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the hydro generator mantra: renovate, modernize and uprate

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contents

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Abstract

Hydroelectric power generation has been around since the late 19th century. Generally seen as a renewable, environment friendly, non-polluting, low-cost and highly reliable source of energy, some 150 nations have hydel-power projects today. Hundreds of hydro-generators installed more than 60 to 80 years ago still operate across the world, using old technology.

Given the long time cycle and huge capital investment required to construct a new power plant, upgrading these old hydro units by Renovation, Modernization and Uprating (RMU) is a quick, cost effective means of capacity addition. RMU essentially uses modern design and materials tramp up the efficiency, output and life of these plants at a low cost. This white paper showcases the capabilities of QuEST in Engineering Services for RMU of Hydro Generators. This method is also applicable to old steam and gas based power stations.

What is RMU?

Renovation, Modernization and Uprating (RMU) is a term used for reconditioning and upgrading old power generating equipment to modern standards.

Renovation

The availability of existing infrastructure like the foundation, stator frame, rotor, brackets and bearings means only selective replacement of critical components is required, making it time and cost efficient. Replacing the turbine runner, generator winding with class “F” insulation, excitation system, governor, etc., and the refurbishment of other worn out parts increases not just efficiency, peak power availability and energy generation, it adds decades of new life to the power plant/equipment.

Modernization

Rapid advances in technology have led to new equipment which improves the peak performance and efficiency of existing systems. It is necessary to constantly keep track of new methods which help improve.

Generator performance and productivity. QuEST engineers weave in continuous modernization as part of the renovation programme itself. Plant reliability can be further improved by using modern equipment like static excitation systems, microprocessor based controls, electronic governors, high speed static relays, data loggers, vibration monitoring systems and partial discharge analyzers, among others.

Uprating

Uprating is the replacement or improvement of components required to increase the unit MVA output. Uprating requires a systematic approach since a number of diverse factors such as hydraulics; mechanical and electrical issues, safety as well as economics are involved. Uprating involves partial or total replacement of the electro-mechanical equipment within the existing civil works, while maintaining liberal safety margins. Modern technology like computer aided design, Finite Element Analysis (FEA) and advancement in material science allows the design and development of new equipment with uprated capacity without changing the existing civil structures. But it is still important to validate that other systems and processes already in place can handle the increased output.

Objectives of RMU

The constant increase in demand for power has necessitated increasing the power output of old hydro sets in various power plants. The main objective is to utilize the existing infrastructure while replacing critical components with new ones designed to step up output and efficiency economically.

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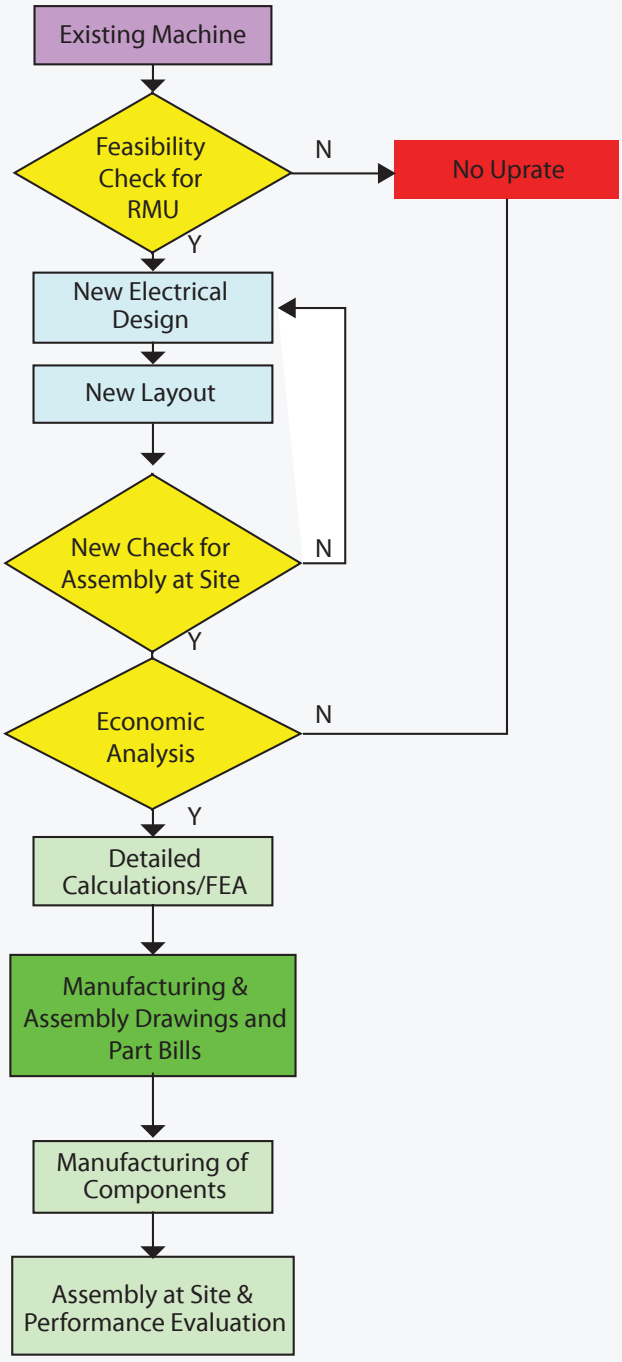
The increased output of the new optimally designed turbines puts additional loads on the generator. These loads need to be evaluated using the latest analytical software to ensure optimum design and safety of various generator assemblies. Improved insulation systems and using high strength materials for the stator and rotor substantially increases output. The increased cooling and ventilation requirements also need be mapped and measured against the existing capacity.

