April 20, 1995

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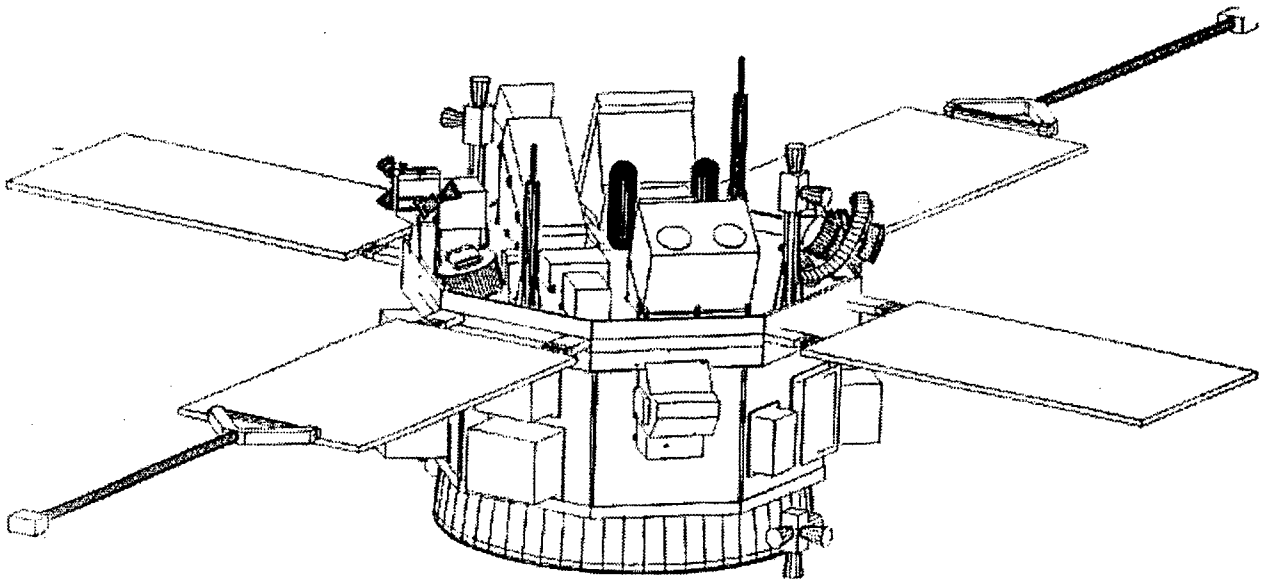
GSFC-410-ACE-019

ACE PROJECT TEST PLAN



FINAL

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ACE Project Test Plan
Signature Page

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1.0 Introduction

This Test Plan documents the approach to the Advanced Composition Explorer (ACE) Project Testing. The Project Testing will be performed to validate the end to end compatibility and functionality of the ACE mission from the spacecraft to the ACE Science Center (ASC).

1.1 Purpose

The purpose of this plan is to identify all of the ACE Project testing, training and activities required to validate the ACE network and ensure the Project's readiness to support launch and perform on-orbit operations. This document will define the process for the Ground Data System Compatibility Testing.

1.2 Scope

The ACE Project Testing encompasses the full list of activities to ensure readiness to support the ACE launch, activation and subsequent on-orbit operations. The major functions to be verified are:

1) End to end system validation - Spacecraft commands from the ASC forwarded to ACE Integrated Mission Operations Center (IMOC) to the ACE spacecraft and telemetry from the ACE spacecraft to the IMOC and ASC, including the level 0 processing.
2) Project Data Base (PDB) validation - Verification of the command and telemetry points, calibration curves, inhibited commands and caution/alarm limit values.
3) ACE spacecraft Radio Frequency (RF) compatibility with the Deep Space Network (DSN) - Verification of space to ground compatibility using the Jet Propulsion Laboratory (JPL) Compatibility Test Trailer (CTT).
4) End to end command/telemetry verification - Spacecraft commands and telemetry to/from the ACE IMOC to the spacecraft at RF through the JPL and the DSN (using the JPL CTT to emulate DSN).
5) Launch Team Training - Training of the Mission Operations Team (MOT) and Flight Operations Team (FOT) to support the launch and early orbit phases of the ACE mission.
6) Contingency Training - Training of the MOT and FOT in anomaly identification and appropriate spacecraft safing and recovery actions.
7) Procedure Validation - Validation of spacecraft procedures; including but not limited to: daily operations procedures, contingency procedures and launch timelines.
8) FOT Training and Certification - Training and certification of the FOT for daily operations of the spacecraft.

These functions are completed through three major testing activities. Spacecraft Ground Data System (GDS) Testing will accomplish the end to end system validation and PDB validation. ACE DSN Compatibility Testing will accomplish ACE spacecraft RF compatibility and end to end command and telemetry verification. Launch team training and contingency training will be accomplished via

simulations. All three of these activities will contribute to and together comprise the procedure validation and the FOT training and certification.

This plan will address all the testing at some level, however, more detail on the ACE JPL/CTT compatibility testing and simulations is provided in other documentation. Figure 1.1 illustrates the relationship of the documentation to the testing and associated functions that are verified.

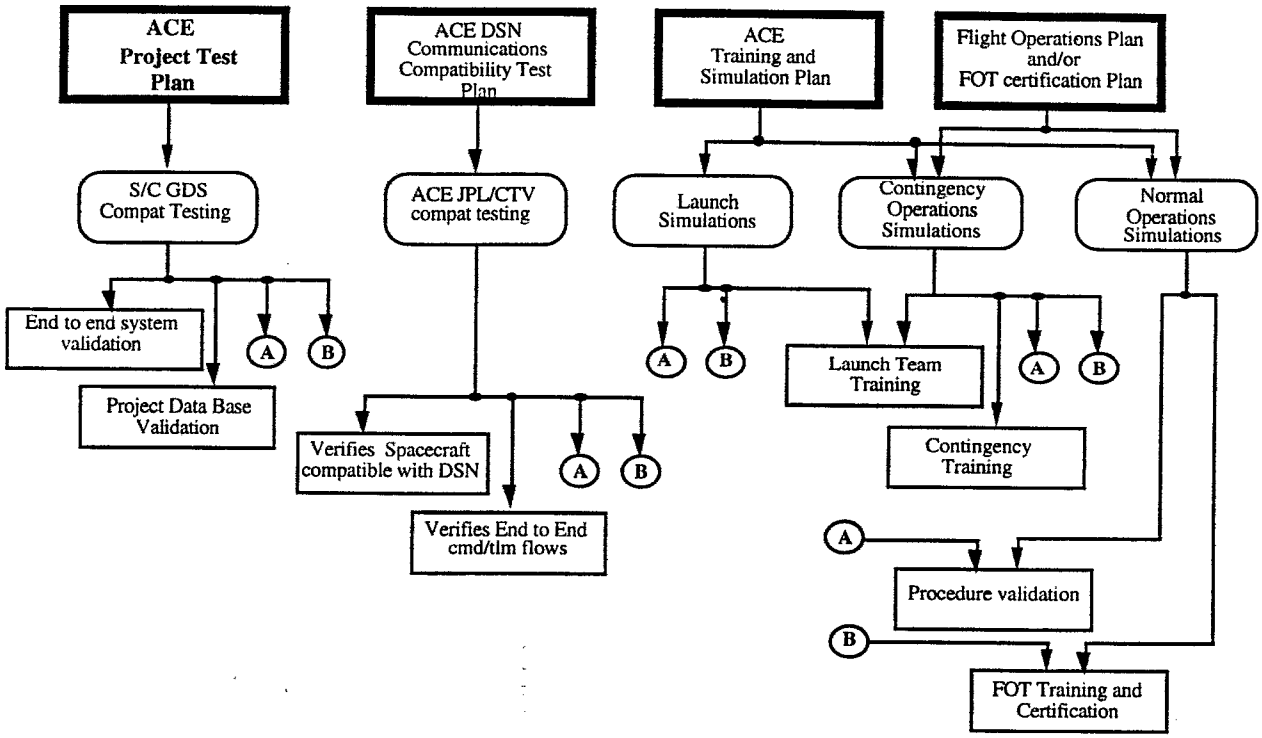


Figure 1.1 ACE Testing Documentation Relationships

This plan will stress the Spacecraft GDS Compatibility Testing. It describes the types of testing to be performed, personnel/group responsibilities for testing, the test procedure development process and sufficient test definition to allow resource planning to be performed. Provided is a high level summary of the testing to be performed to demonstrate that the entire ACE network can support ACE spacecraft daily operations. It defines roles and responsibilities for key ACE Project personnel and other key support personnel with respect to Project Testing. The test procedure development process is defined at a very high level (who is responsible for what and approximately when these products will be required). The scope of this document will be limited to providing sufficient detail to allow resource planning and allocation to be performed and may not specifically document all portions of a certain test. It will define the functions that require validation and then define the responsible groups for ensuring these functions are verified.

