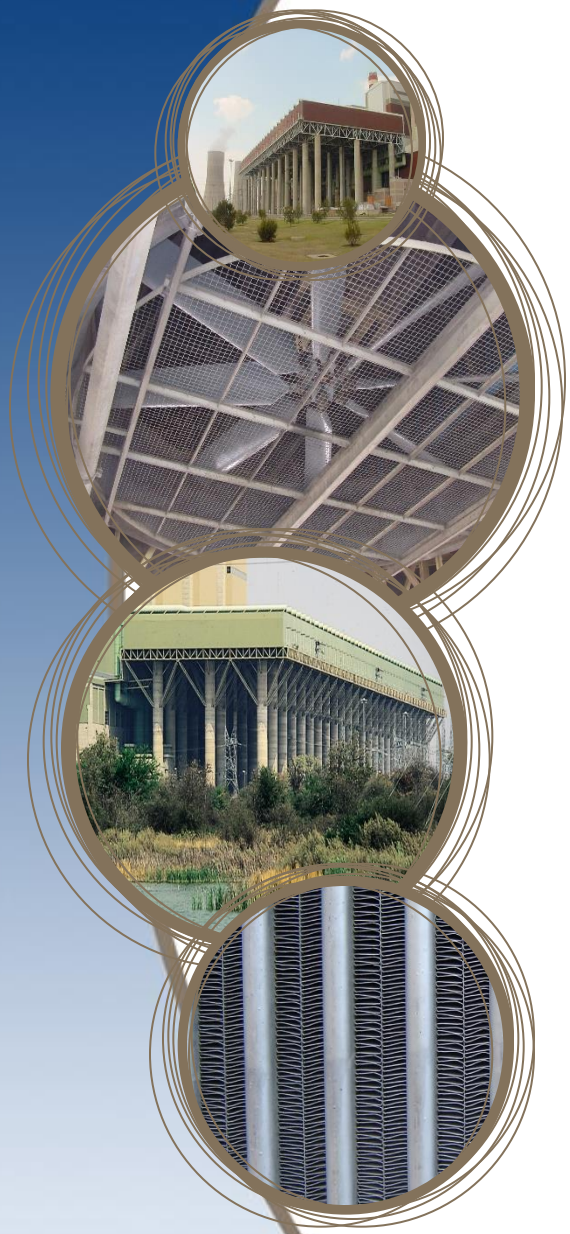

ACC gearboxes – Eskom's experiences of the last 20 years

ACC Users Group 2017

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Presented by **Ockert Augustyn**

Content

- Eskom's ACC fleet
- Various gearbox configurations
- Problems encountered
- Remedies
- Alternatives
- Conclusions

Medupi U6

Eskom's ACC fleet - MEDUPI

- 250 km north of JHB
- U6 commissioned in 2014/2015
- 3 operational units currently
- 64 gearboxes/unit (8 x 8 streets)
- **6 x 794 MW**
- Motor power: 225 kW

Eskom's ACC fleet - MEDUPI

Eskom's ACC fleet - KUSILE

- 100km east from JHB
- U1 commissioned in 2016
- 1 operational unit currently
- 64 gearboxes/unit (8 x 8 streets) – 2 fan designs
- **6 x 800 MW**
- Motor power: 250 kW + soft starters

Eskom's ACC fleet - MATIMBA

- 5 km from Medupi
- First unit commissioned in 1987, last in 1991
- 48 gearboxes/unit (8 x 6 streets)
- **6 x 665MW**
- Motor power: 270 kW
- 10% stall margin on fans

Eskom's ACC fleet - MATIMBA

Eskom's ACC fleet - MAJUBA

- 250 km south east of JHB
- First unit commissioned in 1996 (construction began in 1983), last in 2001
- 48 gearboxes/unit (8 x 6 streets)
- **3 x 657MW**
- 3 units **wet cooled (3 x 713 MW)**
- Very similar design to Matimba

