National Radio Astronomy Observatory

Socorro, New Mexico

3-18-97

VLA Test Memo No. 204

Confined Space Entry

Nitrogen Leak Test Antenna Yoke

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1. INTRODUCTION

The antenna yoke has been classified as a confined space. With waveguide running through the yoke a nitrogen leak, causing a hazardous atmosphere, was a concern raised, with the following questions:

A) If a nitrogen leak occurs how long will it take to reach the minimum safe oxygen threshold level of 19.5% set by OSHA?

B) What if someone entered the antenna on a Monday morning after nitrogen had leaked into the antenna during the weekend?

Entry into an antenna yoke in the field is very seldom; but it does happen on occasion. Servo might be required to replace an encoder; cryo, rotary joint; or the antenna mechanics have had to check gear backlashes. If a nitrogen leak were to occur in the yoke area the atmosphere could become oxygen deficient (Reference sketch for areas of antenna).

2. HISTORY OF NITROGEN LEAKS

Rudy Latasa, from Cryo, recalls two incidents of nitrogen leaks: 1) When antenna #17's pillow block bearing failed, communications were lost; 2) a stub at a vacant station was damaged by a cow. Item 2 would not have been a direct leakage into an antenna. Cryo typically checks nitrogen flows and pressures to each arm daily. Any abnormal flow rates are investigated immediately. In the event of pressure loss, there is an alarm trip at 3.5 psi which gives Operations a printout in the Control Room.

3. LEAK TESTS

A) Test #1 (Break a nitrogen line axially and monitor Control Room alarms.)

On 3-7-97 (9:40am), the waveguide was broken at ground level below antenna #15. The lines were separated axially. The operator immediately lost communications and control of the antenna. Alarms indicated lost data sets and a stream of other errors. The lines were left separated for approximately 12 minutes. During that time, line pressure dropped from 4.004 psi to 3.870 psi. At 9:52am the lines were connected, without the flange gasket. A leak was still present, with the nitrogen pressure continuing to drop. Communications were

established, and the antenna was under operator control once again. At 10:06am the gasket was installed and the waveguide flange connected. At that point the line pressure had fallen to 3.830 psi.

For this type of catastrophic failure, Operations is aware of a problem from antenna communication alarms. There is no alarm to indicate a waveguide separation. However, Operations would get an alarm indication when nitrogen line pressure reached 3.5 psi. At the rate of pressure drop it would have taken 75 minutes to reach alarm set point.

If the operator were to call up the waveguide overlay he would not be aware of a problem unless he knew the flow rate prior to the break. Although this type of failure is highly unlikely, it could happen. If a technician were sent to the antenna without suspecting a nitrogen leak he could encounter a hazardous atmosphere (<19.5% oxygen, set by OSHA). To help predict what sort of atmosphere might be encountered, a second test was performed.

B) Test #2 (Create a nitrogen leak in an antenna and monitor oxygen levels.)

Antenna 27 was chosen for the nitrogen leak test. On 3-10-97, oxygen sensors were placed in the yoke (reference sketch), and in the upper pedestal room, with the meters located so they could be read. The waveguide flange in the yoke was broken at 10:53am and a half gasket was installed allowing nitrogen to flow into the space. The main waveguide nitrogen flow was checked prior to and after the break. The increase in flow was used as the estimated flow into the yoke space. The yoke sensor was positioned 180 degrees from the direction of flow.

Immediately after the break and placement of the half gasket, the oxygen meter read 19.7%, and within the hour had dropped below the threshold level of 19.5%, to 19.0%. During 4 hours of the test oxygen readings from both meters continued to drop, indicating continued oxygen dilution with each reading. At 3:00pm the test was concluded, with the oxygen level in the yoke area dropping to 18.1% and 21.1% in the upper pedestal area.

Tabulated Results:

NOTES	PRESSURE PSI	FLOW SCFH	TIME	%OXYGEN YOKE	%OXYGEN UPPER PED.
BEFORE BRK	4.04	2.57	10:50AM	20.9	21.3
AFTER BRK	4.04	12.66	10:53AM	19.7	21.2
	4.00	15.05	11:30AM	19.0	20.5
	3.975	15.57	12:30AM	18.5	20.3
	3.98	15.91	1:40PM	18.1	20.1
INTERRUPTION					
	3.99	16.1	3:00PM	18.1	20.1
CLOSED FLGE			3:30PM		

The initial drop in oxygen was from breaking the line to install the half gasket. On a volume basis the addition of nitrogen into the yoke would be expected to dilute the oxygen at a rate of approximately .4%/hr -.6%/hr using a yoke volume above the pedestal area of 1000cu.ft., and the indicated flows. Both meters were calibrated prior to the test, and turned off between readings to conserve the batteries.

4. CONCLUSION

Both oxygen meters dropped consistently over the four hour period. The nitrogen discharges into the yoke area first and the safe oxygen threshold level (19.5%, as set by OSHA) was reached first; in the yoke, as expected. Although the test was cut off the readings indicate that the oxygen level in the upper pedestal room would have diluted below the threshold limit within a few hours.

The oxygen level, in the yoke, went below the OSHA limit of 19.5%, and would be considered a hazardous atmosphere as well as a confined space.