1.3 Configuration Control

This document was prepared by the ACE Project Office and is under Code 410 configuration control. Parts of this document will be reproduced and contained in the Code 500 Mission Readiness Plan. Updates will be coordinated by the ACE Data System Operations Project Manager (DSOPM).

Change requests, questions or comments to this document should be directed to:

Mr. F. Snow, Code 410
ACE Data Systems Operations Project Manager
Goddard Space Flight Center
Greenbelt, MD 20771

2.0 DSN Compatibility Testing

DSN Compatibility Testing will be performed between JPL and the ACE spacecraft to verify spacecraft to ground station RF compatibility. Four separate tests are scheduled.

Transponder Test
JPL/CTT Compatibility Test #1 at Applied Physics Laboratory (APL)
JPL/CTT Compatibility Test #2 at Goddard Space Flight Center (GSFC)
Launch Site Testing

The transponder test will be performed at JPL. The ACE transponder will be shipped to JPL to allow compatibility testing to be performed with the JPL RF test equipment. This testing is currently planned to be performed in January 1996.

The Compatibility Test #1 will be performed while the ACE spacecraft is at APL. The JPL CTT will interface with the ACE spacecraft to verify RF compatibility and perform various signal level measurements. Figure 2.1 depicts a proposed test configuration. Testing is currently planned for May 1996.

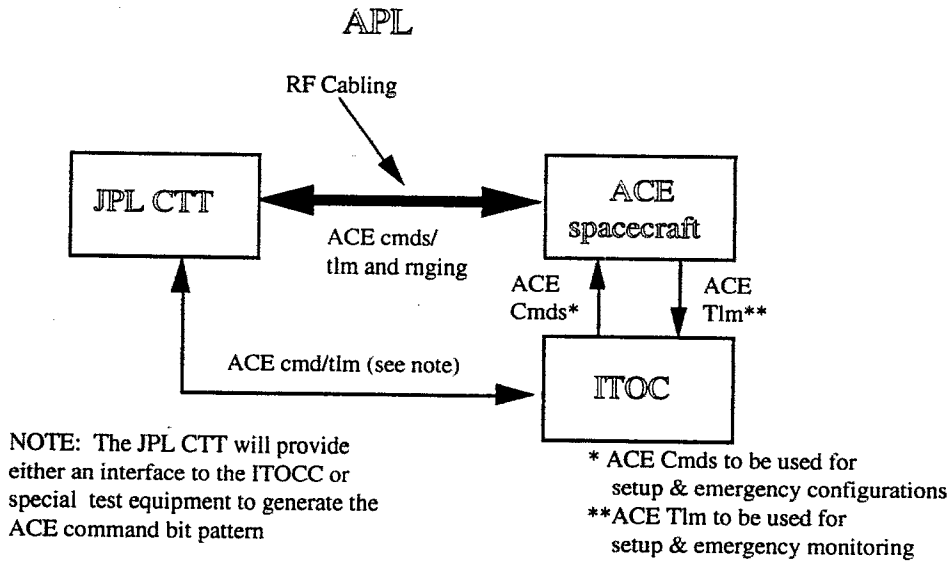


Figure 2.1 Compatibility Test #1 Proposed Test Configuration

The Compatibility Test #2 will be performed while the ACE spacecraft is at GSFC in the thermal vacuum chamber. RF compatibility tests will be performed, along with an end to end command and telemetry flow from the IMOC to the spacecraft (via JPL). Figure 2.2 depicts a proposed test configuration. Testing is currently planned for February 1997.

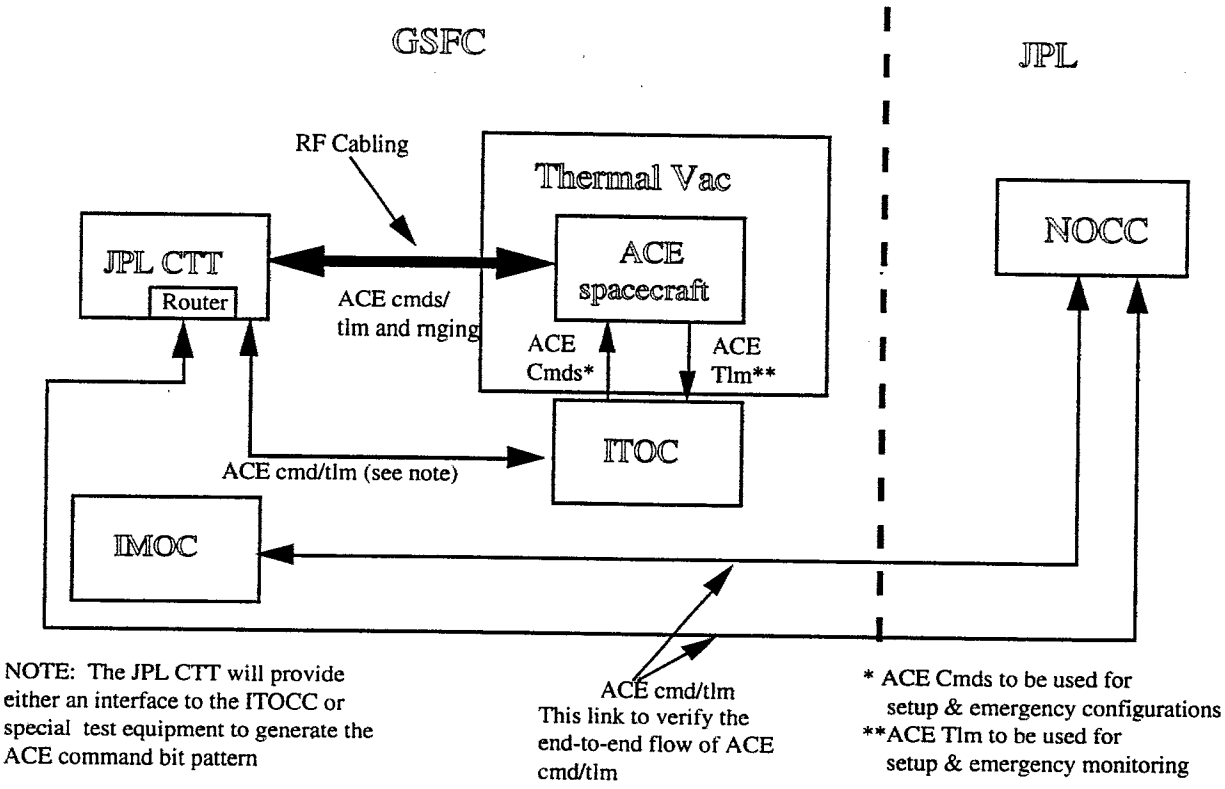


Figure 2.2 Compatibility Test #2 Proposed Test Configuration

The launch site testing will be performed using MIL-71 and will also perform an end to end flow with the IMOC at GSFC. Figure 2.3 depicts a proposed test configuration. Testing is currently planned for July/August 1997.

