U.S. Department
of Transportation

Federal Aviation
Administration

Advisory Circular

Subject: GENERAL GUIDANCE AND SPECIFICATIONS FOR SUBMISSION OF AERONAUTICAL SURVEYS TO NGS: FIELD DATA COLLECTION AND GEOGRAPHIC INFORMATION SYSTEM (GIS) STANDARDS

Date: 05/21/2009
Initiated by: AAS-100

AC No: 150/5300-18B

1. PURPOSE: This Advisory Circular (AC) provides the specifications for the collection of airport data through field and office methodologies in support of the Federal Aviation Administration (FAA). It also explains how to submit data to the FAA, who will forward the safety critical data to the National Geodetic Survey (NGS) for independent verification and validation. The primary purpose of these general guidelines and specifications is to list the requirements for data collection conducted at airports in support of the FAA Airport Surveying – Geographic Information System (GIS) Program. The FAA's Office of Airport Safety and Standards (AAS-1) administers this program. The standards covered in this document provide critical information for the operation and safety of the National Airspace System (NAS) and are classified as critical by the International Civil Aviation Organization (ICAO). ICAO Annex 15 defines data as critical when "there is a high probability when using corrupted critical data that the continued safe flight and landing of an aircraft would be severely at risk with the potential for catastrophe." The information furnished under these standards covers the entire spectrum of the FAA's airport data requirements, including but not limited to runway and stopway data, navigational aid data, obstruction data, and data on various airport features, including taxiways, aprons, and landmark features. Most of this information is source data, acquired by field survey and/or remote sensing methods.

2. CANCELLATION: AC 150/5300-18A, *General Guidance and Specifications for Submission of Aeronautical Surveys to NGS: Field Data Collection and Geographic Information System (GIS) Standards*, dated 9/15/2007, is cancelled.

3. PRINCIPAL CHANGES. The substantial revision of this AC incorporates new standards addressing the collection of a greater spectrum of airport related data and is reformatted to provide better understanding. Users should review the entire document to familiarize themselves with the new format.

4. APPLICATION: The FAA recommends the guidelines and standards in this AC for the collection of geospatial airport and aeronautical data. In general, this AC is not mandatory. However, use of these guidelines is mandatory for the collection of geospatial airport and aeronautical data funded under Federal grant assistance programs. It also provides one, but not the only, acceptable means of meeting the requirements of Title 14 Code of Federal Regulations (CFR) Part 139, *Certification of Airports* for the collection of geospatial airport and aeronautical data. Mandatory terms such as "shall" or "must" used herein apply only to those who purchase the collection of geospatial airport and aeronautical data using Airport Improvement Program (AIP) or Passenger Facility Charge Program (PFC) funds, or those who seek to demonstrate compliance by use of the specific method described by this AC.

5. COMMENTS OR SUGGESTIONS for improvements to this AC should be sent to:

Manager, Airport Engineering Division
Federal Aviation Administration
ATTN: AAS-100
800 Independence Avenue, S.W.
Washington, DC 20591

6. COPIES OF THIS AC. The Office of Airport Safety and Standards is in the process of making ACs available to the public through the Internet. Obtain these ACs through the FAA home page (www.faa.gov). A printed copy of this and other ACs can be ordered from:

U.S. Department of Transportation
Subsequent Business Office
Annmore East Business Center
3341 Q 75th Avenue
Landover, MD, 20785.

Michael J. O'Donnell
Director of Airport Safety and Standards

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CHAPTER 1. GENERAL GUIDANCE AND SPECIFICATIONS

1.1. INTRODUCTION

In developing the guidance in this Advisory Circular (AC), the Federal Aviation Administration (FAA) is striving to maximize the level of data collected while trying to minimize the cost to airports. However, the appropriate collection and safety implications of the prescribed data against defined, repeatable and verifiable standards far outweigh the potential costs. The collection and maintenance of the data regarding airports is a shared responsibility of the FAA and the Airport sponsor or proponent. The uses of the information collected according to these standards and specifications are in part to complete the following tasks:

- Provide geodetic control for engineering projects.
- Assist in airport planning and land use studies, and for other miscellaneous activities.
- Certify airports for certain types of operations.
- Develop instrument approach and departure procedures.
- Determine maximum takeoff weights.
- Update aeronautical publications.
- Plan for and site navigational aids supporting the airport.

The FAA developed these specifications to detail the data collection requirements and processing of airport data. Compliance with these requirements and standards without deviation is mandatory for federally obligated airports, and recommended for all other airports.

Refer all questions about the interpretation and use of these standards to the Manager, Airport Engineering Division (AAS-100), Office of Airport Safety and Standards, Federal Aviation Administration, 800 Independence Avenue, S.W., Washington, DC 20591.

1.2. ADMINISTRATION

1.2.1. Specifications

This document provides general specifications, standards, and guidelines for collecting and maintaining airport and related aeronautical data. These specifications provide the requirements for capturing the data used in all phases of airport development from planning to construction, and publication in selected U.S. Government aeronautical data and related products. These specifications are designed to provide information regarding the different types of data collection tasks on airports. A Statement of Work (SOW) in the contract agreement for each airport should detail the specific survey information for the individual airport. However, the requirements for reporting deviations, unusual circumstances, etc. described in the following paragraphs apply to both the General Specifications and to the SOW.

1.2.2. Conventions

The following conventions provide specific usage of words in this specification:

- The verbs "will" and "must" mean compliance is mandatory.
- The verb "should" implies compliance is strongly recommended but not required.
- The contraction "N/A" means not applicable.
- The term "position" means horizontal position (latitude and longitude) unless specified otherwise.
- The term "elevation" means the distance of a point above a specified datum, measured along the vertical direction of gravity.
- The term "vertical" refers to the direction in which the force of gravity acts.
- The term "height" means the distance, measured along a perpendicular, between a point and a datum (refer to paragraph 1.4 National Spatial Reference System (NSRS)).
- The term "observation" means the survey observations resulting in a position and/or elevation for the survey mark in question, whether it is pre-existing or newly set.
- The term "set" means physically constructed.
- Use the U.S. Survey Foot (3.28083333333333 feet = 1 meter) for any length conversions. If required by state law to use another value, identify this requirement in the project plan.
- "Airport Authority" refers to the administrators at an airport awarding the contract or their designated representatives.

1.3. CONTRACTOR REQUIREMENTS

The contractor will provide all labor, equipment, supplies, material, and transportation to produce and deliver data and related products as required under this guidance. The contractor will be responsible for ensuring all employees (including sub-contractors) meet airport security requirements and follow any other Airport Authority requirements, including making arrangements for escorts, radios, and training.

1.3.1. Maintenance and Calibration

All surveying equipment used will have maintenance logs showing routine preventive maintenance and repairs. Include in the Final Project Report the equipment model and serial numbers, and Electronic Distance Meter Instrument (EDMI) calibrations. If a hand–held EDMI is used, compare its distance-measuring accuracy to a distance measured with a calibrated EDMI and report the results in the Final Project Report.

1.3.2. Original Data

Original observation logs, electronic files, and other records prepared or obtained under the terms of the contract, are instruments of service and remain the property of the consultant unless agreed to by both parties. Provide reproducible copies of drawings and copies of other pertinent data to the Airport Authority. Submit the data required by the FAA under these specifications to the FAA Airport Surveying–Geographic Information System (GIS) Program at https://airports-gis.faa.gov. Original logs and records must be legible, neat, clear, accurate, and fully completed in indelible black ink. All available entries on the recording forms should be completed or indicated as N/A. Use blue ink when checking or verifying field notes and for any required signatures. Clearly write "original" (in blue ink) on the originals of all forms, notes, and computation sheets used. Save original data unmodified whether in handwritten or computer recorded form.

1.3.3. Corrections or Revisions to Data

In the original records (paper or digital), nothing is to be erased or obliterated. If a mistake is made on a form, draw a single line through the mistake and write the correction above or to the side. If space is too limited to permit a field correction, restart with a new log sheet; however, do not recopy the form in the office in order to make a “clean” copy. An explanatory note should be made for all corrections to the original recorded figures. All editing of computer-recorded data will be done on a copy of the original with all changes initialed.

1.3.4. Unusual Circumstances

The contractor will notify the airport sponsor/proponent, local FAA airports office and the FAA Airport Surveying–GIS Program of any unusual circumstances occurring during the data collection according to these specifications. The FAA Airport Surveying–GIS Program Manager will then consult with the government technical representatives to determine an appropriate course of action and advise the sponsor.

1.3.5. Specification Review and Familiarity

It is the responsibility of the potential contractor to ensure all personnel (including subcontractors) involved in the project are thoroughly familiar with the information in this guidance and any material covered in other cited references and publications.

1.4. NATIONAL SPATIAL REFERENCE SYSTEM (NSRS)

The FAA ties all Air Operations Area surveying and positioning to the NSRS. Refer to AC 150/5300-16, *General Guidance and Specifications for Aeronautical Surveys: Establishment of Geodetic Control and Submission to the National Geodetic Survey*, for guidance on establishing geodetic control and the NSRS.

1.4.1. Horizontal Control

The contractor provides horizontal control referenced to the North American Datum of 1983 and year of the latest adjustment [abbreviated NAD83 (YYYY)]. **NOTE**: *The year of adjustment is on the NGS Data Sheet next to the latitude and longitude.*

1.4.2. Vertical Reference

The contractor provides vertical control referenced to the North American Vertical Datum of 1988 (NAVD 88). Information regarding NAVD88 is located at the following website: http://www.ngs.noaa.gov/PUBS_LIB/NAVD88/navd88report.htm. Reference all Ellipsoidal Heights to NAD83 (GRS 80) realization.

1.4.3. GEOID Model

The contractor uses the most recent NGS model, which is currently GEOID03 in CONUS and GEOID06 in Alaska. For information regarding GEOID03 refer to the following website http://www.ngs.noaa.gov/GEOID/GEOID03/. For information regarding GEOID06 refer to the following website http://www.ngs.noaa.gov/PC_PROD/GEOID06/. **NOTE:** *GEOID heights derived from the GEOID06 model are only reliable in Alaska.*

1.5. DATA FORMATS

The contractor submits data collected to the Airport Authority and to the FAA Airports GIS website (https://airports-gis.faa.gov/). Include an inventory of all geospatial digital data in the Final Project Report and identify the physical file formats. In order to facilitate communication and exchange of information, use the following standard formats for data submissions:

1.5.1. Ground Control Data

The contractor submits newly established permanent ground control data to NGS for inclusion into the NSRS. Format this data to meet NGS blue book standards as required by AC 150/5300-16, *General Guidance and Specifications for Aeronautical Surveys: Establishment of Geodetic Control and Submission to the National Geodetic Survey.*

1.5.2. Digital Images from Hand-Held Camera

1.5.2.1. Use digital photographs taken during daylight hours to document monuments used or data collected. These photos assist in the retracing of the surveyor's steps by providing the evaluators with a picture of what the data is describing. Take sufficient photographs to document the conditions the surveyor encountered. They should illustrate the appearance, condition, and location of the points of interest, including visibility obstructions, roads, runways, taxiways, or other dangers and any special setup requirements. A photograph is acceptable if it meets the requirements of this AC and is of good visual quality. Use the highest resolution possible to ensure good clarity and detail definition.

Use at least one (more if required) of the following three types of photos to document a position or object. All three photographs require a digital caption and correct file name as specified in paragraph 1.5.2.3.

- Photograph type 1 is an extreme close up of the object as shown in Figure 1-1. Typically this type of photograph is only used to document control monuments or other defined points such as runway end or displaced threshold locations.

Figure 1-1. Photograph type 1

- Photograph type 2 (Figure 1-2) is taken at eye-level with the station or object 5 to 6 feet in the distance (when practical and accessible) and provides general information about the area immediately surrounding the station or point.

Figure 1-2. Photograph type 2

- Photograph type 3 (Figure 1-3) is taken horizontally with the station approximately 10 to 30 feet in the distance (Figure 1-4). Photograph type 3 provides general orientation information to the user and should include the cardinal direction the camera is pointing in the caption.

Figure 1-3. Photograph type 3

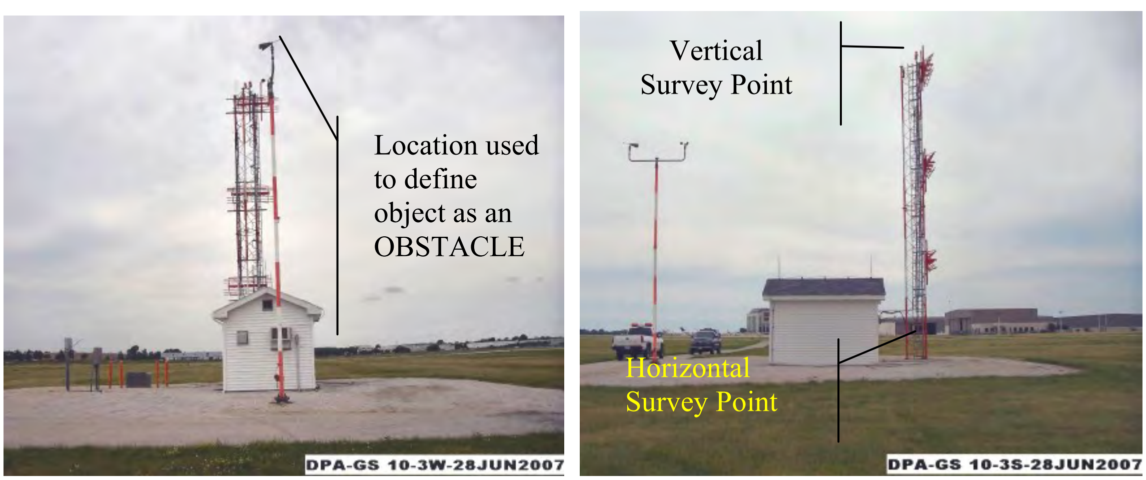

Figure 1-4. Illustrates the documentation of a glideslope antenna from different perspectives.

When documenting navigational aids surveyed, as in Figure 1-4, two photographs oriented from different cardinal directions. When documenting navigational aids, take the photograph with a tripod over the horizontal and vertical (if practical) survey point or electronically add arrows showing the point(s) surveyed. The independent verification and validation team uses these photos to check the correct point was surveyed based on the type of navigational aid.

1.5.2.2. Use the JPEG (Joint Photographic Experts Group) format for digital images taken with a hand-held digital camera. This includes the required images of photo control points.

1.5.2.3. Use the following file naming convention for photograph filenames. The filename is comprised of the airport location identifier assigned by the FAA, runway end designator, photo number, and date, followed by the file type extension, as in the example below. Separate each section of the file name with a underscore —except precede the photo number with a dash.

Sample filename for a runway end point:

LAX_CL_END_RWY_12R-3_04MAY2001.jpg

Decoding the example above, "LAX" provides the airport location identifier, "CL END RWY 12R" identifies the position photographed such as the centerline end of runway designator [CL=centerline, END=end, RWY= runway, 12=runway number, and R=right (or C=center, or L=left)], dash, "3"= photo number, and date. FAA approved location identifiers are located at the FAA web site http://www.faa.gov/airports_airtraffic/air_traffic/publications/.

1.5.2.4. Electronically add a caption to each photograph. The caption should include the following information separated by commas or dashes:

- Airport location identifier assigned by the FAA.
- Runway end designator.
- Photo number.
- Date the photo was taken.

For example, "LAX, 12R, 3, 23 Aug 2004". In addition, the caption for photograph types 2 and 3 include the cardinal direction (N, NE, E, SE, etc.) the camera is pointing.

1.5.3. Documents or Sketches

Provide reports and diagrams, such as Runway End sketches, GPS Visibility Diagrams, Field note sketches, etc., in a non-editable format such as the Adobe Portable Document Format™ (PDF). Obtain these forms from the FAA Airports GIS website (https://airports-gis.faa.gov). The FAA requires field sketches as documentation of the following features as a minimum:

- The selected runway end.
- The location of any displaced threshold.
- The stopway or blastpad associated with a runway.
- New taxiways, ramp (parking) area(s), runways or other construction areas that were not available or completed when the imagery was collected, including sketches or photographs of

photo reference points in the imagery. Include a mark or identifying feature available in the imagery that relates the construction and the field collection together.

- Sketches of the runway profile points (two runs - digital file) annotated with the distances of each of the points collected from the runway end.
- All NAVAIDS located off the airport (digital photographs are sufficient).

1.5.4. Geospatial Vector Files

Submit data to the FAA Airport Surveying–GIS Program in any of the following 3D geospatial vector file formats:

- DWG/DXF (Autodesk AutoCAD).
- SHP (ESRI Shapefile).
- DGN (MicroStation Design File V7/V8).

Submit requests to use other geospatial vector file formats in writing to the FAA Airport Surveying–GIS Program Manager. All geospatial vector files must conform to the data content standard specified in Chapter 5 as defined for each feature submitted.

1.5.5. ESRI Nuances for Dealing with FAA Attribute Names

When submitting data to the FAA Airport Surveying–GIS Program using ESRI software, some of the standard naming conventions specified by the FAA need to change to accommodate ESRI file naming constraints. This limitation is described by ESRI™ in their documentation as “A field's name must be no more than 10 characters in length; additional characters will be truncated”. In most cases within the specified FAA naming structure this is not a problem until the truncation results in duplicate names. In order to solve this problem, data providers should use the following table to avoid the duplication of names in the following feature classes. In all other cases the truncation at 10 characters of attribute names should not have duplicates. A full listing of all FAA features and attributes with the truncated names, as established within the FAA Airports-GIS, is provided in Appendix D for use in quality assurance of the data before submission.

Table 1-1. ESRI Attribute Name Truncation to avoid Duplication

FeatureClass	AttributeName	Shp_Name
RunwayHelipadDesignSurface	determination	determinat
RunwayHelipadDesignSurface	determinationDate	detDate
RunwaySafetyAreaBoundary	determinationDate	detDate
NavaidEquipment	downWindBarElevation	downWindBa
NavaidEquipment	downWindBarThreshold	dWndBarThr
Obstacle	heightAboveAirport	heightAbov
Obstacle	heightAboveRunway	hAbovRwy
Obstacle	heightAboveTouchdownZone	hAbovTdz

1.5.6. Airport Layout Plan Data

Submit digital versions of airport data defined in this standard in one of the following formats.

- Autodesk™ DWG format (version 2002 or later) with attributes defined as object data.
- MicroStation™ DGN format (version 8 or later).
- ESRI™ Shape File format with attributes and metadata elements provided as attributes within each shape file.

1.5.7. Raster Imagery

Raster data is a form of spatial data where rectangular cells each carrying a value are organized into rows and columns. One of the most common forms of raster data is digital imagery in which each cell or pixel of the image carries a grayscale value in the case of black-and-white photographs or red/green/blue values in the case of color photographs. Images taken from aerial or satellite platforms must be orthorectified, meaning that the cells or pixels of the image are positioned to represent their true position on the face of the earth (i.e. removing distortions caused by camera angle, terrain, etc.). Figure 1-5 provides an example of an orthorectified raster image of an airport. Imagery requirements are specified in AC 150/5300-17, *General Guidance and Specifications for Aeronautical Survey Airport Imagery Acquisition and Submission to the National Geodetic Survey*.

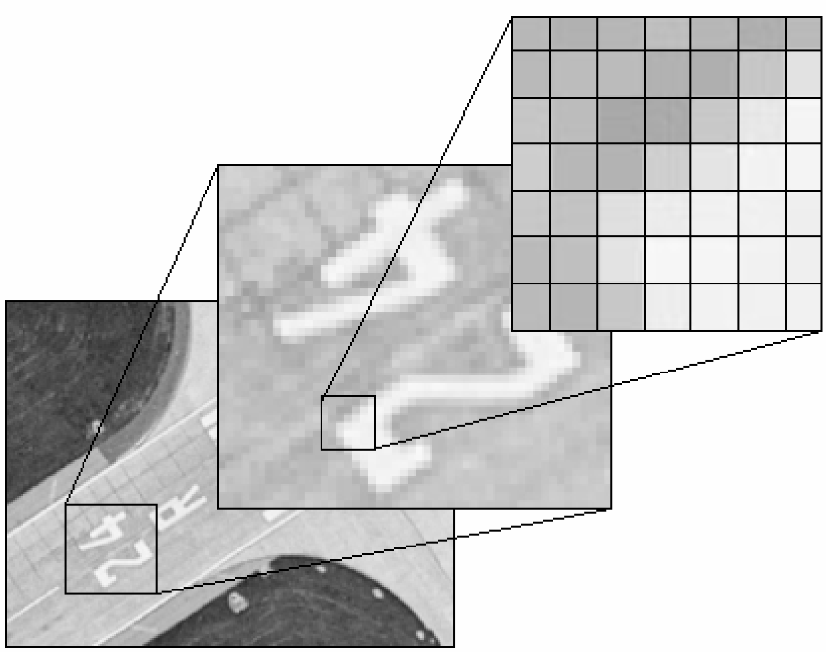

Figure 1-5. Example of Raster Imagery

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CHAPTER 2. SURVEY SPECIFICATIONS AND STANDARDS

2.1. OVERVIEW OF THE PROCESS

Airports have surveys conducted for many different reasons. However, all survey types require the collection, classification and reporting of accurate data about the project. All surveying completed on the airport will provide the information outlined in Chapter 5 within the stated accuracies. The methodology selected to gather the information is up to the professional surveyor's judgment. Some features require observation through ground field methods, while others lend themselves to collection via remote sensing technologies. Since each element of the National Airspace System (NAS) ties to a single reference framework, it is important for every survey conducted on the airport to tie in some way to the NSRS. When the project uses an engineering grid rather than a national grid, tie the local grid to the NSRS to ensure accurate relativity to other NAS elements. In order to tie an engineering grid to the NSRS, the surveyor is required to identify and use positions common to both reference systems to ensure the project remains tied to the other elements of the NAS. This chapter breaks down the different elements of typical airport surveys and provides guidance on completing those tasks. Chapter 5 provides the information on the proper collection, classification and reporting of many airport features.

2.2. INDEPENDENT VERIFICATION AND VALIDATION OF AIRPORT SAFETY DATA.

Due to the critical nature of some airport features, the FAA requires their independent verification and validation by the Aeronautical Survey Program of the National Geodetic Survey or a designated representative. Typically, these features are those associated with the airport's movement areas, navigational systems or those affecting navigable flight such as objects surrounding the airport. Once the independent verification, validation and quality assurance of the safety critical data is completed, the government technical representatives will provide a complete final written analysis of their findings including approval or disapproval of the data. They will identify and list any discrepancies discovered relating to these specifications and decide on the usability of the data.

2.2.1. Verification

In this guidance, "verification" is defined as the confirmation by examination and provision of objective evidence that the specified requirements are fulfilled. Verification is necessary to ensure the data set accurately represents the specifications and is uncorrupted. The verification process proves the data was properly collected. The following verification techniques comprise the government verification of the safety critical data.

- Comparison of a sample of the data set points with samples from an independent measurement system.

- Typically, the government uses photogrammetric analysis along with the provided ground observational data to resample the data set. The more samples checked, the higher the level of confidence in the quality of the data set.

- Comparison of the data set with other existing data sets. For this verification method, the verification must account for the vertical and horizontal reference datums for the data sets and the data sets should be independent. Typically, the government uses this technique when there is an existing good available data set to compare the submitted data against.

- Reasonability checks to ensure the data set does not violate known properties (such as obstacles must have positive orthometric heights).

2.2.2. Validation

In this guidance, "validation" differs from "verification" in scale. The validation process identifies the aeronautical information submission was correctly developed as an input to the system. Validation is the confirmation by examination and provisions of objective evidence showing the data set meets the particular requirements of the intended use. The purpose of the validation process is to demonstrate the data set has sufficient overall integrity to satisfy the requirements for its intended application. Validation answers the questions "is the data reasonable when compared against known data" and "does it meet the identified need." Validation does not typically compare the data against photogrammetric analysis or review of the observational data.

2.3. ACCURACY REQUIREMENTS

The data about airports is critical to the operation and safety of the NAS. Collect this data through a combination of remotely sensed and field survey methods. When determining the best method of collection, consider the required accuracy and efficiency of operations. Remote sensing techniques do not currently meet the accuracy requirements of some airport and aeronautical features requiring their collection through field survey. Typically, linear features, some objects within the object identification surfaces, and visual navigational aids are good candidates for collection by remote sensing techniques. The geographic coordinate accuracies of this data must meet or exceed the requirements in this AC and in the following:

2.3.1. Geodetic Control

The survey monuments established in the airport vicinity must meet all accuracy requirements and other criteria specified in AC 150/5300-16, *General Guidance and Specifications for Aeronautical Surveys: Establishment of Geodetic Control and Submission to the National Geodetic Survey.* These monuments and their accurate connection to the NSRS assure accurate relativity between all surveyed points on an airport and the NAS, including navigation satellites.

2.3.2. Imagery

The geo-referenced imagery of the survey area must meet the accuracy requirements specified in AC 150/5300-17, *General Guidance and Specifications for Aeronautical Survey Airport Imagery Acquisition and Submission to the National Geodetic Survey.*

2.3.3. Remotely Sensed Surveys

Due to the critical nature of airport and aeronautical data, it is important to position and attribute features accurately. Ensure the spatial resolution and vertex spacing provides an accurate representation of features without compromising the accuracy of the data. With respect to imagery, this document defines the word "resolution" as the smallest spacing between two display elements, expressed as dots per inch, pixels per line, or lines per millimeter. Also consider the attribute accuracy. Collecting and identifying attributes from imagery requires skill and knowledge of interpreting airport and aeronautical features. The user must be familiar with the feature classes, attributes, and valid record entries used to identify spatial features contained within this AC.

Features extracted using remote sensing technologies must have spatial accuracies reported in ground distances at the 95-percent confidence level. Use Root-Mean-Square Error (RMSE) to estimate spatial accuracies. Testing is the preferred method of reporting accuracy. Accomplish this by computing RMSE using the square root of the average of the set of squared differences between twenty or more checkpoint coordinate values and the coordinate values from an independent source of higher accuracy. However, if less than twenty checkpoints are available for testing, then report the accuracy as a deductive estimate based on knowledge of errors in each production step. Indicate in the metadata the methods used in the deductive method including complete calibration tests and describe assumptions about error propagation.

2.3.4. Feature Accuracy Requirements

The accuracy for geospatial vector airport features (taxiway, aprons, ramps, buildings, etc.) is typically mapping grade accuracy, nominally within 3 feet horizontally and 5 feet vertically (Refer to Chapter 5 Feature Descriptions for complete accuracy requirements). Specific runway, stopway and navigational aid data accuracies are nominally within 1 foot horizontal and 0.25 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 relative to the NSRS. Derived elevations must be within 10 feet vertically.

2.3.5. Field Surveys

Many airport features have accuracies greater than are achievable using remotely sensed methods and require field survey methods be used. These features, specifically the data for the runway(s) and some navigational aids, are nominally within 1 foot horizontally and 0.25 feet vertically. Chapter 5 lists the features and their required accuracies and unique requirements. Refer to the appropriate section in this chapter for specific guidance on the different types of surveys typically performed on or near an airport.

2.4. RESERVED

2.5. FEATURE ATTRIBUTION

As airports move toward a more data centric environment, more information about the objects on and around the airport is required. Each of the features in Chapter 5 has a list of attributes or information about the feature. Each of these attributes should be completed. Realizing this will be an iterative process, there are some business rules which apply to all submissions.

Generally, the surveyor or consultant hired to collect the data will gather some of this information in the field. Other values can and should be derived from the field measurements. While other values will require information from other sources such a record drawings or interviews. Each attribute for each feature should be submitted with the data. Sponsors should expect surveyors or consultants to complete these attributes based on the purpose of the survey or data collection effort. Typically any attribute that can be measured or computed should be completed as part of the statement of work. Depending on the airport's staff ability and workload other attributes can and should be completed by them. Base the requirement for which attributes the consultant should complete on the intent of the statement of work. If the consultant is hired is to collect data for an airport analysis survey then all attributes relating to those features should be completed.

The more complete the attribution the more complete and useful the data set will be to both the FAA and the airport sponsor in the future. Sponsors should also plan for the maintenance of this information. If a previously submitted features attribution changes it should be updated as soon as possible. Chapter 4 provides more information on the maintenance of data.

2.6. REPORTING REQUIREMENTS

2.6.1. General Reporting Requirements

Thorough reporting is required. Prior to beginning any fieldwork, submit a survey and quality control plan to the airport sponsor/proponent, the local FAA airports office and FAA Airport Surveying–GIS Program Manager. On project completion, provide to the airport sponsor/proponent, the local FAA airports office and the FAA Airport Surveying–GIS Program manager a final project report compliant with paragraph 2.6.4. Include the prime contractor's firm name on all reports. Submit all reports electronically to the FAA using the reporting tools provided by the Airports GIS web site https://airports-gis.faa.gov.

2.6.2. Survey and Quality Control Plan

2.6.2.1. General Requirements. Develop and submit survey work and quality control plans for airport sponsor/proponent and FAA approval before beginning any fieldwork. The FAA Airport Surveying–GIS Program manager or designated representative will review and approve the survey work and quality control plans. In these plans, detail the methodologies for data collection, data safeguarding and quality assurance. Provide insight into how you will completely check all data to ensure it is complete, reliable, and accurate. Identify data safeguards used to protect this sensitive and safety critical data. Utilize a checklist based quality control process with definable and repeatable standards for each element ensuring consistency of work between different personnel within an organization. Submit the plan in a non-editable format such as Adobe Portable Document Format (PDF)™ using the reporting functions of the Airports GIS web site https://airports-gis.faa.gov. A sample survey and quality control plan is available on the FAA Airports GIS website (https://airports-gis.faa.gov).

2.6.2.2. Remote Sensing and Field Survey. The use of remote sensing and ground survey techniques to accomplish the survey is highly recommended. The plans must include a description on the combinations of methods used and discuss the comparison of the results. The plan should detail the processes used to resolve discrepancies between the remote sensing survey and ground survey. The contractor will amend the original plans to identify any deviation to the Airport Authority or to the FAA Airport Surveying–GIS Program Manager immediately. The plan must address each of the following areas but is not specifically limited to these areas:

- **Project Observation (Execution) Plan:** Detail how you expect to execute the project including how you will make GPS observations to achieve two distinct data sets to determine positional data.

- **Geo-referencing**: Describe in detail the plan for utilizing geo-referenced (aero-triangulated) imagery with acceptable accuracies. Refer to AC 150/5300-17, *General Guidance and Specifications for Aeronautical Survey Airport Imagery Acquisition and Submission to the National Geodetic Survey*, for additional guidance and requirements.

- **Feature Extraction**: Detail methodologies for collecting airport features, such as airport buildings, the aircraft movement areas, landmark features, and obstructing area limits (3D), with the required horizontal and vertical accuracies as specified in Chapter 5. Identify any deviations from the data capture rules provided within this guidance.

- **Obstruction Analysis**: Provide a detailed description of the remote sensing and field survey methods used to identify, locate, and observe the required obstacles relative to the specified obstruction identification surfaces provided in this guidance. The contractor needs to describe the data collection methods and the associated horizontal and vertical accuracies expected.

- **Prior Survey Data**: Describe the procedure to use previous airport survey data if available and identify the source of the previous data. If the source of the data is not known or available, then the consultant should verify and document the data set as accurate using the techniques described in Chapter 4.

- **Field Survey Methods**: Identify the methods for data collection and processing used for observing required features. Include a description of the methods of analysis in the report.

- **Geodetic Control**: Describe in detail the plan for connecting to and verifying all existing airport control planned for use during the survey. Use of the established Primary Airport Control Station (PACS) and Secondary Airport Control Stations (SACS) is required.

- **Runway Data**: Describe in detail the methods for the ground survey and data collection used in identifying, locating, and observing all required runway data.

- **Navigational Aid Data**: Describe in detail the survey techniques and procedures used to identify, locate, and observe the required navigational aids associated with the airport. Provide details if you will collect the navigational aids individually or grouped by the type of navigational aid (electronic or visual).

- **Airport Feature Data**: Provide a detailed description of the procedures and methods used for identifying, locating, and observing the required airport feature data associated with the airport. If you plan to use existing data, describe its source, collection data and the techniques used to merge the data sets into a single comprehensive airport data set.

- **Equipment Listing**: Provide a complete listing of the equipment planned for use in the survey, including model and serial numbers, calibration reports, and equipment maintenance reports. This will include field survey and remote sensing hardware and software.

- **Quality Assurance Process**: Describe in detail what quality assurance methods you will use to ensure the quality and protection of the data from the time and point of collection to the time of submission.

2.6.2.3. Quality Control. The Survey and Quality Control Plan must include the quality control (including error analysis) procedures and practices followed during data collection and provide traceability and adherence to the requirements of this guidance. At a minimum, the plan will include the following:

- Summarize what methods you will use to ensure high-quality data.

- Describe the quality control measures used to ensure all data is checked, complete, reliable, and meets the accuracy requirements in this AC.

- Provide evidence of the methods used to collect the various types of features to meet the desired accuracies.

- Describe the data backup and archive procedures and methods used to ensure the integrity of the original data.

- Explain the methods used to check all file formats and provide a summary of the file-naming convention for all electronic files.

2.6.3. Project Status Report

Submit a project status report via email to the airport sponsor/proponent and FAA Airport Surveying–GIS Program Manager every Monday by 2:00 P.M. Eastern Time, from the date of the task order until the work is completed. Include in the reports the percentage complete for each of the major portions of the work with the estimated completion date or completion date. Provide the status of ongoing work (with expected completion dates) and any unusual circumstances and/or deviations from this guidance. Status reports should be brief and contain the current information in the text of the email. Submit all reports using the Add Note function of the Airports GIS web site. This allows all project stakeholders access to the reports in a single location tied directly to the project file. The following is an example Project Status report for an airspace analysis project:

Anyplace Field/Anywhere International Airport

AIP X-XX-XXXX-XXX-20XX

Survey progress update #1

July XX to July XX

Eagle Eye Surveying completed a second week of ground surveying. The first week verified PACS and SACS control, collected runway centerline, and primary surface topographic information.

To date we have surveyed for Runway 12-30:

Airport Control (PACS, SACS, ANY B540)	100%
Runway and Stopway Ends	100%
NAVAIDS (VOR, NDB, Airport Beacon, VASI, PAPI, and REILs)	100%
Runway and Stopway Obstructions (Primary surface, approaches, transitional surfaces)	100%
Aircraft Movement and apron areas	75%
Prominent airport buildings / potential close-in obstructions	42%

This week we will be analyzing the collected obstruction survey data relative to the object identification surfaces. We will check both the required points for each obstruction zone and the navigational aids, and generate the appropriate field documentation. We completed subcontract negotiations with aerial photography sub consultant SkyCamera, Inc. and are submitting the proposed flight map with ground reference points for review and approval before completing our final week of field surveying. This week we will be setting aerial targets and surveying in the targets and PhotoID points, and collecting final outlying obstruction data. Aerial photography is promised to us 2 to 4 days after our targets are in place.

Sincerely,

Any Surveyor, P.S.

Eagle Eye Surveying

2.6.4. Final Project Report

The Final Project Report is a compilation of documentation supporting the survey project providing a standardized delivery of field notes, raw survey data and project summary to facilitate the independent verification, validation, and quality assurance of the safety critical data. In the final project report, address each of the following areas.

2.6.4.1. Project Identification Data. List each of the following items on the first page of the document.

- Official name of airport and FAA assigned location identifier
- Airport Address (Street, City, State, Zip)
- Client Name
- Project, Contract, or Grant Number assigned
- FAA Region
- Start and end dates of project (From contract signing to delivery of data)
- Contractor point of contact (including name, company name, address, telephone number, email)

2.6.4.2. Project Summary. Provide a written overview of the project details and conclusions. In the summary, describe the scope of the survey identifying the key elements for collection (i.e. runway, obstruction, mapping and NAVAID collection). Provide background information on the source(s) of existing airport geospatial data (FAA, airport engineering, etc.) used in the project. Describe any conditions affecting the survey such as, any equipment failures, weather, scope of project, site accessibility, reconnaissance, and/or any other problems experienced.

2.6.4.3. Survey Data Conclusions. Provide your conclusions regarding the following subjects as they relate to this project.

2.6.4.3.1. Control Network Survey Results/Conclusions. Provide a description of the control network utilized as the basis of the survey completed. Include information on the source of the control referenced, whether it was established or verified, and comments on the recovery and status of the control monumentation. When utilizing an existing control network, provide verification computations and results between control points. Also provide information on the data collection methods used, and the third party software vendor used in data reduction.

2.6.4.3.2. Survey Data Collection Conclusions. Provide written and, as necessary, pictorial descriptions of significant findings from the survey results to ensure the information being provided is clear to the reader. Include information on the data collection methods used, and identify the hardware/software used during the survey. Examples of typical information to report are (but not limited to):

- Output information and published data comparison for runway end, stopway and displaced threshold positions.
- Significant objects of concern such as temporary or mobile objects.
- Comments on current or future planned construction at the airport that causes concern.
- Note conditions that affected the final solutions of the survey (vegetation, access, air traffic, etc.).

- Significant NAVAID situations (proposed locations, instruments/lighting removed, etc.).
- Boundary encroachments or significant misclosures.
- Utility system situations (significant utility systems found otherwise unknown, potentially hazardous situations, etc.).

2.6.4.3.3. Data Processing/Adjustment Conclusions. Provide information on the software used to reduce the data. Comment on issues or concerns discovered during the use or translation process of existing data. Also provide comments on any issues or outliers found during the reduction process considered important for the retracement of the survey by the validation team.

2.6.4.3.4. Recommendations/Additional Comments. Provide comments on the survey project including suggestions to improve future work specifications or any information providing additional explanation and understanding of survey project and results.