Eskom's ACC fleet - MAJUBA

Eskom's ACC fleet - MAJUBA

Gearbox types and configurations

- 9 different types of gearboxes > 1200+ gearboxes
- 3 manufacturers
- Casing – Mono and split-casing
- Lubrication – splash and force feed
- Oil – mineral and synthetic
- Fan bridge layout differences

Gearbox types and configurations

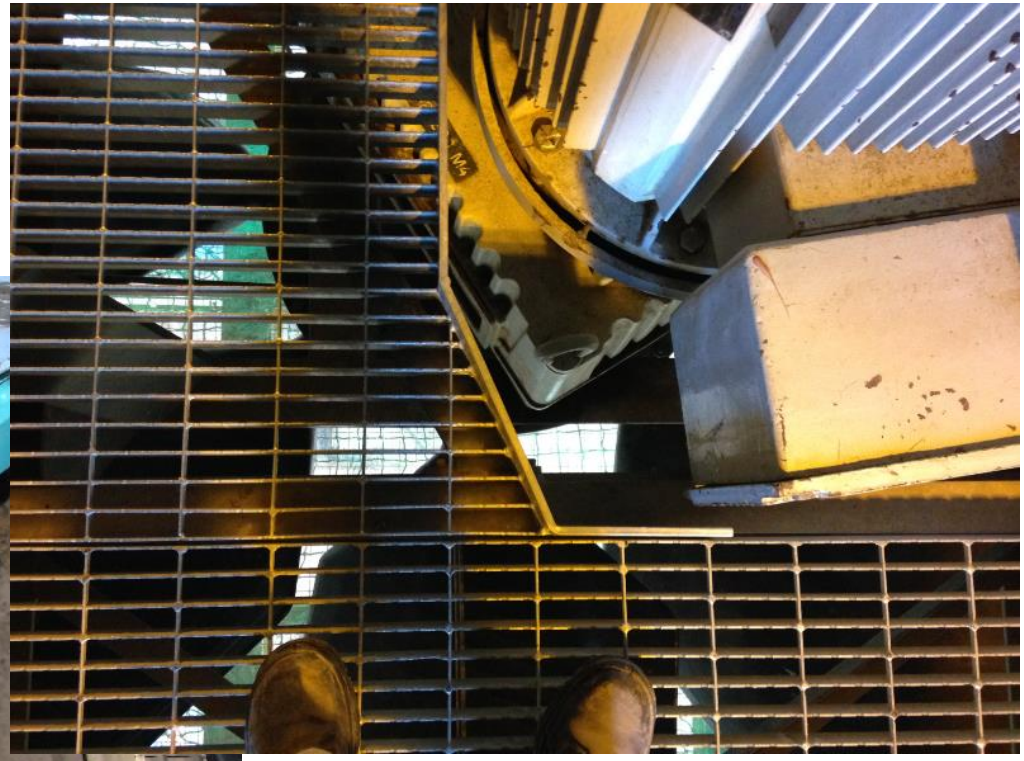
Gearbox types and configurations

Space for movement and maintenance activities

Monorail?

Gearbox types and configurations

Gearbox types and configurations



Airflow over the gearbox should not be underestimated

Gearbox types and configurations

Gearbox types and configurations

- Layout considerations
  - Position of gearbox influences the monorail position
  - Fan grating should allow for maintenance
  - Walkway mass ratings
  - Maximize airflow over the gearbox
  - Getting Oil to 45-60m level – very time consuming
  - Retrofits in the future?

