64-Meter-Diameter Antenna Hydrostatic Bearing Runner Joint Leak Tests

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Oil leaks from the hydrostatic bearing runner joint areas of the 64-m antenna installations at DSS 43 and DSS 63 have been the cause of concern since the erection of these antennas. This article describes the type of leak tests made on a model of the joint seal, the possible causes for leaks, and results after replacing the joint seals at DSS 63.

I. Introduction

The oil leaks from the hydrostatic bearing at the 64-m antenna installations at DSS 43 and DSS 63 are not serious enough to adversely affect the operation of the bearings at present, although considerable time and effort must be spent to prevent unsightly streaks down the outside of the pedestal. However, if the leaks are allowed to continue, the oil will soak into the grout under the runner and may cause it to fail. The leaks were observed primarily in the areas surrounding the runner joints, especially when a hydrostatic bearing pad was over a joint, indicating either a break in the seal or a plugging of the vent holes back into the reservoir.

The hydrostatic bearing runner forms the bottom of an oil reservoir for the bearing with the oil depth approximately 21.5–23 cm deep. The runner is made up of 11 equal segments of steel plates 17.75 cm thick and 1.12 m wide to form a bearing 25.25 m in diameter. The joints between the segments are subject to the full bearing recess pressure, approximately 85 Kg per cm^2. The joint is designed so that leakage through the interface between the ends of adjacent segments goes into a seal cavity which is vented back into the reservoir outside of the high-pressure area. Hence, the seal between the segments must only withstand the pressure due to the depth of the oil plus the small pressure drop across the vent holes (see Fig. 1).

A model of the runner joint seal elements, arranged to duplicate the sealing problems, was constructed as a basis for determining the causes of the leaks and for devising a method of correction.

II. Test Method

The leak tests were made on a full-scale steel model of the joint seal part of the hydrostatic bearing runner section joint. A hand-pump hydraulic actuator was used as a pressure source. A small sealed cavity was bolted in place over the joint to simulate the effect of the hydrostatic bearing pad pressure cavities. Collector pipes were positioned to cover the vent holes so the function of these holes could be observed. The head pressure of these collector pipes was about 9.5 cm of oil, as compared to 25.5–23 cm oil depth in the actual runner. The viscosity of the oil used in the hydraulic actuator at room temperature is slightly lower than the viscosity of the hydrostatic bearing oil at operating temperature. Therefore, the leak rates were slightly higher than for an actual joint.

The first series of tests was made with the joint between the runner sections bolted tightly together, metal to metal, as in an ideal runner joint assembly. The joint seal extrusion (Fig. 1) was fed through the wedge cavity before the seal support strip and wedges were installed. The joint seal extrusion was lifted into place by the seal support strip during assembly without stretching it. The ends of the joint seal extrusion were trimmed, with about 6 mm extending beyond the runner. The end caps and gaskets were placed as shown in Fig. 1. The 6-mm extensions of the joint seal extrusion were forced into the seal slot as the end caps were tightened.

When an oil pressure of approximately 140 Kg per cm^2 was applied to the joint, the combined weep rate (out of both weep collector pipes) was between 10 and 15 cc per min. In the actual hydrostatic bearing, this weepage is returned to the oil reservoir. There was no leakage past the joint seal extrusion to the bottom of the joint, and there was no leakage past the ends of the joint seal extrusion. The vertical cracks at the ends of the joint, which are normally covered by the reservoir walls, were left uncovered. There was slight weepage (too small to measure), but only when the oil at the joint was under pressure.

When the collector pipes over the weep holes were plugged, full hydrostatic bearing oil pressure existed across the joint seal extrusion. Under this condition there was no leakage past the joint seal extrusion to the area under the runner joint. However, there was a combined leakage rate of approximately 25 cc per min from the end cracks, which are normally covered by the reservoir wall.

The second series of tests was performed with the joint between the runner sections spaced apart by 0.025-mm shims. This condition approximates the condition of an actual runner joint, considering imperfections in manufacture and assembly. Under these conditions the combined weepage rate out of both weep collector pipes was approximately 97 cc per min when an oil pressure of 100 $\pm$5 Kg/cm^2 was applied. With this high rate of flow, several pump strokes were required; it was difficult to maintain a steady pressure. There was no leakage or weepage past the joint seal extrusion under the runner joint, and there were no leaks past the ends of the joint seal extrusion. There was weepage out of the cracks at the ends of the joint (which are normally covered by the reservoir wall). However, this weepage was present only when pressure was applied and was too small to measure.

