. - Most aircraft do not overfly an APZ area as defined here during normal flight operations (modifications may be made to alter these zones and adjust them to conform to the line of flight). - Other unusual conditions exist.
2	APZ I width (ft)	500	120	500	
3	APZ II length (ft)	1000	1000	1000	APZ II starts at the end of the APZ I and is centered and measured on the extended runway centerline. Modifications will be considered if: - The runway is infrequently used. - Prevailing wind conditions are such that a large percentage (that is, over 80 percent) of the operations are in one direction. - Local accident history indicates consideration of different areas. - Most aircraft do not overfly an APZ area as defined here during normal flight operations (modifications may be made to alter these zones and adjust them to conform to the line of flight). - Other unusual conditions exist.
4	APZ II width (ft)	500	120	500	

Table A-9

Airspace Imaginary Surfaces						
Item		Legend	UAS Runway			Remarks
No.	Description		MQ-1C	RQ-7B	MQ-5B	
1	Primary surface width (ft)	A	500	120	500	Centered on the runway centerline.
2	Primary surface length (ft)	A	200	100	200	Runway length plus on each end of the runway (extends beyond each end of the runway).
3	Primary surface elevation	A				The elevation of any point on the primary surface is the same as the elevation of the nearest point on the runway centerline.
4	Clear zone surface (graded area) (ft)	B	500	100	300	Graded area only. For land use outside the graded area of the clear zone, apply AICUZ standards.
5	Start of approach-departure surface (ft)	C	200	100	200	Measured from the end of the runway.
6	Length of sloped portion of approach-departure surface (ft)	C	10,000			Measured horizontally.
7	Slope of approach-departure surface	C	40:1			Slope ratio is horizontal: vertical. Example: 40:1 is 40 ft horizontal to 1ft vertical. For clearances over highway and railroads, see UFC 3-260-01, Table 3-8.

Airspace Imaginary Surfaces						
Item		Legend	UAS Runway			Remarks
No.	Description		MQ-1C	RQ-7B	MQ-5B	
8	Width of approach-departure surface at start of sloped portion (ft)	C	500	120	500	Centered on the extended runway centerline, and is the same width as the Primary Surface.
9	Width of approach-departure surface at end of sloped portion (ft)	C	3500	3240	3500	Centered on the extended runway centerline
10	Elevation of approach-departure surface at start of sloped portion (ft)	C	0			Same as the runway centerline elevation at the threshold.
11	Elevation of approach-departure surface at end of sloped portion (ft)	C	250			Above the established airfield elevation.
12	Start of transitional surface (ft)	H	250	60	250	
13	End of transitional surface	H	See Remarks			The transitional surface ends at the inner horizontal surface, conical surface, outer horizontal surface, or at an elevation of 150 ft.

Airspace Imaginary Surfaces						
Item		Legend	UAS Runway			Remarks
No.	Description		MQ-1C	RQ-7B	MQ-5B	
14	Slope of transitional surfaces	H	4:1			Slope ratio is horizontal:vertical. 4:1 is 4 ft horizontal to 1 ft vertical. Vertical height of vegetation and other fixed or mobile obstacles and/or structures will not penetrate the transitional surface. Taxiing aircraft are exempt from this requirement.

Note: See Figure A-9 & A-10

A-5. Taxiways. MQ-5B and RQ-7B do not require taxiways.

a. Taxiways provide for ground movement of aircraft. Taxiways connect the runway(s) of the airfield with the parking and maintenance areas and provide access to hangars, docks, and various parking aprons and pads. Taxiways are designated alphabetically, avoiding the use of I, O, and X. Alphanumeric designations may be used when necessary, for example, A1, B3.

(1) Basic. The basic airfield layout consists of a taxiway connecting the center of the runway with the hangar access apron. This system limits the number of aircraft operations at an airfield. Departing aircraft must taxi on the runway to reach the runway threshold. When aircraft are taxiing on the runway, no other aircraft is allowed to use the runway. If runway operations are minimal or capacity is low, the basic airfield layout with one taxiway may be an acceptable layout.

(2) Parallel Taxiway. A taxiway parallel for the length of the runway, with connectors to the end of the runway and hangar access apron, is the most efficient taxiway system. Aircraft movement is not hindered by taxiing operations on the runway, and the connectors permit rapid entrance and exit of traffic.

b. Taxiway Intersection Criteria. To prevent the main gear of an aircraft from coming dangerously close to the outside edge of the taxiway during a turn, fillets are provided at taxiway intersections. When an aircraft turns at an intersection, the nose gear of the aircraft usually follows the painted centerline marking. The main gears, located to the rear of the nose gear, do not remain a constant distance from the centerline stripe during the turn due to the physical design of the aircraft. The main gears pivot on a shorter radius than does the nose gear during a turn. Intersections should be designed to ensure that the main gear wheels stay a minimum of 5 ft from the pavement edge.

