Refurbishment Strategies and Considerations for HVDC Stations

Sunyoung Lim (UK)

SC B4 – PS 1

2024 CIGRE Session - Paris - Date

cigre
For power system expertise

PSC

Table of contents

INTRODUCTION

- **Background**
  - ✓ With a growing emphasis on renewable energy sources, HVDC's role becomes indispensable
  - ✓ Ensure their ongoing reliability, performance, and compliance with updated regulations

- **Methodology**
  - ✓ Exploring the past HVDC refurbishment projects
  - ✓ Addressing strategies and consideration
  - ✓ Suggest strategies for different types of refurbishments

cigre
For power system expertise

INTRODUCTION

- **Expected Contribution**
  - ✓ Providing valuable insights and a roadmap for stakeholders

- **Importance of HVDC station refurbishment**
  - ✓ Ensuring the ongoing reliability and availability of the existing HVDC systems
  - ✓ Extending lifespan
  - ✓ Optimizing its functionality

- **Why do we need strategies?**
  - ✓ Maximise the value of the investments
  - ✓ Risk mitigation
  - ✓ Contributes to the long-term reliability and sustainability

TYPES OF REFURBISHMENT

For power system expertise

TYPES OF REFURBISHMENT

- **Selective Equipment Replacement**
  - ✓ Focuses on extending operational lifespan (cost-effective)
  - ✓ Identify equipment with malfunctioning, outdated, or have reached the end of their operational life
- **Upgrades**
  - ✓ Aims at enhancing the station's performance
  - ✓ Comply with new standard, incorporate new technologies
  - ✓ Ex. Installation of advanced control systems
- **Overhaul refurbishment**
  - ✓ Involves complete overhaul or replacement of HVDC station components or systems.
  - ✓ Driven by comprehensive system issues, high-maintenance cost, or the systems have reached the end of their design life

HVDC REFURBISHMENT PROJECTS

HVDC REFURBISHMENT PROJECTS

Project Name	Capacity (MW)	Type	Commissioned year	Refurbished year	Refurbishment type
Cahora Bassa HVDC System (Mozambique – South Africa)	1290	LCC	1979	Apollo station :2008 (29y)	**Upgrades** (Valves)
				Songo station : 2013-2014 (35y)	**Overhaul refurbishment** (Converter transformer, Valves, control and protection systems, AIS, earth electrodes, DC smoothing reactors, arresters measuring equipment, Grid Master Power Controller (GMPC))
Nelson River (Canada)	2000	LCC	1972	1993 (21y) 2004 (32y)	**Replacement** (Valves (increased power rating) and cooling plants, controls)
Konti-Skan Pole 1 (Sweden-Denmark)	380	LCC	1965	2006 (41y)	**Overhaul refurbishment**
UK-France Interconnector	2000	LCC	1986	Pole1: 2011 (25y) Pole2: 2012 (26y)	**Upgrades** (Valves and cooling plants, controls)
Heanam-Jeju island (South Korea)	300	LCC	1996	2020 (24y)	**Upgrades** (Valves and cooling plants, controls)
Brazil-Argentina Interconnector (Garabi station)	2200	LCC	2000	Undergoing (23y)	**Upgrades** (Controls)

cigre
For power system expertise

CONSIDERATIONS and STRATEGIES

Technical evaluation

Environmental and safety regulations

Strategic framework and planning

Project management and stakeholder collaboration

CONSIDERATIONS

TECHNICAL EVALUATION

- **Performance Assessment**
  - ✓ Involves comprehensive statistical analysis of operational data, including equipment failure and trip events.
  - ✓ Identifies equipment contributing to decreased availability and reliability.
  - ✓ Prioritise replacements

- **Component Assessment**
  - ✓ Involves detailed inspections and performance assessments of converters, transformers, and control systems.
  - ✓ Inspect wear, aging, malfunction, efficiency, and operational limitations.

- **Diagnostic Testing**
  - ✓ Utilizes tests such as insulation resistance, partial discharge measurements, and thermographic inspections.
  - ✓ Identifies conditions of specific equipment

cigre
For power system expertise

CONSIDERATIONS

ENVIRONMENTAL AND SAFETY REGULATIONS

- **Environmental Considerations:**

- **Safety Measures:**
  - ✓ Prioritizing safety by replacing hazardous equipment (e.g., oil-cooled systems) with safer alternatives (e.g., air-cooled equipment).
  - ✓ Minimizes risks of flammability, enhancing safety during maintenance and operation.

- **Transition to Eco-Friendly Alternatives:**
  - ✓ Shift from hazardous materials (e.g., mercury in arc valves) to environmentally friendly alternatives (e.g., thyristor valves).
  - ✓ Addresses high maintenance costs and mitigates potential environmental risks.

For power system expertise

CONSIDERATIONS

STRATEGIC FRAMEWORK AND PLANNING

- **Risk Analysis**
  - ✓ Identifies potential failure points and assesses their impact on station functionality.
  - ✓ Analyzes consequences of component failure on operation and grid stability.

- **Lifecycle Assessment**
  - ✓ Estimates remaining useful life of components and systems. (Obsolescence)
  - ✓ Lifecycle cost analysis to assess the long-term cost-effectiveness

- **Comparative Analyses**
  - ✓ Evaluates advantages and disadvantages of modern solutions against legacy systems.
  - ✓ Compares capabilities of newer technologies with existing ones for benefits, efficiency gains, and performance enhancements.
  - ✓ Define strategy

cigre
For power system expertise

CONSIDERATIONS

PROJECT MANAGEMENT

AND STAKEHOLDER COLLABORATION

- **Efficient Project Management:**
  - ✓ Crucial for overseeing complex refurbishment processes.
  - ✓ Ensures achievement of project goals within defined timelines and budgets.
  - ✓ Meticulous planning, resource allocation, scheduling, and risk mitigation.

- **Stakeholder Collaboration:**
  - ✓ Involves collaboration with engineers, suppliers, regulatory bodies, local communities, and more.
  - ✓ Facilitates effective decision-making, problem-solving, and alignment with industry standards.

[Case Example - Cahora Bassa HVDC System]

- ✓ Collaboration with the associated generation facility during refurbishment.
- ✓ Coordination efforts to minimize overall outages by synchronizing construction activities.

cigre
For power system expertise

CONCLUSION

- **General Considerations :**
  - ✓ Regulatory compliance
  - ✓ Environmental considerations
  - ✓ Stakeholder collaboration

Selective Replacement	Upgrades	Overhaul Refurbishment
• Component Assessment • Diagnostic testing	• Technology Assessment • Risk analysis	• Performance Assessment • Lifecycle assessment

For power system expertise