

Goldstone Radio Spectrum Protection

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Goldstone is located amidst several military installations where equipment used in the test and training activities is a source of potential electromagnetic interference to the Goldstone tracking receivers. Coordination of the military and NASA Goldstone activities in the Mojave Desert Area is an effective method to protect the Goldstone radio spectrum while maintaining compatible operations for the military and Goldstone.

I. Introduction

One of the prime reasons for selecting Goldstone as the site for the NASA DSN and STDN spacecraft communications stations was its remote location, which provides protection for the sensitive receivers from local interference. The RF environment has changed significantly since Goldstone began operations in 1958. There has been and will continue to be an expansion of the civilian and military use of the radio spectrum for communication, navigation, detection, guidance, and electronic countermeasures (ECM). Each additional system may present a potential electromagnetic interference threat to the DSN/STDN stations.

The present electromagnetic interference (EMI) environment exists because Goldstone is located within one of the largest military training areas in the United States, designated the R2508 Complex. Goldstone's location within the complex is illustrated by Fig. 1. On the northern and eastern boundaries of Goldstone is Fort Irwin (R-2502). Fort Irwin has recently been selected as the Army National Training Center (NTC) and when fully operational the U.S. Army will evaluate techniques

and tactics and conduct training in a realistic warfare scenario. On the western border of Goldstone is the Naval Weapons Center (R2524). The Naval Weapons Center is engaged in testing and evaluating new weapon systems including electronic warfare (EW) systems. To the south and west are several gunnery ranges used to conduct both airborne and ground forces training.

Because of the potential for EMI occurrences within the R-2508 Complex, a NASA/DOD Memorandum of Understanding (MOU) was published on 18 December 1978 to provide a means of coordinating activities for minimizing the impact of potential conflicts. The MOU states that the Department of Defense and the National Aeronautics and Space Administration will jointly establish a Mojave Coordinating Group (MCG) for operational coordination, scheduling, and problem resolution. The primary functions of the MCG are to coordinate major DOD events, classify NASA tracking events, analyze compatibility of events, coordinate facility modifications, and develop procedures. No real-time coordination functions are performed by the MCG as a group. All real-time

coordination is conducted between individual members of the group as the need arises. The MCG, as chartered by the MOU, sets the rules.

II. Functions of the MCG

The MCG is a professional military and civilian technical management group interested in protecting a vital national resource, the radio spectrum. To efficiently protect the radio spectrum and the individual interests of each member of the group requires advance coordination of each major DOD/NASA event. As soon as a major activity is conceived it is the responsibility of the sponsor of the activity to arrange for a project briefing for the MCG. Each member of the MCG must examine the details of the activity and determine the impact, if any, to the organization he is representing.

The specific functions of the MCG are: to coordinate major DOD events, to classify NASA tracking events for specific protection, to analyze compatibility of events, to coordinate facility modifications, and to develop procedures.

A. Coordination of Major DOD Events

At every MCG meeting a representative of the Western Area Frequency Coordinator presents a DOD Operations Schedule. The schedule lists future R-2508 DOD operations by program, sponsor, location, and date. If there are any conflicts of interests, the affected parties may either discuss the problem at the meeting or by personal contact at a later date.

In addition, the military representatives provide a preview of major military exercises in the Mojave Desert far in advance of the actual occurrence. Details of the exercise are expanded as operational plans develop. Goldstone is primarily concerned with the nature of the systems to be deployed, frequencies, air activities, and troop deployment. It is the responsibility of the Goldstone Radio Spectrum Coordinator to protect not only the radio frequency environment but also to protect the physical environment of the Goldstone Complex.

B. Classification of NASA Goldstone Tracking Events

Classification of NASA Goldstone tracking events means sorting the satellite and spacecraft tracking events in terms of their relative importance to mission success. There are 3 classes of NASA Goldstone events.

Class 1 Critical Events are so important in terms of science-mission success or personnel safety that uninterrupted tracking and data acquisition must be guaranteed. The following are Class 1 events:

- (1) Initial acquisition through spacecraft stabilization.
- (2) Primary mission events, including planetary encounters, orbit insertions, probe entries, landings, and selected orbital/surface operations.
- (3) Shuttle flights requiring acquisition/recovery by the Goldstone STDN.
- (4) Spacecraft emergencies when designated by the NASA Associate Administrator for Space Tracking and Data Systems.

