Chapter 8 – EW FLIGHT TEST PLANNING, EXECUTION, AND OPERATIONS

8.1 INTRODUCTION

Other chapters of this Handbook addressed the technical considerations of EW T&E. This chapter deals with EW flight test execution and operations focusing on large OAR missions; however, many of the underlying principles also apply to other EW flight test operations as well as ground and laboratory testing.

EW flight test missions are complex, expensive, and frequently utilise scarce or shared resources. Disciplined test execution is necessary for test mission success. Test planning should be completed well in advance of the required need date to ensure all technical details are addressed, the required resources will be available, and test methods are applicable and sufficient to evaluate test objectives.

Flight test missions often involve coordinating the activities of multiple aircraft, threat simulators, and dozens of people in multiple locations. Each participant must understand others' roles and responsibilities, as well as their own. Data analysts must also thoroughly comprehend the data acquisition and reduction processes for each data source they will encounter.

8.2 TEST PLANNING

Sound test planning is essential to successful test execution. A test plan documents the detailed objectives, MOPs, data requirements, evaluation criteria, success criteria, test procedures, constraints and limitations. The Data Analysis Plan (DAP) details how the collected data will be reduced, processed, analysed, and used to calculate the MOPs. Detailed documentation is important to make certain that test procedures are repeatable and to smooth transitions during personnel changes.

All test plans should be reviewed by qualified engineering and aircrew personnel for technical accuracy. To aid objectivity and completeness, the reviewers should not be affiliated with the test. Test plans should also be reviewed from a safety perspective by similarly unaffiliated parties. Test plans should typically be approved at least 30 days before the first flight, although this may vary by test organisation.

The test team provides a Programme Introduction Document (PID) to the OAR. The PID describes the purpose and scope of the test programme, and documents the expected resource requirements. The test team should normally provide a PID to the OAR at least six months prior to the expected first flight. More complex efforts may require 12 months or longer lead time. The OAR will then respond to the PID with a Statement Of Capability (SOC) detailing the support the OAR can provide, as well as cost and schedule information. Close coordination between the test team and the OAR throughout the PID/SOC development process minimises risk and uncertainty, and ensures all issues and potential problems are thoroughly understood and vetted.

An important purpose of advanced coordination and planning with the OAR is to allow time for the test team to become completely familiar with the test range. Personnel must understand how the threat simulators operate, how they are instrumented, what the available data products and their sources are, and how the OAR communications systems operate.

Some common factors that must be considered in EW flight test planning are:

- **Flight Profiles** – A test plan should document the flight test profiles in such a way that the reader can understand the methodology underlying the profile, i.e., a knowledgeable reader should be able to relate the profile to the data being collected, the MOPs being calculated, and the objectives

being evaluated. If the test range is known, the profile can be drawn very specifically with waypoints identified and altitudes and airspeeds specified. It is important to correctly identify tolerances for specified parameters, such as airspeed and altitude. Tolerances that are too tight reduce flexibility making execution difficult, while tolerances that are too loose risk inability to meet the objective.

