In most cases, a Kalman filter is used in the GPS to develop the smoothed positions and in the INS to observe the platform rates, which are then used in the DR solution. The sample system uses a single, 18-state Kalman filter, combining the inputs of both. This arrangement has the advantage of exploiting the benefits inherent in both a highly precise position fixing system and a DR system. However, it also has the disadvantage that it retains the problems inherent in both systems. Therefore, it is necessary to test the system for all the weaknesses discussed in the INS testing section as well as the new problem areas inherent in the GPS system.

If either the GPS or INS inputs are not available, the algorithm continues to produce a navigation solution using the single source of information. The missing information is calculated as needed. The outputs to the operator are similar; however, the accuracies are limited to approximately that of the stand-alone INS or GPS as applicable.

The GPS/INS integration described here is an example of a coupled position fixing/DR system. It will be seen that the test techniques are logically a combination of those used for the sample INS and OMEGA systems used as the examples of pure position fixing and DR systems. The Preflight and Built-In Tests, and the Controls and Displays tests provided in section 3.2 are applicable as written to the sample GPS/INS.

3.6. GLOBAL POSITIONING SYSTEM TEST TECHNIQUES

3.6.1. Initialization and Alignment

3.6.1.1. Purpose

The purpose of this test is to assess the coupled GPS/INS initialization and alignment procedures for their utility for quickly reaching full navigation status, with a minimum of operator time and attention, and the effect that these procedures have upon the set-up sequence of other aircraft systems.

3.6.1.2 General

Since the GPS/INS used for the sample unit is a coupled system, several different configurations must be tested:

1. Fully coupled INS with GPS, initial latitude and longitude provided, P Code installed, on the ground.
2. GPS alone, initial latitude and longitude provided, P Code installed, on the ground.
3. GPS alone, initial latitude and longitude not known, P Code installed, on the ground.
4. Repeat 1 through 3 with the P code not installed.
5. INS alone.
6. Repeat 1 through 5 using an airborne alignment.

Initialization of the GPS requires two phases. In the first phase, synchronization of the GPS user equipment clock with satellite time is performed. In the second phase, the signal from each satellite is acquired, tracked and decoded to calculate a navigation solution. The initialization process typically takes several minutes to perform.

Initialization indications usually include a graphical display as the first satellite and each subsequent satellite signal is acquired. A quality number is provided as the signal for each satellite is decoded. Usually, the display of the first satellite coincides with the completion of the clock synchronization. The quality numbers will typically vary as the quality of the satellite signal changes, such as may occur as the satellite leaves the visible horizon. A separate quality number is usually provided which indicates the state of the complete GPS navigation solution. This number may be in terms of a confidence level with little physical significance or may directly relate to the expected positional accuracy. A discrete is usually provided which indicates that the system is providing the expected navigational accuracy. This will be considered the completion of the initialization phase for the sample system. [Ref. 10].

As the GPS begins the initialization process, it uses the user-entered or previously stored GPS location, approximate time and the stored library of satellite ephemeral data to determine which satellites are within view and which provide the optimal geometry for the navigation calculations. GDOP is as important to GPS as it is for OMEGA. If the location is significantly incorrect, the initialization takes longer since

the GPS must search for which satellites are within view and which are best to minimize GDOP. The test is performed using a known initial location and then performed again under the assumption that the operator knows little about the initial location. The initial position location error magnitude choice is a bit arbitrary, but 300 nm will be used for this test. This number was chosen under the assumption that the operator can be expected to know the correct location to within five minutes of latitude.

The INS initialization and alignment procedures are outlined in the navigation theory section. During a fully coupled initialization and alignment, the highly precise, GPS-derived, initial position is made available to the INS for an initial alignment position. As long as the initial position is known prior to start and the correct position entered into the INS during initialization, this coupling makes little difference in the time required for initialization and alignment. Waiting for the GPS to initialize typically requires more time than is saved in the alignment, and thus, most systems begin the INS procedures concurrent with the GPS and later allow the GPS position to be used to update the INS position after the GPS alignment is complete. The sample system uses this technique.

