EXHIBIT 2.1B

Airfield Obstruction Survey and

Obstruction Evaluation Criteria for Army Airfields

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CHAPTER 1. GENERAL PROGRAM INFORMATION

1.1. PURPOSE

This document provides criteria for conducting airfield obstruction surveys and analysis for Army airfields and heliports. The Army has more extensive criteria than the other services for the collection, analysis, review and reporting of obstruction surveys. Criteria is in line with existing guidance and are used to help protect life and ensure safety at Army airfields. This document will assist in understanding which parts of these guidance documents apply to Army airfields obstruction surveys and which do not.

1.2. SCOPE

This document provides criteria for airfield obstruction surveys and analysis for Army airfields and heliports which includes (project approach, responsibilities and interaction with airfield managers, required feature collection, feature collection accuracies, survey field procedures, selection of imaginary surfaces, identification and reporting of minimum clearance features, chart development, required deliverables, and the survey review process).

1.3. REFERENCE DOCUMENTS

1.3.1. The references listed in this section were used in the formation of this document. In the event of a conflict between criteria in this document and the references cited herein, this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

1.3.2. Airfield and Heliport Planning and Design, UFC 3-260-01, U.S. Army Corps of Engineers, Air Force Civil Engineer Support Agency, Naval Facilities Engineering Command

1.3.3. Marking of Army Airfield Heliport Operational and Maintenance Facilities, UFC 3-260-04, U.S. Army Corps of Engineers, Air Force Civil Engineer Support Agency, Naval Facilities Engineering Command

1.3.4. Air Traffic Control, Airfield/Heliport, and Airspace Operations, Army Regulation 95-2

1.3.5. General Guidance and Specifications for Aeronautical Surveys: Establishment of Geodetic Control and Submission to the National Geodetic Survey, Federal Aviation Administration Advisory Circular 150/5300-16

1.3.6. Standards for Using Remote Sensing Technologies in Airport Surveys, Federal Aviation Administration Advisory Circular 150/5300-17

1.3.7. General Guidance and Specifications for Submission of Aeronautical Surveys to NGS: Field Data Collection and Geographic Information Systems (GIS) Standards, Federal Aviation Administration Advisory Circular 150/5300-18

1.3.8. World Geodetic System —1984 (WGS-84) Manual, Doc 9674 AN/946, Current Edition, International Civil Aviation Organization.

1.3.9. Annex 14 to the Convention on International Civil Aviation, Aerodrome Design and Operations. International Civil Aviation Organization.

1.3.10. Visual Air Navigation Facilities, UFC 3-535-01. U.S. Army Corps of Engineers, Air Force Civil Engineer Support Agency, Naval Facilities Engineering Command.

1.3.11. FAR PART 77—Safe, Efficient Use, and Preservation of the Navigable Airspace, Title 14: Aeronautics and Space, U.S. Government Printing Office, Electronic Code of Federal Regulations, Subpart C – Standards for Determining Obstructions to Air Navigation or Navigational Aids or Facilities, §77.21 Department of Defense (DOD) airport imaginary surfaces

1.3.12. NIMA Technical Report 8350.2 - Department of Defense World Geodetic System 1984, Current Edition. This document is available at:

http://earth-info.nga.mil/GandG/publications/tr8350.2/wgs84fin.pdf

CHAPTER 2. PROJECT UNDERSTANDING AND APPROACH

2.1. PROJECT UNDERSTANDING

Obstruction surveys for Army airfields use many of the same requirements as the other services; however, in some cases, the Army requirements differ and are more stringent in terms of identifying and reporting obstructions. One of the primary purposes of this document is to ensure that team members conducting obstruction surveys at Army airfields and the subsequent analysis are aware of these differing requirements and adhere to them. The scheduling and review for Army airfield obstructions also follows a different process, so it is important to understand the roles, responsibilities and workflow for obstruction surveys at Army airfields.

The US Army Aeronautical Services Agency (USAASA) serves as the functional proponent for Army airfields/heliports for Department of Army Headquarters and is the responsible official for airspace, aeronautical information, air traffic control, NOTAM and flight procedures policy. USAASA is responsible for tracking completion of airfield obstruction surveys at Army airfields.

Airfield obstruction data is primarily used by USAASA to assist Terminal Instrument Procedures (TERPS) personnel in identifying changes at the airfield which might impact

existing and planned instrument approach and departure procedures. The surveys are also critical to airfield managers for situational awareness and planning for obstruction mitigation if required.

It is the responsibility of the Army Command (ACOM), Direct Reporting Unit (DRU), and/or Army Service Component Commands (ASCC) to schedule and fund required obstruction surveys. Each Army airfield has an individual responsible for oversight and management of the airfield. Individuals in this role may have varying titles so this document will use the term “airfield manager” to reference the individual who is responsible for the airfield and is knowledgeable about the layout and operation of the airfield. The airfield manager is responsible for coordinating with the survey team.

The US Army Corps of Engineers (USACE) is the agency overseeing the project and can contract for this work.

2.2. PROJECT OVERVIEW

2.2.1. Project Start: Upon notice to proceed, the USACE project manager will schedule a kick-off meeting with the airfield manager, airfield's command representatives, USACE project team and survey team. The main purpose of this meeting is to introduce the survey team and airfield manager to facilitate coordination.

2.2.2. Pre-Survey Checklist: The survey team and the airfield manager should work together to complete the pre-survey check list in Appendix A prior to the start of field work. This is an important step that will ensure more productive field time.

2.2.3. Pre-Survey Research: The USACE project team will provide the deliverables from the most recent airfield survey if available. The survey team may need to conduct additional coordination with the airfield in preparation for the survey. To minimize costs, a reconnaissance trip is normally not used in these types of surveys.

2.2.4. Pre-Survey Report: Prior to mobilizing, the survey team shall send a brief pre-survey report. The purpose of this report is to identify any known or potential issues that could affect scope or duration of the field work. See Chapter 8 for report requirements.

2.2.5. Survey: The survey will be conducted in accordance with the criteria in this document and the scope of services. If there are any conflicts in guidance or criteria, they should be directed to the USACE project manager. A majority of Army airfield obstruction surveys over the past ten years have been entirely field surveyed. The use of aerial photography or aerial photography in conjunction with LiDAR may be approved on a case by case basis if a cost savings can be shown. Navigation aids (NAVAIDS) and runway features must be field surveyed in order to meet accuracy requirements. NOTE: The use of LiDAR may be required at installations that experience rapid vegetation growth as taller vegetation may block obstructions behind them when performing a field survey. See Chapter 3 for additional information.

2.2.6. Post Processing and Obstruction Analysis: Obstruction analysis should be conducted in accordance with the criteria provided in this document and the scope of services. To meet both Army and FAA requirements, the obstruction surfaces will be built using a combination of three different guidance documents. See Chapter 4 for definitions for obstruction surfaces.

2.2.7. Phase 1 Review of Deliverables: Draft deliverables will be sent to the USACE project manager for initial review. Standard deliverables are detailed in Chapter 8. Additional deliverables may be specified in the scope of services.

2.2.8. Phase 2 Review of Deliverables: When the deliverables have passed the phase 1 review, they will be sent to USAASA and the airfield manager for review and comment. The deliverables shall not be finalized until both the airfield manager and USAASA have reviewed the information, provided feedback to the USACE project manager and any required changes completed.

2.2.9. Final Deliverables: The scope of services will list the points of contact of individuals who will receive final deliverables, the number of copies required for each and if the deliverables will be hard copy or digital.

CHAPTER 3. DATA COLLECTION APPROACHES

3.1. GENERAL

There are a variety of methods available to collect data for airfield obstruction surveys. Regardless of the approach, the method used must meet the accuracy standards set in Appendix B for the respective airfield feature. When deciding on a method, the most cost effective approach which meets the accuracy requirements should be considered. The acceptable methods and respective guidance for each is contained in this section.

3.2. FIELD SURVEY

The field survey is the preferred approach for most Army airfield obstruction surveys. Other data collection methods still require some key features to be field surveyed including the normal threshold, runway centerline and navigation aids (NAVAIDS). All surveyed features must meet the accuracy standards specified in Appendix B.

3.3. AERIAL IMAGERY

3.3.1. Guidance: The FAA AC 150/5300-17 *Standards for Using Remote Sensing Technologies in Airport Surveys* specifies requirements for the collection and use of imagery that is acceptable for use for obstruction surveys. If imagery will be used, it must be flown at a scale which will meet the required map and feature level accuracies with adequate side overlap as specified in AC 150/5300-17. Satellite

imagery or other imagery sources which do not meet the map accuracies specified in AC 150/5300-17 or do not meet the accuracies of individual features as specified in Appendix B shall not be used for feature extraction for obstructions or other features requiring elevation information.

3.3.2. Temporal Considerations: If existing imagery is available which meets all the requirements of the AC 150/5300-17, it should not be used for extraction of obstruction information if it does not reflect current conditions at the airfield. If changes have occurred at the airfield, such as construction, the use of imagery alone for obstructions identification may be called into question. Use of existing imagery requires approval from the USACE project manager. If approved and existing imagery is used for identifying and extracting obstruction elevations, the date of the imagery should be noted in both the survey/analysis report and the summary data sheet.

3.3.3. Feature Collection: Runway thresholds, runway centerline points and all NAVAIDs must be field surveyed.

3.4. LiDAR

3.4.1. Guidance: The FAA AC 150/5300-17 *Standards for Using Remote Sensing Technologies in Airport Surveys* contains a section which discusses the use of LiDAR for airport mapping. The AC 150/5300-17 Appendix A provides a list of airfield features and denotes whether or not LiDAR is appropriate for collection of the feature. Per AC 150/5300-17 Appendix A, obstruction identification requires complimentary imagery, sufficient look angle and interpretation from data. Based on this guidance, it is not appropriate to use LiDAR by itself for the determination of obstacles and their elevations.

3.4.2. Imagery Requirement: Based on the AC 150/5300-17 Appendix A, in order to conduct an airfield obstruction survey using LiDAR, you must also fly imagery at the appropriate map scale to use for extraction of obstruction elevations. Using the LiDAR approach in AC 150/5300-17 is essentially the same as using imagery with the additional cost of the LiDAR added. This may be appropriate in highly

urbanized areas or areas of heavy vegetation where the concentration of obstructions near the airfield may be extremely high. As a result, the use of LiDAR collection specifically for conducting an airfield obstruction survey should only be considered where it can introduce significant cost savings.

3.4.3. Feature Collection: Runways ends, runway thresholds, displaced thresholds, runway centerline points and all NAVAIDs must be field surveyed.

3.5. INSTALLATION/GARRISON MAPPING

3.5.1. General: For airfield obstruction surveys, installation mapping refers to those features on or around the airfield which are not required for collection, evaluation or reporting of airfield obstruction surveys. This would include features such as taxiways, aprons, buildings, fences, roads and other structures (assuming these features are not obstructions). Normally, these features are not collected during the survey unless they are specifically requested as an option in the scope of services.

3.5.2. Map Layers: While installation mapping is not a requirement for airfield obstruction surveys, the airfield manager may request the mapping of the installation or specific parts based on changes which have occurred at the installation, such as new construction. Any base mapping requirements should be identified in the scope of services.

3.5.3. Airfield Obstruction Charts (AOC): The purpose of an airfield obstruction chart is to provide a graphical representation of the results of the obstruction survey. This is an easier format for individuals to interpret when using the survey results for situational awareness or mitigation planning at the airfield. AOCs are used in the scope of services, use Appendix F for guidance on creating charts.

3.5.3.1. *Mapping Layers Available*: If the airfield has not requested additional mapping and already has the installation mapped in CADD or GIS, this existing data should be used as the reference map data for obstruction charts. The source

of map data should be cited on the AOC if not collected at the same time as the obstruction survey information. It is recommended that the surveyors spot check locations of few points of the existing map data while in the field, such as building corners, to assure there will not be any issues aligning the map data on the AOC.

3.5.3.2. *Mapping Layers Not Available*: If the airfield does not have existing spatial data that could be used for mapping, the data will need to be collected. If the airfield is interested in mapping data for reference on the AOC only, a cost/benefit should be determined between field collecting the map data and developing the map data from a secondary data source, such as heads up digitizing of imagery. While there is a high degree of emphasis placed on the accuracy on airfield obstruction surveys, the installation data used for mapping on the AOCs is not part of the airfield obstruction survey and analysis. It is only used as a visual reference for users to gain a spatial understanding of the location of obstructions.

CHAPTER 4. OBSTRUCTION IDENTIFICATOIN SURFACES (OIS)

4.1. OBSTRUCTION IDENTIFICATION SURFACES (OIS) SELECTION

4.1.1. General: Constructing the appropriate imaginary surface is critical for an airfield obstruction survey since any object which penetrates the imaginary surface is a potential obstruction. Depending on the type of runway, one or more guidance documents may be used to construct the imaginary surfaces.

4.1.2. Class A and Class B Runways: Fixed wing runways at army airfields are designated as Class A or B. The class of runway being surveyed will be identified in the scope of services.

4.1.2.1. *Instrument Flight Rules (IFR)*: Class A/B runways subject only to instrument flight rules (IFR) will use the appropriate imaginary surface as defined in the UFC 3-260-1.

4.1.2.2. *Visual Flight Rules (VFR)*: FAA surveys are not required on runways that are only subject to visual flight rules (VFR); however, airfields may request an obstruction survey for a VFR runway. Class A/B runways subject only to visual flight rules (VFR) will use the appropriate imaginary surface as defined in the UFC 3-260-1.

4.1.3. Rotary Wing Aircraft: The obstruction identification surfaces specified in the UFC 3-260-1 should be used when constructing an OIS for a helicopter runway, helipad or hover point. Note that the UFC contains a separate definition for an IFR OIS and a VFR OIS for helipads. The scope of services should indicate if a helipad analysis will be for IFR or VFR. Some helipads have a one direction ingress/egress approach or multiple one direction ingress/egress approaches which will affect the OIS that is defined for analysis of obstructions. The number and directions of the one direction ingress/egress approaches will be stated in the scope of services. If you are an airfield manager, it is important to communicate specifics about your helipads and helicopter runways to the survey team. The center point of the helipad is the starting point for construction of the OIS.

4.1.4. Emergency GPS (EGPS): When evaluating for obstructions, EGPS are considered IFR and should be evaluated using the appropriate IFR OIS.

4.1.5. Unmanned Aircraft Systems (UAS): When a UAS obstruction survey is required, the airfield manager may request an obstruction survey for a UAS or for sighting of a UAS. Unmanned army aircraft should use the OIS criteria specified in UFC 3-260-1 for UAS type. OIS definitions are for MQ-1C Grey Eagle, and RQ-7B Shadow 200 so the UAS type should be identified prior to the obstruction survey. For UAS OIS definitions not listed in UFC 3-260-1, consult USAASA or USACE for guidance.

4.1.6. End of Runway: The ends of runway (EOR), also known as the normal threshold, are the starting points for construction of the OIS (see Chapter 6 for further understanding on end of runways). When constructing an OIS for pre-survey planning or for the standard obstruction analysis, the end of runway points must be used to define the primary surface. The displaced threshold should never be

used to define the primary surface unless an analysis has been requested in addition to the standard analysis using the normal threshold. If there are any concerns or conflicts concerning the correct end of runway, the issues should be resolved prior to constructing the OIS. See the section on airfield features for further information on runway ends. If there are any questions concerning end of runways, contact USAASA.

4.1.7. Two-Point or Multipoint Method: When constructing the OIS for Army airfields, the two-point method shall be used. In this approach, both end of runway elevations are used as the starting point to define the primary surface. In the event that elevations between the runway ends are variable enough to result in missed obstructions or generate 'false' obstructions, a multipoint method should be used. When applying the multipoint approach, enough elevations from the runway centerline should be used to adequately characterize the elevation variability of the runway. If the survey team has the ability to generate the primary surface using the runway centerline profile shots, that approach is also acceptable. The two-point and multipoint approaches are used because they eliminate false obstructions which may result from using the single point method. The single point method, where the lowest runway end elevation is used, is not acceptable for obstruction surveys at Army airfields.

CHAPTER 5. GEODETIC CONTROL REQUIREMENTS

5.1. GENERAL

5.1.1 Guidance: FAA AC 150/5300-16 is the primary reference document for geodetic control requirements; however, not all requirements in the AC apply to airfield surveys. Some key variations are addressed in this section. If there are any questions about whether or not a specific portion of the FAA AC 150/5300-16 applies, please contact the USACE project manager.

5.1.2 Datum: The FAA AC 150/5300-16 requires WGS84 as the horizontal datum and EGM96 for the vertical datum. For OCONUS Surveys, the host nation datum or installation datum should be used unless otherwise directed.

5.2. CONTROL

5.2.1. PACS and SACS: Most airfields will have two Primary Airport Control Stations (PACS) and two Secondary Airport Control Stations (SACS) though sometimes these controls are lost due to construction. Use of PACS and SACS is preferred. If PACS and SACS cannot be located, other existing control on the airfield should be considered. See the FAA AC 150/5300-16 for guidelines for other acceptable control monuments.

5.2.2. Control Recovery: If a previous airfield obstruction survey has been completed, the control used will be listed in the Summary Data Sheet and may assist in locating monuments. The airfield manager may be able to provide information on location of PACS, SACS or other control set at the airfield as well as any changes which might have affected existing control. Once recovered, the condition of the control should be documented for the survey report including photographs. For guidance on documenting control, see FAA AC 150/5300-16.

5.2.3. NSRS Tie: The FAA AC 150/5300-16 requires that control be tied to the National Spatial Reference System (NSRS). For most airfields, tying control into the NSRS should not be problematic; however, if a situation occurs where tying to the NSRS would require an unusual level of effort, the survey team should bring the issue to the attention of the USACE project manager for discussion prior to mobilization.

5.3. ADDITIONAL INFORMATION

Some past Army airfield obstruction surveys were reported using NAVD88. An elevation for a specific survey location reported in NAVD88 could differ by several feet when compared to the same elevation reported in EGM96.

CHAPTER 6. AIRFIELD FEATURES

6.1. GENERAL

This chapter covers the airfield features that need to be identified and collected for an obstruction survey. This chapter focuses on a field collection perspective and is separated into five main sections: identification and collection of specific runway features, computed runway values, collection of navigational aids, special Department of Army Forms, and different types of obstacles. Collection of spatial data layers for AOC mapping does not fall under airfield features and will not be covered in this chapter. See the data collection methods chapter for guidance on collection of installation mapping data.

6.1.1. Airfield Features: Appendix H is a glossary of airfield features.

6.1.2. Elevations: Elevation values for all features will be provided as orthometric heights using WGS84 in feet and meters.

6.1.3. Accuracies: Specific accuracies of airfield features are listed in Appendix B.

6.1.4. Summary Data Sheet: Airfield features will be reported in the Summary Data Sheet. Instructions for reporting to the Summary Data Sheet are located in Appendix D.

6.2. SURVEYING RUNWAY FEATURES

6.2.1. Runway End Designations: Per FAA AC 150/5300-18, surveyors should refer to and document runways using the number painted on the runway at the time of the field survey. If a number is not painted on the runway, use the runway number published in the current version of the U.S. Terminal Procedures.

6.2.2. Understanding Thresholds

6.2.2.1. *Thresholds*: Airfield obstruction surveys use the location of the normal thresholds as the starting points for the construction of the imaginary surfaces, so it is critical that the correct locations are identified IAW the UFC and surveyed. The normal threshold is synonymous with the term End of Runway (EOR). The EORs define the full strength of pavement of the runway and are not the same as the end of pavement. In most cases, the ends of runway will not change; however, construction or changes at the airfield may result in new end of runway values. In some instances the normal threshold may be displaced. A displaced threshold is a threshold that is not located at the beginning of the full-strength runway pavement. Both the normal and displaced thresholds should be surveyed; however, the normal threshold should be used for the construction of the imaginary surfaces in a standard obstruction survey.

6.2.2.2. *Runway Markings*: The UFC 3-260-04 shows how markings for relocated and displaced thresholds should appear on runways; however, it is possible that markings on the airfield may not be correct and so should never be used as the sole indicator. Surveyors should be familiar with these markings for their discussion with the airfield manager.

6.2.2.3. *Length of Runway*: The length of runway is measured in accordance with Section 2.6.10.5.5 of FAA AC 150/5300 18.

6.2.3. Normal Threshold/End of Runway (EOR): The runway end, or normal threshold, elevations should be taken at the runway end (as defined in the above section) along the centerline and reported with a description that includes the runway end designation (example: End of Runway 11). For documentation purposes photos should be taken to show where the surveyor surveyed on each runway end. The photos should be taken in a manner that would allow an individual to relocate the survey point. These photos should be included in the final survey report. Before leaving the airfield, the surveyed EORs values should be compared to previous

surveys and the published EOR values, if available. Substantial differences should be investigated to ensure the correct EORs have been collected prior to de-mobilization. The airfield manager should be able to provide guidance to the surveyors concerning the ends of runway locations; however, it is important that the survey team understands the concept of the normal threshold in order to communicate effectively with the airfield manager.

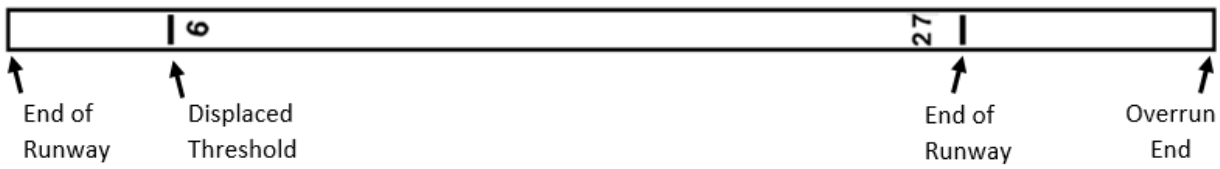
6.2.4. Displaced Threshold: Not all runways have a displaced threshold, so not all surveys will report a displaced threshold location on the Summary Data Sheet. If a runway has a threshold that is not at the beginning of the full-strength runway pavement, a displaced threshold location should be surveyed. See Figure 1 for an example. The displaced threshold will be surveyed at the approach end start of the white line (**NOTE:** Line is 10 feet in width so measuring can be off as much as 10 feet if not on this described spot) and centerline of runway where the displaced threshold crosses and will be reported on the Summary Data Sheet at DISP THLD with the runway designation (example: DISP THLD Runway 6). For documentation purposes, photos should be taken to show where the surveyor set up to measure the displaced threshold if one is present.