- **Airspace Restrictions** – The test team needs to work with OAR personnel to tailor the test profiles to conform to airspace restrictions. Normally, airspace above the OAR's land range boundaries is restricted and can be dedicated to the test mission if required. However, test requirements frequently necessitate operations outside of restricted airspace. These operations must be coordinated well ahead of time to ensure all test requirements can be met and that objectives or procedures can be modified to accommodate any constraints. Supersonic flight operations and low altitude operations (typically below 500 feet AGL) may also require special coordination.
- **Rules of Engagement** – ROE describe how the ground-based and airborne threat simulators will operate during the test mission. Modern radar systems are extremely complicated and have a variety of operating modes and EP features. It is important to document and communicate what restrictions will be placed on threat simulator operators and the rationale for the ROE. Poorly documented and communicated ROE are a common reason for failing to meet test objectives.
- **Radio Frequency Transmission Coordination** – Radio frequency transmissions from test and support aircraft can disrupt civil and commercial communication and must be coordinated with the OAR's frequency managers. The frequency spectrum and type of transmissions such as noise or false target EA techniques must be identified. Some types of transmissions may generate geographic, altitude, or time-of-day restrictions.
- **Expendable Countermeasures (EXCM) Separation** – EXCM such as chaff, flares, and towed decoys require advanced coordination. Chaff is designed to disrupt hostile radars and can also affect civilian air traffic control radars. Chaff clouds can persist for a long time and can also be carried by the wind. Flares pose a fire hazard when dispensed at low altitude. Towed decoys typically weigh several pounds and can pose a risk to ground-based personnel and facilities if an inadvertent separation occurs. Test planning must consider where the towed decoy operations will occur to avoid over-flying manned sites or high value assets.
- **Support Aircraft** – Several types of support aircraft are often employed in EW testing. Airborne threat surrogates function similarly to ground-based threat simulators by resembling hostile airborne weapons systems. Safety chase aircraft may be required for some operations, particularly those involving EXCM separation for new systems. Specialised aircraft can perform signature and other measurements of the test aircraft, such as IR radiometric measurements. Refuelling tankers can increase test efficiency by extending a test aircraft's time on range.
- **Data Products** – Early coordination with OAR data analysts can greatly reduce post-mission data analysis turnaround times. Early coordination ensures that the test team's data analysis tools are compatible with the OAR data products, either by specifying data format requirements with the OAR or by modifying the analysis tools to make them compatible. Processing sample data products from the OAR before testing begins is an excellent risk mitigation procedure.

8.3 FLIGHT TEST EXECUTION

Successful EW T&E test mission execution on OARs requires the disciplined, concerted efforts of numerous people in multiple locations. Accurate and concise documentation for all participants is essential to effective test mission execution. Test planners must understand the roles and responsibilities of the various participants to ensure efficient and effective test execution.

8.3.1 Mission Execution Documentation

The test plan and DAP provide a comprehensive description of the overall test effort. A sufficiently detailed test plan supports the creation of flight and test mission cards that are thorough, yet concise, organised, and targeted to specific readers. The importance of well-written flight and test mission cards cannot be overstated, as they can mean the difference between mission success and failure.

Flight cards provide aircrews with all of the necessary information about each test point. At a minimum flight cards should contain:

- OAR entry and exit procedures;
- Radio frequencies and call signs;
- Test point numbers;
- Test profile diagrams with waypoints and airspace limitations;
- Altitudes and airspeeds with tolerances;
- Manoeuvre information; and
- SUT configuration details and operating procedures.

Pilots and other aircrew members operate in a high-workload environment and in tight quarters; they need complete information formatted for the quickest reading. Superfluous details, extraneous words and inconsistent styles can cause delays or confusion with detrimental results. During a typical RWR test, for example, the test conductor, SUT analysts, and threat simulator radar operators must know the threat simulator modes, such as frequency, PRI, or scan type. This information is generally unnecessary to the pilot and therefore should be omitted from flight cards.

The Test Director (TD), Test Conductor (TC), system analysts, and threat system operators should have mission cards containing the details required to execute each test point. Events happen quickly in a flight test mission. Just as with flight cards, mission cards should be succinct, well-organised and contain only vital information. For a given test point, the threat simulator operators need to know the ROE for target engagement and how to configure their radars so this information should be included on their mission cards. If they do not need to know how the SUT is configured, then SUT configuration details should not be on their mission cards.

Additional SUT and flight test documentation such as the test plan, safety procedures, flight manuals, etc., should be available in the mission control room for SUT troubleshooting or emergencies.

8.3.2 Test Mission Participants and Conduct

Figure 8-1 illustrates the participants and their interaction in a typical EW OAR flight test.

