National Centre for Radio Astrophysics

Internal Technical Report

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Azimuth and Elevation Gearbox Failures and Remedial Actions

Mechanical department

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Introduction

Azimuth and Elevation gearboxes are critical components of the Antenna Drive System. These gearboxes have been in continuous operation for over 25 years. Recently, we have observed failures in these gearboxes. This report analyses the major types of failures observed and outlines necessary preventive actions to address these issues.

Gearbox Life Calculation

Gearboxes are in continuous operation. Design life of the gearbox were is mentioned in the gearbox design data based on which dear boxes were procured.
Rexroth catalogue specified method to calculate design life of bearings inside the gearbox. Both are calculated

A. Design Life of Gearbox

Here we have calculated the tentative no of revolution of gearbox output shaft and compared the same with the design data specified for the Azimuth and Elevation gear box

1) **Total Operation Life (No of revolutions of Antenna since start):**
   Annual Operation Days:
   365-52×1.5 [weekly maintenance days])−42 [MTAC days]=245 days/year
   Total Operation Over 25 Years:
   245 days/year×25 years×0.80=6125 days×0.80=4900 days
   Total Hours of operation since start:
   4900 days×24 hours/day=117,600 hours
2) **Total Rotations of Antenna:**
   Average Rotations Per Day: 20
   Total Antenna Rotations since start: 4900 days×20 rotations/day=98,000 rotations
3) **Gearbox Output Shaft Rotation since start**

   a) **For Azimuth Axis Gearbox Output Shaft:**
      1. **Bull Gear-Pinion Ratio:** 12.63
      2. **Total Rotations of Gearbox output shaft:**
         98,000 rotations×12.63=1,238,000 rotations = 1.2^6 cycles
      3. **Design Life:** 5×10^6 cycles
      4. **Hence gear box is within its design life**
   b) **For Elevation Axis Gearbox Output Shaft:**
      1. **Bull Gear Pinion Ratio: 30.5**
      2. **Total Rotations of Gearbox output shaft:**
         98,000 rotations×30.5=2,990,000 rotations = 2.9^6 cycles
      3. **Design Life:** 4.2×10^6 cycles
      4. **Hence gear box is within its design life**

B. Gear box bearings Life Calculation

Method of calculating bearings of Rexroth Gearbox is mentioned in the Rexroth catalogue. Refer Table 6 and sample calculation mentioned in the catalogue. Following the procedure bearing life of Azimuth and Elevation Gear is calculated. Details given below.

1) **Elevation Gearbox:**
   Model: IPX 95
   Ratio: 821.976

Nominal Output Torque:

At 20 KMPH: 11,000 NM

At 80 KMPH: 16,000 NM

Service Factor (Fw): 1.25 for 20 KMPH continuous 24hrs and 1 for 80 KMPH (upto30min moderate load)

Effective Torque (MN):

At 20 KMPH: 11,000 NM×1.25=13,750 NM

At 80 KMPH: 16,000 NM×1.0=16,000 NM

Bearing Life: (See Figure-1 attached)

At 20 KMPH: 100,000 hours

At 80 KMPH: 100,000 hours

2) **Azimuth Gearbox:**

Model: IPX 120

Gearbox Ratio: 1488.93

Nominal Output Torque:

At 20 KMPH: 25,400 NM

At 80 KMPH: 36,000 NM

Service Factor (Fw): 1.25 for 20 KMPH continuous 24hrs and 1 for 80 KMPH (upto30min moderate load)

Effective Torque (MN):

At 20 KMPH: 25,400 NM×1.25=31,750 NM

At 80 KMPH: 36,000 NM×1.0=36,000 NM

Bearing Life: (See Figure-2 attached)

At 20 KMPH: 100,000 hours

At 80 KMPH: 100,000 hours

As calculated in A-(1) GMRT Antenna including the gearbox is under use for about 117600 hrs. Where as bearing life is 100000 hrs.

Hence, gearbox bearings exceeded their life.

Conclusion of Gearbox Life & Bearing Life Calculation as per Rexroth Catalogue-

- **Gearbox Life:** Both Azimuth and Elevation gearboxes are within their design life.
- **Bearing Life:** Bearings inside the gearboxes have exceeded their design life and need replacement.

