Report to the CIGRE Australian Technical Committee 2023

Australian Panel AU A1 Activities

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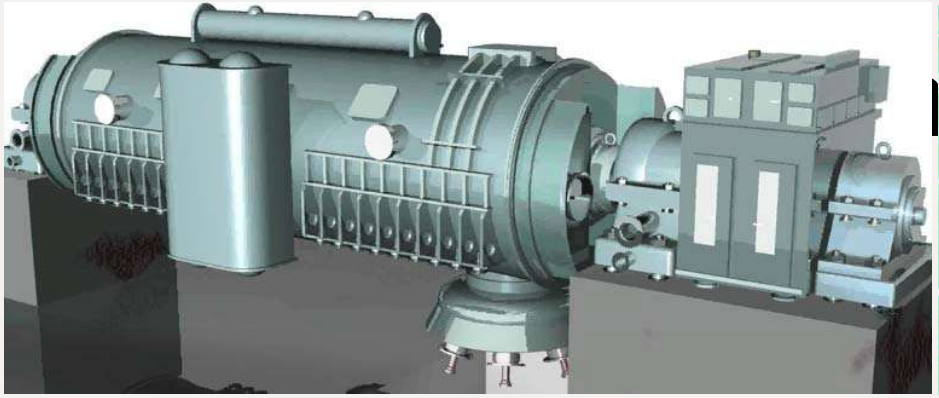
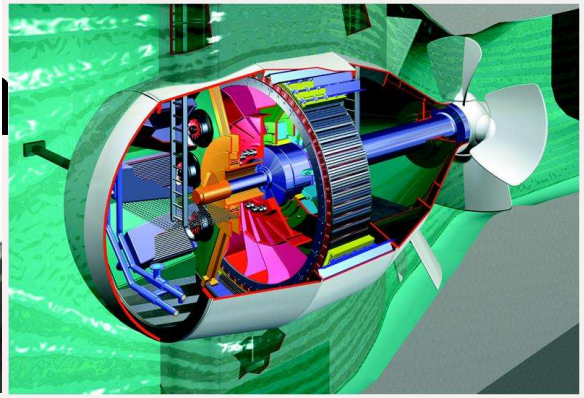
SC A1 Overview

Study Committee Purpose

SC A1 focuses on the development of new technologies and the international exchange of information and knowledge in the field of rotating electrical machines, to add value to this information and knowledge by means of synthesizing state-of-the-art practices and developing guidelines and recommendations.

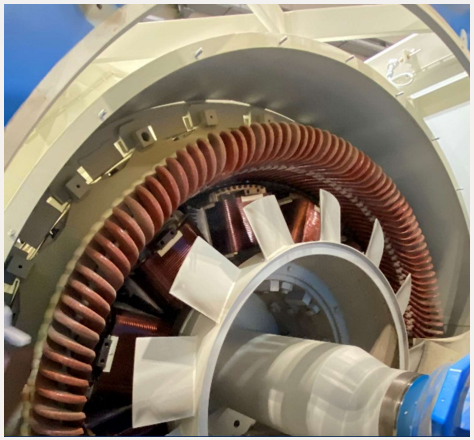




SC A1 Overview

Four Advisory Groups (study areas)

- **Turbo generators: (AG A1-01)** focuses on condition assessment, maintenance, refurbishment, power upgrade, asset management and long-term health assessment.
- **Hydro Generators: (AG A1-02)** focuses on condition assessment, maintenance, refurbishment, power upgrade, asset management and long-term health assessment.
- **Non-conventional Rotating Machines: (AG A1-05)** focuses on wind turbine generators and superconducting machines. In addition review of grid codes as impact on generators.
- **Large Motors and Drives: (AG A1-06)** focus on Motors >1kV and >500kW; benefits of High Efficiency Motors, Variable Speed Drives (VSD) on motors and impacts of flexible operation on larger motors.