6.2.5. Overrun End: Not all runways will have an overrun end. An overrun is pavement between the threshold and end of pavement that may be used for overrun for landing aircraft. See figure 1 for an example. The overrun end may not be at the physical end of pavement, so the airfield manager should be consulted on the overrun end location. If an overrun is present, the overrun end point should be surveyed at the centerline at the end of the overrun area.

6.2.6. Runway Profile Points (Runway Centerline): The runway centerline is a line connecting the two opposite runway end points. The line may be physically marked on the surface of the runway. The runway profile points provide information about the runway gradient, establishes the airfield and touchdown zone elevation(s) and aids in the computation of the abeam points. Profile points along the runway centerline shall be collected at 50 foot intervals and continue to the end of the pavement. If the elevation difference between any two adjacent profile points is more than 0.3m then an additional profile point must be measured at the midpoint between the two.

6.2.7. Runway: The corners of the runway should be collected in order to report the runway as a polygon in the geodatabase only. This information is not reported or needed in the Summary Data Sheet. The polygon of the runway, one object, will run from normal threshold to normal threshold, and polygon of the overrun, one object.

Figure 1



6.2.8. Ancillary Information

6.2.8.1. Geodetic and Magnetic Azimuth: Both the geodetic and magnetic azimuths of each runway end should be recorded in degrees, minutes and seconds. The first two numbers of the magnetic azimuth determine the runway approach designation.

6.2.8.2. Magnetic Declination: The magnetic declination of the airfield should be recorded in degrees, minutes and seconds.

6.2.9. Helipads

6.2.9.1. Helipad Survey Point: Helipads do not have an end of runway so a survey location should be taken at the center of the helipad. This is the point that will be used to construct the imaginary surface. The center point of the helipad should be reported in the Summary Data Sheet with a description that indicates it is a helipad and the helipad designation. Photos should also be taken to document the location. The accuracy requirement for the helipad survey point is the same as the runway end.

6.2.9.2. Helipad Extent: Enough survey points should be taken to capture the extent of the helipad which will be reported as a polygon feature in the geodatabase. The extent is not reported in the Summary Data Sheet.

6.2.9.3. Helipad Approaches: If a helipad has limited ingress/egress, it should have been identified during the scoping process; however, it is a good idea to verify the information with the airfield manager while in the field.

6.3. COMPUTED LOCATIONS

6.3.1. Touchdown Zone Elevation (TDZE) Points: The Touchdown Zone (TDZ) is the first 3,000 feet of the runway beginning at the threshold (THLD) or displaced threshold (D-THLD). The TDZE is the highest elevation in the TDZ and may be determined from the runway profile measurements.

6.3.2. Airfield Elevation: Airfield Elevation is the highest point of the usable landing area or Helipad. If there are multiple runways, the Airfield Elevation will be based on the highest runway that is over 1,600 feet in length.

6.3.3. Airfield Reference Point: The Airfield Reference Point (ARP) shall be computed using the centerline end positions of all usable runways. Runways without specially prepared hard surfaces are often not required to be surveyed, so the ARP position for these airfields will be approximate. The ARP will be tagged with the year of the most recent runway end survey used in the ARP computation, such as, "ARP (1995)." The ARP computation methodology is detailed in the FAA AC 150/5300-18 Appendix B.

6.3.4. Abeam Points: Abeam points will need to be calculated for each feature below that exists on the airfield. An abeam point is a location along the runway center line that is at a 90 degree angle from the centerline to the feature begin referenced. The position and elevation of an abeam point is a computed value with the elevation determined from the runway profile using interpolation.

Features requiring abeam points:

- Visual Glide Slope Indicators (VGSI)
- Transponder Landing System (TLS)

- Offset Localizer Type Directional Aid (LDA)
- Offset Simplified Directional Facility (SDF)
- Glide Slope (GS)
- Microwave Landing System Elevation Guidance (MLSEL)
- Microwave Landing System Azimuth Guidance (MLSAZ)
- Microwave Landing System DME/P
- Precision Approach Radar (PAR)
- PAR Touchdown Reflector
- Precision Approach Path Indicators (PAPI)
- Visual Approach Slope Indicators (VASI)

6.4. NAVIGATIONAL AIDS (NAVAIDS)

6.4.1. General: There are two categories of NAVAIDs, Electronic and Visual. NAVAIDs are usually located on or near the airfield. The exceptions to this rule are the Airfield Surveillance Radar (ASR), Tactical Air Navigation (TACAN), Non-Directional Beacon (NDB) and the Air Route Surveillance Radar (ARSR) which may be located further than 7 nautical miles from the airfield but still within the Airfield airspace analysis area.

6.4.2. Accuracy Requirements: The accuracy requirements for the electronic and visual NAVAIDs are contained in Appendix B.

6.4.3. NAVAID Survey Point Locations: All NAVAIDs have a horizontal survey point (HSP) and vertical survey point (VSP) as identified in Appendix C. Unless otherwise indicated in Appendix C, all NAVAID VSP elevations should be located at the base of the NAVAID and all HSP located in the center of the NAVAID. When the NAVAID is composed of more than one unit, the HSP is typically the center of the unit array. Some exceptions for specific types NAVAIDS are noted in Appendix

C and in the following sections. If a NAVAID will also qualify as an obstruction, an elevation measurement should be taken at the VSP normally required for the NAVAID and at the top of the structure. The VSP elevation will be reported for the NAVAID and the top elevation will be reported for the obstruction.

6.4.4. Electronic NAVAIDs: The airfield manager should assist in identification of electronic NAVAIDS during the scoping process or during completion of the pre-survey checklist. Some specific concerns for Electronic NAVAIDS are as follows:

- If the DME and Azimuth function of the VORTAC and VOR DME facilities are located within 10 feet of each other, consider them collocated and report them as a single NAVAID. The single point should be taken on the VORTAC.

- Localizer and Glide Slope **must** be surveyed and reported as both an obstacle (Permissible Deviation) and NAVAID.

6.4.5. Visual NAVAIDS: Visual navigational aids consist of a variety of lighting and marking features used to guide the pilot both in the air and on the ground. These aids provide visual clues to the pilot about the aircraft's alignment or height in relation to the airfield or runway. The airfield manager should assist in identification of visual NAVAIDS during the scoping process or during the completion of the pre-survey checklist. Some specific concerns for Visual NAVAIDS are as follows:

- When the NAVAID is composed of more than one unit, the center of the NAVAID may fall between structures, such as in the Precision Approach Path Indicator (PAPI) array.

- For approach lighting systems only the first and last lights need to be positioned. The first light is the light farthest from the runway and the last light is the light closest to the threshold, this includes the flush lights embedded in the overrun.

6.5. DEPARTMENT OF ARMY FORMS

The required Department of Army forms shall be completed where applicable. Samples of each form are in Appendix E. If there are any questions about the content of these forms, please contact USAASA. The field survey team should familiarize themselves with the forms prior to mobilizing to the airfield.

6.5.1. Airfield Computation Report: An Airfield Compilation Report form must be filled out for each airfield surveyed. The compilation form contains a subset of the information reported in the Summary Data Sheet. A sample Compilation Report form is located in Appendix E.

6.5.2. Precision Approach Radar (GCA) Data Sheet: For facilities with precision approach radar, a PAR data sheet should be completed. A sample PAR data sheet in Appendix E. For facilities without PAR, the sheet does not need to be completed.

6.5.3. Instrument Landing System Data Sheet: For facilities with an instrument landing system (ILS), an ILS data sheet should be completed. A sample ILS data sheet in Appendix E. For facilities without PAR, the sheet does not need to be completed.

6.6. OBSTRUCTIONS

6.6.1. Obstruction Identification Surface (OIS): Obstruction analysis is based on imaginary surfaces, so construction of a preliminary OIS (based on published End of Runway values) will assist the survey team in planning field collection prior to deploying. Army airfield obstruction surveys use a combination of three guidance documents to define the OIS for a given runway or helipad so it is absolutely critical that the OIS criteria defined in Chapter 4 of this document be reviewed and understood before field work begins.

6.6.2. Obstructions: An obstruction is any object (natural or manmade) that penetrates the defined Obstacle Identification Surface (OIS). The survey team should survey

all objects that may penetrate the OIS (see exceptions below). Where no object would penetrate a specific OIS, the highest object underlying the OIS shall be surveyed, but not reported as an obstruction. Determination of what objects are required to be reported as obstructions will be made during the obstruction analysis.

6.6.2.1. Obstruction Exceptions: The items listed below do not require measuring and reporting as obstructions for Army airfield surveys. If there is any uncertainty while in the field, the surveyor should measure the object and a final determination will be made during the obstruction analysis.

- Annual vegetation: Annual vegetation such as annual weeds, corn, millet and sugar cane. This **does not** include trees, which is required.
- Frangible Objects Fixed by Function: Frangible objects are designed to break away if struck by an aircraft. Fixed by Function indicates that the object must exist in that location to be functional for its intended purpose. Examples include runway and taxiway signs and many approach light structures.
- Parked Aircraft: Parked or temporarily located aircraft should not be reported as obstructions. This exemption does not include aircraft permanently parked for display.
- Temporary Debris: Dirt or piles of batch plants which are temporary in nature, located on airfields property and under the control the airfield authorities.

6.6.2.2. Obstruction Waivers: The airfield may have waivers (permanent/temporary) or built to a previous design standard for some obstructions. These obstructions should still be surveyed and analyzed.

6.6.3. Obstruction Elevations: The elevations of obstructions will be taken at the top of the obstructing object and shall meet the accuracy requirements specified in Appendix B.

6.6.4. NAVAIDS as Obstructions: A NAVAID that could potentially penetrate the OIS should be evaluated as an obstruction. In most cases NAVAID elevations are not taken at the top of the structure so NAVAIDs that are potential obstructions will require an elevation be taken at the top of the structure. Localizer and Glide Slope **must** be surveyed and reported as both obstacles and NAVAIDs.

6.6.5. Special Situations:

6.6.5.1. *Estimated Maximum Elevations (EME)*: In some situations it may not be possible to access known obstructions and obtain elevation measurements. In other situations the feature may regularly change in height, such as a crane. In these situations, the elevation of the feature should be reported as an estimated maximum elevation and a note made in the survey report concerning why it was necessary to use an EME.

- For cranes and other objects that change height, the top of the crane base may be surveyed and the maximum extension distance added to the elevation to report the EME.
- Potential obstructions that can only be measured using a method that does not meet the accuracy requirements in Appendix B should be reported as an EME and the survey accuracy recorded.

6.6.5.2. *Inaccessible Obstructions*: In circumstances where there is a known or potential obstruction that is inaccessible at the time of the survey and for which an EME could not be determined in the field, the surveyor should notify the airfield manager to assist with access if unable to enter. If unable to access note the circumstances for the survey report. If the inaccessible obstacle is present on the previous survey, the survey should be evaluated to determine if the value from the previous survey could be used. Leaving known obstructions off the report and Summary Data Sheet because they are inaccessible may give the impression that the obstruction no longer exists.

6.6.5.3. *Guyed Structures*: Guys may be a significant distance from the structure they anchor and may be considered a separate obstruction. When surveying guyed structures, capture any guys that may penetrate the OIS separately from the

structure itself. Where the guys of any structure penetrate the OIS at a distance greater than 100 feet from the actual structure, it will be identified as a separate obstruction where it penetrates the OIS.

6.6.6. Minimum Clearance Obstructions: Roads, railroads, waterways and trees that are within the scope of the OIS, but do not penetrate the OIS may need to be further evaluated based on the minimum clearance criteria below. The surveyor should measure any objects which within the minimum clearance distance from the OIS. The object elevation will be reported and the additional minimum clearance distances will be added during the obstruction analysis.

6.6.6.1. *Trees*: The tops of trees must be 3 meters (10ft) below the OIS, per UFC 3-260-01. The surveyor should measure any tree or tree area which would fall within the minimum clearance requirement. The top elevation of the feature should be reported and the minimum clearance distance will be added during the obstruction analysis.

6.6.6.2. *Roads and Railroads*: Evaluation of minimum clearance for roads or railroads is only required if specifically stated in the in the scope of services. If required in the scope of services, the surveyor should collect survey points for roads or railroads where the road or railroad is within the minimum clearance distance of the OIS. All minimum clearance requirements for road and railroads are specified in the UFC 3-260-1.

6.6.6.3. *Waterways*: Evaluation of minimum clearance for waterways is only required if specifically stated in the in the scope of services. There is no standard minimum clearance for vessels that cross waterways. If there is a waterway which could fall within the minimum clearances requirement, the surveyor should check with the airfield manager to determine the highest mobile object that would usually traverse the waterway and record it for use during the analysis.

6.6.6.4. No potential obstructions in an OIS: If the imaginary surface of a specific OIS does not appear to have an obstruction, the feature closest to the imaginary

surface (vertically) should be recorded, but will not be considered an obstruction.

6.6.7. Obstruction Feature Types:

6.6.7.1. *Point*: Obstructions with minimal cross-section will be collected as obstruction points. These include features such as single trees, towers, antennae. Point obstructions will be included in the geodatabase as a point feature and reported on the Summary Data Sheet as a point.

6.6.7.2. *Line*: Linear obstructions, such as fences and catenaries, will be included in the geodatabase as linear features, but reported in the Summary Data Sheet as a point. Adequate elevation points should be taken along the feature to define the elevation profile across all OIS. When encountering catenaries that may be potential obstructions, the towers should be collected even if they are outside the OIS. The tower elevations will be used to construct the catenary line and to assign an estimated maximum elevation (EME) based on the tower height. Chapter 6 provides information on how linear obstructions are analyzed and reported and may assist the surveyor in selection of representative elevation points to measure while in the field.

6.6.7.3. *Area*: Obstruction areas are used for continuously obstructing objects, such as buildings, or where obstructions are clustered, such as wooded areas, building areas or ground areas. Area obstructions will be shown as polygons in the geodatabase, but are reported as a single point on the Summary Data Sheet based on the highest elevation within a specific OIS. For area obstructions with variable elevations which may intersect more than one OIS, the surveyor should capture and report a maximum elevation within each OIS. For area obstructions within the approach/departure surface, the surveyor should capture and report an additional elevation for a point on the downslope end of the polygon and the upslope end of the polygon. These points are needed to illustrate the first and last penetration within the area that could obstruct upon approach and departure. The use of obstruction areas instead of point locations is at the discretion of the surveyor. Chapter 7 provides information on how area

obstructions are analyzed and may assist the surveyor in selection of representative elevation points to measure while in the field.

6.7. FIELD DOCUMENTATION

6.7.1. Photos:

6.7.1.1. *Required*: As noted previously in this document, control monuments, end of runway survey points, displaced threshold survey points and helipad survey points all require photographic documentation which should be included in final reports. The need for additional photos is at the discretion of the surveyor.

6.7.1.2. *Requested*: Any additional requirements for photographic documentation will be stated in the scope of services. If photos of obstructions are requested, a photo should be taken of each feature surveyed for obstruction analysis. A single photo may encompass more than one potential obstruction if adequate notes are taken. These photos may also serve as a resource during the obstructions analysis, especially when there are questions concerning exemptions. If additional photographic documentation is requested, the photos will be included with the final deliverables.

6.7.2. Field Notes: Surveyors should document in field notes any specific directions or information provided by the airfield manager during the course of the survey. This may include information concerning exempted or temporary obstructions, minimum clearance heights and requests to survey or not survey specific objects. If there is any doubt about whether or not to survey an object, it is recommended that the surveyor err on the side of caution and survey the object. Unless specifically requested in the scope of services, it is not necessary to provide a copy of the survey field notes as a deliverable. If field notes are not provided as a deliverable, the surveying agency should keep field notes on file for seven (7) years. Army airfield surveys reoccur every five years and it is during the subsequent survey that questions may arise about the previous survey. Field notes may help resolve questions and discrepancies.

CHAPTER 7. OBSTRUCTION ANALYSIS

7.1. GENERAL

The FAA AC 150/5300-18 is the primary guidance for criteria for identification and documentation of obstructions; however, there are some differences between the AC and obstruction surveys for Army airfields. Most are addressed below, but if there are any questions, the surveyor should contact the USACE project manager. Chapter 6 covered many of the same topics in this section but from a field surveying perspective. This section covers how certain information should be addressed for Army airfields.

7.2. OBSTRUCTION ANALYSIS

7.2.1. Obstruction Identification Surface: See Chapter 4 for requirements on selecting and constructing the obstruction identification surface to be used for analysis.

7.2.2. Obstructions: An obstruction is any object (manmade, terrain, or vegetation) that penetrates the defined Obstacle Identification Surface (OIS) excluding annual vegetation, frangible objects fixed by function, parked aircraft (unless permanently on display) and temporary debris piles (see Chapter 6 for more details on these exceptions). Objects that penetrate the OIS and have been granted a waiver must still be reported as obstructions.

7.2.3. Penetrating Obstructions: The top elevation of all features captured for analysis will be used, including NAVAIDS. Any feature that meet the definition of an obstruction above and penetrates the OIS will be considered an obstruction and the elevation of the obstruction will be reported in the Summary Data Sheet.

7.2.4. Special NAVAIDS: Localizer and Glide Slope must be surveyed and reported as both obstacles and NAVAIDs.

7.2.5. Minimum Clearance Obstructions

7.2.5.1. Trees: Any trees that do not penetrate the OIS should have 10 feet added to their elevation and be re-evaluated using the new elevation. If any of the trees or tree groups with minimum clearance height added penetrates the OIS, it will be reported as minimum clearance obstruction on the Summary Data Sheet. The reported elevation will be the minimum clearance elevation (MCE) which includes the minimum clearance height added to the surveyed elevation.

7.2.5.2 Other*:* If the scope of services specifies a minimum clearance evaluation for roads, railroads or waterways, the UFC 3-260-01 should be consulted for minimum clearance requirements for the specific feature. Once the appropriate minimum clearance height has been determined, it should be added to the feature and re-evaluated. Reporting requirements are the same as the minimum clearance for trees. (See instructions for analyzing linear obstructions in this section).

7.2.6. Unverified Obstructions: Any features that were identified as obstructions in the last survey and are known to still be in place with no changes but were inaccessible during the survey, may be evaluated as unverified obstructions. If the horizontal and vertical coordinates from the previous survey appear to be usable the potential obstruction can be evaluated against the current OIS. If the unverified obstruction penetrates the OIS, is should be reported as an unverified obstructions.

7.2.7. No Obstructions within an OIS: If no feature penetrates a given imaginary surface, the object closest to the surface (vertically) should be reported on the Summary Data Sheet.

7.2.8. Analyzing Linear Obstructions: Any linear feature which penetrates the OIS and meets the definition of an obstruction will be reported as an obstruction. The geodatabase format accommodates reporting the linear feature; however, the Summary Data Sheet only accommodates reporting of point locations. It will be necessary to determine the appropriate point or points along the linear obstruction which need to be reported on the data sheet. These points should also be reported in the geodatabase as points.

7.2.8.1. *Catenaries*: The elevation of the towers should be used to determine the height and slope of the line used to represent the catenary. If the constructed catenary line intersects the OIS, the intersecting portion will be considered an obstruction.

7.2.8.2. *Identifying Points for Linear Obstructions*: For <u>each</u> OIS penetrated by the linear obstacle, a point should be reported for the highest elevation along the feature which penetrates the OIS and a second point should be reported for the point along the feature which has the greatest degree of penetration. These may be the same point, in which case only one point needs to be reported. Depending on the nature and extent of the linear obstruction, the analyst may choose to include additional points at his or her discretion. In cases, such as catenaries, where the line elevation may be calculated, the obstruction points should be noted as an estimated maximum elevation (EME).

7.2.9. <u>Analyzing Area Obstructions</u>: Any area feature which penetrates the OIS and meets the definition of an obstruction will be reported as an obstruction will be reported as an obstruction. The geodatabase format accommodates reporting the area feature; however, the Summary Data Sheet only accommodates reporting of point locations. It will be necessary to determine the appropriate point or points within the area obstruction which need to be reported on the data sheet. These points should also be reported in the geodatabase.

7.2.9.1. *Using Areas and Points*: For the purposes of obstruction analysis, the polygon representing the obstruction area should be assigned the elevation value of the highest elevation point within the polygon. The individual elevation points collected within the obstruction area will also be used in the analysis. The obstruction area, using the highest elevation, should be used for an initial assessment of which OIS may be penetrated by the obstruction area. For each OIS penetrated, an evaluation should be made of the elevation to report based on available point data.

7.2.9.2. *Identifying Points for Area Obstructions*: For each OIS penetrated by the obstacle area, a point should be reported for the highest elevation within the obstruction area and a second point should be reported for the point within the obstruction area which has the greatest degree of penetration. This may be the same point, in which case only one point need be reported for that OIS. If only one survey point is available within the OIS, the analysis should determine if the single point is representative of the area obstruction within the part of the OIS that was penetrated. Depending on the nature and extent of the obstruction area, the analyst may choose to include additional points at his or her discretion. The next section addresses how to report elevations for an area obstruction that penetrates the OIS, but for which no survey points exist.

7.2.9.3. *Lack of Area Obstruction Survey Points*: When area obstructions are surveyed in the field, an area is determined and point elevations taken for features within the area including the highest elevation. In situations where an obstruction area has variable heights, such as a group of trees, it is possible that not enough elevation points were collected to characterize the highest and most penetrating point within each OIS. When this occurs, the area obstruction height should be used. The area obstruction height is the maximum elevation point surveyed within the area. When no actual survey location is available, the highest elevation should be reported as an estimated maximum elevation (EME).

CHAPTER 8. DELIVERABLES

8.1. GENERAL

All deliverables will be in digital format and a hard copy AO Chart to the airfield only as specified in the scope of services.

8.2. PRE-SURVEY REPORT

8.2.1. General: The pre-survey report should be sent to the USACE project manager at least three weeks before mobilization unless otherwise approved.