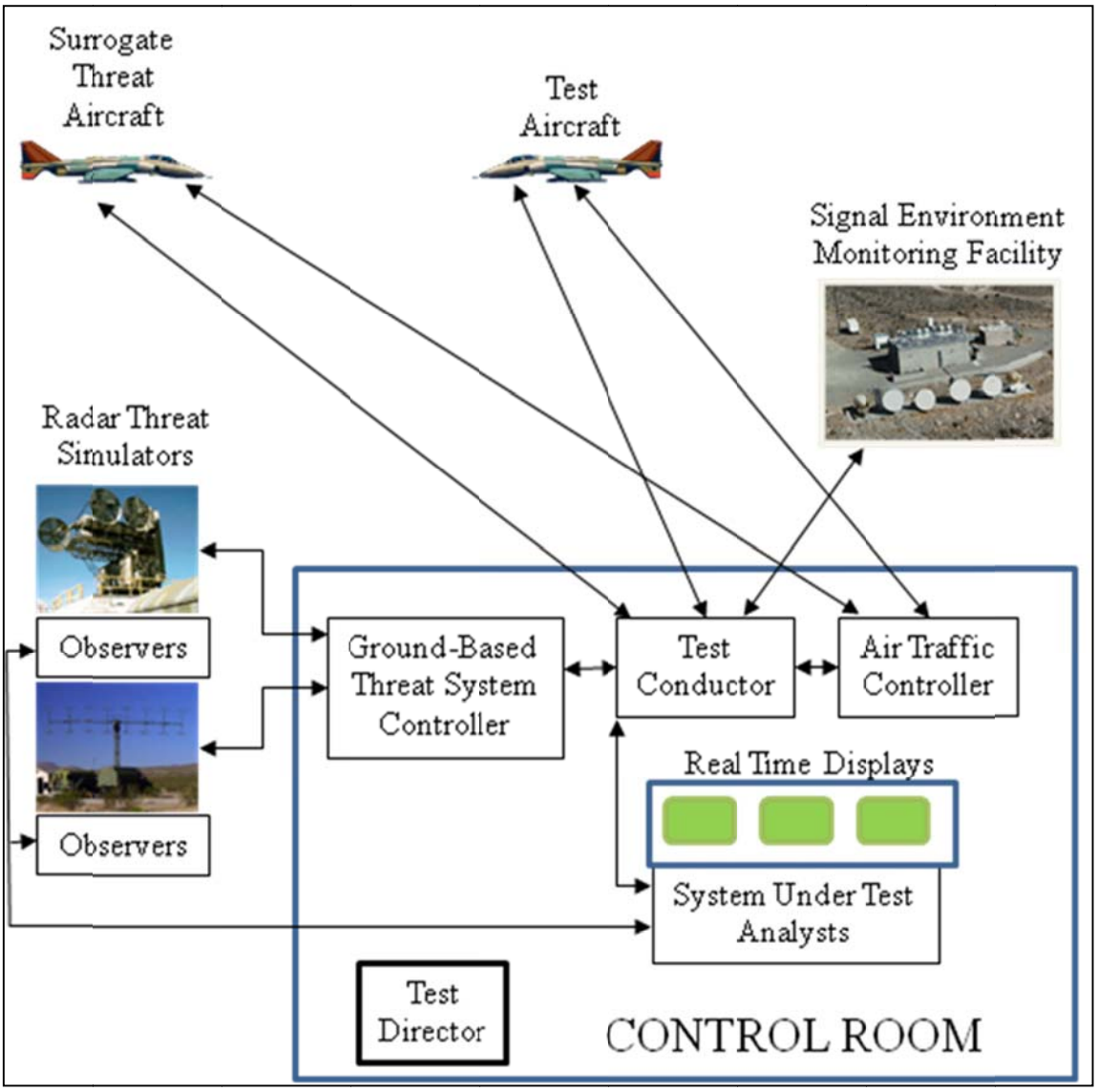

Figure 8-1: Typical EW OAR Mission Participants.

