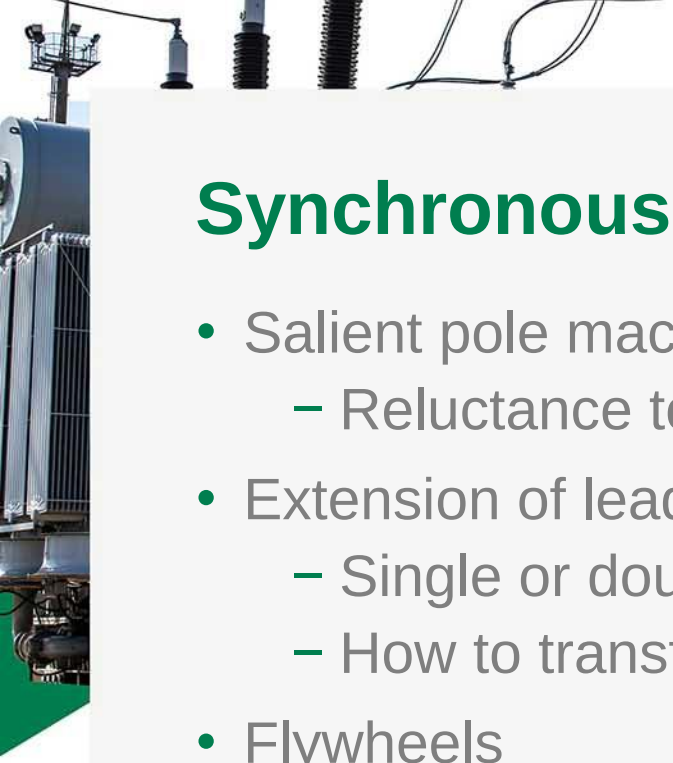
Session 2024

Key take away SC A1

Content

1. Synchronous condensors
2. Changing grid characteristics
3. Monitoring / Maintenance
4. Sustainability / Carbon footprint
5. Small “things”, large consequences
6. Protection
7. E-mobility



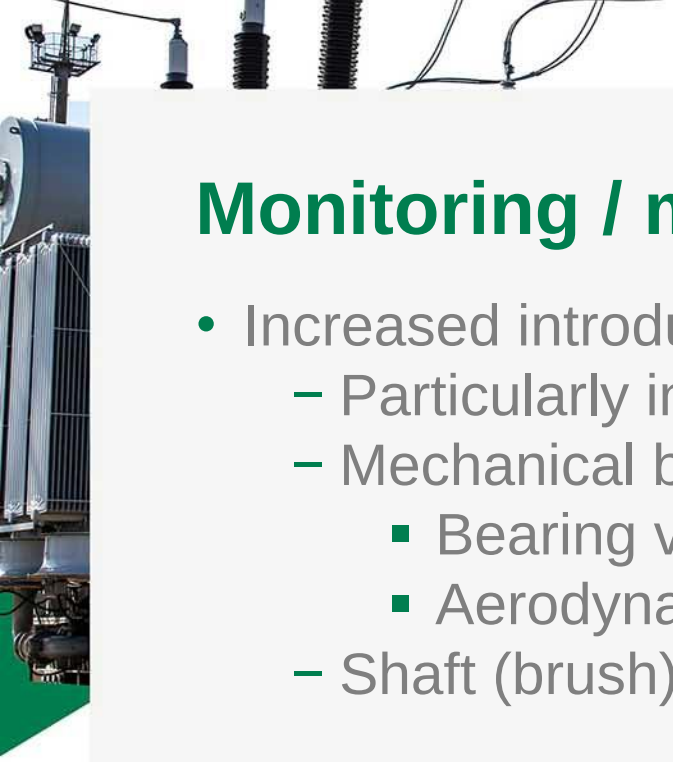
Synchronous condensors

- Salient pole machines are better suited as synchronous condenser
  - Reluctance torque increases operating range
- Extension of leading operating range by negative excitation current
  - Single or double bridge
  - How to transfer from positive to negative current
- Flywheels
  - Safety
  - Choice on speed
- Need of specific standard for synchronous condensors
- Influence of step-up transformer

Changing grid characteristics

- Increased harmonic distortion
- Less stable frequency and voltage
- Larger voltage range

- Consequences:
  - Influence on existing, older equipment
  - Need to modify standards for rotating machines
  - Modified design for new machines



Monitoring / maintenance

- Increased introduction of AI and deep learning in monitoring
  - Particularly in the wind turbine business
  - Mechanical behavior:
    - Bearing vibrations
    - Aerodynamic imbalance
  - Shaft (brush) grounding

- Repair of stator winding insulation in situ
  - Necessary or not?
  - Sufficient results?
  - Fault finding
  - Secondary damage: ozone production!

Sustainability / Carbon footprint

- Awareness for the necessity to investigate
  - Total cost of life
  - Reuse of material
  - Design life
  - Second life?