RMU objectives

- Increase output power
- Replace only critical components
- Optimal use of existing infrastructure
- Increase plant safety, reliability and life



The Stages of RMU

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The Challenges

Lack of information: Given the age of the plants requiring RMU, it is usually difficult to get comprehensive information about them. Limited Drawings and other documents available are sometimes illegible.

Working within existing infrastructure: For a generator designer, the key challenge is to retain the existing civil works and bearing arrangements to minimise the cost.

Pre-and post installation safety: Adequate care must also be taken while transporting large fabricated structures for installation and a meticulous design check is required to ensure safe operation of the equipment in the uprated condition.

The table below indicates the expertise required for an uprate study of various generator assemblies:

Areas of Expertise	Generator Assemblies
Electrical and Insulation Engineering	Stator winding scheme, stator bar/coil design, pole jumpers and bus bar design, extended bus bars and their mechanical supports
	Rotor field coils, pole to pole connections, rotor leads, collector assembly, brush gear and their supports
Mechanical Engineering	Strength aspects of all structural components like statorframe, stator core bracketsand rotating components like rotor shaft, spider, rotor rim, poles, field leads, etc.
Civil Engineering Aspects	Normal forces and abnormal short circuit forces for checking foundation loading
Instrumentation and Controls	Electrical, mechanical, flow, temperature, schematics, etc.

The Process

QuEST design engineers have vast experience in design, manufacture and erection of generators as well as RMU of generators. After studying the limited documentation on the existing generator, these engineers identify critical gaps in the information and make arrangements to generate the data. Site measurements and photographs of partially disassembled generator are used to supplement the information available from the customer-supplied drawings.

A detailed layout is then prepared with the existing information, and the parts which require refurbishment are listed out. Strength analysis is conducted to ensure that the retained components as well as new components do not fail in the uprated capacity under normal and abnormal operating conditions. Finite Element Analyses (FEA) are done for critical components.

After freezing on the layout, detailed drawings and part bills are generated along with uprate study report for verification.

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The QuEST Advantage

QuEST has been involved in providing engineering services for RMU activities for the past nine years, and has completed fifty hydro generator RMU projects to date.

QuEST design engineers are well--versed in the use of software/tools required for a complete RMU project execution.These include:

Software/Tools	Purpose
UG	Modelling and drafting
MathCAD/Microsoft Excel	Design calculations
ANSYS	Finite element analysis

All QuEST engineers constantly track the latest developments in the RMU domain, and regularly upgrade their skills.

Conclusion

Oldpower generators can be given a new lease of life using RMU. RMU involves upgrading critical components to improve output and plant life without disrupting the existing civil infrastructure, thereby cutting time and costs. With fifty RMU projects already completed, QuEST engineers are well-placed to provide the service for not just hydro, but old steam and gas powered generators as well. Apart from the experience gained from these earlier projects, QuEST engineers constantly upgrade themselves with the latest developments in design and manufacture in the RMU domain. This ensures that the latest technology and material is used for each new project, at minimal cost.

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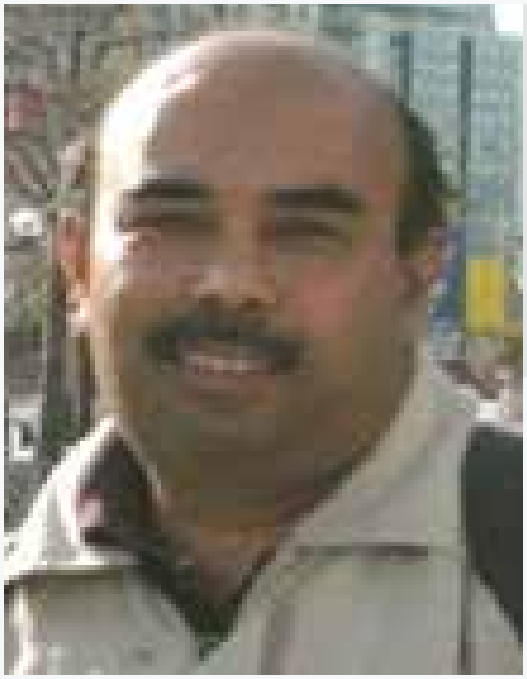
Author Profile



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Madhukara has over 16 years experience in Mechanical Design of Rotating Electrical Machines – Motors and Generators. Prior to joining QuEST, he worked as Senior Engineer in DC Motor Engineering at Kirloskar Electric Company for 7 years.

He holds a Bachelor's Degree in Mechanical Engineering from Bangalore University and a Master's Degree in Materials Engineering from Karnataka Regional Engineering College – Surathkal. With QuEST since 9 years, he is currently working as Principal Engineer for Generator and Motor teams and is engaged in supporting General Electric for requisition activity (Modelling and Drafting of Large Motors).

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About QuEST Global

QuEST Global is a focused global engineering solutions provider with a proven track record of over 17 years serving the product development & production engineering needs of high technology companies. A pioneer in global engineering services, QuEST is a trusted, strategic and long term partner for many Fortune 500 companies in the Aero Engines, Aerospace & Defence, Transportation, Oil & Gas, Power, Healthcare and other high tech industries. The company offers mechanical, electrical, electronics, embedded, engineering software, engineering analytics, manufacturing engineering and supply chain transformative solutions across the complete engineering lifecycle.

QuEST partners with customers to continuously create value through customer-centric culture, continuous improvement mind-set, as well as domain specific engineering capability. Through its local-global model, QuEST provides maximum value engineering interactions locally, along with high quality deliveries at optimal cost from global locations. The company comprises of more than 7,000 passionate engineers of nine different nationalities intent on making a positive impact to the business of world class customers, transforming the way they do engineering.

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