8.2.2. Delivery Format: MS Word 2013 and PDF.

8.3. FINAL PROJECT REPORT

8.3.1. General: The project report should contain all the information specified in 150/5300-18, Final Project Report. If imagery and/or LiDAR was flown, include all report information required in FAA AC 150/5300-17.

8.3.2. Additional Requirements: The following information should be included in the final report.

- Airfield four character ICAO location identifier.
- Description of the OIS surface. This information is important to document since some airfields will not be using the standard OIS definitions in the UFC 3-260-1.
- Date of survey and date of obstruction analysis
- Names of individuals who conducted the obstruction analysis.
- Runway type (Class A or B) if fixed wing
- Flight rules applying to the runway or helipad (IFR/VFR)
- For helipads note any special requirements, such as one direction ingress/egress used to analyze for obstructions
- Document decisions on any items which may have been questionable as to whether or not to report.
- If any minimum clearance obstructions were reported, document which minimum clearance distances were applied to specific objects.
- Document any estimated maximum elevations and the reason for having to use EME.
- Document any known unverified obstructions from the last survey.

8.3.3. Delivery Format: MS Word 2016 or 365 (MS Excel 2016 where appropriate) and PDF.

8.4. OBSTRUCTION COMPARISON REPORT

8.4.1. General: If a previous obstruction survey has been completed for the airfield and is available, an obstruction comparison report should be completed. This report should evaluate changes in obstructions between the last survey and the results of the current survey. The report should include all obstructions in the current and last survey with elevations and the surfaces penetrated. This report should be part of the Obstruction Analysis Report. The report should evaluate the following:

(a) Change in obstruction status: Obstructions identified in the previous survey which are not reported as obstructions on the current survey and reason, if known. Note C in report for Changed.

(b) New obstructions: Obstructions in the current survey that were not reported in the previous survey and any comments. Note N in report for New.

(c) Unchanged Obstructions: Obstructions which were reported on both surveys. Note U in report for Unchanged.

(d) Comparison of control if the same control points was used for both surveys.

8.4.2. Delivery Format: MS Word 2016, 365 and PDF. Any spreadsheet maybe delivered in MS Excel 2016 or 365.

8.5. SUMMARY DATA SHEET

8.5.1. General: See Appendix D for Summary Data Sheet reporting requirements.

8.5.2. Delivery Format: MS Excel 2016 or 365

8.6. UNIVERSAL DATA DELIVERY FORMAT (UDDF)

8.6.1. General: In accordance with FAA's Airport Surveying-GIS program a valid UDDF file may be required at Joint Use Airfields. You can contact USAASA for the current list of Joint Use Airfields. Each survey point submitted in UDDF format must have an associated vertical and horizontal accuracy codes.

8.6.2. Exclude from UDDF: The following are data reported in the geodatabase and Summary Data Sheet that should not be included in the UDDF file.

- Minimum Clearance Obstructions
- Unverified Obstructions
- The highest feature below the OIS for a given surface which does not have a penetrating obstruction.

8.6.3. Delivery Format: Text File.

8.7. DEPARTMENT OF ARMY DATA SHEETS

8.7.1. General: The Department of Army (DAO forms for Airfield Compilation Report, Instrument Landing System (ILS) Data Sheet and Precision Approach Radar (PAR) Data Sheet are standard forms. See Chapter 6 for when forms are required. See Appendix E for example Department of Army Data Sheets.

8.7.2. Delivery Format: PDF.

8.8. SPATIAL DATA DELIVERABLES REQUIREMENTS

8.8.1. Geospatial Database: While the survey data reported on the Summary Data Sheet may be used to generate spatial data layers for points, it cannot be used to construct area or linear obstructions. The OIS used to evaluate for obstructions is a critical element in evaluating and validating the obstruction results. This

information is important to capture for installation records, as a record of the obstruction analysis parameters and as an information base for future surveys. The minimum data layers are listed in this section.

8.8.1.1. *Minimum Data Elements for Geospatial Reporting*: Additional GIS, CADD or other spatial data requirements may have been identified and recorded in the scope of services. The minimum data elements that need to be reported are listed below. Each data elements should have a Z value (containing the reported elevation) and the indicated attributes. When reporting airfield features and obstructions in geodatabase feature layers, obstructions should be reported as obstructions not as other features layer types. For example, if a building is an obstruction, the building would be an obstruction feature, not a building feature.

(a) Control Monuments used in the survey attributed with monument name/description recorded in the Summary Data Sheet.

(b) NAVAIDs reported in the Summary Data Sheet with identifier and description used in the Summary Data Sheet.

(c) Obstruction and minimum clearance points attributed with the obstruction identifier and description used in the Summary Data Sheet.

(d) Obstruction areas attributed with the obstruction identifier and description of the area as it relates to the points reported in Summary Data Sheet for the area.

(e) Obstruction lines attributed with the obstruction identifier and description of the features as it relates to the points reported in the Summary Data Sheet. Lines should have appropriate M values.

(f) Obstruction identification surfaces as three dimensional areas.

8.8.1.2. *Spatial Data Standards, Facilities, Infrastructure and Environment*: SDSFIE is a multi-service standard for reporting spatial data. Spatial data delivered for this survey should either be in a SDSFIE 3.0 format the FAA geodatabase format. The most recent version of SDSFIE may be obtained at www.sdsfieonline.org.

Questions concerning Army standards for SDSFIE should be directed to the Army Geospatial Center (AGC).

8.8.1.3. *Metadata*: All CADD and GIS deliverables must have FGDC (Federal Geographic Data Committee) compliant metadata. FGDC standards may be found at https://www.fgdc.gov/standards.

8.8.1.4. *Delivery Format*: The data layers should be in the most current ESRI geodatabase format unless otherwise specified in the scope of services. All features must use Z feature types (PointZ, PolylineZ, or PolygonZ) and have M values where appropriate.

8.8.2. Products Associated with Alternate Data Collection Methods: If aerial imagery or LiDAR data is collected specifically for the survey and the delivery of the processed imagery and/or LiDAR products are not covered under another scope of services, the relevant products listed below should be included with the deliverables. If pre-existing imagery or LiDAR was used to extract elevations used for obstructions or other features and the airfield does not already possess it, it should also be delivered. Imagery or LiDAR not specifically collected for the survey or not used to extract elevations (ancillary in nature) does not need to be delivered unless specifically noted in the scope of services.

8.8.2.1. Aerial Imagery

Deliverable	Format	Note
Imagery	Variable	Delivered with pixel and spectral resolution specified for collection. Deliver format depends on processing. Should deliver ortho-rectified is processed; MrSID images if processed
Imagery tiles	ESRI Shapefile	If imagery was tiled
Metadata (FGDC)	XML	For each data set
Report including the following: --Survey report --Daily flight plan --Aero Triangulation Report	Word or PDF	Report should include adequate documentation to show the imagery was collected at the map scale necessary to allow for feature specific accuracy standards to be met.

8.8.2.2. LiDAR

Deliverable	Format	Note
Classified LAS files	LAS	Based on specific classes. Tiled if necessary.
Model Key Points	LAS	Based on specific classes. Tiled if necessary.
Digital Elevation Models	IMG	If created
Digital Terrain Model	ESRI personal geodatabase	If created
Metadata (FGDC)	XLM	Required for each spatial deliverable
Flight lines	ESRI Shapefile	
Tiles	ESRI Shapefile	Only required if data was tiled
Report including the following: --LiDAR System Data Report --Flight Report --Ground Control Point --Data Processing Procedures Report --System Calibration Report	PDF or Word	

8.8.2.3. Data Set Delivery:

- *Datasets less than 3 GB*: Unless otherwise specified in the scope of services, the electronic media for delivery of Army airfield obstruction surveys on CD/DVD.
- *Datasets greater than 3 GB*: Large datasets may occur when aerial photography or LiDAR is collected. Unless otherwise specified in the scope of services, large data sets will be delivered via external hard drives.

8.9. AIRFIELD OBSTRUCTION CHARTS (AOC)

8.9.1. General: AOCs are not required unless specified in the scope of services. AOC requirements are in Appendix F.

8.9.2. Delivery Format: In addition to the hard copies, AOCs should be delivered as both PDF and CADD (or GIS) format (whichever was the native format used to create

the AOCs). Unless otherwise specified, the CADD data will be in MicroStation v8 or later and all GIS data will be submitted in the most recent version of ESRI geodatabase and mxd files.

8.10. PHOTOS

8.10.1. General: If additional photos were requested at part of the survey, such as photos of each NAVAID and obstruction, the photos should be delivered as individual files. If the picture is associated with a feature in the Summary Data Sheet or geodatabase, the photo file name should contain the unique identifier (station name) used in the Summary Data Sheet or geodatabase.

8.10.2. Delivery Format: JPEG

APPENDIX A

Airfield Survey Preparation and Planning Checklist

AIRFIELD SURVEY PRE-DEPLOY CHECKLIST

INSTALLATION INFORMATION

AIRFIELD IDENTIFIER:
AIRFIELD NAME:
STATE:

AIRFIELD PERSONNEL

NAME:
TITLE:
TELEPHONE:
EMAIL:
ALTERNATE PHONE:

NAME:
TITLE:
TELEPHONE:
EMAIL:
ALTERNATE PHONE:

NAME:
TITLE:
TELEPHONE:
EMAIL:
ALTERNATE PHONE:

ACCESS INFORMATION

	What are the requirements for base and airfield entry? Who should the survey team contact upon arrival?
	What gate should the survey team enter for access to the base?
	Is an escort required for base access?
	Is a security clearance is required to access the base and/or airfield?
	Is a radio required? Who provides the radio?

	Are there specific requirements for airfield driving? Can the survey team drive on the airfield unescorted?
	What is the airfield operating schedule? When is the best day/time for surveying runways?
	Can the airfield manager provide local escort in foreign locations?
EXISTING AOS INFORMATION - PACS/SACS	
	Does the airfield have a PACS? If so, can the installation provide control data, location, and condition?
	Does the airfield have a SACS? If so, can the installation provide control data, location, and condition?
	Who is the point of contact for survey information and base mapping?
	If not previously provided, can the airfield provide any previous survey data of any kind?
	Are there any other NGA, NGS, or local control points on the airfield?
	Are there any future airfield changes that may endanger survey marks?
EXISTING AOS INFORMATION - RUNWAYS/HELIPADS	
	Any information on known changes since the last survey? (Length, width, repaving, construction, etc.)
	Any information on planned future changes to the runways? (including dates of future changes)
	Does the airfield have photographs or other documentation of the runway ends and thresholds? (Note: The airfield manager is responsible for proper identification of thresholds - may need to check with CE for proper location)
	For helipads, are there multiple approaches? What are they?
NAVAIDs	
	Are there any changes to NAVAID systems since the previous survey?

	Are there any plans for NAVAID changes or additions in the future?
	Are there any off airfield NAVAIDs where DOD has responsibility?
Do any of the following NAVAIDs exist on the airfield:	
	Inner or Outer Marker? Where is it located, and does the survey team need an escort to reach it?
	ASR? Where is it located, and does the survey team need an escort to reach it?
	PAR? Who can provide/confirm PAR datasheet information?
	ILS? Who can provide/confirm ILS datasheet information?
LIST OF ON AIRFIELD NAVAIDs:	
LIST OF OFF AIRFIELD NAVAIDs:	
OBSTRUCTIONS	
	Who is the TERPS specialist for the airfield? Does this person have comments on existing obstructions?
	Is there a list of current obstructions available for the airfield?
	Are there any obstructions of special concern?
	Are there any new potential obstructions on the airfield?
	Is there any new construction in the vicinity that may be an obstruction for the airfield?

	Is there a list of controlling obstructions for the airfield?

APPENDIX B

Accuracy Requirements

APPENDIX B – Accuracy Requirements

Per the FAA AC 150/5300-18, the accuracy for geospatial vector airfield features (taxiway, aprons, ramps, buildings, etc.) should typically be at mapping grade accuracy, nominally within 3 feet horizontally and 5 feet vertically. Accuracy requirements for geospatial features used for geographic orientation (major highways and roads, lakes, rivers, coastline, and other items of landmark value) are usually 20 feet horizontally and 10 feet vertically. Derived elevations must be within 10 feet vertically.

Specific features such as runway ends, NAVAIDs and obstacles, have specific accuracies which are listed in this appendix. If there are questions concerning accuracy requirements of specific features, please contact USAASA.

POINTS OF INTEREST	Accuracy Requirements in Feet		
	Rel (ϕ,λ)	Ellipsoid (h)	Orthometric (h)
Geodetic Control Stations			
Primary Airport Control Station (PACS)	0.1	0.13	0.13
Secondary Airport Control Stations (SACS)	0.1	0.13	0.13
Other Geodetic Control	0.1	0.13	0.13
Runway Points			
Runway Ends	1	0.2	0.25
Airport Reference Point (ARP)	1	N/R	N/R
Touch Down Zone Elevation (TDZE)	1	0.2	0.25
Thresholds	1	0.2	0.25
Displaced Threshold	1	0.2	0.25
Overrun (stopway) Ends	1	0.2	0.25

Runway Centerline (Profile) Points	1	0.2	0.25
Airport Elevation	1	0.2	0.25
Electronic NAVAIDS			
Air Route Surveillance Radar (ARSR)	10	N/R	20
Airport Surveillance Radar (ASR)	10	N/R	20
Tactical Air Navigation (TACAN)	10	N/R	20
VHF OMNI Directional Range (VOR)	10	N/R	10
VOR/TACAN (VORTAC)	10	N/R	10
Ground Control Approach Radar Reflector (GCARR)	10	20	20
Precision Approach Radar Touchdown Reflector (PARTD)	5	N/R	10
Precision Approach Radar (PAR) antenna	1	0.2	0.25
Instrument Landing System (ILS)			
Localizer (LOC)	1	0.2	0.25
Glide Slope (GS)	1	0.2	0.25
Glide Slope (End Fire GS)	1	0.2	0.25
Middle Marker (MM)	10	N/R	20
Inner Marker (IM)	10	N/R	20
Back Course Marker (BCM)	10	N/R	20
Outer Marker (OM)	10	N/R	20
Compass Locator	10	N/R	20
Distance Measuring Equipment (DME)			

Frequency paired with LOC	1	N/R	1
Frequency paired with MLSAZ	1	N/R	1
Frequency paired with NDB	1	N/R	1
Frequency paired with VOR	1	N/R	1
Not frequency paired	1	N/R	1
Fan Marker (FM)	10	N/R	20
Localizer Type Directional Aid (LDA)	1	N/R	1
MLS Azimuth Guidance (MLSAZ)	1	N/R	1
MLS Elevation Guidance (MLSEL)	1	N/R	0.25
Non-directional Beacon (NDB)	1	N/R	20
Simplified Directional Facility (SDF)	1	N/R	1
Visual NAVAIDS			
Precision Approach Path Indicator (PAPI)	5	N/R	10
Pulsating Visual Approach Slope Indicator (PVASI)	5	N/R	10
Visual Approach Slope Indicator (VASI)	5	N/R	10
Tri-Color Visual Approach Slope Indicator (TRCV)	5	N/R	10
“T”-Visual Approach Slope Indicator (TVASI)	5	10	10
Approach Light Systems (ALS)	3	N/R	5
Runway End Identifier Lights (REIL)	3	N/R	5
Airport Beacon (APBN)	5	N/R	10
Enroute NAVAIDS			

NAVAIDS within 7 nautical miles of the airfield	50	N/R	100
Meteorological Equipment			
Treat as obstruction when appropriate			
Obstacles			
All obstacles/obstructions that penetrate ANY surface must be collected. The height of all obstacles above ground is required to be:	20	N/R	1
Calculated Locations			
Abeam Points			
Visual Glide Slope Indicators (VGSI)	1	0.2	0.25
Localizer (LOC)	1	N/R	N/R
Transponder Landing System (TLS)	1	0.2	0.25
Offset Localizer Type Directional Aid (LDA)	1	0.2	0.25
Offset Simplified Directional Facility (SDF)	1	0.2	0.25
Glide Slope (GS)	1	0.2	0.25
Microwave Landing System Elevation Guidance (MLSEL)	1	0.2	0.25
Microwave Landing System Azimuth Guidance (MLSAZ)	1	0.2	0.25
Microwave Landing System DME/P	1	0.2	0.25
Precision Approach Radar (PAR)	1	0.2	0.25
PAR Touchdown Reflector	1	0.2	0.25
Precision Approach Path Indicators	1	0.2	0.25
Visual Approach Slope Indicators	1	0.2	0.25

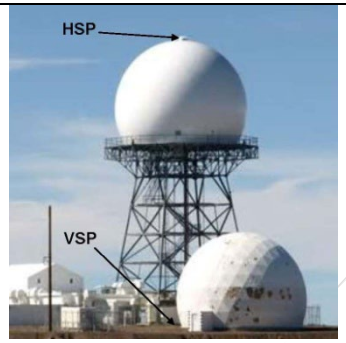
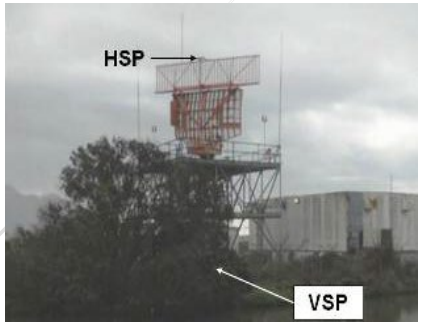
* N/R Not required in the deliverable.

Lengths	Feet
Overrun length	3
Runway Length	3
Landing Distance Available (landing threshold to runway end)	1
Microwave Landing System Elevation Guidance (MLSEL) to threshold	10
Microwave Landing System Azimuth Guidance (MLSAZ) to runway end	10
Runway Width at Threshold	1
Distance Localizer to runway end	1
ILS or MLS DME to threshold	10
ILS Glide Slope antenna to threshold	1
ILS Markers to threshold	3
MLS DME/P	3

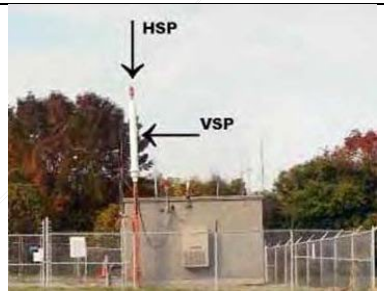
APPENDIX C

NAVAID Survey Points

APPENDIX C – NAVAID Survey Points

NAVAID NAME	Acronym	Survey Point Location (Horizontal: HSP & Vertical: VSP)	Survey Point Location (Horizontal)	Survey Point Location (Vertical)
ELECTRONIC NAVAIDS				
Air Route Surveillance Radar	ARSR		Axis of antenna rotation, if covered center of cover	Ground level through plumb line
Airport Surveillance Radar and Digital Airport Surveillance Radar	ASR and DASR		Axis of antenna rotation, if covered center of cover	Ground level through plumb line

APPENDIX C – NAVAID Survey Points

NAVAID NAME	Acronym	Survey Point Location (Horizontal: HSP & Vertical: VSP)	Survey Point Location (Horizontal)	Survey Point Location (Vertical)
Airport Surveillance Radar Touchdown/Centerline Reflector	ASR TDR/ Centerline Reflector	 Each reflector is pointed at its associated NAVAID (ex. ASR or PAR). Centerline reflectors align with the centerline of the runway and touchdown reflectors are located near the touch down zone.	Phase Center of Antenna	Phase Center of Antenna
Differential Global Positioning System	DGPS	Not Available	Phase Center of Antenna	Phase Center of Antenna
Distance Measuring Equipment not frequency paired	DME		Center of Antenna Cover	Center of Antenna Cover (3)

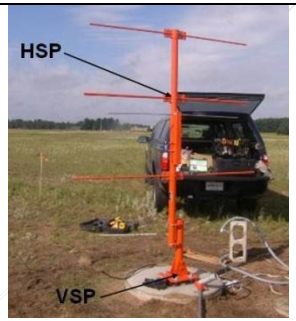
APPENDIX C – NAVAID Survey Points

NAVAID NAME	Acronym	Survey Point Location (Horizontal: HSP & Vertical: VSP)	Survey Point Location (Horizontal)	Survey Point Location (Vertical)
Frequency paired with Instrument Landing System	ILS DME		(1)	(3)
Frequency paired with Localizer	LOC DME	See DME	Center of Antenna Cover	Center of Antenna Cover
Frequency paired with Microwave Landing System Azimuth Guidance	MLSA DME		Center of antenna cover	Intersection of the ground, gravel, concrete pad, or other base and plumb line through the HSP
Frequency paired with Non-Directional Beacon	NDB DME	See MLSAZ/DME	Center of antenna cover	Intersection of the ground, gravel, concrete pad, or other base and plumb line through the HSP

APPENDIX C – NAVAID Survey Points

NAVAID NAME	Acronym	Survey Point Location (Horizontal: HSP & Vertical: VSP)	Survey Point Location (Horizontal)	Survey Point Location (Vertical)
Frequency paired with VHF Omni Directional Radio Range/Distance Measuring Equipment	VOR DME		Center of antenna cover	Intersection of the ground, gravel, concrete pad, or other base and plumb line through the HSP
Fan Marker	FM	See IM, OM, MM	Center of Antenna Array	Ground level through plumb line
Back Course Marker	BCM	See IM, OM, MM	Center of Antenna Array	Ground level through plumb line
Glide Slope	GS		Center of Antenna Supporting Structure	Ground level through plumb line

APPENDIX C – NAVAID Survey Points

NAVAID NAME	Acronym	Survey Point Location (Horizontal: HSP & Vertical: VSP)	Survey Point Location (Horizontal)	Survey Point Location (Vertical)
Glide Slope (End Fire Type)	GSF		Phase center of antenna reference point (3)	Phase center of antenna reference point at the ground
Inner Marker	IM		Center of Antenna Array	Ground level through plumb line

APPENDIX C – NAVAID Survey Points

NAVAID NAME	Acronym	Survey Point Location (Horizontal: HSP & Vertical: VSP)	Survey Point Location (Horizontal)	Survey Point Location (Vertical)
Localizer	LOC		Center of Antenna support structure	Ground level through plumb line
Middle Marker	MM		Center of Antenna Array	Ground level through plumb line