In most systems, the presence or absence of a P code makes little difference to the GPS initialization process. In the sample system, the only difference is the time required to transfer the code from the cryptographic unit's memory and the BIT on the unit itself. These processes occur during and before the BIT process and thus are timed during the Navigation System Preflight and BIT tests discussed earlier. However, for completeness, the initializations will be repeated without the presence of the P code, to ensure there is no difference in the time required.

All of the ground initialization and alignment configurations can be performed while airborne. Airborne alignment may be required after a very rapid alert launch or after losing the alignment while airborne. Typically, the GPS initialization times will be similar for both the airborne and ground cases. The INS will take significantly longer to align while airborne for the case of the INS alone. The required time is significantly reduced when the GPS is coupled due to the presence of a continuously updating, highly precise fix. The time will still be greater than the ground alignment time.

Initialization of the INS includes providing the system with position and orientation inputs from which to reference the alignment. Alignment involves first leveling the platform and then orienting the true north axis to the geographic true north. Alignment is usually serially dependent upon initialization. The set up of other aircraft systems is sometimes partially dependent upon the presence of an INS alignment. As an example, geostable tactical displays require navigation input to operate. While alignment is taking place, the pilot will have many other tasks to perform, such as turning on other systems, starting the aircraft, attempting to obtain tactical SA, or putting on his or her flight gear and strapping into the aircraft seat. A quick and easy alignment process requiring a minimum of operator inputs and attention is essential.

Several factors can affect the INS initialization and alignment process. Navigation control and display issues, addressed earlier can affect the time and effort required for the entry of the initialization parameters. Outside air temperature can affect alignment time. The colder the temperature of the INS, the longer the alignment will take. Motion of the aircraft can slow the alignment process. Actually moving the aircraft, whether by taxiing or towing, usually requires suspending the alignment with an additional penalty of time as the process is resumed. Alignment latitude can affect the alignment time. An alignment often will take longer at higher latitudes, with a significant delay above 70° latitude. Ship-based alignments usually take 50% to 100% longer than shore-based alignments. Most systems require four to ten minutes for the shore-based initialization and alignment procedure. A wide variance of times can be obtained depending upon the factors listed above and so it is important to carefully record the conditions of the alignment. Since the alignment process takes a significant amount of time, a status indication should be provided to give the pilot an indication of the time left to a complete alignment and to provide feedback that the process is proceeding normally.

Ideally, the system should be checked over the entire range of expected alignment conditions. Checking all conditions is rarely possible. A wide

range of temperature conditions can require much travel, time, or expensive test chambers. Testing the alignment times over a variety of locations also requires expensive travel. This test procedure will be performed at the given test location and current atmospheric conditions providing a spot check of one possible condition. If a choice is available; however, it is always best to test at the expected operational conditions and secondarily at the extremes of the expected range of parameters. For this technique, ship-based alignments will not be discussed. The ship-based test technique is essentially the same except that automatic recording of the continuously changing position and orientation parameters is required.

3.6.1.3. Instrumentation

A stop watch, thermometer (suitable for measuring outside air temperature) and data cards are required for this test. A voice recorder is optional.

3.6.1.4. Data Required

For each of the initialization and alignment configurations, record the time required to input the GPS and INS initialization parameters as appropriate. Record qualitative comments concerning the ease and complexity of the data entry. Note if the initialization process interferes significantly with the start-up and turn-on procedures for the entire aircraft. For all of the configurations, record the surveyed latitude and longitude of the aircraft and the position provided to the INS and GPS as part of the initialization process.