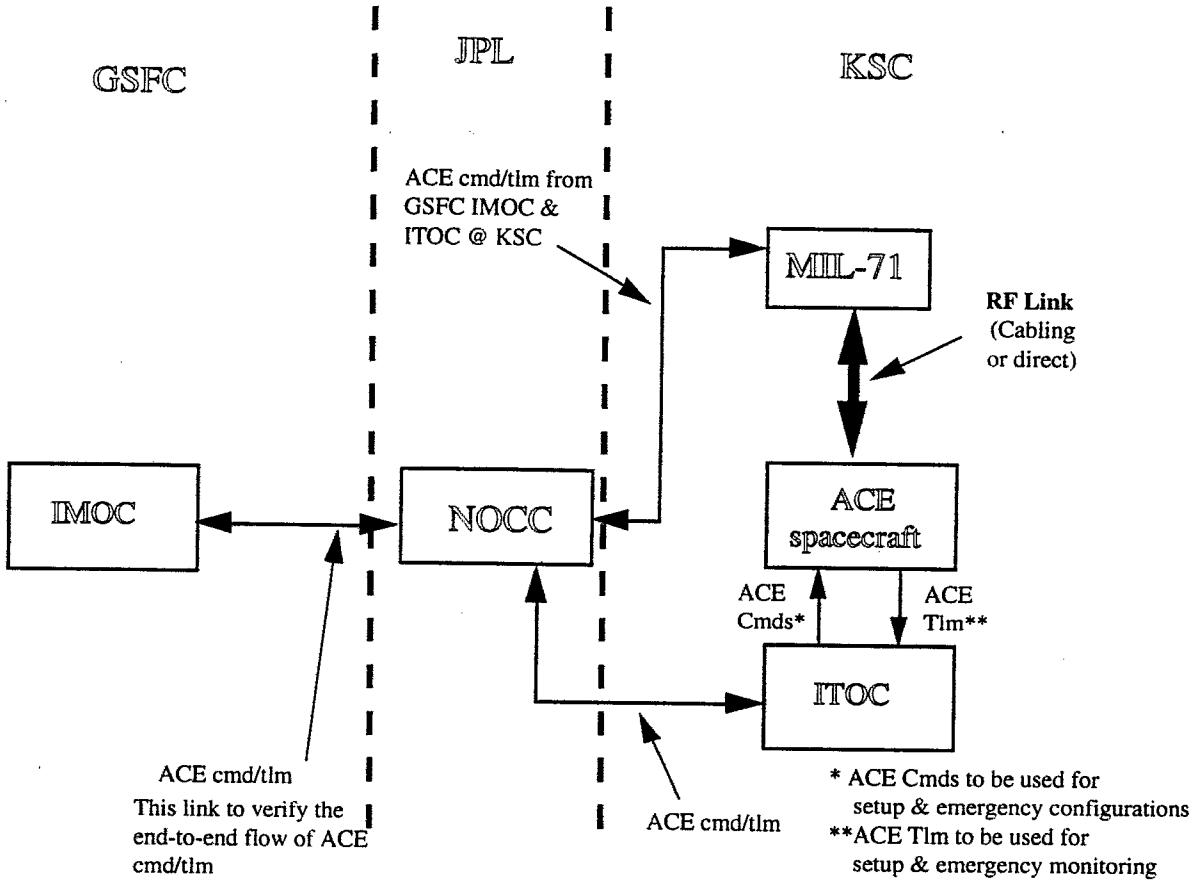


Figure 2.3 Launch Site Test Proposed Test Configuration

Testing dates defined in this document are to be used for planning purposes only. The test descriptions and configurations provided in this document are for informative purposes only. The ACE Detailed Mission Requirements (DMR) defines the testing requirements. The ACE/DSN Communications Compatibility Test Plan provides the details and actual test configurations for the RF compatibility testing.

3.0 Simulations

The goal of the ACE simulation program is to train the MOT and FOT for launch and early orbit operations. Contingency training for both the MOT and FOT is also required. Normal operations training along with a certification program is required for the FOT. The ACE Training and Simulation Plan provides more detail on launch operations training, normal operations training and contingency operations training. The Flight Operations Plan (or the Flight Operations Team Certification Plan) defines the FOT certification process.

4.0 Testing Process and Test Conduct

Project Testing will ensure the ACE Ground System readiness to support ACE spacecraft operations by performing two types of testing. The Operations Validation Testing will be performed to validate functions with each ground system release. This validation testing will be performed after each IMOC release. Spacecraft GDS Compatibility Testing will also be performed between the Ground System and the ACE spacecraft . The Spacecraft GDS Compatibility Testing consists of five tests:

- Eavesdrop Line Testing
- Command Test
- Spacecraft Ground Compatibility Tests 1
- Spacecraft Ground Compatibility Tests 2
- End to End Test at the Cape.

To ensure the spacecraft safety, the process will set up to validate the software release prior to testing with the spacecraft. Once the ground system software is delivered, the software release used to support the Project Testing will not be changed (without proper approval cycle) from the start of the formal Operations Validation testing (run number 2) through the subsequent interface with the ACE Spacecraft.

The Project Testing will be coordinated and scheduled via the normal Mission Readiness Test Team (MRTT) process as defined in the Code 500 Mission Readiness Plan. The DSOPM or his representative will be responsible for ACE Ground System validation. Validation will be required after each Ground System release prior to allowing that software release to command the spacecraft. The Operations Validation testing will consist of defined generic testing with the simulator (or appropriate test bed) followed by a dry run of the GDS Compatibility Test procedure on the simulator (or appropriate test bed). This dry run will not only validate the Ground System, but will also check out the test procedure and allow redlines to be incorporated prior to testing with the spacecraft. The spacecraft will be scheduled and coordinated by the Project and any activities involving a command interface with the spacecraft will require Project approval. The Project will provide Test Conductor support for Project testing with the exception of Eavesdrop Line "target of opportunity" testing. For the target of opportunity testing, the Ground System will only monitor spacecraft telemetry while the APL I&T team is performing testing or checkout activities with the spacecraft.

Prior to each spacecraft test (excluding target of opportunity eavesdrop line testing), a test readiness review will be conducted. This review will be conducted as part of the MRTT process. The Project Test Manager will co-chair the MRTT meeting and the meeting will address at least the following topics: Identification of Ground System releases; Procedure redlines (from validation testing); Impacting DR's; Spacecraft limitations/constraints; Supporting elements input. The Project Test Manager will provide an agenda input to the MRM at least one week prior to the test readiness review.

4.1 Procedure Development Process

Sections 4.1.1 through 4.1.3 explain the procedure development process. These Sections identify the procedures required, the elements responsible for developing procedures (when new procedures are required), and the timetable for the process. The review and approval process will also be defined. The Project Office will have final approval on all procedures which require interfacing with the ACE spacecraft.

4.1.1 Procedures Required

Several types of procedures will be required for the Project Testing. The following paragraphs will define the procedures needed for performing the Project Testing. Three specific types of procedures are required: 1) Ground System Operating Procedures; 2) ACE Spacecraft Procedures; 3) Project Test Procedures. This Section provides detail on the procedures required. Section 4.2.2 addresses the development of Project Test Procedures.

Ground System Operating Procedures will be required for configuring the Ground System to support the testing. These procedures will include System Boot-Up and System Operations Configuration procedures. For the actual performing of spacecraft operations, the Project Test Procedure will either contain the sequence of steps or when available, reference the execution of actual operations procedures. Operations procedures will only be executed on the spacecraft after being validated during the Operations Validation Testing.

ACE Spacecraft Procedures will be required for initial spacecraft configuration for testing, spacecraft special configurations and spacecraft close out upon completion of compatibility testing. Other special spacecraft procedures will be developed as identified. These procedures will be executed by (or under the direction of) the APL I&T test team. The actual Project Test Procedures will contain a step to verify completion of a given spacecraft companion procedure. In certain conditions, the Project Test procedure may contain a step with a checklist to verify the spacecraft is in a safe configuration to proceed.

Project Testing procedures will be required for the Operations Validation Testing and the Spacecraft GDS Compatibility Testing. The Operations Validation Testing consists of a generic system check out procedure followed by a dry run of the Spacecraft GDS Compatibility Test procedure. The generic procedure will be developed to check out the functionality of the Ground System. It will be developed in three sections. Section 1 will contain procedures to test the functions available in the Prototype release. Section 2 will contain procedures to test the functions available in Release 1 . Section 3 will contain procedures to test the functions available in Release 2. Section 3 will be updated as required to support Release 3 testing. Using this approach, the test procedure will be executed to check out the functions as delivered. By beginning each Operations Validation Test at Section 1, regression testing will be incorporated in the Operations Validation process. The Spacecraft GDS Compatibility Test procedures will be written to exercise the spacecraft to Ground System interfaces, also to exercise the overall spacecraft operations (including interfacing with the ASC). Certain functions may not be fully tested due to limitations of the ACE Spacecraft (i.e., firing thrusters to check out burn scenarios). Each of the Spacecraft GDS Procedures will be executed with the ACE simulator (or appropriate test bed) as part of the Operations Validation Testing prior to actually interfacing with the spacecraft.

4.1.2 Responsibility for Procedure Development

Development of the IMOC and/or Ground System Operations procedure is not the responsibility of the Project. The Project review will be performed as part of the normal review cycle for these procedures. The FOT will be responsible for execution of these procedures in their configuring the IMOC and/or Ground System for the test support. They will support the review cycle and will also exercise these procedures as part of their IMOC training.