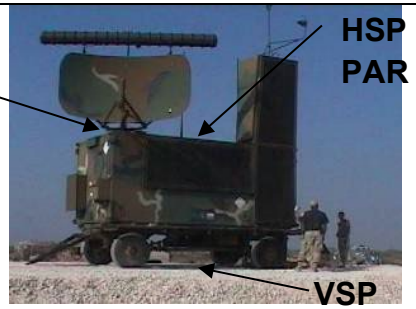
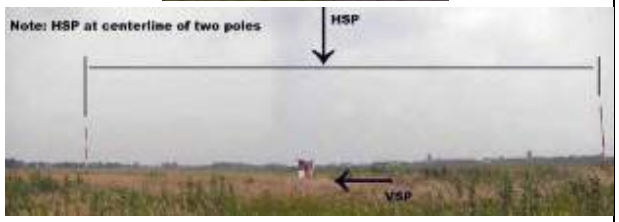
APPENDIX C – NAVAID Survey Points

NAVAID NAME	Acronym	Survey Point Location (Horizontal: HSP & Vertical: VSP)	Survey Point Location (Horizontal)	Survey Point Location (Vertical)
Outer Marker	OM		Center of Antenna Array	Ground level through plumb line
Localizer type Directional Aid	LDA	See LOC (offset from centerline of runway)	Center of Antenna support structure	Ground level through plumb line
Locator Beacon (without DME IM)	LB	Not Available	Center of Antenna Array	Ground level through plumb line
(AN/TPN 31A Air Traffic Navigation Integration and Coordination System	ATNAVICS		Center of the pintle hook on the rear of the HMMWV	Ground level through plumb line

APPENDIX C – NAVAID Survey Points

NAVAID NAME	Acronym	Survey Point Location (Horizontal: HSP & Vertical: VSP)	Survey Point Location (Horizontal)	Survey Point Location (Vertical)
Microwave Landing System	MLS		Phase center reference point	Phase center reference point
Microwave Landing System Azimuth Guidance	MLSAZ		Phase center reference point	Phase center reference point
Microwave Landing System Elevation Guidance	MLSEL		Phase center reference point	Phase center reference point

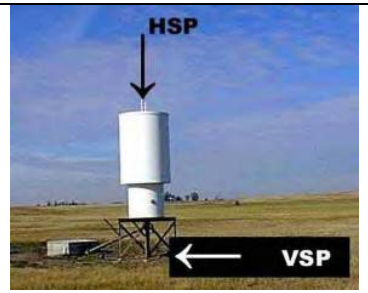
APPENDIX C – NAVAID Survey Points

NAVAID NAME	Acronym	Survey Point Location (Horizontal: HSP & Vertical: VSP)	Survey Point Location (Horizontal)	Survey Point Location (Vertical)
AN-MPN14K (Mobile ASR and PAR)	MPN14K		(4)	Ground level through plumb line
Non-Directional Beacon	NDB		Center of Antenna Array	Ground level through plumb line

APPENDIX C – NAVAID Survey Points

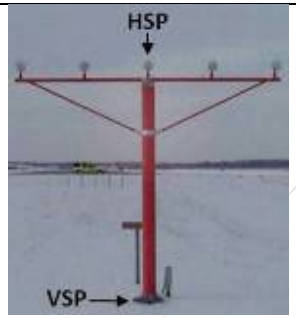
NAVAID NAME	Acronym	Survey Point Location (Horizontal: HSP & Vertical: VSP)	Survey Point Location (Horizontal)	Survey Point Location (Vertical)
Precision Approach Radar	PAR		(4)	Ground level through plumb line
Precision Approach Radar Touchdown/Centerline Reflectors	PAR TDR/ Centerline	See ASR TDR/ Centerline	Phase Center of Antenna	Phase Center of Antenna
Simplified Directional Facility	SDF	See LOC (Localizer)	Center of Antenna support structure	Ground level through plumb line

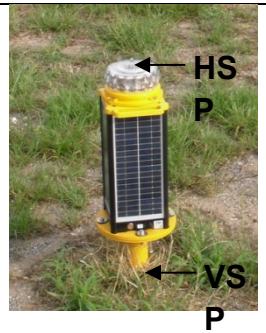
APPENDIX C – NAVAID Survey Points

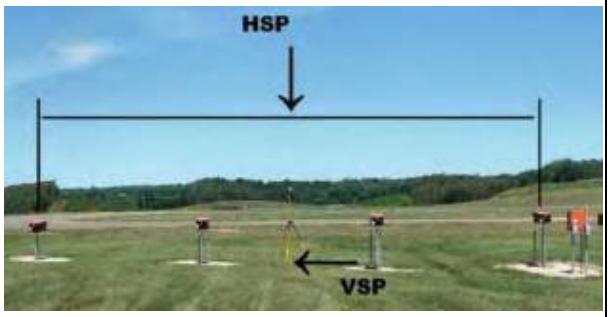
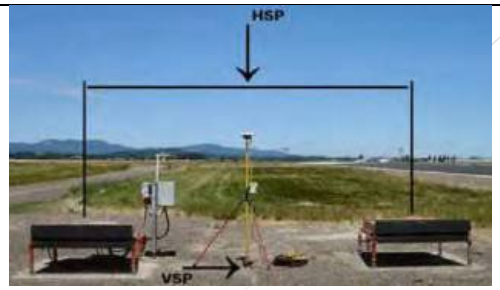
NAVAID NAME	Acronym	Survey Point Location (Horizontal: HSP & Vertical: VSP)	Survey Point Location (Horizontal)	Survey Point Location (Vertical)
Tactical Air Navigation or Digital Tactical Air Navigation	TACAN or DTACAN		Center of Antenna Cover	Ground level through plumb line
VHF Omni Directional Range	VOR		Center of Antenna Cover	Ground level through plumb line
VHF Omni Directional Radio and TACAN	VORTAC		Center of Antenna Cover	Ground level through plumb line

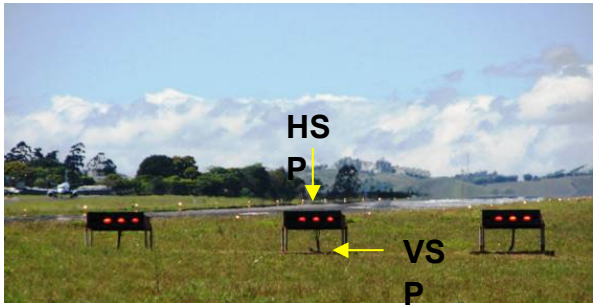
APPENDIX C – NAVAID Survey Points

APPENDIX C – NAVAID Survey Points

VISUAL NAVAIDS				
Airport Rotating Beacon	APBN		Center of cover or axis of rotation	Ground level through plumb line
Approach Light Systems	ALS		Horizontal center of the center light of the first and last lights rows	Ground level through plumb line

Elevated Airfield Ground Lights	EAGLE		Center of light	Ground level through plumb line
Runway End Identifier Lights	REIL		Center of light	Ground level through plumb line

Visual Glide Slope Indicators (VGSI)				
Precision Approach Path Indicator System	PAPI		Survey point is the center of the light array. Since PAPI systems usually have two or four light units installed in a row-aligned perpendicular to the runway centerline, the array center "survey point" will be between the units.	Ground level through plumb line
Pulsating Visual Approach Slope Indicator	PVASI		Center of light array	Ground level through plumb line
Tri-Color Visual Approach Slope Indicator System	TRCV	See PVASI	Center of the light array	Ground level through plumb line
"T"-Visual Approach Slope Indicator System	T-VASI	See PVASI	Center of the light array	Ground level through plumb line

Visual Approach Slope Indicator System	VASI		Center of the light array. Center of the near, middle (if present), and far VASI bars. Where two light units exist in a bar, the “plot point” is midway between the two units	Ground level through plumb line

1. If instruments are not collocated (having the same horizontal position), each instrument will be surveyed separately.

2. DME elevations are required only when the DME is frequency paired with an ILS or MLS.

3. End Fire Type survey point: phase center of antenna reference point/phase center of antenna reference point.

4. The horizontal survey point for PAR facilities will be as follows:

   a. For antennas mounted on a mobile van, the center of the van.

   b. For antennas mounted on rotating equipment housings, the axis of rotation.

   c. For antennas hard mounted on a fixed structure, the center of the azimuth antenna. If the antenna is covered, the HSP will be the center of the antenna cover.

APPENDIX D

Summary Data Sheet Instructions

APPENDIX D – Summary Data Sheet

The Summary Data Sheet is a spreadsheet that contains critical information about the survey. An overview of the columns and sections along with special reporting instructions is provided below. The end of this appendix contains a sample Summary Data Sheet. For complex airfields, separate data sheets may be used for each runway where appropriate.

Columns:

- Station Name: This is a unique identifier for the feature. Unless specified below, a station name is required for all entries. This identifier should be the same one used in any geospatial products, such as a geodatabase or photos, to allow correlation between the Summary Data Sheet and other products.

  AOC No: Only required if airfield obstruction charts (AOC) are required. If an Airfield Obstruction Chart (AOC) has been requested, an "AOC No" column may be added to the spreadsheet and populated with the obstruction number identified on the obstruction chart. This will allow users to correlate the obstructions listed on the Summary Data Sheet to the ones listed in the AOC. The obstruction identifier may also be used on the AOC at the discretion of the mapping agency.

- Description: Required for all entries. This is a short description of what the feature is and any relevant associated information. Examples will be given in each section.

- Latitude: These entries consist of 4 columns that define the latitude (degrees, minutes, seconds, and latitude hemisphere [N/S]). Data must be presented in DD MM SS.SSS format with each value in a separate column.

- Longitude: These entries consist of 4 columns that define the longitude (degrees, minutes, seconds, and the longitude hemisphere [E/W]). Data must be presented in DD MM SS.SSS format with each value in a separate column.

- Elevation M.S.L (meters): Orthometric elevation in meters.

- Elevation M.S.L (feet): Orthometric elevation in feet.

- Accuracy Horizontal/Accuracy Vertical: If the accuracy of the surveyed feature is within the accuracy requirements specified in Appendix B, this column should contain the accuracy value from Appendix B. For obstructions only, if it was not possible to achieve the required accuracy, the actual accuracy should be reported. This occurs in situations where less accurate measurement methods are the only option.

- Penetration Distance (meters): Only required for obstructions and minimum clearance obstructions. This the difference of the reported obstruction elevation and the elevation of the OIS at the point the obstruction penetrates (reported in meters). The survey team may include a negative number for distance an object is below OIS for other features but this is optional.

- Penetration Distance (feet): Only required for obstructions and minimum clearance obstructions. This the difference of the reported obstruction elevation and the elevation of the OIS at the point the obstruction penetrates (reported in feet). The survey team may include a negative number for distance an object is below OIS for other features but this is optional.

The Summary Data Sheet is broken into parts which are outlined below.

Part 1 – Geodetic Control Stations

PACS, SACS and any other control should be reported on the Summary Data Sheet under the geodetic control section. If using a station that was reported in the previous survey, use the same station name when possible. If not possible, add the station name used in the previous survey to the description.

Station Name	AOC No.	Description	WGS 84 Latitude (deg min secs)				WGS 84 Longitude (deg min secs)				Elevation M.S.L. (meters)	Elevation M.S.L. (feet)	Accuracy Horizontal	Accuracy Vertical	Penetration Distance (meters)	Penetration Distance (feet)
Geodetic Control Stations																
CMY A		PACS	43	57	30.527	N	90	44	11.037	W	251.190	824.114	3 cm	5 cm		
CM-1		SACS	43	57	22.707	N	90	44	06.870	W	254.684	835.577	3 cm	5 cm		
JARROD		SACS	43	57	16.658	N	90	44	17.872	W	255.316	837.651	3 cm	5 cm		

Part 2 – Runway/Helipad Information

- A separate section labeled with the runway designation should be created for each Class A, Class B or helicopter runway. The description column should identify the feature being reported (End of Runway, Threshold, Displaced Threshold or Centerline). Points associated with specific runway ends should be labeled with the relevant approach (e.g. End of Runway 11, Runway 11 Threshold, etc). Points associate with the runway centerline should list include the runway designation (e.g. Runway 11-29 Centerline).
- If helipads are surveyed, a Helipad section should be added to the data sheet with entry per helipad. The helipad designation should be used for the description.

Station Name	AOC No.	Description	WGS 84 Latitude (deg min secs)				WGS 84 Longitude (deg min secs)				Elevation M.S.L. (meters)	Elevation M.S.L. (feet)	Accuracy Horizontal	Accuracy Vertical	Penetration Distance (meters)	Penetration Distance (feet)
Geodetic Control Stations																
CMY A		PACS	43	57	30.527	N	90	44	11.037	W	251.190	824.114	3 cm	5 cm		
CM-1		SACS	43	57	22.707	N	90	44	06.870	W	254.684	835.577	3 cm	5 cm		
JARROD		SACS	43	57	16.658	N	90	44	17.872	W	255.316	837.651	3 cm	5 cm		
Runway 11-29																
P1014		END OF RUNWAY 11	43	57	44.084	N	90	44	45.624	W	250.043	820.350	1 ft	0.25 ft	-0.011	-0.035
P1018		DISPLACED THRESHOLD RUNWAY 29	43	57	28.199	N	90	43	51.609	W	252.876	829.643	1 ft	0.25 ft	0.000	0.000
P1021		END OF RUNWAY 29	43	57	26.596	N	90	43	46.150	W	253.065	830.265	1 ft	0.25 ft	-1.571	-5.153
P1022		RUNWAY 11-29 CENTERLINE	43	57	26.690	N	90	43	46.466	W	253.067	830.271	1 ft	0.25 ft	-1.378	-4.522
P1025		RUNWAY 11-29 CENTERLINE	43	57	26.788	N	90	43	46.796	W	253.072	830.286	1 ft	0.25 ft	-1.175	-3.855
P1026		RUNWAY 11-29 CENTERLINE	43	57	26.880	N	90	43	47.109	W	253.064	830.262	1 ft	0.25 ft	-0.994	-3.260
P1029		RUNWAY 11-29 CENTERLINE	43	57	26.880	N	90	43	47.109	W	253.068	830.274	1 ft	0.25 ft	-0.990	-3.248

Parts 3/4 – Electronic Navigational Aids and Visual Navigation Aids

A sections should be included for any Electronic NAVAIDS and for any Visual NAVAIDS.

- The latitude/longitude for the NAVAID should correspond to horizontal survey point (HSP) and the vertical elevation should be based on the vertical survey point (VSP) specified in Appendix C.
- They NAVAID description should capture if the NAVAID is associated with a specific runway or helipad or specific end of runway. For example, RELIS are associated with a specific end of runway so the description should include the runway end designation.

Station Name	AOC No.	Description	WGS 84 Latitude (deg min secs)				WGS 84 Longitude (deg min secs)				Elevation M.S.L. (meters)	Elevation M.S.L. (feet)	Accuracy Horizontal	Accuracy Vertical	Penetration Distance (meters)	Penetration Distance (feet)
P1324		RUNWAY 11-29 CENTERLINE	43	57	43.756	N	90	44	44.507	W	250.097	820.526	1 ft	0.25 ft		
P1325		RUNWAY 11-29 CENTERLINE	43	57	43.849	N	90	44	44.822	W	250.083	820.481	1 ft	0.25 ft		
P1326		RUNWAY 11-29 CENTERLINE	43	57	43.944	N	90	44	45.145	W	250.065	820.423	1 ft	0.25 ft		
P1327		RUNWAY 11-29 CENTERLINE	43	57	44.031	N	90	44	45.443	W	250.050	820.373	1 ft	0.25 ft		
P1328		RUNWAY 11-29 CENTERLINE	43	57	44.084	N	90	44	45.623	W	250.037	820.330	1 ft	0.25 ft		
Electronic Navigational Aids																
P1130		NDB (POLE)	43	56	15.277	N	90	38	31.293	W	311.600	1022.307	10 ft	20 ft		
P1131		NDB (CENTER)	43	56	16.210	N	90	38	30.688	W	309.538	1015.543	10 ft	20 ft		
P1132		NDB (POLE)	43	56	17.111	N	90	38	30.085	W	309.894	1016.711	10 ft	20 ft		
Visual Navigational Aids																
P1329		RUNWAY 11 REILS	43	57	43.352	N	90	44	46.495	W	250.629	822.271	1 ft	5 ft		
P1330		RUNWAY 11 REILS	43	57	45.020	N	90	44	45.554	W	250.246	821.014	1 ft	5 ft		
P1396		RUNWAY 29 PLASI	43	57	31.027	N	90	43	57.445	W	253.184	830.655	5 ft	10 ft		
P1397		RUNWAY 29 REILS	43	57	29.099	N	90	43	51.406	W	253.394	831.344	1 ft	5 ft		
P1398		RUNWAY 29 REILS	43	57	27.459	N	90	43	52.315	W	253.517	831.748	1 ft	5 ft		
P1421		AIRPORT BEACON	43	57	09.775	N	90	43	57.933	W	288.465	946.406	5 ft	10 ft		
Obstructions																

Parts 5-8 – All Obstructions

Army airfields have several subcategories of obstructions and require additional information in description when certain circumstances arise.

- <u>More than one runway or helipad</u>: If there is more than one runway or helipad on the survey, each group of obstructions associated with the runway or helipad should be put in a separate section and labeled with the runway or helipad designation.

- Penetration Distance: All subcategories of obstructions should report the distance the object penetrates. The penetration distance minimum clearance obstructions includes the minimum clearance height.
- NAVAIDS: If any NAVAID is identified as an obstruction, it should be reported in both the NAVAID and obstruction portions of the data sheet. When reporting in the NAVAID Section using the VSP and HSP. When reporting a NAVAID as an obstruction, use the top elevation.
- Point Obstructions: All obstructions are assumed to be point locations unless an indicator is used to designate the entry is a point from a linear or area obstruction.
- Point Representing Linear Obstructions: The description for points which represent a linear obstruction should include (Line) the description. The obstruction identifier may be tagged with an L (optional). Example: Obstruction Identifier: P1323L, Description: Fence (Line).
- Points Representing Area Obstructions: The description for points which represent an area obstruction should include (Area) the description. The obstruction identifier may be tagged with an A (optional). Example: Obstruction Identifier: P1373A, Description: Trees on Ridge (Area).

APPENDIX D – Summary Data Sheet

Station Name	AOC No.	Description	WGS 84 Latitude (deg min secs)				WGS 84 Longitude (deg min secs)				Elevation M.S.L. (meters)	Elevation M.S.L. (feet)	Accuracy Horizontal	Accuracy Vertical
		Runway 17-35 Obstructions												
L1233	R1	Tree 1	31	21	28.668	N	85	39	02.922	W	110.235	361.663	1 ft	0.25 ft
L1234	R2	Tree 2	31	21	28.781	N	85	39	05.185	W	109.678	359.836	1 ft	0.25 ft
L1235	R3	Tree 3	31	21	29.433	N	85	39	08.764	W	109.358	358.786	1 ft	0.25 ft
L1236	R4	Tree 4	31	21	26.362	N	85	39	02.861	W	107.973	354.242	1 ft	0.25 ft
L1237	R5	Tree 5	31	21	19.269	N	85	39	03.295	W	106.987	351.007	1 ft	0.25 ft
L1238	R6	Tree 6	31	21	24.365	N	85	39	02.598	W	107.024	351.129	1 ft	0.25 ft
L1239	R10	Control Tower	31	20	45.727	N	85	39	15.305	W	130.709	428.835	1 ft	0.25 ft
L1240	R11	Antenna	31	20	37.983	N	85	39	09.090	W	128.463	421.467	1 ft	0.25 ft
		Helipad D - North Obstructions												
		None Found												
		Helipad D - South Obstructions												
L1342	D1	Antenna 1	31	20	37.983	N	85	39	09.090	W	128.463	421.467	1 ft	0.25 ft
L1343	D2	Siren 1	31	20	38.790	N	85	39	10.611	W	110.698	363.182	1 ft	0.25 ft
L1344	D3	Power Pole 1	31	20	39.212	N	85	39	11.153	W	106.552	349.580	1 ft	0.25 ft
L1345	D4	Power Pole 2	31	20	38.146	N	85	39	10.592	W	103.397	339.229	1 ft	0.25 ft
L1346	D5	Antenna 2	31	20	37.598	N	85	39	09.529	W	110.808	363.543	1 ft	0.25 ft
L1347	D6	Antenna 3	31	20	39.650	N	85	39	10.878	W	111.241	364.964	1 ft	0.25 ft
L1348	D7	Power Pole 3	31	20	37.519	N	85	39	10.135	W	101.959	334.511	1 ft	0.25 ft
L1349	D8	Siren 2	31	20	38.868	N	85	39	10.471	W	106.921	350.791	1 ft	0.25 ft

Each of the parts below should be reported in a separate section on the data sheet with the appropriate label:

Part 5 – Obstructions

- Contains all obstructions acquired during the survey that meet the required accuracy standard and penetrate the OIS.
- Description column should be unique.

Part 6 – Minimum Clearance Elevations (MCE)

- If any minimum clearance obstructions were identified in the analysis, they should be listed in a separate 'minimum clearances obstruction' section just below the obstruction section. Objects listed in this section would not penetrate the OIS without the addition of the minimum clearance distance. Minimum clearance obstructions have the same reporting requirements as normal obstructions except for the following. The reported elevation should include the added minimum clearance distance. For example, if the highway had an elevation of 1230 foot and the minimum clearance was 15, the reported elevation would be 1245 foot.
- The description column should contain a description of the feature, "MCE" and the height added to obtain the reported elevation. Example: Highway 71 (MCE 15ft added). The obstruction identifier may also be tagged with an "M" (optional). Example: P2131M
- Minimum clearance obstructions are not reported in the UDDF.

Part 7 – Estimated Maximum Elevation (EME)

- Any obstruction identified as an EME should be reported with EME in the description name. For example, "OL on Tower (EME)"
- The accuracy column should include the approximate horizontal and vertical accuracy of the reported data.