When the collector pipes over the weep holes were plugged, the leakage rate remained about 100 cc per min, but the oil squirted out of the end cracks, which now had a gap because of the 0.025-mm shim. There was no leakage past the joint seal extrusion to under the runner joint. Unplugging the weep hole collector pipes reduced the leakage out of the end cracks to a slight weep, as before.

The third series of tests was performed with the joint spaced apart 0.025 mm and with the seal support strip and wedges emplaced before the joint seal extrusion was pulled into place. The joint seal extrusion was cut to a length of 110 cm and was pulled through the seal cavity until the trailing end was flush with the edge of the runner. The joint seal extrusion stretched until approximately 25 cm extended out of the leading end before the trailing end was flush. The excess 25 cm was cut off flush with the edge of the runner. The joint seal extrusion did not appear to retreat into the slot. The end caps were emplaced, and the oil at the joint was pressurized to approximately 100 kg/cm^2 (1500 psi). There were no leaks past the joint seal to under the runner, and the amount of weeping at the end cracks was too small to be measured.

When the end caps were removed, it was found that the end of the joint seal extrusion, which had been pulled out and cut off flush, had retreated into the slot approximately 6 mm. There was indication of some leakage around the end of the joint seal extrusion. The trailing end had also retreated about 1.5 mm, but it had remained in contact with the end cap seal gasket, which had been extruded into the seal slot. When a slight force was applied to the ends of the joint seal extrusion (as could occur if room-temperature vulcanizing compound (RTV) was packed into the ends of the seal cavity), it caused the pulled end to retreat into the hole approximately 3.8 cm and the trailing end somewhat less. Therefore, if the ends of the seal slot were packed, the packing could extend beyond the weep holes and plug them. This would cause excessive leakage out of the end cracks and around the end of the joint seal extrusion as noted above.

III. Recommendations

The recommended assembly technique is as follows:

(1) Feed the joint seal extrusion through the wedge and seal support strip hole.

(2) Straighten the joint seal extrusion but do not stretch it. Position the joint seal extrusion so that it extends at least 5 cm beyond each side of the runner.

(3) Lift the joint seal extrusion straight up into the seal cavity with the seal support strip.

(4) Place the upper, center, and lower wedges under the support strip, forcing the joint seal extrusion vertically upward, into the seal slot, until the support strip just makes contact with the top of the wedge cavity. Do not force the support strip beyond this.

(5) Cut off the ends of the joint seal extrusion so that it extends between 5 and 10 mm outside the runner joint.

(6) Clean all traces of oil and dirt from the end cap seal area with a solvent.

(7) Apply a limited amount of plastic sealing compound over the end of the wedges and the seal support strip. Seal the slot area and the edge of the runner up to (and covering) the bottom edge of the reservoir wall.

(8) While the plastic sealing compound is still soft, emplace the end caps and their gaskets and bolt them tight, forcing the 5-mm extension of the joint seal extrusion back into the runner joint seal slot.

(9) After the end caps have been installed, apply a liberal amount of plastic sealing compound to the area between the reservoir wall and the end cap gasket to seal that area from any possible leakage from the crack between the runner sections left exposed in this area.

IV. Conclusion

Following these tests the hydrostatic bearing runner joint seals were replaced at DSS 63. When the seals were removed, it was discovered that the seal extrusion had retreated back into the seal slot and that the ends of the seal slot, including the weep passages, had been filled with a silastic material (Fig. 2). When the seals were replaced, rods were pushed into the weep holes to prevent any blockage. These rods were then removed and a flow check made to assure that the weep holes were open. No runner joint leaks have been observed at DSS 63 since the seals were replaced.