Problems encountered

- Working conditions
  - Adverse weather conditions (wind, up to 45°C ambient)
  - ACC design unknowns/flaws (eg. Matimba)
  - High production demand > less maintenance
  - Increase blade angles > increase load on gearbox (+ oil)
  - Poor cooling of casing (i.e. oil) due to configuration/fan design
  - Increased fan power consumption
  - Step sequencing of fans (new build fleet)

Problems encountered

- Gearbox failures

Problems encountered

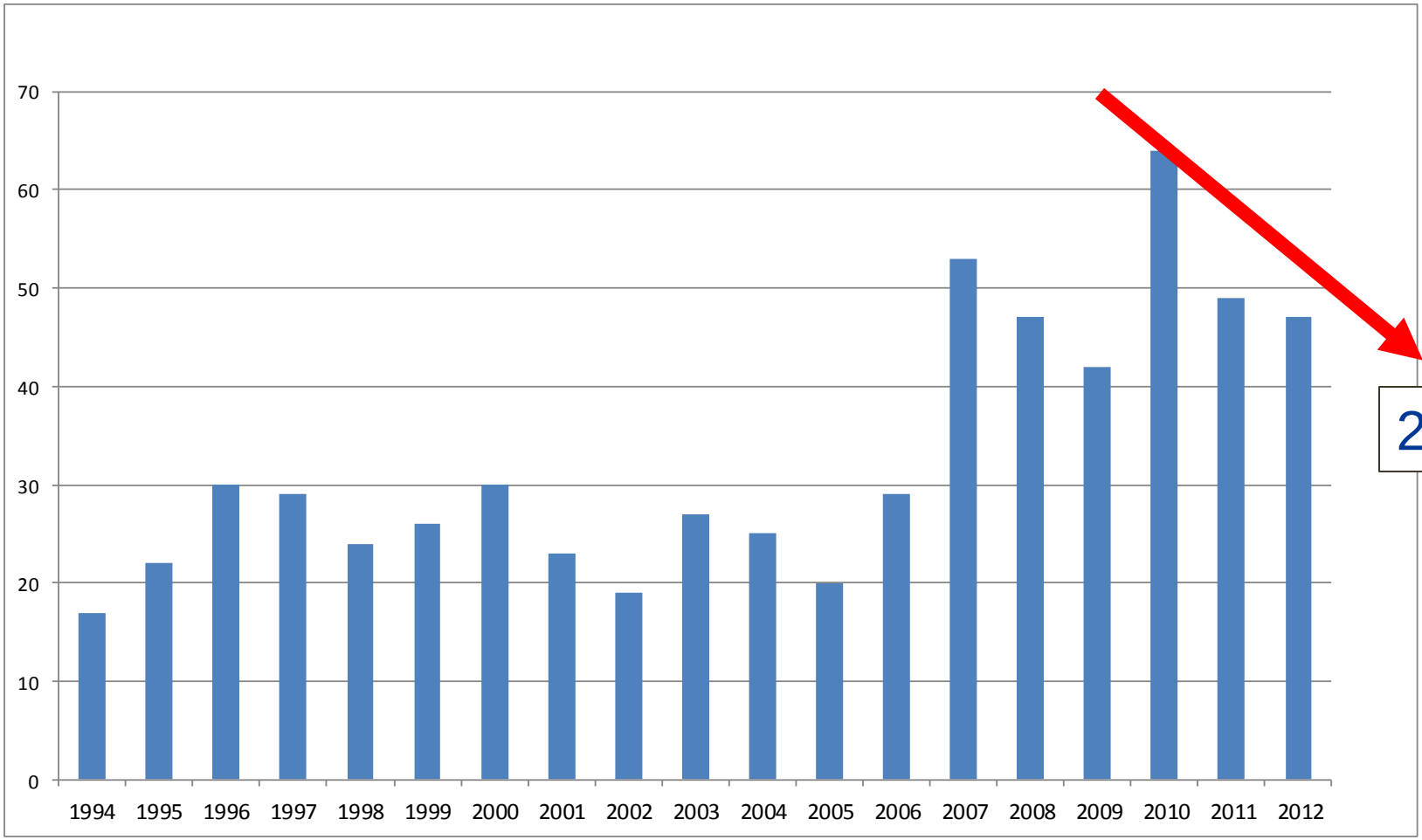
- Gearbox failures

Problems encountered

- Matimba gearbox failures
  - 48 gearboxes procured in 2009
  - 8 months later first catastrophic failures
  - Multiple problems:
    - Micro pitting
    - 40% of oil pumps failed
    - Similar trends at Medupi experienced already