Development and control of the ACE Spacecraft Procedures will be the responsibility of the APL I&T team. They may choose to use sections of their normal I&T procedures as appropriate. The development process of the Spacecraft GDS Compatibility Test procedure will identify initial spacecraft configurations, special configurations and restricted operations. ACE Spacecraft Procedures or checklists will be developed by the APL I&T team to support the desired configurations.

The Project Test Procedures will be developed by the FOT. The FOT will generate the procedures to support the Operations Validation Tests. The Operations Validation Test procedures will be developed as sections to support the IMOC releases. The FOT will also be responsible for the development of the Spacecraft testing procedures. Outlines will be developed for the Spacecraft GDS Compatibility Tests and End to End Test prior to development. The outlines will be reviewed by the APL I&T team to verify spacecraft ability to support the desired operations and also review the sequence of events to ensure the efficient use of test time (testing ordered to minimize spacecraft reconfigurations). Upon approval of the outlines, the FOT will develop the procedures and a review will be conducted by the APL I&T team. The APL I&T test team will be responsible for reviewing the procedures to ensure no activities are attempted which will endanger the spacecraft or personnel supporting in the immediate vicinity of the spacecraft. The APL I&T team will also be responsible for reviewing the procedures to ensure the correct commands and correct sequencing of commands for the desired operations. When applicable, the procedures may reference execution of a normal operations procedure. These normal operations procedures will require the same approval as the Project Test procedures.

The DSOPM and/or his designee will have the overall responsibility for coordinating the procedure development effort and ensuring all procedures are developed, reviewed and approved at the appropriate Project Level to support the testing. The Spacecraft/GDS Test Procedures will be executed against the simulator (or appropriate test bed) during the Operations Validation Testing as a final verification. Any redlines incurred during the operations validation run will be reviewed and approved by the Project during the MRTT Test Readiness Review.

4.1.3 Timetable for Procedure Development

This section will address the need dates for the ACE Project Test Procedures. Procedures for the Operations Validation testing are required to be issued as baseline for review four weeks prior to their test date. Review comments will be accepted up to two weeks prior to the test and the final version will be issued at least three days prior to the actual test. All procedures which involve interfacing with the spacecraft are required to be issued as a baseline for review at least six weeks prior to the actual spacecraft test. Review comments from the APL test team are required three weeks prior to the testing. After receipt of the APL review comments, a review round table meeting will be conducted to discuss updates. The final version will be available three days prior to the test. Table 4.1.2 provides the need dates based on latest projected test dates.

Test Procedure	Baseline issued	Review comments due	Final issued	Test Date *
Operations Validations Procedures				
Operations Val - Section 1 (Prototype Ops Val Testing)	4 Dec 95	18 Dec 95	30 Dec 95	2 Jan 96
Operations Val - Section 2 (Release 1 Ops Val Testing)	13 Apr 96	27 Apr 96	8 May 96	11 May 96
Operations Val - Section 3 (Release 2 Ops Val Testing)	8 Sept 96	22 Sept 96	3 Oct 96	6 Oct 96
Operations Val - Section 3 update (Release 3 Ops Val Testing)	n/a	23 Feb 97	6 Mar 97	9 Mar 97
Spacecraft Ground Data System Compatibility Procedures				
Eavesdrop Test	6 Sept 95	27 Sept 95	15 Oct 95	18 Oct 95
Command Test	31 Jan 96 **	21 Feb 96	10 Mar 96	13 Mar 96
Spacecraft GDS Compatibility Test 1a	4 May 96	25 May 96	12 June 96	15 June 96
Spacecraft GDS Compatibility Test 1b	10 May 96 **	24 Sept 96	12 Oct 96	15 Oct 96
Spacecraft GDS Compatibility Test 2	5 Oct 96 **	19 Dec 97	6 Jan 97	9 Jan 97
End to End Test (At Cape)	8 Mar 97 **	10 Jul 97	28 Jul 97	31 Jul 97

* Dates provide for the Operations Validation test are rough dates for the Run #1 Validation Test
** Baseline needed early to support dry run test during Ops Val Testing Run #1

Table 4.1.2 Procedure Need Dates

5.0 Personnel Responsibilities

This section identifies key personnel required to support the Project Testing. Personnel descriptions of other key Code 500 personnel, including the Mission Readiness Manager (MRM), are provided in the Mission Readiness Plan. These descriptions are provided to detail each position's responsibilities in support of the ACE Project Testing. Section 5.1 will cover ACE Project personnel and section 5.2 will identify other support personnel.

5.1 Project Personnel

The ACE project is under the direction of GSFC Explorers Project (Code 410). The Explorers Project is under the management of GSFC Flight Projects Directorate (Code 400). Sections 5.1.1 through 5.1.7 describe the Project personnel and their support to the ACE Project Testing.

5.1.1 Associate Project Manager for ACE

The Associate Project Manager has final approval authority for all testing involving the ACE spacecraft. All testing procedures requiring interface with the ACE spacecraft will require the approval of the Associate Project Manger or his designee. The Associate Project Manger will be responsible for resolving all conflicts arising in scheduling spacecraft resources to support the Project Testing.

5.1.2 Systems Manager

The Systems Manager is responsible to the Associate Project Manger for all systems aspects of the flight and ground system segments. He has review and sign-off responsibilities for the Project Test Plan and associated procedures.

5.1.3 Data Systems and Operations Project Manger

The DSOPM is responsible for coordinating Ground System resources in support of the Project Testing. The DSOPM represents the Project in coordination functions for the Project Testing; he will be the first level of Management involved in conflict resolution. If the conflict cannot be resolved at this level, it is elevated to the Associate Project Manager. The DSOPM has review and sign-off responsibilities for the Project Test Plan and associated procedures.

5.1.4 Principal Investigator

The Principal Investigator (PI) will be responsible for reviewing and resolving conflicts resulting from the Science requirements The PI will review the Project Test Plan to ensure the Test Plan (and subsequent test procedures) adequately validate all the interfaces to meet the scientific objectives of the mission.

5.1.5 Instrument Manager

The Instrument Manager is responsible for Test Plan review to ensure adequate checkout of the instrument and ground system compatibility. The instrument manager will be responsible for detailed review of instrument command sequences contained in the test procedures. He will be responsible for ensuring instrument safety through-out the testing process. The instrument manager may provide a representative during testing involving the spacecraft instrument. As required the instrument representative may be required to support the test process to provide authority to proceed for certain instrument sequences. The instrument manager will also be the focal point for coordination for instrument issues during the development of the test procedures.

5.1.6 Spacecraft Manager

The Spacecraft Manager is responsible for reviewing the Test Plan and procedure outlines to ensure adequate checkout of the spacecraft and ground system compatibility. The spacecraft manager will be responsible for detailed review of command sequences contained in the test procedures. He will be responsible for ensuring spacecraft safety through-out the testing process. The spacecraft manager may provide a representative during compatibility testing with the spacecraft. As required the representative may be required to support the test process to provide authority to proceed for certain spacecraft sequences. The spacecraft manager will also be the focal point for coordination of spacecraft issues during the development of the test procedures.

5.1.7 APL Integration & Test Team

The APL Integration & Test (I&T) Team will be responsible for the ACE Spacecraft during compatibility testing. They will be responsible for configuring the spacecraft for the tests, post test spacecraft operations, special configurations including test fixtures. The APL I&T team will be responsible for development of any required spacecraft companion procedures and responsible for execution of these procedures during the testing. The APL I&T team will be monitoring the spacecraft during the testing and will be in a position to initiate spacecraft safing if required. The APL I&T team has the authority to halt the testing to ensure spacecraft safety. The APL I&T team will provide a representative at the IMOC to support the testing. The APL I&T team will participate in the procedure outline review to ensure no harmful spacecraft operations are included and to also review the sequence of testing to ensure the most efficient use of spacecraft time.

5.2 Other Support Personnel

Certain other support will be required to support the ACE Project Testing. The personnel identified in the sections 5.2.1 and 5.2.2 will support the ACE Project Testing as defined.

5.2.1 ACE Science Center

The ACE Science Center will be required to support the testing as they would support operations. These functions include sending instrument command requests, monitoring realtime telemetry (specifically instrument data) and analyzing level zero products produced by the ACE Ground System.