Part 8 – Unverified Obstructions

- Unverified obstructions are those that cannot be measured for a given reason, but are known to exist and were known to penetrate the OIS in the previous survey. These may also be known minimum clearance obstructions that were not specifically evaluated on this survey.

- If the known elevation of the obstruction in the previous survey will penetrate the current OIS, the obstruction should be reported as an unverified obstruction.
- Unverified obstructions should be reported with all the location and elevation data, but the accuracies should remain blank.
- Do not report unverified obstructions in the UDDF file.

Part 9 – OIS not penetrated

- For any OIS surface that is not penetrated by an obstruction, report the obstruction that came the closest to the OIS in a separate section of the data sheet.
- Do not report unverified obstructions in the UDDF file.

Part 10 – Meteorological Apparatus: If required, include meteorological apparatus captured during the survey.

Part 9 – Miscellaneous Data: Any surveyed features that do not fit into another category will be reported in this section. Examples of miscellaneous features are the Control Tower Cab Floor and Control Tower Top.

Part 10 – Computed Data: The computed data entries for this section are the Airfield Reference Point, Airfield Elevation and Touchdown Zones for each runway end. The Touchdown Zone description should include the runway approach designation.

Part 11 – Abeam Points: Features requiring abeam points are listed in Chapter 6.

Part 12 – Runway Length/Width: The length and width of the runway should be reported in for each runway surveyed and should be reported in both meters and feet.

Part 13 –Azimuth and Declination: The geodetic and magnetic azimuth of each end of runway should be reported along with the Magnetic Declination.

Part 14 – Datum Information: Datum information should include horizontal and vertical datum as well as any other relevant information.

Par 15 – Other Information: This section is used for other relevant information including the Airfield code, Date of survey

Surveyed by, OIS definitions, Notes, and any definitions

APPENDIX D – Summary Data Sheet

This Summary Data Sheet is provided an example only to illustrate different aspects of the summary sheet. This is not an actual airfield summary sheet. The data sheet file name should include the four letter airfield code.

Station Name	AOC No.	Description	Latitude (deg min secs)				Longitude (deg min secs)				Elevation M.S.L. (meters)	Elevation M.S.L. (feet)	Accuracy Horizontal	Accuracy Vertical	Penetration Distance (meters)	Penetration Distance (feet)
		Geodetic Control Stations														
CMY A		PACS	43	57	30.527	N	90	44	11.037	W	251.190	824.114	3 cm	5 cm		
CM-1		SACS	43	57	22.707	N	90	44	06.870	W	254.684	835.577	3 cm	5 cm		
JARROD		SACS	43	57	16.658	N	90	44	17.872	W	255.316	837.651	3 cm	5 cm		
		Runway 11-29														
P1014		END OF RUNWAY 11	43	57	44.084	N	90	44	45.624	W	250.043	820.350	1 ft	0.25 ft		
P1018		DISPLACED THRESHOLD RUNWAY 29	43	57	28.199	N	90	43	51.609	W	252.876	829.643	1 ft	0.25 ft		
P1021		END OF RUNWAY 29	43	57	26.596	N	90	43	46.150	W	253.065	830.265	1 ft	0.25 ft		
P1022		RUNWAY 11-29 CENTERLINE	43	57	26.690	N	90	43	46.466	W	253.067	830.271	1 ft	0.25 ft		
P1025		RUNWAY 11-29 CENTERLINE	43	57	26.788	N	90	43	46.796	W	253.072	830.286	1 ft	0.25 ft		
P1026		RUNWAY 11-29 CENTERLINE	43	57	26.880	N	90	43	47.109	W	253.064	830.262	1 ft	0.25 ft		

P1029		RUNWAY 11-29 CENTERLINE	43	57	26.880	N	90	43	47.109	W	253.068	830.274	1 ft	0.25 ft		
P1030		RUNWAY 11-29 CENTERLINE	43	57	26.974	N	90	43	47.431	W	253.063	830.257	1 ft	0.25 ft		
P1033		RUNWAY 11-29 CENTERLINE	43	57	27.067	N	90	43	47.745	W	253.056	830.235	1 ft	0.25 ft		
P1321		RUNWAY 11-29 CENTERLINE	43	57	43.481	N	90	44	43.574	W	250.132	820.643	1 ft	0.25 ft		
P1322		RUNWAY 11-29 CENTERLINE	43	57	43.575	N	90	44	43.892	W	250.120	820.602	1 ft	0.25 ft		
P1323		RUNWAY 11-29 CENTERLINE	43	57	43.664	N	90	44	44.195	W	250.105	820.553	1 ft	0.25 ft		
P1324		RUNWAY 11-29 CENTERLINE	43	57	43.756	N	90	44	44.507	W	250.097	820.526	1 ft	0.25 ft		
P1325		RUNWAY 11-29 CENTERLINE	43	57	43.849	N	90	44	44.822	W	250.083	820.481	1 ft	0.25 ft		
**** Runway centerline data removed to shorten example ****																
P1327		RUNWAY 11-29 CENTERLINE	43	57	44.031	N	90	44	45.443	W	250.050	820.373	1 ft	0.25 ft		
P1328		RUNWAY 11-29 CENTERLINE	43	57	44.084	N	90	44	45.623	W	250.037	820.330	1 ft	0.25 ft		
		Electronic Navigational Aids														
P1130		NDB (POLE)	43	56	15.277	N	90	38	31.293	W	311.600	1022.307	10 ft	20 ft		
P1131		NDB (CENTER)	43	56	16.210	N	90	38	30.688	W	309.538	1015.543	10 ft	20 ft		

P1132		NDB (POLE)	43	56	17.111	N	90	38	30.085	W	309.894	1016.711	10 ft	20 ft		
P1351		PAR REFLECTOR	41	42	29.795	N	90	31	27.642	W	250.629	822.271	5 ft	10 ft		
P1352		PAR REFLECTOR	41	42	31.027	N	90	31	23.273	W	250.246	821.014	5 ft	10 ft		
P1363		PAR	41	42	56.918	N	90	31	39.528	W	253.184	830.655	10 ft	20 ft		
P1846		OLD ASR (DECOMMISSIONED)	41	42	28.596	N	90	31	17.600	W	253.394	831.344	10 ft	20 ft		
P1847		ASR	41	43	58.861	N	90	30	44.747	W	253.517	831.748	10 ft	20 ft		
P1850		VOR	41	44	41.261	N	90	33	09.029	W	288.465	946.406	10 ft	10 ft		
P1851		FAN MARKER NORTH (DECOMMISSIONED)	41	44	36.415	N	90	33	15.533	W	250.629	822.271	1 ft	20 ft		
P1856		FAN MARKER SOUTH (DECOMMISSIONED)	40	55	43.525	N	90	39	46.830	W	251.629	825.271	1 ft	20 ft		
		Visual Navigational Aids														
P1329		RUNWAY 11 REILS	43	57	43.352	N	90	44	46.495	W	250.629	822.271	1 ft	5 ft		
P1330		RUNWAY 11 REILS	43	57	45.020	N	90	44	45.554	W	250.246	821.014	1 ft	5 ft		
P1396		RUNWAY 29 PLASI	43	57	31.027	N	90	43	57.445	W	253.184	830.655	5 ft	10 ft		
P1397		RUNWAY 29 REILS	43	57	29.099	N	90	43	51.406	W	253.394	831.344	1 ft	5 ft		
P1398		RUNWAY 29 REILS	43	57	27.459	N	90	43	52.315	W	253.517	831.748	1 ft	5 ft		
P1421		AIRPORT BEACON	43	57	09.775	N	90	43	57.933	W	288.465	946.406	5 ft	10 ft		
		Obstructions Runway 11/29 - Class A IFR														

P1335	3	TREES 1	43	57	45.904	N	90	44	38.413	W	261.977	859.502	20 ft	3 ft	11.769	38.614
P1341	4	TREES 2	43	57	46.565	N	90	44	35.584	W	270.216	886.533	20 ft	3 ft	19.474	63.891
P1343A	5	TREES AREA	43	57	46.865	N	90	44	58.956	W	264.906	869.111	10 ft	3 ft	8.536	28.005
P1356	7	SHRUBS 1	43	57	31.386	N	90	43	51.718	W	254.070	833.560	20 ft	3 ft	1.247	4.092
P1358	8	SHRUBS 2	43	57	29.324	N	90	43	47.754	W	253.242	830.843	10 ft	3 ft	0.248	0.813
P1362	9	TREES 5	43	57	40.339	N	90	45	00.631	W	271.316	890.142	20 ft	3 ft	8.962	29.402
P1394	10	WINDSOCK	43	57	35.633	N	90	43	58.979	W	260.128	853.436	20 ft	3 ft	7.620	25.000
P1395	11	WEATHER STATION	43	57	35.659	N	90	43	58.623	W	255.479	838.183	20 ft	3 ft	2.693	8.836
P1423	13	POLE	43	57	20.491	N	90	43	49.144	W	260.213	853.716	20 ft	3 ft	0.299	0.980
P1437	15	TREE 2	43	57	18.750	N	90	43	13.198	W	277.761	911.286	10 ft	3 ft	3.847	12.621
P1441	16	POWER POLE 1	43	57	50.930	N	90	45	05.017	W	262.016	859.630	10 ft	3 ft	1.333	4.374
P1442	17	POWER POLE 2	43	57	55.528	N	90	44	58.969	W	266.889	875.618	20 ft	3 ft	6.633	21.763
P1444	18	ANTENNA 1	43	58	10.215	N	90	43	28.586	W	338.742	1111.355	20 ft	3 ft	38.291	125.626
P1445A	19	TREE AREA	43	58	15.734	N	90	43	27.782	W	328.703	1078.420	20 ft	3 ft	28.252	92.690
P1450	21	TREE 5	43	58	27.475	N	90	42	13.931	W	365.684	1199.748	20 ft	3 ft	37.330	122.474
P1451	22	TREE 6	43	58	35.262	N	90	42	39.991	W	353.623	1160.178	20 ft	3 ft	36.770	120.637
P1452	23	GOVT COMMUNICATION TOWER	44	02	38.683	N	90	37	41.765	W	530.046	1738.994	20 ft	3 ft	122.915	403.265
P1458	24	RIDGE 1	43	55	17.694	N	90	35	35.257	W	413.498	1356.619	20 ft	3 ft	6.367	20.890

P1459	25	ANTENNA 2	43	54	35.890	N	90	35	09.670	W	450.263	1477.239	20 ft	3 ft	43.132	141.510
P1460	26	COMMUNICATION TOWER 1	43	53	45.035	N	90	35	05.153	W	589.855	1935.217	20 ft	3 ft	182.724	599.488
P1461	27	COMMUNICATION TOWERS	43	53	45.994	N	90	35	02.247	W	623.269	2044.843	20 ft	3 ft	216.138	709.114
P1461G	28	TERRAIN 1	43	53	45.994	N	90	35	02.247	W	440.389	1444.843	20 ft	3 ft	33.258	109.114
P1463	29	RIDGE 2	43	53	33.442	N	90	35	30.022	W	434.231	1424.641	20 ft	3 ft	27.100	88.912
P1464	30	TERRAIN 2	43	53	06.232	N	90	36	02.053	W	433.163	1421.137	20 ft	3 ft	26.032	85.408
P1465	31	COMMUNICATION TOWER 2	43	53	12.980	N	90	37	17.825	W	526.201	1726.379	20 ft	3 ft	119.070	390.650
P1471	33	TERRAIN 4	43	52	55.391	N	90	40	13.977	W	431.401	1415.356	20 ft	3 ft	24.270	79.627
P1476	34	CELL TOWER	43	57	37.495	N	90	51	25.443	W	426.985	1400.867	20 ft	3 ft	19.854	65.138
P1477	35	COMMUNICATION TOWER 3	43	58	06.700	N	90	51	35.675	W	447.304	1467.530	20 ft	3 ft	40.173	131.801
P1478	36	COMMUNICATION TOWER 4	43	58	32.633	N	90	51	54.976	W	447.660	1468.697	20 ft	3 ft	40.529	132.968
P1488L	37	FENCE - LINE	43	57	46.275	N	90	44	37.382	W	250.626	822.261	20 ft	3 ft	0.375	1.229
	38	OL ON TOWER	UNVERIFIED OBSTRUCTION FROM 2008 SURVEY REPORT.												49.808	163.413
	39	TREE ON RIDGE	UNVERIFIED OBSTRUCTION FROM 2008 SURVEY REPORT.												1.939	6.363
	40	TREE ON RIDGE	UNVERIFIED OBSTRUCTION FROM 2008 SURVEY REPORT.												24.929	81.789
	41	RIDGE	UNVERIFIED OBSTRUCTION FROM 2008 SURVEY REPORT.												17.868	58.621
	42	RIDGE	UNVERIFIED OBSTRUCTION FROM 2008 SURVEY REPORT.												20.870	68.471

		Minimum Clearance Obstructions Runway 11/29 - Class A IFR														
P1449M	20	TREE 4 - MCE 10 ft Added	43	58	16.546	N	90	42	50.255	W	326.207	1070.231	20 ft	3 ft	25.756	84.502
P1422M	12	TREE 1 - MCE 10 ft Added	43	57	17.688	N	90	43	48.558	W	273.897	898.612	20 ft	3 ft	3.076	10.093
P1353M	6	TREE 3 - MCE 10 ft Added	43	57	34.129	N	90	43	50.723	W	269.229	883.297	20 ft	3 ft	12.921	42.391
P1468M	32	ROAD - MCE 15 ft added	43	51	28.052	N	90	40	14.823	W	432.186	1417.930	20 ft	3 ft	25.055	82.201
P1424M	14	13TH AVENUE - MCE 15 ft added	43	57	22.560	N	90	43	49.463	W	257.652	845.314	10 ft	3 ft	3.508	11.508
		Obstructions -Helipad A - Standard IFR														
		None Found													25.055	82.201
		Obstructions - Helipad B - IFR 1 dir ingress/egress														
L1342	D1	ANTENNA 1	43	58	16.546	N	90	42	50.255	W	255.479	838.183	20 ft	3 ft	2.693	8.836
L1343	D2	SIREN 1	43	57	21.541	N	90	41	47.555	W	260.213	853.716	20 ft	3 ft	0.299	0.980
L1344	D3	POWER POLE 1	43	57	21.846	N	90	43	51.023	W	277.761	911.286	10 ft	3 ft	3.847	12.621
		Meteorological Apparatus														

P1003		WINDSOCK	43	57	12.101	N	90	44	25.429	W	257.545	844.962	20 ft	3 ft	-42.906	-140.767
P1336		WINDSOCK	43	57	44.086	N	90	44	34.837	W	252.487	828.366	20 ft	3 ft	2.080	6.824
P1379		ANEMOMETER	43	57	29.229	N	90	44	23.030	W	254.898	836.279	20 ft	3 ft	-8.178	-26.830
P1380		CEILOMETER	43	57	29.245	N	90	44	23.211	W	253.204	830.721	20 ft	3 ft	-10.018	-32.868
P1381		RAIN GAUGE	43	57	29.371	N	90	44	23.210	W	252.531	828.513	20 ft	3 ft	-10.170	-33.367
P1382		WIND METER	43	57	29.149	N	90	44	23.118	W	262.466	861.107	20 ft	3 ft	-1.044	-3.426
P1394	10	WINDSOCK	43	57	35.633	N	90	43	58.979	W	260.128	853.436	20 ft	3 ft	7.620	25.000
P1395	11	WIND METER	43	57	35.659	N	90	43	58.623	W	255.479	838.183	20 ft	3 ft	2.693	8.836
Miscellaneous Data																
ATCT-FLOOR		Control Tower Cab Floor	43	57	18.393	N	90	44	5.796	W	270.608	887.821	20 ft	3 ft	-17.359	-56.953
ATCT-TOP		Control Tower Top	43	57	18.476	N	90	44	5.839	W	285.521	936.745	20 ft	3 ft	-2.158	-7.079
Computed Data																
ARP		Airfield Reference Point	43	57	30.178	N	90	44	16.461	W			1 ft			
AE		Airfield Elevation									254.730	835.729		0.25 ft		

TDZE 11		Touchdown Zone Elevation 11 Approach									252.096	827.086		0.25 ft		
TDZE 29		Touchdown Zone Elevation 29 Approach									253.071	830.286		0.25 ft		
Abeam Points																
P3261		VOR Abeam Point	43	57	37.961	N	90	44	24.792	W	250.959	823.354	1 ft	0.25 ft		
P3262		PAR Abeam Point	43	57	42.672	N	90	44	40.820	W	250.188	820.825	1 ft	0.25 ft		
		Runway Length														
RWY11-29		Runway 11-29 Length									1431.646	4697.000				
RWY11-29		Runway 11-29 Width									30.480	100.000				
			Geodetic Azimuth (deg min sec)				Magnetic Azimuth (deg min sec)									
RWY 11		Runway 11-29	112 08 38.35				115 22 48.00									
RWY 29		Runway 11-29	292 09 19.63				295 24 00.00									
MAG DEC		Magnetic Declination					01 32 14 W									
Datum Information																
HORIZ. DAT.		WGS84 (G1674)														
VERT. DAT.		WGS84 (G1674)														
ORTHO HT.		EGM96														

UTM		15T							
Other Information									
AIRFIELD		[4 letter airport code]	XYZ Army Airfield at Fort ABC						
SURV DATE		September 12 - 14, 2013							
SURV BY		[List Surveying Agency]							
MCE		Minimum Clearance Elevations	Except as noted in the description column, all minimum clearances were per Table 3-8 of UFC 3-260-01.						
UNVERIFIED		Unverified Obstructions	Elevations were from the 2008 survey. Obstructions were inaccessible due to construction.						

APPENDIX E

Sample Department of Army Data Sheets

APPENDIX E – Sample DA Data Sheets

The sample Airfield Compilation Report, Instrument Landing System (ILS) Data Sheet and Precision Approach Radar (PAR) Data Sheet provided here are forms developed by the Army school. Forms DA 5821, DA 5822 and DA5827 are DA forms. In xfdl format they require a DoD common access card (CAC) to view and edit. Individuals who do not have access to the DA forms may use similar forms developed in Word.

AIRFIELD COMPILATION REPORT

For use of this form, see FM 3-34.331; the proponent agency is TRADOC.

SURVEY AGENCY: NGA, Saint Louis			
AIRPORT NAME: Blackstone Army Airfield			IDENTIFIER: LIPA
CITY: Aladdin	STATE: South Dakota	EDITION: 1	SURVEY DATE *(YYYYMMDD)*: 20081030
AIRPORT REFERENCE POINT: ARP	LATITUDE: 46°01'51.879"N	LONGITUDE: 12°35'47.266"N	Δ CL OR θ ANGLE: -01°43'49"
AIRPORT LOCATION POINT: ARP	LATITUDE	LONGITUDE	DECLINATION: -02°09'
AIRPORT ELEVATION *(feet)*: 413.7 MSL	LOCATED: EOR 23	CONTROL TOWER FLOOR ELEVATION *(feet)*: 447.9 MSL	
DATUM: WGS 84		POSITION CODE - 1. Field Survey 2. Photogrammetric 3. Other	

AIRPORT DATA	ELEVATION	LATITUDE	LONGITUDE	YR-CODE	REMARKS	OFFICE CODE
05 WINDSOCK	359.0	46°01'30.067"N	12°35'07.079"E	08/10	Windsock near 05 approach	
ASR	349.8	46°01'19.069"N	12°36'17.167"E	08/10	Elevation, Lat, and Long at ground level	
BEACON	512.3	46°02'14.242"N	12°36'50.247"E	08/10	TOP Center	
GLIDE SLOPE	332.1	46°01'26.425"N	12°35'13.787"E	08/10	Elevation, Lat, and Long at ground level	
23 WINDSOCK	433.5	46°02'17.462"N	12°36'22.733"E	08/10	Windsock near 23 approach	
LOCALIZER	423.7	46°02'30.244"N	12°36'48.080"E	08/10	Elevation, Lat, and Long at ground level	
NDB	128.2	45°55'27.607"N	12°25'42.678"E	08/10		
PAR	376.8	46°01'51.900"N	12°36'01.156"E	08/10	Elevation, Lat, and Long at ground level	
PAR REF	402.6	46°01'43.117"N	12°35'47.228"E	08/10	Top center of PAR Reflector	
TACAN	343.7	46°0140.341"N	12°35'12.761"E	08/10	Elevation, Lat, and Long at ground level	
05 ASOS	331.7	46°01'26.978"N	12°35'15.000"E	08/10	Center of 05 ASOS Elevation at ground level	

RUNWAY	DSPLCD THR LENGTH	RWY END ELEVATION	LATITUDE	LONGITUDE	WIDTH / LENGTH	GEODETIC AZ. (N) / MAG. BEARING (N)	OFFICE CODE
05ER	N/A	323.5	46°01'23.385"N	12°35'02.127"E	148.3 / 8596.3	47°48'21.8" / 45°39'21.8"	
SD location 05	N/A	323.6	46°01'23.453"N	12°35'02.241"E			
23ER	N/A	413.7	46°02'20.372"N	12°36'32.406"E	147.8 / 8596.3	227°49'26.8" / 225°40'26.8"	
SD location 23	N/A	413.7	46°02'20.343"N	12°36'32.368"E			

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APPENDIX E – Sample DA Data Sheets

PRECISION APPROACH RADAR (GCA) DATA

For use of this form, see FM 3-34.331; the proponent agency is TRADOC.

