Science & Technology · GS - III

Examine the significance of life extension and renovation of India's ageing nuclear power reactors in strengthening energy security. Discuss the associated safety, technological and regulatory considerations.

EXAM YEAR	PAPER	SUBJECT
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MARKS	WORD LIMIT
15	~250 words

Answer Hint

Nuclear energy, PHWR technology, life extension, energy security, reactor safety, NPCIL, AERB regulation, radioactive waste management

Model Answer

Introduction

Nuclear energy provides low-carbon, reliable electricity and contributes to India's energy diversification. The renewed criticality of Kaiga Nuclear Power Plant Unit-1 following renovation and life-extension work highlights the importance of maintaining existing nuclear infrastructure.

Significance of Nuclear Reactor Life Extension

1. **Energy security:** Extending the operational life of existing reactors helps maintain electricity generation capacity and reduces dependence on imported fossil fuels.

2. **Low-carbon electricity:** Nuclear power provides reliable, low-carbon baseload electricity, complementing variable renewable sources such as solar and wind.

3. **Economic efficiency:** Renovating an existing plant may be more cost-effective and quicker than constructing an entirely new nuclear facility, subject to safety and economic assessments.

4. **Technological capability:** Life-extension programmes encourage domestic expertise in reactor engineering, component replacement, instrumentation and control systems.

5. **Fuel-cycle advantages:** India's Pressurised Heavy Water Reactors can use natural uranium, supporting the country's long-term nuclear energy strategy.

Key Challenges and Safeguards

1. **Ageing components:** Structural degradation, corrosion and material fatigue require comprehensive inspection and replacement of critical components.

2. **Nuclear safety:** Periodic safety reviews, emergency preparedness and rigorous testing are essential before extending reactor operations.

3. **Regulatory oversight:** Independent safety assessment and licensing by the Atomic Energy Regulatory Board are crucial for continued operation.

4. **Radioactive waste:** Safe handling, storage and disposal of radioactive waste must remain integral to reactor management.

5. **Public confidence:** Transparent communication, environmental monitoring and emergency response mechanisms can strengthen public trust.

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Way Forward

India should combine life-extension programmes with investment in advanced reactor technologies, domestic manufacturing, skilled personnel and robust independent safety regulation.

Conclusion

Life extension of nuclear reactors can strengthen India's reliable low-carbon electricity capacity, provided it is based on rigorous scientific assessment and uncompromising safety standards.