For all of the configurations which include the INS, record the actual heading of the aircraft during alignment (if available via an independent source such as a calibrated compass alignment rose), local magnetic variation and outside air temperature. If a compass rose is not available, record the surveyed alignment position, magnetic compass heading (with deviation applied) and magnetic variation. Record a complete description of aircraft motion during the alignment. For the interrupted alignment, record the elapsed time at interrupt, resumption of the alignment and a complete description of the aircraft movement. Include the new surveyed location and aircraft heading. At the completion of the alignment, record the INS displayed latitude and longitude, magnetic heading, true heading, magnetic variation and the total time for the alignment. Note qualitative comments concerning the utility of the INS alignment status indications including the alignment complete indication.

For all of the configurations which include the GPS, record the approximate heading of the aircraft and any obstructions between the GPS antenna and the sky, including buildings, mountains, vehicles, etc. Record the elapsed time and satellite numbers as each satellite is acquired, and if applicable, dropped. Make comments as to the quality number trends for each satellite. The quality numbers should continuously improve until an adequate fix is calculated. Comment on the utility of the GPS initialization displays for determining the status of the initialization.

3.6.1.5. Procedure

Most airfields have a surveyed compass rose which is used for calibrating installed magnetic compasses. The center of the rose is accurately surveyed in latitude and longitude and magnetic headings are marked around the circumference of the rose. When possible, the alignment should be performed at the surveyed rose to provide accurate position and heading truth data. When a compass rose is not available, perform the alignment at any other surveyed location. Most hangars have surveyed parking slots on the ramp. In this case, an estimate of aircraft heading after alignment can be obtained using the magnetic compass with deviation applied. Local area magnetic variation should be obtained from published field charts, approach plates, en route charts, TPCs, etc.

Large obstructions between the aircraft and the sky may affect the GPS initialization by obstructing the view of satellites. Select a location which is representative of the types of obstructions which will be encountered by operational users. Carefully note any and all obstructions in case problems with satellite acquisition are noted. Heading must still be recorded for the GPS-only initialization; however, the accuracy need not be as precise.

Tow the test aircraft to the local compass rose and record the surveyed position, heading and magnetic variation. If a compass rose is not used, record the surveyed alignment

location, the magnetic heading as displayed on the back-up magnetic compass with deviation applied and the magnetic variation. Allow the INS to remain OFF for at least one hour before beginning the test to allow the components to cool to ambient temperature. Record the outside air temperature.

Using the procedure published for the GPS/INS, perform a coupled GPS/INS initialization. Record the time required for initialization of both systems along with qualitative comments concerning the ease of the initialization procedures and the extent to which initialization distracts the pilot from turning on the entire aircraft. The GPS synchronization and satellite acquisition will begin automatically after the initialization is performed. The INS initialization must be selected by the operator. Start the clock as the GPS initialization is completed and the satellite acquisition begins; and note the elapsed time upon starting the INS alignment. As the alignment progresses, note the quality of the alignment status indicators and of the alignment complete indication. Note as each satellite is acquired and make general comments about how the quality numbers for each satellite progress. When the alignment is complete, note the total elapsed time, the indicated magnetic and true aircraft heading and the magnetic variation. Completely describe any aircraft motion during the alignment process. Repeat the initialization and alignment test before each test flight.

At least one interrupted alignment should be performed. Begin the alignment process at any surveyed point and then tow or taxi the aircraft to the surveyed compass rose to complete the alignment. Record the parameters described above at both the first and second location. Note the elapsed time at interrupt and again when the alignment is resumed.

Repeat the test with the INS turned off, recording only the parameters related to the GPS. Repeat the test again, but this time, provide the GPS with an initial position which is in error by 300 nm. Next, repeat all three tests with the P code not installed. As the final ground task, perform the test with the GPS turned off, recording only the parameters related to the INS. Ensure that for each test including the INS, that the INS has been off for at least one hour.