Class 2 Sensitive Events are highly important in terms of science-mission objectives. The following are Class 2 events:

- (1) Trajectory correction maneuvers.
- (2) Spacecraft attitude maneuvers
- (3) Spacecraft/satellite emergencies
- (4) Station calibrations for Class 1 events
- (5) Solar conjunctions
- (6) Precision navigation tracking cycles
- (7) Other selected events:
 - (a) Planetary operations
 - (b) Radio astronomy planetary radar
 - (c) Far-encounter operations
 - (d) Readiness tests
 - (e) Spacecraft calibrations

Class 3 Routine Events are those events which do not meet the Class 1 or Class 2 criteria, but require normal spectrum protection. When possible, Class 3 events are scheduled to avoid activities having known EMI sources.

The classification of Goldstone NASA DSN/STDN events is normally performed by the Goldstone Radio Spectrum Coordinator in conjunction with information from the Jet Propulsion Laboratory flight project offices. The Goldstone Radio Spectrum Coordinator continually reviews the schedule of events and updates it for submission to the MCG. Each month a teletype message is transmitted to all interested organizations, listing the Class 1 and Class 2 events, the times that Goldstone requires spectrum protection, and the specific spectrum protection required.

C. Analyzing Compatibility of Events

If there is any question of compatibility, the Electromagnetic Compatibility Analysis Center (ECAC), located in Annapolis, Maryland, will be requested to produce a computer

profile of the system planned for the Mojave Desert Area. ECAC has access to many commercial and military equipment specifications, including some classified systems. ECAC also has on file the susceptibility characteristics of the DSN and STDN antenna and receiver systems. The ECAC analysis will compare the frequency, power, and the spectral characteristics to existing systems and submit a written report of their findings to the MCG or to the MCG requestor. Based upon ECAC's findings a determination will be made concerning the compatibility of the equipment with established operations. Prior coordination will be required when specific equipment or events present interference potential.

D. Coordinating Facility Modifications

Facility modifications may seem to have no relationship to the radio spectrum and little potential impact on activities other than those of the involved facility. Actually, however, facility modifications may create not only an EMI problem but also a safety problem. It is the responsibility of the sponsor to present a modification briefing to the MCG for examination by the members.

Examples of modifications that could impact Mojave operations are DSN high-power radiation power increases, installation of the Goddard Mobile Laser (MOBLAS), relocation of the Cuddeback air/ground gunnery range, and construction of new facilities.

E. Development of Procedures

The MCG depends upon the Central Coordinating Facility (CCF), which is knowledgeable of all operations in the R-2508 complex, to recognize problems and conflicts as they arise. It is necessary for the CCF to adopt standard operating procedures that have been recommended by the MCG.

In addition to the CCF procedures, each facility in the R-2508 complex has its own local operating procedures. The MCG as a group produces procedures to control, coordinate and isolate radio spectrum problems in the Mojave Desert Area.

III. Real-Time Coordination

Real-time coordination mainly involves those events requiring attention prior to the bimonthly MCG meetings. These events could be special weapons tests, aircraft/EW activities in the R-2508 complex and surrounding airspace, Goldstone high-power radiation requirements, and NASA spacecraft emergencies and personnel emergencies, or they could include assistance in identifying the source of any external radio frequency interference thought to have caused an unexpected data interruption or signal degradation.

A prerequisite to real-time coordination is the availability of adequate means for communication. A two-digit hotline provides a dedicated, point-to-point telephone link between sponsors, ranges, and operational areas in the R-2508 complex (See Fig. 2). NASA/DOD teletype circuits are also used to coordinate on a day-to-day basis. Future plans call for the addition of at least one Autovon line to Goldstone for contacting the many military agencies outside the R-2508 complex.

A. Event Notification

Although most NASA spacecraft events are scheduled well in advance, most of the routine military operations conducted in the area are not. However, the need for adequate advance notification of scheduled events is constantly stressed, as time is required to analyze the impact of the activity on the DSN/STDN missions.