Small “things” leading to large consequences

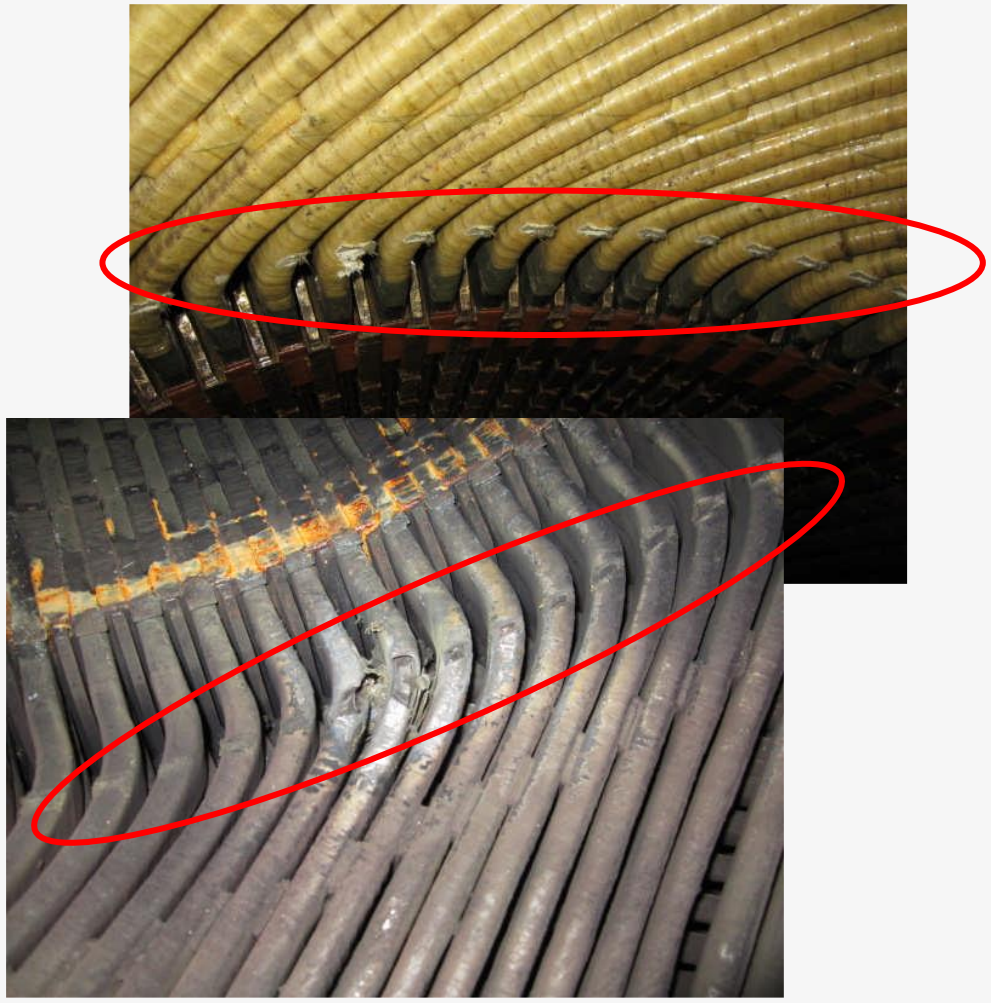
- Typical issues
  - Mistakes during maintenance
    - Wrong type of bolt material (magnetic steel versus stain less steel)
    - Improper torquing
    - Leaking seals
    - Neglecting brush wear
  - Mistakes during design / construction
    - Bad locking set screws
    - Improper bleeding pressure measurement devices
    - Using the wrong design drawings

Situation

- Water pump station
  - Built 2009, in service from half 2012
  - 5 asynchronous motors
  - Rating: 11 200 kW, 11 kV, 1493 rpm, 50 Hz, air/water cooled
  - Starting: Direct on Line

- Motor failure end October 2012
  - Differential protection 11 s after start
  - Two additional unsuccessful attemps to start
  - Stator winding failed

Inspection findings after failure



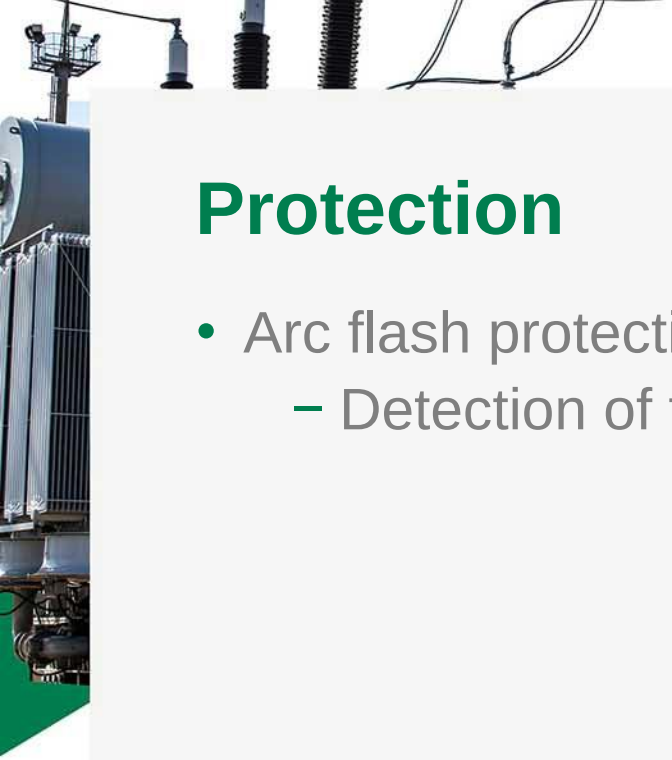
Construction

- Aluminum short circuit ring (D = 1 m)
- Nickel aluminum bronze retaining ring (CuAl11FeNi4)
- Steel hexagon socket set screws (M8x25)

Consequences

- Failed motor (39 tons)
  - Shipped back to OEM (4200 nautical miles, 6 weeks one-way travel)
  - GVPI stator winding: new built including stator core
  - Rotor repaired

- Other 4 motors
  - On-site inspection with rotor (10 tons) withdrawal



Protection

- Arc flash protection in generators
  - Detection of failures that otherwise cannot be detected

E-mobility (source: IEEE)

- Developments in EV traction motors
  - Avoid dependence on rare earth permanent magnets
  - Use non-rare earth PM’s
  - Low temperature magnets -> motor designs with improved cooling
  - New development: wound rotors
    - Field control is possible
    - Less temperature restriction compared to PM’s
    - Rotating rectifiers built in the shaft to avoid sliprings