Perform the airborne initialization and alignments using each of the five test configurations. Prior to the flight, select a flyover point near the field as discussed in the earlier section on The Flyover Method. Take off with both the INS and GPS secured. Initialize the INS and GPS by turning on the systems, allowing the BIT to run and then by flying over the surveyed point and inputing the flyover latitude and longitude as the present position. Start the clock as the point is entered. As on the ground, this is the time that the GPS begins its synchronization and acquisition process. Note the elapsed time when the INS alignment mode is manually selected. Most systems, including the sample system, require a maximum amount of straight and level flying as the INS aligns. The GPS is typically affected little by maneuvering as long as the antenna can maintain satellite visibility. Since the first test is coupled, perform this portion while maintaining a maximum of straight and level flying. Record the elapsed time as each new satellite is acquired and as the initialization is complete. Record as notes the general trends and the satellite quality numbers as each satellite is tracked and the navigation solution converges.

Upon completing the GPS initialization, the sample system uses the GPS position to update the INS position. The final position accuracy must be measured after the alignment. The expected accuracy of the position provided by the GPS makes the measurement problematic while airborne, requiring that the goal of minimum outside instrumentation be violated. Since the required accuracy must be on the order of feet to validate the accuracies of the coupled system, only two sources are typically available. The first is via laser-based tracking and the second is by theodolite. These trackers were discussed in the GPS theory section.

Upon completion of the airborne alignment, also note the total elapsed time, the indicated magnetic heading, INS derived true heading and the magnetic variation. Completely describe any aircraft maneuvers during the alignment process.

Repeat the test with the INS turned off, recording only the parameters related to the GPS. Repeat the test again, but this time, provide the GPS with an initial position which is in error by 300 nm. Next, repeat all three tests with the P code not installed. As the

final task, perform the test with the GPS turned off, recording only the parameters related to the INS.

3.6.1.6. Data Analysis and Presentation

Relate the time required to perform the ground INS and GPS initialization, the complexity of the procedure and the overall operator intensity as a distraction to the pilot as he or she attempts to turn on other systems, straps into the aircraft, starts the engines and gains SA. Compare the initialized aircraft position at the start of the alignment (input by the operator) to the position at the time the alignment is complete. There should be no INS drift during the alignment process and the GPS position should be the same. Apply the actual aircraft heading on the compass rose and the local magnetic variation to equation (21) to obtain true heading. Where a compass rose is not used, apply the magnetic back-up compass heading with deviation applied and local magnetic variation to equation (21) to obtain true heading. The accuracy of the truth data will be degraded. Compare the true heading, magnetic heading and magnetic variation provided by the INS at the time of the alignment to the actual values and relate the difference to the quality of the alignment, the effect that inaccuracies will have upon positional drift and the utility of INS headings for accurately navigating in a mission relatable ingress and attack.

Relate the quality of the status indicator, including the alignment complete indication, as a guide to how long the alignment has left to complete, as a source of confidence that the alignment is progressing normally and as an indicator that the aircraft has an operating navigation system with which to launch. Relate this to the time requirements and stress of an alert launch. Compare the alignment time to the time requirements of an alert launch and to the specification at the ambient temperature recorded during the test. If extreme variation in the alignment time and quality is noted during alignments where aircraft motion is a factor (for instance while maintenance personnel are climbing on the airplane) relate it to the requirement for preflight trouble shooting before aircraft launches. Compare the time for a suspended alignment less the actual time the alignment was suspended, to the time for an uninterrupted alignment. Relate any extreme variation to the requirement to occasionally move aircraft on a crowded ramp during a mass alert sortie.

Relate the time and effort to perform the airborne INS and GPS initialization, the complexity of the procedure and the overall operator intensity as a distraction to the pilot as he or she attempts to fly the airplane on a rapid alert launch. Relate any degradation in the GPS initialization or the INS alignment caused by essential maneuvering and speed changes to the necessity to perform normal navigation after the alert launch. Compare the total time for the GPS to reach full capability and the satellite acquisition times to the times recorded for the ground tests. There should be only minor differences for the airborne initialization. The total INS alignment time should meet the specified requirement and should allow the INS to become aligned before it becomes essential to the mission. This time is typically during the final phases of an attack, where weapons are being targeted.