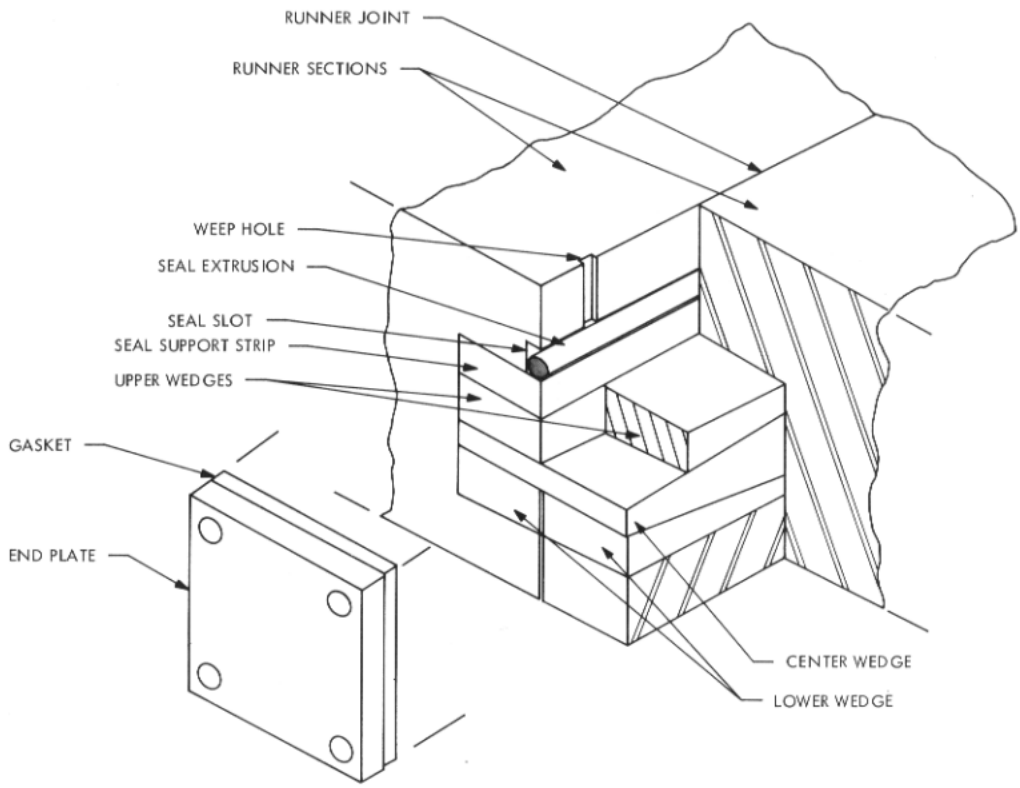

Fig. 1. Cutaway of runner joint showing joint seal

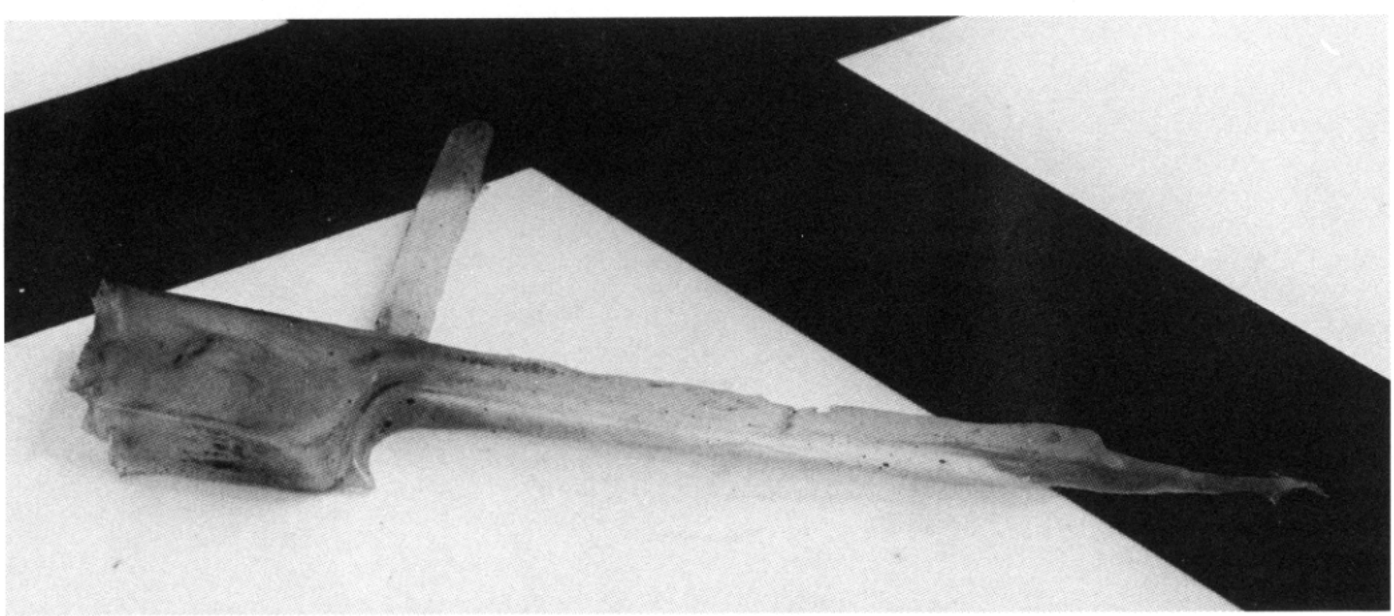

Fig. 2. Silastic seal plug removed from DSS 63