- **Test Director** – The TD has overall responsibility for a test mission. The TD is ultimately responsible for safe and efficient mission execution and generally does not get involved in the details of the test point-by-test point conduct of a test mission. The TD must maintain a separation from the mission details to ensure the mission is conducted safely and avoid becoming fixated on the mission details and losing overall perspective. The TD needs to have substantial aircraft and sub-systems knowledge to assist the aircrew in the event of an emergency. The TD also makes real-time decisions when there are planned or unplanned mission changes that could affect mission success or test point completion.
- **Test Conductor** – The TC coordinates the step-by-step execution of each test point as documented on the test cards. For safety reasons, the TC has limited discretion to deviate from the approved test procedures documented on the test cards. The TC ensures that all active participants (the test aircrew and air traffic controllers, threat system controllers, and analysts) are ready to perform the

duties associated with the current test plan. In test missions with multi-position aircraft, particularly those with complex EW suites, an airborne test conductor can coordinate the activity within the aircraft. However, an airborne TC should always take mission direction from the TC in the control room, who will always have the most complete knowledge of the overall mission situation, particularly the operational status of the threat simulator systems and their availability to participate on a given test point.

- **SUT Analysts –** The engineers and analysts are experts on the SUT and its performance. They monitor the real-time SUT data as well as data from the threat simulator systems. When the SUT is not operating as expected, these experts advise the TD and the TC regarding how or whether the mission should continue.
- **Ground-Based Threat System Controller –** The ground-based threat system controller communicates the details of each test point to the threat simulator operators who will be participating on a given test point. Typical information details include frequencies, PRIs, modes, and ROE. The ground-based threat system controller also communicates information about threat system maintenance status to the TC and the system analysts, which allows them to react to changes in threat system availability.
- **Air Traffic Controller –** The air traffic controller directs the activity of airborne assets including test aircraft carrying the SUT (or SUTs) and surrogate threat aircraft. The air traffic controller also coordinates the test aircraft range entry and egress process, and handles other air space coordination issues.
- **Test Aircraft Aircrew –** The aircrew fly the test aircraft and operate the SUT(s) and onboard instrumentation. They operate under the direction of the TC and/or the air traffic controller. In multi-crew member aircraft, mission support aircrew can monitor onboard instrumentation systems and provide additional information to system analysts in the control room beyond what telemetry data provide.
- **Test Support Aircrew –** The test support aircrew operate airborne threat surrogate aircraft or airborne measurement aircraft under the direction of the TC and/or the air traffic controller.
- **Signal Environment Monitoring Facility** – The signal environment monitoring facility provides an important resource to analysts during the mission. The facility can monitor threat simulator outputs and the transmissions generated by the SUT(s), including ECM signals. It also monitors the environment for signals that are not part of the test setup, as extraneous signals can interfere with the performance of the SUT.
- **Threat System Observers –** The threat system observers supply information about the effectiveness of a given ECM technique. Many ECM techniques are visually subtle; a knowledgeable observer at a threat site with the radar operators can be an invaluable source of information. Observers need to be familiar with the specific threat system they will be observing, as well as the ECM technique design and its intended effect(s).

8.4 OAR DATA COLLECTION

The purpose of a flight test is to collect data, which is used to calculate MOPs for test objective evaluation. The flight test team must understand what data are available and how the data will be obtained and processed. Figure 8-2 illustrates the various data sources and how they are collected.

