1. Introduction

The Autonomous Rotorcraft Project operates two Yamaha RMAX helicopters (Fig. 1-1). This document describes the system telemetry and communications with the ATC tower.

Fig 1-1. AFDD Autonomous Rotorcraft Project RMAX helicopter in operation at Fort Hunter Liggett in California.

2. RC Control

The Yamaha RMAX transmitter is shown in figure 2-1. This transmitter is purpose-built by Yamaha for use with the RMAX. The transmitter is ruggedized, with a metal housing and is weather-sealed.

The transmitter is configured as a typical helicopter RC transmitter with collective and yaw control on the left and cyclic on the right. Trim adjustment can be made for the four axes. RPM trim adjustments can be made via a covered pot at the top of the transmitter. On the upper right edge is a switch that is used for engaging and disengaging the autonomous flight control system. A red momentary switch in the upper left is used to kill the engine. Directly adjacent to the engine kill is a rotor air brake switch which commands the collective to its full down position to help slow the rotor once the vehicle has landed.

The transmitter frequency is in the 72 Mhz band. RMAX tail no. 444 uses 72.11 Mhz (Ch 16) and tail no. 445 uses 72.13 Mhz (Ch 17). The setting can be changed between these two frequencies using a screwdriver in a rotary switch on the back of the transmitter.

Fig 2-1. RMAX RC transmitter.

3. Telemetry

In addition to the RC control, there are two means of communicating with the RMAX helicopter.

A 1W 900-928 Mhz frequency-hopping Freewave radio modem is used as the primary means of telemetry. Over 900 variables are downlinked and recorded via this link. Telemetry of these data uses approximately half of the available throughput.

A second telemetry pathway is an amplified 1W 802.11g connection. This pathway is used primarily for the video downlink JPEG stream.

4. Crew Communications

Communications between the crew members is achieved using a dedicated channel on the NASA Ames UHF trunking radio system. Both the External Pilot (EP) and the Safety Observer (SO) wear trunking radios with headsets. In the ground station is a third trunking radio installed in an in-vehicle with headsets and the ground computer sound wired in. All three trunking radios are set to also scan the Moffett ATC tower ground traffic radio frequency. All radio communications is recorded along with the SA video and downlink data. The same trunking radio can be

used to talk directly to the NASA Ames safety and security dispatch.

5. ATC Communications

Communication with the Moffett ATC tower is done using the UHF ground frequency on the trunking radios described above. All ATC ground radio traffic is continuously monitored. The primary responsibility for communications with the ATC tower lies with the SO. Any movement by the ground station, permission to begin operations, etc. is coordinated with the ATC tower. The ATC tower is always kept informed of the RMAX status (airborne, landed, etc.). The RMAX is able to cease operations and land within one minute of being notified by the tower to do so.