Compare the GPS-derived position, course, groundspeed and altitude to the truth data. The position and altitude should meet the accuracy requirements as outlined in the theory section. The course and groundspeed should be accurate enough to allow degraded navigation while awaiting completion of the inflight alignment.

Compare the position, course, groundspeed and altitude after the GPS/INS is fully aligned to the specified requirements. Typical position and altitude requirements are discussed in the theory section. Typical course and groundspeed requirements are within the resolution of the heading display and a few knots.

Relate the same parameters for the GPS-only configuration to the necessity to perform the mission after the INS has failed following a rapid alert launch which occurs before either system is ready. For the INS only configuration, relate the parameters to the need to perform the mission after the GPS fails under the same conditions.

Relate the P code absent test conditions to the necessity to perform the mission after loss of the code or after a launch from a location where the code is not available.

3.6.1.7. Data Cards

Sample data cards are provided as cards 48 and 49. For the condition of the GPS turned off and the INS alignment performed independently, use data card 38 from the INS test techniques section. Reuse cards 48 and 49 when the P code is not installed.

CARD NUMBER ___

GPS/INS COUPLED INITIALIZATION AND ALIGNMENT

ALIGNMENT LOCATION _____ _____ P CODE YES/NO

ALIGNMENT HEADING _____ MAGNETIC VARIATION _____

[ALLOW THE AIRCRAFT TO COLD SOAK FOR ONE HOUR. PERFORM A NORMAL COUPLED GPS/INS INITIALIZATION.]

INITIALIZATION EASE/COMPLEXITY/EFFECTS UPON OTHER TURN ON AND START PROCEDURES:

INITIALIZATION TIME _____

[WHEN THE POSITION IS INPUT INTO THE GPS AND INS, START THE STOP WATCH, THEN START THE ALIGNMENT.]

ELAPSED TIME AT START OF ALIGNMENT _____

OUTSIDE AIR TEMPERATURE _____

[NOTE THE ELAPSED TIME AS EACH SATELLITE IS ACQUIRED.]

SAT # _____ TIME _____ SAT # _____ TIME _____

SAT # _____ TIME _____ SAT # _____ TIME _____

SAT # _____ TIME _____ SAT # _____ TIME _____

NOTE QUALITATIVE COMMENTS CONCERNING THE SATELLITE QUALITY NUMBER PROGRESSION AND UTILITY OF THE GPS READY INDICATIONS:

COMPLETELY DESCRIBE ANY OBSTRUCTIONS BETWEEN THE GPS ANTENNA AND THE HORIZON:

TIME WHEN THE GPS READY INDICATION IS PROVIDED _____

FINAL GPS POSITION WHEN READY FOR NAV _____ _____

Card 48: Initialization and Alignment Ground Test Data Cards

CARD NUMBER ___

GPS/INS COUPLED INITIALIZATION AND ALIGNMENT

COMPLETELY DESCRIBE ANY AIRCRAFT MOVEMENT:

[IF THE AIRCRAFT IS TURNED OR TOWED, NOTE THE TIME OF THE SUSPENDED ALIGNMENT AND THE TIME OF THE RESTART.]

SUSPENDED _____ RESTART _____

DESCRIPTION OF AIRCRAFT MOVEMENT DURING SUSPENDED ALIGNMENT:

FOR THE NEW AIRCRAFT LOCATION:

COMPLETELY DESCRIBE ANY NEW OBSTRUCTIONS BETWEEN THE GPS ANTENNA AND THE HORIZON:

ALIGNMENT LOCATION _____ _____

ALIGNMENT HEADING _____ MAGNETIC VARIATION _____

TIME TO COMPLETE THE ALIGNMENT _____

QUALITATIVE COMMENTS CONCERNING THE UTILITY OF THE ALIGNMENT STATUS AND THE ALIGNMENT COMPLETE INDICATORS:

WHEN THE ALIGNMENT IS COMPLETE:

