Overseas 64-m Hydrostatic Bearing Performance

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The first azimuth rotation of the 64-m antenna under construction at the Ballima DSS (Australia) was made June 12, 1971. Film height records, profile records, and a bull gear reference level survey were made during this and subsequent rotations. This report includes the summary of data collected during these rotations.

I. Introduction

The first azimuth motion of the 64-m antenna at DSS 43 was made June 12, 1971. It was made before the addition of the dish and associated elevation motion components such as the elevation gear, bearings, etc. Estimated weight at the time of rotation was 40% of final weight.

Because this first rotation was a crucial step in the construction of the antenna, trying out for the first time much of the antenna hydraulic system, detailed plans were made and reviewed by both Collins Radio Corporation (CRC) and JPL personnel. The hydrostatic bearing instrumentation had been installed and calibrated, and CRC personnel were trained to operate it. The cognizant CRC personnel had full responsibility for all of the critical observation points with JPL and Australian Works Administration personnel assisting as additional observers. The following critical checks were made before and during the rotation.

II. System Check

A. High-Pressure Skids (with lift off)

(1) Relief valve settings.

(2) Flow switch operation.

(3) Instrumentation action.

(4) Oil temperature.

B. Hydrostatic bearing instrumentation

(1) Dial indicators. Note hour hand and rotation sense.

(2) Transducers.

(3) Skateboard springs.

C. Drive motor rotation, phasing and speed control

(1) Uncoupled from gear drives.

(2) Check brake function and other controls.

(3) Connect drive motors.

(4) Drive/back interlock.

D. Clearance

(1) Radial bearing.

(2) Pedestal top deck.

(3) Catwalk.

(4) Rotating stair clearance.

(5) Gear drive back-up rolls.

E. Actual Rotation—Manning

(1) Central control station: test conductor, talker, motor and brake controller.

(2) High-pressure skids (at each skid): pressure gage observer, sight glass observer, talker.

(3) Precharge skid: filter pressures, oil temperature.

(4) At each pad (two observers for dial indicator talker): rotating stair, radial bearings, hydrostatic bearing instrumentation, intermediate panel points cover/wall clearance.

F. Data Recording

Over each 10-deg increment: film height ranges, recess pressures (approximate range), precharge pressure and temperature.

G. Causes for alarm

(1) Film height under 0.075 mm (0.003 in.).

(2) Flow failure as shown by flow switches or site gages.

(3) Structural interferences at ground, reservoir cover-wall, or pedestal top deck.

(4) Oil temperature either rapidly increasing or above 32°C.

(5) Radial truck tilt or pitch due to radial bearing truck drift.

H. Preload radial bearing

I. Panic buttons—number and location

The reservoir oil was warmed up from 8.3 to 25.5°C (47 to 78°F) starting the day before the motion. The warmup procedure was essentially the same as the procedure followed at the Goldstone DSCC. The 30-kW heater was used and the oil circulated through both precharge filters and oil heater by initially operating one precharge pump. The oil was discharged directly into the reservoir in the precharge pump pick up area. The precharge filter case pressures were initially about 8.75 kg/cm^2 (125 psi) against a working pressure of 10.5 kg/cm^2 (150 psi). The differential pressure across the filters was initially about 3.5 kg/cm^2 (50 psi). As the oil warmed up, the filter differential pressure dropped off, and the flow to one filter was adjusted, maintaining the filter case pressure in the other filter in the 8.75 kg/cm^2 (125 psi) range. When the oil temperature reached 65°F the runner flush valve was opened partway, starting circulation around the reservoir and bringing colder oil into the precharge pick up area.

When the oil temperature reached about 21°C (70°F), one high-pressure pump on each skid was started and others added, keeping the skid inlet differential pressure in the range of 1.75 kg/cm^2 (25 psi). The process took about four hours to warm the oil up, and the system was operated overnight to maintain the oil temperature in the desired range for the rotation.

Two eddy current coupled 5.6 kW (7½ h.p.) motors were fitted to the forward gear drive in the left bilge and to the aft gear drive in the right bilge. One motor on each gear drive was wired to drive cw rotation and to float in ccw rotation. The second motor to drive ccw and idle in the cw direction. The motors were controlled by a special box which was set up on the cryodyne platform adjacent to the hydrostatic bearing instrumentation.

The first rotation was made in 10-deg steps with stops to record pertinent data at each 10-deg point. After approximately 60 deg the rotation was stopped to realign the right rear drive assembly because a pattern in the bull gear grease indicated an uneven contact. The rest of the 360-deg rotation went smoothly, taking about two hours to complete.

During the rotation the pumps for recess 2 (outside center) on each pad were turned off because of cavitation at the high-pressure pump inlet. The cavitation was caused by pressure losses in the inlet filter selector valve due to the cold oil. Only a slight loss in film height at the outside of the pads was observed by not pressurizing these cavities.

