MINETA SAN JOSE INTERNATIONAL AIRPORT

SURVEY DATA STANDARD COMPLIANCE QC/QA PROCEDURES

TABLE OF CONTENTS

1.0 INTRODUCTION

1.1 Scope

This document details the quality assurance (QA) procedures that are to be carried out on survey data submitted to the Mineta San José International Airport (SJC). Survey data encompasses information on monuments, photo control points, field measurements, point data showing the location of specific features, elevation data and vector data derived from survey points. This document details procedures that should be applied to all survey data submitted to SJC so that the quality of this data can be assured.

1.2 Purpose

Survey data provides the foundation of spatial accuracy for all CADD, GIS, orthophotography and remotely sensed data used by the airport. Survey data is also the ultimate source of higher accuracy that is used as a source to assess the accuracy of other data sets that are submitted. Survey data cannot, however, perform this vital function if it is not of impeccable quality.

The purpose of this document is to detail procedures that should be used to assure the quality of survey data used by the airport. These procedures should be applied to all survey data regardless of the source. In this manner not only the quality but the consistency of the survey data used by the airport can be maintained.

This document is written as an instruction manual for airport staff or 3rd parties tasked with reviewing survey data submitted or provided to the airport. The procedures are not intended for the surveyors who are tasked with collecting the data. Instead, they should be following quality control procedures designed to make sure that data is collected to the specifications required by the airport.

1.3 Contact Information

This document was prepared by the Carter & Burgess (C&B) Team. If you have any questions, please call Lysée Moyaert, AIMS Manager at (408) 501-7712, Barry Ng, CSJ Land Surveyor at (408) 998-6086, David Tamir or Behzad Mohammadi of the C&B Consulting Team at (818) 784-7585.

2.0 OVERVIEW OF THE QUALITY ASSURANCE PROCESS

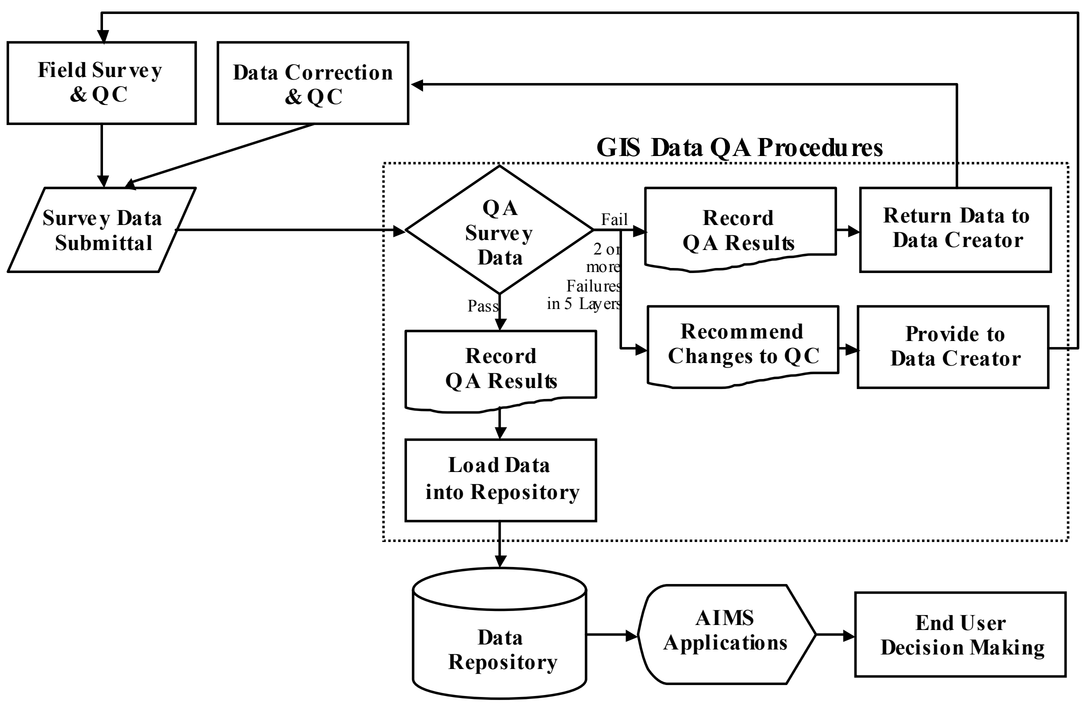
Quality Assurance (QA) serves as a final check of the data, to catch any problems that may have been missed by Quality Control (QC) procedures carried out in the field. QA also serves as a regular test of whether or not the production and QC processes are producing data of the required quality. QC, on the other hand, occurs during the development of GIS data that will be submitted to the airport. These definitions are based on definitions used in ISO 8402:1994 Quality Management and Quality Assurance.