2.6.5. Field Note Information and Data

2.6.5.1. Geodetic Control Data. Provide the raw-data files collected containing the data used for establishment or verification of the geodetic control, including any data used to plot temporary points occupied. Typically, these files include the original raw GPS data files (in both the manufacture's download format and in RINEX II format), binary files containing ionosphere modeling information and vector reduction and adjustment files. If the project required the establishment of new PACS or SACS, this information is already available and does not require duplication here. Provide digital photographs, sketches, and scans of the field book or log sheets supporting the geodetic control survey (including temporary points occupied) as outlined in AC 150/5300-16, *General Guidance and Specifications for Aeronautical Surveys: Establishment of Geodetic Control and Submission to the National Geodetic Survey*.

2.6.5.2. Survey Information and Data: Providing the survey data allows the independent verification and validation team to analyze the data. Provide the instrument or data collector raw measurement data files used to compute final positional data. Provide the independent verification and validation team the same information you provide for office computation/compilation. The internal and external quality assurance teams use this information to verify and validate the survey. Provide digital photographs taken during the survey to document or provide clarification of the survey data submitted. This includes photos of stations occupied, obstructions to visibility or any other information you wish to convey to the FAA and the independent verification and validation team regarding the survey. Scan and include all pages of the field book, log sheets or sketches completed during the survey.

2.6.6. Deliverables Checklist

The tasks completed during the survey process require careful planning and execution to ensure the geospatial data generated complies with the specifications in this AC. Provided below is a checklist identifying specific details to assist in ensuring proper planning and execution of a successful survey project. The FAA provides an appropriate checklist for the deliverables on the program website at https://airports-gis.faa.gov.

- Survey and Quality Control Plan (completed before data collection begins)
- Weekly Project Status reports provided to the sponsor

- Final Project Report (develop for all survey types)
- Digital Files to be delivered:
  - Provide the documentation required for each feature as defined by the descriptions in Chapter 5, Airport Data Features. Documentation types include data such as digital photographs, scans of field notes (log sheets, field sketches, field book pages, etc.), and field/office and quality assurance checklists used.
  - Provide the raw observational data collected from terrestrial and/or photogrammetric survey operations in formats identified in paragraph 2.6.5, Field Note Information and Data. Providing this data for all surveys allows the independent verification and validation team to retrace the survey. The types of data files to be delivered (but not limited to) are:
    - Data collector files
    - GPS receiver files
    - CORS data downloaded
    - Photogrammetric observation files
    - Other field measurement device’s digital raw data (range finder, scanner, etc.)
  - Provide the final processing, adjustment or reduction files used to produce the final data. This includes the results of independent software files produced during the reduction of the final data. The intent is to provide the data necessary to recreate the data delivered if required.
  - Provide an airport point of contact list for use by the independent verification and validation team.
  - Copies of the transmittal letters for all deliveries posted to the sponsor or FAA.

2.6.7. Pre-Survey Preparation Activities

2.6.7.1. Contact with Airport Authorities. Close communication with airport management is critical throughout the entire survey process. Make appointments with airport management well in advance to ensure a qualified airport representative is available to discuss the survey. Obtain proper clearances to work in the aircraft operations areas prior to performing any work at an airport. A security and safety briefing may be required before field crews access the airfield. Follow standard safety procedures and equip all vehicles with flashing yellow lights and radios capable of receiving Air Traffic Control ground and aircraft frequencies. Contact with the airport traffic control tower is mandatory while during surveys at controlled airports. If vehicles are not properly equipped, an escort is required. Be sure to inquire about off airport navigational aids and the process for accessing them. Ensure approval to work on or near these sites is received not only from the airport authorities but also the FAA maintenance personnel and any private landowners whose land is adjacent or near the site. When approaching landowners regarding access, be sure to fully document their name, contact information and details about the discussions or copies of any correspondence sent or received from the landowners regarding access to their land.

2.6.7.2. Interviews. During the interviews, ask specific questions based on the interview checklists located on the FAA Airports GIS website (https://airports-gis.faa.gov). In addition, discuss with airport authorities the runway/stopway data published in the latest editions of the Airport/Facility Directory (A/FD) and U.S. Terminal Procedures (TPP), both U.S. Government Flight Information Publications (http://www.naco.faa.gov). During the survey, additional meetings may be required to discuss unusual circumstances, problems, or changes to published or given data. Include in the final report a summary of all such meetings. Upon completion of the survey, the airport authorities may require a final meeting. Turn in any badges, passes, or keys; discuss any significant and/or unusual findings with the data collection effort; and notify the airport authorities of your departure. Avoid discussing specific problems since the data is unverified. Especially avoid any statements about approaches being "clear," because the requirements for the use of the data are different based on the needs of the organizations within the FAA. Smaller airports might not have persons in all of these areas of expertise or they may not be located at the airport. Complete interviews with the following personnel if possible.

2.6.7.2.1. Airport Manager/operations. The airport manager/operations is the key individual on the airport. It is important for the contractor to contact the airport management prior to visiting the site. This allows the contractor to introduce themselves, their company and their purpose before arriving at the airport. It also allows the airport manager to prepare other airport staff members and schedules for the field team visit and to gather information the field team may require during their visit. In this interview, obtain permission to enter the airfield for the survey. Use this interview to gather valuable information about recent, ongoing, and future construction; obstruction changes; clearing; and operational considerations (scheduled runway closures or special events, high-security areas on the field, etc.). Include the contact information of the airport manager/operations person interviewed on the checklist.

2.6.7.2.2. Airport Engineering. This interview will only be necessary or helpful at larger airports. The engineering department can provide specific information about runway dimensions, construction projects, and control stations. They can be helpful in scheduling runway work. Include the engineering department point of contact in the Final Project Report in case questions arise after the survey.

2.6.7.2.3. Air Traffic Control. If an Airport Traffic Control Tower (ATCT) is operational during the time of survey, discuss the survey with the Chief Control Tower Operator or their designated representative. This interview can provide information on operational factors and facilitate the working relationship between the contractor and the controllers. Include contact information in the final report.

2.6.7.2.4. FAA Airway Facilities. An interview with FAA Airway Facilities personnel is necessary on any airport with FAA owned and maintained navigational facilities. In some cases, the personnel who maintain the facilities for the airport may be located at another site. Complete these portions of the interviews by telephone. The first purpose of the interview is to determine all pertinent facilities and changes to navigational aids within 10 nautical miles surrounding the airport. It might also be necessary to schedule a technician to accompany the contractor to certain facilities to let them through a gate or monitor an alarm while survey personnel are within critical areas of the site. Include the contact information for the assigned FAA Airway Facilities Point of Contact (POC) in the final report in case questions arise after the survey.

2.6.8. Field Survey Operations

2.6.8.1. Data. The project will include accurate positions and elevations of points, lines, or polygons based on the type of survey required (see Table 2-1 Survey Requirements Matrix). For airport airspace analysis surveys, specific points along runways, runway vertical profiles, positions and elevations of navigational aids, positions and elevations of obstructions, analysis of obstructing areas, and positions and elevations of certain non-obstructing obstacles are required. For other survey types, data portraying aircraft movement and apron areas, prominent airport buildings, selected roads and other traverse ways, cultural and natural features of landmark value, topography, other miscellaneous features, and special request items could be required. The accuracy of this data must meet the standards published in this guidance.

2.6.8.2. Preparation. Carefully evaluate the requirements in the statement of work from the airport sponsor or proponent. A careful review of all available data enables the team to begin the survey work in an efficient way and to conduct all necessary preparations and communications. The unique source data requirements of each survey requires the team to identify potential sources, research the necessary data, and review the requirements of the survey thoroughly. The following list provides information the survey team should review to prepare for the survey. Generally, addressing each item listed below will prepare the survey team to begin the survey:

- Ensure a thorough understanding of the specifications and requirements for the type of survey required. If you are unsure of a requirement, ask.
- Review imagery and USGS quadrangles of the airport (a terrain analysis tool).
- Prepare an imagery acquisition plan that ensures sufficient coverage of the entire survey area.
- Determine areas of private or government property and arrange for access.
- Prepare a list of questions to discuss with the airport sponsor or proponent about the survey.
- Review the descriptions for control stations identified for use in the project.
- Acquire and review an accurate airport diagram for use on the airport.
- Review FAA Form 5010, Airport Master Record, at http://www.gcr1.com/5010web/.
- Coordinate with airport authorities.
- Produce and deliver a Survey Plan and Quality Control Plan.

2.6.9. Determining the Survey Requirements.

The following matrix identifies the requirements for the different survey types typically encountered at an airport.

Intentionally left blank.

Table 2-1. Survey Requirements Matrix

This table is designed for use in two ways. First, it defines in a general fashion the task required to meet a specific objective. Each task listed is generalized and the process to complete it many contain many other pieces. Users should refer to the text of the referenced AC to ensure that all the required subtasks are completed. The second way to use this matrix is as a checklist to ensure all the required data is collected either before leaving the field or submitting the data to the FAA.

Intended End Use of the Data ➢	AC Reference	Category II or III Operations	Navigational Aid Siting			Airport Layout Plan (ALP)	Airport Obstruction Chart	Construction		Instrument Procedure Development	Pavement Design, Construction, Rehabilitation or Roughness	Airport Mapping Database
Required Tasks ⮛			Non-Precision	Precision	Visual			Airside	Landside			
Provide a Survey and Quality Control Plan	150/5300-16/17/18	•	•	•	•	•	•	•	•	•	•	•
Establish or validate Airport Geodetic Control	150/5300-16	•	•	•		•	•	•		•	•	•
Perform, document and report the tie to National Spatial Reference System (NSRS)	150/5300-16	•	•	•	•	•	•			•		•
Survey runway end(s)/threshold(s)	150/5300-18	•		•	•	•	•	•[1]		•	•	•
Monument runway end(s)/threshold(s)	150/5300-18	•		•	•	•	•	•[1]		•	•	
Document runway end(s)/threshold location(s)	150/5300-18	•		•	•	•	•	•[1]		•[1]	•[1]	
Identify and survey any displaced threshold(s)	150/5300-18	•		•	•	•	•	•[1]		•	•	•
Monument displaced threshold(s)	150/5300-18	•		•	•	•[1]	•[1]	•[1]		•		
Document displaced threshold(s) location	150/5300-18	•		•	•	•	•	•[1]		•	•	•
Determine or validate runway length	150/5300-18	•				•	•	•[1]		•	•	•
Determine or validate runway width	150/5300-18	•				•	•	•[1]		•	•	•
Determine runway profile using 50 foot stations	150/5300-18			•[2]		•[2]	•[2]	•[1]		•	•[2]	
Determine runway profile using 10 foot stations	150/5300-18	•		•[2]		•[2]	•[2]	•[1]		•	•[2]	•[2]
Determine the touchdown zone elevation (TDZE)	150/5300-18	•		•		•	•			•	•	
Determine and document the intersection point of all specially prepared hard surface (SPHS) runways	150/5300-18	•				•	•					•
Determine and document the horizontal extents of any Stopways	150/5300-18	•				•	•			•		•
Determine any Stopway profiles	150/5300-18	•				•	•			•		•
Determine if the runway has an associated clearway	150/5300-18	•				•	•					
Survey clearway to determine objects penetrating the slope	150/5300-18	•				•	•			•		•
Determine and document the taxiway intersection to threshold distance	150/5300-18					•						
Determine runway true azimuth	150/5300-18	•		•		•	•			•		•
Determine or validate and document the position of navigational aids	150/5300-18	•	•	•	•	•	•			•		
Determine or validate and document the position of runway abeam points of navigational aids	150/5300-18	•		•	•		•			•		
Determine potential navigational aid screening objects	150/5300-18		•	•	•							
Collect and document VOR receiver checkpoint location and associated data	150/5300-18		•								•	
Perform or validate and document an airport airspace analysis	150/5300-18	•	•	•	•	•	•	•[1]		•		
Collect and document helicopter touchdown lift off area (TLOF)	150/5300-18				•	•	•	•		•	•	•
Collect and document helicopter final approach and takeoff area (FATO)	150/5300-18				•	•	•	•		•	•	•
Collect or validate and document airport planimetric data	150/5300-18					•	•	•	•			•
Determine or validate the elevation of the Air Traffic Control Tower Cab Floor (if one is on the airport)	150/5300-18	•				•	•	•	•			•

[1] Only when runway construction is involved.
[2] All 14 CFR Part 139 airports require 10 foot stations. At all other airports the distance between stations is between 10 and 50 feet to meet local requirements

Intended End Use of the Data ➤ / Required Tasks ⮟	AC Reference	Category II or III Operations	Navigational Aid Siting			Airport Layout Plan (ALP)	Airport Obstruction Chart	Construction		Instrument Procedure Development	Pavement Design, Construction, Rehabilitation or Roughness	Airport Mapping Database
			Non-Precision	Precision	Visual			Airside	Landside			
Perform or validate a topographic survey	150/5300-18	•[3]	•	•		•		•	•	•[4]		
Collect and document runway and taxiway lighting	150/5300-18	•				•						•
Collect and document parking stand coordinates	150/5300-18											•
Collect cultural and natural features of landmark value	150/5300-18					•	•					•
Determine elevation of roadways at the intersecting point of the Runway Protection Zone (RPZ) or the runway centerline extended	150/5300-18	•				•						
Determine all Land Use to 65 DNL contour	150/5300-18					•						
Document features requiring digital photographs	150/5300-18	•	•	•	•	•		•		•		
Document features requiring sketches	150/5300-18	•	•	•	•	•		•		•		•
Collect position and type of runway markings	150/5300-18	•				•						•
Collect position and type taxiway markings	150/5300-18											•
Locate, collect, and document photo ID points	150/5300-17						•					
Identify collect, and document wetlands or environmentally sensitive areas	150/5300-18					•						
Collect imagery	150/5300-17	•				•	•			•		•
Provide a final Project Report	150/5300-16/18	•	•	•	•	•	•	•	•	•	•	•

[3] Only required for the identified Category II and III special topographic survey
[4] For Cat II and III radar altimeter area or if specifically requested

2.6.10. Types of Airport Survey Projects

2.6.10.1. Airport Geodetic Control. Recover (if existing) the Primary Airport Control Station (PACS) and the associated Secondary Airport Control Stations (SACS) at the airport. These marks are typically set at commercial service airports and some high activity general aviation airports. A listing of airports with PACS and SACS and the dates of observation is available from the NGS website http://www.ngs.noaa.gov/cgi-bin/airports.prl?TYPE=PACSAC. PACS are set to meet high-stability standards and positioned to meet high-accuracy standards. SACS have slightly less stringent stability and positioning specifications. Refer to AC 150/5300-16, *General Guidance and Specifications for Aeronautical Surveys: Establishment of Geodetic Control and Submission to the National Geodetic Survey* for full PACS and SACS requirements. Use the established PACS and SACS as starting control for all airside surveys at the airport. When a local control grid is established for engineering purposes, make direct ties to existing control stations with published NSRS coordinates. Existing control should consist of monumented points such as the PACS, SACS, runway ends, displaced thresholds, other published NSRS monuments etc. Incorporate at least two existing recoverable control stations into the local control network to maintain the airport relative to the NAS. If the PACS and/or either of the SACS are not found, are destroyed, are damaged, or are not usable for some other reason, contact the FAA Airport Surveying–GIS Program Manager immediately. The FAA Airport Surveying–GIS Program will review the situation and may advise the airport proponent, Airports District Office, or Airports Regional Office to reschedule the work at the airport.

2.6.10.1.1. Verification of Survey Marks. Before use, verify the unmoved position and elevation of the PACS and SACS. The verification of each control station includes:

- Physically visiting each control station to determine its usability and checking its identity;
- Ascertaining its unmoved position;
- Determining its condition, stability, visibility; and
- The submission of recovery information to NGS.

Make two independent GPS sessions, each at least 10 minutes long with a 5-second collection interval, between the PACS and each SACS, or measure the distance between the PACS and each SACS using calibrated electronic distance meter instrument (EDMI), and compare the results to a computed inverse distance. Compute the inverse using either the NGS program INVERS3D (available on the NGS website at http://www.ngs.noaa.gov/TOOLS/) or a comparable commercial product. Compare the newly measured distances or inverse distances (from new observations) against the distances determined from the published positions. Provide the results or the comparisons as part of the observational data in the final report. Obtain elevation checks either from GPS observations or from spirit levels. The distances must agree within 3 cm; the difference in ellipsoidal height must agree to ±4 cm, and the difference in orthometric height must agree to ±5 cm or the data must be recollected.

Submit a recovery report for the PACS and SACS to the NGS at:

http://www.ngs.noaa.gov/FORMS_PROCESSING-cgi-bin/recvy_entry_www.prl

Verification is not required if the contractor performing the survey also established the monuments by satisfying the requirements of AC 150/5300-16, *General Guidance and Specifications for Aeronautical*

Surveys: Establishment of Geodetic Control and Submission to the National Geodetic Survey, for the same airport as part of the same contract.

2.6.10.2. Runway Data. This section provides field surveyors with guidelines for properly identifying the precise survey point for runway ends, displaced thresholds, and stopway ends. It highlights the importance of resolving runway/stopway discrepancies with airport authorities and official U.S. Government aeronautical publications. Accurate runway data is critical to aircraft safety. Inaccurate data can result in unnecessary operational limitations or dangerous misassumptions. The positions and elevations of runway/stopway/displaced threshold points are elements used to determine airport design and operation information such as runway length, Accelerate Stop Distance Available (ASDA), Takeoff Distance Available (TODA), Takeoff Run Available (TORA), Landing Distance Available (LDA), runway gradient, and runway azimuth, among other data elements. In many cases, the location of these points is not intuitively obvious and the precise survey point selection may not be consistent among surveyors.

The FAA has issued a series of advisory circulars establishing standards for construction, markings (painting), lighting, signage, and other items pertaining to runways/stopways. Airports certified under 14 CFR 139 and those federally obligated must comply with the published standards; however, complicating this are situations where the repainting of markings based on runway/stopway changes is delayed, leaving inappropriate painting in place at the time of the survey. Other situations occur when the airport intends to comply with the AC, but the marking standard is misinterpreted or applied incorrectly. An example of misinterpreted criteria is, where the threshold bar is painted on a blast pad adjacent to a runway end rather than on the runway. These guidelines should help surveyors correctly identify runway/stopway survey points, not only when standard markings exist, but also in the many cases where a nonstandard situation is encountered.

2.6.10.2.1. Runway and Stopway Points. The location and orientation of the runway(s) are paramount to the safety, efficiency, economics, and environmental impact of the airport. This section provides guidance on the collection of data regarding the specific features and attributes about the runway, stopway, clearway and displaced threshold (if any). See Figure 2-1. Additionally, it provides guidance on the accurate collection of profile points along the runway, used in many different areas of airport planning and design as well as other initiatives within the FAA. Typically, the runway end, stopway, and displaced threshold positions are typically collected using GPS or ground based methods. Since the points are fairly high accuracy points and are used to establish the approach and departure characteristics for the runway, collection using remote sensing technologies is not acceptable. Provide the runway/stopway data required for a runways and stopways using the Runway, RunwayEnd, Stopway, and AirportControlPoint (for displaced thresholds and stopway ends) features in Chapter 5 for all runways and stopways with a specially prepared hard surface (SPHS) existing at the time of the field survey. Provide the data for non-specially prepared hard surface (non-SPHS) runways/stopways required existing at the time of the field survey and depicted in the current version of the U.S. Government flight information publication U.S. Terminal Procedures. Provide Stopway data (using the feature StopwayEnd or Stopway) and Clearway data using the RunwayProtectArea feature if it is requested by appropriate authorities (FAA, Airport sponsor, State Aviation authority).

Surveyors should refer to and document runways using the number painted on the runway at the time of the field survey. Use the runway number published in U.S. Terminal Procedures (version current at the time of the field survey) if a number is not painted on the runway. Use the FAA Runway Data Sheet form to document published data and collected data. Download the form from the FAA Airports GIS website at https://airports-gis.faa.gov.

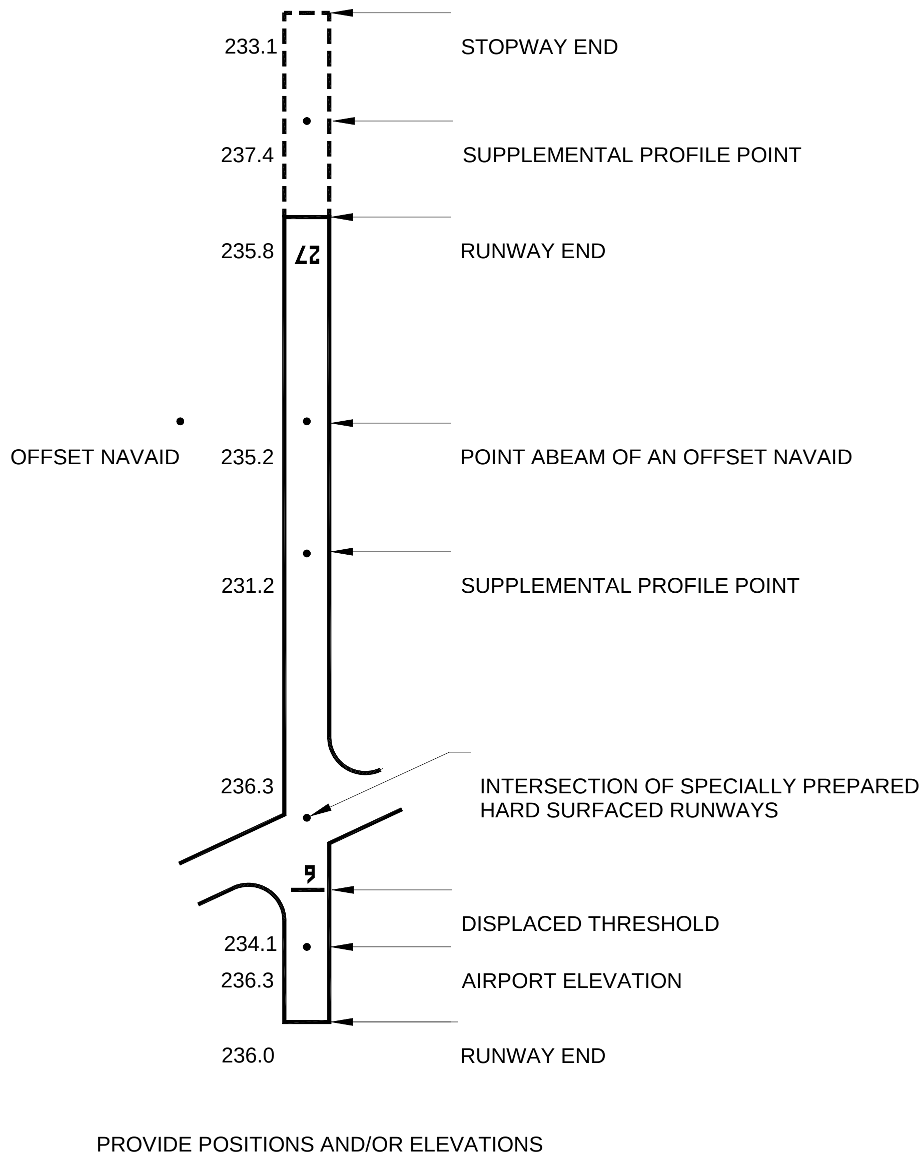
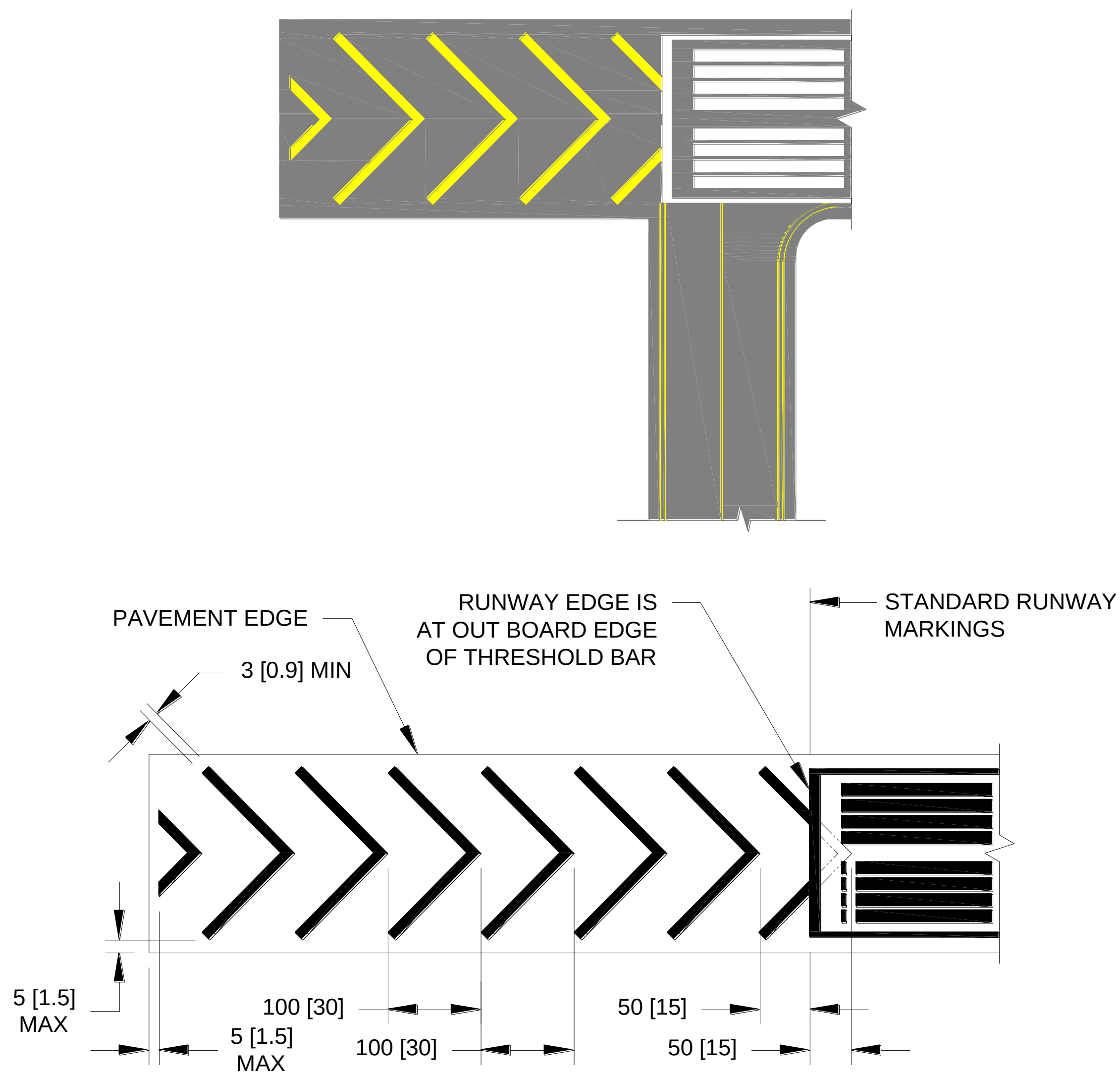


Figure 2-1. Depicts some of the required points and elements of a runway or stopway.

In order to be a stopway, the area must be officially designated, appropriately marked, and approved as a stopway by the airport and FAA authorities. The following points about stopways are important for the surveyor to keep in mind:

- A stopway is an area beyond the runway, with sufficient strength to support a decelerating aircraft in all weather conditions. It is not a runway safety area.

- A stopway must be designated as such. This means the airport owner/operator determines that a stopway exists and commits to maintaining the area as a stopway, including the appropriate marking and lighting (see Figure 2-2). The existence of a stopway means the runway has a declared accelerate/stop distance, even though it may not be published. Unless otherwise stated, all runway, stopway, and clearway points must be on the runway, stopway, or clearway (as appropriate) centerline.



NOTES:

1. 50 FOOT [15M] SPACING MAY BE USED WHEN LENGTH OF AREA IS LESS THAN 250 FEET [75M] IN WHICH CASE THE FIRST FULL CHEVRON STARTS AT THE INDEX POINT (INTERSECTION OF RUNWAY CENTERLINE AND RUNWAY THRESHOLD).
2. CHEVRONS ARE YELLOW AND AT AN ANGLE OF 45° TO THE RUNWAY CENTERLINE.
3. CHEVRON SPACING MAY BE DOUBLED IF LENGTH OF AREA EXCEEDS 1000 FEET [300M]
4. DIMENSIONS ARE IN: FEET [METERS].

Figure 2-2. An example of the proper marking for a blast pad or stopway.

2.6.10.2.2. Determining the Runway Length and Width. The runway length does not include blast pads or stopway surfaces located at one or both ends of a runway; however, the displaced threshold (if there is one) is included in the physical length of the runway. Runway lengths are determined from the positions of the runway ends. Determine the runway end positions using the guidance provided in the RunwayEnd feature in Chapter 5. Measure the runway width from the outer edge of the runway, excluding shoulders (see Figure 2-3) and stopways. The runway width is the physical width extending over the entire length of the rectangle, or the area within the runway side stripes if the full pavement width is not available as a runway. Measure and record runway widths to the nearest tenth of a foot (0.1 ft) and include the dimension on the runway end sketch. If the determined dimensions of the runway, displaced threshold, stopway, or blast pad dimensions do not agree with the information published for the airport, discuss the discrepancies with the airport manager or designated representative and resolve any discrepancies in the values before departing the site. If the discrepancy cannot be resolved, note the discrepancy and document the discussions with the airport officials in the final report for review by NGS and resolution by the FAA with the airport.

Determine and provide the runway true azimuth reckoned from North to the nearest thousandth of a degree as the azimuth between the physical runway ends. The runway true azimuth is documented as an attribute in the RunwayEnd feature. Each runway end will have a different runway true azimuth specified.

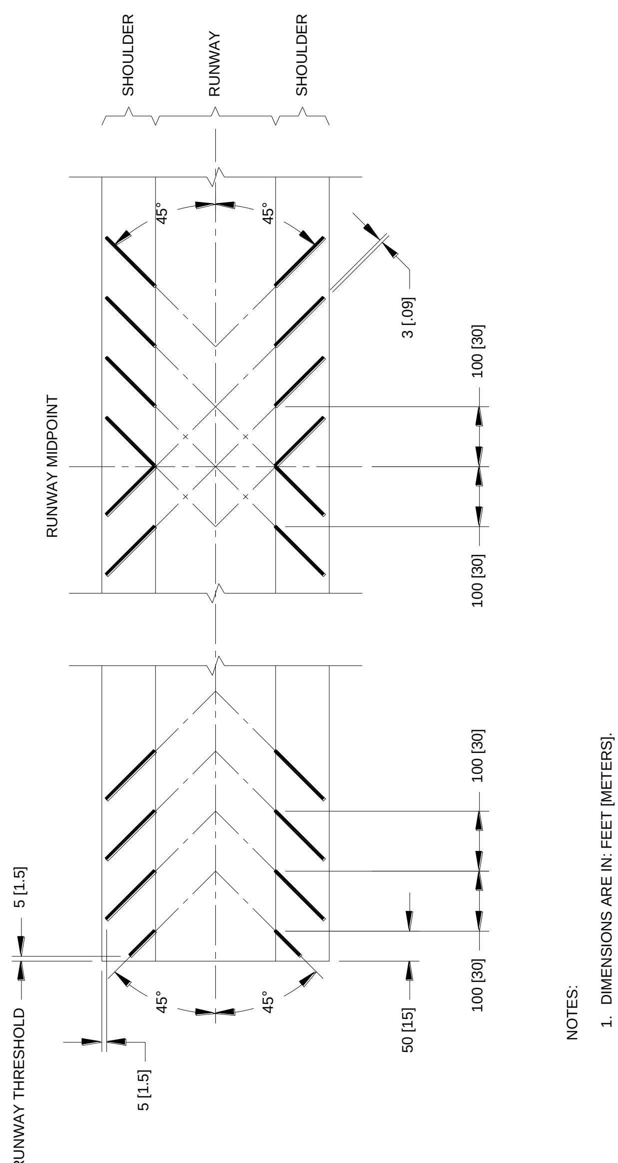
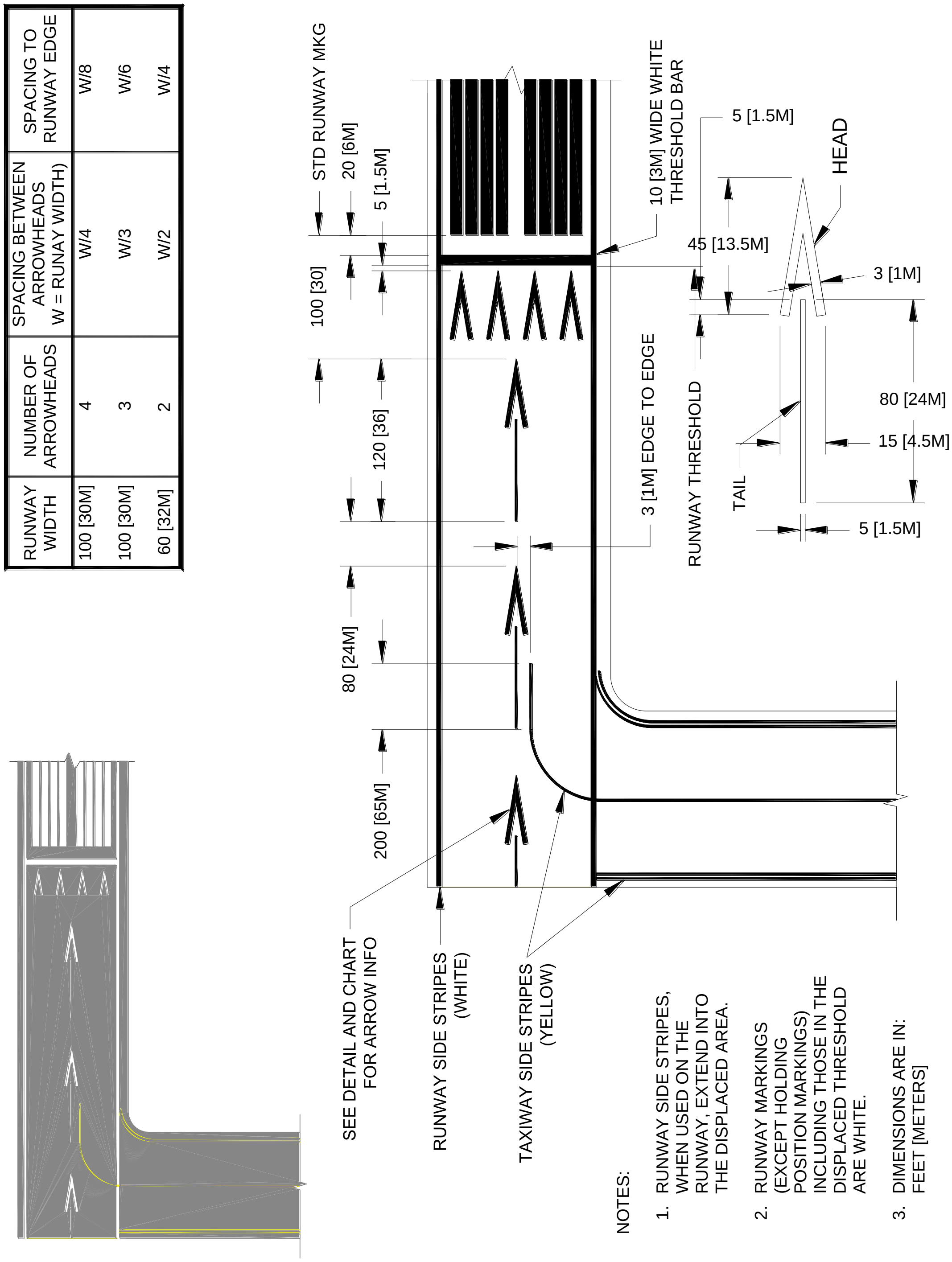


Figure 2-3. Standards for marking of runway shoulders.

2.6.10.2.3. Displaced Thresholds. On some runways, the threshold is displaced due to other requirements such as objects in the approach area penetrating the siting surface or where the airport is constrained to meet runway safety area length. When a displaced threshold is encountered it must be identified (see Figure 2-4), classified, and documented (see paragraphs 1.5.2 and 1.5.3 for documentation requirements) similarly to a runway end. In the FAA Airports GIS a displaced threshold is modeled using the AirportControlPoint feature in Chapter 5.



RUNWAY WIDTH	NUMBER OF ARROWHEADS	SPACING BETWEEN ARROWHEADS W = RUNAY WIDTH)	SPACING TO RUNWAY EDGE
100 [30M]	4	W/4	W/8
100 [30M]	3	W/3	W/6
60 [32M]	2	W/2	W/4

Figure 2-4. Illustrates the proper marking of a displaced threshold.

2.6.10.2.4. Establishing the Runway End Point**.** Use existing FAA or airport provided runway end point data to assist in locating the points identifying the ends (physical and displaced) of the runway. Proper identification of these points is in the data standard descriptions for the RunwayEnd, and AirportControlPoint (Displaced Threshold and stopway end) features in Chapter 5 of this AC, with further clarifying guidance provided in Appendix C. Recover, verify or establish and document (see paragraphs 1.5.2 and 1.5.3 for documentation requirements) the following points using the appropriate feature in Chapter 5.