5.2.2 IMOC Support

IMOC support personnel will be required to support the testing to provide assistance in operating the IMOC workstations. Also the IMOC support representative will be able to collect information on the IMOC system performance if an IMOC anomaly were to occur during the testing.

6.0 Key Milestones

The key milestones for the ACE Project testing can be broken into five major events. They are:

1) Eavesdrop Testing
2) Command Test
3) Spacecraft Ground System Compatibility Test #1
4) Spacecraft Ground System Compatibility Test #2
5) End to End Test at the Launch Site

The tests are being scheduled to allow the most efficient checkout of the Ground System. The eavesdrop testing will consist of a quick check-out of the interface between APL and GSFC and also validation of the ACE Generic system's ability to process ACE telemetry. Once the interface has been verified, target of opportunity testing will be performed (the FOT will monitor special I&T activities with the spacecraft to provide training and when possible verify Ground System processing functions; for example if the I&T team is performing a recorder playback the FOT may verify the Ground System ability to ingest the playback telemetry).

The next three tests are being scheduled to allow testing of the IMOC Prototype release, Release 1 and Release 2 respectively. The Command test will test the ability of the Prototype Release to send commands to the ACE spacecraft. This test will verify the command line interface to APL, the ability of the Ground System to transport an ACE command via Internet using ISIS protocol, the IMOC command syntax and also verify the IMOC has the correct timing for generation of commands for the ACE spacecraft. The first and second compatibility tests will validate the functions of IMOC releases 1 and 2 respectively. Spacecraft GDS Compatibility Test 1 will test most spacecraft command and processing functions with the exception of instrument commanding. Spacecraft GDS Compatibility Test 2 will re-validate a subset of items validated in the first test, validate new spacecraft command and processing capabilities, validate instrument commanding and processing and also validate off-line functions (pre-pass mission planning, post-pass trending, level zero processing, etc.).

The last test will be an End to End Test performed at the Cape. The test will verify spacecraft "aliveness" and functionality after the shipment of the ACE Spacecraft and verify IMOC release 3 compatibility. If possible, this test will also include an end to end flow through the Cape RF equipment and back to GSFC through JPL/DSN.

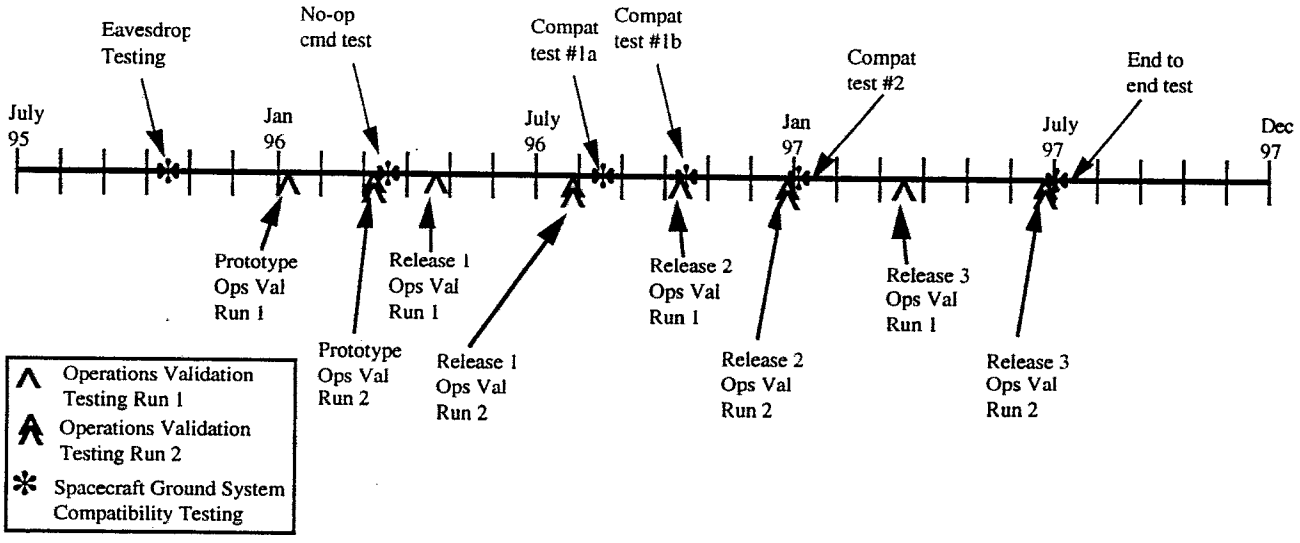
Based on these milestones, the Project has defined the capabilities required for each phase of testing. Table 6.1 provides the capabilities required for each release to support the Project testing.

RELEASE	CAPABILITIES REQUIRED
ACE Generic	Telemetry Processing
IMOC Prototype	Command transmission (and ability to verify in telemetry)
IMOC Release 1	Command and telemetry processing Command to each subsystem All command types (except instrument) All telemetry formats (dump modes, etc.) and data rates
IMOC Release 2	Full functionality (including instrument commanding, pre-pass and post-pass functions)
IMOC Release 3	Clean up of Release 2 discrepancies

Table 6.1 System Capability Requirements

All of the milestones above are the actual testing with the ACE spacecraft. Prior to each test opportunity, validation testing will be performed on each release to verify its integrity prior to interfacing with the spacecraft.

The Project Testing is to be performed at the end of the MRTT test period. The validation testing may actually occur during the last week. The following timeline provides release dates and indicates the Project testing as it is currently scheduled. The dates in this timeline are for planning purposes only.



7.0 Test Descriptions

Project testing consists of two types of testing. Operations Validation testing is performed on each release prior to interfacing that IMOC release with the ACE spacecraft. Spacecraft Ground Data System Compatibility testing is performed to validate the actual spacecraft to ground data system interfaces.

7.1 Operations Validation Testing

The purpose of the validation testing is to validate the IMOC release prior to interfacing with the ACE spacecraft. Each validation test session will consist of a "generic" test to validate IMOC functions as delivered. Upon completion of the generic testing, the Spacecraft Ground Data System Compatibility test procedure will be executed using the ACE simulator (or appropriate test bed). The Operations Validation testing will be performed twice. Run number 1 will be performed during the MRTT test period. The IMOC release will not be frozen and the developers will be able to make fixes to the software during this run of the testing. Run number 2 will be performed after the release is officially delivered and frozen. This will ensure full operations validation of the frozen system prior to testing with the ACE Spacecraft.

7.1.1 IMOC Prototype Software Operations Validation Testing

Test Objective:

To validate the functions of the IMOC Prototype system. Validate the ability of the system to generate ACE commands in the correct syntax for the upcoming Command Test. It also will be verified that the system only sends a no-op and does not inadvertently transmit any other spacecraft commands or bit streams.

Test Description:

This test will consist of executing Section 1 of the operations validation procedure. Section 1 will verify all the prototype functions as well as verify that only desired commands are executed when requested (no spurious bits or commands transmitted by the system). Upon completion of Section 1, the Command Test will be performed using the ACE simulator (or appropriate test bed). The Command Test will be executed to verify the Prototype ability to support the test and will also serve as a dry run of the test procedure.

Test Participants:

The following personnel/support groups will be required to support the test:

- FOT
- IMOC support
- APL I&T Test team representative (during dry run of the No-op test)
- MRM, Test Engineer (TE)

Resources Required:

The following resources will be required to support this test:

- IMOC
- ACE Simulator (or appropriate test bed)
- NASA Communications (NASCOM)

Test Pre-requisites:

IMOC Prototype release integration testing complete.

ACE simulator command processing capability verified (or appropriate simulator functionality).

Test Configuration (Data Flow Diagram):

Figure 7.1.1 depicts the configuration for the test.

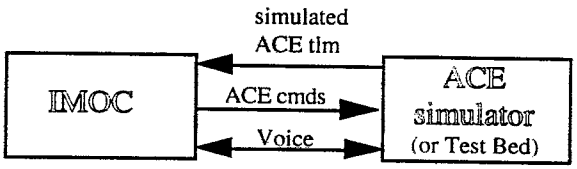


Figure 7.1.1 Prototype Operations Validation Test Configuration

Test Timeline:

The test will consist of 3 days of testing. Day 1 and day 2 will be executing section 1 of the operations validation procedure. Day 3 will be required for the dry run of the Command Test.

7.1.2 IMOC Software Release 1 Operations Validation Testing

Test Objective:

To validate the functions of the IMOC Release 1 system. Spacecraft command and telemetry monitoring functions will be validated to support the Spacecraft GDS Compatibility Test 1.