A continuous record was made of the film height at each of the four corners of the rear pad during the first rotation. The hydrostatic bearing instrumentation which was built at JPL and furnished for this purpose was housed in a temporary wooden shelter constructed on the cryodyne platform in the right-hand bilge. Film height detection devices were fastened to each of the four corners of all three pads and electronic meters driven by them and located in the hydrostatic bearing instrumentation racks were used to visibly check the film height. Dial indicators at each of the pads were also observed.

In addition, five film height detection devices were mounted on the ccw end of the rear pad and were used to drive the recorder in the hydrostatic bearing instrumentation racks; thus, records were made of the film height at five equally spaced intervals across the runner at the leading edge of the rear pad (ccw rotation) plus the two trailing (cw) corners of this skid. Data from these records (Figs. 1–3), show a mean film height of 0.46 mm (0.018 in.) and minimum film height of 0.32 mm (0.0125 in.) recorded for the first 360-deg rotation.

A second 360-deg rotation was made a week later to complete the survey of the top surface of the bull gear which is used as a reference surface for the runner profile (contour) determinations.

III. Results

From the data collected the runner would appear to be flat within ±0.38 mm (0.015 in.) and predicted minimum film height based on theoretical consideration allowing for the additional weight of the final assembly (estimated present weight is 40% of final) and for 35°C (95°F) oil instead of 26.6°C (80°F) oil will be 0.19 mm (0.0075 in.)

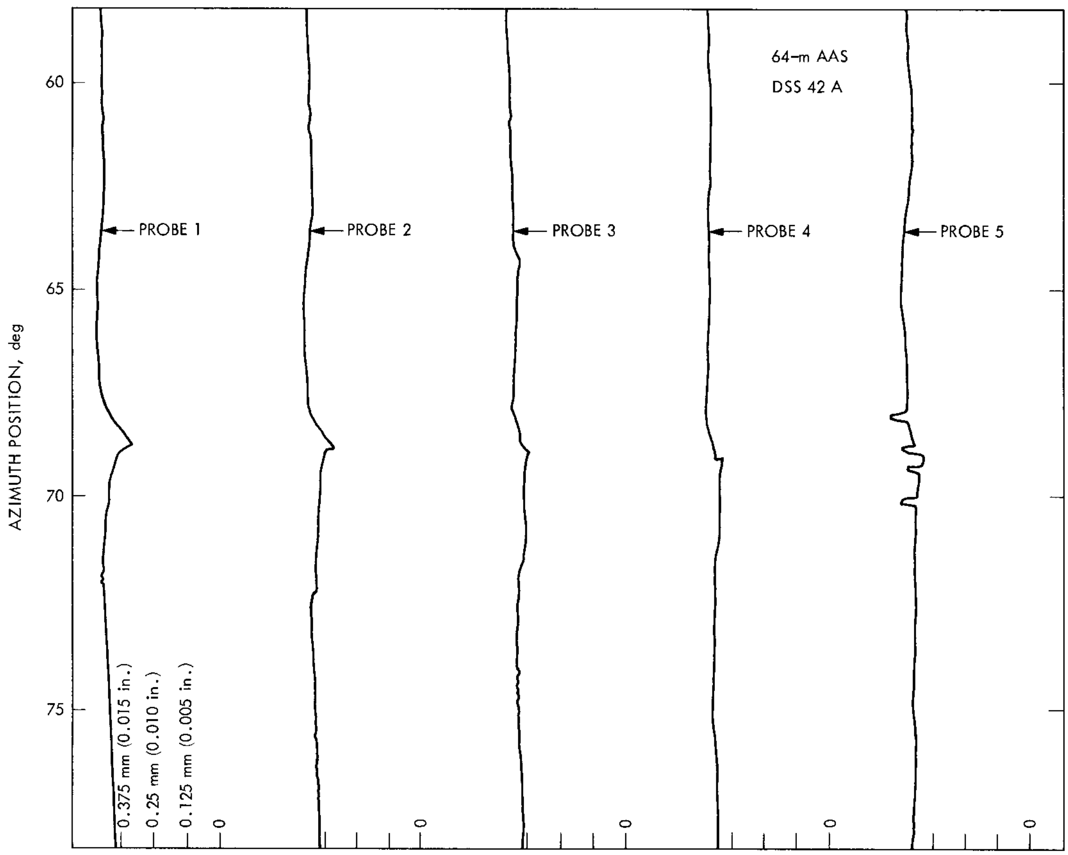

Fig. 1. Hydrostatic bearing film height (lowest recorded)