QA procedures will be performed on all survey data submitted to SJC. The QA procedures for survey data submitted or provided to the airport have been developed independently from any QC processes that have or will be developed by the surveyors who will be collecting data in the field and are based on the survey standards adopted by SJC as well as nationally accepted survey practice. QC procedures need to be developed by surveying teams as an integral part of their data creation process. They should be administered using checklists on a daily basis by the staff and contractors hired to collect data, as well as other agencies and private firms who collect GIS data.

QA procedures are to be carried out by airport staff or an independent 3rd party reviewer. For survey data, most of these procedures involve manually checking a random sampling of data elements against a predefined set of acceptance criteria. Survey data in which errors are found beyond an acceptable limit will be rejected and returned to the submitter for correction and re-submittal. All data that passes the acceptance criteria can be loaded into the data repository as specified in document SJC-ACM-AIMS-4140.

The QC/QA Process diagram (see Figure 2.0 -1) presents a generalized process for performing quality control (QC) and quality assurance (QA) on drawings.

Figure 2.0 - 1
Overview of QC/QA Process



3.0 SURVEY DATA ACCEPTANCE CRITERIA

The Survey Standard (SJC-ACM-AIMS-2400) defines the acceptance criteria for survey data submitted or provided to SJC. This document details the surveying standards that must be met. In addition, survey data must be submitted along with metadata a requirement that is specified in the metadata standard (SJC-ACM-AIMS-2600).

4.0 DETAILED QUALITY ASSURACE PROCEDURES

4.1 Informal Review

An informal, cursory review of survey data submitted or provided to the airport is recommended prior to applying the rigor of the formal QA procedures. This cursory review should focus on obvious discrepancies between what was submitted and what was supposed to have been submitted. With survey data, the validity of the data itself is hard to test in this manner but missing, inconsistent or inadequate supporting materials such as control point identification, log reports, site sketches, etc. can be found.

Since this check is informal, it is not effective to outline a definitive procedure for this step. Instead, it is intended to be defined on a case-by-case basis by a trained technician who is familiar with the type and content of data being submitted. Such personnel are more likely to spot the obvious errors that this step is intended to identify. If such errors are found, the more time consuming and costly formal QA steps can be avoided. If no such errors are found, then QA can proceed as follows.

4.2 Completeness Checking

An important element of data quality is completeness. This is especially true with survey data, because its quality is based on its integrity and can only be established when a complete data set is provided. Figure 4.2 -1 details the data elements that are required to complete various types of survey data sets.

Figure 4.2 -1

Matrix of Required Survey Data Elements

Data Type ↓ / Required Element →	Metadata	Ties to SJC Network	Station Log Reports	Site Sketch	Digital Photos	Codes Described
New Monumentation	✓	✓	✓	✓	✓	
New Photo Control	✓	✓	✓	✓	✓	
Field Measurements	✓			?		✓
Point Data	✓	✓		?	?	✓
Elevation Data	✓	✓		?	?	
Derived Vector Data	✓	✓		?	?	✓