c. Hanger Access Taxiways. Hangar access taxiways are provided for aircraft access onto an hangar access apron. The apron access taxiways should be located to enhance the aircraft's departing sequence and route.

d. Shoulders. Shoulders are provided along a taxiway to allow aircraft to recover if they leave the paved taxiway. Paved shoulders prevent erosion caused by prop wash, support an occasional aircraft that wanders off the taxiway, support vehicular traffic, and reduce maintenance of unpaved shoulder areas. Criteria for UAS taxiway shoulders, including widths and grading requirements to prevent the ponding of storm water, are presented in Table A-10. Manholes, hand holes, and drainage structures constructed within these areas should, at a minimum, be designed as provided in this section. Beyond the shoulders, sub-grade structures are not designed to support aircraft wheel loads. The top surface of foundations, manhole covers, hand hole covers, and frames should be flush with the grade. Maintenance action is required if the drop-off at the edge of the structure or foundation exceeds 3 in.

Table A-10

UAS Taxiways					
Item		MQ-1C	RQ-7B	MQ-5B	Remarks
No.	Description	Requirement			
1	Width (ft)	30	NA		
2	Total width of shoulders (paved and unpaved) (ft)	10	NA		Any or all of the shoulders may be paved or unpaved.
3	Longitudinal grade of taxiway and shoulders	Max 3.0 percent			Grades may be positive or negative but must not exceed the limits specified.
4	Rate of longitudinal taxiway grade change	Max 1.0 percent per 100 ft	NA		The minimum distance between two successive points of intersection (PI) is 500 ft. Changes are to be accomplished by means of vertical curves. Up to a 0.4 percent change in grade is allowed without a vertical curve where non-high-speed taxiways intersect runways.
5	Transverse grade of taxiway	Min 1.0 percent Max 1.5 percent	NA		Taxiway pavements will be centerline crowned. Slope pavement downward from the centerline of the taxiway. When existing taxiway pavements have insufficient transverse

UAS Taxiways					
Item		MQ-1C	RQ-7B	MQ-5B	Remarks
No.	Description	Requirement			
					gradients for rapid drainage, provide for increased gradients when the pavements are overlaid or reconstructed. The transverse gradients requirements are not applicable at or adjacent to intersections where pavements must be warped to match abutting pavements.
6	Transverse grade of optional paved shoulders	Min 2.0 percent Max 4.0 percent	NA		
7	Transverse grade of unpaved shoulders	1.5 in drop-off at edge of pavement +/- 0.5 in 2.0 percent min, 4.0 percent max	NA		Unpaved shoulders shall be graded to provide positive surface drainage away from paved surfaces.
8	Clearance from taxiway centerline to fixed or mobile obstacles (taxiway clearance line) (ft)	100	NA		
9	Distance between taxiway centerline and parallel taxiway/taxilane centerline (ft)	125	NA		
10	Grade of area between taxiway shoulder and taxiway clearance line	Min of 2.0 percent prior to channelization Max 10.0 percent			Unpaved areas shall be graded to provide positive surface drainage away from paved surfaces. 1.5-in drop-off at pavement edge, +/- 0.5 in.

e. Towways. A towway is used to tow aircraft from one location to another or from the runway to a hangar/storage facility.

(1) Dimensions. Table A-11 presents the criteria for towway layout and design, including clearances, slopes, and grading dimensions. When designing for access to a hangar, flare the pavement to the width of the hangar door from a distance beyond the hangar sufficient to allow maintenance personnel to turn the aircraft around.

Table A-11 Towways

Item		MQ-1C	RQ-7B	MQ-5B	Remarks
No.	Description	Requirement			
1	Width (ft)	30	15	20	
2	Total width of shoulders (ft)	10	10	10	Any or all of the shoulders may be paved or unpaved.
3	Longitudinal grade of towway	Max 3.0 percent			Grades may be both positive and negative but must not exceed the limit specified.
4	Rate of longitudinal grade change per 30 m (100 ft)	Max 1.0 percent			The minimum distance between two successive PI is 150 m (500 ft). Changes are to be accomplished by means of vertical curves.
5	Longitudinal sight distance	N/A (See note 1.)			
6	Transverse grade	Min 2.0 percent Max 3.0 percent			Pavement crowned at towway centerline Slope pavement downward from centerline of towway.
7	Towway turning radius (ft)	75	50	50	Criteria presented here are for straight sections of towway. Pavement width and horizontal clearance lines may need to be increased at horizontal curve locations, based on aircraft alignment on the horizontal curve.
8	Fillet radius at intersections (ft)	50	30	40	

9	Transverse grade of shoulder	(a) 40 mm (1.5 in) drop-off at edge of pavement, +/- 13 mm (0.5 in). (b) 2.0 percent min, 4.0 percent max.	
10	Horizontal clearance from towway centerline to fixed or mobile obstacles	The greater of: ½ the wing width of the towed +25 ft.; or the minimum of 60 ft.	
11	Vertical clearance from towway pavement surface to fixed or mobile obstacles	(Height of towed mission aircraft) + 3 m (10 ft)	
12	Grade (area between towway shoulder and towway clearance line)	Min of 2.0 percent prior to channelization Max 10 percent. (See note 2.)	