- Runway end points
- Displaced threshold points
- Clearway end points
- Stopway end points

2.6.10.2.5. Location of Specific Survey Points**.** The locations of the following runway/stopway survey points are defined by the intersection of the runway/stopway centerline and one of the indicated survey point locators as detailed in the feature descriptions in Chapter 5. When the survey point is determined, the selection of the point is solidified through the use of various supporting features. Occasionally, a supporting feature will conflict with the selected survey point or another supporting feature. If this occurs, resolve the conflicts before leaving the airport. For example, a runway number may be located near the end of the pavement, but threshold lights and a threshold bar are located down the runway at an apparent displaced threshold. Discuss the conflict with airport authorities and, if necessary, contact the FAA Airport Surveying–GIS Program Manager for assistance. In the feature descriptions (see Chapter 5), reference is made to inboard or outboard threshold and runway end lights. These terms are defined in Appendix A. If light units or day markers are used to construct the trim line defining a survey point, as in the case of a runway end with an aligned taxiway, use the two units nearest to the runway (one light on each side of the runway). Always define the trim line perpendicular to the runway centerline. If a line connecting the lights (or markers if the runway is unlighted) is not perpendicular to the runway centerline, then the trim line must be best fit to the defining lights or markers.

2.6.10.2.6. Runway and Stopway Profiles**.** The runway profile provides information about the runway gradient, establishes the airport elevation and the touchdown zone elevation(s), and supports runway pavement roughness studies. Collect runway profile data along the runway centerline at 50-foot stations. Additionally, at 14 CFR 139 airports collect runway centerline profiles at 10-foot stations and two (2) additional profiles offset 10 feet on either side of the centerline. Collect the runway or stopway profiles beginning and ending on the runway ends. Each point collected in the profile should be accurate to within 0.5 inches relative to its adjacent points and modeled using the AirportControlPoint feature in Chapter 5. Use the actual date the profile was collected as the dateRecovered attribute. Specify the monumentType attribute as spot from the enumeration table codeMonumentType. Specify the pointType attribute as a CenterlinePoint from the enumeration table codePointType.

2.6.10.2.7. Preliminary Computations and Data Discrepancies. The runway end or displaced threshold position establish the starting and end point of the runway. Use these positions to compute the runway length, length of any threshold displacement and stopway length. Before leaving the airport, compute these safety critical distances and compare them to the known data provided by the FAA or airport authority. Determine these lengths using a three dimensional geodetic inverse computation between the end points. Using a three dimensional computation corrects for the elevation of the points and difference in elevation between points. The official runway, stopway, or displaced threshold length is the straight-line distance between end points. This line does not account for surface undulations between points.

Computed lengths seldom match published lengths exactly. Discrepancies are most likely caused by interpretation of runway/stopway survey point location, remarking of thresholds, or comparison with less accurate published data. As the magnitude of discrepancies increases, the probability also increases that physical changes have occurred to the runways/stopways or that the thresholds have been moved. Differences with published data should be considered as an alert that there may be a problem in the survey. However, published lengths are often not as accurate as the new surveyed lengths and are occasionally obsolete or otherwise grossly erroneous. Therefore, the validity of the published data must always be questioned when comparing it with the new survey data, especially if the survey points are selected correctly.

Even though published data is often incorrect or obsolete, new survey data should be carefully reexamined when discrepancies between published and surveyed data occur. The reasons for small discrepancies are often difficult or impossible to identify. As discrepancies become larger, the reasons typically become more apparent. Even though the source of the discrepancy may not be identified, the reexamination should be conducted to provide the highest level of confidence that accurate runway data has been provided. Fully document and report the situation in the final report for examination by the independent verification and validation team.

Stopway discrepancies pose a special problem. Before an area is officially declared a stopway and published in official U.S. Government documents, airport authorities must file the request for a stopway through appropriate FAA offices. Discrepancies in the reported value for a stopway are generally harder to determine. If the apparent stopway dimensions on the ground differ by more than 10 percent from the stopway dimensions as published by the FAA or given by the airport authority, contact the FAA Airport Surveying–GIS Program Manager for assistance. If a published stopway does not appear to meet the definition of a stopway, including the requirement to support an aircraft during an aborted takeoff, without causing structural damage to the aircraft, fully document (including taking digital photos of the area in question) for resolution by the FAA with the airport authority. If the airport authorities request an area be surveyed as a stopway but the stopway is not published in the current FAA publications or the airport authorities request a change to or do not concur with the published stopway data or data resulting from the new survey, complete the survey as requested and completely document the request and the data in the final report for resolution by the FAA.

Because of the importance of runway/stopway data, always discuss the location of runway, stopway and displaced thresholds with the appropriate airport authorities. Discrepancies occurring between the judgment of the surveyor and the opinions, understandings, or intentions of the airport authorities should be resolved. It may be necessary to revisit the field with airport personnel and explain the survey and survey point selection. If a discrepancy in the location of a position cannot be resolved, assistance should be sought from the FAA Airport Surveying–GIS Program Manager. In some cases, final resolution may ultimately require a FAA field visit.

2.6.10.2.8. Comparison With Critical Runway Length. Runway lengths that are whole thousands of feet (5,000, 8,000, etc.) or whole thousands of feet plus 500 feet (5,500, 8,500, etc.) often have special operational significance. For purposes of this document, these lengths are called critical lengths. Many aircraft operations require a minimum runway length, which is often a critical length, and many runways are built to these lengths. If a runway is incorrectly published shorter than a critical length, certain operations could be unnecessarily restricted. In addition to imposing unnecessary operational limitations, incorrectly surveyed runways may not be retrieved during a computer search. This situation is especially likely to occur with critical length runways. In some cases, this failure could have safety implications. While all runway/stopway lengths should be accurate, even small errors in critical length could have significant and far-reaching ramifications. Runway lengths determined to be less than, but within 20 feet of, a critical length should be carefully reexamined to provide the highest level of confidence that the survey is correct. This reexamination should include an inspection of the runway end survey points to ensure the longest runway length possible was provided.

2.6.10.3. Navigational Aid (NAVAID) Surveys.

2.6.10.3.1. Navigational Aids**.** Navigational aids are vital elements of the NAS. The FAA Pilot/Controller Glossary defines a navigational aid as "any visual or electronic device, airborne or on the surface, providing point-to-point guidance information or position data to aircraft in flight". The FAA operates over 4,000 ground-based electronic navigational aids, each broadcasting navigation signals within a limited area. The FAA and airports also provide a variety of approach lighting systems to assist the pilot in transitioning from instrument reference to visual reference for landing (see Figure 2-5). The navigational aid survey is the process of determining the position and/or elevation of one or more navigational aids and associated points on the airport or along the runway centerline(s) extended. Where a centerline abeam position (perpendicular to) the navigational aid is required it is detailed in Chapter 5. A navigational aid survey is normally completed as part of the total airport survey, airport layout plan update or accomplished entirely independently depending on the needs of the airport sponsor/proponent.

Figure 2-5. This photo illustrates how lights used at airports assist the landing pilot.

2.6.10.3.2. Determining the NAVAID Horizontal and Vertical Survey Position**.** Determine the horizontal survey point (HSP) by either field survey or remotely sensed means. The HSP may be the center of the navigational aid or, when the navigational aid is composed of more than one unit, the center of the array. If the DME and azimuth functions of VORTAC or VOR/DME facilities are located within 10 feet consider them collocated and report them as a single navigational aid. Be sure to include a note identifying the method used to determine the identification of collocation. Survey the navigational aid position if the navigational aid is associated with the airport surveyed. If the navigational aid penetrates a surface, also identify it in the airport airspace analysis evaluation with the associated object requirements and accuracies applying.

The data standards in Chapter 5 provide the data capture rules, horizontal and vertical survey points, accuracy requirements and necessary documentation for NAVAID observations. If you encounter a navigational aid not listed, contact the FAA Airport Surveying–GIS Program Manager for guidance.

In addition, survey Airport Surveillance Radar (ASR) and Air Route Surveillance Radar (ARSR) located within the limits of the Airport Airspace Analysis Area for the airport, but not located on a military airport.

2.6.10.3.3. Electronic Navigational Aids. Determine the position (and sometimes the elevation, depending on the navigational aid) for electronic signal generating navigational aids associated with the airport. Chapter 5 identifies the accuracy requirements for electronic navigational aids. Each navigational aid feature lists the HSP and VSP, and in many cases provides photos or sketches identifying the proper survey point, accuracy requirements, documentation and monumentation requirements and coordinate resolution for the electronic navigational aids typically found on and around airports.

Table 2-2. List of typical Electronic NAVAIDs associated with an Airport

Air Route Surveillance Radar (ARSR)	Outer Marker (OM)
Airport Surface Detection Equipment (ASDE)	Back Course Marker (BCM)
Airport Surveillance Radar (ASR)	Localizer Type Directional Aid (LDA)
Distance Measuring Equipment (DME)	MLS Azimuth Antenna (MLSAZ)
Fan Marker (FM)	MLS Elevation Antenna (MLSEL)
Localizer (LOC)	Non-directional Beacon (NDB)
Glide Slope (GS)	Simplified Directional Facility (SDF)
End Fire Type (GS)	Tactical Air Navigation (TACAN)
Inner Marker (IM)	VHF Omni Directional Range (VOR)
Middle Marker (MM)	VOR/TACAN (VORTAC)

2.6.10.3.4. Visual Navigational Aids. To enhance visual information to the pilot during the day, when visibility is poor, and at night, airports provide visual aids to pilots. These aids provide visual clues to the pilot about the aircraft's alignment or height in relation to the airport or runway. Visual navigational aids consist of a variety of lighting and marking aids used to guide the pilot both in the air and on the ground. Determine the position of the HSP for the visual aids located on the airport. The position of the HSP may be the center of the navigational aid or, when composed of more than one unit, the HSP is typically the center of the unit array. For approach lighting systems capture and report only the first and last lights.

The HSP, VSP, accuracy and resolution requirements for the visual navigational aids typically found on and around airports are provided with each navigational aid in Chapter 5. Chapter 5 provides sample images of most typical navigational aids depicting the horizontal and VSPs for each.

Table 2-3. List of Typical Visual Navigational Aids on an Airport

Airport Beacon (APBN)	Visual Glide Slope Indicators (VGSI)
Runway End Identifier Lights (REIL)	Approach Light System (ALS)

NOTE: *Visual navigational aids are associated with the runway end they serve; the Airport Beacon is an exception.*

2.6.10.3.5. Reference Measurements. For any navigational aid, provide reference measurements to other features, which could affect the system performance or separation from runways or taxiways. For all navigational aids provide at least two reference measurements to other prominent features (runway centerline, taxiway centerline, aircraft parking areas, detailing the navigational aid and its compound (area) and the point surveyed. Document these dimensions using the Navigational Aid Facility or Runway End Sketch form from the FAA Airports GIS website (https://airports-gis.faa.gov).

2.6.10.3.5.1. Navigational Aid Screening and Interference Reference Measurements. In addition to the reference measurements above provide the following reference measurements. All measurements are derived from the horizontal survey point. Document these measurements on the FAA Navigational Aid Screening and Interference Measurement Sketch.

- The distance and azimuth from the navigational aid to any structure located with 1,000 feet.
- The distance and azimuth from the navigational aid to any metal structure beyond 100 feet and above a 1.2° angle from the antenna base or proposed location.
- The distance and azimuth from the navigational aid to all non-metal structures greater than 1,000 feet from the navigational aid and penetrating a 2.5° plane from the antenna base or proposed location.
- The distance and azimuth to any metal fence within 500 feet of the navigational aid antenna or proposed location and any overhead powerline within 1,200 feet of the antenna or proposed location.
- The distance and azimuth to any trees within 1,000 feet of the antenna or proposed location, however, a single tree is acceptable as long as it is greater than 500 feet from the antenna or proposed location.
- The distance and azimuth to any tree(s) greater than 1,000 feet from the antenna penetrating a 2.0° plane from the antenna base or proposed location.
- The distance and azimuth to any building(s) or other objects with the potential to cause signal interference with an ASR antenna within 1,500 of the antenna and identify any other electronic equipment within 2500 feet of the ASR antenna or proposed location.

2.7. AIRPORT AIRSPACE ANALYSIS SURVEYS

When required, use the following specifications and associated figures to identify, collect, and analyze objects on, and surrounding airports. These specifications require extensive field/remote sensing operations, providing data to support a wide range of NAS activities. This section details the requirements for completing an Airport Airspace Analysis Survey to support the planning and design activities of airports and ancillary tasks such as instrument flight procedure design. This section is complementary to other sections on the collection of runway, navigational aid, and other airport data. Complete the analysis based on the highest runway designation. For example, if one end of the runway is designated as a precision runway and the other end non-precision use the Runways with Vertical Guidance analysis criteria for both ends. When both ends of the runway are or plan to be used for non-vertically guided or visual operations, complete the analysis using the Non-vertically Guided criteria.

2.7.1. Airport Airspace Survey Surfaces and Analysis

2.7.1.1. Runways with Vertical Guidance. These specifications support the airport's planning and design activities for the development of vertically guided instrument approaches such as ILS, PAR, MLS, LPV, TLS, RNP and Baro VNAV. These surfaces assist in the identification of possible hazards to air navigation and critical approach/departure obstructions within the vicinity of the airport. All surfaces identified below must be completed for both ends of a runway. Evaluate each surface independently of other surfaces. Design all appropriate airport surfaces in reference to the runway ends and not displaced thresholds.

2.7.1.1.1. Vertically Guided Runway Primary Surface (VGRPS). A 1,000-foot wide rectangular surface (500 feet either side of runway centerline) longitudinally centered on the runway centerline. The VGRPS also extends 200 feet beyond each runway end. The surface elevation of any point within the VGRPS is the same as the runway centerline elevation beam at the selected point (follows the runway centerline contour). The elevation of any point within the 200 foot VGRPS extension areas are equal to the runway end elevation on the side to which the extension applies.

2.7.1.1.2. Vertically Guided Primary Connection Surface (VGPCS). The VGPCS is a set of 500 foot wide lateral extensions of the VGRPS surface (one on each side of the runway) and is used to connect the VGRPS with the Vertically Guided Approach Transitional Surface (VGATS). The VGPCS starts along the outer edges of the VGRPS surface, and extends out laterally 500 feet. The VGPCS also extends 200 feet beyond each runway end. The surface elevation of any point within the VGPCS is the same as the runway centerline elevation abeam the selected point (follows the runway centerline contour). The elevation of any point within the 200 foot VGPCS extension areas is equal to the runway end elevation on the side to which the extension applies.

2.7.1.1.3. Vertically Guided Approach Surface (VGAS). The VGAS is a 40:1 (2.5%) sloping surface that is longitudinally centered on the extended runway centerline. It begins at the runway end, and extends outward towards the final approach course for a total horizontal distance of 20,200 feet. The surface is 2,000 feet wide (1000 feet either side of centerline) at the runway end, and expands to a width of 8,000 feet at 10,200 feet from runway end. From 10,200 to 20,200 feet from the runway end, the surface is 8,000 feet wide (4,000 feet either side) and parallel to the runway centerline extended. The surface begins at the runway end elevation and rises towards the final approach course for a total of 505 feet. This surface overlaps the VGRPS and VGPCS surfaces for 200 feet.

2.7.1.1.4. Vertically Guided Protection Surface (VGPS). The VGPS is a 62.5:1 sloping surface longitudinally centered on the runway centerline extended. The surface begins at the runway end and extends outward towards the final approach course for a distance of 6,000 feet. The surface is 400 feet wide at the runway end (200 feet either side of centerline) and expands to a final width of 1217.6 feet (608.8 feet either side of centerline). The surface begins at the runway end elevation and rises towards the final approach course for a total rise of 96 feet. This surface overlaps the VGRPS for 200 feet.

2.7.1.1.5. Vertically Guided Approach Transitional Surface (VGATS). The VGATS is a 3,000 foot wide, 20:1 (5%) sloping surface that extends outward from the outer edges of the VGPCS (from runway end to runway end) and along the VGAS tapered boundary, to a point 4,000 feet abeam the runway centerline (see Figure 2-6). The VGATS surface starts at the airport elevation along the VGPCS/VGATS edge (or imaginary extended edge for tapered area), and rises 150 feet above airport elevation abeam the runway centerline.

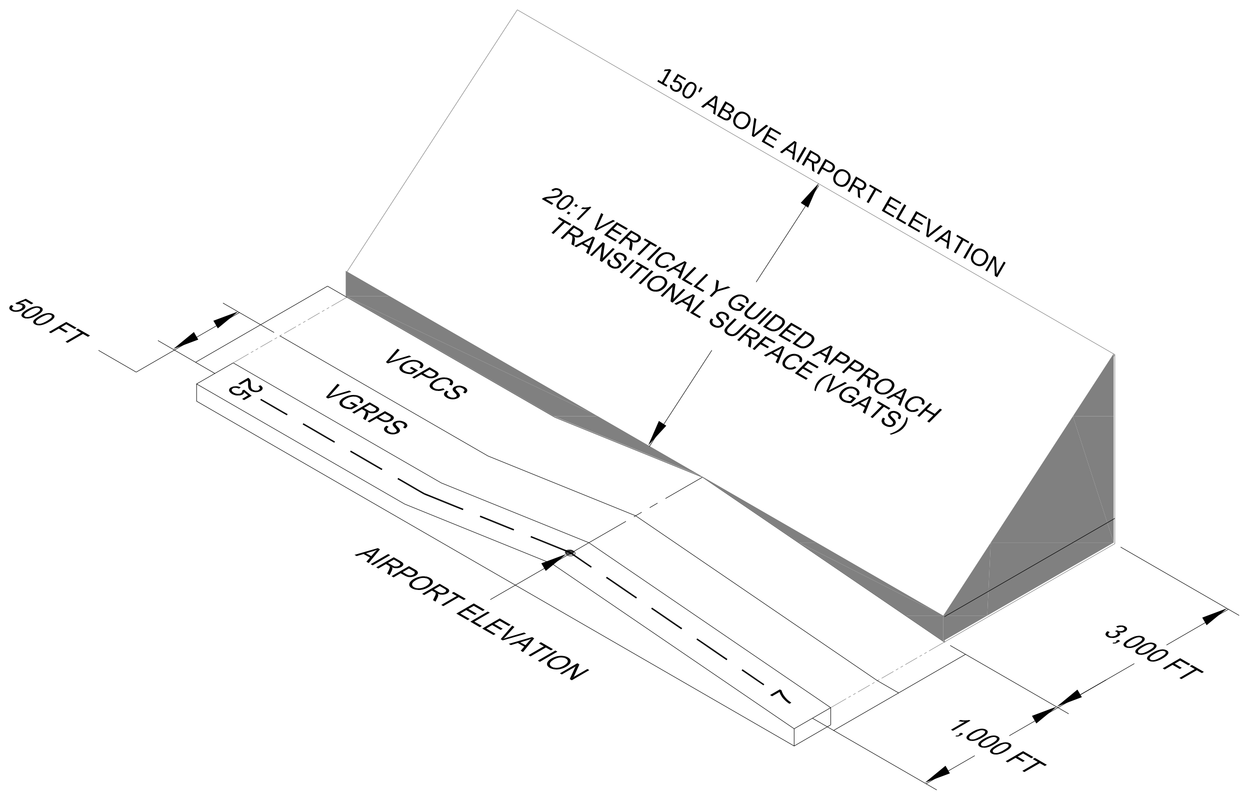


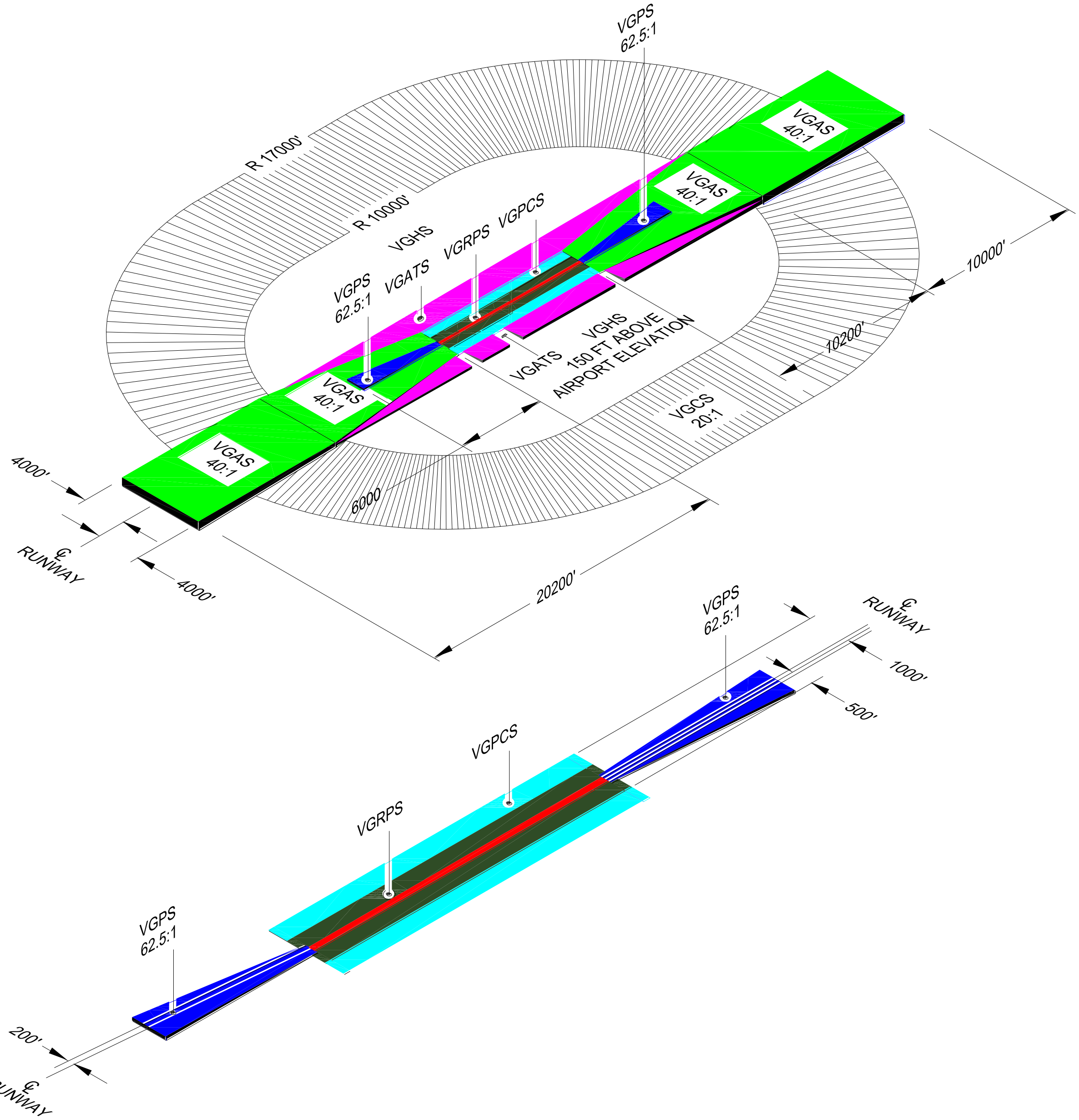
Figure 2-6. Illustrates the dimensional criteria associated with the VGATS and the connection to the VGPCS.

2.7.1.1.6. Vertically Guided Horizontal Surface (VGHS). Is a horizontal plane established 150 feet above the established airport elevation; construct the perimeter of the VGHS by scribing 10,000-foot arcs from the center of each end of the VGRPS. Use tangential lines to connect the arcs and complete the identification area.

2.7.1.1.7. Vertically Guided Conical Surface (VGCS). The VGCS is a sloping surface, extending upward and outward from the outer limits of the VGHS for a horizontal distance of 7,000 feet. The slope of the VGCS is 20:1 (5%) measured in the vertical plane. At the outer edge of the surface, the elevation of the VGCS is 500 feet above the airport elevation.

VGATS AREA (20:1)
MAXIMUM OBSTACLE HEIGHT = AIRPORT ELEVATION +
(150 - (DISTANCE FROM OUTER EDGE /20))

VGPS END WIDTH COMPUTATION (62.5:1)
(0.068133D) + 200
(0.68133 X 6000) + 200
(408.798) + 200
608.798 OR 608.8 FEET



DETAIL OF IMMEDIATE RUNWAY VICINITY

Figure 2-7. Illustrates the areas, dimensions, and slopes of the Vertically Guided Approach Survey and Analysis Specification required to support instrument procedure development.

2.7.1.2. Analysis of Runways with Vertically Guided Operations. Analyze the surfaces according to the following criteria for each runway end. Where an object meets multiple requirements (highest and most penetrating, highest and highest manmade etc.) the point only needs to be identified once. In this guidance the word "object" includes but is not limited to above ground structures, navigational aids, people, equipment, aircraft (parked or taxiing), equipment, vehicles, natural growth, and terrain. Where multiple runways are surveyed, perform and report the analysis for each runway separately. When an object is determined to be within one or more surfaces, identify the penetration value for each surface. Provide the penetration value (positive or negative) for the most adverse surface (closest to centerline or runway end) in the attribute field penValSpecified and provide the penetration amount (positive or negative) of the secondary surface in the attribute penValSupplemental.

2.7.1.2.1. Divide the VGRPS into three equal length zones each representing one third of the total length of the runway. Analyze all objects within the lateral confines (see Figure 2-8) of the surface to identify, classify, and report the following representative objects using either feature type Obstacle or ObstructionArea in Chapter 5 as appropriate:

- The highest object outward from the runway end to 200 feet from the end of the runway within the lateral limits of the VGRPS.
- The highest object, highest manmade object, and the highest natural (terrain or vegetation) object in each one-third (1/3) of runway length section of the VGRPS on each side (left and right) of the runway.
- When meteorological apparatus (see Figure 2-10) are located within the surface area, do not analyze this equipment against the surfaces as objects because their location is fixed by function and they are frangibly mounted. Instead, determine and report the distance from threshold, distance from all runway/taxiway centerline(s), the MSL elevation, the above ground height and distance from the edge of any apron or aircraft parking area. Use the FAA form Navigational Aid Facility or Runway End Sketch to document the information on meteorological apparatus.

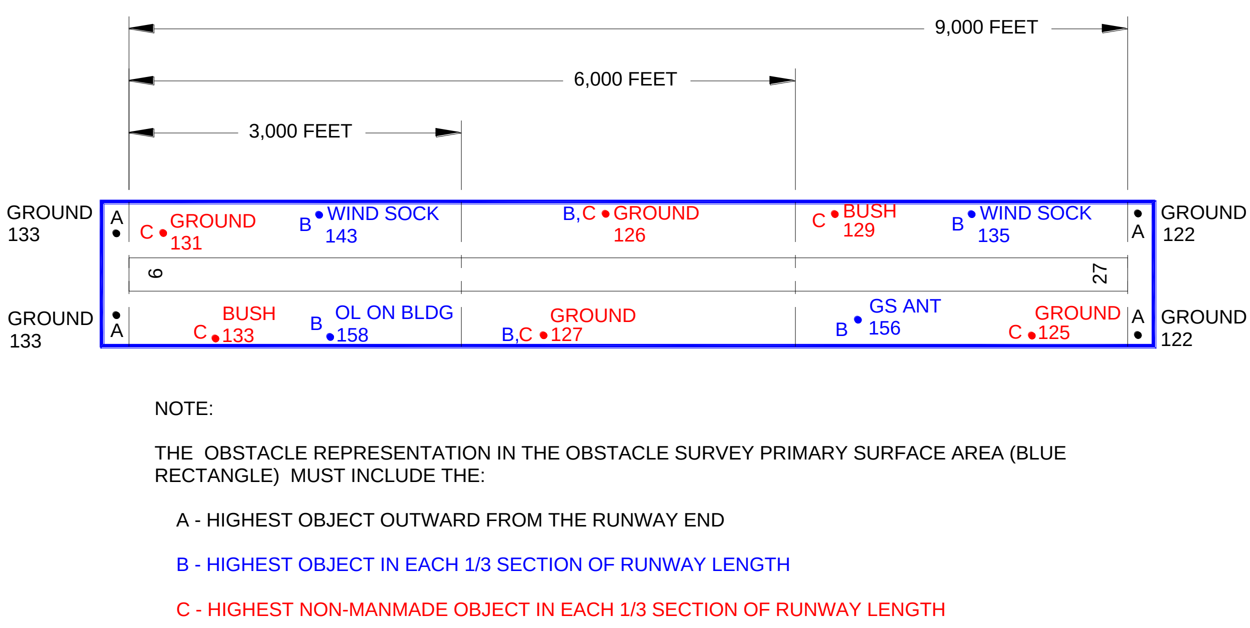
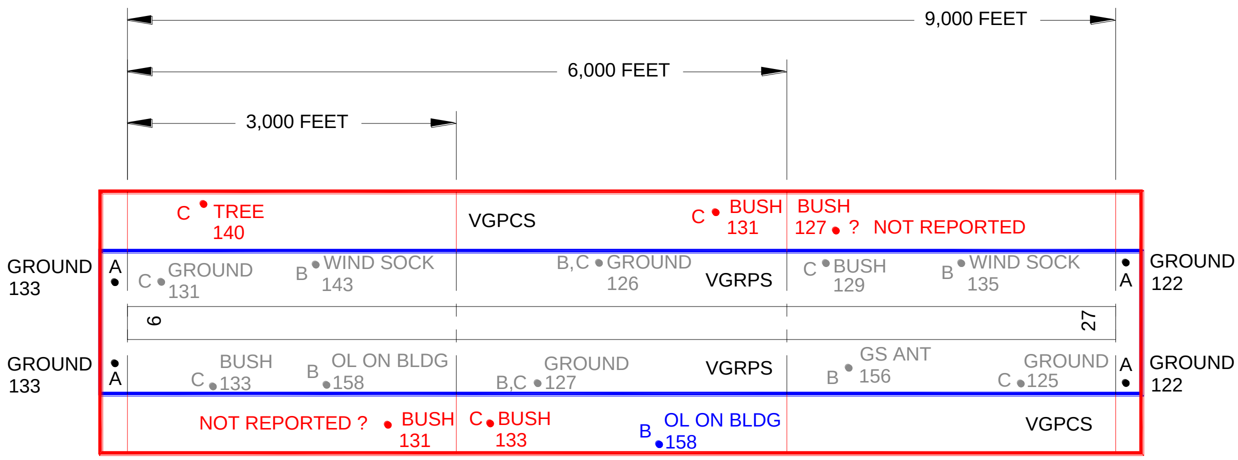


Figure 2-8. Object Representation in the VGRPS Area.

2.7.1.2.2. Divide the VGPCS into three equal length zones each representing one third of the total length of the runway. Analyze all objects within the lateral confines (see Figure 2-9) of the surface to identify, classify, and report the following representative objects using feature type Obstacle or ObstructionArea as appropriate:

- The highest object outward from the runway end to 200 feet from the end of the runway within the lateral limits of the VGPCS.
- The highest object, highest manmade object, and the highest natural object in each one-third (1/3) of runway length section of the VGPCS on each side (left and right, as viewed from the high numbered runway end) of the runway.
- When meteorological apparatus (see Figure 2-10) are located within the surface area, do not analyze this equipment against the surfaces as objects because their location is fixed by function and they are frangibly mounted. Instead, determine and report (as a sketch) the distance from threshold, distance from all runway/taxiway centerline(s), the MSL elevation, the above ground height and distance from the edge of any apron or aircraft parking area.

EXCEPTION: If the representative object(s) selected in the VGRPS sections are higher than the adjacent VGPCS sections, then selection and representation of an object in the VGPCS section is not required.



NOTE:

THE OBSTACLE REPRESENTATION IN THE VGPCS AREA (RED RECTANGLE) MUST INCLUDE THE:

A - HIGHEST OBJECT OUTWARD FROM THE RUNWAY END

B - HIGHEST OBJECT IN EACH 1/3 SECTION OF RUNWAY LENGTH

C - HIGHEST NON-MANMADE OBJECT IN EACH 1/3 SECTION OF RUNWAY LENGTH

Figure 2-9. Illustrates the VGRPS and VGPCS object representations.

Figure 2-10. SAWS, AWOS and ASOS Station Installations.

2.7.1.2.3. In the Vertically Guided Approach Surface (VGAS) identify, classify and report all significant objects of landmark value underlying the VGAS using the respective feature type in Chapter 5 (i.e. Building, ForestStandArea, Fence, etc.) even if the objects(s) do not penetrate the surface.

In this guidance, objects of significant landmark value are geographic features located in the vicinity of an airport aiding in geographic orientation. These features include but are not limited to objects such as roads, railroads, fences, utility lines, shorelines, levees, quarries and nearby airports underlying the airport airspace analysis surfaces.

Identify, classify, and report the following representative objects using the feature type Obstacle or ObstructionArea according to the following criteria. For analysis as penetrating the VGAS, the VGAS area excludes VGPS area as illustrated in Figure 2-11 in blue.

- The five most penetrating objects within the VGAS.
- The highest manmade and natural objects in the first 10,200 feet of the VGAS on each side of the runway centerline extended.
- The highest manmade and natural objects in the area between the 10,200-foot point and the end of the VGAS on each side of the runway centerline extended.
- The overall highest object in the VGAS.

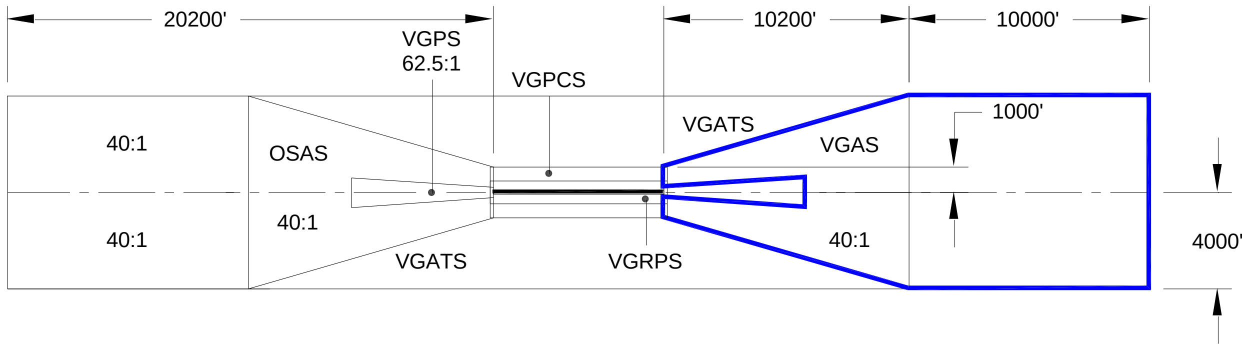


Figure 2-11. The area outlined in blue illustrates the lateral limits of the VGAS.

2.7.1.2.4. In the VGPS, identify, classify and report all significant objects of landmark value (for a definition refer to paragraph 2.7.1.2.3) underlying the surface using the respective feature type in Chapter 5 (i.e. Building, ForestStandArea, Fence, etc.) even if the objects(s) do not penetrate the surface.

Also, identify, classify, and report the following representative objects using the feature type Obstacle or ObstructionArea according to the following criteria.

In the VGPS, analyze all objects to identify, classify, and report the following representative objects.

- All objects penetrating the VGPS.
- The highest manmade and natural object on each side of the runway centerline extended within the lateral limits of the surface.

2.7.1.2.5. Divide the VGATS into four sections by drawing a line perpendicular to the runway centerline as illustrated in Figure 2-12 on each side of the centerline. Analyze the sections beginning with the northeasternmost section and analyze subsequent sections in a counterclockwise direction. Define left and right as viewed from the high numbered runway end.

- In the VGATS, identify, classify, and report the following representative objects using feature type Obstacle or ObstructionArea as appropriate: the highest manmade, highest natural, and the most penetrating object in each section of the VGATS.

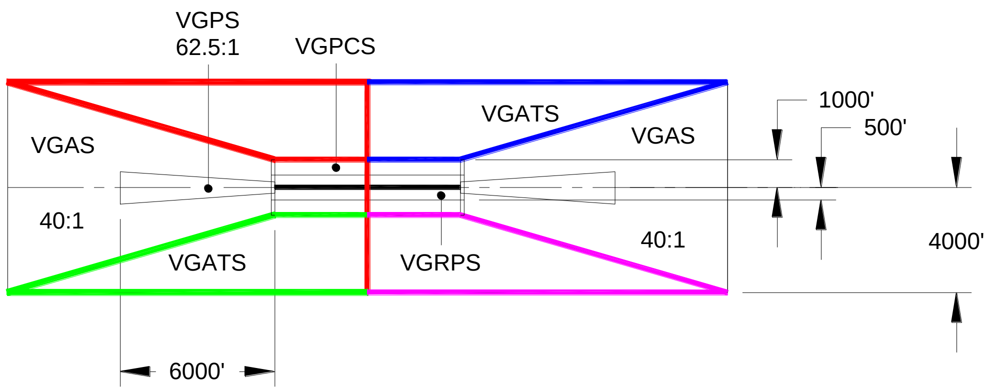


Figure 2-12. Illustrates the VGATS divided into four (4) sections for analysis.

2.7.1.2.6. Divide the VGHS into quadrants (as depicted by the red lines in Figure 2-13) centered on the meridian and parallel, intersecting the Airport Reference Point (ARP). Analyze all objects to identify, classify and report (using feature type Obstacle or ObstructionArea as appropriate) the two highest and the most penetrating object in each quadrant. Analyze the sections beginning with the northeastern most section and analyze subsequent sections in a counterclockwise direction.