✓= required ? = as necessary

- Metadata - Metadata is the information about the survey data itself including source, method of collection, date acquired, etc. Metadata requirements for SJC survey data are detailed in the metadata standard (SJC-ACM-AIMS-2600).
- Ties to the Existing SJC Survey Network - The National Geodetic Survey has established one Primary Airport Control Station (PACS) and two Secondary Airport Control Stations (SACS) at SJC. In addition, the airport has established 4 primary control points and 28 secondary control points. Together, these points establish a highly accurate survey control network. Ties to points in this network are required for certain types of survey data. The locations and data sheets for each of these are provided in the SJC Survey Control Network Standard (SJC-ACM-AIMS-2400).
- Station Log Reports – When differential or RTK equipment is used to occupy a control point, log reports of the GPS signals received during this occupation are required.
- Site Sketch – A manual sketch made in the field is invaluable in locating survey control points and measurements. These sketches should be legible and clearly mark the control point or measurement nodes in relation to easily identifiable features. These sketches should be scanned and submitted to SJC in digital format.
- Digital Photos – Photos can also help in locating survey control points and measurements. These photos much be clear and shown the subject point in relation to other easily identified features.
- Codes – All codes used should be fully and clearly described in layman's terms in the data itself as opposed to a key or legend which can also be optionally provided.

4.3 Random Sampling Procedures

4.3.1 Determining Sample Sizes

To assure data quality, the American National Standards Institute (ANSI) MIL-STD-105E sampling standards are used to define the method and sample size of elements to be tested. The size of the sample to be inspected during the quality assurance testing is determined by the lot size, which is the total number of features on a given layer. Table 4.2.1, Sample Sizes and Allowable Error Rates, is derived from the ANSI standards document. This table illustrates the random sample sizes and allowable number of errors based on different lot sizes. For example, under Normal Inspection criteria survey data submitted with 20,000 features to be tested (lot size) would produce a Sample Size of 125, with a maximum of three allowable errors. If a data set produces three or less errors during quality assurance testing, then it will pass the testing with a rated accuracy of 98%. Even though the data set had passed, any errors that were identified are to be corrected before the data is converted and loaded into the spatial repository.

If two out of five consecutive data sets fail, then tightened inspection criteria are used until five consecutive data sets pass inspection. Under tightened inspection criteria, the number of allowable errors is reduced. The far right column in Table 4.2.1 - 1 indicates the number of allowable errors under tightened inspection criteria. After five consecutive datasets pass tightened inspection, then normal sampling procedures will be re-instituted.

Figure 4.2.1 -1
Sample Sizes and Allowable Error Rates
(Derived from ANSI/ASQC Z1.4-1993)

Lot Size	Sample Size	# of Allowable Errors – Normal Inspection	# of Allowable Errors – Tightened Inspection
2 – 15	2	0	0
16 – 25	3	0	0
26 – 90	5	0	0
91 – 150	8	0	0
151 – 280	13	0	0
281 – 500	20	0	0
501 – 1200	32	1	0
1201 – 3200	50	1	0
3201 – 10,000	80	2	1
10,001 – 35,000	125	3	2

Lot Size	Sample Size	# of Allowable Errors – Normal Inspection	# of Allowable Errors – Tightened Inspection
35,001 – 150,000	200	5	3
150,001 – 500,000	315	7	5
500,001 and over	500	10	8

4.3.2 Determining Lot Size

The application of this procedure to determine the sampling size requires knowledge of the number of features contained in the survey data set. Because each of the survey data types listed above are different, the following methods should be used to estimate lot size.

- New Monumentation – The number of new monuments should be few and can easily be counted manually.
- New Photo Control - The number of new photo control points should be few and can easily be counted manually.
- Point Data – The point data should be provided in a comma-delimited text file that can easily be imported into MS Word or MS Excel. Each line represents a separate feature. The total number of lines is the lot size.
- Elevation Data – Elevation data is a form of point data. The method used above to determine the lot size of point data should be used.
- Derived Vector Data - The number of features can be queried using GIS software.

4.3.3 Generating a Random Sample

Based on the guidelines described above, the next step in the QA process is to randomly select the appropriate number of features based on the sample size indicated in Figure 4.2.1-1. To do this in an unbiased manner, a computerized random generator is recommended. Perhaps the easiest random generator to use is the RAND() function in MS Excel. Using the steps below, this function will yield a list of randomly generated numbers. Since SJC Survey Data Standards require a numeric unique id for each feature, these randomly generated numbers can be used as pointers to a randomly generated list of features in the data layer. The following steps can be used to generate this list:

1. Determine the lot size and sample size as indicated in Section 4.2.3 and 4.2.1.
2. Using GIS software, determine the highest numeric value of the numeric unique id used as the key field in the data set.
3. Open a new worksheet in MS Excel.