5. RECOMMENDATIONS

The yoke space should be considered a confined space, with the potential for having or developing a hazardous atmosphere. There is also a potential for

the upper and lower pedestal rooms to develope a hazardous atmosphere. With this as a consideration, precautions should be taken to prevent anyone from entering an antenna when there is a potential nitrogen leak. Some modifications to the NRAO Safety Manual and Operational Procedures are indicated.

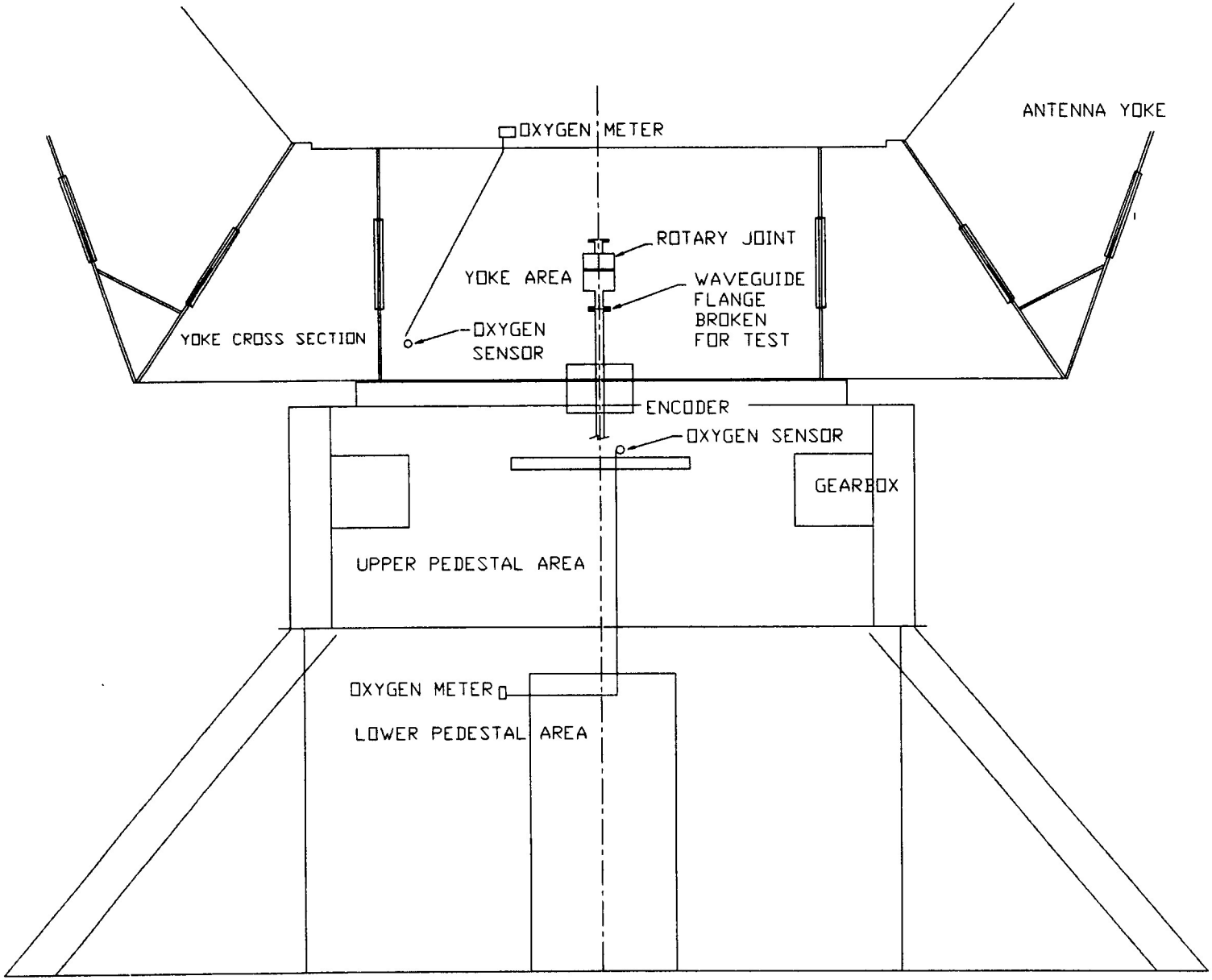
Cryo routinely (daily) monitors nitrogen flows and pressures; notifying Operations whenever there are abnormal flows, or a suspected leak. They immediately send personnel to find the leak and make the necessary repairs. We should formalize the communications between Cryo and Operations. When any abnormal nitrogen flow exists, Cryo will contact Operations. Until the leak is found or explained, one of the following conditions should apply: 1) The Confined Space Procedure (with Hazardous Environment) would be in effect (follow procedure described in NRAO Safety Manual Appendix B2.11.2) or 2) No admittance to any antenna on the particular arm, until the leak is found and repaired.

6. ADDITIONAL RECOMMENDATIONS

A) Investigate the possibility of raising the nitrogen low pressure alarm limit to a level closer to the typical operating pressure; such as 3.9 psi. In our initial test, with antenna #15, an alarm would have sounded within a 5-10 minute time frame, initiating a quicker response to the problem.

B) A secondary alarm initiated by the flow, might also be considered. The flow changes more dramatically than the pressure, so with any change in flow the alarm could be almost instantaneous.

C) Introducing ventilation into the pedestal/yoke areas is a possibility. This would be a more costly alternate than A or B.



NO SCALE
REF. ONLY

PARTIAL ANTENNA VIEW