NOTES:
1. N/A = not applicable
2. Bed of channel may be flat.

A-6. Aprons and Other Pavements.

a. Hanger Access Apron. The pavement that allows access from the taxiway/towway to the hangar is referred to as a “hangar access apron” and is discussed in more detail below.

b. Apron Requirements. They should be sized to allow safe movement of aircraft towed or under their own power.

c. Types of Aprons and Other Pavements. Listed here are types of aprons and other aviation facilities:

-Hangar access apron/Warm up pad
-Arm/disarm pad

(1) Location. Access aprons should be located contiguous to maintenance and hangar facilities. Do not locate them within runway and taxiway lateral clearance distances. A typical access apron is illustrated in Figure A-13. Based on VCSA approval of concept, there is no aircraft parking apron authorized for UAS.

(2) Size. As a general rule, there are no standard sizes for aircraft aprons. Aprons are individually designed to support aircraft and missions at specific facilities. The actual dimensions of an apron are based on the number of authorized aircraft, the maneuvering space, and the type of activity that the apron serves. The ideal apron size affords the maximum parking capacity with a minimum amount of paving.

(3) Hanger Access Apron.

(a) Variety of Aircraft. Where there are a large variety of UAS aircraft types, UAS access/parking apron dimensions will be based on the MQ-1C. The MQ-1C parking space width is 70 ft, and the parking space length is 50 ft.

(b) Specific Aircraft. If the assigned aircraft are predominantly one type, the access/parking apron will be based on the specific dimensions of that aircraft, i.e. an RQ-7B parking space 34 ft in width and 34 ft in length, the MQ-5B parking space is 54ft in width and 43 ft in length.

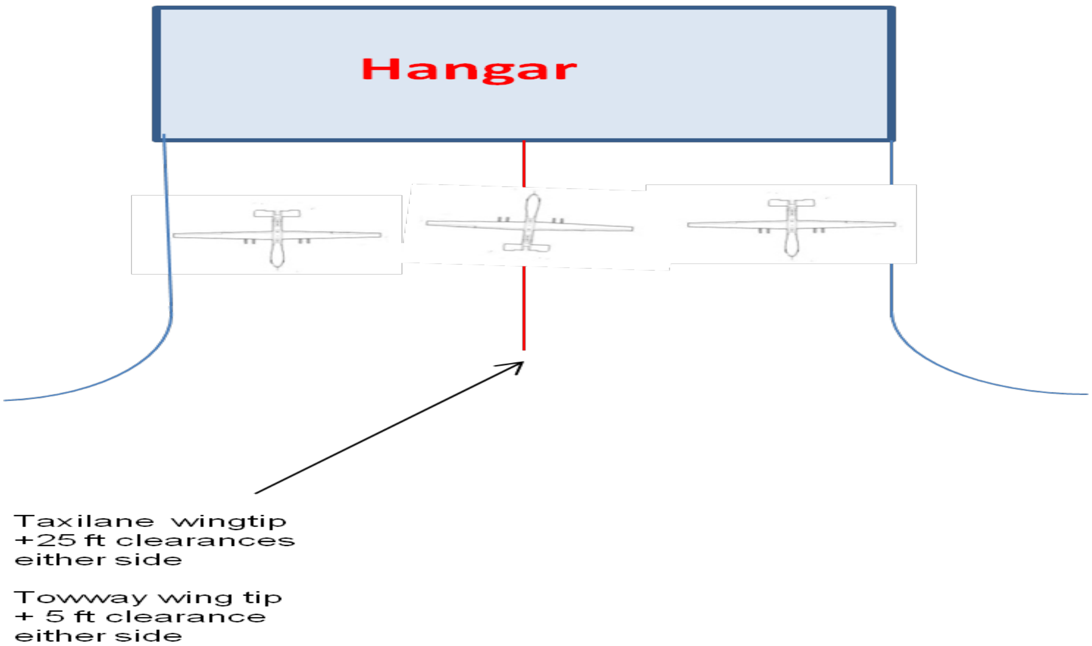
(c) Layout. The hangar access/ parking apron will be sized to accommodate a minimum of 2 UAS's with a pass thru taxilane (See Figure A-13).