B. EMI Avoidance

The majority of military activities involving EW emitters or airborne telemetry are coordinated to minimize the potential for EMI. However, one of the difficulties is that in many of the activities there are uncertainties such as the actual frequency bands to be used, the power of the radiation, and the time period or the area in which the activity will take place. When an activity is thought to pose an EMI threat, efforts are made to provide sufficient distance or frequency separation to avoid interference.

C. Contingencies

In the event NASA has a spacecraft emergency, all military activities that have the potential to cause EMI to Goldstone will be requested to terminate the emitters at the earliest possible time.

IV. Spectrum Protection Requirements

The stringency of the type of spectrum protection required for an event depends upon its classification according to the provisions of paragraph II.A. Spectrum protection for the three classes of Goldstone tracking events is provided as described below.

Class 1 Critical Event

- (1) No airborne EW within line of sight of Goldstone.
- (2) No airborne Tactical Air Navigation System (TACAN) transmissions on Channels 116 through 126 within 50 nautical miles of Goldstone.
- (3) No operation that would have a theoretical possibility of EMI impact on Goldstone.

- (4) Specific spectrum protection for the STDN for shuttle missions will be coordinated through the Western Area Frequency Coordinator (WAFC) until standardized protection is established.

Class 2 Sensitive Event

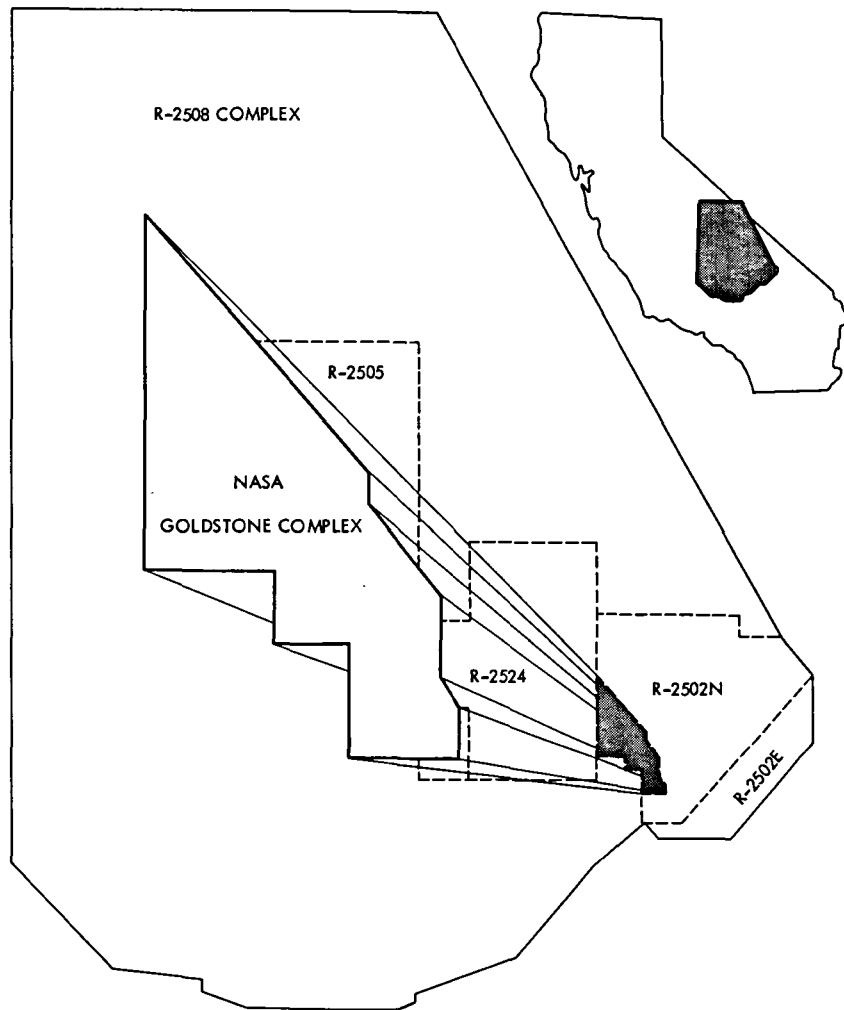
- (1) No airborne noise jamming 1800-2700 MHz and 7900-9000 MHz within line of sight of Goldstone.
- (2) No airborne repeat jamming 2150-2350 MHz and 8350-8550 MHz within line of sight of Goldstone.
- (3) No airborne TACAN transmissions on Channels 116 through 126 within 50 nautical miles of Goldstone.
- (4) No airborne EW to be conducted using EA-6B, EF-111 or EF-16 aircraft within line of sight of Goldstone.
- (5) Specific spectrum protection for the STDN for launch pass coverage will be handled in near real-time with the WAFC, due to instability of the launch dates/times.