DISPLAYED INS LOCATION _____ _____

DISPLAYED MAGNETIC HEADING _____

DISPLAYED TRUE HEADING_____

DISPLAYED MAGNETIC VARIATION _____

WERE OTHER SYSTEMS/PROCEDURES WAITING ON THE INITIALIZATION OF THE GPS OR INS, OR THE INS ALIGNMENT? IF SO, DESCRIBE:

Card 48: Initialization and Alignment Ground Test Data Cards (Continued)

CARD NUMBER ___

GPS INITIALIZATION (CORRECT POSIT AVAILABLE)

ALIGNMENT LOCATION _____ _____ P CODE YES/NO

ALIGNMENT HEADING _____ MAGNETIC VARIATION _____

[PERFORM A NORMAL GPS INITIALIZATION.]

INITIALIZATION EASE/COMPLEXITY/EFFECTS UPON OTHER PROCEDURES:

INITIALIZATION TIME _____

[WHEN THE POSITION IS INPUT INTO THE GPS, START THE STOP WATCH]

ELAPSED TIME AT START OF TIME SYNC _____

[NOTE THE ELAPSED TIME AS EACH SATELLITE IS ACQUIRED]

SAT # _____ TIME _____ SAT # _____ TIME _____

SAT # _____ TIME _____ SAT # _____ TIME _____

SAT # _____ TIME _____ SAT # _____ TIME _____

NOTE QUALITATIVE COMMENTS CONCERNING THE SATELLITE QUALITY NUMBER PROGRESSION AND UTILITY OF THE GPS READY INDICATIONS:

COMPLETELY DESCRIBE ANY OBSTRUCTIONS BETWEEN THE GPS ANTENNA AND THE HORIZON:

TIME WHEN GPS READY INDICATION PROVIDED _____

FINAL GPS POSITION WHEN READY FOR NAV _____ _____

WERE OTHER SYSTEMS/PROCEDURES WAITING ON THE INITIALIZATION OF THE GPS? IF SO, DESCRIBE:

CARD NUMBER ___

GPS INITIALIZATION (CORRECT POSIT NOT AVAILABLE)

INITIALIZATION LOCATION _____ _____ P CODE YES/NO

INITIALIZATION HEADING _____ MAGNETIC VARIATION _____

[PERFORM A NORMAL GPS INITIALIZATION USING AN INITIAL POSIT IN ERROR BY 300 NM.]

ERRONEOUS INITIAL POSIT _____ _____

INITIALIZATION EASE/COMPLEXITY/EFFECTS UPON OTHER PROCEDURES:

INITIALIZATION TIME _____

[WHEN THE POSITION IS INPUT INTO THE GPS, START THE STOP WATCH.]

ELAPSED TIME AT START OF TIME SYNC _____

[NOTE THE ELAPSED TIME AS EACH SATELLITE IS ACQUIRED.]

SAT # _____ TIME _____ SAT # _____ TIME _____

SAT # _____ TIME _____ SAT # _____ TIME _____

SAT # _____ TIME _____ SAT # _____ TIME _____

NOTE QUALITATIVE COMMENTS CONCERNING THE SATELLITE QUALITY NUMBER PROGRESSION AND UTILITY OF THE GPS READY INDICATIONS:

COMPLETELY DESCRIBE ANY OBSTRUCTIONS BETWEEN THE GPS ANTENNA AND THE HORIZON:

TIME WHEN GPS READY INDICATION PROVIDED _____

FINAL GPS POSITION WHEN READY FOR NAV _____ _____

WERE OTHER SYSTEMS/PROCEDURES WAITING ON THE INITIALIZATION OF THE GPS? IF SO, DESCRIBE:

Card 48: Initialization and Alignment Ground Test Data Cards (Continued)

CARD NUMBER ___ TIME ___ PRIORITY L/M/H

GPS/INS COUPLED INFLIGHT INITIALIZATION AND ALIGNMENT

[INITIALIZE FOR A FLYOVER UPDATE AND ALIGNMENT.]