Table A-12

Hangar Access Apron					
Item		MQ-1C	RQ-7B	MQ-5B	Remarks
No.	Description	Requirement			
1	Length (ft)	125	15	100	
		See Remarks			Access aprons are located between the taxiway/towway and the front of the hangar. The hangar cannot be located within the taxiway/towway clearance distance.
2	Width (ft)	200	32	100	Pavement should be sized for type of aircraft, number of hangar bays, and location of hangar bays.

Hangar Access Apron					
Item		MQ-1C	RQ-7B	MQ-5B	Remarks
No.	Description	Requirement			
3	Grades in direction of drainage	Min ±0.5 percent Max ±1.5 percent			
		Min -1.0 percent first 50 ft from hangar			NFPA 415 requires aircraft fueling ramps to slope away from terminal buildings, aircraft hangars, aircraft loading walkways, or other structures.
4	Width of shoulders (total width including paved and unpaved) (ft)	10	5	10	
5	Width of paved shoulders	Not required			
6	Transverse grade of unpaved shoulder	(a) 1.5 in drop-off at edge of pavement. (b) 2.0 percent min, 4.0 percent max.			
7	Wingtip clearance to fixed or mobile obstacles (ft)	25			Along length of access apron. Wingtip clearance at entrance to hangar may be reduced to 10 ft either side of the door for MQ-1C, 5 ft either side for RQ-7A/B and MQ-5B
8	Grade (area between access apron shoulder and wingtip clearance line)	Max 10.0 percent			If the wingtip clearance line falls within the access apron shoulder, no grading is required beyond the access apron shoulder.

Figure A-13 MQ-1C/MQ-5B



d. Arm/Disarm Pad. The arm/disarm pad is used for arming aircraft immediately before takeoff and for disarming (safing) weapons retained or not expended upon their return. Do not site arm/disarm pads or taxiways to these facilities in a way that will allow penetration of the approach-departure clearance surface.

(1) Location. Arm/disarm pads should be located adjacent to runway thresholds and sited such that armed aircraft are oriented in the direction of least populated areas or towards revetments.

(2) Turning Radius. The turning radius for taxilanes on arm/disarm pads should be designed to provide the minimum allowable turn under power of the largest aircraft that will use the arm/disarm pad.

(3) Access Road. An all-weather access road should be constructed to the arm/disarm pad from outside the airfield's taxiway and runway clearance areas. Design this road in accordance with UFC 3-250-18FA and UFC 3-250-01FA. Access roads must not encroach on taxiway clearances or taxilane wingtip clearance requirements (except at necessary intersections with these areas), nor shall any parking area associated with the access road be sited so that maintenance vehicles will violate the approach-departure clearance surface or any NAVAID critical area.

APPENDIX B

Frangibility Requirements

B-1. The TALS-TS and similar structures should be designed such that frangible points including electrical connections must withstand wind loads from jet blasts up to 300 mph (483 kph) but must break before reaching an applied static load distributed over the cross sectional area of the TALS-TS surface of 2.8 psi (19.3 kPa). No part of the TALS-TS foundation and any remaining structure attached to it will extend 3 inches or more above grade after the frangible connections fail. This load shall be applied to the front side of the TALS-TS for the first part of the test. This load shall be applied to the back side of the TALS-TS for the second part of the test.

B-2. Frangibility testing. TALS-TS and similar structures must be tested to withstand jet blasts of 300 mph (483 kph) without damage.

B-3. All testing must be performed with TALS-TS fully assembled including the electrical connections and mounted on its foundation.

B-4. Jet blast tests must be designed to ensure that the TALS-TS receives the full jet blast.

B-5. To simulate wind loading, a static force equivalent to the specified jet blast (2.0 psi (13.8 kPa) for jet blast of 300 mph) must be uniformly applied to the entire front surface of the TALS-TS for 10 minutes. Then, the specified jet blast (2.0 psi (13.8 kPa) for jet blast of 300 mph) must be uniformly applied to the entire back surface of the TALS-TS for 10 minutes.

a. The TALS-TS must not break at the frangible points.

b. Both the TALS-TS and its supports must be inspected for damage. If there is any breakage or permanent deformation, it is considered as a test failure and a cause for rejection.

B-6. The static force (equivalent to the specified wind velocity) applied in paragraph c must be increased until the TALS-TS breaks at the frangible points. Frangible point failure must occur before the TALS-TS loading reaches a maximum equivalent static force of 2.8 psi (19.3 kPa). If frangible point failure does not occur before the TALS-TS loading reaches a maximum equivalent static force of 2.8 psi (19.3 kPa), it is considered as a test failure and a cause for rejection.

B-7. The testing must be performed by a laboratory accepted by the FAA as third party certifiers under the Airport Lighting Equipment Certification program. At this time the laboratory accepted by the FAA is Intertek Testing Services, 3933 U.S. Route 11, Cortland, New York 13045.