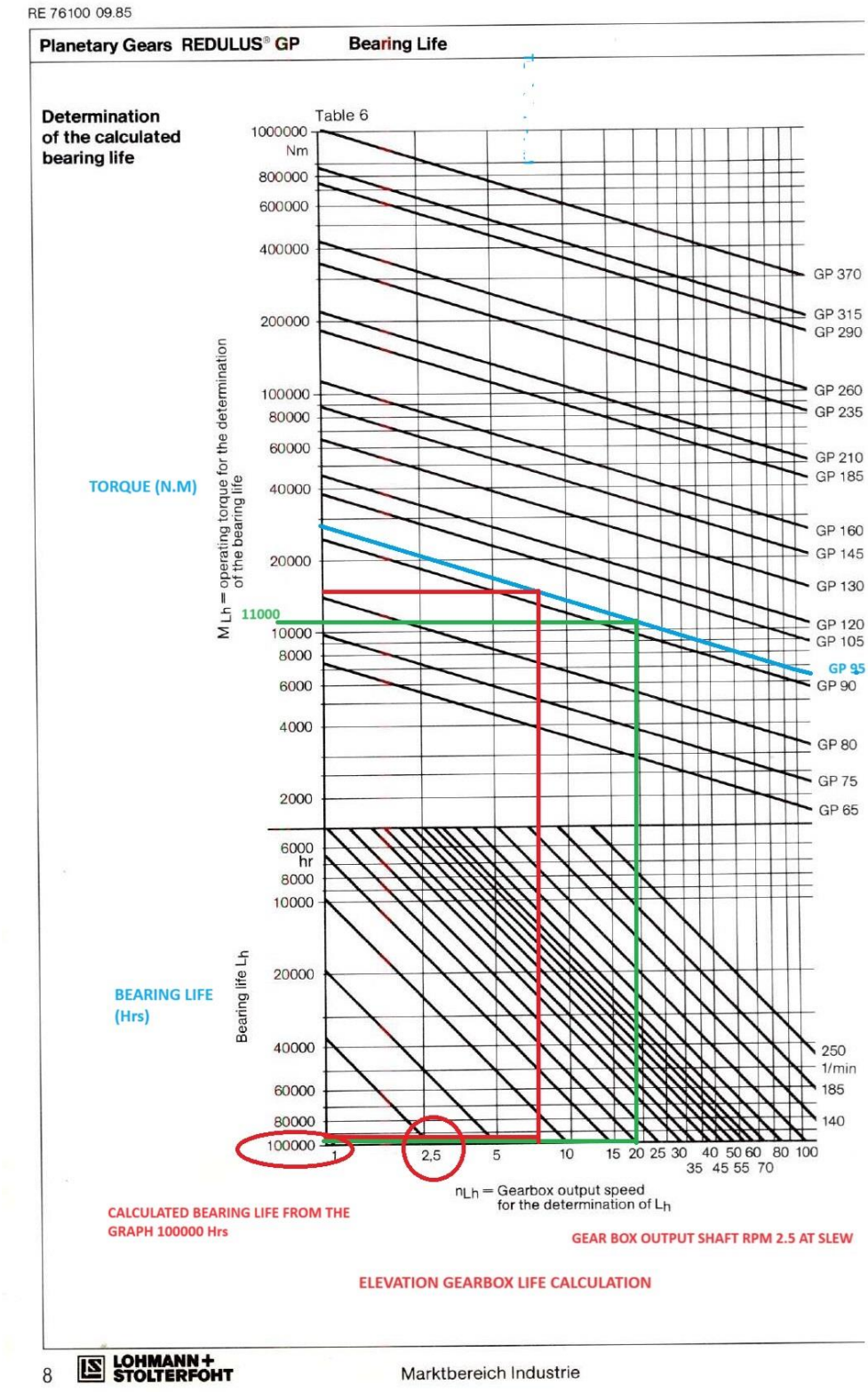


Figure 1- ELEVATION Gear Box Bearing Life (Hrs)