SC A1 Overview

Key Areas of Interest

- Enhancements in the construction of large turbo and hydro generators
- Asset Management to extend the life of existing generators or to recommend their replacement
- Machine monitoring, diagnosis and prognosis to perform optimal maintenance
- Renewable generation which may be connected directly to the transmission and distribution or even directly to consumers setting up microgrids
- Large motors and high efficiency motors
- High efficiency rotating electrical machines with new materials, improving cooling and insulation systems in generators and motors
- Utilization of Polymer nano-composites as near-future HV electrical insulation in rotating machines

A1 Study Committee Colloquium and Tutorials from 11th to 15th September 2023 in Kyoto – Japan on Preferential Subjects:

PS 1 – Changing Row of Electrical Machines in Power Generation

- Impacts and effects of an increasing renewable power mix on new and existing generators, generator auxiliaries, and motors,
- Variable speed/pump storage and synchronous compensator design and performance for supporting power generation networks
- Increasing focus on alternative power generation sources (wind, tidal, solar, small thermal/nuclear, geothermal, small hydro).

PS 2 – Optimisation of Installed Assets

- Adaptation of maintenance regimes due to new operating regimes.
- Experience with refurbishment, replacement, conversions, power up-rating and efficiency improvement of generators.
- Developments in condition monitoring, diagnosis, prognosis to improve reliability and extend operational life of conventional plant, including data handling and digital modelling.

PS 3 – New Developments and Operational Experience

- Evolution and trends in designs of rotating machines, materials, manufacture, maintenance, and performance improvements.
- Operational experience: Failures, root cause analysis, recovery options, cost, and time reduction initiatives.
- Developments in the use of variable or high-speed motors in power generation.

2023 A1 SC Colloquium Papers and Presentations

PS 1 - Changing Row of Electrical Machines in Power Generation

- Impact of generators losses on the carbon footprint of an electrical system
- Damping electromechanical oscillations with synchronous compensators: a fundamental study
- Impact of synchronous compensators on wind farm stability issues

PS 2 - Optimisation of Installed Assets

- Developments in condition monitoring, diagnosis, prognosis to improve reliability and extend operational life of conventional plant, including data handling and digital modelling
- Development of Turbine Generator Inspection Robots
- Optimization of Reactive Power Distribution Among Generating Units Connected to Network via Step-Up Transformers with Different Transmission Ratios

2023 A1 SC Colloquium Papers and Presentations

PS 3 - New Developments and Operational Experience

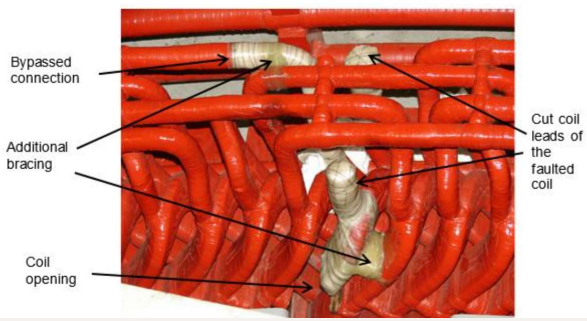
- Analysis of the Causes of Breakdown of the Stator Winding Bars in Main Generator No. 4 at HPP Djerdap 1
- Development of Winding to Reduce Unbalanced Magnetic Pull by Rotor Eccentricity for Large Capacity Hydro-generator
- Development of a program for three-dimensional Thermoelastic Hydro Dynamic lubrication characteristics calculation of guide bearings in vertical axis rotating machines
- Advanced Electromagnetic Design Technology for Magnetic-Geared Generator Evaluation of Characteristics by 3-D FEM Analysis and Testing on Verification Model
- Development of Large Indirectly Hydrogen-Cooled Turbine Generator for Double-end Driven Combined Cycle
- Features and Operating Conditions of Adjustable Speed Generator-Motor for Kyogoku Pumped Storage Hydro Power Station

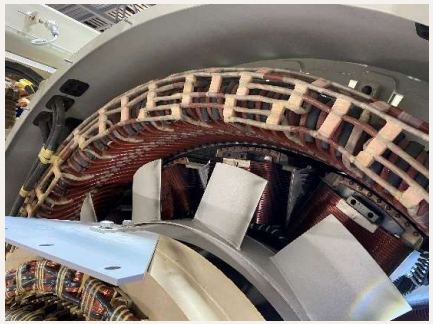
2023 A1 SC Colloquium Tutorials

Tutorial 1: "Survey on Industry Practices and Effects associated with the Cutting Out of Stator Coils in Hydrogenerators"

Tutorial 2: "Renewable Power Integration - Synchronous Condenser role in Grid Stability"

Tutorial 3: "History of High Thermal Conductivity Insulation Development and Application