AIRPORT NAME Blackstone Army Airfield		
CITY Aladdin	STATE South Dakota	SURVEY DATE *(YYYYMMDD)* 20081030

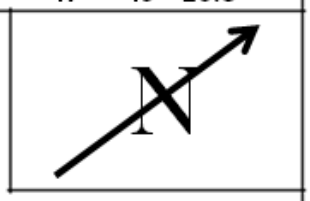
PAR COMPONENTS AND PERTINENT RUNWAY DATA Numbered items correspond to the diagram below.	LATITUDE (1/ 100 Second)	LONGITUDE (1/ 100 Second)	ELEVATION (1/ 10 Foot)
1. PAR Antenna	46°01'51.900"N	12°36'01.156"E	376.8
2. Touchdown Reflector			
3. The point on runway C/L closest to the Touchdown Reflector (item 2).	46°01'47.918"N	12°35'40.981"E	364.4
4. Runway C/L End.	Approach End 23 46°02'20.372"N	12°36'32.406"E	413.7
5. Runway C/L End.	Approach End 05 46°01'23.385"N	12°35'02.127"E	323.5
6. The point on runway C/L closest to PAR Antenna.	46°01'56.706"N	12°35'54.904"E	378.3
7. Displaced Threshold (if applicable).	N/A		

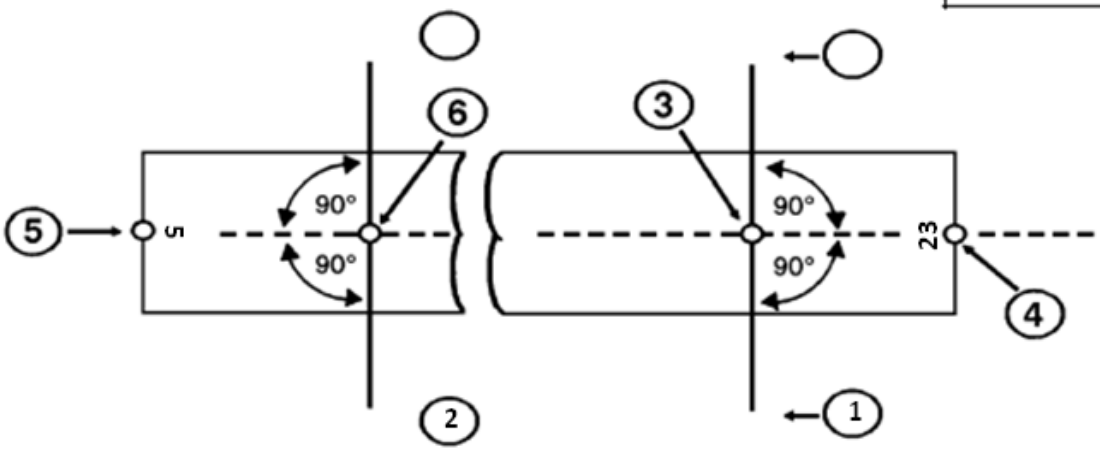
PAR Antenna - Enter Numeral 1 in circle to indicate PAR Antenna Position.

Touchdown Reflector - Enter Numeral 2 in circle to indicate Touchdown Reflector.

PAR - GROUND DISTANCE											
3 to 7	FEET	1 to 6	705.5	FEET	2 to 3	656.4	FEET	GEODETIC AZIMUTH SOUTH			
(If applicable)		3 to 6	1325.7	FEET	3 to 4	4896.1	FEET	4 to 5	47°	49'	26.8"

ADD APPLICABLE NUMBERS TO CIRCLES AND RUNWAY ENDS. SHOW NORTH ARROW.





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APPENDIX E – Sample DA Data Sheets

INSTRUMENT LANDING SYSTEM DATA

For use of this form, see FM 3-34.331; the proponent agency is TRADOC.

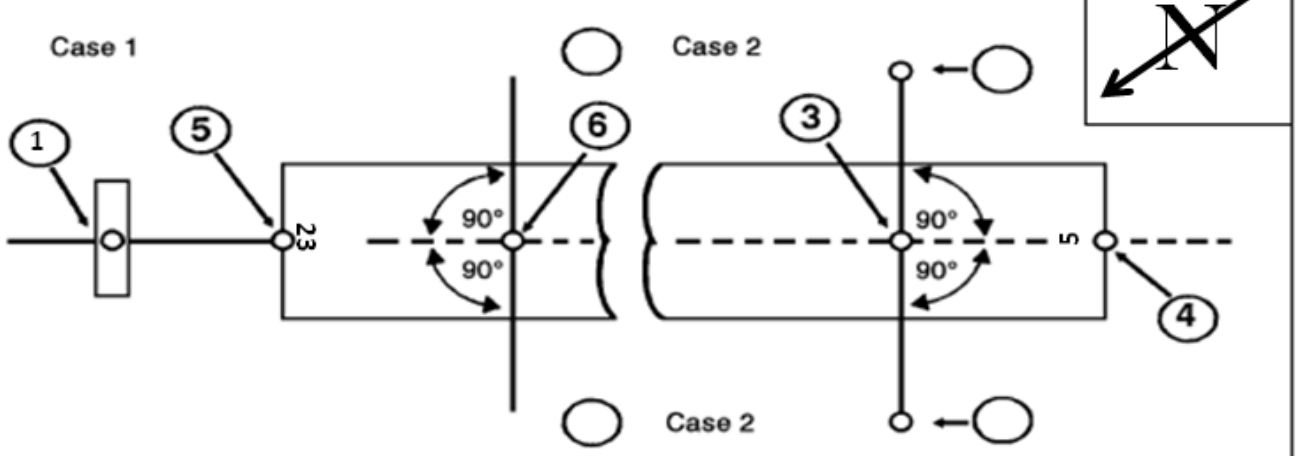
AIRPORT NAME	Blackstone Army Airfield		
CITY: Aladdin	STATE: South Dakota	SURVEY DATE *(YYYYMMDD)* 20081030	

ILS COMPONENTS AND PERTINENT RUNWAY DATA Numbered items correspond to the diagram below.	LATITUDE (1/ 100 Second)	LONGITUDE (1/ 100 Second)	ELEVATION (1/ 10 Foot)
1. Localizer Antenna (Course Array): Point on ground beneath the localizer antenna.	46°02' 30.244"N	12°36' 48.080"E	423.7
2. Glide Slope Indicator (GSI): Center of the base supporting the antenna.	46°01' 26.425"N	12°35' 13.787"E	332.1
3. The point on runway C/L closest to the base of the Glide Slope Indicator Antenna (Item 2).	46°01' 28.798"N	12°35' 10.698"E	333.0
4. Runway C/L End.	Approach End 05 46°01'23.385"N	12°35'02.127"E	323.5
5. Runway C/L End.	Approach End 23 46°02'20.372"N	12°36'32.406"E	413.7
6. The point on runway C/L closest to the base of the offset localizer (Case 2).	N/A	N/A	N/A

MARKERS	LATITUDE *(1/10 Second)*	LONGITUDE *(1/10 Second)*	GROUND DISTANCE TO END OF RUNWAY
INNER OR B.C. MARKER (RUNWAY END)	N/A	N/A	N/A
MIDDLE MARKER (RUNWAY END)	N/A	N/A	N/A
OUTER MARKER (RUNWAY END)	N/A	N/A	N/A

LOCALIZER - GROUND DISTANCE								
Case 1 (normal)		Case 2 (offset)						
1 to 5	1490.9 FEET	1 to 6	N/A FEET	2 to 3	324.5 FEET	GEODETIC AZIMUTH SOUTH		
		5 to 6	N/A FEET	3 to 4	816.4 FEET	4 to 5	227° 48' 22.3"	

ADD APPLICABLE NUMBERS TO CIRCLES AND RUNWAY ENDS. SHOW NORTH ARROW.



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APPENDIX F

Airfield Obstruction Chart Criteria

1.0 Understanding Airfield Obstruction Charts (AOC): AOCs are no longer required by USAASA; however, are required by the airfields. They find them useful for visualizing obstructions and for planning mitigation. Much of the guidance in this section is from the FAA 405 which has been rescinded. Since the charts are required and do not have to meet FAA requirements, there is flexibility in the design and appearance of the charts. All charts must meet the general chart requirements but the specific design guidance in section 7 below is intended as general guidance. Individuals constructing the AOCs should use their cartographic expertise to ensure the charts are readable and suitable for their intended purpose.

2.0 General Chart Requirements: Any charts should meet the following guidance unless otherwise specified in the scope of work.

2.1. Chart Size: Border dimensions of printed chart shall be either 30 inches by 42 inches or 30 inches by 48 inches.
2.2. All latitude/longitude coordinated displayed shall be in DD MM SS.SSS format.
2.3. All coordinates must be notated with “N”, “S” (Latitude) or “E”,”W” (Longitude) to indicate compass direction.
2.4. All elevations listed shall be in orthometric feet.
2.5. Plan charts and profiles should be on separate sheets.
2.6. Labeling should be clear with no overlaps. Additional charts at different scales may be used to address problems with representing dense information.
2.7. Charts shall contain the following information:

- Date of field survey
- Plot date
- Chart title
- Name of Airfield, four-letter airfield code and installation/garrison name
- Company or agency who conducted the survey
- Agency for which the survey was prepared for/submitted to
- Magnetic North
- Scale bar
- Legend showing symbols and their meaning
- All information concerning the horizontal and vertical datums and geodetic control information associated with the survey
- Survey Station Data
  - Station identifier
  - Description (i.e. PACS, SACS, etc)
  - Latitude/Longitude
  - Station Elevation

2.8. Reference sources of data shown on the chart that were not collected as part of the survey, such as GIS base data, aerial photography, a map of Airfield, Waivers (permanent/temporary), Permissible Deviations, built to a previous

design standard. (Airfield Manager will provide surveyor with a current list of all approved items) etc.

2.9. Identifiers for obstacles reported on the AOCs must correlate to an identifier in the Summary Data Sheet so users may cross-reference the Summary Data Sheet with the AOC.

2.10. Due to frequent changes on Army airfields, all charts will be current with all new facilities/airfield surfaces (runways, taxiway, aprons, hangars, etc.) shown. Consultation with Airfield Manager is required to ensure all new facilities/airfield surfaces are included or those that may have been left off of previous surveys. A thorough comparison to existing airfield layout should be done to detect changes and ensure accuracy of chart/map/images used.

3.0 Airfield Obstruction Charts (AOC) and Profiles: In addition to the general chart requirements, each AOC sheet should contain the following information unless noted otherwise.

3.1. Obstructions Table: The obstruction table should only contain those features which penetrate the obstruction surface. Features which do not penetrate the obstruction surface without the addition of the minimum clearance should not be listed as obstructions. The obstruction table should contain all points listed in the Summary Data Sheet. Obstruction areas and lines should be shown on the AOC with a symbol indicating they are obstructions features; however, only the obstruction points reported in the Summary Data Sheet need to be listed in the obstruction table. The table should contain the following information:

3.1.1. Reference Number or identifier (must be able to correlate number in obstruction table to the Summary Data Sheet).

3.1.2. Obstruction name/description (Description criteria is the same as the Summary Data Sheet).

3.1.3. Elevation

3.1.4. Number of feet the obstruction penetrates the OIS (This is also reported on the Summary Data Sheet.

3.2. Minimum Clearance Obstructions: Minimum clearance obstructions may be reported in a separate table on the AOC or in a separate section of the obstruction table if desired. The description for minimum clearance obstructions has the same requirements as the Summary Data Sheet.

3.2.1. Reference Number or identifier (must be able to correlate number in obstruction table to the Summary Data Sheet).

3.2.2. Obstruction name/description (Description criteria is the same as the Summary Data Sheet).

3.2.3. Elevation

3.2.4. Number of feet the obstruction penetrates the OIS (This is also reported on the Summary Data Sheet)

3.3. Operational Data

- **3.3.1.** Airport Elevation
- **3.3.2.** Airport Reference Point (Lat/Lon)

3.4. Runway Data Table
- **3.4.1.** Runway Designation
- **3.4.2.** Latitude/Longitude
- **3.4.3.** Elevation
- **3.4.4.** Geodetic and Magnetic Azimuth (where applicable)
- **3.4.5.** Touchdown zone elevation (where applicable)
- **3.4.6.** The runway or helipad/runway types used to determine the obstruction surfaces per the UFC 3-260-1.
  - **3.4.6.1.** Flight Rules: IFR or VFR
  - **3.4.6.2.** Note if runway is ILS CAT I
  - **3.4.6.3.** Runway Type: Class A or Class B
  - **3.4.6.4.** Any notes concerning OIS used
  - **3.4.6.5.** Note any ingress/egress restrictions for helipads

3.5. Applicable Notes
- **3.5.1.** Inaccessible or non-validated obstructions
- **3.5.2.** Obstruction notes

3.6. Available base map data layers from the installation, if used (Plan View Only)
3.7. Runway with dimensions labeled
3.8. Labeled runway end points with elevation and runway end designations
3.9. Labeled displaced threshold point (if present) with elevation and runway end designation
3.10. Labeled overrun end (if present) with elevation
3.11. Obstructions with reference label to table
3.12. Obstruction areas with reference label to table
3.13. Minimum clearance features with reference label to table
3.14. Off chart obstructions with reference label to table along with direction and distance to obstruction
3.15. Survey monuments with labels
3.16. PAR (Plan View Only)
3.17. Key NAVAID Features (Plan View Only)
3.18. Depiction of imaginary surfaces with labels (Approaches only in profile view)
3.19. Accident Potential Zones (Plan View Only)
3.20. Other information deemed necessary to make the chart useful

4.0 Airfield Obstruction Chart Plan View: The AOC plan view may consist of one or more sheets depending on the size and complexity of the airfield and associated obstructions. One map should be at a 1:12,000 scale or at a scale which will adequately show the extent of obstruction surface. A second map shall be provided at a scale that allows a clearer view of the obstructions approximate to the runway or helipad (e.g., 1” = 200’ to 1” = 300’). All maps should contain information specified in the General Chart Requirements section unless specified otherwise.

5.0 Airfield Obstruction Chart Profile View: The profile chart depicts the runway and approach slopes to scale along with obstructions. The approach slope for runways should be based on the obstruction approach surface and appropriately labeled. In addition to the approach slope defined by the imaginary surfaced used, additional slopes should be displayed in light gray dashed lines. Slopes included on the profile include 8:1, 20:1, 34:1, 40:1 and 50:1 with only the slope used for obstruction analysis being displayed in black**. In addition, all fixed wing runways must have a light gray dashed line at a 40:1 slope that starts from the runway end.** No analysis is required for these additional slopes; they are for visual interpretation only. The map should be at the same scale as one of the plan views for cross referencing and show a plan view of the runway below the profile. For longer runways, the profile may be broken into two parts on a single map. For multiple runways or helipads, more than one may be displayed on a single sheet if cartographically appropriate. For helipads, a slope profile for each approach should be rendered. For IFR runways and helipads, the VFR approach slope should be displayed and labeled. A note should specify which slope was used for the analysis. For cases of VFR only profile, only the VFR slope need be displayed unless otherwise specified. All maps should contain information specified in the General Chart Requirements section unless specified otherwise.

6.0 Runway Marking Charts: Airfield/heliport/helipad runway marking charts are no longer required as part of AR 95-2, but may be requested by a facility if they would like markings checked. The purpose of the charts is to validate the presence and spacing of the runway markings, so it is not necessary detail survey all of the markings. A combination of survey and measurements may be used to acquire the location and spacing information.

6.1. Chart should contain the following information in addition to the general chart information

6.1.1. Runway outline with dimensions labeled

6.1.2. Runway markings

6.1.2.1. Label dimensions of representative markings

6.1.2.2. Label representative spacing between markings

6.1.2.3. Label any marking colors other than white

7.0 Design Guidance

While this AOC guidance specifies symbology for certain features, the individual constructing the chart should us his or her cartographic expertise to ensure the chart is readable and is usable for the intended purpose. This subsection lists recommended graphical depictions for AOC Plan Views

Runways

- Outline Solid
- Runway length and width labeled in whole feet
- Surface type labeled as “PAVED” if paved and “UNPAVED” if not paved
- Displaced Threshold (DTHLD)

    - Solid line perpendicular to runway centerline at the DTHLD but not touching runway outline
    - Elevation depicted by 1 mm filled circle placed tangent to touchdown side of DTHLD line and - Magnetic Bearing labeled to one decimal place in feet
    - Labeled "DISPLACED THRESHOLD" with length labeled to whole feet. Use leader pointing to DTHLD with label, such as, "400 FT. DISPLACED THRESHOLD.
- Physical End Elevation
    - Depicted by a 1 mm filled circle placed tangent to touchdown side of runway end line.
    - Elevation labeled to one decimal place in feet
- Airport Elevation
    - Depicted by a 1 mm filled circle placed at the airport elevation location
    - Labeled to one decimal place in feet
    - Elevation closed in a solid line box
- Touchdown Zone Elevation (TDZE)
    - The TDZE shall NOT be depicted. (The TDZE shall be indicated in the Tabulated Operational Data section of the Airfield Plan (AP) but only for Special Prepared Hard Surface (SPHS) runways with a landing length equal to, or greater than, 3,000 feet).
- Magnetic Bearing
    - Shown in whole degrees with direction arrow near each runway end
- Runway Numbers
    - Shown in their true locations as painted on runway at the time of the field survey. If no number is painted on runway, runway number published in the United States Government flight information publication "U.S. Terminal Procedures" current at the time of the field survey shall be shown on runway with the base of the number approximately 100 feet from the threshold

Obstructions

- Obstructions shall be depicted with a 1 mm filled circle.
- Non-obstructions and objects with no elevation information shall be depicted with a 1 mm open circle.
- Obstruction areas and lines will be shown on the charts along with the associated points reported in the Summary Data Sheet. The area and line obstructions should have a symbol as associated legend entry so it is clearly indicated the feature is an obstruction.

Navigational Aids

- The horizontal survey point for electronic NAVAIDS shall be plotted. The plot point for visual NAVAIDS shall be plotted. In addition, approach light systems shall be symbolized between the plot points
- An elevation shall not be shown unless the NAVAID is also an obstruction. In this case, only the top elevation shall be shown
- If no elevation is indicated, or the NAVAID does not obstruct, it shall be depicted with a 1 mm open circle. If an elevation is shown and the NAVAID obstructs, it shall be depicted with a 1 mm filled circle

Meteorological Apparatus

- Meteorological apparatus is not required unless it is to be depicted for its elevation value or request was specifically requested in the scope of work. In this case, it shall be treated as other objects

Plainimetric Detail

- Planimentric detail may vary based on source data and intended use of the AOC. In most cases, the focus is on the information collected specifically for the obstruction chart and it is important to ensure that information is clear and readable. Complex areas may become hard to read if there is too much information and not much variation in line thickness or other symbology. While this AOC guidance specifies symbology for certain features, the individual constructing the chart should us his or her cartographic expertise to ensure the chart is readable and is usable for the intended purpose.
    - Existing source data or installation map layers: If using map layers from other sources, it is recommended that this information be presented in gray to indicate they were not collected as part of the survey. This also allows surveyed information to be easily readable.
    - Field surveyed planimetric data may include the include the following
        - All usable runways located on the airfield. Runways with specially prepared hard surfaces shall be delineated with a solid line. Runways without specially prepared hard surfaces shall be delineated with a

dashed line. Paved runways shall be labeled "PAVED." All other runways shall be labeled "UNPAVED."

- Runways with specially prepared hard surfaces that are not located on the AOC airfield but fall within the AP limits on the published AOC. These runways shall be delineated with a solid line and will include the airfield name if available.
- Paved helipads that are isolated from other apron areas. These areas shall be delineated with a solid line and labeled "HELIPAD." Helipads on other apron areas need not be identified.
- Closed runways if they are sufficiently prominent to be of value to a pilot in airfield identification. Closed runways with specially prepared hard surfaces shall be delineated with a solid line. Closed runways without specially prepared hard surfaces shall be delineated with a dashed line. In both cases the runway shall be labeled "CLOSED RUNWAY."
- Aprons and taxiways with specially prepared hard surfaces. These items shall be delineated with a solid line.
- Approximate limits of non-SPHS tiedown areas if permanent tiedown fixtures are present and portion of the area is located within 200 feet of a primary or approach obstruction identification surface. If any portion of the area meets these criteria, the entire area shall be delineated with dashed line and labeled "UNPAVED TIEDOWN AREA."
- Traverse ways, dikes, transmission lines, fence lines, or other linear features having obstruction or landmark value. Feature delineation should be sufficient to allow positive feature identification by the chart user.
- A selection of roads, especially in the airfield vicinity, to assist the AOC user in geographic orientation.
- The terminal building complex, plus hangars, maintenance facilities, and other prominent buildings directly associated with aircraft operations and directly connected to the apron. These items shall be hatched.
- Coastlines, lakes, rivers, major highways and buildings, or other features of landmark value that aid in geographic orientation.
- Elevation information is not required for planimetric detail charted only for its planimetric value. Features selected for their elevation value as well as their planimetric value, such as, transmission lines, shall carry a representative spot elevation.

Miscellaneous

- A compass rose oriented to geodetic north showing both geodetic north and magnetic north arrows. The magnetic variation at the time of the field survey shall be labeled along the magnetic arrow to the nearest tenth (0.1) of a degree. The official source for magnetic variation for the AOC and related products is the U. S. Geological Survey, Branch of Global Seismology and Geomagnetism, Denver CO.
- Elevation of floor of control tower cab shown in whole feet

Runway Plans and Profiles (RPP)

- Orientation
  - The RPP shall be oriented so that for each runway the runway end with the highest longitude shall be to the left on the published AOC.
- Scale
  - Horizontal scale shall be the same as the AP. Vertical scale shall be 1 inch = 100 feet.
- Area of Coverage
  - The extent of the RPP shall be limited to the primary and approach surface areas, including supplemental approach surface, as depicted in the AP. The longitudinal extent of the RPP will depend on obstruction locations in the approaches and the available space for the RPP on the published AOC.
  - The following guidelines should be followed, when practical, to determine RPP longitudinal limits:
    - Extend the RPP at least 2,000 feet beyond the near runway end.
    - Extend the RPP to a 1,000 foot multiple + 500 feet, such as, 5,500 feet, 8,500 feet etc. from the opposite runway end.
    - Extend the RPP at least 500 feet beyond the last obstruction that penetrates the approach. If this extension is not practical, the RPP should be terminated at a convenient point that meets the criteria above. All approach obstructions located beyond this point shall be leadered with distances shown to the nearest whole foot.
- Content and Portrayal in Plan
  - The Plan portion of the RPP shall include:
    - The runway outline
    - Objects carried on the AP with a spot elevation.