4. In any cell, type the following formula =INT(RAND()*[Highest ID Value]). This will generate a randomly generated integer between the value of 0 and the Highest ID Value determined in step 2.
5. Copy the formula down a column in the MS Excel spreadsheet so there are at least twice as many entries as required for the sample size.
6. Sort this list using the ‘Sort’ function from the MS Excel ‘Data’ menu item.
7. Use this list to select GIS features based on their Unique ID, skipping 0s or repeated values.
8. Continue selecting Unique ID values until the required sample size has been reached.

The steps listed above assume that the submitted survey data conforms to SJC Survey Data Standards. If the data has been provided by a source not required to meet these standards, it is possible that numeric unique ids may not exist. This would render the steps above useless. In their place, the sample features can be selected manually. When manual procedures are used, care should be taken to obtain as random of a sample as possible while insuring that the features selected are well disbursed throughout the extent of the data.

4.4 Checking Absolute Positional Accuracy

The primary benefit of survey data is derived from its absolute positional accuracy. This refers to the difference between a feature’s location in the GIS versus its true position on the earth’s surface. In this case, the survey control data provided in Airport Grid should be compared with other data representing the same features in Airport Grid. More information on Airport Grid can be found in document SJC-ACM-AIMS-2400.

For data sets that are provided from sources not required to adhere to SJC standards, it is likely that the data will not be in Airport Grid. In these cases, the data must first be transformed into Airport Grid using the transformation procedure described in SJC-ACM-AIMS-2400.

To validate that the absolute positional accuracy of submitted survey data meets or exceeds the specifications to which it was collected, the following procedure should be used:

1. The GIS layer being tested should be compared with an alternate source of high and known accuracy. For data that was collected outside (i.e. the outside domain), the SJC orthophotos should be used. For data that was collected inside buildings (i.e. the inside domain), the highest accuracy floorplan available should be used. Once the appropriate source has been identified, the data being tested should be over overlaid on top of it.
2. For each of the randomly selected features, measure the distance between the position shown on the submitted data versus the position shown on the source of known accuracy. If this difference plus the error tolerance of the source of known accuracy exceeds the survey specifications then the feature fails the test.
3. Repeat step 3 for all randomly selected features. If the number of allowable errors is exceeded, stop and record that the survey data has failed due to positional accuracy errors.
4. If all randomly selected features are checked and the number of allowable errors has not been surpassed, record that the drawing has passed positional accuracy quality assurance.

4.5 Checking for Tightness of Fit

Survey data is supposed to be highly accurate. Because of this, geometric relationships between newly collected points and existing survey control points should correlate to a tight tolerance. Randomly selected features from the sample set should each be correlated with at least two existing control points in the SJC Survey Control Network (as described in SJC-ACM-AIMS-2400).

5.0 REPORTING OF QUALITY ASSURANCE RESULTS

The results of each QA procedure should be recorded as a means to communicate identified errors to the individuals who will be loading data into the data repository, in the case of data that passes QA tests, and to surveyors who will be required to correct data that fails. The results should identify the file name, format, submitter, date submitted, GIS layer, feature ID, nature of the error and any relevant notes. The form shown in Figure 5.0-1 should be used for this purpose.

Figure 5.0 - 1:
Sample Form for Reporting of QA Results

NORMAN Y. MINETA SAN JOSE INTERNATIONAL AIRPORT

GIS Data Submittals
Results of Quality Assurance

File Name ______________________

Format
☐ GeoMedia Warehouse
☐ ESRI Shape

Submitted By ______________________

Date Submitted ______________________

QA Performed By ______________________

Date QA Performed ______________________

Results

☐ PASS

☐ FAIL

Layer Name	Feature ID	Nature of Error	Notes