APPENDIX E : CONVERTING LOCATION DATA FOR LOCATION SPECIFIC TEST

Converting Decimal Data to Geodetic Coordinate Data

First, the two measurements must be in the same physical format. The format of the "known" locations was in geodetic coordinates (with degrees, minutes, and seconds), while the CSC data was in decimal format. The evaluation team had to first convert the CSC data into geodetic coordinates.

Example Decimal Format:	**47.57363575**
Converted Degrees:	First two numbers of decimal format (e.g. 47).
Converted Minutes:	(Original decimal format - degrees)* sixty. In this example: (47.57363575 47)*60 = 34.418145. Minutes is first two digits (e.g. 34).
Converted Seconds:	[(Original decimal format - degrees)* sixty - minutes]*60. In this example, seconds equals [(34.418145-34)*60], which equals **25.08870.**

Geodetic Coordinates 47 deg., 34' 25.08870"

Converting Location Data to the Comparable Geodetic Coordinate Systems

The second data conversion involves ensuring that all of the geodetic data is based on the same or comparable geodetic coordinate systems. There are a number of different datums that are used throughout the world, including World Geodetic Datums (such as WGS84), which attempt to describe the shape of the earth over intercontinental distances. National Geodetic Datums (such as NADS3) attempt to describe the shape of the earth over smaller geographic areas. Some of these datums are very similar, while others are somewhat different.

For the PuSHMe location specific test, the "known locations" were previously measured locations provided primarily by the WSDOT with geodetic locations based on the NAD83/91 system, The geodetic locations determined by the two PuSHMe systems are based on different coordinate systems: XyPOINT's locations are based on the WGS84 system. Motorola's locations are

initially determined based on the WGS84 system, but in order for Motorola to settle data with their mapping system, the data had to first be internally converted to NAD27 format. The evaluation team received the data in NAD27 format.

NAD83 is the current standard for USGS maps. It uses the General Reference System of 1980 (GRS-80) ellipsoid which is nearly identical to the WGS84 ellipsoid. NAD83 and WGS84, then, are similar enough to be directly compared. NAD27 data, however, is somewhat different, and first needs to be converted to NAD83 or WGS84.

The evaluation team, then, converted Motorola's data from NAD27 format to NAD83 format. This was done through the use of a conversion program called *NADCON* 2.1

Converting Geodetic Data to the State Plane Coordinate System

Finally, the evaluation team compared the two sets of locations ("known locations" and system derived locations) based on comparable geodetic coordinate systems to determine the location differences in meters. Because the distance (in meters), of a degree, minute, or second varies according to where on the globe the measurement is taken, it is not possible to simply take the differences (in degrees, minutes, and seconds) between sets of geodetic coordinates and multiply the differences by a single conversion factor. One way to determine the distance in meters between two geodetic coordinates is to first convert the geodetic locations to state plane coordinates. The evaluation team used the program *SPCS83* to convert the geodetic locations to the state plane coordinate system.

Determining the Distance Between the Known Monument Locations and the PuSHMe Derived Locations

Once the "known locations" data (based on the NAD83 system) and the PuSHMe systems derived locations (based on the WGS84 or NAD83 systems) were converted to state plane coordinates (in meters), the difference between the two locations in meters could then be determined.

For trials in which users indicated that they were not positioned directly over the monument, the distance users were off of the monument was subtracted from the location difference. Because the users did not always indicate which direction they were away from monument, or the directions were estimates, the "benefit of the doubt" was given to the PuSHMe systems.

To compute the distance between the known monument location and the location identified by the PuSHMe system, the following equation was used:

$$(\text{distance off})^2 = (\text{east meters off})^2 + (\text{north meters off})^2$$

A small portion of the trials resulted in outliers (more than 250 meters off). These trials were removed from the analysis.