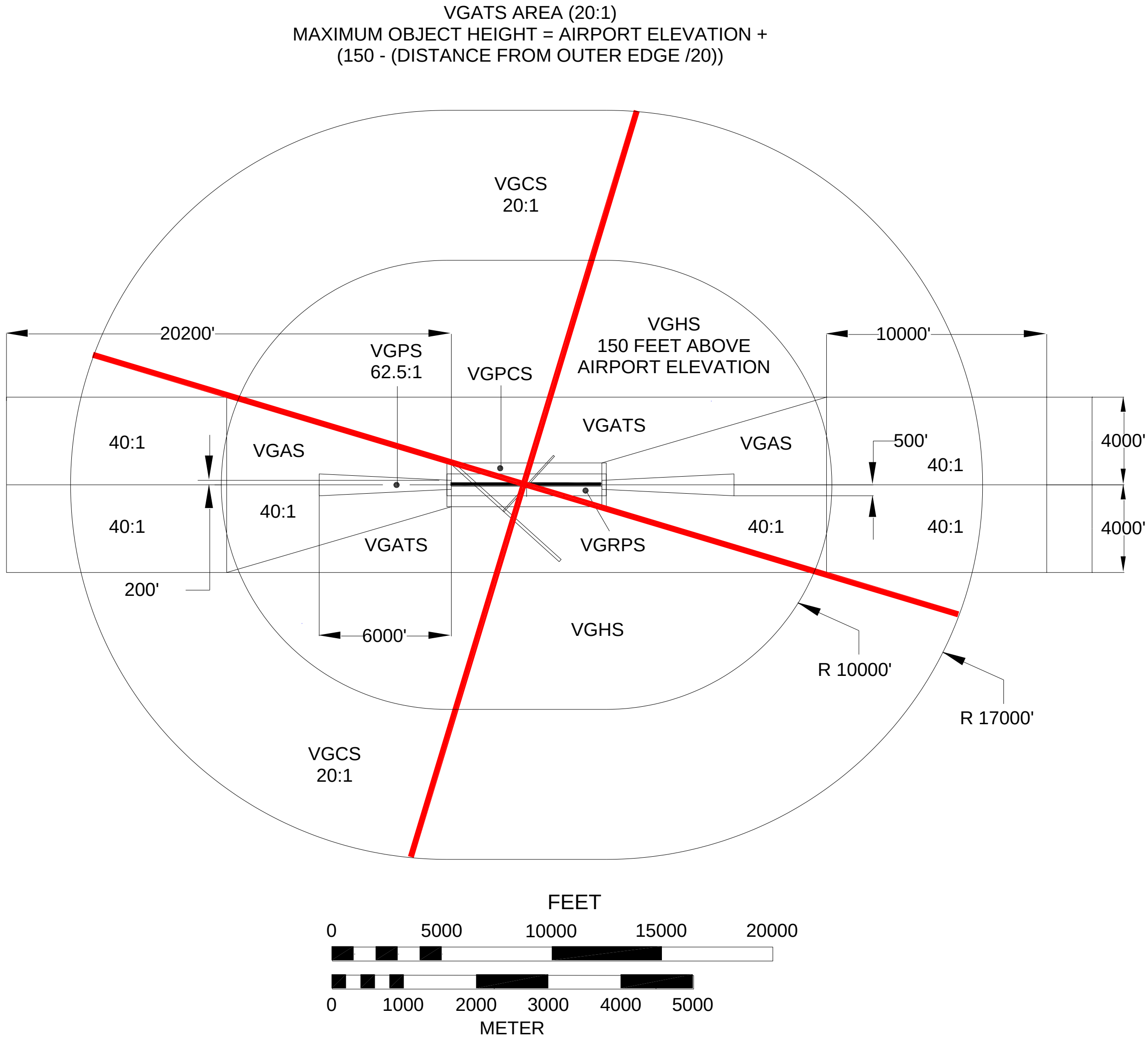


Figure 2-13. Illustrates dividing the VGHS into quadrants through the ARP.

2.7.1.2.7. Divide the VGCS into quadrants (as depicted by the red lines in Figure 2-13), extended to the outer edge of the VGCS, centered on the meridian and parallel intersecting the ARP. Analyze all objects to identify, classify, and report (using the feature type Obstacle or ObstructionArea as appropriate) the highest object and the most penetrating object in each quadrant. Analyze the sections beginning with the northeastern most section and analyze subsequent sections in a counterclockwise direction.

2.7.1.3. Runways without Vertical Guidance. These specifications and associated figures supports airport planning and design obstacle identification activities for runways designed for visual maneuvers, non-vertically guided (NVG) operations (Lateral Navigation (LNAV), Localizer Performance (LP), VOR, NDB, Localizer, Localizer Directional Aid (LDA), etc.) and instrument departure procedures. These surfaces assist in the identification of possible hazards to air navigation on, and within the vicinity of, the airport. Evaluate each surface independently of all other surfaces.

2.7.1.3.1. NVG Primary Surface (NVGPS). A 1,000-foot wide rectangular surface (500 feet either side of runway centerline) longitudinally centered on the runway centerline and extending from runway end to runway end. For runways that have, or plan to have, a Specially Prepared Hard Surface (SPHS), the NVGPS expands outward 200 feet beyond each runway end. The surface elevation of any point within the NVGPS is the same as the runway centerline elevation abeam the selected point (follows the runway centerline contour). The elevation of any point within the 200 foot SPHS runway type extension areas are equal to the runway end elevation on the side to which the extension applies.

2.7.1.3.2. NVG Approach Surface (NVGAS). (Must be completed for both ends of the runway) The NVGAS is a 20:1 (5.0%) sloping surface that is longitudinally centered on the extended runway centerline. It begins at the NVGPS and extends outward towards the final approach course. Runway ends that have the same elevation as the airfield elevation will have a standard NVGAS length of 10,000 feet from the NVGPS. Runway ends with elevations lower than the airfield elevation will have NVGAS length longer than 10,000 feet. The length of the NVGAS must be determined by subtracting the runway end elevation from the airfield elevation, adding 500 feet to the difference, then divide the total by .05 (20:1) as shown in the following formula:

$$NVGAS\ Length\ (Ft) = \frac{((Airport\ Elevation - Runway\ End\ Elevation) + 500\ feet)}{0.05}$$

The NVGAS surface is 1,000 feet wide (500 feet either side of runway centerline) at the NVGPS and expands to a width of 4,000 feet (2,000 feet either side of runway centerline) at a point 10,000 feet from the NVGPS. For NVGAS lengths longer than 10,000 feet, the NVGAS continues to expand laterally beyond the 10,000 foot point (to the distance calculated above) at the same rate as the initial portion of the NVGAS. The surface height begins at the runway end elevation and rises towards the final approach course at 20:1 (5.0%) until reaching 500’ above the airport elevation (End Elevation = Airport Elevation + 500 feet).

2.7.1.3.3. NVG Transitional Surface (NVGTS). The NVGTS is a series of 20:1 (5.0%) sloping surfaces extending upward and outward from the edge of the NVGPS and the edge of the NVGAS (at right angles to the runway centerline/centerline extended) until reaching 500 feet above the airport elevation. The shape of each transitional surface varies based on location, runway type, runway end elevations, and airfield elevation. There are 3-types of transitional surfaces for runways with a SPHS (Type 1, Type 2, Type 3), and 2-types for runways without a SPHS (Type 1, Type 3 only).

NVGTS Type 1: A muli-sloped polygonal surface located directly between and abeam the runway end points. This surface starts at the edge of the NVGPS (at the straight line elevation slope created when joining runway end to runway end) and slopes upward and outward from the NVGPS at a 20:1 (5.0%) slope until reaching 500 feet above the airport elevation. Use the following formula to calculate the distance from the outer edge of the NVGPS abeam each runway end to the outer edge of the transitional surface:

Formula:

Distance NVGPS to Outer Edge = ([Airport Elevation – Runway End Elevation] + 500 feet) ÷ 0.05

NOTE: *Separate calculations must be made for each runway end. Always use real numbers when completing calculations. Always round numbers containing decimals down to their associated real numbers when making surface calculations.*

NVGTS Type 2 (For SPHS Runways Only): A single-sloped rectangular surface created to fill in the transitional area gap abeam the 200 foot runway end extension areas. This surface starts abeam the NVGPS surface between the runway end and the end of the 200 foot extension at the runway end elevation to which the extension applies. The surface rises upward and outward from the NVGPS at a 20:1 (5.0%) slope to a distance equal to the NVGAS length on the runway end to which the extension applies. The end height of the surface must be 500 feet above the airport elevation.

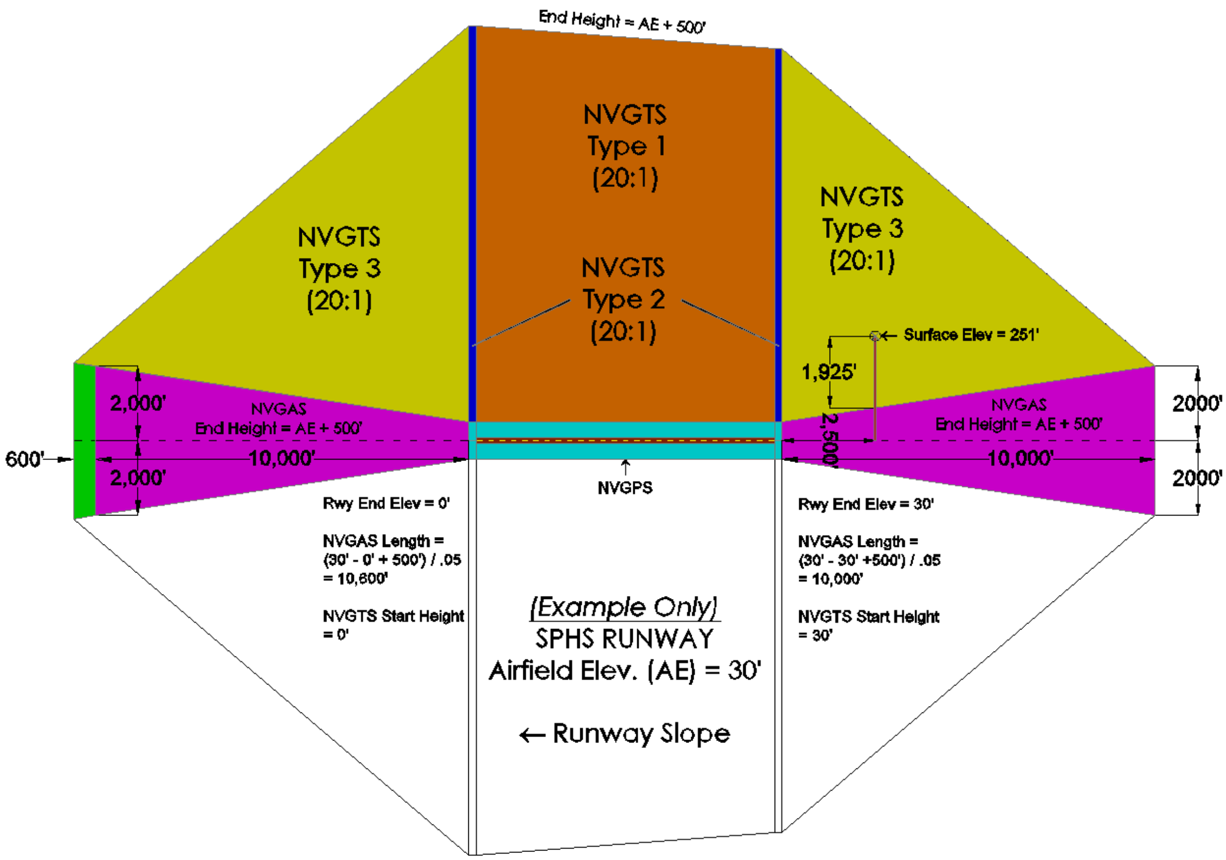


Figure 2-14. NVGPS, NVGAS, and NVGTS Types 1/2/3 for Non-Vertically Guided (NVG) Airport Surfaces

NVGTS Type 3: A single-sloped triangular surface that connects either the NVGTS Type 1 surface (for non-SPHS runways) or the NVGTS Type 2 (for SPHS runways) surface to the NVGAS. The slope of this surface is measured from the edge of the NVGAS perpendicular to the runway centerline extended. To complete this surface, draw a line connecting the outer corner of the NVGTS Type 1 or Type 2 surface (whichever surface applies) to the closest NVGAS outer corner. The low corner of this surface is located at the meeting point of the NVGPS, NVGAS, and NVGTS surfaces. The two outer corners must be 500 feet above the airport elevation.

2.7.1.3.4. NVG Horizontal Surface (NVGHS). A horizontal plane established 500 feet above the airport elevation extending outward from the edges of the NVGAS and NVGTS. The outer boundary of this area is constructed by scribing 20,000-foot arcs centered on the midpoint of the line that joins the NVGPS and the NVGAS for both runways. Tangential lines then connect the arcs to complete the surface.

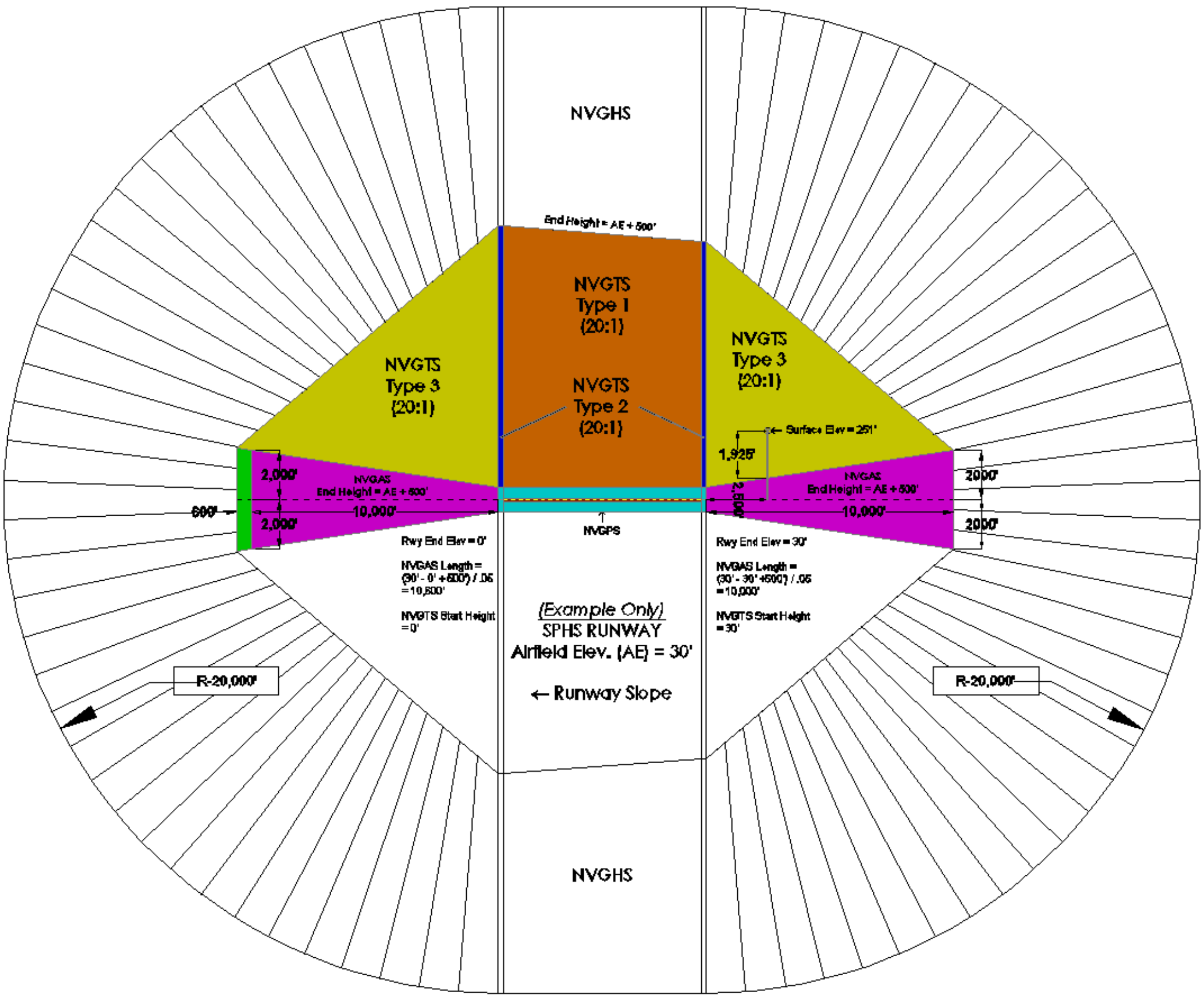


Figure 2-15. Horizontal Surface (NVGHS) for Non-Vertically Guided (NVG) Airport Surfaces

2.7.1.4. Analysis of Runways Non-Vertically Guided Operations. Perform an analysis of the NVG surfaces according to the following criteria for each runway end. Where multiple runways are surveyed, accomplish and report the analysis for each runway separately. When an object is determined to be within one or more surfaces, identify the penetration value for each surface. Provide the penetration value (positive or negative) for the most adverse surface (closest to centerline or runway end) in the attribute field penValSpecified and provide the penetration amount (positive or negative) of the secondary surface in the attribute penValSupplemental.

2.7.1.4.1. Divide the NVG Primary Surface (NVGPS) into three equal length zones each representing one third of the total length of the runway (see Figure 2-16). Analyze all objects within the lateral confines of the surface to identify, classify, and report the following representative objects using feature type Obstacle or ObstructionArea (as appropriate), the highest manmade and the highest natural obstacle in each one-third of runway length section of the primary surface on each side (left and right, as viewed from the high numbered runway end) of the runway.

Additionally identify, classify, and report the following representative object (using feature type Obstacle or ObstructionArea):

- The highest object outward from the runway end to 200 feet from the end of the runway, within the lateral limits of the NVGPS.

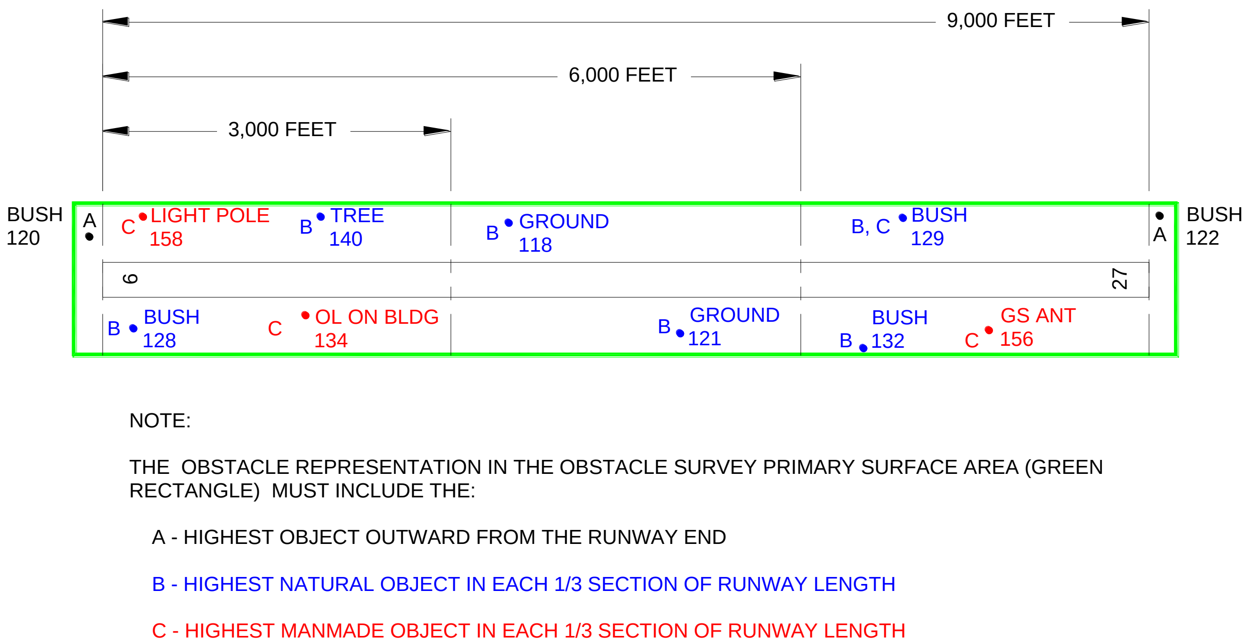


Figure 2-16. Object Representation in the non-vertically guided operations primary surface area.

2.7.1.4.2. In the NVG Approach Surface (NVGAS), identify, classify and report all significant objects of landmark value (for a definition refer to paragraph 2.7.1.2.3) underlying the NVGAS using the respective feature type in Chapter 5 (i.e. Building, ForestStandArea, Fence, etc.) even if the objects(s) do not penetrate the surface.

In this guidance, objects of significant landmark value are geographic features located in the vicinity of an airport aiding in geographic orientation. These features include but are not limited to objects such as roads, railroads, fences, utility lines, shorelines, levees, quarries and nearby airports underlying the airport airspace analysis surfaces.

Additionally identify, classify, and report the following representative objects using the feature type Obstacle or ObstructionArea according to the following criteria:

- The most penetrating object within the approach surface on each side of the centerline.

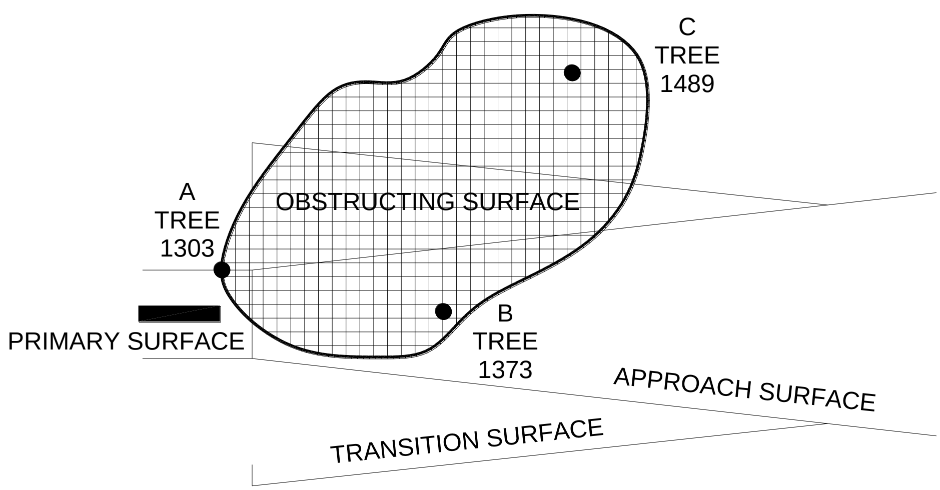
- The two highest manmade and natural objects on each side of the runway centerline extended and the overall highest object within the approach surface.

2.7.1.4.3. Transitional Surface(s). Divide the transitional surface into three sections (as illustrated in Figure 2-12 on each side of the runway). Analyze all objects within the lateral confines of the surface to identify, classify, and report the following representative objects using the feature type Obstacle or ObstructionArea (as appropriate), the highest manmade, natural, and the most penetrating object in each sub-section of the transitional surface(s). Analyze the sections beginning with the northeasternmost section and continue in a clockwise manner.

2.7.1.4.4. Horizontal Surface**.** In the NVG horizontal surface analyze all objects to, identify, classify and report using feature type Obstacle or ObstructionArea (as appropriate) all manmade and natural objects exceeding 500 feet above the established airport elevation

2.7.1.5. Airport Airspace Analysis Special Cases and Exemptions:

Area Limit Object Requirements – When a large area of objects such as buildings, terrain or vegetation penetrate a surface, identify the limits of the area using a bounding polygon within the lateral limits of the surface. Overlay the area lateral limits with a grid established parallel and perpendicular to the extended runway centerline of the surface (see Figure 2-17). Establish the grid beginning at the runway end using the appropriate spacing until reaching the obstructing area. Within 10,200 feet of the runway threshold, use 200-foot grid spacing; outside 10,200 feet from the threshold, use a grid spacing of 500 feet. Analyze, identify and report the highest manmade or natural object penetrating the surface within each grid sector. Additionally, report the highest manmade or natural object within the area limits (see Figure 2-17). If two objects with the exact same MSL elevation are within a grid sector, choose the sector object by first selecting the object closer to the centerline, then if required, by the object closer to the runway.



NOTES:

1. THIS GRAPHIC EXPLAINS OR CLARIFIES CERTAIN DATA REQUIREMENTS.
2. SEE TEXT WHEN OBJECT CONGESTION OCCURS.
3. DIMENSIONS ARE IN FEET. DO NOT SCALE THIS DRAWING.

Figure 2-17. Reporting highest object(s) within ObstructionArea limits.

Figure 2-18. This picture illustrates the importance of appropriately identifying catenaries.

Catenaries – In most cases, the position and elevation of supporting towers will adequately represent catenaries. Treat these towers as any other object. However, if one or both towers are outside the limits of the obstruction identification surface (OIS), the catenary itself may become a significant object (see Figure 2-18). In these cases, provide a position and elevation on the imaginary straight line connecting the tops of the two adjacent catenary support towers at the highest point within the OIS. Designate the elevation of this point as an estimated maximum elevation (EME).

Guyed Structures – The guys of a 2,000-foot skeletal tower are anchored 1,600 feet from the base of the structure. This places a portion of the guys 1,500 feet from the tower at a height of between 125 feet to 500 feet AGL. When surveying guyed structures, capture any guys penetrating a surface separately from the structure itself. Where the guys of any structure penetrate a surface at a distance greater than 100 feet from the actual structure, identify it as a separate point object where it penetrates the surface.

Vehicular Traverse Ways – Treat a vehicular traverse way as any other object, except include an appropriate vehicle height allowance in the elevation. Measure the clearance for roads and highways from the crown and edges of the road. Make measurements for railroads from the top of the rail. Make measurements for vehicle parking areas from the grade near the highest point. Use the following tolerances for vehicle height.

Non-interstate roads	15 feet
Interstate roads	17 feet
Railroads	23 feet

Mobile Objects – Determine the travel limits of mobile representative objects within a defined area (except vehicles on roads and railroads, and vessels, which treated under separate headings). Furnish an estimated maximum elevation (EME) for each of these mobile object areas penetrating the OIS (see Figure 2-19). If a non-penetrating mobile object is outward from the runway end, is the highest object in the VGRPS or VGPS, and is higher than the runway end, provide an EME point nearest to the runway centerline end, however the travel limits need not be determined. Include the word "MOBILE" which will always imply an EME, in the object name, such as, "MOBILE CRANE".

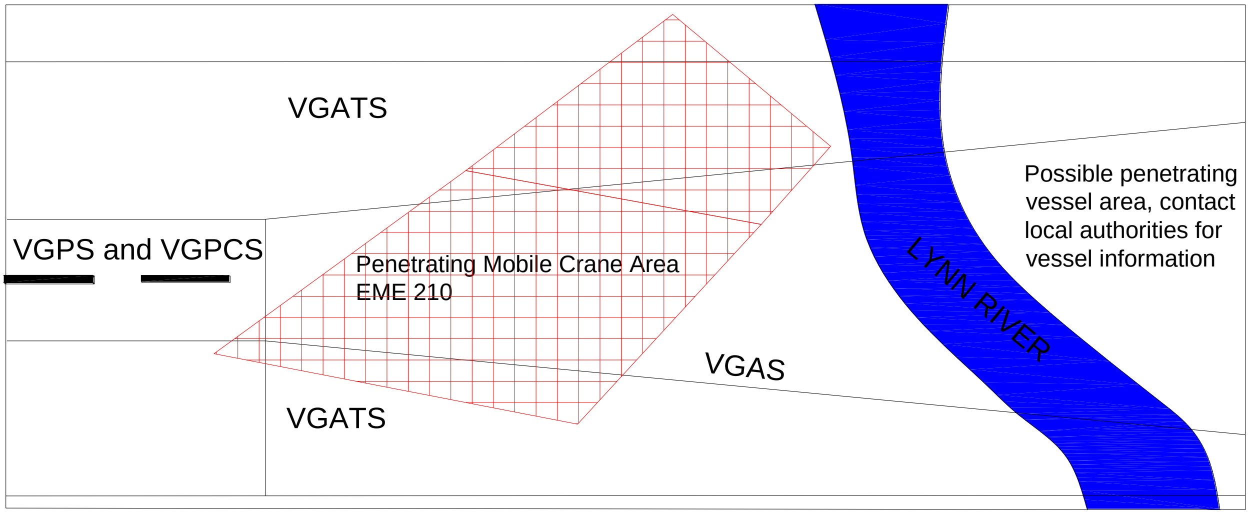


Figure 2-19. Illustrates the collection of penetrating vessel and mobile object areas.

Objects Under Construction – Identify representative objects under construction as, "BUILDING UNDER CONSTRUCTION". Determine the elevation of the object at the time of the survey. However, if a construction crane extends above the feature under construction, it is necessary and sufficient to determine the elevation and position of the crane. Identify, classify and report using the ConstructionArea feature and associated accuracies and collection requirements.

"Manmade" Objects –Measure the height from the highest point of ground in contact with either the object or the structure on which the object rests:

- *Within the boundaries of the airport,* determine the AGL elevation for all manmade objects.

  NOTE: *If any part of the RPZ falls outside of the airport boundary, also determine the AGL elevation of all manmade objects within this area.*

- *Outside the boundaries of the airport,* determine the AGL elevation for all manmade objects that are:

  - Determined as a representative object during the Airport Airspace Analysis Surveys, VG or NVG.

  - Have a height equal to or greater than 200 feet AGL.

Exemptions – The measurement and consideration of the following objects is not required.

- When vegetation exceeds the surface by less than three feet and has a maximum cross sectional diameter no greater than one-half inch where transected by a surface.

- Annual vegetation, such as annual weeds, corn, millet, and sugar cane.

- Roads with restricted public access intended for airport/facility maintenance only. This exemption does not apply to airport service roads associated with other airport operations, such as, food, fuel, and freight transportation.

- Construction equipment and debris, including dirt piles and batch plants, which are:

    - Temporary in nature

    - Under the control of airport authorities

    - Located on airport property

- Vessels, if possibly penetrating a surface, make an entry with the feature cautioning that vessels may penetrate certain surfaces at certain times and further investigation, travel limits, and frequency of passage is advised. This exemption does not apply to permanently moored vessels.

2.7.1.6. OBJECT DENSITY SELECTION CRITERIA. In some cases, strict adherence to the obstacle selection criteria listed above might result in congestion or inadequate obstruction representation. To minimize these situations, the following guidelines must be followed in obstacle selection:

- If obstacles that are required in the primary area or first 10,000 feet of an approach area are located within 100 feet of each other, the lower obstacle may be omitted.

- If obstacles that are required outside the primary or first 10,000 of an approach area are located within 500 feet of each other, the lower obstacle may be omitted. (Note: Required primary or approach obstacles must not be omitted because of the close proximity of higher obstacles outside of the primary or approach areas).

- When a required obstacle is omitted because of congestion, a replacement obstacle/obstacles must be selected, if possible, that meets the spacing criteria.

- Occasionally, additional obstruction information may be useful in representing certain obstructing conditions. While a rigorous selection criterion is not practical, information useful to obstruction clearing activities should be considered in the selection..

2.8. ONE ENGINE INOPERATIVE (OEI) ANALYSIS SURVEY REQUIREMENTS

AC 150/5300-13, *Airport Design*, describes the object evaluation area (OEA) and requirements for analyzing one engine inoperative (OEI) operations. This paragraph provides information about how to analyze the area and identify penetrations to the area. The OEI surface is an identification surface it does not require clearing of any penetrations of the surface. For analysis purposes, the evaluation area is subdivided into four areas. The extended runway centerline divides the first two areas on either side of the center section. These areas begin at the departure end of the runway or clearway and extend to 50,000 feet from the point of beginning. Define the third and fourth areas by constructing a line splaying 7° inside the outer area boundary and extending this line from the point of beginning to the point it intersects the outer boundaries of the OEA (40,000 feet). Further subdivide the entire OEA by constructing a series of lines perpendicular to the runway centerline extending to the edges of the OEA outer boundaries (see Figure 2-20). Within the first 21,000 feet of the surface, construct these lines every 300 feet. For the last 29,000 feet of the OEA construct these lines every 1,000 feet.

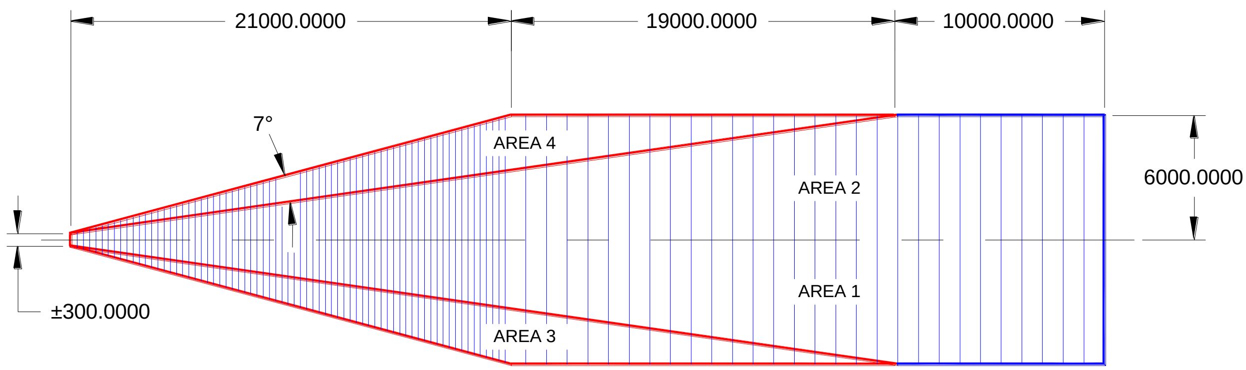


Figure 2-20. Illustrates the OEI object evaluation area and dimensions.

Analyze each polygon within the boundaries of the OEA and identify, classify and report all penetrations to the surface using the feature type Obstacle. If no object penetrates the surface in a specific polygon, no further representation is required in that polygon. When a group of objects (terrain, buildings, vegetations etc.) penetrates the surface, define it using a bounding polygon around the perimeter of the objects and identify, classify and report the object(s) using the ObstructingArea feature type. Use the Area limit Object requirements (see paragraph 2.7.1.5) grid method to analyze any ObstructionArea.

2.9. TOPOGRAPHIC SURVEYING

Complete topographic surveys to determine the shape and slope of the project area allowing the user to visualize the rise and fall of the land. Topographic surveys include the collection of natural and manmade features. Typically, airport topographic surveys provide landform data for planning studies, engineering designs, navigational aid installation and support instrument flight operations. At locations where there is (or plans to be) a Category II or III Instrument Landing System (ILS), the topography is important for operation of the navigational aid and in the design of the instrument procedure. Tie airport airside topographic surveys to the National Spatial Reference System. This tie ensures the data regarding airside operations is set to the same horizontal and vertical datum as the rest of the airport and the NAS. Create these ties directly to the established PACS or SACS at the airport. It is the responsibility of the surveyor to determine the equipment and methodologies used to meet the required accuracy. Planning projects typically require contours be established at two to ten-foot intervals yielding a map scale of in the range of 1” = 200 or 1” = 400 feet. Use the feature ElevationCountour in the Geospatial feature group to classify topographic surveys. When performing topographic surveys of the airside, ensure the collection and modeling of these following manmade features:

- Document the location of permanent structures including bridges, piers, culverts and docks using the Bridge feature in the Surface Transportation feature group.
- Document the location of street or road paving entrance drives, openings, and sidewalks using features from the Surface Transportation feature group.
- Classify the elevations on the top of curbs, gutters and sidewalks using features from the Surface Transportation feature group.

- Provide spot elevations covering the entire survey limits showing high points, low points, and grade changes. This should be done at sufficient intervals to represent the general character of the terrain using the AirportControlPoint feature in the Geospacial feature group.

- Location and elevation of lakes, rivers, streams or drainage courses on or near the airport or design area using the Shoreline feature in the Environmental feature group.

- Location, diameter, and species of all trees over a 6-inch diameter using features from the Environmental feature group.

- Outline the perimeter outline of thickly wooded areas unless otherwise directed using features from the Environmental feature group.

- Electric utilities – the location of power poles, guy wires, anchors, vaults, etc. using features from the Utilities feature group.

As with other aspects of airport surveys, the positional accuracy of the topographic survey ensures the data collected meets the needs of the FAA. The following relative (with respect to the established PACS, SACS, or temporary control stations occupied on the airport) positional accuracies are provided as a general guide for topographic surveys and are specified at the 95% confidence level.

Table 2-4. Topographic Survey Accuracy Requirements

Contour Interval	Vertical Positional Accuracy (in feet)	Horizontal Positional Accuracy (in feet)
1 foot	±0.50	±1.0
2 feet	±1.30	±2.0
4 feet	±2.60	±4.0
5 feet	±3.20	±4.0
10 feet	±6.50	±8.0
Spot ground elevations	±0.20	±2.0
Spot paving elevations	±0.05	±1.0
Well defined planimetric features	±0.10	±1.0

Table 2-5. Federal Geodetic Data Committee spatial data accuracy standards (ASPRS Class II Mapping Accuracy for large scale maps)

Map Accuracies as a Function of Photo/Map Scale

Map Scale 1"= -ft	Photo Scale 1"= -ft	Min Contour Interval, ft	Accuracy XY RMSE ft	Accuracy Z RMSE ft
20	200	0.5	0.4	0.33
40	320	1.0	0.8	0.66
50	400	1.0	1.0	0.66
100	800	2.0	2.0	1.32
200	1600	4.0	4.0	2.64
250	2000	5.0	5.0	3.30
400	3200	8.0	8.0	5.28
500	4000	10.0	10.0	6.60
800	6400	16.0	16.0	10.56
1000	8000	20.0	20.0	13.20
1667	12800	32.0	33.3	21.12

Collect and provide the location and elevation of water and gas components extending more than 3 inches above the surface. These components include items such as water or gas valves, standpipes, meters, regulators, fire hydrants, etc. Locate, classify, and determine the elevation (MSL) of other utility components such as telephone or light poles, manholes, boxes, etc., visible on the airport. Classify these features using the appropriate feature types in the Utility feature group in Chapter 5.

