GPS Classification Standards

GPS technology may be used to determine relative horizontal and vertical positions with a high degree of accuracy and precision. Due to the implied accuracy of GPS derived survey positions great care must be taken in the gathering and computation of GPS data. GPS control surveys should be completed with the following minimum methodology:

(1) GPS field data should be gathered with sufficient redundancy to identify any blunders.
(2) No polygon of data sets should be closed within one static session.
(3) GPS results should always be computed with a minimum 95% confidence interval for linear and spherical components.

As stated in 343 FW 2.6(C), geodetic surveys requiring accuracies of 1:100,000 or better (conventional First-Order or GPS Order C1) should be done in accordance with the applicable FGCS standards and specifications. Similar to conventional control surveys, the majority of GPS surveys do not require the detailed and complex specifications set forth by the FGCS. With the exception of geodetic surveys requiring relative accuracies of 1:100,000 or better, the following ***Standards for GPS Cadastral Control Surveys using Relative Positioning Techniques*** (Jerry Fiedler, 1992) will be used.

A GPS control survey can be classified as either Class A or Class B, by reference and comparison to minimum distance accuracy and redundancy components. The appropriate class is referenced and determined by evaluating three factors:

(1) Maximum Allowable Distance Error (MADE).
(2) Redundancy Factor (RF).
(3) Distance Standard Error (DSE, referred herein as σ).

Distance Accuracy

The distance accuracy is expressed in terms of MADE.

$$MADE = C(D + 0.33)$$

Where:

MADE is the Maximum Allowable Distance Error expressed in cm.
D is the distance between any two stations expressed in km.
C is a distance classification constant.

Class A; C=2
Class B; C=6

The MADE is compared with three times σ expressed in cm. The σ indicates the precision of a mark-to-mark distance between any two stations. It is derived from a minimally constrained least squares network adjustment. By definition from statistical error analysis, the σ implies 68% uncertainty that the error of a measurement will not exceed the magnitude of the σ (2σ implies 95% and 3σ implies 99.7%). To meet the distance accuracy standard classification the following relationship must be met:

$$3\sigma \leq MADE$$

Redundancy Factor

The GPS redundancy standard is defined in terms of the redundancy classification constant (R) and a redundancy factor (RF). Where R constants are given as follows:

Class A; R=2.5
Class B; R=2.0

The RF is expressed as a ratio of the number of baselines and the number of unknown stations.

$$RF = B/S$$

Where:

RF is the Redundancy Factor.
S is the number of unknown stations.
B is the number of GPS baselines.

A GPS baseline is a mark-to-mark vector (spatial distance) having three components: North, East, and Up; the components are based on a Local Geodetic Coordinate System.

The GPS control surveys are classified and checked according to compliance with relative accuracy and redundancy standards. Table 1 summarizes the classification requirements for GPS surveys. Table 2 gives examples of redundancy factors for a various configurations.

Table 1. GPS Control Survey Classification

Class	Accuracy	Redundancy
A	$3\sigma \leq MADE = 2(D+0.33)$	$RF \geq 2.5$
B	$3\sigma \leq MADE = 6(D+0.33)$	$RF \geq 2.0$

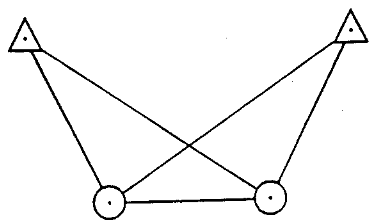
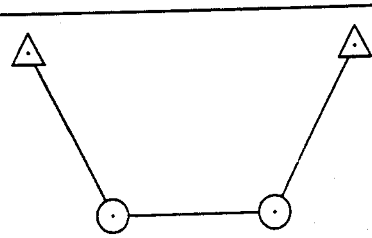
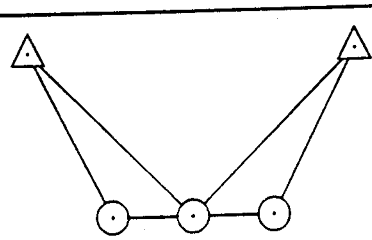
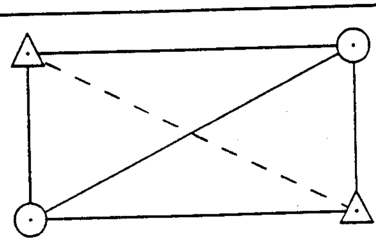
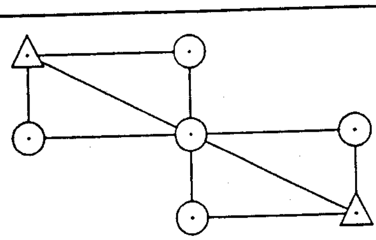
In project planning and contract inspection the RF ≥ R condition must exist to specify or meet a required redundancy classification.

Table 2. Redundancy Factor (RF)

△ = Control Station
⊙ = Unknown Station

$RF = \frac{B}{S}$

B = Number of Baselines
S = Number of Unknown Stations

	B = 5 S = 2 RF = 2.5
	B = 3 S = 2 RF = 1.5
	B = 6 S = 3 RF = 2.0
	B = 5 S = 2 RF = 2.5
	B = 12 S = 5 RF = 2.4