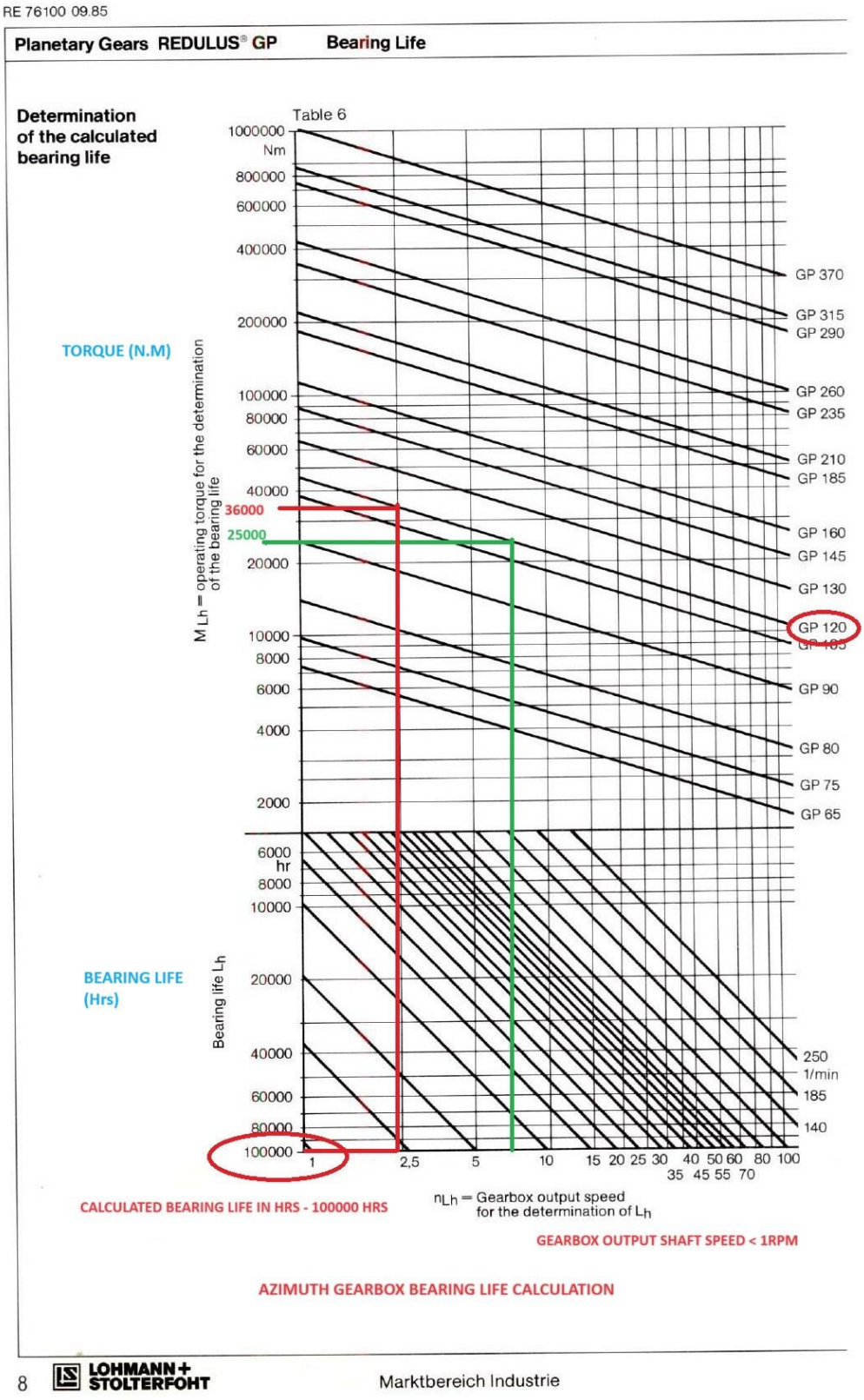


Figure 2- Azimuth Gear Box Bearing Life (Hrs)

C. Observed Failure Types

In GMRT we have observed various AZ & EL gearbox failures in last 10 years. Year wise gearbox failures are categorized in two major types of failure-