Determine and classify, according to the standards in Chapter 5, the location and dimensions of any existing buildings, tanks, fences, miscellaneous structures, driveways, or other objects on the airport. When required by the appropriate personnel, determine the location, classification (according to Chapter 5) and elevation of swamps; or wetland limits.

2.9.1. Category II and III Operation Area Topographic Survey.

This is a special topographic survey completed to provide specific information for the installation, maintenance and development of instrument procedures for Category II and III operations. The purpose of this area is to define the terrain within the area, which could provide for false radar altimeter readings. The collection of this information meets the requirements of the International Civil Aviation Organization (ICAO), Annex 15 regarding Area 4.

The area of consideration is an area 3000 feet long by 400 feet wide centered on the runway centerline extended (see Figure 2-21). In this area provide only terrain data to the accuracy requirements in Table 2-6. Classify the terrain using the Contour feature type in Chapter 5.

Table 2-6. Cat II and III Operation Area Accuracy Requirements

Area Attributes	Accuracy Requirement
Horizontal Accuracy	4.0 ft.
Vertical Accuracy	2.6 ft.
Vertical Resolution	0.1 ft.
Confidence Level	95%
Post Spacing	0.3 arc seconds (approximately 30 feet)

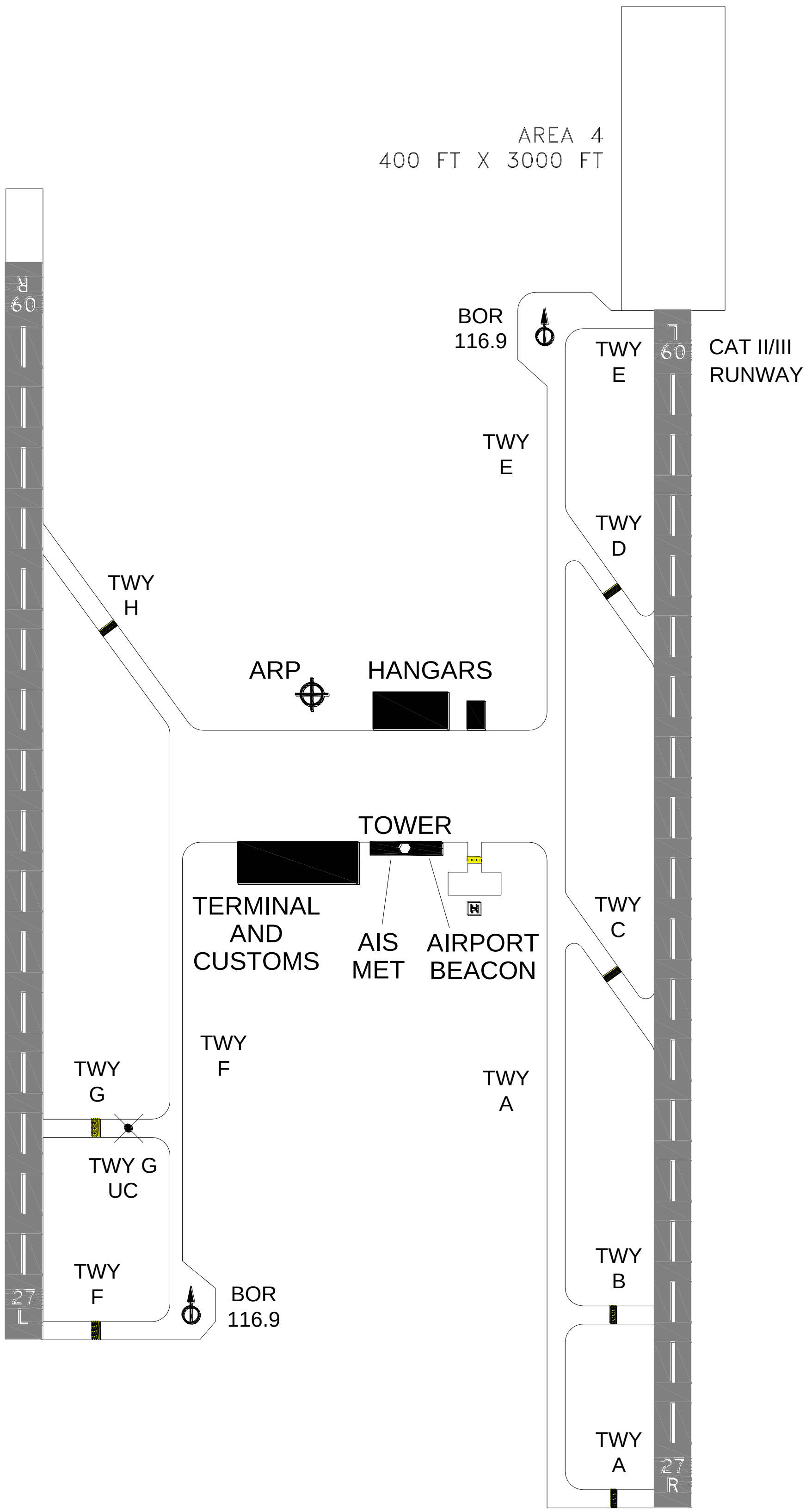


Figure 2-21. Terrain data collection surface – Area 4.

2.10. AIRPORT MAPPING DATABASE SURVEYS

Traditionally, pilots have relied on visual aids such as airfield markings (e.g. painted centerlines), signs and lighting in conjunction with a paper chart (see Figure 2-22) of the airport to navigate from point to point on the surface. Through radio communications, air traffic control (ATC) provides directions to pilots on the route to follow while on the surface. As a rule, the ground controller will issue route instructions to pilots using explicit instructions and strict protocol (phraseology) so that there is no misunderstanding. These instructions are sometimes very complex requiring the pilot to memorize it, write it down and repeat it to ATC to ensure comprehension. The pilot then needs to follow those instructions (typically without further assistance from ATC) following the surface markings and signs (see Figure 2-23) to the destination while avoiding other surface traffic (airplanes or on-airport vehicles).

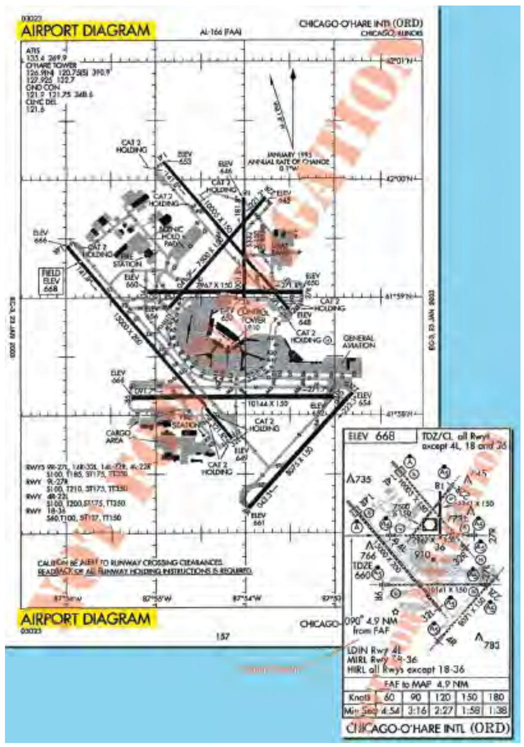


Figure 2-22. Paper chart.

Figure 2-23. The development of highly accurate digital representations of the airport environment will enhance the operational safety systems at the airport.

In extremely adverse weather, aircraft follow a designated route to ensure they avoid other traffic. The airport information used for airport mapping databases consists of airport features and associated information in the form of geometry, attribute, and attribute coding. This information is linked to data via a relational database schema or equivalent method. This information, when combined with other airport features such as the runways, taxiways, parking areas etc., forms a digital map of the airport for display in the aircraft flight deck.

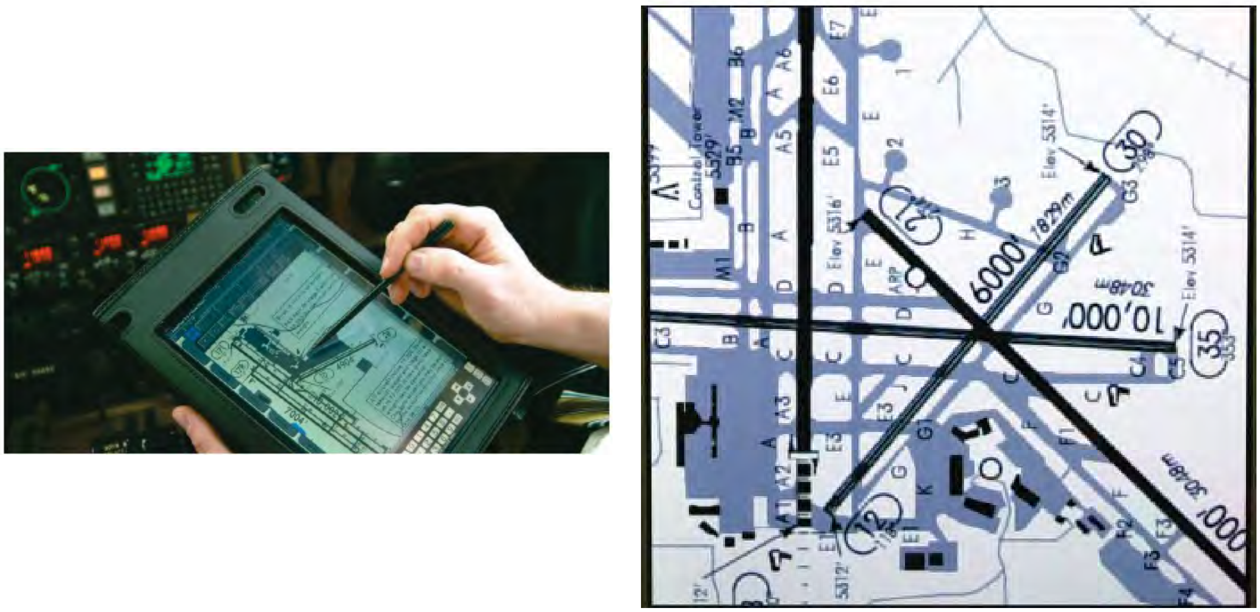


Figure 2-24. Highly accurate digital representations of the airport environment.

There are two areas of consideration: the collection and classification of vertical objects and the collection and classification of the movement area markings.

Collect and classify all runway markings using the feature marking line or marking area in Chapter 5. Delineate each feature further using the attribute enumerations for Color and Marking feature type.

Collect and classify all vertical objects exceeding 1.5 feet above the nearest movement area surface within 165 feet of the edge of the movement area, excluding the runways. For all runways, analyze, identify, classify (according to the features in Chapter 5) and report all vertical objects exceeding 1.5 feet above the elevation of the nearest runway surface surrounding the runway. The lateral area of consideration begins at the edge of the runway and extends until it is 300 feet from the centerline.

Use the greater of the accuracy defined in this specification for a feature (Chapter 5) or a horizontal and vertical accuracy of 1.5 feet with a resolution 0.25 feet. The confidence level of the data collected in this survey type is 95%. The collection of data under this section meets the requirements of the International Civil Aviation Organization (ICAO), Annex 15 requirements for Area 3.

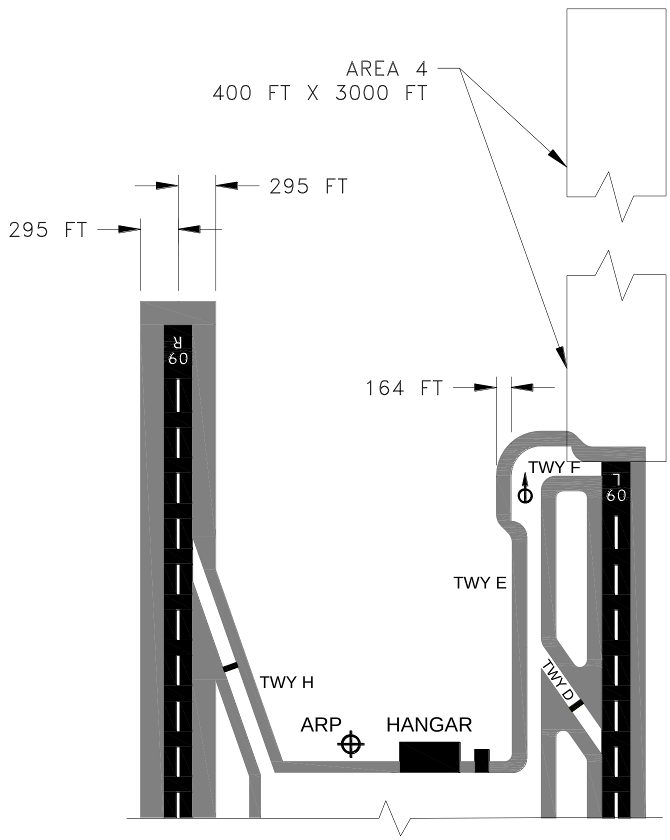


Figure 2-25. Areas of collection for vertical objects surrounding the movement areas.

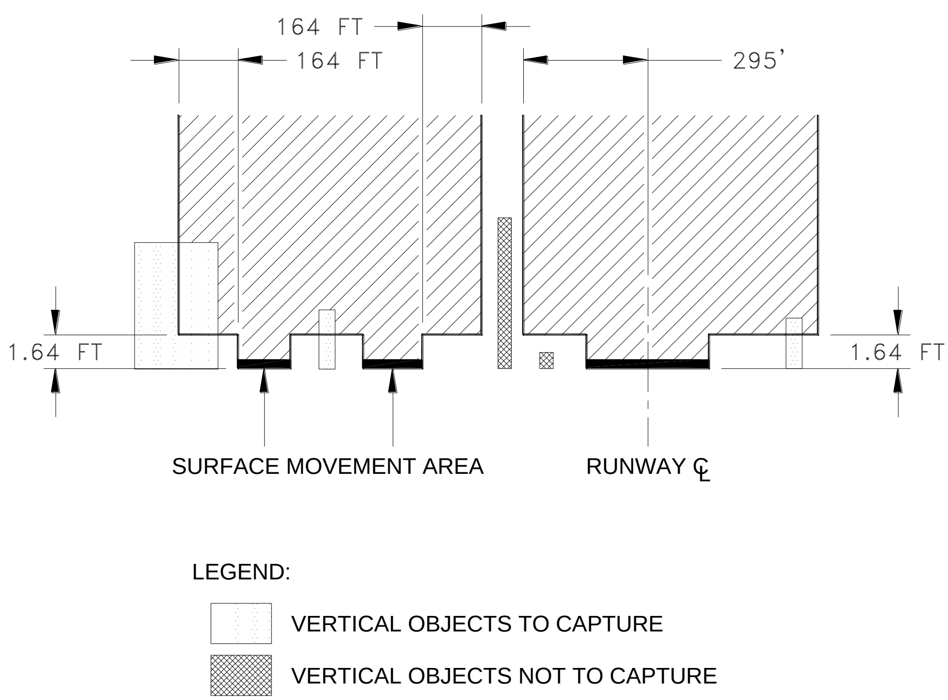


Figure 2-26. Airport Mapping Database Collection of Vertical objects meeting the requirements of ICAO Area 3.

2.11. ENGINEERING (CONSTRUCTION) SURVEYS

The typical engineering surveys encountered for an airport relate to the planning and construction of runways and taxiways. Tie all Airport Operating Area (AOA) planning and construction to the NSRS through inclusion of the PACS and SACS located on the airport. When used, engineering grids or coordinate systems must include these monuments as part of the survey control scheme. This tie to the NSRS ensures the relative connection of all AOA features to the entire NAS. In planning for or proceeding with construction on the airport, especially airside, it is essential to survey and document each element of construction according to the standards in this AC. This ensures that the airport authority and the FAA have the information regarding the construction to make the appropriate operational and safety decisions required. Through appropriate identification and classification of the proposed construction area and activities, the airport and the FAA can ensure the continuity of service and safety of operations during construction. This feature classification and identification ensures the data concerning the construction activity is available for other FAA offices to begin or plan their work such as Non-RuleMaking Airport (NRA) studies, navigational aid relocation, or flight procedure revision or establishment. For further information regarding safety during construction on airports refer to AC 150/5370-2, *Operational Safety During Construction on Airports*.

Engineering Surveys are those surveys associated with the engineering design (topographic, layout and as-built) and often require geodetic computations beyond normal civil engineering practices. AOA construction activities generally require two types of survey activities design and construction. Design data surveys require collecting the data needed for the planning and design of a project. In most cases, this involves a simple topographic survey but may require more detailed surveys especially when environmental considerations must be accounted for in the design. Construction surveys are typically further divided into layout, stake-out or As-Built surveys. Most airports require a record (drawings) of all construction projects at the airport. Layout or stake-out surveys are the translation of construction plans into physical points on the ground used as a basis for the actual construction. As-Built surveys include making measurements to verify or identify the location and dimensions of structures or objects.

The following is a checklist of features required on a typical As-Built survey. Define each of these elements according to the features in this guidance.

- The identification of the boundary lines of the project tract using the features in the Man Made Structures group.
- Show lines of original lot boundaries using features from the Cadastral group.
- The collection of all existing roads, alleys and easements with their widths and platted using the features in the Surface Transportation group.
- The collection of sufficient spot elevations defining the surface drainage on the project site and within 50 feet outside the boundary using the features of the Geotechnical group.
- Identification of control Benchmark(s) through use of Geotechnical group features.
- Locate and classify all visible evidence of utilities and storm water drainage features on or within 50 feet of the project boundary to include water lines, valves, backflow devices, meters and fire hydrants. This information uses features from the Utilities group.
- Sanitary sewer, manholes with invert and top elevation, pipe sizes through manholes with direction of flow indicated. Irrigation lines, catch basins, storm sewer pipes, junction boxes with

inverts, type of inlet, pipe sizes, pipe types and direction of flow. Swales, curbs, gutters with spot elevations and direction of flow can all be modeled with features from the Utilities group.

- Sidewalk, street parking, loading areas, driveway width(s) along with the edge(s) of existing paved areas using the SurfaceTransportation feature group.
- Power poles, guy wires, overhead power lines are classified using the Utilities features group.
- Trees, tree groupings and shrubs using the Environmental feature.
- Model existing building structures, fences or walls on site and within 50 feet of the property line using features within the Man Made Structures group.
- Show existing contours on 0.50 foot intervals if existing site elevations vary by greater than 1.5 feet using features from the Geotechnical group.
- Existing natural features such as high points, water courses, depressions, ponds, marshes, swamps, wooded areas and flood elevations (if available) are modeled using the features in the Environmental group.
- Location of any protected species habitat or environmentally sensitive lands or vegetation, as well as any known historical or archaeological resources using the Environmental and Man Made Structures feature groups.

2.12. AIRPORT PAVEMENTS

2.12.1. Construction/Roughness

Complete a pavement evaluation survey to determine airport pavement condition indexing through visual surveys of paved surfaces using the Pavement Condition Index (PCI) method of quantifying pavement condition. These pavement evaluations will include porous friction courses and plain or reinforced jointed Portland cement concrete pavements.

Most airports use the ASTM D5340 Standard Test Method for Airport Pavement Condition Index Surveys developed by the US Army Corps of Engineers through the funding provided by the US Air Force and the FAA.

By developing an airport pavement history an airport can predict the rate of deterioration of a runway or taxiway.

2.12.2. Airport Pavement Inventory

Airport pavement inventories are commonly broken into “networks”, “branches” and “sections”. A network is a group of pavements managed together – typically as a budget line item. For example, state aviation agencies manage multiple general aviation (GA) airports.

Consequently, each GA airport is a separate network within the state’s pavement management database. Commercial and military airports often break airside and landside pavements into separate networks. A branch is an area of pavement that shares a common use. For example, a specific runway is defined as a branch.

A “Section” is defined as a pavement area within a branch sharing similar structural characteristics and loading conditions. Of equal importance, however, is the fact that a section can be considered a management unit – meaning that condition analysis and work planning is performed at the section level and then rolled-up to the branch and network levels. There is often a one to one relationship between facilities and sections at GA airports. Commercial and military airports typically have multiple sections within a branch due primarily to the size of the facilities and the growth that occurs at larger airports which results in section extensions and structural improvements.

Using “user-defined-fields” available in most pavement management software at the network, branch, and section levels of the hierarchy an airport can further subdivide their pavement network. This capability can allow a state aviation department to store the county road network for an airport at the network level using county road standards and to store data on funding sources for pavement work at the section level. Additionally, new branch uses and pavement surface types can be defined as required. Assign new branch uses as either airside or landside, and define new surface types as either asphalt or concrete. These definitions are necessary for determining which PCI standard and set of distresses to use with the new surface type.

Enter information about pavement condition into the pavement management software as linear station offsets of the runway or feature collected with an offset left or right to give a field location of the pavement issue being measured and reported. Rotate the linear stations and offsets with the runway and convert to the correct NAD83 survey adjusted coordinates.

For further information on PCI, refer to the following Airport Circulars:

- AC 150/5380-6, *Guidelines and Procedures for Maintenance of Airport Pavements*, provides FAA recommended guidelines and procedures for maintenance of rigid and flexible airport pavements. **NOTE**: *AC is not available on-line, but may be purchased from Superintendent of Documents.*

- AC 150/5380-7, *Pavement Management System*, presents concepts of a Pavement Management System, discusses the essential components of such a system, and outlines how to use it in making cost-effective decisions regarding pavement maintenance and rehabilitation.

2.13. SUB-SURFACE UTILITIES ENGINEERING (SUE)

Perform sub-surface utility engineering (SUE) surveys to:

- reduce conflicts with utilities;

- reduce delays in construction schedules because of unforeseen conflicts with utilities that have been eliminated;

- and added construction costs because of unexpected utility adjustments that are no longer needed.

Additionally, fewer contractor claims based on utility delays can be anticipated and the chance of severing a utility line can be greatly reduced, therefore increasing the safety level.

The strength of the geodetic control has a direct bearing on the quality of the mapping and utility surveys, which may require additional supplemental control stations in strategic locations. Reference all SUE work to the PACS and SACS established at the airport.

Reference the datum for X and Y coordinates to NAD 1983 for the airport. Record the datum for Z values in NAVD 88 datum with US Survey Feet being the unit of measure.

Although considerable time and effort goes into a utility investigation and mapping project, the locations of some utility lines can be somewhat obscure. This is due to the lack of clear source information and/or surface features. In many cases, the surveyor must make professional judgments regarding the validity and location of the utility alignments. As a result, some of these vagaries can impede the development of new projects for the improvement or expansion of the airport.

The American Society of Civil Engineers (ASCE) developed standard guidelines for the collection and depiction of existing subsurface utility information, *Standard Guidelines for the Collection and Depiction of Existing Subsurface Utility Data (ASCE/C-I 38-02),* by the civil engineering profession, the FHWA, ASCE, AGC, and other national organizations.

The guideline breaks down utility collection into four separate levels of confidence. The initial field collection and mapping for most airports is Quality Level (QL) D. These four separate levels of confidence are as follows:

- **Quality Level "D" - Existing Records**: Results from review of available records. It gives overall "feel" for congestion of utilities, but is highly limited in terms of comprehensiveness and accuracy. For projects where route selection is an option, this Quality Level is useful when combined with cost estimates for utility relocations following applicable "clear zone" and other accommodation policies.

- **Quality Level "C" - Surface Visible Feature Survey**: QL "D" information for existing records is augmented using surface visible feature survey and digitizing data into Computer-Aided Drafting and Design (CADD) drawings. The danger here is that much of the data is "digitized fiction." There may be as much as a 15-30% error and omission rate in QL "C" information.

- **Quality Level "B" - Designating**: Two-dimensional horizontal mapping. Obtain this information through surface geophysical methods. It is highly useful for design basis information for conceptual design and for proceeding prudently to QL "A". Do not use this level for design basis vertical information or where exacting horizontal tolerances are expected.

- **Quality Level "A" - Locating**: Three-dimensional horizontal and vertical mapping. Collect this information through vacuum excavation of test holes at points of conflict. This is the highest level of accuracy of subsurface utility engineering data. It provides horizontal and vertical design basis information for engineering, construction, maintenance, remediation, condition assessment, and related efforts.

Put forth a concerted effort with maintenance personnel, engineers, planners, and GIS personnel to determine what features and attributes to collect in the field. It is more efficient to spend the time planning before entering the field to decide what data is needed. Data collection efforts can be costly and time consuming if it becomes necessary to survey features twice because of an overlooked, undetermined, or deemed unimportant attribute.

2.13.1. Utility Research

Prior to beginning the designation work, the contractor should contact the utility owners known to be within the project limits. Gather this information from a multitude of utility agencies including, the Airport representatives operating and maintaining facilities within the airport grounds, other utility owners, the one-call lists of utilities and past project contact lists. The contractor should ask for all record information within the project limits and specifically ask to speak to the engineering/planning departments to identify utility projects completed but not depicted in the utility owners' records section. Prepare a utility record log, and maintain records for future reference. Review the record information for the following:

- Material type joining procedures that will influence equipment selection.
- Amount of utilities to be expected, which will influence number and phasing of personnel assigned to the project.
- Local geology/soil conditions if data is available, which may influence equipment selection.
- Number and type of access points, such as manholes, etc., which will influence safety procedures.
- Expected depth of utilities, which will influence equipment selection.
- Presence of rebar or other paving characteristics, affecting the methods/procedures/equipment.

2.13.2. Utility Designation

Once the project control surveys, aerial photography and aerial mapping are completed, the appropriate surface geophysical locating equipment and methods (combined with existing utility records and field observations), the marks that designate the utility on the surface of the ground can be preformed. If the utility changes horizontal direction, but has no physical aperture at that point, every standard of care of the subsurface utility engineering profession will be taken to designate the point at which the utility 'bends' or changes direction.

The temporary utility paint marks on the ground will follow the Utility Location and Coordination Council Uniform Color Codes as shown in Figure 2-27:

	RED – Electric power lines, cables, conduit and Lighting cables
	YELLOW – Gas, Oil, Steam, Petroleum or Gaseous Materials
	ORANGE – Communications, Alarm or Signal lines, cables or conduits
	BLUE – Potable Water
	PURPLE – Reclaimed Water, Irrigation, or Slurry lines
	GREEN – Sewers and Drain lines
	PINK – Temporary Survey Markings

Figure 2-27. Uniform Color Codes.

Divide the airport project area into appropriately sized grids and “sweep” for unknown/non-recorded utilities. Because not all utilities run parallel with, or perpendicular to buildings or hard surfaces such as roadways and sidewalks, sweeping will include multiple equipment orientations. If found, mark these utility locations in pink and recorded as an ‘unknown’ utility line.

2.13.3. Utility Field Collection

While the utility designating is taking place, the survey crew will simultaneously be collecting data for the utility features and the temporary paint marks over the utility line.

2.13.4. Optional SUE Quality Level A Testholes

If the Airport Authority determines specific utilities need additional information such as vertical depths/elevations and condition assessments, complete Quality Level A testhole services. Digitally photograph the testhole sites before and after the testhole operations. For Quality Level A data, provide a certification form in addition to the plotted position of the utility with additional information. This information includes:

- horizontal and vertical location of top and/or bottom of utility referenced to project datum,
- elevation of existing grade over utility at test hole referenced to project datum,
- outside diameter of utility and configuration of non-encased, multi-conduit systems,
- utility structure material composition, when reasonably ascertainable,
- benchmarks and/or project control used to determine elevations,
- paving thickness and type, where applicable,
- general soil type and site conditions, and
- other pertinent information as is reasonably ascertainable from each test hole site.

References to the project datum will maintain vertical tolerances to 0.05' (15mm) based on benchmarks used or established with the base mapping deliverables and horizontal tolerances to applicable surveying standards.

2.14. Boundary Surveying/Land Use

This section discusses the general guidelines for airport Boundary surveys; each state has various regulations and requirements. These guidelines are the basis for all surveys relating to the retracing of property boundaries at an airport. Where local or other prescribed regulations are more restrictive than these rules, the survey will conform to all local and state regulatory standards. When a client desires only a portion of his property surveyed, and this portion can be clearly isolated from the remainder of the property without affecting the interests of adjoining owners, these rules will apply to the survey of only the desired portion.

2.14.1. Research and Investigation.

When the deed description of the subject property and the deed descriptions of adjoining properties do not resolve the unique locations of the corners and lines of the property, identify and consult other sources of information to assemble the best possible written evidence of every corner and line of the property. These sources include, but are not limited to: records of previous surveys, deed descriptions of adjacent properties, records of adjacent highways, railroads and public utility lines; subdivision plats, tax maps, topographic maps, aerial photographs, and other sources as may be appropriate.

After analysis of the necessary written documents, the survey is based on a field investigation of the property. The surveyor will make a thorough search for physical monuments, analyze evidence of occupation and confer with the owner(s) of the property. In addition, the surveyor will, when necessary, confer with the owner(s) of the adjoining property and take statements.

2.14.2. Monumentation.

When necessary, the surveyor will set boundary monuments in accordance with the accepted surveying practice and legal requirements so that, upon completion of the survey, each corner of the property and each referenced control stations will be physically monumented.

When it is impossible or impracticable to set a boundary monument on a corner, the surveyor will set a reference monument, similar in character to the boundary monument and preferably along one of the property lines intersecting at the corner. When a reference monument is used, clearly identify it as a reference monument on the plat of the property and in any new deed description, written for the property.

Every boundary monument and/or reference monument set by the surveyor will, when practicable:

- Be composed of a durable material.
- Have a minimum length of thirty inches.
- Have a minimum cross-section area of material of 0.2 square inches.
- Be identified with a durable marker bearing the surveyor's registration number and/or name or company name.
- Be detectable with conventional instruments for finding ferrous or magnetic objects.

When a case arises due to physical obstructions where a boundary or reference monument cannot be conveniently or practically set in accordance with paragraph (C) of this rule, then alternative monumentation will be established for the particular situation. This alternative monumentation must be durable and identifiable (e.g. chiseled "X" in concrete, drillhole, etc.).

2.14.3. Measurement specifications.

Make all measurements in accordance with the following specifications:

- The surveyor will keep his equipment in such repair and adjustment as to conform to the requirements stipulated by the local State agency code. The specifications, tolerances, and regulations published in the National Bureau of Standards *Handbook 44* will be the specifications, tolerances and regulations for commercial weighing and measuring devices of the state.

- Make every measurement of distance either directly or indirectly so the linear error in the distance between any two points (not necessarily adjacent points) does not exceed the reported distance divided by five thousand (allowable linear error = reported distance ÷ five thousand). Make every angular measurement so the allowable (directional) error, in radians, does not exceed the allowable linear error divided by the reported distance (allowable (directional) error = allowable linear error ÷ reported distance). When the reported distance is less than one hundred feet, the linear error will not exceed 0.02 feet. The reported distance is the distance established by the survey.

- In all new deed descriptions and plats of survey, specify the length and direction of the lines so the mathematical error in closure of the property boundary does not exceed 0.02 feet in latitudes and 0.02 feet in departure.

2.14.4. Plat of survey.

The surveyor will prepare a scale drawing of every survey in which he retraces previously established property lines or establishes new boundaries. The features for this type of survey will be placed on feature types found in the Cadastral feature group.

Provide a copy of this drawing to the client. When required, file a copy with the proper state agency.

As a general guideline, include the following details:

- A title identifying the general location

- Provide a north arrow depicting a clear reference to the basis direction used.

- Identify the control station(s) or line cited in the deed description and the relationship of the property to this control.

- Provide a notation at each corner of the property stating the boundary monument type as found or set. In addition, there will be a statement describing the material, size, position and condition of every monument found or set.

- A general notation describing the evidence of occupation expected along every boundary line and/or occupation line.

- The length and direction of each line as specified in the deed description of the property or as determined in the actual survey if this differs from what is in the deed description by more than the tolerance specified in state regulations.

- A citation of pertinent documents and sources of data used as a basis for carrying out the work.
- The written and graphical scale of the drawing.
- The date of the survey.
- The surveyor's printed name and local state survey registration number, signature and seal (in a form, which may clearly reproduce on any copies, which may be made of the original drawing).

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CHAPTER 3. GEOSPATIAL SPECIFICATIONS AND STANDARDS

Geospatial data collected with remotely sensed or field survey methods consists of airport features such as navigational aids, taxiways, and aprons as well as potential obstacle features and features of landmark value used for general orientation, including shorelines, roads, and railroads. The collection of the features must adhere to cartographic rules to ensure topological integrity. These geospatial data features, when entered into the FAA Airport Surveying–GIS Program database, provide a foundation for GIS analysis and provide content to create various aeronautical charts.

3.1. INTEGRATING GIS AND ENGINEERING DATA

Engineering data, usually in the form of record drawings are the source of most GIS data. The basis for the FAA GIS standards is the National CADD Standards and the Aeronautical Information Conceptual Model (AICM). For a single system to remain compatible with two standards is a daunting task but, with appropriate management of the data, it is possible. The National CADD Standards form part of the Master Specifications used for engineering contract procurement. The AICM defines the modeling and exchange of aeronautical features worldwide. The adoption of these standards allow the uninhibited flow of data from the source or design phase to uploading of information to the FAA. This AC provides the information to connect the CADD data to the GIS elements allowing the data to move in a geospatial data format.

3.2. ADVANTAGES OF DATA COMPLIANCE

Complying with standards provides the airport sponsor or data provider the opportunity to "clean house" and properly classify the data they maintain. These specifications provide the framework for developing and maintaining the data about the airport so it can be shared with the FAA and other users. Complying with these specifications provides the following benefits to the sponsor or data provider:

- Uniform data distribution procedure complying with FAA requirements
- Clear digital distribution methods for airport staff to consistently use
- Flexibility to meet changing expectations and technical requirements of end-users
- Creating documentation and data-quality information for the data sets
- Automate distribution methods to the greatest extent possible so the data can be delivered on demand
- Available "raw" data can be quickly implemented into other projects and used appropriately (i.e. documentation)

3.3. RELATIONSHIP OF GIS FEATURES TO CADD LAYERS

3.3.1. Layering of Feature Types

Each Feature Type in Chapter 5 corresponds to a single GIS layer and one or more CADD layers in this standard. GIS and CADD software superimpose layers on top of one another to form a map or drawing, as shown in Figure 3-1. Because layers are a fundamental element of GIS and CADD software, layers are often associated with tables containing attributes (e.g., width, material type, condition, etc.), metadata (e.g., accuracy, source, date of relevance, etc.), and properties (i.e. color, line type, etc.). To maintain compatibility with both standards, specific drawing and layer naming conventions apply. These are covered, respectively, in more detail in the following sections.

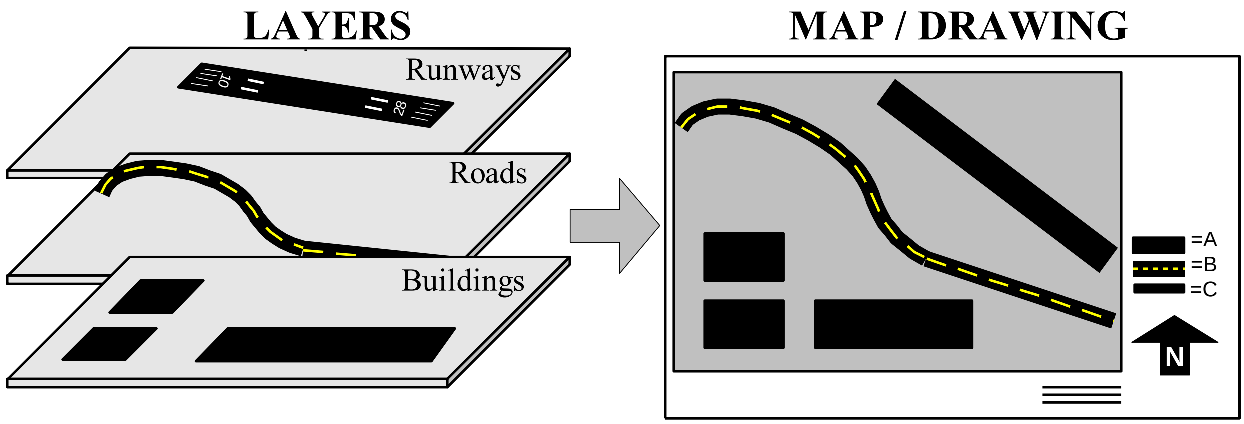

Figure 3-1. Portrays the layering of feature types to form a map or drawing.

3.3.2. Feature Type Layering in GIS Software

GIS software provides a great deal of flexibility when distinguishing, rendering, and annotating different types of features (i.e. feature instances) within a single layer (i.e. feature type) of a map. Because of this flexibility, features having the same properties and attributes but with only minor differences, such as type and status, allows us to group them onto a single layer and display them differently. The result is fewer layers used to represent more real world situations.

3.3.3. Relationship of GIS and CADD Layers

Because we use many more CADD layers to represent the same features represented on far fewer GIS layers, there is a natural many-to-one relationship in the matching of CADD to GIS layers. In order to manage all of the CADD drawings and associated layers effectively, data producers should establish and follow a drawing management hierarchy. This hierarchy should establish each drawing into a cascading flow of data from the overall airport view down to the minutest detail of a feature. At the highest level of the cascading system is the master airport drawing. Name this drawing using the full name of the airport or its ICAO identifier (i.e. KBOS, for Boston Logan International). Referenced into this master drawing are drawings representing each of the major feature groups (Airspace, Airfield, Cadastral, etc.). Referenced inside each of the major feature group drawings are drawings representing each of the airport features. The final level is the individual layers making up each of the feature drawings. Name these layers according to the National CADD layering specifications.