- EME points for obstructing mobile object areas. (The area but not the EME point is shown on the AP). EME point(s) shall be selected at: (1) the point nearest to the runway centerline end for primary surface penetrations, (2) the most penetrating point for approach surface penetration, and (3) as appropriate to represent the area. (See Figure 4.7 and Figure 4.8)
- Taxiways and other planimetric detail carried in the AP shall not be shown in the RPP.
- Objects that penetrate the approach or supplemental approach surface of the profiled runway and are located beyond the published limits of the RPP shall be leadered from the runway end with distances shown to the nearest whole foot. Objects within the limits of the approach or supplemental approach areas but penetrating the horizontal or conical surface only, shall not be leadered.
- A runway centerline extended locator shall be placed in each approach in the Plan portion of the RPP.

- Content and Portrayal in the Profile
  - The profile shall include all objects carried in the Plan with spot elevations, including leadered obstructions.
  - If profiling all objects results in congestion in the Profile, lower objects may be omitted.
  - The line portrayal of objects in the Profile shall be 0.5 inch in length or extend to 0.1 inch below the elevation of the runway end, whichever is shorter.
  - The runway, and stopways when present, shall be depicted in the Profile portion of the RPP with the elevation of each profile point labeled.
  - Each Profile shall portray the specified approach surface and supplemental approach surface, if present. In addition, the Profile for specified PIR approaches shall depict a 34:1 surface in addition to the specified PIR surface.

- Object Numbering Scheme
  - All profiled objects shall be numbered consecutively from left to right in the Profile with matching numbers for the corresponding objects in the Plan.
  - A north arrow shall be placed between each Plan and Profile

- When there is insufficient room to print the RPP on the AOC front, the RPP shall be printed on the AOC back. In these cases, a runway layout diagram, at the scale of the AP, showing runway numbers and a north arrow shall be included on the chart back.

APPENDIX G

Glossary of Geodetic Terms

APPENDIX G – Glossary of Geodetic Terms

Accuracy – The degree of conformity with a standard, or a value accepted as correct. Precision is the degree of uniformity of repeated measurements or events. For example, repeat measurements of the distance between two points may exhibit a high degree of precision by virtue of the relative uniformity of the measurements. However, if a "short" tape were used in the measurements, accuracy would be poor in that the measured distance would not conform to the true distance between the points. Surveying and mapping accuracy standards should include three elements: (1) a stated variation from a true value or a value accepted as correct, (2) the point to which the new value is relative, and (3) the probability that the new value will be within the stated variation. For example, "Horizontal accuracy will be 5 cm relative to the nearest Continuously Operating Reference Station (CORS) at the 95 percent confidence level."

Angle – The inclination to each other of two intersecting lines, measured by the arc of a circle intercepted between the two lines forming the angle, the center of the circle being the point of intersection.

Area – In general, an area is any aggregate of plane spaces to be considered in an investigation; especially the quantity projected on a horizontal plane enclosed by the boundary of any polygonal figure.

Azimuth

- ***Astronomic Azimuth –*** At the point of observation, the angle measured from the vertical plane through the celestial pole and the vertical plane through the observed object. The astronomic azimuth is established directly from observations on a celestial body and is measured in the plane of the horizon. Astronomic azimuths differ from geodetic azimuths because of the deflection of the vertical which can be greater than one minute of arc in extreme cases. Astronomic azimuths may be reckoned clockwise or counter-clockwise, from either north or south, as established by convention.

- ***Geodetic –*** The angle at point A between the tangent to the meridian at A and the tangent to the geodesic from A to B whose geodetic azimuth is wanted. It may be reckoned clockwise from either geodetic north or south as established by convention. Because of earth curvature, the geodetic azimuth from A to B (forward azimuth) differs from the geodetic azimuth from B to A (back azimuth) by other than 180 degrees, except where A and B have the same geodetic longitude or where the geodetic latitude of both points is zero. The “geodesic line”is the shortest surface distance between two points on the reference ellipsoid. A “geodetic meridian” is a line on the reference ellipsoid defined by the intersection of the reference ellipsoid and a plane containing the minor axis of that ellipsoid.

- ***Grid –*** The angle in the plane of projection between a straight line and the central meridian of a plane-rectangular coordinate system. Grid azimuths may be reckoned clockwise from either geodetic north or south as established by convention.

- ***Magnetic –*** At the point of observation, the angle between the vertical plane through the observed object and the vertical plane in which a freely suspended symmetrically magnetized needle, influenced by no transient artificial magnetic disturbance, will come to rest. Magnetic azimuths are reckoned clockwise from magnetic north.

APPENDIX G – Glossary of Geodetic Terms

Bench Mark – A relatively permanent natural or artificial material object bearing a marked point whose elevation above or below an adopted surface (datum) is known.

BERNESE GPS Software - The Bernese GPS Software Version 5.0 is a high performance, high accuracy, and highly flexible reference GPS/GLONASS post processing software. State of the art modeling, detailed control over all relevant processing options, the adherence to up to date internationally adopted standards, and the inherent flexibility due to a highly modular design are characteristics of the Bernese GPS Software.

Continuously Operating Reference Station (CORS) – A permanent GPS facility whose GPS receiver continuously provides observables from the GPS satellites, allowing stations occupied temporarily by GPS receivers to be differentially positioned relative to it. CORS are related to the WGS84 coordinate system at the 1-3 cm level either by being collocated at VLBI sites which were used to define the coordinate system or by being differentially positioned relative to such a collocated GPS station.

Control Station – A point on the ground whose position and/or elevation is used as a basis for obtaining positions and/or elevations of other points.

Coordinates – Linear or angular quantities which designate the position that a point occupies in a given reference frame or system. Also used as a general term to designate the particular kind of reference frame or system, such as plane rectangular coordinates or spherical coordinates.

Cross Section – A horizontal grid system laid out on the ground for determining contours, quantities of earthwork, etc., by means of elevations of the grid points.

Datum – In general, a point, line, surface, or set of values used as a reference. A “geodetic datum” is a set of constants specifying the coordinate system and reference used for geodetic control (refer to **Control Station**), i.e. for calculating coordinates of points on the earth. At least eight constants are needed to form a complete datum: three to specify the location of the origin of the coordinate system; three to specify the orientation of the coordinate system; and two to specify the dimensions of the reference ellipsoid. Any point has a unique X, Y, Z datum coordinate which can be transformed into latitude, longitude, and ellipsoid height (height relative to the ellipsoid). A “horizontal control datum” is a geodetic datum specified by two coordinates (latitude and longitude) on the ellipsoid surface, to which horizontal control points are referenced. A “vertical datum” is a theoretical equipotential surface with an assigned value of zero to which elevations are referenced. (Refer to **GEOID**.)

Datum Tie – The process of determining, through appropriate survey methods, a position (horizontal tie) or elevation (vertical tie) of a new point relative to a control station with established datum values such as a control station in the National Spatial Reference System (NSRS). The new point may be a permanent survey monument. This process ensures that the new point will have the proper relationship to NSRS and to all other points tied to NSRS.

Differential GPS (DGPS) - Differential **G**lobal **P**ositioning **S**ystem **(**DGPS) uses two or more satellite receivers to determine the geodetic coordinates of a roving (dynamic) receiver relative to a stationary (base or static) receiver. The underlying principle is the difference between the geodetic coordinates derived from satellite data and known coordinates of the base station is

applied to the satellite data of the roving receiver. DPGS can refer to a Ground Based Augmentation System consisting of multiple base stations covering large areas for navigation purposes or survey-grade activities from one base station achieving millimeter accuracy.

Distance – The spatial separation of two points, measured by the length of a line joining them.

Earth Gravitational Model 1996 (EGM96) – A geopotential model of the earth consisting of spherical harmonic coefficients complete to degree and order 360.

Earth Gravitational Model 2008 (EGM08) - Soon to be announced.

Elevation – Vertical distance from a datum, usually mean sea level, to a point or object on the earth's surface. Not to be confused with altitude which refers to points or objects above the earth's surface.

Ellipsoid – Refer to **Reference Ellipsoid**.

Ellipsoid Height – The distance between a point and the reference ellipsoid taken along the perpendicular to the ellipsoid. Ellipsoid heights are the heights resulting from GPS observations. Ellipsoid heights are positive if the point is above the ellipsoid. Ellipsoid Height = GEOID Height + Orthometric Height.

Epoch – (1) A particular instant for which certain data are given. **(2)** A given period of time during which a series of related acts or events takes place. **(3)** An arbitrary moment in time to which measurements of position for a body or orientation for an orbit are referred.

Equipotential Surface – A surface having the same potential (usually of gravity or of gravitation) at every point.

Error – (1) The difference between an observed or computed value of a quantity and the ideal or true value of that quantity. **(2)** A class of small inaccuracies due to imperfections in equipment or techniques, surrounding conditions, or human limitations; not to be confused with blunders or mistakes.

European Terrestrial Reference Frame (ETRF) - is a subset of the global ITRF at epoch 1989.0 in which the Eurasian Plate is assumed static for mapping purposes. ETRF-89 used the GRS 80 ellipsoid and was identical to the WGS 84ellipsoid at the millimeter level.

Federal Base Network (FBN) – A fundamental reference network of permanently monumented control stations in the United States at a 1 degree x 1 degree nominal spacing, established, maintained, and monitored by the National Geodetic Survey, providing precise latitude, longitude, ellipsoidal height, orthometric height, and gravity values. The FBN is a very precise subset of the National Spatial Reference System.

Geocentric – Relative to the earth as a center; measured from the center of the earth.

APPENDIX G – Glossary of Geodetic Terms

Geodesy – The science which treats of the determination of the size and figure of the earth (GEOID) by such direct measurements as triangulation, leveling, and gravimetric observations; which determines the external gravitational field of the earth and, to a limited degree, the internal structure.

Geographic Position – The position of a point on the surface of the earth expressed in terms of latitude and longitude, either geodetic or astronomical.

Geodetic Reference System 1980 (GRS80) - is a global reference ellipsoid adopted by the **I**nternational **U**nion of **G**eodesy and **G**eophysics (IUGG). The equatorial (semi-major) axis is the same as WGS 84, but differs slightly by the derivation of the ellipsoid flattening. GRS 80 is used by the U.S National Geodetic Survey and the International Earth Rotation and Reference Systems Service.

GEOID – The theoretical surface of the earth that coincides everywhere with approximate mean sea-level. The GEOID is an equipotential surface to which, at every point, the plumb line is perpendicular. Because of local disturbances of gravity, the GEOID is irregular in shape.

GEOID Height – The distance, taken along a perpendicular to the reference ellipsoid, between the reference ellipsoid and the GEOID. The GEOID height is positive if the GEOID is above the reference ellipsoid. (GEOID height is negative for the conterminous United States). GEOID Height = Ellipsoidal Height – Orthometric Height.

Geospatial Data, Geospatially-Referenced Data or Geospatial Vector Data – Data that identifies the geographic location (2D or 3D coordinates) and characteristics (feature attributes) of natural or constructed features and boundaries on the earth. This information may be derived from remote sensing and surveying technologies. The features are represented by a point, line, or polygon. The position of a point feature is described by a single coordinate pair (or triplet for three dimensional data). The spatial extent of a line feature is described by a string of coordinates of points lying along the line, while the extent of a polygon feature is described by treating its boundary as a line feature. Vector data may be stored in a sequential, a chain node, or a topological data structure.

Global Navigation Satellite System (GNSS) - includes satellite navigation networks providing autonomous geo-location with global coverage. GNSS includes: Navigation Satellite Timing and Ranging (NAVSTAR), Global Position System (GPS), US; and Russia's Global Navigation Satellite System (GLONASS). Regional augmentations include: Galileo, Europe; Compass, China; Indian Regional Navigational Satellite System (IRNAA), India; and Japan's Quazi-Zenith Satellite System (QZSS).

Global Positioning System (GPS) – Is a space-based radio-positioning, navigation, and time-transfer system. The system provides highly accurate position and velocity information and precise time on a continuous global basis, to an unlimited number of properly equipped users.

GNSS-Inferred Positioning System /Orbit Analysis and Simulation Software (GIPSY/OASIS) - is a Precise Point Positioning and GNSS satellite orbit analysis service developed by the Jet Propulsion Laboratory (JPL) and maintained by the Near Earth Tracking Applications and System groups.

Gradient – A rate of rise or fall of a quantity against horizontal distance expressed as a ration, decimal, fraction, percentage, or the tangent of the angle of inclination.

GRAPE - NGA's Precise Point Positioning (PPP) software GPS/RINEX ARL:UT PPP Estimator, developed by the Space and Geophysics Laboratory of Applied Research Laboratory, University of Texas, Austin (ARL:UT). An absolute (single receiver) software package utilizing a Kalman filter to process dual frequency RINEX data, SP3 formatted satellite ephemerides and clock states, satellite phase center offsets, earth orientation parameters, Solid Earth Tides, and Ocean Loading effects, resulting in centimeter accuracy relative to the center of the geodetic reference frame. Both WGS 84 and ITRFyy solutions can be obtained.

Gravity – Viewed from a frame of reference fixed in the earth, acceleration imparted by the earth to a mass which is rotating the earth. Since the earth is rotating the acceleration observed as gravity is the resultant of the acceleration of gravitation and the centrifugal acceleration arising from this rotation and the use of an earthbound rotating frame of reference. It is directed normal to sea level and to its geopotential surfaces

GRiTS – GPSTk RINEX Tools is a Graphic User Interface (GUI) for GRAPE Precise Point Positioning processing, developed by the Space and Geophysics Laboratory of the Applied Research Laboratories, The University of Texas at Austin (ARL:UT), under sponsorship of NGA. GRiTS is the 'front end' of GRAPE with a complete set of data analytical tools.

Height – (1) Vertical distance above a datum, usually the surface of the earth. **(2)** The distance between a surface (in most cases an equipotential surface) through the point in question and a reference surface, measured along a line of force or along its tangent.

Height of Instrument – (1) (spirit leveling) The height of the line of sight of a leveling instrument above the adopted datum. **(2)** (stadia surveying) The height of the center of the telescope (horizontal axis) of transit or telescopic alidade above the ground or station mark. **(3)** (trigonometrical leveling) The height of the center of the theodolite (horizontal axis) above the ground or station mark.

High Accuracy Reference Network (HARN) - developed by the U.S. National Geodetic Survey, was a statewide or regional horizontal accuracy upgrade of NAD 83 coordinates using Global Positioning System (GPS) observations. HARNs were observed to support the use of GPS by Federal, state, and local surveyors, and geodesists. The cooperative program was from 1986 to 1997, horizontally upgrading 16,000 survey stations to A-order or B-order status.

Horizontal Survey Point (HSP) – A point that represents the horizontal position of a feature. This point may be located on the feature or located between feature components. For example, the horizontal survey point for a Precision Approach Path Indicator (PAPI) system is the center of the light array which falls between light units.

Imagery Control Point (ICP) -Surveyed points used to support photogrammetric triangulation of imagery. The points usually consist existing features such as building corners, runway or

taxiway corners, and generally features that have a clean 90 degree corner easily identified from imagery without potential for shadows or overhanging objects such as trees or vegetation.

International Association of Geodesy (IAG) - is an Association of the International Union of Geodesy and Geophysics (IUGG) whose mission is the global advancement of Geodesy through the following components: Reference Frames, Gravity Field, Geodynamics and Earth Rotation, Positioning and Applications, Inter-commission Committee on Theory, Global Geodetic Observing System (GGOS), and 15 International Scientific Services.

International Earth Rotation and Reference Systems Service - formerly known as the International Earth Rotation Service (IERS), is the organization responsible for maintaining global time and reference frame standards, through its Earth Orientation Parameter (EOP) and International Celestial Reference System (ICRS) groups. The IERS was established in 1987 by the International Astronomical Union (IAU) and the International Union of Geodesy and Geophysics (IUGG), replacing the earlier International Polar Motion Service (IPMS) and the earth-rotation section of the Bureau International de l'Heure (BIH).

International GPS Service for Geodynamics (IGS) - In 1993, the International Association of Geodesy (IAG) established the International GPS Service for Geodynamics (IGS), now the International GNSS Service, which is a voluntary federation of more than 200 worldwide agencies that process permanent GPS & GLONASS station data. Its primary purpose is to promote standards for GNSS data acquisition and analysis, operate a comprehensive global tracking network to provide data in support of geodetic and geophysical research.

Products include GNSS satellite ephemerides, earth rotation parameters, satellite and tracking station clock information, ionospheric and tropospheric information and tracking network station coordinates and velocities reference to the ITRF.

International Terrestrial Reference Frame (ITRF) - is a realization of the International Terrestrial Reference System (ITRS) maintained by the International Earth Rotation and Reference Systems Service. New ITRF solutions are produced every few years, using the latest mathematical and surveying techniques to realize the ITRS as precisely as possible. The latest is ITRF08 and ITRF12 is in development.

International Union of Geodesy and Geophysics (IUGG) - is dedicated to advancing, promoting, and communicating knowledge of the Earth system, its space environment, and dynamical processes. IUGG convenes international assemblies and workshops, conducts research, coordinates observations and activities, and is an advocate of global education and participation. IUGG is a non-governmental scientific organization consisting of a multitude of international Associations and Commissions.

Latitude – A linear or angular distance measured north or south of the equator on a sphere or spheroid.

Least Squares – A method of adjusting observation in which the sum of the squares of all the deviations or residuals derived in fitting the observations to a mathematical model is made a minimum.

Leveling – The process of determining the difference in elevation between two points. In geodetic leveling, this process results in a vertical distance from a vertical datum.

- ***Direct*** – The determination of differences in elevation by means of a series of horizontal observations on a graduated rod. Also known as **Differential Leveling**. The leveling instrument maintains a horizontal line of sight through spirit leveling or a compensation mechanism. The rod is observed while it is resting on a point of known elevation (backsight) and then, without disturbing the elevation of the leveling instrument, is observed a second time while resting on the unknown point (foresight). The differential in rod readings is applied to the starting elevation to determine the elevation of the unknown.

- ***Indirect*** – The determination of differences in elevation by means other than differential leveling, such as **trigonometric leveling**. In trigonometric leveling, the vertical angle and distance from the instrument to the point of unknown elevation are measured, and the difference in elevation between the instrument and the unknown point is computed using trigonometry.

Light Detection and Ranging (LiDAR) - is an optical remote sensing technology that can measure the distance to, or other properties of, a target by illuminating the target with light, often using pulses from a laser. A vertical accuracy of below 50mm can be achieved with a lower flyover and a slimmer 200m swath, even in forest, where it is able to give you the height of the canopy as well as the ground elevation. a reference point is needed to link the data in with the WGS (World Grid System)

Local Control – A control station or network of control stations in a local area used for referencing local surveys. Local control may or may not be tied to the National Spatial Reference System. (See Control Station).

Longitude – A linear or angular distance measured east or west from a reference meridian (usually Greenwich) on a sphere or spheroid.

Mean Sea Level (MSL) – The average location of the interface between the ocean and atmosphere, over a period of time sufficiently long so that all random and periodic variations of short duration average to zero.

Monument – A structure used or erected to mark the position of a survey station; permanence is implied.

National Spatial Reference System (NSRS) – A network of permanent survey monuments located throughout the United States with accurately determined positions (horizontal network) and/or elevations (vertical network). Gravity values, not always monumented, are also part of NSRS. Responsibility for establishing and maintaining NSRS rests with the National Geodetic Survey under the U.S. Department of Commerce. Current authority is contained in United

States Code, Title 33, USC 883a as amended, and specifically defined by Executive Directive, Bureau of the Budget (now Office of Management and Budget) Circular No. A-16 Revised.

NAVSTAR GPS - Navigation Satellite Timing and Ranging (NAVSTAR) Global Position System (GPS), developed and maintained by the U.S. Department of Defense, is a satellite-based radio navigation system that provides precise geo-location and timing to an unlimited number of GPS receivers globally. The mathematical model is a 3-dimentional geocentric rectangular system which defines positions as X, Y, Z relative to the center of mass of the earth.

Orthometric Height – The distance taken along the plumb line between a point and the GEOID. Orthometric heights are positive if the point is above the GEOID. Orthometric Height = Ellipsoid Height – GEOID Height.

Perpendicular – (1) A straight line which intersects another line, not necessarily straight itself, at right angles. **(2)** By extension, a straight line which intersects a surface at right angles to all lines in the surface that pass through the point of intersection.

Plumb Line – (1) The line of force in the geopotential field. The continuous curve to which the direction of gravity is everywhere tangential. **(2)** A cord with a plumb bob at one end for determining the direction of gravity.

Positional Accuracy – The difference between a geospatial feature's displayed position and its actual position. Absolute positional accuracy is the difference between a geospatial feature's displayed position and its actual position on the face of the earth. Relative positional accuracy is the difference between a geospatial feature's displayed position and that of other geospatial features in the same data set.

Precision – The smallest separation that can be represented by the method employed to make the positional statement which is the number of units or digits to which a measured or calculated value is expressed and used

Profile – A vertical section of the surface of the ground, or of underlying strata, or both, along any fixed line.

Reference Ellipsoid – A geometric figure comprising one component of a geodetic datum, usually determined by rotating an ellipse about its shorter (polar) axis, and used as a surface of reference for geodetic surveys. The reference ellipsoid closely approximates the dimensions of the GEOID. Certain ellipsoids fit the GEOID more closely for various areas of the earth. Elevations derived directly from satellite observations are relative to the ellipsoid and are called ellipsoid heights.

Scale – (1) The ratio of a distance on a photograph, map, or other graphic to its corresponding distance on the ground, or to another graphic. Scales are named by the type of graphic on which they appear, and the manner in which they are expressed. **(2)** A series of marks or graduations at definite intervals on a measuring device or instrument. **(3)** Measurement by means of a scale.

Geocentric Reference System for South America (SIRGAS) - Sistema de Referência Geocêntrico para a América do Sul, begun in 1995 is an international effort resulting in a network adjustment of 70 GPS tracking stations throughout the South American continent, relative to ITRF94 on the GRS 80 ellipsoid. In 2000, the network was extended to Central America, expanding to 200 stations, readjusted and renamed Geocentric Reference System for the Americas, SIRGAS2000.

Station – A definite point on the earth whose location has been determined by surveying methods. It may or may not be marked on the ground. A station usually is defined by the addition of a term which describes its origin or purpose. Usually marked on the ground by a monument of special construction, or by a natural or artificial structure.