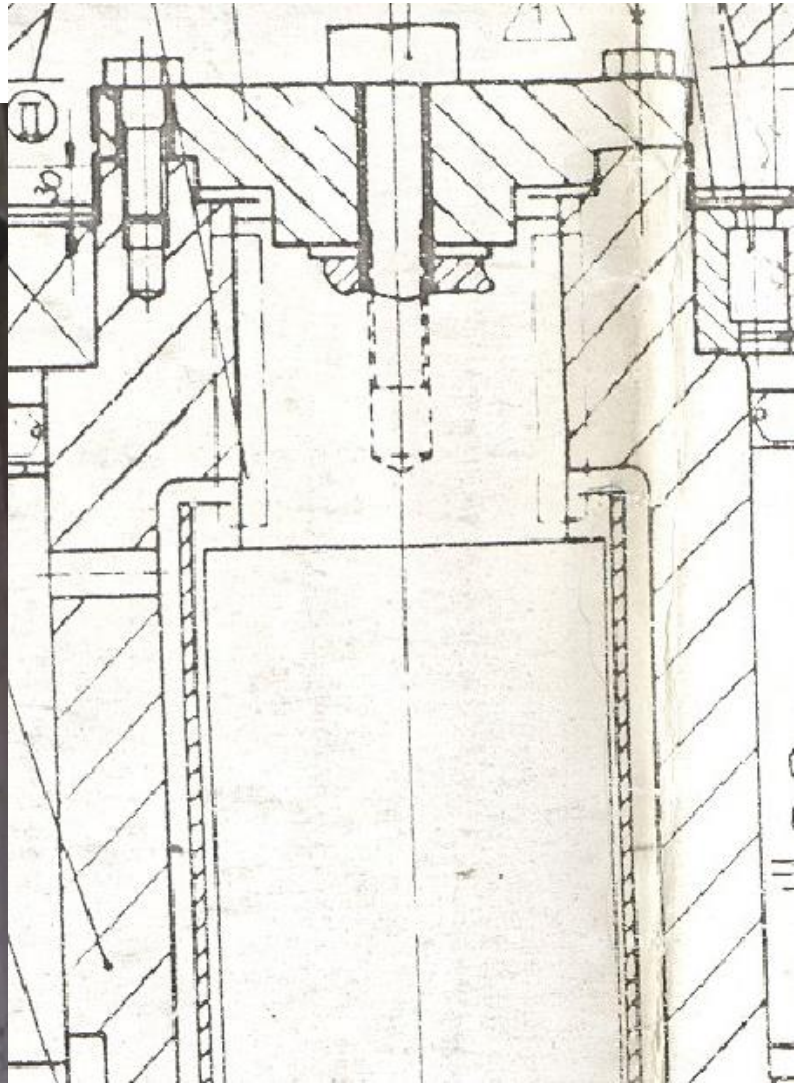
Problems encountered

- Matimba gearbox failures



Problems encountered

- Fan shaft failures

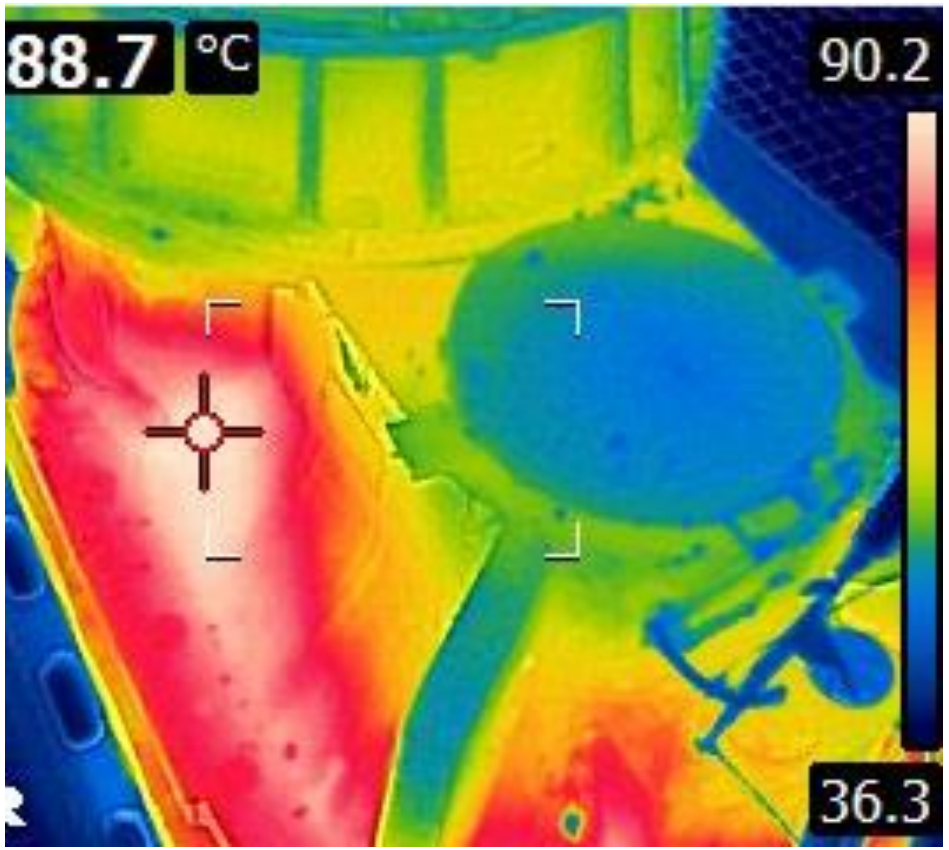


Problems encountered

- Fan shaft failures

Problems encountered

- High oil temperatures