FLYOVER POINT LOCATION _____ _____ P CODE YES/NO

ALIGNMENT HEADING _____ MAGNETIC VARIATION _____

INITIALIZATION EASE/COMPLEXITY, EFFECTS UPON OTHER PROCEDURES:

INITIALIZATION TIME _____

[NOTE ANY HEADING/SPEED/ALTITUDE CHANGES WITH TIME.]

CHANGE _____ TIME_____ CHANGE _____ TIME_____

CHANGE _____ TIME_____ CHANGE _____ TIME_____

[WHEN THE POSITION IS INPUT INTO THE GPS AND INS, START THE STOP WATCH, THEN START THE ALIGNMENT.]

ELAPSED TIME AT START OF ALIGNMENT _____

OUTSIDE AIR TEMPERATURE _____

[NOTE THE ELAPSED TIME AS EACH SATELLITE IS ACQUIRED.]

SAT # _____ TIME _____ SAT # _____ TIME _____

SAT # _____ TIME _____ SAT # _____ TIME _____

SAT # _____ TIME _____ SAT # _____ TIME _____

NOTE QUALITATIVE COMMENTS CONCERNING THE SATELLITE QUALITY NUMBER PROGRESSION AND UTILITY OF THE GPS READY INDICATIONS:

COMPLETELY DESCRIBE ANY OBSTRUCTIONS BETWEEN THE GPS ANTENNA AND THE HORIZON:

Card 49: Initialization and Alignment Airborne Data Cards

CARD NUMBER ___

GPS/INS COUPLED INFLIGHT INITIALIZATION AND ALIGNMENT

[CALL A MARK TO THE SPACE POSITIONING GROUND STATION WHEN THE GPS IS READY.]

TIME WHEN GPS READY INDICATION PROVIDED _____

FINAL GPS POSITION WHEN READY FOR NAV _____ _____ ALT ___

DISPLAYED TRUE COURSE ___ GROUNDSPEED ____

GROUND STATION SPACE POSITIONING _____ _____

GROUND STATION TRUE HEADING _____ GROUNDSPEED _____ ALT ___

TIME TO COMPLETE THE ALIGNMENT _____

QUALITATIVE COMMENTS CONCERNING THE UTILITY OF THE ALIGNMENT STATUS AND THE ALIGNMENT COMPLETE INDICATORS:

[WHEN THE ALIGNMENT IS COMPLETE, CALL A MARK TO THE SPACE POSITIONING GROUND STATION.]

DISPLAYED INS LOCATION _____ _____ ALT ___

DISPLAYED MAGNETIC HEADING _____

DISPLAYED TRUE HEADING_____

DISPLAYED MAGNETIC VARIATION _____

GROUND STATION SPACE POSITIONING _____ _____

WERE OTHER SYSTEMS/PROCEDURES WAITING ON THE INITIALIZATION OF THE GPS OR INS OR THE INS ALIGNMENT? IF SO, DESCRIBE:

Card 49: Initialization and Alignment Airborne Data Cards (Continued)

CARD NUMBER ___

GPS AIRBORNE INITIALIZATION (CORRECT POSIT AVAILABLE)

[INITIALIZE FOR A FLYOVER UPDATE.]

INITIALIZATION LOCATION _____ _____ P CODE YES/NO

INITIALIZATION HEADING _____ MAGNETIC VARIATION _____

INITIALIZATION EASE/COMPLEXITY/EFFECTS UPON OTHER PROCEDURES:

INITIALIZATION TIME _____

[WHEN THE FLYOVER UPDATE IS PERFORMED AND THUS A POSITION IS AVAILABLE TO THE GPS, START THE STOP WATCH.]

ELAPSED TIME AT START OF TIME SYNC _____

[NOTE ANY HEADING/SPEED/ALTITUDE CHANGES WITH TIME.]