A1 SC Colloquium and Tutorials from 11th to 15th September 2023 in Kyoto, Japan – Activity Update

2023 Active Working Groups

- **3 Technical Brochures published**:-
  - A1.33 (TB 860) Guide for Cleanliness and Storage of Generators.
  - A1.44 (TB 879) Guideline on Testing of Turbo and Hydro Generators.
  - A1.48 (TB 878) Guidance on High-Speed Testing of Turbo Generator Rotors
- **2 WG work completed** TB to be published (JWG C4/B4.52, A1.54)
- **9 WG at final stage** (A1.42, A1.43, A1/C4.52, A1.56, A1.59, A1.60, A1/C4.66, A1.53, A1.58)
- **11 WG in progress** (A1.45, A1.55, A1.61, A1.62, A1.63, A1.64, A1.67, A1.68, A1.69, A1.70, A1.71)
- **6 New WG** (A1.72, A1.73, A1.74, A1.75, A1.76, A1.77)

SC A1 Meeting hightlights

- All working groups status review,
- Technical Council meeting and activities,
- Presentations from Advisory Group convenors
- Study Committee scope and strategic directions – “More focus on wind generation and synchronous condensers”
- 2024 Paris paper submission and review process.

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Relevance to Australia

Turbo and Hydro generators

- TB 860 (A1-33) Guide for Cleanliness and Storage of Generators.
- TB 879 (A1-44) Guideline on Testing of Turbo and Hydro Generators.
- TB 878 (A1-48) Guidance on High-Speed Testing of Turbo Generator Rotors
- TB 690 - Vibration and stability problems met in New, Old and Refurbished Hydro-generators, Root Causes and Consequences
- WG A1-54 (finalize) Impact of Flexible Operation on Large Motors.
- WG A1-29 Guide on New Generator - Grid Interaction Requirements. - Relevant to prevention of widespread state blackout; similar to that in 2016 in SA.
- WG A1-31 State of the Art of Stator Winding Supports in slot area and winding overhang of hydro generators
- WG A1-37 Generator Stator windings support systems experience. - Highly relevant to the older turbo and hydro generators where they experience in high end winding vibration.
- WG A1/C4-66 - Guide on Synchronous Condensers for System Inertia, Short Circuit withstand capability (fault levels) and MVAr support in power grids with high level of renewable energy generation. - Highly relevant to South Australia due to high proportion of wind and solar generation.
- WG A1.70 Dielectric Dissipation Factor Measurements on Stator Windings. - Highly relevant to diagnostics to the ageing generator fleet in Australia.

AU A1 Activities

- The AU A1 panel currently has 14 members and 3 guest experts
- Representation from Utilities, Consultants, Service Providers and Testers, all states of Australia,
- Members participate 4 SC A1 working groups
- One technical paper synopsis submitted in
- Members share experience in the form of technical presentations at panel meetings in a wide range of relevant topics such as generator & motor failures, abnormal operations, major overhaul experience, new industry practice and technologies, condition monitoring, management of aged generators.
- Members make contributions to technical papers and working groups
- Excellent technical networking

Looking Ahead Proposed Study Topics

Turbo-generators AG-01

- Transient currents in rotor forgings
- Energizing at standstill (generator considerations at startup)
- Generator core integrity
- Issues related to stator wedges (tightness, ripple spring replacement, cracking) and wedge testing methods
- Generator operation without cooling water
- Developing a guideline for design reviews of major generator refurbishment projects
- Capacitance mapping and other stator winding evaluation techniques
- Factory quality assurance testing requirements

Looking Ahead Proposed Study Topics

Large Motors and Drives AG-06

- State of the art in new advanced motor technologies
- Guide on specification and selection of motors for various industry applications
- Guide on methods for detection of broken bars in squirrel age induction motors
- Guide on rotor faults detection in squirrel-cage induction motors by current signature analysis
- Guide on specification and design of large synchronous compensators
- Guide on starting and speed/torque control methods for large three phase induction motors
- Guide on experience of implementation of IE4 efficiency class
- Guide for specification/operation of motors in explosive environments
- Guide for special application motors: marine motors. Water cooled motors, brake motors, motors for high ambient temperatures, traction motors
- Motor performance under abnormal conditions
- Effect of different types of windings on efficiency, torque and harmonics of induction motor
- Guide on use of expert systems for determining the risk of failure in motors

Thank You