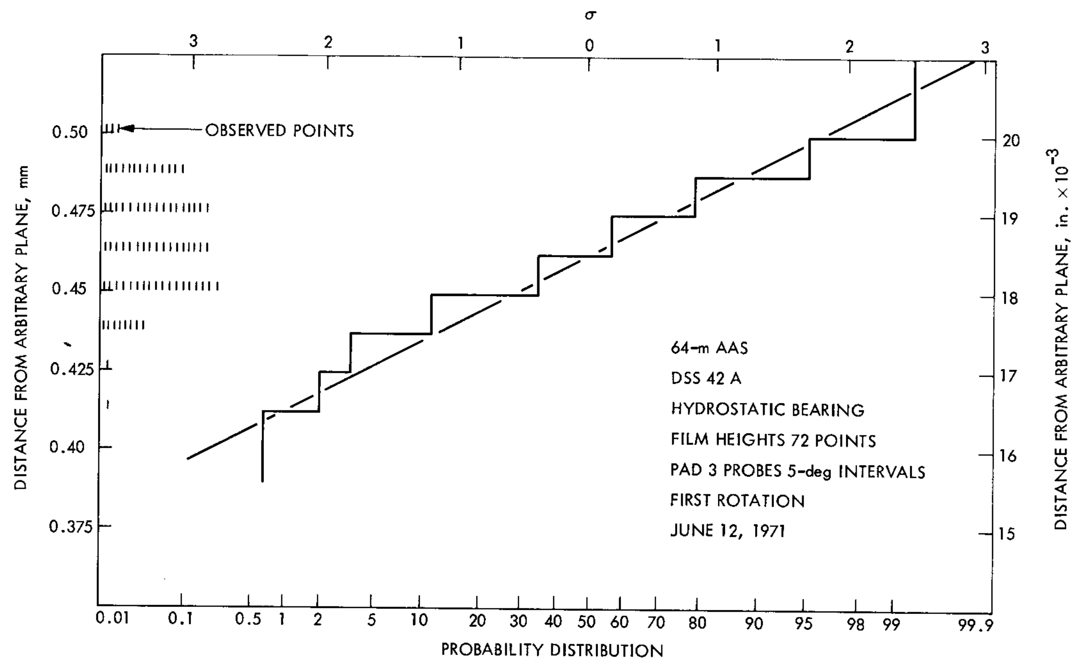

Fig. 2. Probability distribution of film height

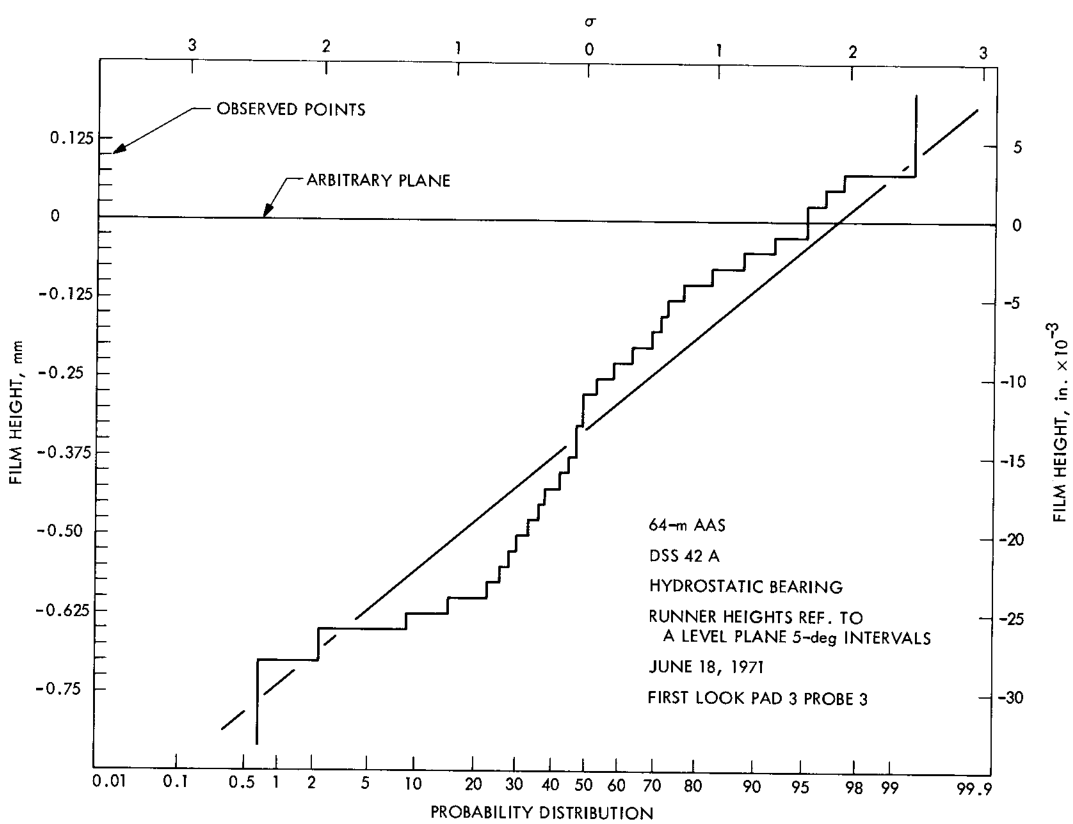

Fig. 3. Deviation from arbitrary plane