- Master Drawing - named using full airport name, ICAO identifier, or other meaningful method as desired by the airport sponsor.
  - Reference each feature group-drawing file to the master airport drawing.
    - Airfield Feature Group
    - Airspace Feature Group
    - Cadastral Feature Group

- Environmental Feature Group
- Geotechnical Feature Group
- Man Made Structure Feature Group
- Navigational Aids Feature Group
- Seaplane Feature Group
- Security Feature Group
- Surface Transportation Feature Group
- Utilities Feature Group

o Reference each individual feature to its parent group.

The final level of the hierarchy is the naming of the individual layers of each feature drawing. It is important these layer names use the following convention to remain complaint with the National CADD Standards.

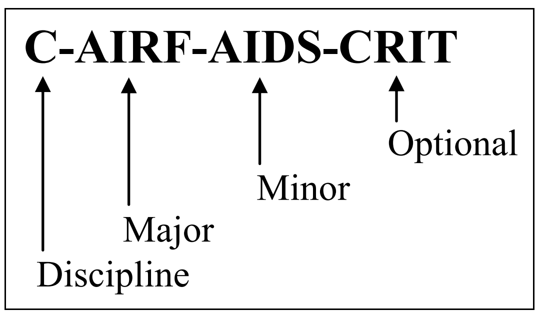

Figure 3-2. Format of CADD Layer Names.

3.3.4. Feature Type Layering in CADD Software

The use of these layers is a means to structure the data defined by this standard in CADD software. Each CADD layer is consistent with the layer name format used in the National CADD Standard, recommended by the American Institute of Architects CAD Layer Guidelines (AIA 2001). Please refer to Chapter 5 for more information about CADD layers associated with the Feature Types defined in this standard.

Assign each CADD layer a name made up of five (5) parts, each separated by a dash (-). The first part of the layer name is a single character indicating the discipline of the data contained on that layer. The disciplines used in this standard and the associated one-character codes are provided in the following list:

A	Architectural
C	Civil
E	Electrical
G	General
H	Hazardous Materials
L	Landscape

M	Mechanical
P	Plumbing
S	Structural
T	Telecommunications
V	Surveying/Mapping

The second part of the layer name is a four-character code for the major group. Major groups in this standard include:

AERI – Aerial Imagery
AIRF – Airfield related features
AIRS – Airspace related features
ANNO – Annotations
APRN – Apron related features
BCNS – Beacons
BLDG – Building related features
BRDG – Bridges
COMM – Communications
FUEL – Fuel related features
GRAD – Grading
GRID – Gridlines
HELI – Heliport/pad
INDW – Industrial Waste
IRRG – Irrigation
LITE – Lighting
OBST – Obstacle related features
OVRN – Overrun
PLNT – Plants
POLE – Pole
PROP – Property
PVMT – pavement
RAIL – Railroad
ROAD – Road
RUNW – Runway
SEAP – Seaplane
SITE – Site
SPCL – Special
SSWR – Sanitary Sewer
STOR – Storage
STRM – Storm
SURV – Survey
TANK – Tank
TAXI – Taxiway or Taxilane
TOPO – Topographic
TRAF – Traffic

The third part of the layer name is a four (4)-character code for the minor group. Minor groupings further distinguish layers, some examples are.

ACPK – Aircraft Parking
AIDS – Navigational Aids
AIRS – Airspace
AXIS – Axis
ANOM – Area Non-movement
AUZN – Auditory Zone
BLST – Blast Pad
BNDY – Boundary
CLRW – Clearway
CNTY – County
DEIC – Deicing
DISP – Displaced Threshold
DIST – Distance
DSRF – Design Surfaces
EDGE – Edge markings
ENDP – Endpoint
ESMT – Easement
FAAR – FAA Region
FENC – Fencing
FLZN – Flood Zone
HAZM – Hazardous Materials
IDEN – Markings
LINE – Line
LNDM – Landmark
LUSE – Land Use
LEAS – Leased
MAJR – Major
MUNI – Municipality
OTLN – Outline
OBSC – Obstruction Identification Surface
OBST – Obstructions
PART – 14 CFR Part 77 Surfaces
PLTS – Plants
PROP – Property
SAFT – Safety Areas
SAMP – Sampling station
SECR – Security
SHLD – Shoulder
SHOR - Shoreline
SIGN – Signs
SPEC – Special
STAT – State
TLOF – Helipad Takeoff and Landing
TOWR – Tower
WETL – Wetland(s)
VEGE – Vegetation
ZONG - Zoning

The fourth part of the layer name is similar to the third but it is optional and used to further distinguish features. An example is the breakdown of COMM for communications, WTHR for weather and ILS_ for instrument landing system navigational aids within the Major group AIRF and the minor group AIDS.

The fifth and last part of the layer name is an optional character established solely by the user, typically indicating the status of the data contained on the layer. Figure 3-2 provides an example of a CADD layer name for a NAVAID critical area.

3.4. GEOMETRIC REQUIREMENTS

3.4.1. Feature Types

These specifications focus on the definition of geographic features required to depict an airport and its surrounding environment. These include features unique to airports, such as runways and taxiways, as well as features of a more general nature such as roads and buildings. Each of these types of geographic features refers to a Feature Type. A specific instance of a Feature Type is referred to as a Feature Instance. For example, Runways is a Feature Type, but Runway 15R/33L at Boston's Logan International Airport is a Feature Instance. For simplicity in data development and transfer, this standard associates a single geometry with each feature type. This standard uses the UpperCamelCase convention in feature type naming.

3.4.2. Geometry

For the purposes of these specifications, points, lines, and polygons describe geometry. Refer to Chapter 5 for specific requirements for each feature type.

3.4.2.1. A "point" is the smallest unit of geometry and has no spatial extent (see Figure 3-3). Describe points in three-dimensional (3D) coordinates. Collect all point feature types except the ARP in 3D coordinates.

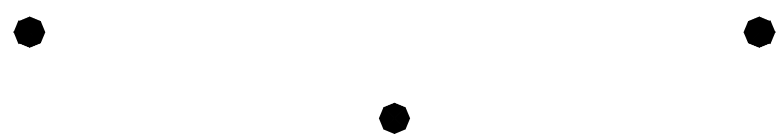

Figure 3-3. Typical depiction of a series of points.

3.4.2.2. A "line" or polyline consists of a connected sequence of points. Start and end points of a line are referred to as start and end nodes (see Figure 3-4). A vertex is the name for the connecting points in between start and end nodes and define the line structure, curvature, or shape. A start-node and an end-node define a line's directionality. A line can only change direction at vertices and only direction in 2D or a single plane. Provide an orthometric elevation for each vertex in a line.

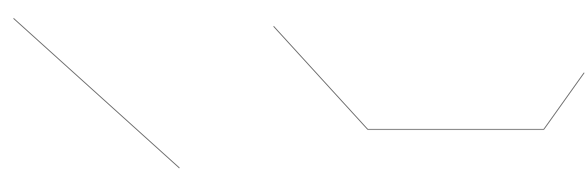

Figure 3-4. Illustrates examples of a line.

3.4.2.3. A "polygon" is a closed figure, or surface, bounded by lines (i.e. a series of lines whose start-node is coincident with another's end-node). These lines form the outer edge of the surfaces (see Figure 3-5). Provide all polygon vertices with 3D coordinates.

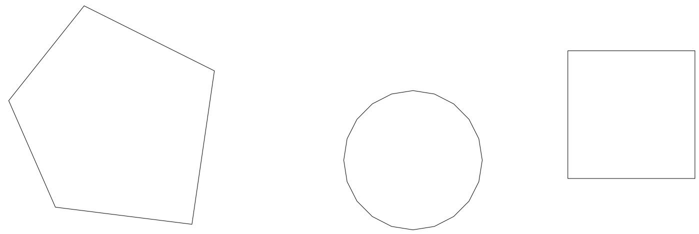

Figure 3-5. Depicts some typical polygon examples.

3.4.2.4. Complex Geometry Types**,** such as arcs, circles, donuts, and ellipses, are not included in this standard. This standard's intended use is to facilitate data exchange between software handling these complex data types differently. If, in a CADD drawing for example, arcs are used, they must first be broken into a line with vertices placed at intervals sufficient to maintain the accuracy requirements described in paragraph 3.4.3.

3.4.3. Topological Integrity

The placement of geometric elements (i.e. feature instances) in correlation to one another (i.e. next to, connected to, and on top of) is referred to as topology. Topology rules establish requirements for the placement of instances of a feature type in relation to one another and in relation to instances of other feature types. Follow these guidelines to ensure topological integrity:

3.4.3.1. Lines:

- Start-nodes and end-nodes of adjacent line segments belonging to a single feature type must be identical (collocated).
- Define the intersections of lines of the same feature type by a vertex/node shared by the intersecting lines.
- Eliminate all unintentional dangles (line segments extending beyond the intended end) and gaps (spaces between line segments intended to connect) between lines.
- Lines should contain one or more line segments with vertices placed at intervals required so the line feature does not stray from the actual feature by more than the half accuracy limit defined in Chapter 5 for the feature type, as shown in Figure 3-7.
- For lines not naturally joined by physical features (e.g., marking lines), place beginning and ending nodes where an attribute or other property change occurs.

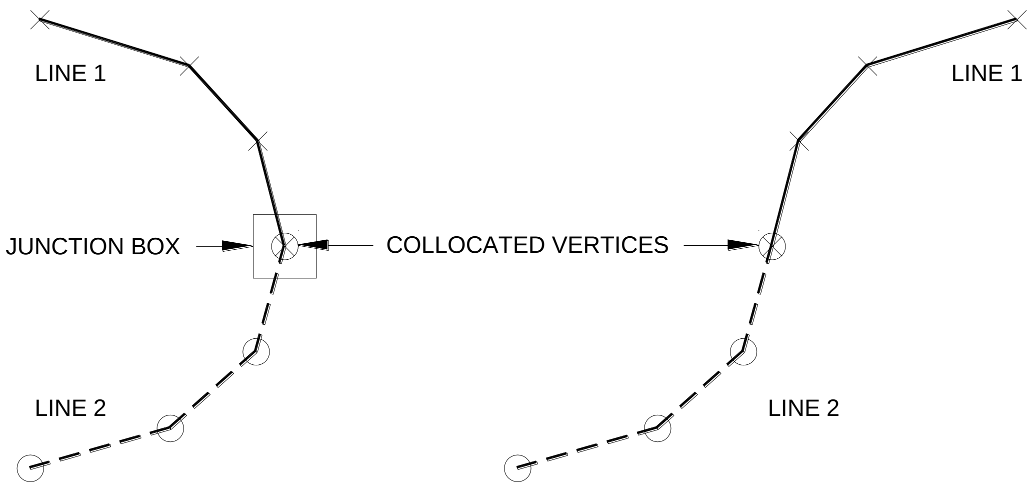

Figure 3-6. Depicts the topology rules for line segments.

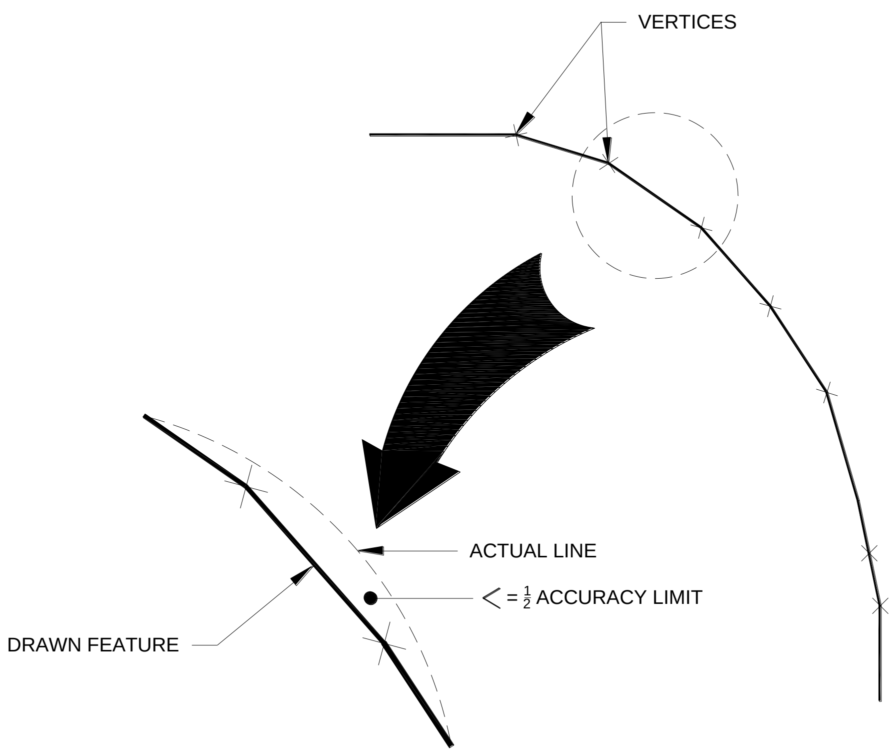

Figure 3-7. Depicting the placement of vertices along a curve.

3.4.3.2. Polygons:

- Geospatial locations of the start-node and end-node of any line forming the edge of a polygon must be identical (coincident) as in Figure 3-8.

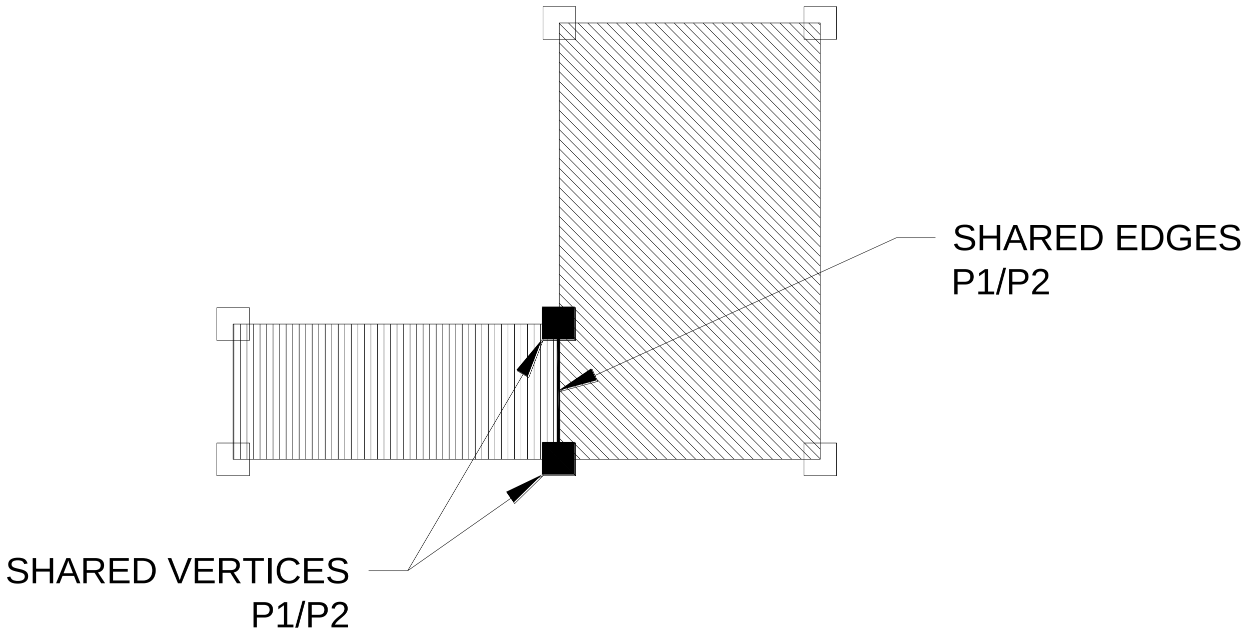

Figure 3-8. Illustrates the shared edges and shared vertices topological rule.

- Polygons sharing an edge (see Figures Figure 3-8 and Figure 3-9) must share all vertices along this edge. This rule applies to features of the same type and for features of different feature types.

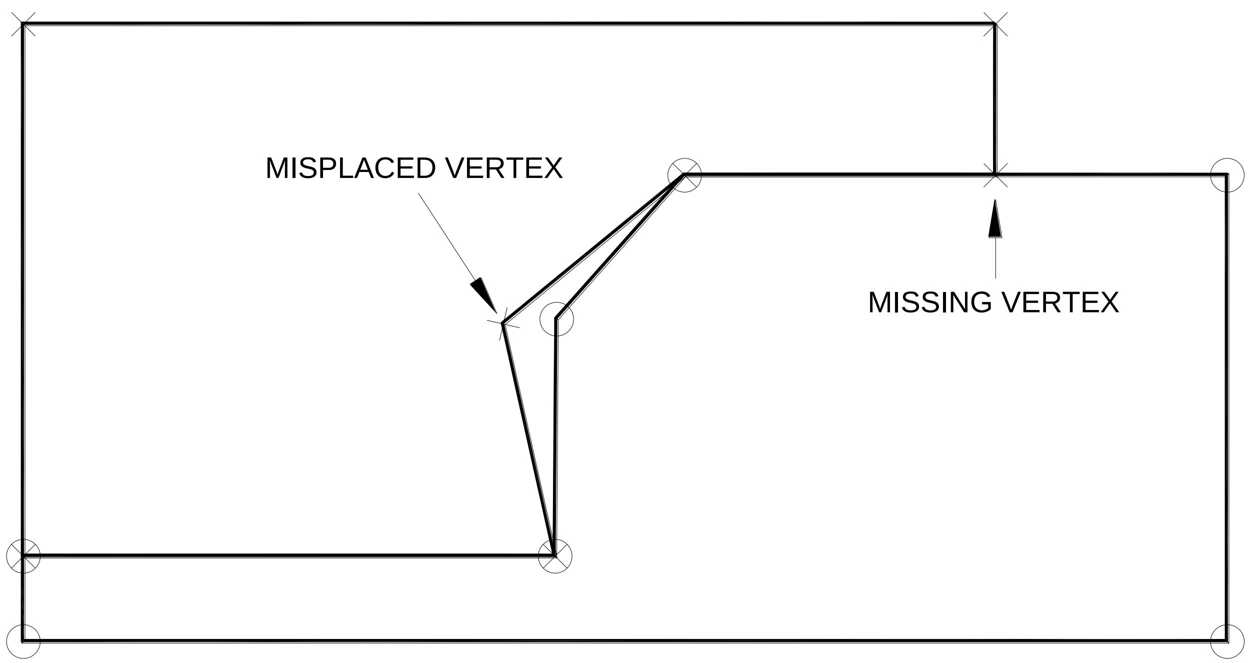

Figure 3-9. Depicts an example of the placement of vertices of adjacent polygons with misplaced vertices.

- No polygon will overlap, intersect or fall within another polygon of the same type (see Figure 3-10), except for the Runway feature type, whose polygons can overlap.

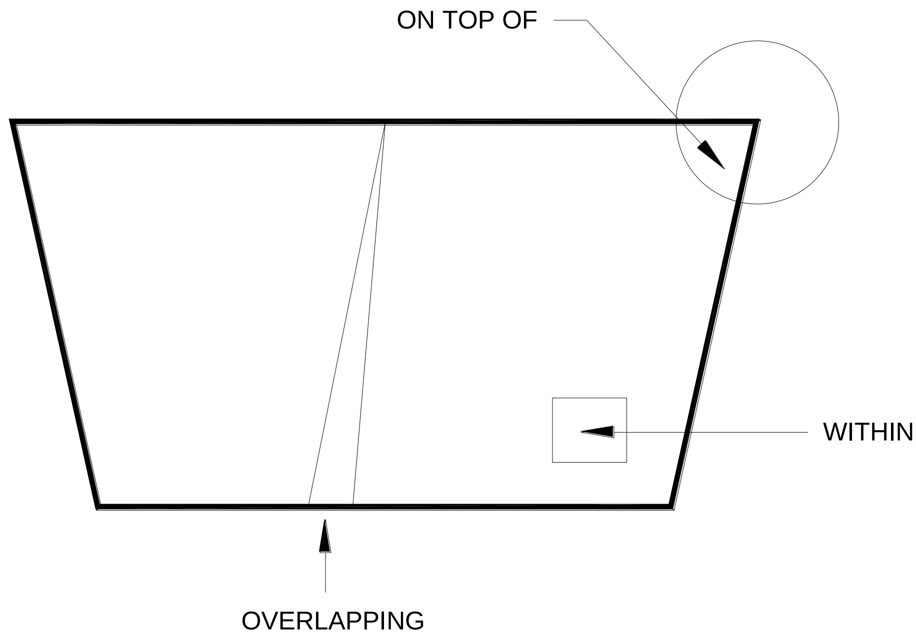

Figure 3-10. Illustrates the topological rule of overlapping polygons of the same feature type.

- Close all polygons (see Figure 3-11). Closed polygons, meaning each pair of adjacent line segments form the edges of the polygon as shown in Figure 3-9, must share all vertices.

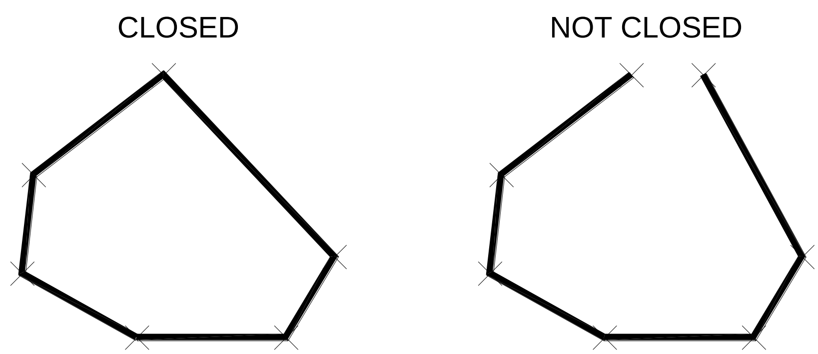

Figure 3-11. Illustrates the difference between closed and unclosed polygons.

3.5. ATTRIBUTES

Attributes add alphanumeric descriptors to the geometry of a feature. Attributes typically contain information such as the name, type, or condition of a feature. For example, the attributes of a runway include its designator (e.g., 15R/33L), material type (e.g., concrete) and length (e.g., 6,500 feet). In this standard attributes are typed in lowerCamelCase letters. Figure 3-12 shows a typical list of attributes associated with a feature type. Airport sponsors should work with the consultants to completely attribute each feature submitted to the FAA.

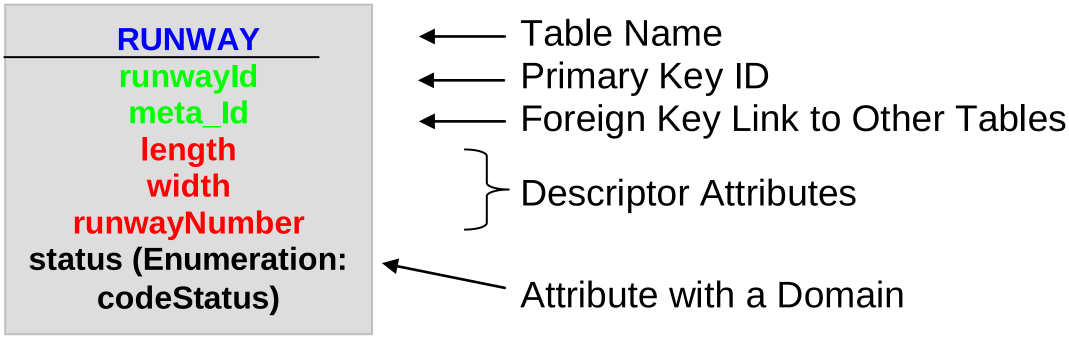

Figure 3-12. Sample Attribute Table for a Feature Type.

3.5.1. Domain Values

Sometimes it is necessary to limit the range of values for an attribute. This AC uses the domain for an attribute to list the acceptable values. Range domains limit the attribute values to a range of numeric or date values. List domains limit values to a selection of choices. A code list allows users to add values to a list of acceptable values and still be compliant with the standard. An enumeration is a list users cannot add to. In this standard, most of the list domains are enumerations. For each such attribute, there is an associated table in Chapter 5 listing the acceptable values and their definitions.

3.5.2. Primary Key Identifiers

Primary keys are unique attributes the system uses to identify each record (i.e. feature instances). Primary key values are globally unique, meaning there is no other record in the FAA Airports GIS system or any other system exchanging data with the FAA Airports GIS system having the same identifier. Maintaining this uniqueness is critical to ensuring long-term data integrity of the system. To help establish uniqueness, a numeric ID containing the FAA region, airport location ID, feature type, date, and a timestamp is used.

This key is is illustrative in nature. These values are assigned by the system and cannot be changed by the user.

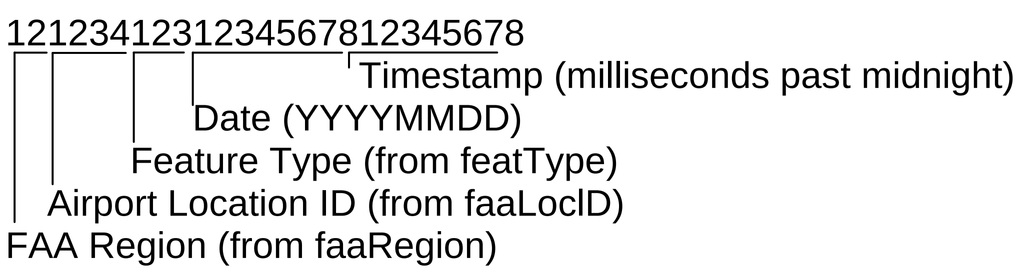

Figure 3-13. Format for globally unique primary keys.

3.5.3. Foreign Key Identifiers

Attributes containing primary key values of related records in other feature type tables are called foreign key identifiers. Foreign key identifiers provide a link between different types of features with logical relationships. For example, a taxiway leading to a runway might carry a foreign key to the runway table populated with the primary key value for that runway.

3.6. METADATA

Metadata is information about the data itself, such as its source, accuracy, and the dates during which it is valid. Metadata values take the form of alphanumeric descriptors of the data and in this way are very similar to attributes. For clarity and because they are stored separately, metadata descriptors are referred to in this standard as metadata elements and not as attributes.

Metadata elements can be applied at various levels of data aggregation. They can describe a collection of data submitted at one time. A collection may comprise one or more drawings containing several layers, such as those making up an Airport Layout Plan; several individual shape files each representing a layer; a single layer stored in a drawing or shape file; or any other combination of allowable data sets. Metadata elements can also describe all geometry and attributes on a given layer or feature type, as is the case with traditional FGDC-compliant metadata. This level of metadata applies if different layers within a collection have different metadata. Next, metadata elements can describe a given feature instance. This level applies when individual features or groups of features within a layer have different metadata. Finally, they can describe the geometry and each attribute of a given feature instance separately.

For this standard, metadata is required at the collection level (see Figure 3-14) when data is submitted. The standard also accommodates metadata elements at the feature type, feature instance, and attribute levels. More detailed metadata increases the usefulness of the data provided. Accordingly, data providers are encouraged to submit metadata at the most detailed level possible.

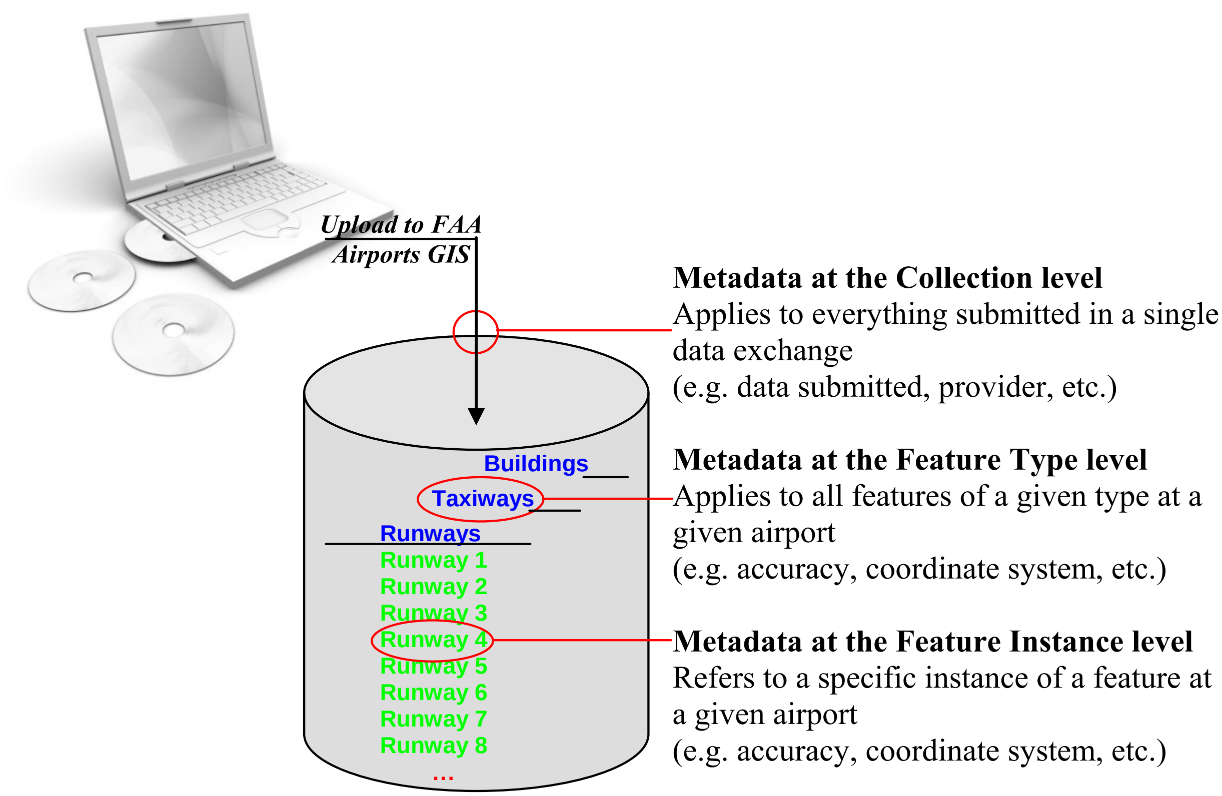

Figure 3-14. MetaData elements have different levels of aggregation.

This standard uses metadata elements defined by International Standards Organization's (ISO) Geographic Information–Metadata Standard (ISO 19115). Of the 409 elements defined in ISO 19115, only 29 are used by this standard because many of the elements defined in ISO are classified as optional or conditional and do not apply to this standard. Furthermore, some of the mandatory elements in the ISO standard are redundant with the specifications of this standard and are therefore not necessary for data exchange. For example, the security classification code is a mandatory ISO element, but since this standard sets the classification code based on the feature type, it is not necessary to convey the security classification code in metadata. Table 3-1 lists each metadata element used in this standard along with the level of applicability. Chapter 5 provides further details about these metadata elements.

Table 3-1. List of MetaData elements

	Collection	**Set**	**Feature**
Overview			
Abstract	X	X	X
Status	X	X	X
GeometricObjectCount	X	X	
Scope			
Dataset	X		
Features	X	X	
Attributes			X
Usage			
SpecificUsage	X	X	X
BegusageDateTime	X	X	X
EndUsageDateTime	X	X	X
Source			
Statement	X		
IndividualName	X		
OrganizationName	X		
PositionName	X		
DeliveryPoint	X		
City	X		
AdministrativeArea	X		
PostalCode	X		
ElectronicMailAddress	X		
VoicePhoneLine	X		
Coordinate System			
Projection	X	X	
HorizontalDatum	X	X	
VerticalDatum	X	X	
Code	X	X	
Data Quality			
HorizontalAccuracy	X	X	X
VerticalAccuracy	X	X	X
EvaluationMethodName	X	X	X
EvaluationMethodDescription	X	X	X
Pass	X	X	X
GroundSampleDistance	X	X	X

3.6.1. Temporal Relevance

One of the most critical metadata elements to the aviation industry is time. With changes in technology, it is possible for data to become outdated. Accordingly, spatial data needs to carry an indication of the time period for which it is valid. An aircraft's location along a flight path might only be valid for a moment, whereas the existence of a runway might be valid from when it was authorized for use until further notice. This standard defines the beginning and ending date and the time for which each feature instance is valid. All features must carry a beginning date (i.e. data is valid until further notice), an ending date (i.e. the data expires at a specified time) or both (i.e. the data is valid only during the period specified). These values are held in the begUsageDateTime and endUsageDateTime defined in Chapter 4. Dates and times should be recorded based on Aeronautical Information Regulation and Control (AIRAC) requirements defined in ICAO Annex 15–Aeronautical Information Services (AIS).

3.6.2. Accuracy

One metadata element particularly important to airport GIS applications is accuracy. "Accuracy" is broadly defined as the quality of nearness to the true value. For the exchange of data as specified in this standard, it is important to be more specific. This standard, therefore, provides limits for the absolute horizontal positional accuracy of each feature type. These limits are described as a maximum number of feet (or metric equivalent) between a feature's actual position and the position indicated in the data provided. The actual position is defined as the feature's true location on the specified datum or ellipsoid. Furthermore, the difference between a feature's true and recorded positions is required at a 95 percent confidence level. This means that statistically, 95 percent or more of the features provided fall within the required accuracy limit.

For some features types, vertical accuracy limits are also provided. These accuracies are expressed as the maximum number of feet a feature's recorded elevation can differ from its actual elevation. Since the earth's surface has many variations, it is approximated by what is referred to as a GEOID, with the actual elevation measured from the GEOID elevation at that location. Elevations are also provided at a 95 percent confidence level.

The driving factor in accuracy requirements relates to how the data is used. The location of an airport on a map used for aircraft navigation must be much more accurate than its location on a national map of airports intended for informational purposes. This standard provides accuracy guidelines for maps used for many airport and aeronautical functions. The accuracy guidelines provided in this standard are derived from several sources and compiled here for standardization. Further information on accuracy definitions and methods to assess the accuracy of existing data can be found in FGDC's Geospatial Positioning Accuracy Standards, Part 3: National Standard for Spatial Data Accuracy (FGDC-STD-007.3-1998).

3.6.3. Security Sensitivity Levels

Another important metadata element is sensitivity level. Because spatial data can be used for nefarious purposes, it is important to protect it from unauthorized users. The Title 49, Code of Federal Regulations, Part 1520, defines Sensitive Security Information (SSI) and how it should be protected. Based on this definition, many forms of spatial data are considered SSI. Protecting sensitive spatial data is therefore not just good practice - it is the law. However, being too protective of data can unnecessarily limit its usefulness. The challenge is to restrict data to users having an operational need to know and whose credentials the data provider has qualified. With spatial data this challenge is particularly complex because there is such a wide variety of data users and ways in which they need to use the data. One of the more efficient ways of restricting access to spatial data is to apply specific restrictions at the feature type level. This standard applies one of the following sensitivity levels to each feature type. These are based on classifications listed in the MD_ClassificationCode list in ISO 19115.

- Unclassified data is available for general disclosure.
- Restricted data is not available for general disclosure.
- Confidential data is available to persons who can be entrusted with the information.
- Secret data is to be kept private, unknown, or hidden from all but a select group of people.
- Top Secret data is of the highest secrecy restricting access to only those requiring access to perform their jobs.

Since sensitivity levels are established for each feature type by this standard (see Chapter 5), it is not necessary to carry this information (i.e. a classification code in ISO terminology) in the metadata itself.

3.7. COORDINATE SYSTEMS

With the ability to provide spatial data in a variety of coordinate systems, datums, and units of measure, it is critical these elements are appropriately defined. For the purposes of data exchange, any combination of the following alternatives is acceptable.

3.7.1. Acceptable Coordinate Systems

Submit spatial data in either a latitude/longitude (i.e. unprojected) or a projected grid based coordinate system such as state plane or UTM.

3.7.1.1. Provide latitude/longitude data in decimal degrees with positive latitude values in the Northern hemisphere and negative longitude values in the Western hemisphere.

3.7.1.2. Provide state plane data in U.S. survey feet as defined by any of the accepted U.S. State Plane Coordinate System definitions. It is acceptable to provide data in another unit of measure if required by state law. Data providers should identify this requirement in survey plan.

3.7.2. Acceptable Datum

With regard to spatial data, a datum is a reference to an approximation of the earth's surface or a Datum. Use the following Datums for spatial data submitted in compliance with this standard:

3.7.2.1. All horizontal data must be submitted referenced to the North American Datum of 1983 (NAD83).

3.7.2.2. All vertical data must be referenced to the North American Vertical Datum of 1988 (NAVD88).

CHAPTER 4. DATA TRANSLATION AND USE OF EXISTING DATA

4.1. USE OF EXISTING DATA

Many airports have developed and collected data over the years through different projects or planning efforts. This data exists in many forms from drawings in a CADD system, to individual records in databases or through a hardcopy management system. Since the 1980's the form of the data has evolved from a totally paper-based product to where many airports have some if not all the data available electronically. As the tools and technology changed from linen to Mylar and finally to digital CADD and GIS formats, only a few airports made the effort to ensure the quality of the data set. In some cases, the user performed data transformations from one datum to another without regard to the actual accuracy of the data. With the availability of more digital data and its associated detail, the expectations of those charged with maintaining this information also increased. However, no real effort or process related the data values to the true value and associated data accuracy by tracing the data back to its source. When considering the reuse of this data in a current or future project, the quality of the data is the first and most important factor determining its usability. The International Civil Aviation Organization (ICAO) defines data quality as, "A degree or level of confidence that the data provided meets the requirements of the data user in terms of accuracy, resolution and integrity"[5]. One of the first steps in determining the quality of a data set is determining its origin. What is the data source, and is it traceable to the time and point of collection? If the data is not traceable to the source, then the data provider should implement a defined and repeatable process to determine the spatial accuracy and reliability of the data before the data is used.

Today's aviation system requires us to build and maintain seamless aviation data sets reflecting the real world such as airport mapping databases. To accomplish this we must determine how the current data we have meets that vision. To provide "real world" airport data, it is required that the airport updates and integrates all of their legacy information and has all this information tied to a single consistent data standard and the same horizontal and vertical datums. These datum ties ensure the data accurately connects the different parts of the NAS together forming a seamless integrated system of navigational and airport data.