Test Description:

This test will consist of executing sections 1 and 2 of the operations validation procedure. Section 1 will re-verify all the prototype functions. Section 2 of the operations validation procedure will validate the command and telemetry functions of the IMOC release. Upon completion of Sections 1 and 2, the Spacecraft Ground System Compatibility Test 1 will be performed using the ACE simulator (or appropriate test bed). The test will be executed to verify the Ground System's ability to support the test and will also serve as a dry run of the test procedure.

Test Participants:

The following personnel/support groups will be required to support the test:

- FOT
- IMOC support
- APL I&T Test team representative (during dry run of the Spacecraft GDS Compatibility Test)
- MRM, TE

Resources Required:

The following resources will be required to support this test:

- IMOC
- ACE Simulator (or appropriate test bed)
- NASCOM

Test Pre-requisites:

IMOC release 1 integration testing complete.

ACE simulator command and telemetry functionality verified (or appropriate test bed functionality).

Test Configuration (Data Flow Diagram):

Figure 7.1.2 depicts the configuration for the test.

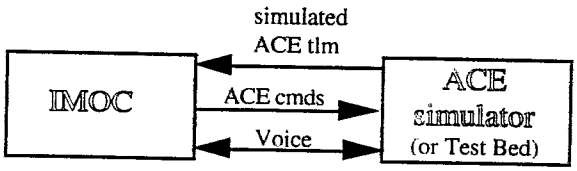


Figure 7.1.2 Release 1 Operations Validation Test Configuration

Test Timeline:

The test will consist of 5 days of testing. Days 1, 2 and 3 will be executing sections 1 and 2 of the operations validation procedure. Days 4 and 5 will be required for the dry run of the Spacecraft GDS Compatibility Test #1.

7.1.3 IMOC Software Release 2 Operations Validation Testing

Test Objective:

To validate the functions of the IMOC Release 2 system. Spacecraft command and telemetry monitoring functions will be validated to support the Spacecraft GDS Compatibility test 2. Instrument commanding will also be verified. Offline pre-pass and post pass functions will also be validated, including interfacing with the ASC.

Test Description:

This test will consist of executing sections 1, 2 and 3 of the operations validation procedure. Sections 1 and 2 will re-verify all the previous IMOC release functions. Section 3 of the operations validation procedure will validate newly delivered functions (including off-line functions) of the IMOC release. Upon completion of sections 1, 2 and 3, the spacecraft ground system compatibility test 2 will be performed using the ACE simulator (or appropriate test bed). The test will be executed to verify the Ground System's ability to support the test and will also serve as a dry run of the test to gather any required red-lines for the test.

Test Participants:

The following personnel/support groups will be required to support the test:

- FOT
- IMOC support
- APL I&T Test team representative (during dry run of the Spacecraft GDS Compatibility Test)
- Flight Dynamics Facility (FDF)
- Science Center
- MRM, TE

Resources Required:

The following resources will be required to support this test:

- IMOC
- ACE Simulator (or appropriate test bed)
- ASC Transportable Payload Operations Control Center (TPOCC)
- NASCOM

Test Pre-requisites:

IMOC release 2 integration testing complete.

ACE simulator command and telemetry functionality verified (or appropriate test bed functionality).

Test Configuration (Data Flow Diagram):

Figure 7.1.3 depicts the configuration for the test.

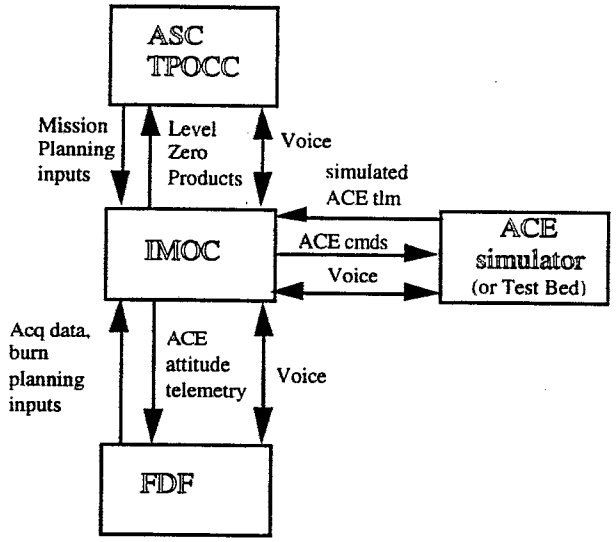


Figure 7.1.3 Release 2 Operations Validation Test Configuration

Test Timeline:

The test will consist of 7 days of testing. Days 1 through 4 will be executing Sections 1, 2 and 3 of the operations validation procedure. Days 5 through 7 will be required for the dry run of the Spacecraft GDS Compatibility Test #2.

7.1.4 IMOC Software Release 3 Operations Validation Testing

Test Objective:

To validate the IMOC functionality after the clean-up release and to validate the new implemented functions of the system. Full Ground System functionality will be validated.

Test Description:

This test will consist of executing sections 1, 2 and 3 (updated) of the operations validation procedure. Any new functions added should have been included in section 3 of the operations validation procedure but "redlined" out prior to the Release 2 testing. Running all three sections in their entirety will ensure proper regression testing and verify full functionality of the system. Upon completion of Sections 1, 2 and 3, the End to End Test procedure will be performed using the ACE simulator (or appropriate test bed). The test will be executed to verify the Ground System's ability to support the test and will also serve as a dry run of the test to gather any required red-lines for the test.

Test Participants:

The following personnel/support groups will be required to support the test:

- FOT
- IMOC support
- APL I&T Test team representative (during dry run of the End to End Test)
- FDF
- Science Center
- MRM, TE

Resources Required:

The following resources will be required to support this test:

- IMOC
- ACE Simulator (or appropriate test bed)
- ASC TPOCC
- NASCOM

Test Pre-requisites:

IMOC release 3 integration testing complete.

ACE simulator command and telemetry functionality verified (or appropriate test bed functionality).

Test Configuration (Data Flow Diagram):

Figure 7.1.4 depicts the configuration for the test.

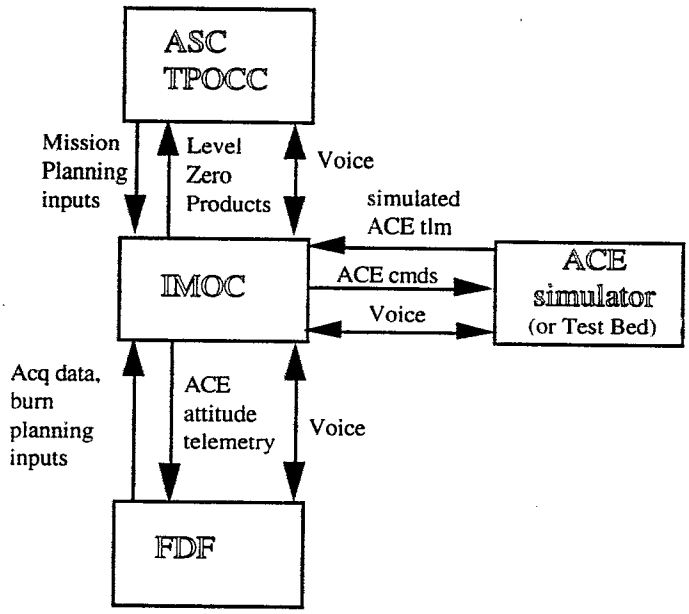


Figure 7.1.4 Release 3 Operations Validation Test Configuration

Test Timeline:

The test will consist of 7 days of testing. Days 1 through 5 will be executing sections 1, 2 and 3 of the operations validation procedure. Days 6 and 7 will be required for the dry run of the spacecraft End to End Test.

7.2 Spacecraft Ground Data System Compatibility Testing

The purpose of the Spacecraft GDS Compatibility Testing is to validate the spacecraft to Ground System interface by interfacing with the ACE spacecraft. The testing will be a building block approach based on the capabilities of the IMOC releases. The first testing performed will be Eavesdrop line testing to verify hard-line interfaces and validate the IMOC's ability to process the ACE spacecraft telemetry. The next test will be the Command Test to validate the commanding functions of the Ground System. Spacecraft GDS Compatibility Test 1 will validate initial command and telemetry functions of the Ground System and Spacecraft GDS Compatibility Test 2 will revalidate initial command and telemetry functions, validate instrument commanding and will also validate other Ground System functions as delivered in IMOC release 2. The End to End Test will be performed with the ACE Spacecraft supporting at the Cape. It will perform an abbreviated validation test to verify spacecraft compatibility after shipment to the Cape. The following sections will provide details of each of the types of testing.