Class 3 Routine Events

- (1) NASA and DOD activities to be scheduled and coordinated for compatibility.
- (2) Predictions of EMI potential provided to the flight projects.

V. Conclusion

Protection of the Goldstone radio spectrum is very essential to the safeguarding of data communications capabilities between spacecraft and the Goldstone tracking antennas. This spectrum protection is being successfully accomplished through the mutual coordination and cooperation of the DOD and NASA Goldstone representatives in spite of the high density of potential military sources of electromagnetic interference. The maintenance of operational compatibility between both agencies is essential and continued coordination and cooperation are considered to be the key elements in maintaining this compatibility.



FORT IRWIN (NATIONAL TRAINING CENTER) - R-2502E & R-2502N
U.S. NAVAL WEAPONS CENTER - R-2505 & R-2524

Fig. 1. NASA Goldstone location within the R-2508 Complex

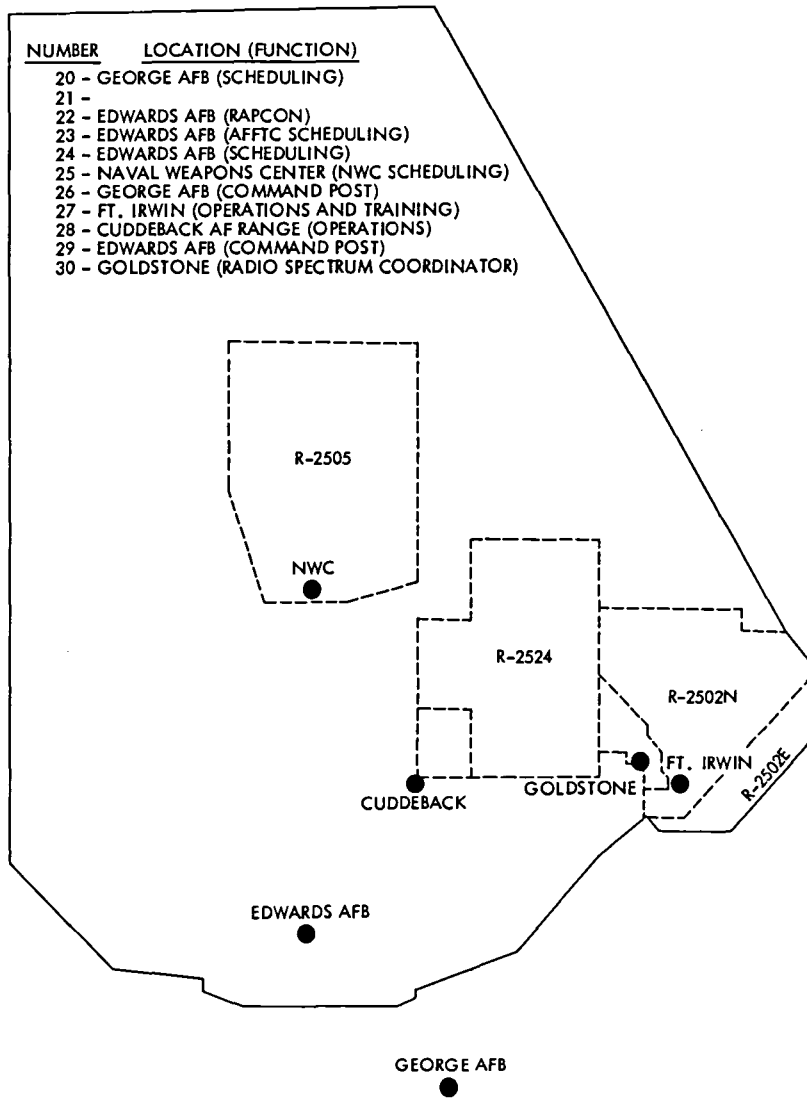


Fig. 2. R-2508 Complex two-digit hotline