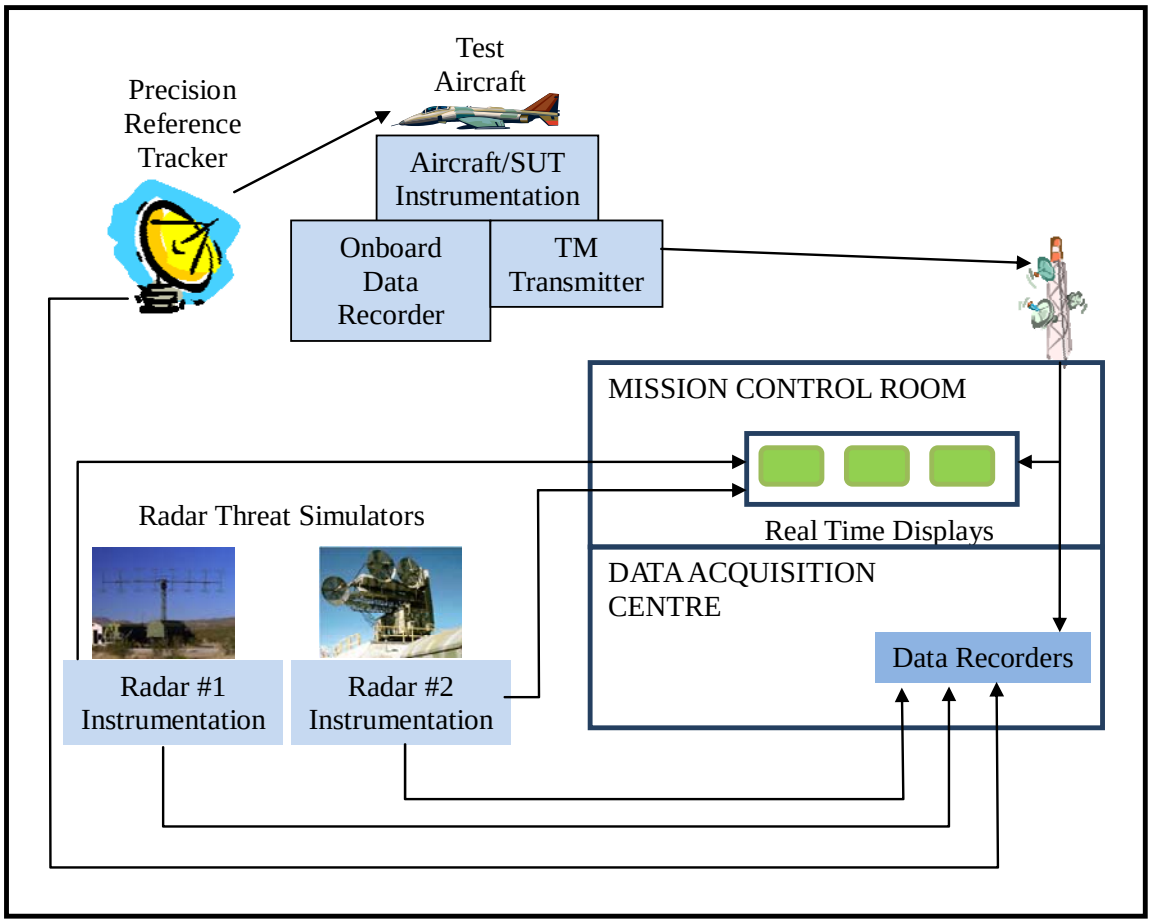

Figure 8-2: EW OAR Test Mission Data Sources and Routing.

There are three primary points of data collection:

- **Test Aircraft** – The SUT(s) will generally have onboard data recorders to capture, store and transmit time-encoded critical test data. Certain aircraft parameters, such as position and attitude, are frequently recorded as well. Modern data recorders are normally solid state devices, although magnetic tape recorders are still common. Video capture devices record the aircraft displays, directly where possible. Telemetry (TM) allows selected critical parameters to be transmitted from the test aircraft for real-time processing and display to analysts in the control room. TM provides analysts with instantaneous data to determine if the system under test is operating as expected.
- **Threat Simulator** – Instrumentation is largely system specific, and should be researched and understood by the data analysts. Common parameters are: system on time, system off time, operating frequency, PRI, and EP modes. These parameters are commonly extracted from the system, time encoded and transmitted to a data acquisition centre where they are recorded. The OAR personnel will normally work with customers to provide data in customer-specified formats and media. During flight testing, video and certain parameters can be extracted and provided to SUT analysts in the control room to support real-time analysis.
- **Precision Reference Tracker** – Precision reference radar trackers are less important than they were in the past due to the increasing availability of GPS-based TSPI sources, although they still are generally available and have applications. A variety of radar types provide TSPI for aircraft. Each OAR can provide information about the radar types they employ. Radar beacon transponders can greatly enhance TSPI radar accuracy.