7.2.1 Eavesdrop Line Testing

Test Objective:

To verify the Ground System ability to transfer ACE telemetry from APL to GSFC using the Internet protocol and to process ACE spacecraft telemetry. To verify the integrity of the Eavesdrop line. Provide the Flight Operations Team (FOT) with "On the Job Training" (OJT) by allowing the FOT to monitor I&T testing as it is performed at APL by the spacecraft builders.

Test Description

The test will consist of establishing a hard-line communications link between APL and GSFC IMOC. A formal verification of this interface will be performed requiring one day of ACE spacecraft time. If the spacecraft is not in a position to provide telemetry (due to the level of ongoing I&T activities), either a telemetry generator or test tape at APL can be used to validate the link. All other testing will be performed as Target Of Opportunity testing by the FOT (or IMOC development team) whenever the I&T team is performing spacecraft operations with telemetry output.

Test Participants:

- FOT
- IMOC support
- APL I&T Test team
- MRM, TE

Resources Required:

IMOC

ACE spacecraft (or telemetry generator or telemetry tape at APL)

DSN emulator box

ITOC

NASCOM

Test Pre-requisites:

NASCOM line to APL installed and checked out.

Test Configuration (Data Flow Diagram):

Figure 7.2.1 depicts the configuration for the test.

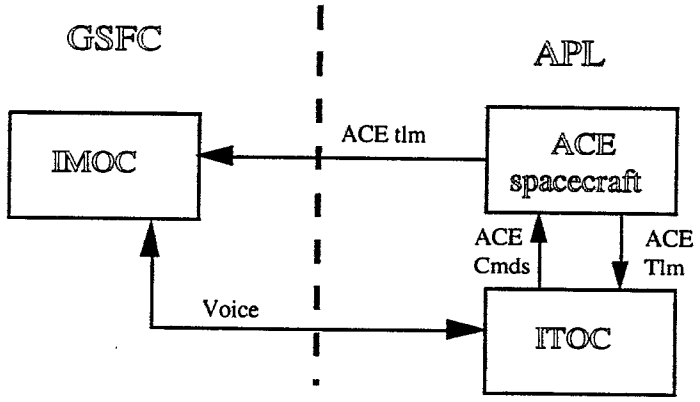


Figure 7.2.1 Eavesdrop Test Configuration

Test Timeline:

One day will be required for initial check-out and verification of the hard-line interface. After this check-out is completed successfully, all other eavesdrop testing will be target of opportunity tests. The FOT will monitor ACE spacecraft activities when the APL I&T team is performing spacecraft checkout with telemetry available.

7.2.2 **Command Test**

Test Objective:

The objective of the First Command test is to verify correct command syntax of the Ground System command transmission. Verify the ability of the Ground System to send ACE commands using Internet protocol.

Test Description:

The test will consist of sending an ACE command (a "No-Operations" command or some benign functional command) from the IMOC to the ACE spacecraft and verify ACE spacecraft acceptance of the command. This test will be performed while the ACE spacecraft is at the I&T facility at APL.

Test Participants:

- FOT
- IMOC support
- APL I&T Test team
- MRM, TE

Resources Required:

IMOC
ACE spacecraft
DSN emulator box
Integration & Test Operations Center (ITOC)
NASCOM

Test Pre-requisites:

Successful completion of the Prototype Operations Validation testing.

Test Configuration (Data Flow Diagram):

Figure 7.2.2 depicts the configuration for the test.

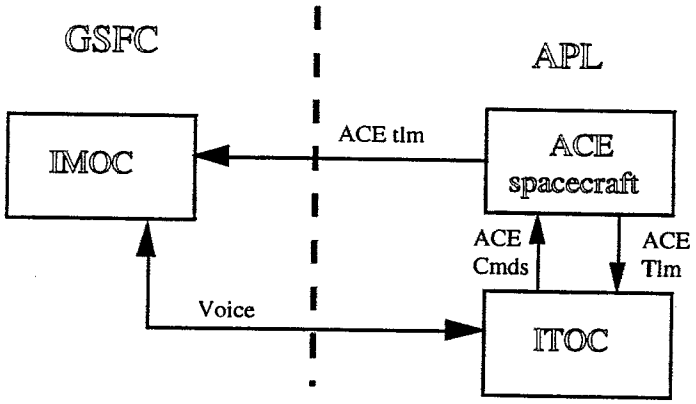


Figure 7.2.2 Command Test Configuration

Test Timeline:

The test should be performed in an 8 hour shift. The first four hours will be for configuring the spacecraft and the command line. The next two hours to perform the command test and two hours at the end to shut down the spacecraft and ensure the command line into the spacecraft from the IMOC is removed.

7.2.3 Spacecraft Ground Data System Compatibility Test # 1

Test Objective:

The objective of this test is to verify functional capabilities of the IMOC system release 1 (realtime commanding, generation of stored memory commands, memory dump and compare functions, etc.). If off-line functions are available in release 1 these functions will be also checked out.

Test Description:

The test will consist of establishing a command and telemetry interface between the ACE spacecraft at APL and IMOC at GSFC. The FOT will exercise Ground System functions. When a spacecraft configuration change is required, the APL I&T test team will reconfigure the spacecraft using their companion procedures.

Test Participants:

- FOT
- IMOC support
- APL I&T Test team
- MRM, TE

Resources Required:

IMOC

ACE spacecraft

DSN emulator box

ITOC

NASCOM

Test Pre-requisites:

Successful completion of the Release 1 Operations Validation testing.

Test Configuration (Data Flow Diagram):

Figure 7.2.3 depicts the configuration for the test.

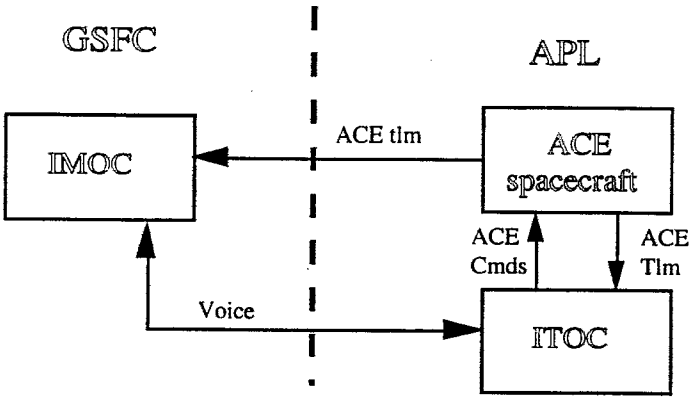


Figure 7.2.3 Compatibility Test #1 Test Configuration

Test Timeline:

The test will be performed during three twelve hour days. This will allow eight hours of spacecraft testing each day. The first two hours will be for configuring the ACE spacecraft and verifying the data lines. The next eight hours will be actual test time and the last two hours will be used to return the spacecraft to a safe configuration. The exact test sequence during the three days will be defined when the test procedure outline is completed.

7.2.4 Spacecraft Ground Data System Compatibility Test #2

Test Objective:

The objective of this test is to verify spacecraft ground system interface functions of the IMOC system release 2, including instrument commanding . Off-line functions will also be checked out.

Test Description:

The test will consist of three different sequences. The first sequence will consist of "pre-pass" activities. Mission planning functions will be validated as they would be performed during normal operations. The second sequence will consist of establishing a command and telemetry interface between the ACE spacecraft at APL and IMOC at GSFC. The FOT will exercise IMOC functions. When a spacecraft configuration change is required, the APL I&T test team will reconfigure the spacecraft using their companion procedures. The third sequence will consist of performing post pass activities as they would be performed during normal operations.

Test Participants:

- FOT
- IMOC support
- APL I&T Test team
- FDF
- Science Center
- MRM, TE
- JPL

Resources Required:

IMOC
ACE spacecraft
DSN emulator box
ITOC
ASC TPOCC
NASCOM
JPL

Test Pre-requisites:

Successful completion of the Release 2 Operations Validation testing.

Test Configuration (Data Flow Diagram):

Figure 7.2.4 depicts the configuration for the test.