Problems encountered

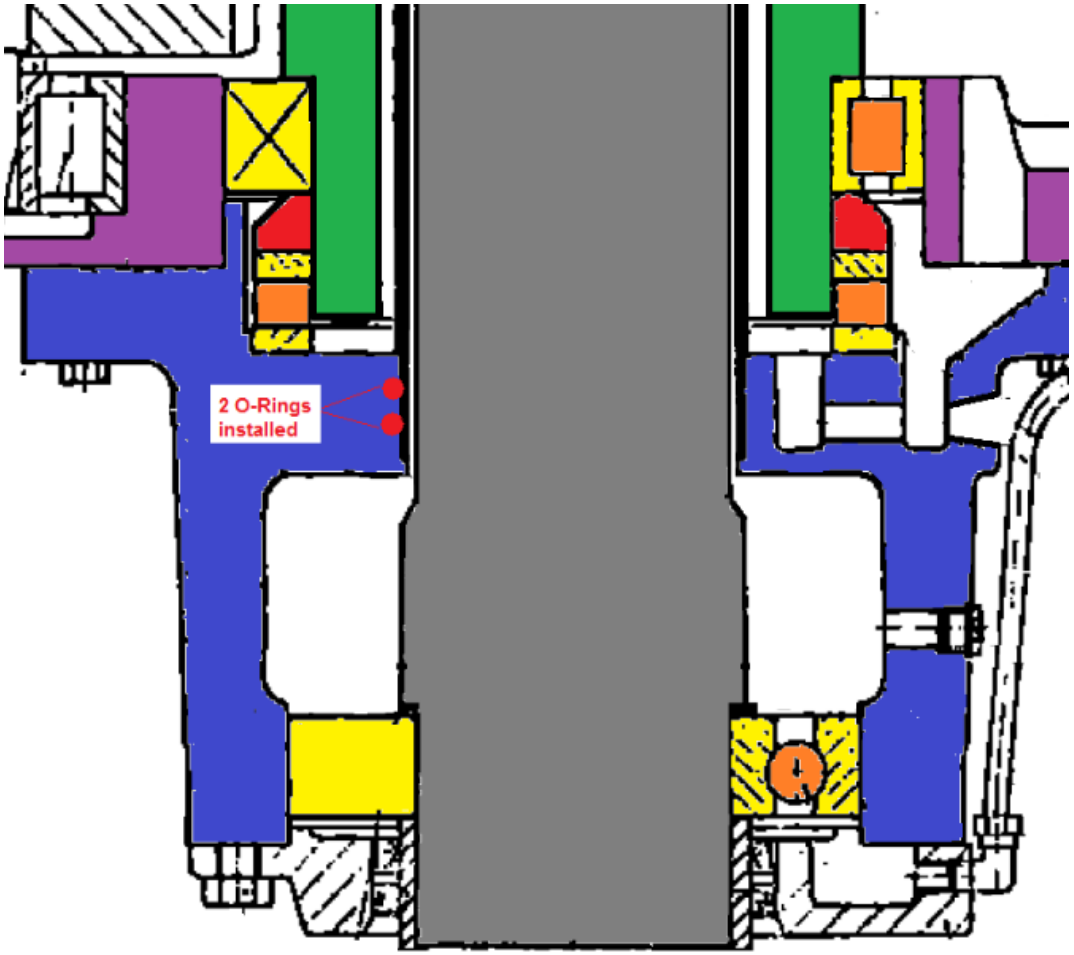
- Backstop > oil leaks
- Logic – start/stop sequencing
- Oil seal leaks & over filling
- Safety concerns (e.g. loose blades/fan assemblies)
- Local manufacturing concerns (i.e. quality)