4.1.1. Maintenance of Data

Adherence to this guidance ensures the data quality remains at an acceptable level. Terrain and obstacle databases require updating to account for uncovered errors as well as to change appropriate data (e.g. due to construction activities or vegetation growth). Make updates to obstacle data as changes occur with sufficient lead-time to ensure the information is available when required to meet the AIRAC cycle amendment schedule. There is no update cycle specification for terrain data. Update terrain databases as required and in accordance with their intended use. Whenever a change affects safety critical data, immediately update it through the Notice to Airmen (NOTAM) process. Provide follow up information through the FAA Airport Surveying–GIS Program.

4.1.2. Data Set Maintenance and Update

The increasing use, sharing and interchange of geographic data sets in dynamic environments require both accuracy and temporal relevance. Airport and aeronautical data changes frequently while the base

[5] International Civil Aviation Organization (ICAO), Annex 15 to the Convention on International Civil Aviation , Aeronautical Information Services, Twelfth Edition, Amendment 33, 24 November 2004

mapping data, such as terrain, changes infrequently. The data provider is responsible for updating the data set at appropriate intervals to ensure its accuracy. The appropriate management of a data set is an indicator of its reliability to meet the requirements for use. The purpose of describing the maintenance and update criteria of airport and aeronautical geographic data is to facilitate the selection of the data set best suited to the needs or requirements. Complete confidence in the maintenance and temporal quality of a data set encourages the sharing, interchange, and use of appropriate geographic databases. Continuous maintenance and timely updates of geographic databases are vital to the aeronautical users of such databases. Three principal conditions typically affect a geographical data set:

1. When any quantity of data is deleted from, modified in, or added to a data set
2. When there is a modification to the data set's specification(s)
3. When the actual geography changes

The first condition, a modification to a data set, may occur quite frequently since many data sets in an existing database are not static. As there is an increase in the interchange of information, there is a corresponding increase in the use of data sets for multiple purposes and the accompanying update and refinement of data sets to meet multiple purposes. If a database is likely to change with modifications to the elements of the encompassed data sets, assess the quality of the overall database and the data updated when changes occur. Using and updating the metadata provides the user with knowledge of the data quality. The only metadata element remaining static is the "usage" element provided as part of the data set creation. There is a reliance on data users to report uses of a database differing from its intended purpose. In these cases, make continual updates to particular data elements to reflect unforeseen uses that occur using the temporality functions of the system. The second condition, updates to this AC, will occur as needed to meet changing requirements based on the actual need. When this type of change occurs, the quality of the current data set also changes. The quality information for a data set should always reflect the current data set given its current product specification. The third condition, a change in the actual geography, occurs continuously. These changes can be caused by natural phenomena such as, movement in the earth's crust or erosion, but are most often a result of human activity. Changes are often very rapid and dramatic. For this reason, the date of data collection is important when judging the quality of a data set. In some cases, when known, even the rate of change is of interest. Throughout this document, the various identified data elements represent the minimum necessary for the development and interchange of accurate geographical airport and aeronautical information used for aeronautical purposes.

The following tables identify the safety critical and non-safety critical features:

Table 4-1. Airport-Related Safety Critical Data

The values published in these tables are the publication resolutions. The data should be collected to one decimal place more than required for publication for use in computations and to eliminate rounding errors in the final value.

Item	Publication Resolution (Unit of Measurement)	Integrity Classification
Airport Control Area (Airspace)	1 arc second in latitude and longitude	1×10^{-5}
NAVAIDs located at the airport/heliport	1/10 arc second in latitude and longitude	1×10^{-5}
Obstacles in the circling area and at the airport/heliport	1/10 arc second in latitude and longitude	1×10^{-5}

Item	Publication Resolution (Unit of Measurement)	Integrity Classification
Significant obstacles in the approach and departure area	1/10 arc second in latitude and longitude	1×10^{-5}
Runway threshold	1/100 arc second in latitude and longitude	1×10^{-8}
Runway end (flight path alignment point)	1/100 arc second in latitude and longitude	1×10^{-8}
Taxiway center line points	1/100 arc second in latitude and longitude	1×10^{-5}
Geometric center of a Touchdown Lift Off Area (TLOF) or the Final Approach and Takeoff Area (FATO) thresholds, heliports	1/100 arc second in latitude and longitude	1×10^{-8}
Airport/heliport elevation	1 ft (0.3 m)	1×10^{-5}
NAD-83 geoid undulation at airport/heliport elevation position	1 ft (0.3 m)	1×10^{-5}
Runway or FATO threshold elevation, non-precision runway	1 ft (0.3 m)	1×10^{-5}
NAD-83 geoid undulation at runway or FATO threshold, TLOF geometric center, non-precision runway	1 ft (0.3 m)	1×10^{-5}
Runway or FATO threshold elevation, precision runway	0.1 ft. (0.03 m)	1×10^{-8}
NAD-83 geoid undulation at runway or FATO threshold, TLOF geometric center, precision runway	0.1 ft. (0.03 m)	1×10^{-8}
Threshold crossing height, precision runway	0.1 ft. (0.03 m)	1×10^{-8}
Obstacles in the approach and departure areas	3 ft (1 m)	1×10^{-5}
Obstacles in the circling areas and at the airport	3 ft (1 m)	1×10^{-5}
Distance measuring equipment associated with a NAVAID providing precision approach guidance (DME/P)	1/100 arc second in latitude and longitude	1×10^{-5}
Distance Measuring Equipment (DME) associated with a NAVAID providing non-precision approach guidance	1/100 arc second in latitude and longitude	1×10^{-5}
VHF (Very High Frequency) Omni-directional Radio-range (VOR) Checkpoint alignment	±1 degree	1×10^{-5}
Airport/heliport magnetic variation	±1 degree	1×10^{-5}
Instrument Landing System (ILS) localizer antenna magnetic variation	±1 degree	1×10^{-5}
Microwave Landing System (MLS) azimuth antenna magnetic variation	±1 degree	1×10^{-5}
ILS localizer azimuth	1/100 degree (referenced to True North)	1×10^{-5}

Item	Publication Resolution (Unit of Measurement)	Integrity Classification
MLS zero azimuth alignment	1/100 degree (referenced to True North)	1×10^{-5}
Runway and FATO length, TLOF dimensions	1 ft (0.3 m)	1×10^{-8}
Stopway length	1 ft (0.3 m)	1×10^{-8}
Landing distance available	1 ft (0.3 m)	1×10^{-8}
ILS markers-threshold distance	10 ft (3.0 m)	1×10^{-5}
ILS DME antenna-threshold, distance along centerline	10 ft (3.0 m)	1×10^{-5}
MLS DME/P antenna-threshold, distance along centerline	10 ft (3.0 m)	1×10^{-5}
Touchdown Zone Elevation	1 ft (0.3 m)	1×10^{-8}
Displaced threshold data	1 ft (0.3 m)	1×10^{-8}

Table 4-2. Airport-Related Non-Safety Critical Data

The values published in these tables are the publication resolutions. The data should be collected to one decimal place more than required for publication for use in computations and to eliminate rounding errors in the final value.

Item	Publication Resolution (Unit of Measurement)	Integrity Classification
Obstacles outside Circling, Approach, Departure areas	1 arc second in latitude and longitude	1×10^{-3}
Obstacles outside Circling, Approach, Departure areas	10 ft (3 m)	1×10^{-3}
Airport/heliport reference point	1 arc second in latitude and longitude	1×10^{-3}
Aircraft parking positions (stand points) or Inertial Navigation System (INS) checkpoints	1/100 arc second in latitude and longitude	1×10^{-3}
Non-Directional Beacon (NDB) NAVAID magnetic variation	±1 degree	1×10^{-3}
Runway and FATO bearing	1/100 degree (referenced to True North)	1×10^{-3}
ILS localizer antenna-runway end, distance	1ft. (0.3 m)	1×10^{-3}
ILS glide slope antenna-threshold, distance along centerline	1ft. (0.3 m)	1×10^{-3}
MLS azimuth antenna-runway end, distance	10 ft (3.0 m)	1×10^{-3}
MLS elevation antenna-threshold, distance along centerline	10 ft (3.0 m)	1×10^{-3}

4.1.3. Establishing a Common Data Reference Framework

Establishing a common reference framework is the process of making sure the information (data) about the airport truly represents the airport as it is built. In other words, is it current and accurate? One of the most important tasks associated with integrating existing data and newly collected data is to reference all the data to the same horizontal and vertical datum.

If an overlay of information, depicting runway ends, is in relation to an accurate base map of some known standard (such as NAD27, State Plane), the conversion to the NSRS reference framework using commercially available coordinate conversion tools is a relatively straightforward process. A more difficult situation arises when an overlay map is drawn in relation to an inaccurate base map. When these data sources are merged and updated to a new standard and/or overlaid with a new base map or a rectified orthophotography, the errors and distortions should be obvious.

From field verification of various points around the airport, a comparison can be done to the same measured points in your CADD or base-mapping file to verify the positional accuracy as defined for each feature in Chapter 5. The choice of field measured points must coincide with known points in the CADD files and the known points on the orthophotographs. The choice of where the field verifications points should be taken represent a fairly even distribution of points around and across the airport property.

By comparing the field measured values to the CADD and orthophotography values, a determination of whether the data falls inside the acceptable accuracy for the features can be determined. All data to be submitted must meet the accuracies for the appropriate feature; otherwise additional transformation steps may be required.

The number of required field verification points is dependent on the size and complexity (volume of air traffic) of each airport, and is further described in Table 4-3.

Table 4-3. Required Field Validation Points based on Annual Aircraft Operations and Airport Area

Acres	Operations per year								
	<10,000	<25,000	<50,000	<100,000	<200,000	<300,000	<500,000	<750,000	>750,000
<2,500	20	20	20	40	80	80	80	80	80
<5,000	20	20	40	80	120	120	120	120	120
<7,500	20	40	80	120	120	120	120	150	150
<10,000	40	80	120	120	150	150	180	180	180
<12,500	40	80	120	150	150	180	200	200	200
<15,000	40	80	120	150	180	180	200	200	200
>15,000	40	80	120	150	180	200	200	200	200

Using Table 4-4 in conjunction with the acreage and operations information available within an airport's 5010 form, intersect the columns and rows to establish the number of field verification points (see Table 4-4) required to quality control the legacy datasets for an airport.

Table 4-4. Examples of Field Verification Points required of various airports

Sample Airport	Operations per year	Acres	Value From Chart	Sample Airport	Operations per year in 1,000's	Acres	Value From Chart
1	211,000	830	80	**9**	340,000	2500	80
2	121,000	4200	120	**10**	83,000	700	40
3	980,000	4700	120	**11**	651,000	3500	80
4	699,000	18,076	200	**12**	139,000	2800	5
5	71,000	2000	40	**13**	411,000	5200	120
6	972,000	7280	180	**14**	405,000	680	120
7	384,000	3300	120	**15**	409,000	2384	80
8	310,000	1380	120	**16**	352,000	5207	20

If the field verification process reveals a distortion in the base mapping, further analyze the data and the base map. As airports enter data into the system, they become the first level of independent verification and validation. The airports assume this role by offering the data they use to manage the airport into the aeronautical information "public domain" as source data. Regardless of the eventual use of the data, integrating new data with existing data requires the data provider (airport) to validate the usability of the combined data prior to using it for their own purposes. The data provider uses the combined and validated data to update the official aeronautical data sources at the State or FAA.

From reviewing similar types of features, an analysis of the errors can show when there are systematic errors that can be corrected or random errors that require data be verified or recollected to meet the accuracies required in Chapter 5.

In the sample plot (see Figure 4-1), above the circle is the field verified location with the direction of the arrows indicating the direction and magnitude of the error associated with features in either the vector file (red arrow) or orthophotography file (green arrow).

Arrows indicating the same direction and magnitude of error indicate a systematic type error which can be corrected using various transformation techniques. Arrows pointing in multiple directions and having multiple magnitudes indicate random type errors that are more difficult and perhaps even impossible to correct. Additional field checks may be required at this point in order to further isolate the error source(s) in the legacy datasets.

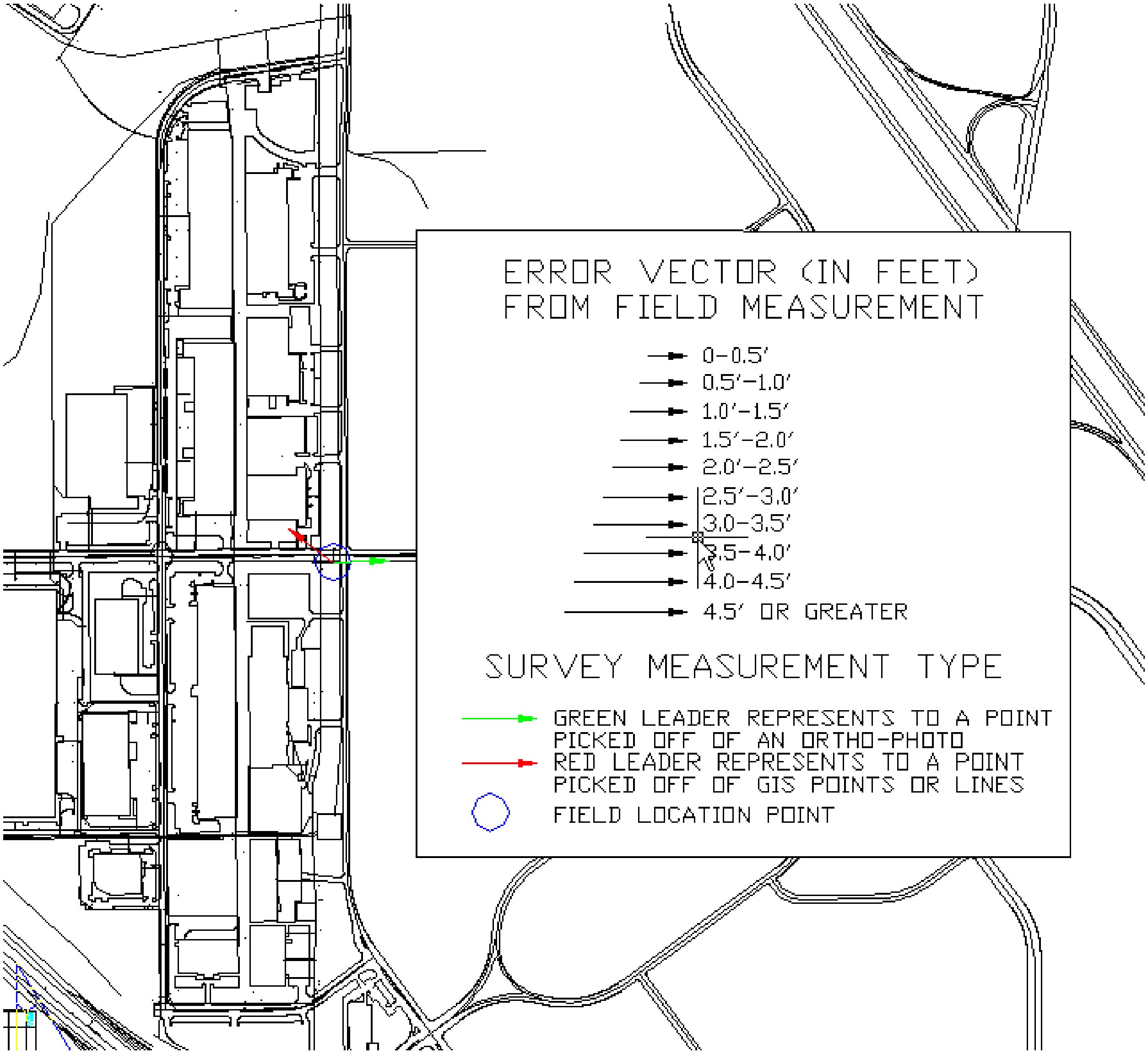

Figure 4-1. Sample Plot showing ranges of Error for Vector and Ortho-photography Mapping to field Verified Position.

4.1.4. Data Distortion Handling Strategy

Existing or legacy data regardless of the source, typically suffers from the following conditions:

- Shifts and translations occur when the data is in the correct relationship to one another, but this relationship is not maintained when compared against newer or more accurate sources or against a new reference framework (i.e. NAD27 vs. NAD83). Correct shifts and translations by field verifying a select group of points of the shifted and rotated data and moving to its true location.
- Linear Shifts or Stretching occurs when the data distorts in a single direction producing long or short data when compared to a higher accuracy source. To correct these errors use field verified points matched to the CADD data and processed to readjust the base mapping to fit the existing true positions.

- Multiple directional shifts occur when at least three validation coordinate pairs are located in close proximity but misplaced in very different directions. This kind of distortion is hard to repair, and may not allow the data to meet data accuracies required for data submission. Each data element identified in Chapter 5 has minimum data accuracies; the accuracy for each element in a data set must meet these minimum required accuracies prior to submission to the FAA.

When the quality of the source data is suspect, the data producer should apply one or more of the following strategies for handling the distortion error prior to submitting the data to the FAA.

- Convert the faulty data if error falls within allowable accuracies for the feature as stated in Chapter 5.
- Drop the faulty data when not required for submission to the FAA.
- Fix the source data and re-compare to field verified points.

Although working with legacy data (particularly converting it to meet new standards or specifications), can be a difficult and time-consuming task, dividing the problem into each individual data type usually makes the task more manageable. Working through data-oriented efforts in an iterative and incremental process is recommended.

4.1.5. Legacy Data Elements Standards Compliance

The FAA developed and provided to industry a Data Migration Tool (DMT) to assist in converting legacy data to the FAA standards. The DMT helps identify compliant and non-compliant data elements and aids in the changing of layer names from airport specific to FAA compliant names for submission to the FAA Airport Surveying–GIS System. Data submitted to the FAA Airport Surveying–GIS Program is a generalized or rolled up aggregation of features used at an airport. Additionally, by tying each drawing and its associated elements to a common coordinate reference frame (the NSRS, using the airport PACS and SACS) the data's accuracy is maintained relative to the entire NAS.

To submit data to the FAA, organize your CADD layers into drawings that represent themes (i.e. a drawing containing all the man made data where the drawing name would be 'ManmadeStructures.dwg' or .dgn). Inside each of the drawings would be the layer names as outlined in the National CADD Standard and AIA standard and the features have the correct attribute data attached using products such as Autodesk's Map™ or Civil 3D™ software. Files organized by theme and National CADD standards with attributes will allow for the data migration process to be initiated. Without this basic framework in place, the DMT cannot be used effectively.

4.2. PREPARING YOUR DATA FOR SUBMISSION TO THE FAA

Archive existing data before beginning any data organization or translation process. Now is also the time to organize your data into a more manageable form which will result in less time spent in the translation process. The translation process will not be done by converting all layers at one time. It will be an iterative process involving finding layers with all compliant objects, converting those layers, identifying layers with non-compliant objects and converting those objects to make them compliant, converting those layers, and transferring attribute data to describe the airport objects.

This is also a good time to clean up your data by eliminating dangles, ensuring all polygons are closed, extra layers or elements are deleted, etc. as this will yield time savings and promote an easier translation. Remember, the FAA is looking to aggregate data you have broken down into small details, so several features and layers may end up in the same feature class. All features in the file need to be primary objects (points, lines and polygons). The FAA system does not support other object types like text, solids, hatches, blocks etc. If you have features created as unsupported object types, you must change them to compliant types or delete them if not required. The DMT will identify any noncompliant objects and will allow the processing of the drawings with both compliant and non-compliant types in the layer, leaving the non-compliant types on the existing layer, while converting the compliant types to the new FAA compliant layer.

Metadata and attributes are required for the data conversion. The metadata standard does not specify how to organize the dataset in a computer system or in data transfer. The metadata standard provides the structure and content to describe the characteristics of the dataset allowing other users to know the origination, accuracy, and usage of the dataset. In moving to a system where the information is stored in a database, many of the clarifying elements such as text become a part of the feature as attributes. The data about a runway end is a good example. Typically, CADD systems provided clarifying data such as latitude, longitude, elevation, etc. as text. However, in a database or GIS these elements are attributes of the runway end feature. If the text in a drawing is critical to the understanding of the feature or an element or describe special information about the feature, move it to a text field in the feature's attributes. The attribute "userFlag" is associated with every feature and provides a place for this type of clarifying information. Chapter 5 provides recommended layer naming conventions according to the National CADD Standards and American Institute of Architects (AIA) and how the layers are aggregated to the features. These recommendations follow the drawing hierarchy discussed in paragraph 3.3.3. Data providers should complete each attribute about a feature before submission. Some of the features can be completed by the consultant(s) for the airport while others will require the input from the airport sponsor.

4.3. DATA MIGRATION TOOL (DMT)

The FAA Airports GIS website (https://airports-gis.faa.gov) has a link to download the FAA recommended DMT to assist the data provider in translating their data to comply with the standards established in this AC. The DMT requires Autodesk Civil 3D 2008™ to run. Versions of the DMT for use with other CADD and GIS software will be made available when they are developed and tested.

When using any other supported file format than Autodesk DWG files, your first step is running the DMT as outlined in paragraph 4.3.3, Run Data Migration Tool (DMT). After running the DMT, use the DMT to import your files see paragraph 4.3.3.1, Importing non-Autodesk files for conversion.

The flow chart in Figure 4-2 describes the process of using the DMT, with figures to follow that explain each step.

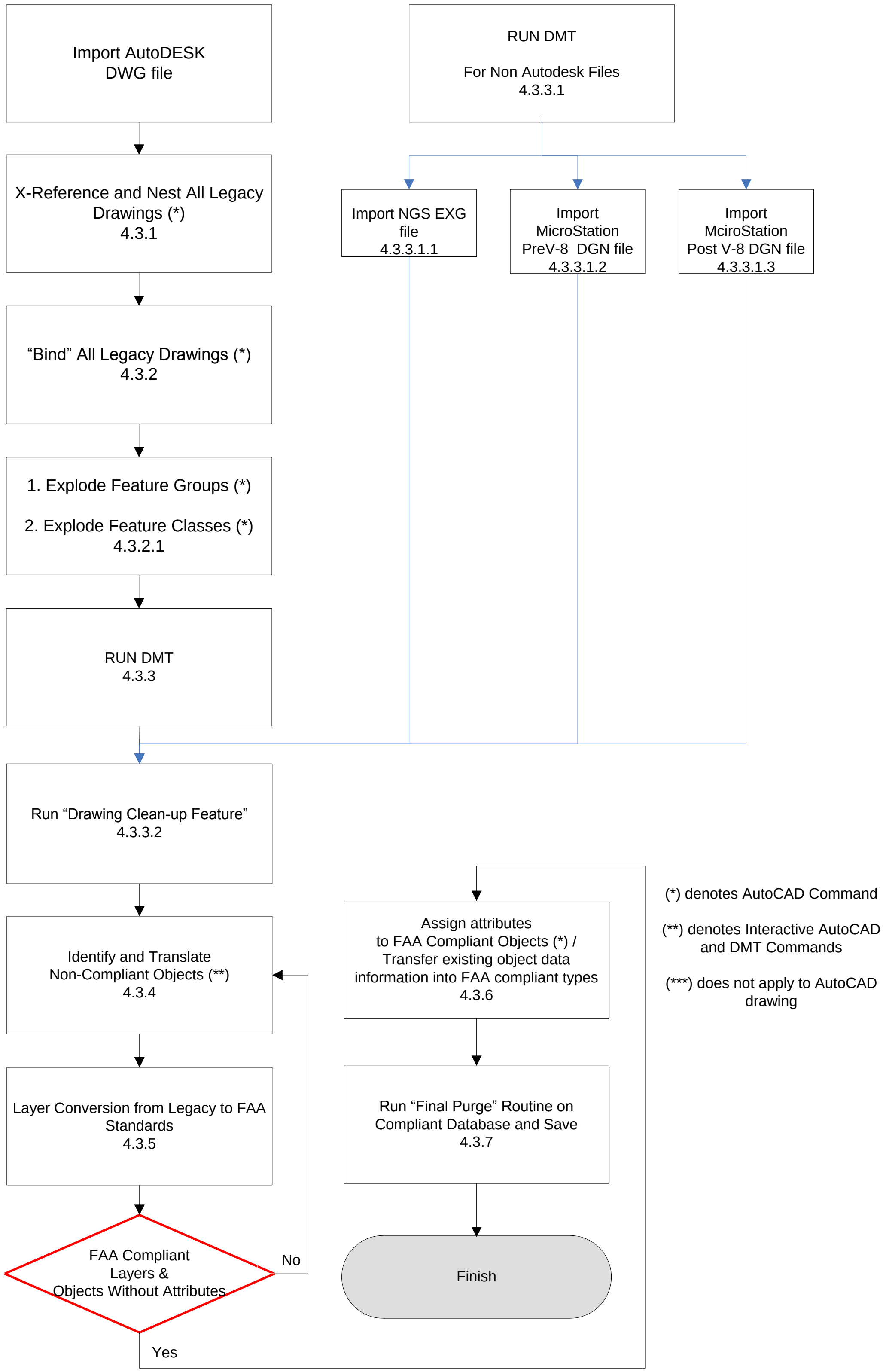

Figure 4-2. DMT Process.

4.3.1. External-reference and Nest all Legacy Drawings for Autodesk DWG format only

In order for the DMT to successfully translate legacy data to FAA standards, a hierarchy of AutoCAD drawings must be established. Once established, create the feature group drawings by "referencing" (use AutoCAD *Xref* command) all of the proper feature class drawings into the correct feature group. (For details on how to organize the files, see paragraph 3.3.3) The next step is to reference all feature group drawings to one master drawing identified generically (i.e. AIRPORT.dwg). The drawing now contains the airport data needed for the FAA submittal.

The way the files are structured, the AIRPORT.dwg is organized in such a way that it is updated automatically as you update your base feature class drawings. If you use your original file for conversion to the FAA standard you will have to bind your reference files which would mean your drawing will not update on its own. By doing a *Save As* from your AIRPORT.dwg and renaming it to 'Airport-FAA Submittal'.dwg, you now have a file that can be created from your base updated airport legacy files and converted at any time by executing the DMT.

4.3.2. Bind all Legacy Drawings

Once you have your Airport-FAA submittal.dwg, the ref files must have the *Bind* command run on the file. To *bind* the drawing, go into the *ref* box, press the shift key and select all reference drawings. Right-click and click on *bind* as shown in Figure 4-3.

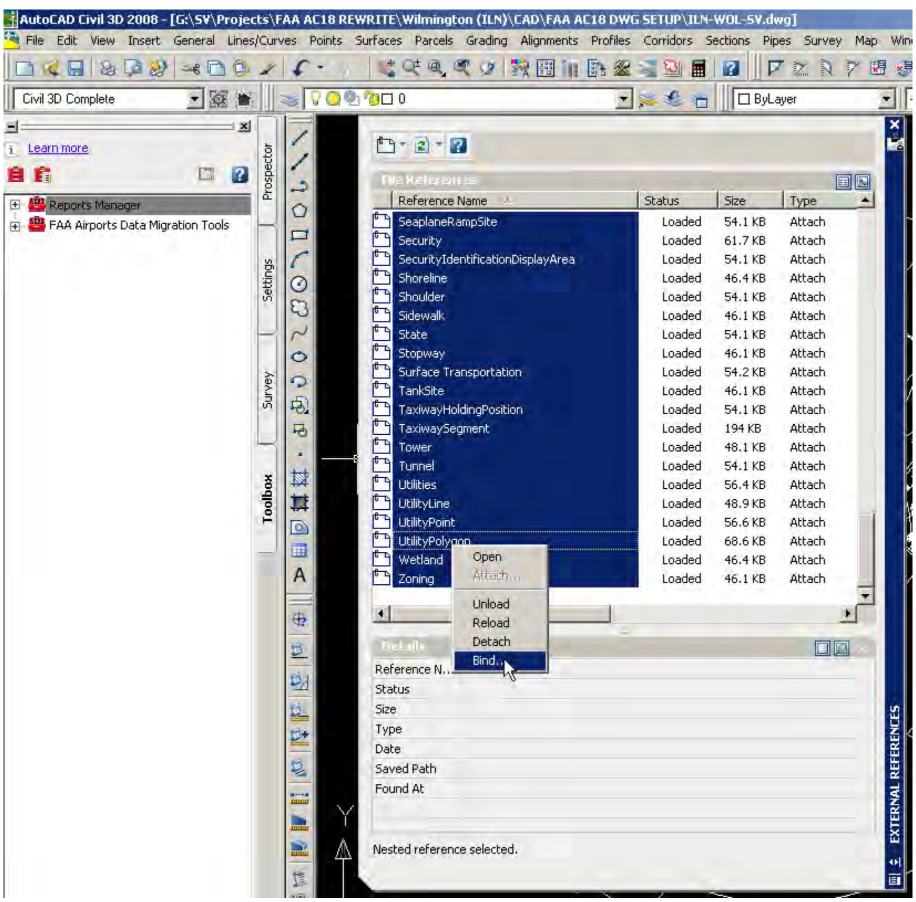

Figure 4-3. Binding Multiple Legacy Files.

Another box will come up asking whether to *Bind* or *Insert*, the difference between the two, is that *Bind* keeps the x-referenced drawing's name in front of the layer, whereas *Insert* only keeps the layer's name.

NOTE: *After binding this data, it is no longer x-referenced and has no link to the original file. If changes are made to a feature class drawing, you must go back into the AIRPORT.dwg (which contains your x-references unbound) and rerun a Save As to an 'AIRPORT-FAA Submittal.dwg'.*

After binding, the objects are now blocks inside of your drawing. You need to use the *Explode* command twice. First *Explode* the feature group type, then *Explode* the feature classes. All objects are now physically in this drawing, and layer conversion can be performed.

4.3.3. Run Data Migration Tool (DMT)

When using any of the other supported file types, running the DMT is your first step in the conversion process.

Ensure that Autodesk Civil 3D 2008™ has been loaded along with the latest service pack upgrade from Autodesk. Download the latest executable for the FAA DMT from the FAA Airports GIS website (https://airports-gis.faa.gov). With Autodesk Civil 3D 2008™ closed, run the FAA DMT installation executable. A shortcut to the readme file will be placed on the desktop, and it is recommended that you review it prior to using the DMT for the first time. (**NOTE:** *If a previous version of the DMT already exists on your computer, you must remove it by using the Add/Remove Programs feature in Windows before installing the new version.*)

After installation, open Autodesk Civil 3D 2008™. It should show the *Toolspace* box open on the left part of the screen. If the *Toolspace* box is not there, type the command *Showts* in the command line and hit enter; the application should then look like Figure 4-4.

Figure 4-4. Toolbox Tab.

Ensure that all four tabs ("Prospector," "Settings," "Survey," and "Toolbox") are displayed as shown in Figure 4-4. If you are missing the "Toolbox" tab go to the menu "General" and click on "Toolbox." If everything is properly installed, the software should now show all four tabs.

The "Convert Layers to FAA Standards" and the "Convert Object Data to FAA Standards" tools should be shown on the bottom of the Toolbox menu under the "FAA Airports Data Migration Tools" toolbox. (Expand the three tool groups to access the specific tools.) When these two objects are shown, you have now successfully loaded the FAA DMT.

4.3.3.1. Importing non-Autodesk files for conversion. The FAA DMT provides tools to import ESRI shapefiles, or MicroStation V7 (Pre-V8 DGN Files) or V8 DGN files. To load a new set of data for these files types to convert with the DMT, go the Toolbox Tab on the *Toolspace* box as shown in Figure 4-4. All three of these tools are available within the DMT Toolbox under the "Existing Data Migration Tools" category. For converting native AutoCAD .dwg or .dxf files, open the file using core AutoCAD Civil 3D 2008™ functionality.

When working with supported file types other than Autodesk DWG files, importing the file through the DMT import tool is the first step. Importing these file formats through the DMT assists with the conversion process. To run any of these import tools, right-click on the tool in the toolbox and select "Execute…" as in Figure 4-5. Each tool works in a slightly different manner, as explained in the following paragraphs:

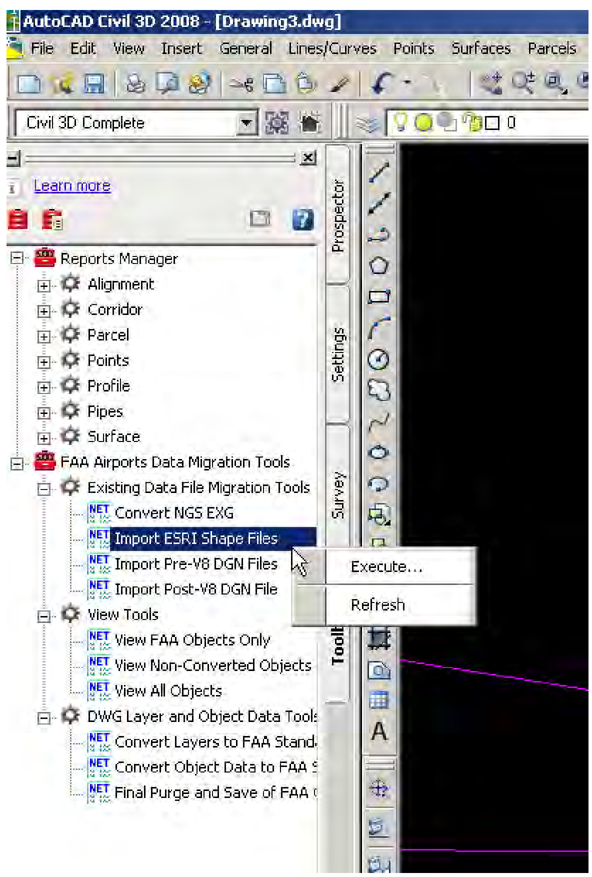

Figure 4-5. Import non-Autodesk file formats.

4.3.3.1.1. Importing ESRI Shapefiles. Existing airport data in ESRI shapefiles format can easily be migrated to the FAA standards using the existing tools in the DMT. It is recommended that you organize all of the shapefiles that you want to convert into a separate folder on your system. The DMT "Import ESRI Shapefiles" tool (see Figure 4-6) will read in the available shapefiles from the selected folder and allow you to select which files you want to import. (Hint: double-click on the "SHP File" column to select/unselect all files in the dialog). When you select "Convert File(s)," the tool will create a layer in your .dwg for each shapefile (with the same name) and will attach a default object data table to the layer from the shapefile's attributes. Then you can run the "Convert Layers to FAA Standards" and "Convert Object Data to FAA Standards" tools to continue the migration process. Shapefiles are a good starting point for converting GIS attribute data to the FAA standards.

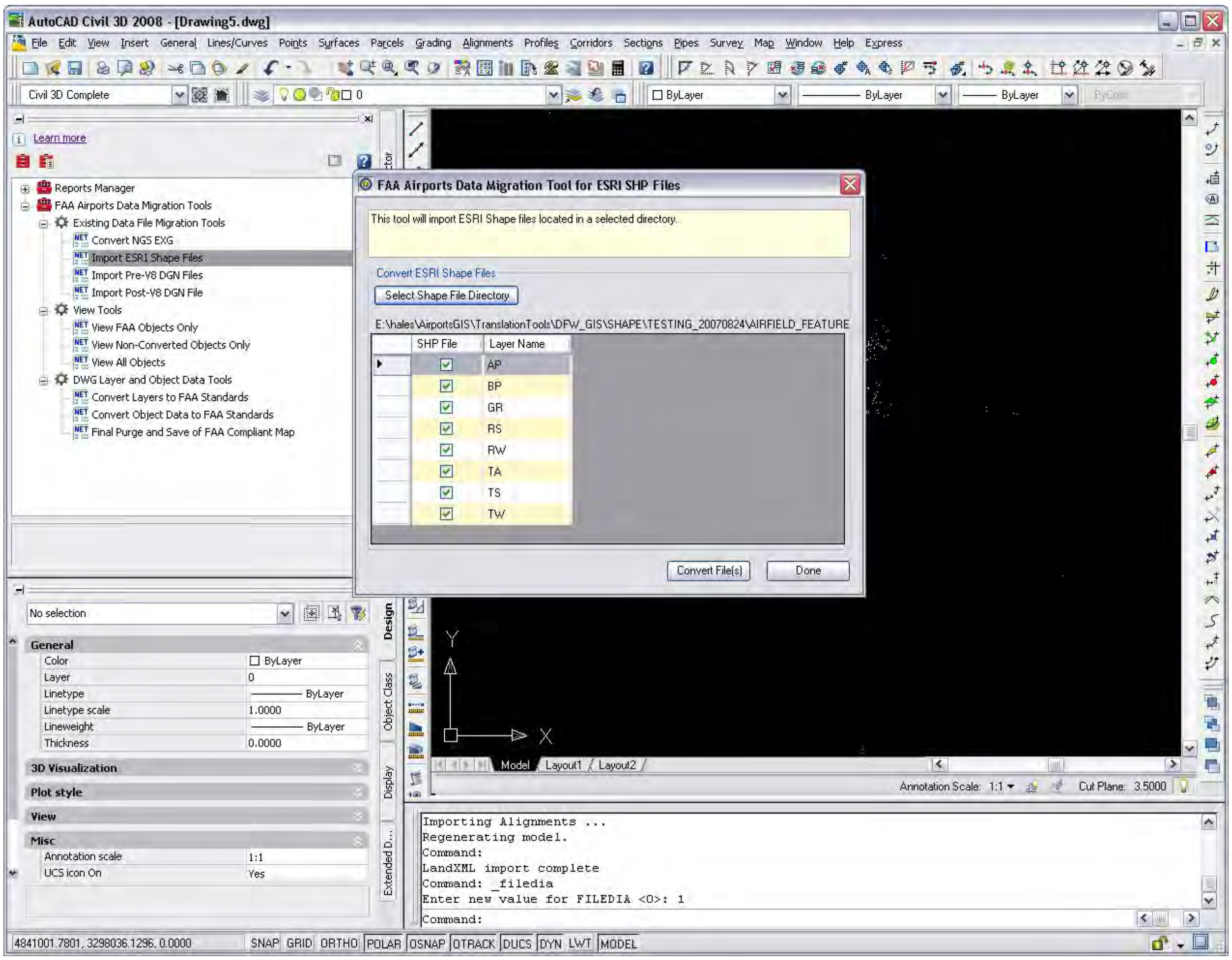

Figure 4-6. Import ESRI Shapefiles.

