DSS 13 Antenna Subsystem Automation

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Unattended station operation has been implemented at DSS 13, permitting full operational control from NOCC. Sensors have been installed in the mechanical subsystem to monitor critical functions. These are arranged to permit automated premission checkout of the subsystem, automated reaction to component failure, and identification of failed components under control of the antenna pointing computer. This monitoring installation will serve as a prototype for monitoring equipment to be installed throughout the DSN.

I. Introduction

Unattended station operation has been implemented at DSS 13, permitting full operational control from the Network Operations Control Center (NOCC). Sensors have been installed in the mechanical subsystem to monitor critical functions. These are arranged to permit automated premission checkout of the subsystem, automated reaction to component failure, and identification of failed components under control of the antenna pointing computer. This monitoring installation will serve as a prototype for monitoring equipment to be installed in the DSN.

II. Automated Premission Checkout

The function of a premission checkout is to assure that all of the antenna subsystem equipment required for tracking and for automated response to an equipment failure is functioning. The automated checkout, controlled by the Modcomp pointing computer, was planned to be carried out in the following steps:

(1) Verify that the wind velocity on site is within acceptable limits.

(2) Verify that the level in the servo hydraulic fluid reservoir is within the prescribed limits.

(3) Start the servo high-pressure pumps and the filter circulating pumps and verify that these are operating.

(4) Verify hydraulic pressure at the azimuth and elevation servo valves.

(5) Start the gear drive lubrication pumps and verify lubrication pressure or flow.

(6) Test the drive brakes as follows:

  (a) Set in a zero rate command for each axis.

  (b) Release the brakes for each axis, and verify that the brakes release.

  (c) Reset the brakes for each and verify that they set.

(7) Check the drive operation as follows:

(a) Release the brakes and sound the horn.

(b) In low-speed mode, command a small rate in each axis.

(c) Calculate $\Delta\theta/\Delta t$ for each axis over a small period and verify that the antenna is moving at the commanded rate.

(d) Read the analog rate signal from the antenna and verify that it is within tolerance compared to the calculated $\Delta\theta/\Delta t$.

(e) Command a zero rate and set the brakes.

III. Monitoring During Operations

Monitoring during operations is required to determine if the mechanical components are operating within normal parameters and to initiate, by computer control, defensive action to prevent a catastrophic failure. The sensing points were chosen to isolate major potential failure points, and to provide the computer with the information necessary to initiate a defensive reaction when called for. The functions monitored and the action to be taken on a sensed failure are listed in Table 1. The actual sensed points are listed in Table 2.

IV. Present Status

All of the monitoring equipment has been installed on the antenna and is presently operational. The microcomputer for collecting data and transmitting operational data has been installed and is operational. A demonstration of remote operation controlled from NOCC has been conducted. Operational experience is now being developed to validate the checkout. Monitor and failure response rationale data are also being developed on the normal operating range of the various parameters prior to implementing the final monitoring software in the antenna controller.

Table 1. Monitoring during antenna operation

Parameter	Action on failure
Reservoir oil level change	
Slow leakage rate	Drive to stow
Large leakage rate	Stop pumps immediately
High-pressure pump and motor operation	
Motor current excessive	Shut off system
Pressure output excessive	Shut off system
Low pressure at servo valves	Shut off high-pressure pump and filter circulation pumps
Gear drive lubricant flow failure	Drive to stow, set brakes
System oil temperature excessive	Drive to stow, set brakes
Wind velocity excessive	Drive to stow, set brakes
Cable wrap-up limits	Command zero rate, set brakes
Tracking error excessive	Shift to low rate command in high-speed mode and drive to stow
DC power supplies failure (control room)	Automatic servo system shutdown if both power supplies fail
Remote DC power supply	Automatic servo system shutdown

Table 2. Sensor implementation

In control room	Clockwise cable wrapup limit
	Counterclockwise cable wrapup limit
	Azimuth 1 brake status
	Azimuth 2 brake status
	Elevation left brake status
	Elevation right brake status
	Azimuth high-speed mode select
	Elevation high-speed mode select
	Disable circuit status
	Power supply 1 status
	Power supply 2 status
	Azimuth prelimit status
	Elevation prelimit status
At antenna	Elevation low-speed servo valve pressure differential
	Elevation system pressure
	Elevation high-speed servo valve pressure differential
	Elevation high-speed system supply pressure
	Elevation low-speed system supply pressure
	Azimuth high-speed servo valve differential pressure
	Azimuth low-speed servo valve differential pressure
	Azimuth high-speed system supply pressure
	Azimuth low-speed system supply pressure
	Fluid level (hydraulic tank)
	Wind speed (southwest wind tower)
	Wind speed (southeast wind tower)
	Wind direction (southwest wind tower)
	Wind direction (southeast wind tower)
	Hydraulic oil temperature
	Lube oil pressure
	75-horsepower starter status
	125-horsepower starter status
	Pump flow 75 horsepower (left)
	Pump flow 75 horsepower (right)
	Pump flow 125 horsepower (left)
	Pump flow 125 horsepower (right)
	Hydromech building 28 V DC power supply status