Remedies

- **General failures**
  - Mostly intermediate gears
  - Most probably due to pitting due to high loads
  - High temperatures means oil viscosity too low
  - Changed from grade 220 to 320

Remedies

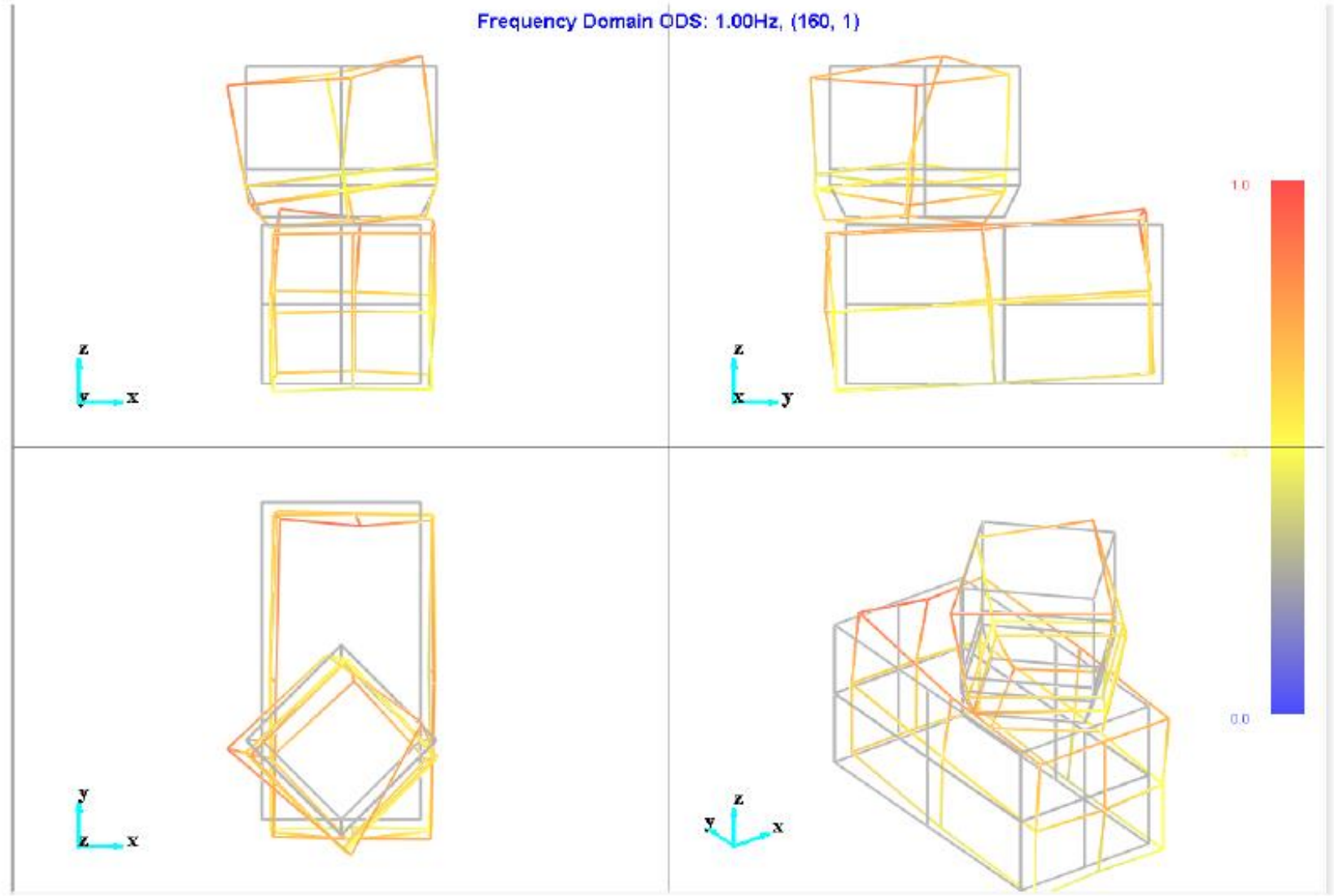
- **Oil leaks**



Remedies

- **Oil pump failures**
  - 40% of oil pumps failed
  - ODS analysis indicated continuous distortion of gearbox casing under the motor weight.
  - Resulted in deflection of shaft driving oil pump
  - Stiffening cradle was installed and significantly reduced oil pump failures

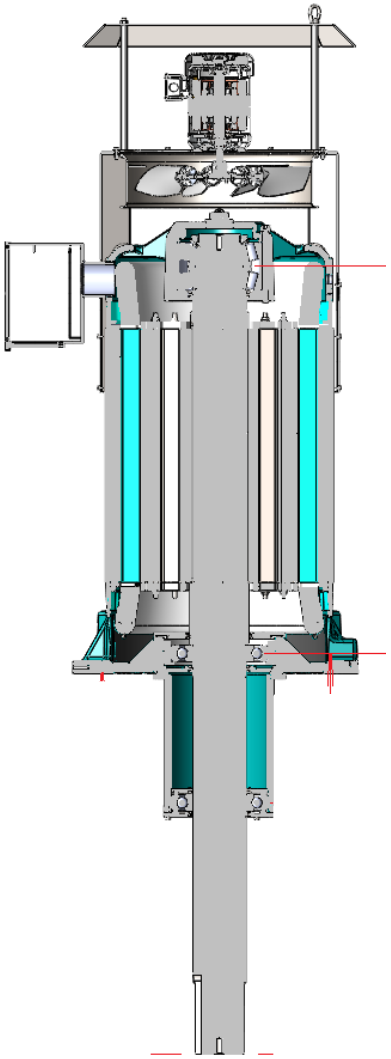
Research & Remedies



Remedies

- **High Oil temperatures**
  - Continuous operating temperatures of ~100°C [~210 °F]
  - 160 liter oil sump [42 US gallons]
  - Oil replacement twice a year
  - Project initiated to install coolers which will circulate the oil through small radiator
  - Reduce oil temperature 60°C

Alternatives?



- Direct drive motor
- No oil required, VSD
- Operational at Dry Fork
- 30% heavier

Conclusions

- Oil – Mineral vs Synthetic
- Lubrication mechanisms – force feed vs self lubricated
- Maintenance
  - Split case found to be easier to maintain
  - Mono blocks require hydraulic press
- Life cycle costs (options differ by up to ~40%)

Acknoledgements

- Francois Nel
- Hein Goldschagg

Questions