CHANGE _____ TIME_____ CHANGE _____ TIME_____

CHANGE _____ TIME_____ CHANGE _____ TIME_____

[NOTE THE ELAPSED TIME AS EACH SATELLITE IS ACQUIRED.]

SAT # _____ TIME _____ SAT # _____ TIME _____

SAT # _____ TIME _____ SAT # _____ TIME _____

SAT # _____ TIME _____ SAT # _____ TIME _____

CARD NUMBER ___

GPS AIRBORNE INITIALIZATION (CORRECT POSIT AVAILABLE)

NOTE QUALITATIVE COMMENTS CONCERNING THE SATELLITE QUALITY NUMBER PROGRESSION AND UTILITY OF THE GPS READY INDICATIONS:

DESCRIBE ANY OBSTRUCTIONS BETWEEN THE GPS ANTENNA AND THE HORIZON:

[CALL A MARK TO SPACE POSITIONING GROUND STATION WHEN GPS READY.]

TIME WHEN GPS READY INDICATION PROVIDED _____

FINAL GPS POSITION WHEN READY FOR NAV _____ _____

ALT _____

DISPLAYED TRUE HEADING ___

GROUNDSPEED _____

GROUND STATION SPACE POSITIONING _____ _____

ALT _____

GROUND STATION TRUE HEADING _____

GROUNDSPEED _____ ALT _____

NOTE IF SYSTEMS/PROCEDURES WAITING ON THE INITIALIZATION OF GPS:

Card 49: Initialization and Alignment Airborne Data Cards (Continued)

CARD NUMBER ___

GPS AIRBORNE INITIALIZATION (CORRECT POSIT NOT AVAILABLE)

[INITIALIZE FOR FLYOVER UPDATE USING INITIAL POSIT ERROR OF 300 NM]

LOCATION _____ _____ P CODE YES/NO

HEADING _____ MAGNETIC VARIATION _____

INITIALIZATION EASE/COMPLEXITY/EFFECTS UPON OTHER PROCEDURES:

INITIALIZATION TIME _____

[WHEN THE FLYOVER UPDATE IS PERFORMED AND THUS A POSITION IS AVAILABLE TO THE GPS, START THE STOP WATCH.]

ELAPSED TIME AT START OF TIME SYNC _____

[NOTE ANY HEADING/SPEED/ALTITUDE CHANGES WITH TIME.]

CHANGE _____ TIME_____ CHANGE _____ TIME_____

CHANGE _____ TIME_____ CHANGE _____ TIME_____

[NOTE THE ELAPSED TIME AS EACH SATELLITE IS ACQUIRED]

SAT # _____ TIME _____ SAT # _____ TIME _____

SAT # _____ TIME _____ SAT # _____ TIME _____

SAT # _____ TIME _____ SAT # _____ TIME _____

Card 49: Initialization and Alignment Airborne Data Cards (Continued)

CARD NUMBER ___

GPS AIRBORNE INITIALIZATION (CORRECT POSIT NOT AVAILABLE)

NOTE QUALITATIVE COMMENTS CONCERNING THE SATELLITE QUALITY NUMBER PROGRESSION AND UTILITY OF THE GPS READY INDICATIONS:

DESCRIBE ANY OBSTRUCTIONS BETWEEN THE GPS ANTENNA AND THE HORIZON:

[CALL A MARK TO THE SPACE POSITIONING GROUND STATION WHEN THE GPS IS READY.]

TIME WHEN GPS READY INDICATION PROVIDED _____

FINAL GPS POSITION WHEN READY FOR NAV _____ _____

ALT _____

DISPLAYED TRUE HEADING ___

GROUNDSPEED _____

GROUND STATION SPACE POSITIONING _____ _____

ALT _____

GROUND STATION TRUE HEADING _____

GROUNDSPEED _____ ALT _____

NOTE IF SYSTEMS/PROCEDURES WAITING ON THE INITIALIZATION OF GPS:

Card 49: Initialization and Alignment Airborne Data Cards (Continued)