Vector – Any quantity, such as force, velocity, or acceleration, which has both magnitude and direction at each point in space, as opposed to a scalar which has magnitude only. Such a quantity may be represented geometrically by an arrow of length proportional to its magnitude, pointing in the assigned direction.

Vertical Survey Point (VSP) – A point that represents the elevation position of a feature. This point may be located on the top or base of the feature or located between feature components. For example, the vertical survey point for a Precision Approach Path Indicator (PAPI) system is the ground at the center of the light array which falls between light units.

Weight – The relative value of an observation, source, or quantity when compared with other observations, sources, or quantities of the same or related quantities. The value determined by the most reliable method is assigned the greatest weight.

World Geodetic System 1984 (WGS 84) – is an Earth-centered, Earth-fixed terrestrial reference system and geodetic datum. WGS 84 is based on a consistent set of constants and model parameters that describe the Earth's size, shape, and gravity and geomagnetic fields. WGS 84 is the standard U.S. Department of Defense definition of a global reference system for geospatial information and is the reference system for GPS. The latest realization of WGS 84, GPS week 1674 (G1674), is aligned to ITRF2008 with the same epoch of 2005.0.

WGS & ITRF Precise Positioning Service (WIPPS) - is NGA's web-based PPP service utilizing the suite of GRAPE software, developed by the Space and Geophysics Laboratory of the Applied Research Laboratories, The University of Texas at Austin (ARL:UT). Processing uses GRiTS default options with limited data editing.

Zenith – The point at which a line opposite in direction from that of the plumb line at a given point on the earth's surface, meets the celestial sphere.

APPENDIX H

Glossary of Airfield Features

APPENDIX H – Glossary of Airfield Features

Abeam Point – The point on the runway centerline perpendicular to the feature (for example, a point on the runway centerline is "abeam" the Glide Slope Antenna when the distance from the centerline point to the antenna is at a minimum).

Airfield Elevation – The single highest point of all useable runways on an airfield.

Airfield Lighting – Various lighting aids that may be installed on an airfield. Types of airfield lighting include:

• ***Airfield Rotating Beacon (APBN) –*** A visual navigational aid operated at many airfields. At civil airfields, alternating white and green flashes indicate the location of the airfield. At military airfields, the beacons flash alternately white and green, but are differentiated from civil beacons by dual-peaked (two quick) white flashes between the green flashes.

• ***Approach Light System (ALS) –*** An airfield lighting facility which provides visual guidance to landing aircraft by radiating light beams in a directional pattern by which the pilot aligns the aircraft with the extended centerline of the runway on his final approach for landing. Condenser-Discharge Sequential Flashing Lights/Sequenced Flashing Lights may be installed in conjunction with the ALS at some airfields.

• ***Omnidirectional Approach Lighting System (ODALS) –*** Seven omnidirectional flashing lights located in the approach area of a nonprecision approach. Five lights are located on the runway centerline extended with the first light located 300 feet from the threshold and extending at equal intervals up to 1,500 feet from the threshold. The other two lights are located, one on each side of the runway threshold, at a lateral distance of 40 feet from the runway edge or 75 feet from the runway edge when installed on a runway equipped with a VASI.

• ***Precision Approach Path Indicator (PAPI) –*** A visual approach slope indicator normally consisting of light units similar to the VASI but in a single row of either two or four light units set perpendicular to the runway centerline. The row of light units is normally installed on the left side of the runway. Indications are as follows: Below glide path – all lights red; Slightly below glide path – three lights closest to runway red, other light white; On glide path – two lights closest to runway red, other two lights white; Slightly above glide path – light closest to runway red, other three lights white; Above glide path – all lights white.

• ***Pulsating Visual Approach Slope Indicator (PVASI) –*** A pulsating visual approach slope indicator normally consists of a single light unit projecting a two-color visual approach path into the final approach area of the runway upon which the indicator is installed. The on glide path indication is a steady white light. The slightly below glide path indication is a steady red light. If the aircraft descends further below the glide path, the red light starts to pulsate. The above glide path indication is a pulsating white light. The pulsating rate increases as the aircraft gets further above or below the desired glide slope.

• ***Runway Alignment Indicator Lights (RAIL) –*** Sequenced Flashing Lights (SFLs) which are installed only in combination with other light systems.

• ***Runway End Identifier Lights (REIL) –*** Two synchronized flashing lights, one on each side of the runway threshold, which provide rapid and positive identification of the approach end of a particular runway.

• ***Threshold Lights –*** Fixed green lights arranged symmetrically left and right of the runway centerline identifying the runway end. When all light units are located outside the runway edge or runway edge extended, the runway end lights are considered to be "outboard." If any light unit is located inside the runway edge or runway edge extended, the lights are considered to be "inboard."

• ***Tri-Color Visual Approach Slope Indicator (TRCV) –*** A visual approach slope indicator normally consists of a single light unit projecting a three-color visual approach path into the final approach area of the runway upon which the indicator is installed. The below glide path indication is red; the above glide path indication is amber; and the on glide path indication is green.

• ***"T"-Visual Approach Slope Indicator System (T-VASI) –*** T-VASI system provides approach slope guidance by means of illuminated symbols like the PAPI.

• ***Visual Approach Slope Indicator (VASI) –*** An airfield lighting facility providing vertical visual approach slope guidance to aircraft during approach to landing by radiating a directional pattern of high intensity red and white focused light beams which indicate to the pilot is "on path" if he sees red/white, "above path" if white/white, and "below path" if red/red. Some airfields serving large aircraft have three-bar VASIs which provide two visual glide paths to the same runway.

Airfield Reference Point (ARP) – The approximate geometric center of all usable runways. ARP is not monumented, therefore not recoverable on the ground.

Airfield Surface Detection Equipment (ASDE) – Radar equipment specifically designed to detect all principal features on the surface of an airfield, including aircraft and vehicular traffic, and to present the entire image on a radar indicator console in the control tower. This is used to augment visual observation by tower personnel of aircraft and/or vehicular movements on the runways and taxiways.

Airfield Surveillance Radar (ASR) – Approach control radar used to detect and display an aircraft's position in the terminal area. ASR provides range and azimuth information but does not provide elevation data. Coverage of the ASR can extend up to 60 nautical miles.

Air Route Surveillance Radar (ARSR) – Air route traffic control center (ARTCC) radar used primarily to detect and display an aircraft's position while en route between terminal areas.

Arresting Gear (AG) - Safety equipment usually located on s used to stop aircraft from running off the pavement area. This equipment housings are surveyed for obstruction purposes only. The Arresting Gear Centerline of Runway (AGCL) is surveyed to obtain the distance from the threshold.

Attributes or Attribute Data – Alphabetical and/or numeric information that describes particular characteristics of a geospatial feature, such as type, dimensions, usage, occupancy, etc.

Compass Locator (CL) – A low power, low or medium frequency (L/MF) radio beacon installed at the site of the outer or middle marker of an instrument landing system (ILS). It can be used for navigation at distances of approximately 15 miles or as authorized in the approach procedure. Also see NDB.

Compass Rose (CR) - A compass rose oriented to geodetic north showing both geodetic north and magnetic north arrows. The magnetic variation at the time of the field survey shall be labeled along the magnetic arrow to the nearest tenth (0.1) of a degree. **CRCP** is the center point of the Compass Rose.

Direction Finder (DF) – A radio receiver equipped with a directional sensing antenna used to take bearings on a radio transmitter.

Distance Measuring Equipment (DME) – Equipment (airborne and ground) used to measure the slant range distance of an aircraft from the DME navigational aid in nautical miles. DME is usually frequency paired with other navigational aids such as a VOR or localizer.

Displaced Threshold (DTHLD) – A threshold that is located at a point on the runway other than the designated runway end. The displaced area is available for takeoff or rollout of aircraft, but not for landing. A displaced threshold does not mark the end of a runway.

Fan Marker (FM) – Electronic NAVAID that provides horizontal (alignment) guidance for aircraft on a final approach.

Glide Slope (GS) – Provides vertical guidance for aircraft during approach and landing.

Ground Controlled Approach Radar (GCA) - Usually a portable radar used by the military when either or both precision and non-precision approaches are required. It consists of the ASR radar and PAR radars and has similar reflectors associated with it.

Helipad – A small designated area, usually with a prepared surface, on a heliport, airfield, landing/takeoff area, apron/ramp, or movement area used for takeoff, landing, or parking of helicopters.

Heliport – An area of land, water, or structure used or intended to be used for the landing and takeoff of helicopters, including its buildings and facilities if any.

Heliport Reference Point (HRP) – The geographic position of the heliport expressed in latitude and longitude at (1) the center of the final approach and takeoff (FATO) area or the centroid of multiple FATOs for heliports having visual and nonprecision instrument approach procedures or (2) the center of the final approach reference area when the heliport has a precision instrument approach.

Instrument Landing System (ILS) – A precision instrument approach system which normally consists of the following electronic components and visual aids: Localizer, Middle Marker, Glide Slope, Approach Lighting, and Outer Marker.

Localizer (LOC) – The component of an ILS which provides course guidance to the runway.

Localizer Type Directional Aid (LDA) – A navigational aid used for nonprecision instrument approaches with utility and accuracy comparable to a localizer but which is not part of a complete ILS and is not aligned with the runway.

Marker Beacon – An electronic navigational facility transmitting a 75 MHz vertical fan or bone-shaped radiation pattern to be received by aircraft flying overhead. Marker beacons are identified by their modulation frequency and keying code, and when received by compatible airborne equipment, indicate to the pilot aurally and visually that he is passing over the facility.

- ***Back Course Marker (BCM)*** – When installed, normally indicates the localizer back course final approach fix where approach descent is commenced.

- ***Inner Marker (IM)*** – A marker beacon, used with an ILS Category II precision approach, located between the middle marker and the end of the ILS runway and normally located at the point of designated decision height (normally 100 feet above the touchdown zone elevation) on the ILS Category II approach. It also marks progress during an ILS Category III approach.

- ***Middle Marker (MM)*** – A marker beacon that defines a point along the glideslope of an ILS, normally located at or near the point of decision height for ILS Category I approaches.

- ***Outer Marker (OM)*** – A marker beacon at or near the glideslope intercept altitude of an ILS approach. The outer marker is normally located four to seven miles from the runway threshold on the extended centerline of the runway.

Microwave Landing System Azimuth Antenna (MLSAZ) – Antenna in a Microwave Landing System (MLS) providing horizontal guidance for incoming aircraft. MLS is precision instrument approach system operating in the microwave spectrum which normally consists of an Azimuth Station, an Elevation Station and Precision Distance Measuring Equipment.

Microwave Landing System Elevation Antenna (MLSEL) – Antenna in a Microwave Landing System (MLS) providing vertical guidance for incoming aircraft. MLS is precision instrument approach system operating in the microwave spectrum which normally consists of an Azimuth Station, an Elevation Station and Precision Distance Measuring Equipment.

Moving Target Indicator Reflector (MTI) -

Navigational Aid (NAVAID) – Any visual or electronic device airborne or on the surface which provides point-to-point guidance information or position data to aircraft in flight. (Refer to Air Navigation Facility).

Non-Directional Radio Beacon (NDB) – An L/MF or UHF radio beacon transmitting nondirectional signals whereby the pilot of an aircraft equipped with direction finding equipment can determine his bearing to or from the radio beacon and "home" or track to or from the station. When the NDB is installed in conjunction with an Instrument Landing System marker, it is normally called a Compass Locator. Also see Compass Locator.

Obstacle – Any object that has a vertical element to it and may or may not penetrate an obstruction identification surface.

Obstruction – Any object that penetrates an obstruction identification surface.

Overrun- An area the width of the runway plus paved shoulders extending from the

end of the runway to the outer limit of the end zone. This is a prolongation of the runway which can also be used by a decelerating aircraft in all weather conditions. It is also able to support the airplane during an aborted takeoff without causing structural damage to the airplane.

Precision Approach Radar (PAR) – Radar equipment in some ATC facilities operated by U.S. ARMY and/or the military services at joint use civil/military locations and separate military installations used to detect and display azimuth, elevation, and range of aircraft on the final approach course to a runway. This equipment may be used to monitor certain non-radar approaches but is primarily used to conduct a precision instrument approach wherein the controller issues guidance instructions to the pilot based on the aircraft's position in relation to the final approach course (azimuth), glide path (elevation), and distance (range) from the touchdown point on the runway as displayed on the radar scope. See also touchdown reflector.

Primary Airfield Control Station (PACS) – A control station established in the vicinity of, and usually on, an airfield, and tied directly to the National Spatial Reference System. PACS must be declared PACS by the National Geodetic Survey and must meet the specific sighting, construction, and accuracy requirements for PACS.

Radar Set AN/MPN-14K (MPN-14K) – The AN/MPN-14K Landing Control Central (Radar Set) can be configured as a complete Radar Approach Control (RAPCON) or Ground Controlled Approach (GCA) facility. The radar unit is used by air traffic controllers to identify, sequence, and separate participating aircraft; provide final approach guidance, guidance through air defense corridors and zones, and coordinate ID and intent with local air defense units at assigned airfields / air bases / bare bases. The radar unit is capable of identifying aircraft using secondary radar up to a 200 NM radius and primary radar coverage to 60 NM. The PAR provides both azimuth and elevation information from 15 NM to touchdown. Both the PAR and ASR can be used as final approach aids. The system is limited to a single runway but has the capability of providing opposite direction runway operations with the aid of a transportable turntable.

Relocated Threshold – A threshold located at a point on the runway other than the beginning of the full strength pavement. The area between the former threshold and the relocated threshold is not available for the landing or takeoff of aircraft. Thus, a relocated threshold marks the end of the runway. The precise end is on the landing approach edge of the relocated threshold paint bar. The abandoned runway area may or may not be available for taxiing.

Runway – A defined rectangular area prepared for the landing and takeoff run of aircraft along its length in a land airfield. Being exactly rectangular, it excludes narrow, rounded, deteriorated, and irregular ends that are not as wide as the general or overall width of the runway. The runway width is the physical width that extends over the entire length of the rectangle. The runway length does not include blast pad or clearzone surfaces. Displaced thresholds are

included in the physical length. Runways are normally numbered in relation to their magnetic direction rounded off to the nearest 10 degrees: e.g., Runway 10, Runway 25.

Runway Centerline – A line connecting the two opposite runway end points. The line may be physically marked on the surface of the runway.

Runway Centerline Reflectors (RWYCR) -

Runway End Point – The point at the runway end halfway between the edges of the runway.

Runway Length – The straight line (spatial) distance between runway end points. This line does not account for surface undulations between points. Official runway lengths are normally computed from runway end coordinates and elevations.

Runway Profile Point – A runway/ point selected so that a straight line between any two adjacent published runway/ points will be no greater than one foot from the runway/ surface. For purposes of this manual, the points shall be spaced no more than 100 feet apart.

Secondary Airfield Control Station (SACS) – A control station established in the vicinity of, and usually on, an airfield, and tied directly to the Primary Airfield Control Station. SACS must be declared SACS by the National Geodetic Survey and must meet the specific sitting, construction, and accuracy requirements for SACS.

Simplified Directional Facility (SDF) – A navigational aid used for nonprecision instrument approaches. The final approach course is similar to that of an ILS localizer except that the SDF course may be offset from the runway, generally not more than 3 degrees, and the course may be wider than the localizer, resulting in a lower degree of accuracy.

Tactical Air Navigation (TACAN) – An ultra-high frequency electronic rho-theta air navigational aid which provides suitably equipped aircraft a continuous indication of bearing and distance to the TACAN station.

Threshold (THLD) – The beginning of that portion of the runway available for landing. A displaced threshold (DTHLD) is a threshold that is located at a point on the runway other than the designated beginning of the runway.

Touchdown Zone (TDZ) – The first 3,000 feet of the runway beginning at the threshold.

Touchdown Zone Elevation (TDZE) – The highest elevation in the Touchdown Zone.

Touchdown Reflector (TDR) - These reflectors work with either the Precision Approach Radar or the Ground Controlled Approach Radar to provide precision approach information for incoming aircraft.

Transmissometer (TMOM) – An apparatus used to determine visibility by measuring the transmission of light through the atmosphere. It is the measurement source for determining runway visual range (RVR) and runway visibility value (RVV).

Transponder Landing System (TLS) – Transponder landing system providing azimuth and elevation guidance to aircraft on approach.

Very High Frequency Omni-Directional Range Station (VOR) – A ground-based electronic navigation aid transmitting very high frequency navigation signals, 360 degrees in azimuth, referenced from magnetic north.

Very High Frequency Omni-Directional Range/Tactical Air Navigation (VORTAC) – A navigation aid providing VOR azimuth, TACAN azimuth, and TACAN distance measuring equipment (DME) at one site.

APPENDIX I

Acronyms

APPENDIX I –Acronym List

Note: The ## implies to insert the applicable numbers as stated.

Acronym	Definition
AM	Airfield Manager
AG##	Arresting Gear(followed by runway designator)
AGCL	Arresting Gear Centerline of Runway
ALS##	Approach Light Systems(followed by runway designator)
APBN	Airfield Rotating Beacon
ARP	Airfield Reference Point
ARSR	Air Route Surveillance Radar
ASDE	Airfield Surface Detection Equipment
ASR	Airfield Surveillance Radar
BCE	Base Civil Engineer
BCM##	Back Course Marker(followed by runway designator)
CL	Compass Locator
CORS	Continuously Operating Reference Station
CTWR	Airfield Control Tower
DF	Direction Finder
DGPS	Differential Global Positioning System
DME	Distance Measuring Equipment
DoD	Department of Defense
DTHLD##	Displaced Threshold(followed by runway designator)
EGM08	Earth Gravitational Model 2008
EGM96	Earth Gravitational Model 1996
EOR##	End of Runway(followed by runway designator)
EAGLE	Elevated Airfield Ground Lights
EOS##	End of (followed by runway designator)
EME	Estimated Maximum Elevation
ETRF	European Terrestrial Reference Frame
FAA	Federal Aviation Administration
FBN	Federal Base Network
FM##	Fan Marker (followed by runway designator)
GIPSY	GNSS-Inferred Positioning System
GNSS	Global Navigation Satellite System
GPS	Global Positioning System
GRAPE	GPS/RINEX ARL-UT PPP Estimator
GRITS	GPSTk RINEX Tools

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GRS80	Geodetic Reference System 1980
GSAB##	Glide Slope Abeam Point (followed by runway designator)
GST##	Top of Glide Slope Tower (followed by runway designator)
GCA	Ground Control Approach Radar
GCAANT##	Ground Control Approach Reflector (followed by runway designator)
HARN	High Accuracy Reference Network
HRP	Heliport Reference Point
ICP##	Imagery Control Point (followed by sequential numbering)
IAG	International Association of Geodesy
ICAO	International Civil Aviation Organization
IERS	International Earth Rotation and Reference Systems Service
IGS	International GNSS Service
ILS##	Instrument Landing System(followed by runway designator)
IM##	Inner Marker(followed by runway designator)
ITRF	International Terrestrial Reference Frame
IUGG	International Union of Geodesy and Geophysics
LB	Locator Beacon
LDA	Localizer type Directional Aid
LOC##	Localizer (followed by runway designator)
MLS##	Microwave Landing System (followed by runway designator)
MLSAZ##	Microwave Landing System Azimuth Guidance Antenna (followed by runway designator)
MMLS##	Mobile Microwave Landing System Antenna (followed by runway designator)
MM##	Middle Marker (followed by runway designator)
MSL	Mean Sea Level
MTI	Moving Target Indicator Reflector
NAVAID	Navigational Aid
NAVSTAR	Navigation Satellite Timing and Ranging Global Positioning System
NDB	Non-Directional Radio Beacon
NGA	National Geospatial-Intelligence Agency
NGS	National Geodetic Survey
NSRS	National Spatial Reference System
ODALS	Omni Directional Approach Light System
OIS	Obstruction Identification Surface
OM	Outer Marker
PACS	Primary Airfield Control Station

APPENDIX I –Acronym List

PAPI##	Precision Approach Path Indicator (followed by runway designator)
PAPIA##	PAPI Abeam point(followed by runway designator)
PAR	Precision Approach Radar
PAREF###	Precision Approach Reflector(followed by designation)
PIR	Precision Instrument Approach
PVASI	Pulsating Visual Approach Slope Indicator
RAIL	Runway Alignment Indicator Lights
REIL	Runway End Identifier Lights
RINEX	Receiver Independent Exchange Format
RWY##CR	Runway (numerical designation) Centerline Reflectors
RWY##EP	Runway (numerical designation) End Point
RWY##PP	Runway (numerical designation) Profile Point(followed by sequential number)
RWYOR##	Runway (followed by runway designator)
RVR	Runway Visual Range
RVV	Runway Visibility Value
SACS	Secondary Airfield Control Station
SDF	Simplified Directional Facility
SIRGAS	Geocentric Reference System for South America
SPHS	Specially Prepared Hard Surface
TACAN	Tactical Air Navigation
TAGGS	Terminal Aeronautical GNSS Geodetic Survey Program
TDR	Touchdown Reflectors
TDZ##	Touchdown Zone (followed by runway designator)
TDZE##	Touchdown Zone End (followed by runway designator)
TDZEL##	Touchdown Zone Elevation (followed by runway designator)
THLD##	Threshold (followed by runway designator)
THLDLT##	Threshold Light (followed by runway designator)
TLS	Transponder Landing System
TMOM	Transmissometer
TRCV	Tri-Color Visual Approach Slope Indicator System
T-VASI##	T-Visual Approach Slope Indicator System (followed by runway designator)
USAASA	US Army Aeronautical Services Agency
USACE	US Army Corps of Engineers
VASI##	Visual Approach Slope Indicator System (followed by runway designator)
VGSI##	Visual Glide Slope Indicators (followed by runway designator)
VOR	VHF Omni Directional Range

APPENDIX I –Acronym List

VORTAC	VHF Omni Directional Radio and TACAN
WS##	Windsock (followed by runway designator)
WST##	Windsock top (followed by runway designator)
WGS 84	World Geodetic System 1984
WIPPS	WGS & ITRF Precise Positioning Service