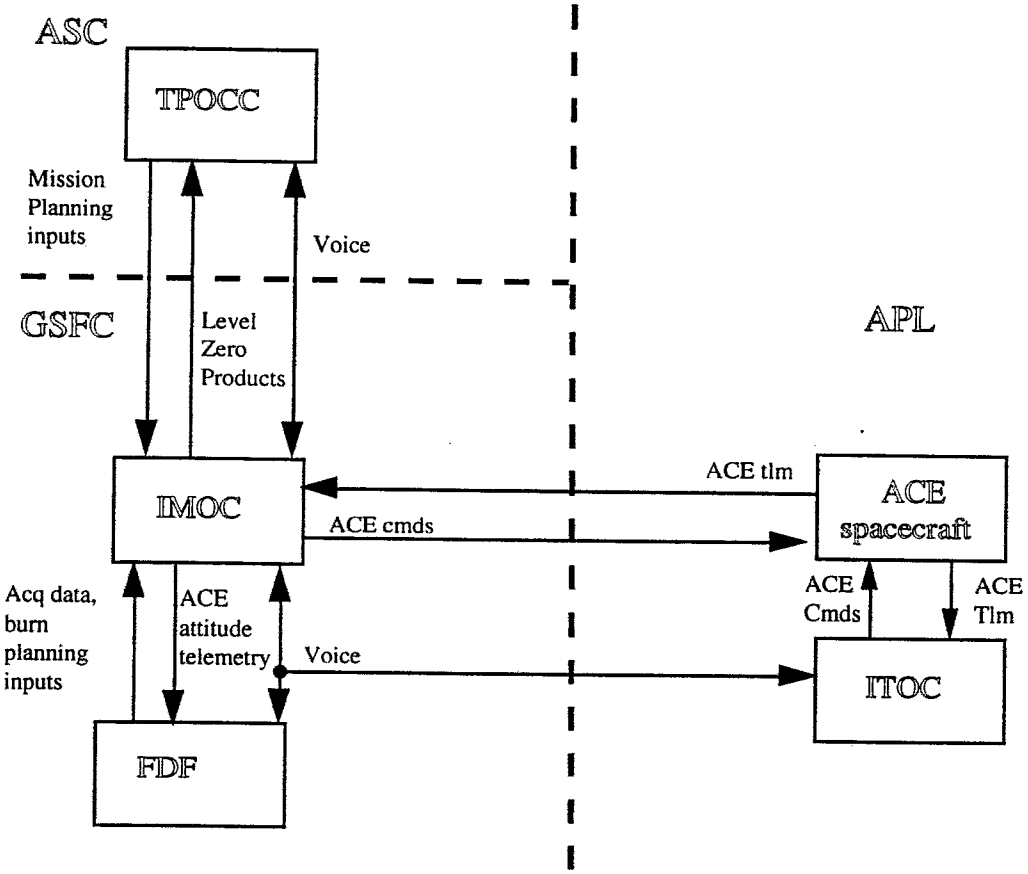


Figure 7.2.4 Compatibility Test #2 Test Configuration

Test Timeline:

The test will be approximately one week. Day 1 will be used to perform the pre-pass functions validation and preparation for interface with the spacecraft. Days 2 through 4 will be twelve hour days interfacing with the spacecraft. The actual test sequence will be defined when the procedure outline is completed. Day 5 will consist of performing the post pass activities on the data received during the day 2 through 4 testing.

7.2.5 **Spacecraft End to End Test**

Test Objective:

The objective of this test is to verify spacecraft aliveness after shipment to the Cape. Another objective is to validate IMOC Release 3 by performing selected regression testing and testing of any items corrected in this release.

Test Description:

The test will consist of interfacing the ACE spacecraft at the launch site with the ACE Ground System. The test will execute select spacecraft/ground system interface functions and any necessary re-test items. Certain pre-pass and post-pass functions will be validated and any necessary re-test items. The test will also attempt to piggy back the MRTT End to End Test with the network and flow command and telemetry through the network interfaces.

Test Participants:

- FOT
- IMOC support
- APL I&T Test team
- FDF
- Science Center
- MRM, TE
- JPL

Resources Required:

IMOC

ACE spacecraft

ITOC

ASC TPOCC

NASCOM

JPL

MIL-71

Test Pre-requisites:

Successful completion of the Release 3 Operations Validation testing.

Test Configuration (Data Flow Diagram):

Figure 7.2.5 depicts the configuration for the test.

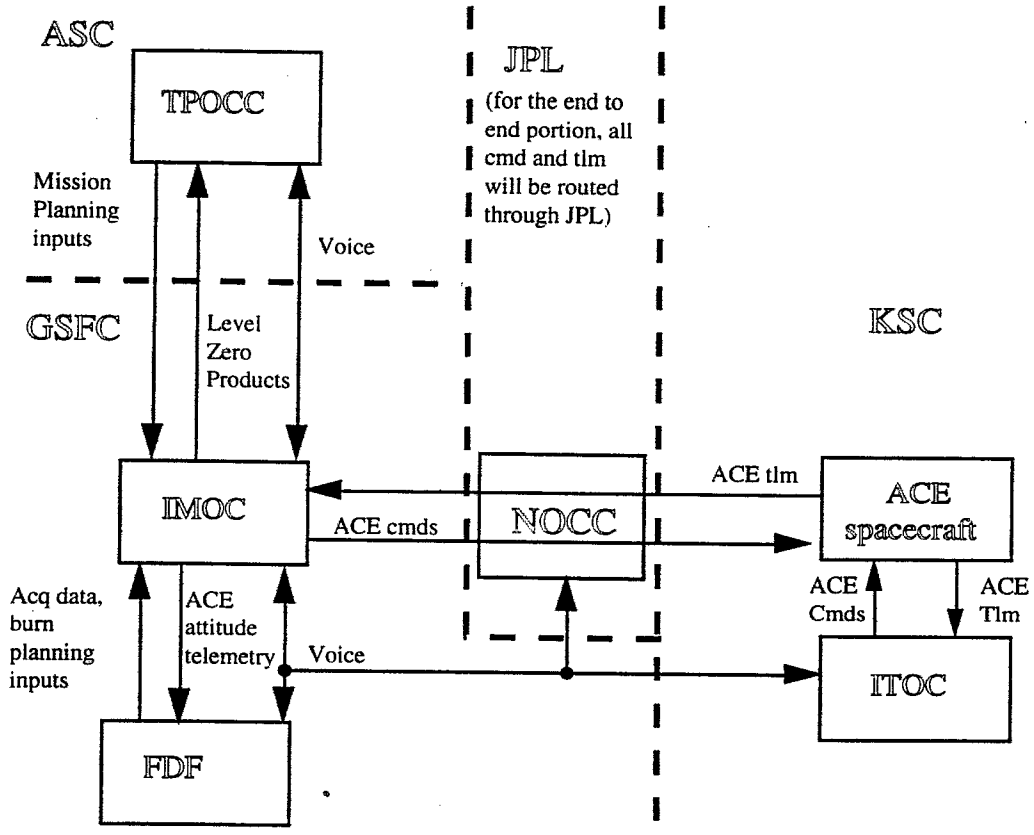


Figure 7.2.5 End to End Test Configuration

Test Timeline:

The test will take three days. Day 1 will be used to perform the pre-pass functions validation and preparation for interface with the spacecraft. Day 2 will be interfacing with the spacecraft and possible supporting the end to end data flow. Day 3 will consist of performing the post pass activities on the data received during the day 2 testing.

8.0 Acronym List

ACE	Advanced Composition Explorer
APL	Applied Physics Laboratory
ASC	ACE Science Center
CTT	Compatibility Test Trailer
DMR	Detailed Mission Requirements
DSN	Deep Space Network
DSOPM	Data System Operations Project Manager
FDF	Flight Dynamics Facility
FOT	Flight Operations Team
GDS	Ground Data System
GSFC	Goddard Space Flight Center
I&T	Integration & Test
IMOC	Integrated Mission Operations Center
ITOC	Integration & Test Operations Center
JPL	Jet Propulsion Laboratory
KSC	Kennedy Space Center
MIL-71	JPL Radio Frequency Facility at Merritt Island
MOT	Mission Operations Team
MRM	Mission Readiness Manager
MRTT	Mission Readiness Test Team
NASCOM	NASA Communications
NOCC	JPL Network Operations Control Center
OJT	On The Job Training
PDB	Project Data Base
PI	Principal Investigator
RF	Radio Frequency
TE	Test Engineer
TPOCC	Transportable Operations Control Center