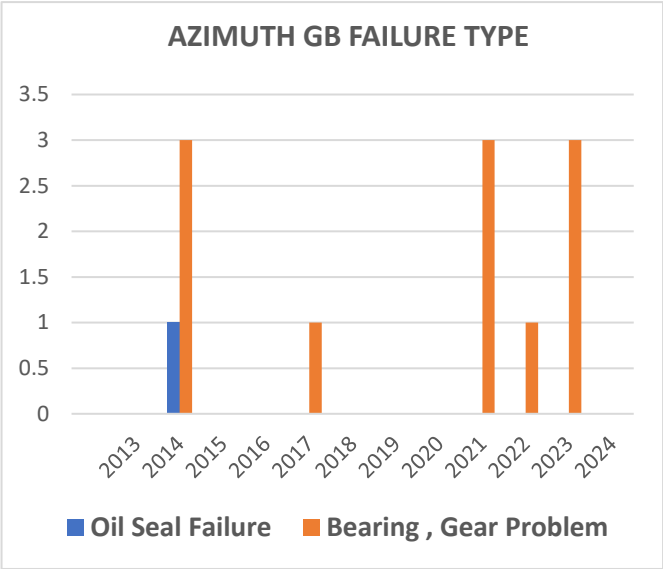
a) **Oil Seal failure** - Sometimes we observe oil leakage from gear box. In such situation we remove the gearbox from the antenna and replace oil seals.

b) **Bearing / internal gear problem**- Whenever we observe abnormal sound from gearboxes of motor coupled with gearbox draws more current we remove the gearbox from the antenna. After opening the gearbox we mostly see bearing problems and sometimes both internal gear defect and bearing problem. Such failures were analysed and we came to the conclusion that this kind of problem mostly originates from bearing defects. Subsequently damaged bearing it causes further damage to the gearbox internal parts.

Summary of gearbox failures are prepared and these failures are categorized into two main types of failures mentioned above.
Summery is presented in both tabular and graphical format given below.

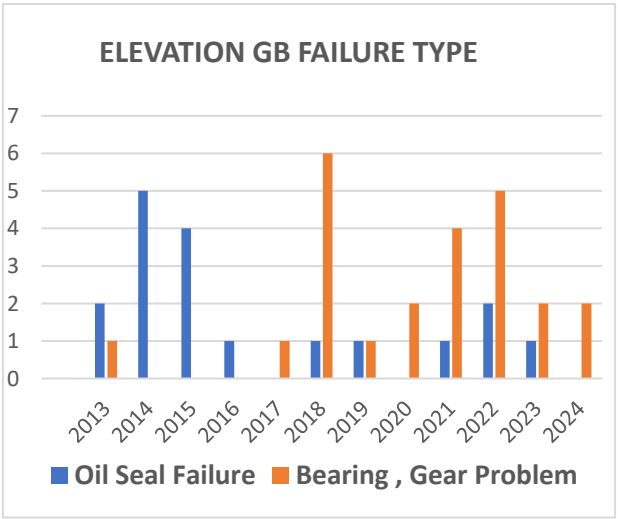
I . Azimuth Gearboxes

Year	Oil Seal Failure	Bearing/Gear Problem
2013	0	0
2014	1	3
2015	0	0
2016	0	0
2017	0	1
2018	0	0
2019	0	0
2020	0	0
2021	0	3
2022	0	1
2023	0	3
2024	0	0



II. Elevation Gearboxes

Year	Oil Seal Failure	Bearing/Gear Problem
2013	2	1
2014	5	0
2015	4	0
2016	1	0
2017	0	1
2018	1	6
2019	1	1
2020	0	2
2021	1	4
2022	2	5
2023	1	2



Year	Oil Seal Failure	Bearing/Gear Problem
2024	0	2

Observations

- **Initial Failures:** Oil seal leakages were the primary issue in earlier years (before 2017)
- **Recent Failures:** During recent years, bearing failures have become more frequent, and major cause of failure.

D. Proposed Remedial Actions

1. **Replacing Gearbox Bearings During Breakdown Maintenance:** Replaceing oil seals and bearings whenever gearboxes are removed for maintenance.
2. **Scheduled Preventive Maintenance:** Preparing a preventive maintenance schedule to systematically replace bearings and also damaged components.
3. **Maintain Adequate spares:** Ensure an adequate stock of gearbox bearings, oil seals, and other necessary spares.
4. **Procure New Gearboxes:** Purchasing new gearboxes to replace old ones during maintenance, allowing for immediate replacement.
5. **Monitor During Regular Maintenance:** Regular monitoring of gearboxes for abnormal sounds or high current, and prioritize gearbox maintenance based on these observations.

Conclusion

Addressing bearing failures through regular maintenance and timely replacement will significantly reduce gearbox problems. Implementing these preventive measures will enhance the longevity and reliability of the Azimuth and Elevation gearboxes in the Antenna Drive System.

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