4.3.3.1.2. Importing MicroStation (pre-V8) DGN files. To import MicroStation™ (pre-V8) DGN files for migration, use the "Import Pre-V8 DGN Files" tool from the DMT toolbox (see Figure 4-7). This tool works in a similar manner to the ESRI™ Shapefile import, allowing you to select DGN files to import from a folder on your computer. When you select "Convert File(s)," the DGN layers are imported into your Autodesk DWG file. **NOTE:** *There is no option to import attribute data using pre-V8 MicroStation™ DGN files, as this is not supported in this file type.* Object data can be entered manually using the process described in 4.3.6 after running the "Convert Layers to FAA Standards" tool.

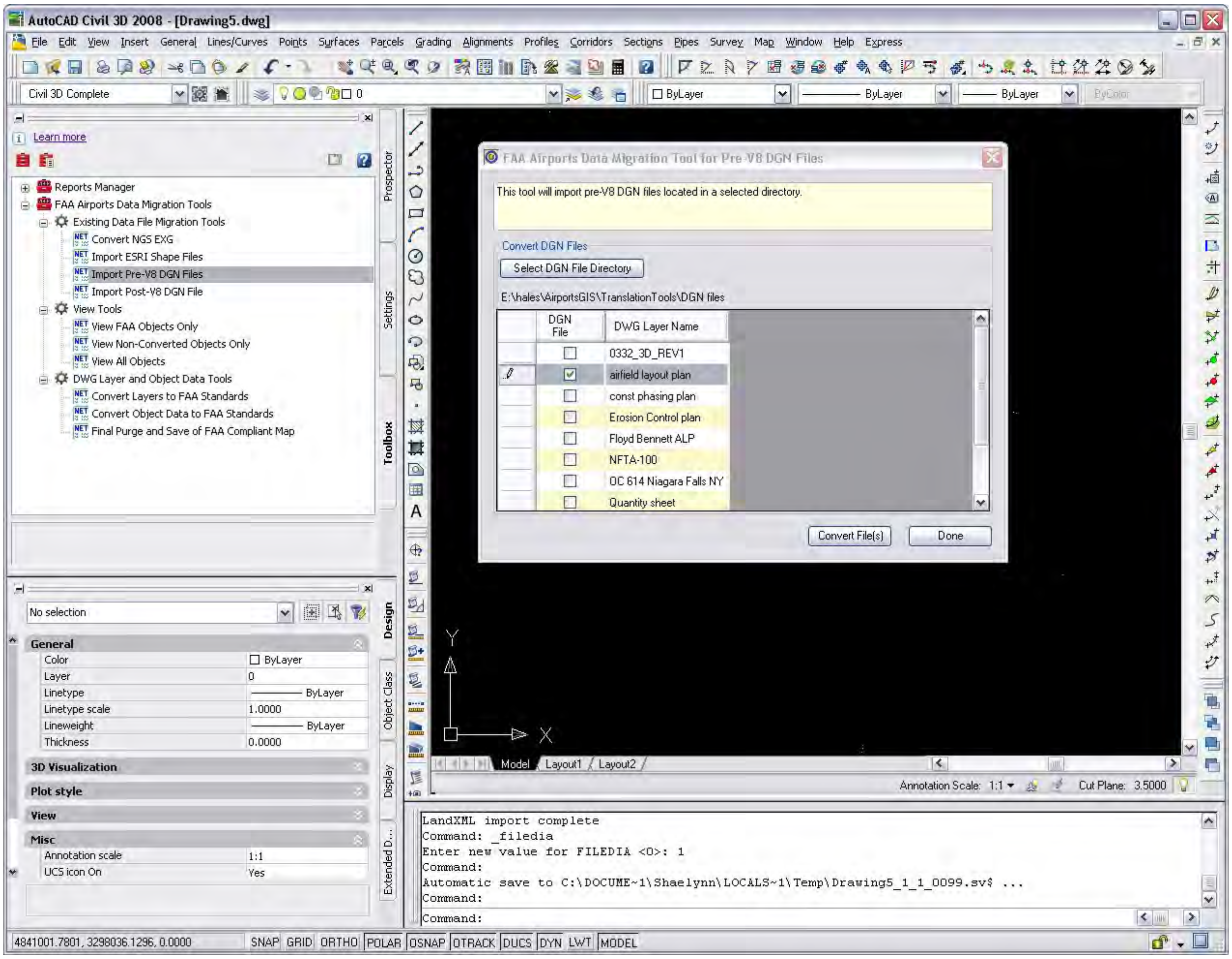

Figure 4-7. Import MicroStation™ (pre-V8) DGN files.

4.3.3.1.3. Importing MicroStation™ V8 DGN files. Using the import tool from the DMT, import the MicroStation™ V8 file. During the import process a dialog box will open as shown is Figure 4-8.

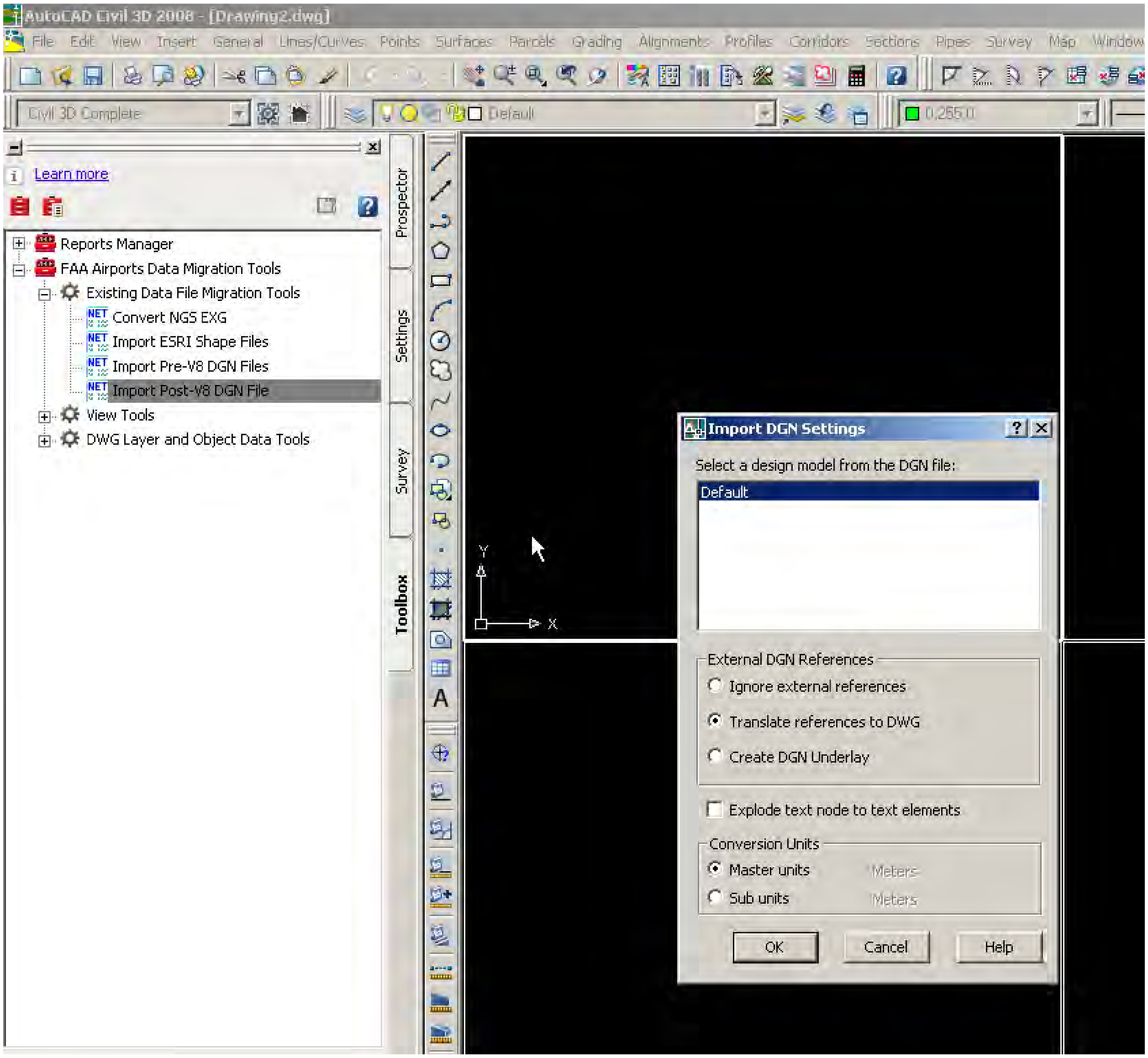

Figure 4-8. Translate Reference files.

When importing the MicroStation™ V8 design file, the system will ask if you want to translate references to DWG. The user will want to translate references by selecting the 'Translate references to DWG' option in the DMT. If you do not follow this process, you will have to run a similar process as in the Autodesk workflow of reattaching the references files in Autodesk.

4.3.4. Identify and Translate Non-Compliant Objects

The DMT provides you with a report showing the number of compliant objects and non-compliant objects on each of the CADD layers as shown in Figure 4-11. When you initially run the "Convert Layers to FAA Standards" tool, these values are based on all allowable object types (points, lines, polylines, and lightweight polylines) that can be converted to the FAA required simple geometry types of point, line, and polygon. It may be useful to run this on your data without completing the layer conversion (as described in paragraph 4.3.5) in order to get a feel for the distribution of valid/invalid objects on your layers. You may want to correct each layer so there are no non-compliant objects in the layer. The file will translate if there are non-compliant objects in the layer, but the non-compliant objects will not be moved to the new FAA Layer during the translation process. Instead, they will remain on the non-compliant layer, which can later be removed from the drawing using the "Final Purge and Save" tool.

Compliant and non-compliant object counts may change as you select potential FAA layers to convert to. This is because the valid/invalid status of the objects on the layer is being updated to meet the more stringent requirements of the specific geometry allowed for the feature class as defined in Chapter 5 of this AC. For example, if you have an airport specific layer that contains open lines that you want to convert to the APRON layer, those objects will change status to invalid when APRON is selected from the drop down menu. If you escape from the tool and clean up the open lines on the APRON layer by closing the lines and then rerun the tool, these objects will now be considered valid for the APRON polygon layer and will be converted.

The DMT also provides you with some viewing options so that you can see FAA objects (objects compliant and already converted) and Non-Converted objects. These tools are all run with the right-click "Execute" command. Figure 4-9 shows how to access these tools in the DMT.

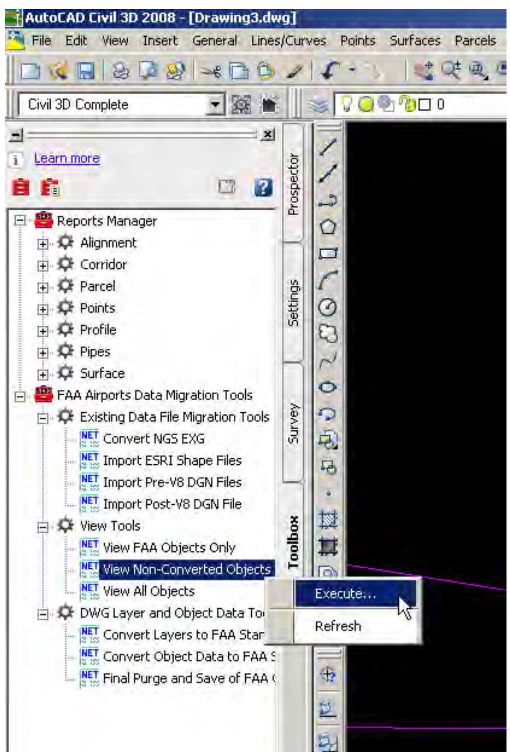

Figure 4-9. Tools to View Converted and non-converted data.

By working with each layer on its own to correct the invalid objects, they can be reorganized for translation. As shown in Figure 4-10, standard AutoCAD tools such as *Show Properties* can be used to identify non-compliant objects such as arcs, circles, blocks, etc. By using standard AutoCAD manipulation tools, these arcs can be moved to the correct layers and modified to a compliant object type and moved back or deleted, whichever is the correct action to make the file compliant.

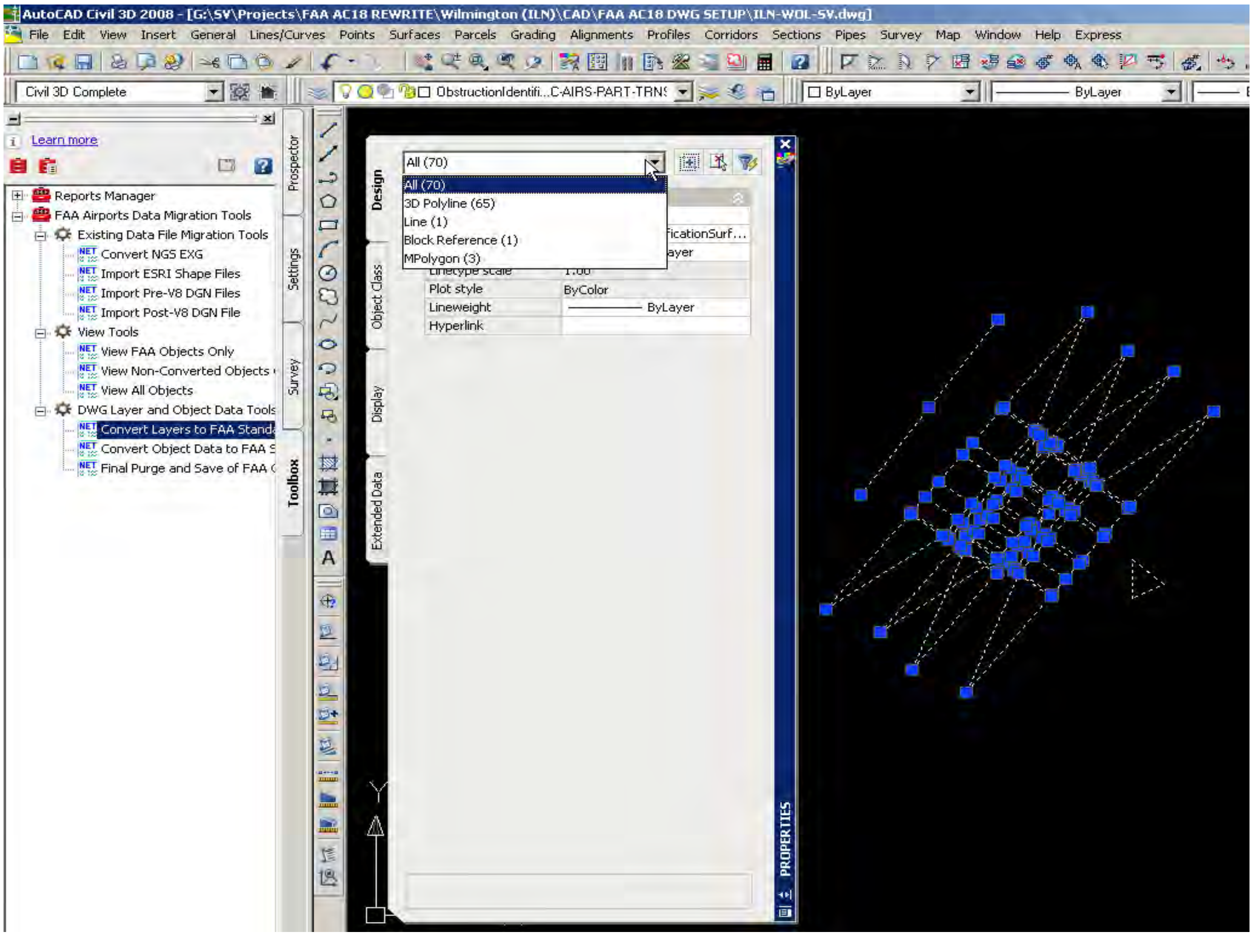

Figure 4-10. Isolated layer containing non-compliant data with *Show Properties* AutoCAD function.

4.3.5. Layer Conversion from Legacy to FAA Standards

Using standard AutoCAD tools, open the DWG file for conversion to the FAA Standard. The drawing will open and display in the main drawing panel (window). (Alternatively, you can also import other valid file formats into a new AutoCAD DWG using the DMT tools as described in paragraph 4.3.3.1.)

In the toolbox tab, right-click on the "Convert Layers to FAA Standards" and left-click on "Execute." The DMT will run and generate a report as shown in Figure 4-11. The table created shows the existing drawing layers on the left. On the right are the FAA layers on the pull down Tab with the existing layer name. To change the name to compliant FAA named layers, select the pull down tab and all compliant FAA feature classes are listed.

Select the correct FAA layer name for the data set you are converting and put a check mark in the DMT column "Convert Layer Name". (**NOTE:** *you can turn all of the layers on/off by double-clicking this* *column header*.) Only those layers that are checked and have been assigned a FAA compliant layer name will be converted. **NOTE**: *the DMT will highlight each layer in blue to indicate that the layer will be converted.*

When you initially run the "Convert Layers to FAA Standards" tool, these values are based on all allowable object types (points, lines, polylines, and lightweight polylines) that can be converted to the FAA required geometry types of point, line, polygon. You may want to correct each layer so there are no non-compliant objects in the layer. The file will translate if there are non-compliant objects in the layer, but the non-compliant objects will not be moved to the new FAA Layer during the translation process. Instead, they will remain on the non-compliant layer, which can later be removed from the drawing using the "Final Purge and Save" tool.

Compliant and non-compliant object counts may change as you select potential FAA layers to convert to. This is because the valid/invalid status of the objects on the layer is being updated to meet the more stringent requirements of the specific geometry allowed for the feature class chosen. Each feature may have more than one object type that is allowed for a feature. The number or count of objects is specific to a feature and its allowable geometry type depending upon the definition in Chapter 5 of this AC. For example, if you have an airport specific layer that contains open lines that you want to convert to the APRON layer, those objects will change status to invalid when APRON is selected from the drop down menu. The layer conversion tool can be viewed in Figure 4-11.

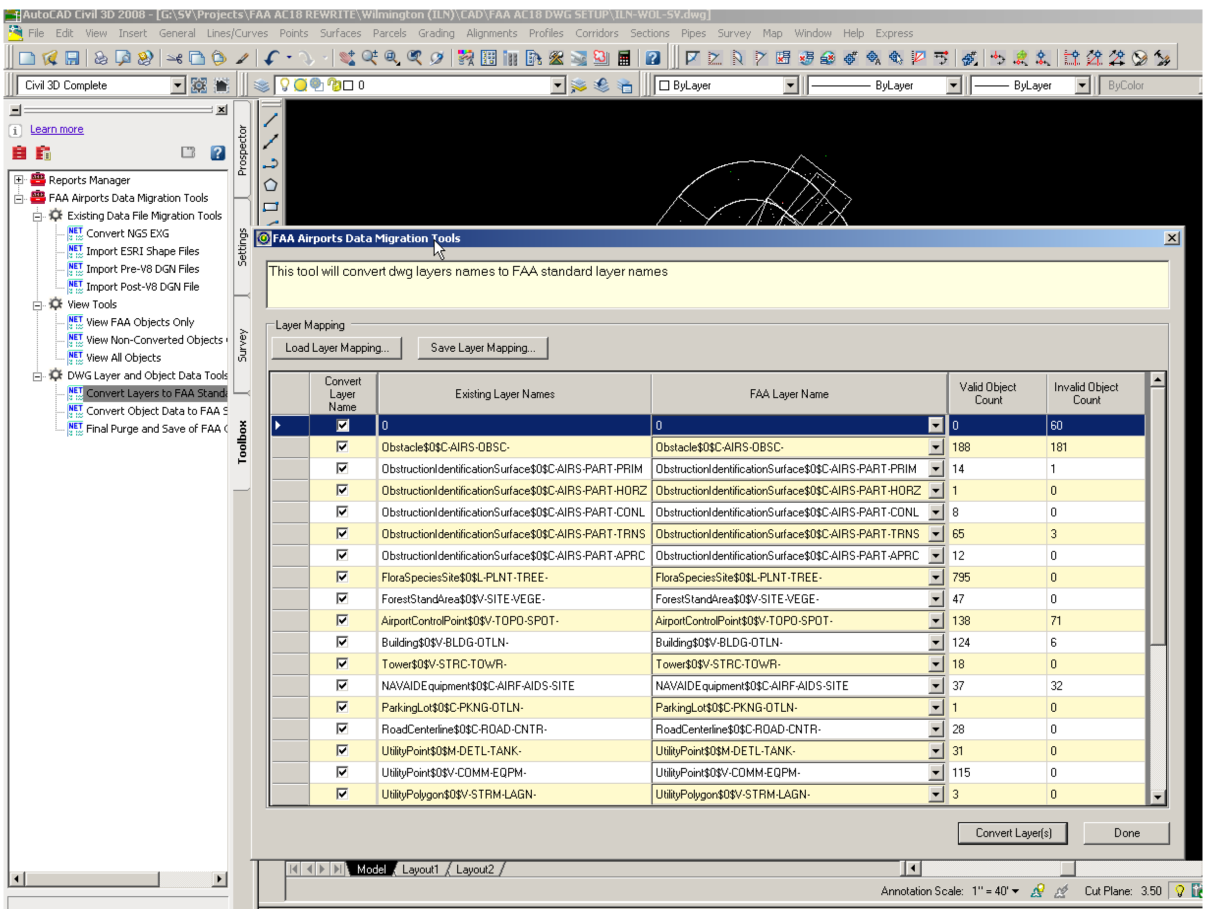

Figure 4-11. Layer mapping dialog box from DMT.

DMT also has a set of View tools that allowing you to quickly see layers with objects that have been converted to FAA standards ("View FAA Objects Only") and those that still need to be converted ("View Non-Converted Objects Only"). These tools are all run with the right-click "Execute" command.

To complete the conversion, select the "Convert" button. Prior to converting, it is recommended that you save your mapping. The DMT was designed to allow the user to create the translation mapping and save it as a template for re-use in the future, as shown in Figure 4-12. This will also provide supporting evidence for the conversion process that was performed if audited. **NOTE**: *clicking the "Done" button quits the tool but does not perform the conversion.*

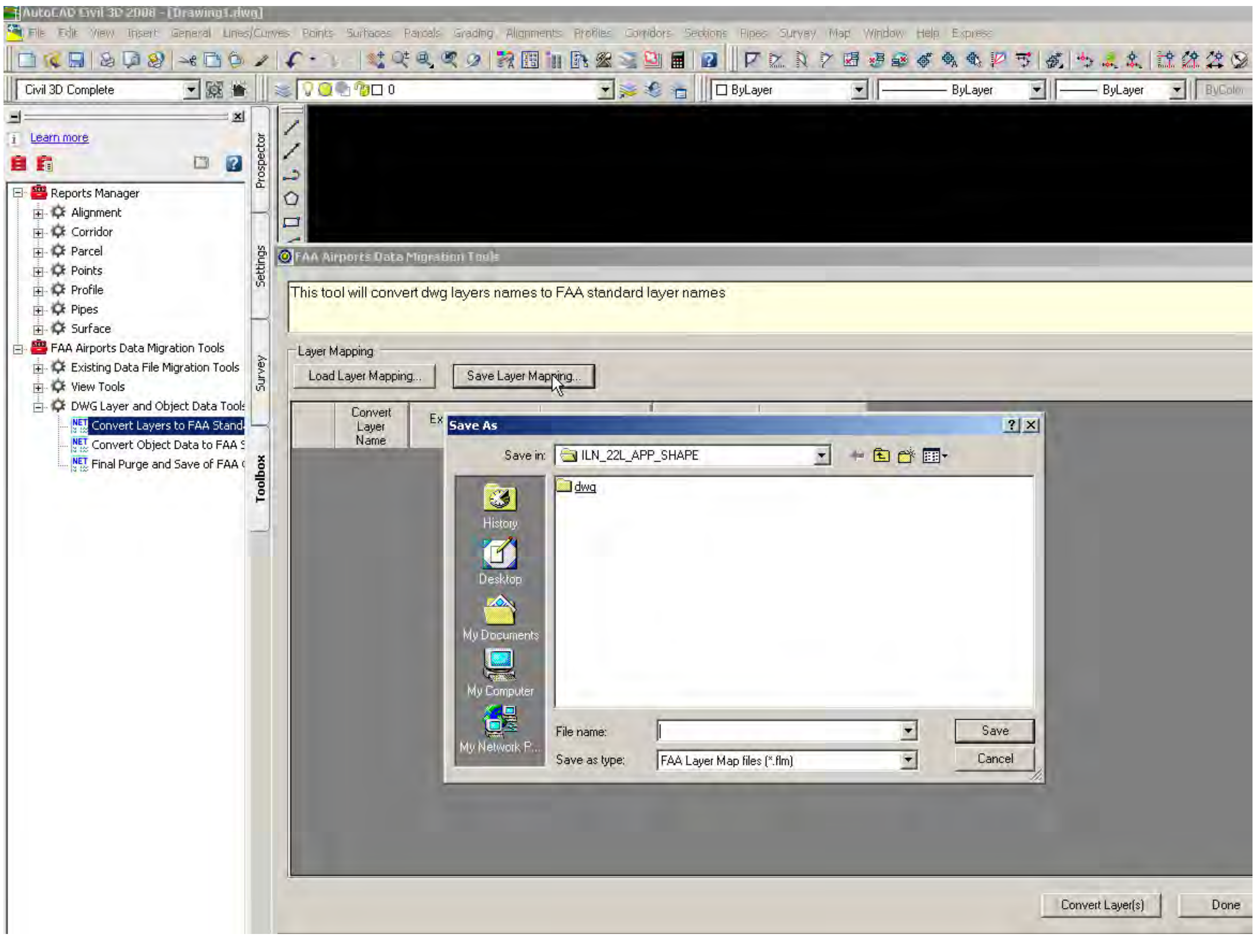

Figure 4-12. Saving the translation mapping template.

4.3.6. Assign Attributes to FAA Compliant Objects

Once the layer conversion is done, the "show properties" box is used for assigning object data. Since each layer has its own attribute requirements (as described in Chapter 5), the DMT automatically assigns an empty FAA compliant object data table to objects when doing the layer conversion. Figure 4-13 shows the object data table information in the bottom half of the show properties box. Using this box, you can fill in the correct attribute data required for each object.

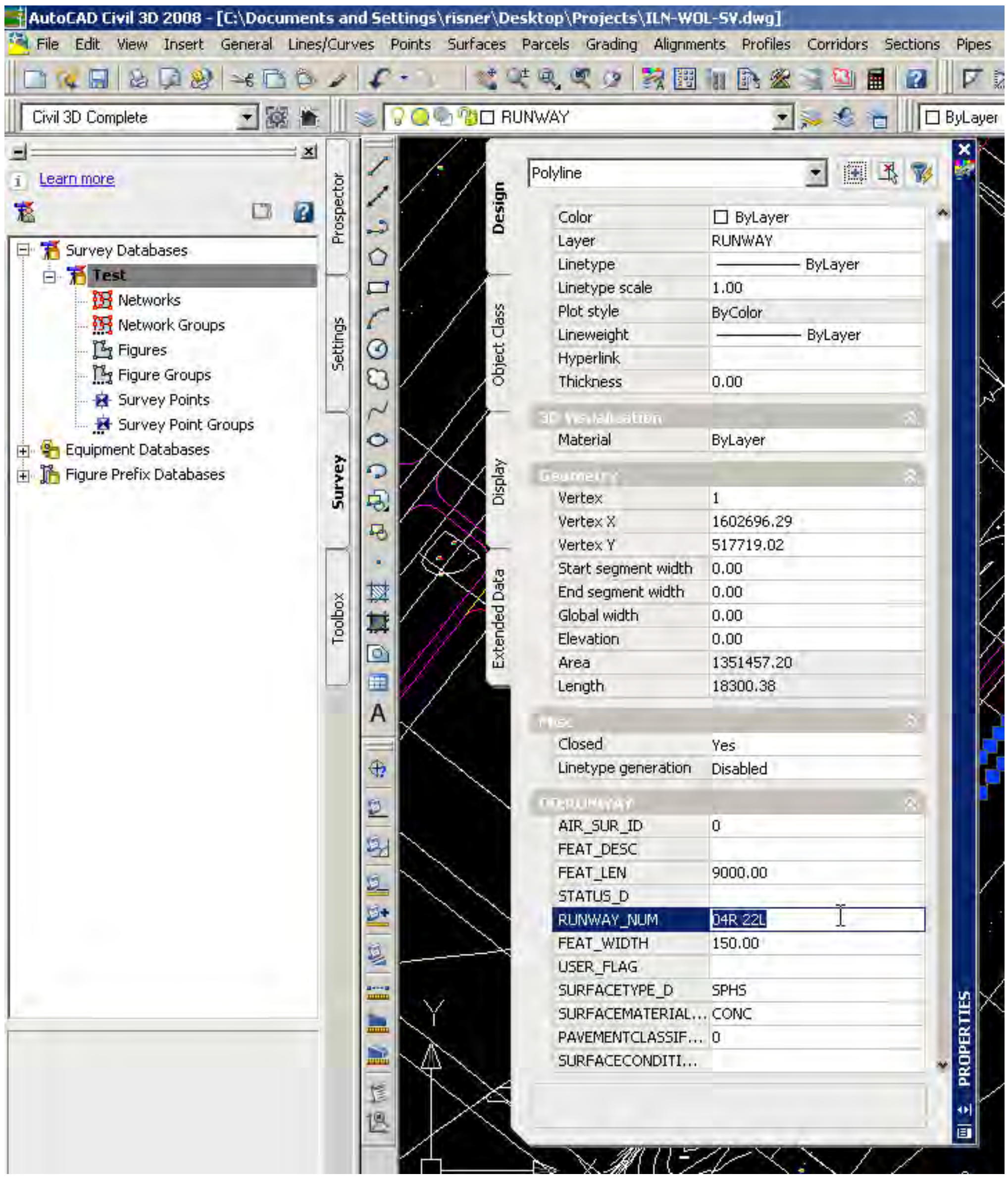

Figure 4-13. Assigning Object Data.

Some tips to keep in mind while assigning attributes:

- ESRI, MicroStation or AutoCAD files that initially had attribute tables attached during conversion are accessible and shown when filling in the attribute fields. In this scenario, it is recommended that you run the "Convert Object Data to FAA Standards" tool to map them to the FAA compliant object data tables (as described below).

- If there are multiple objects in a layer that have the same value for an attribute, try selecting them at the same time and then editing the attribute value in the Properties dialog. This will be more time efficient.

- Refer to the feature tables in Chapter 5 for acceptable values for attributes that have an enumeration datatype.

When you have object data tables attached to your original drawing, the DMT contains a tool "Convert Object Data to FAA Standards" that allows you to map your existing attributes to the required FAA attributes in the FAA compliant object data table. This tool also allows you to create an enumeration mapping from existing values to the FAA compliant enumeration values. **NOTE:** *the layer conversion must be done before the Convert Object Data Tool will process the information*. See Figure 4-14 to see how the Convert Object Data tool works.

Similar to the layer conversion tool, the object data conversion tool allows you to create and save your object data mapping to use again. It is highly recommended that you save your mapping configurations prior to completing the conversion.

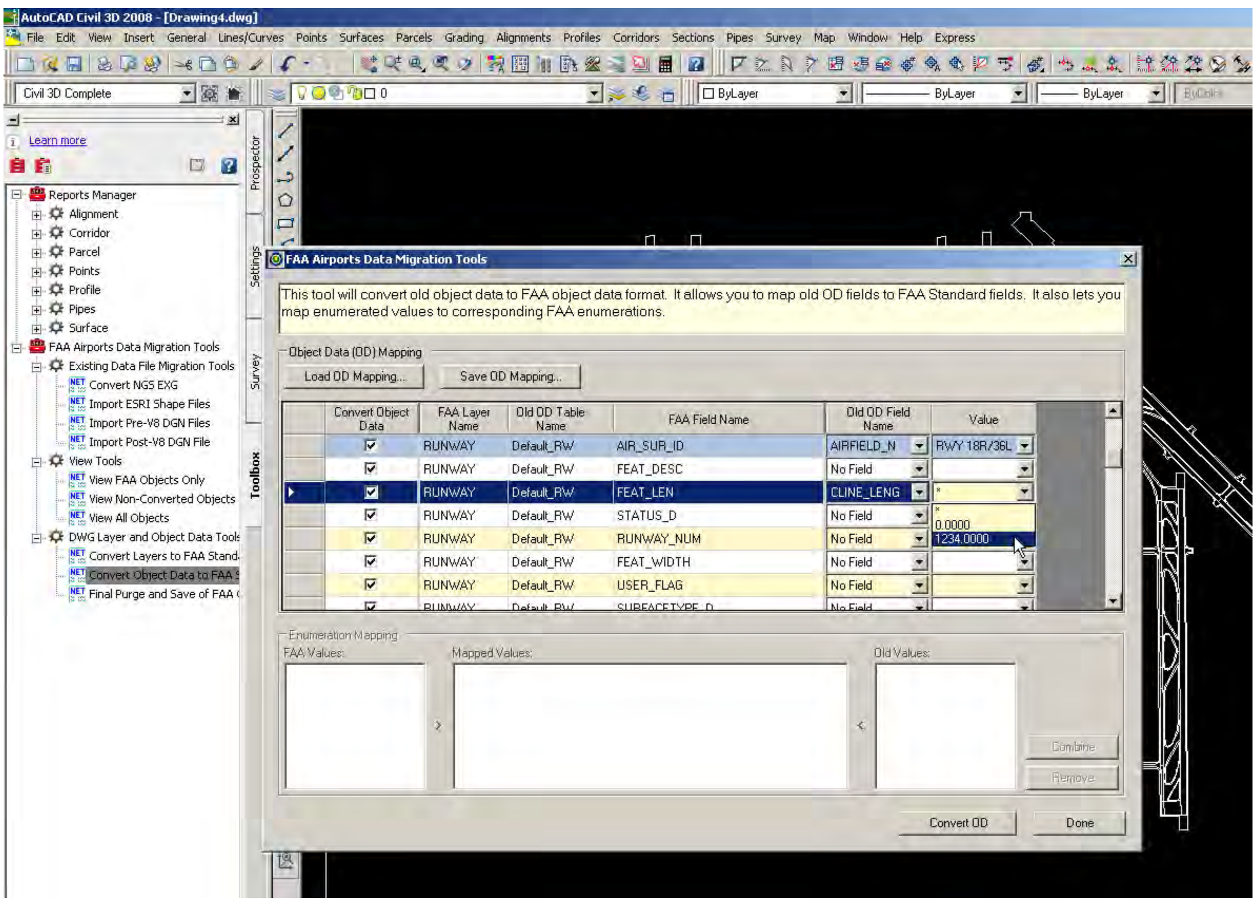

Figure 4-14. Convert Object Data to FAA screen.

4.3.7. Run "Final Purge" Routine on Compliant Database and Save

Once all layers and objects have become FAA compliant, the DMT has a "Final Purge and Save of FAA Compliant Map" command. Right-click on this command and then left-click to execute. A dialog will then come up on the screen asking you to save your drawing in an AutoCAD 2000 format. Before executing this command, be sure that everything is compliant, otherwise any non-compliant layer names and/or objects will be deleted from your drawing. Figure 4-15 shows the steps for the "Final Purge". This resulting .dwg should now be in a compliant format that can be uploaded by the data provider to the FAA Airports GIS website (https://airports-gis.faa.gov).

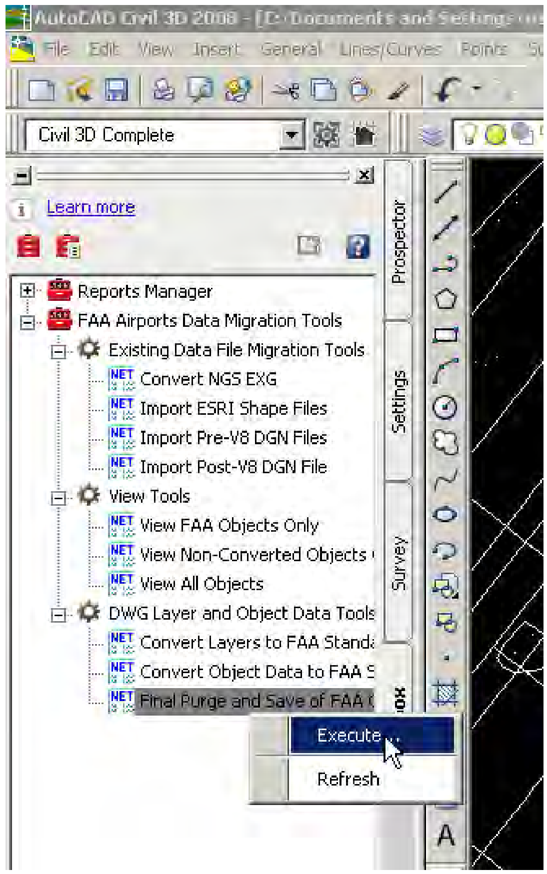

Figure 4-15. Final Purge.

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