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Ageing of Nuclear Reactors:

Safety and Security Perspectives for the Future

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1. Introduction

- **Clear signs for nuclear power expansion**
  - No serious accident during last 20 years
  - Good safety performance
  - Improved public confidence in operator and regulator

- **But many 'aged plants' in the future**
  - Most current reactors in operation for more than 30 years

- **Ageing**
  - Time dependent degradation in SSCs (Structures, Systems and Components)
  - Ageing effects on large components have the potential to limit operating lifetime of plants

2. Approaches to Physical Ageing

- **Provisions to limit the effects on safety in design stage**
  - Specification of service conditions on SSCs
  - Arrangements for monitoring, examination, inspection and testing
  - Maintenance programme

- **Operating experience feedback in operation stage**
  - To address unexpected ageing effects
  - To prevent the recurrence of ageing problems raised in other countries

- **Use of advanced science and technology**
  - More accurate diagnosis using advanced NDE techniques
  - Earlier detection of defects with new inspection tools
  - More reliable determination of replacements with improved assessment of the condition of ageing

3. Non-physical Aspects of Ageing

- **Documentation control**
  - Essential for effective ageing management
  - Necessary to determine the level of ageing that has taken place and how much residual life is to be expected
  - Make long term operation possible

- **Knowledge transfer**
  - From personnel who worked at the time of construction to new generations of personnel
  - Lessons and detailed knowledge concerning the particular SSCs

- **Securing components**
  - Seeking replacement or equivalent parts when manufacturers no longer exist
  - Identifying critical components and making them ready on-site as spare parts

4. Regulatory Issues

- **Ageing is believed to be manageable**

  ➡ Long term operation would be continuously attempted in the future

- **Long term operation relies on**
  - Management capability of the operating organization
  - Regulatory competence to deal with the whole spectrum of technical, societal and global issues

- Design Criteria for External Events

- **Change of design criteria to consider**
  - Unusual weather conditions such as local heavy rain and snow, fierce heat and cold, and super typhoon/hurricane
  - Sea-level rising, tsunamis and earthquakes beyond design criteria

- **Design criteria should be re-established**
  - Reflecting new data on weather, earthquake and tsunami

➡ **International cooperation is needed among countries suffering from similar natural disasters**

- Security Aspects

- **Possibility of attack on NPPs**
  - Security has become very important with conventional nuclear safety issues after 9/11
  - Interface between safety and security has been emphasized

- **Security aspects of ageing reactor**
  - ❖ Still in need of scrutiny
  - More opportunity to get loose information related to the plant
  - More intelligent and systematic sabotage

➡ **Protection of security information should be considered and duly incorporated in ageing management**

- Human and Organizational Factors and Safety Culture

- **Skilled operators familiar with reactor systems**
  - Invaluable assets of safe operation
  - Sometimes a source of events with their overconfidence

- **Overconfidence**
  - Resulted from past good performance, praise from domestic or international parties, and no critics from peers
  - No accident and good performance → overconfidence and complacency → accident in the long run

- **Leadership for safety**
  - Plays an important role in promoting safety culture

➡ **Regulatory or self-obligatory framework on top manager's leadership requirements**

- Stakeholder Interaction

- **Increased expectation of the public on safety**
  - Demand more involvements in regulatory decision processes
    - When long term operation is planned, they may argue the plant shutdown at the expiration of license
  - Challenges to regulators when influences are strong enough to affect regulatory decision
- **Regulatory approach to meeting the public demands**
  - Transparency in regulatory process, public communication, public trust and confidence
- **Future role of regulator**
  - Should the role of regulator end with just assurance of nuclear facilities' being operated within an acceptable level of safety?
  - Should it be extended to achieving the public's satisfaction with safety?

5. International Cooperation

- **Global approach to assuring safety and security of ageing reactors**
  - Effective for wide and rapid exchange of information about the unexpected ageing effects
  - ❖ IAEA's contribution to this area appreciated

- **System for operational experience feedback**
  - Ageing-related defects are rarely reported
  - Needs to be refined
    - To cover ageing related events
    - To classify the events into more categories

- **Safety Review Service for Long Term Operation**
  - For comprehensive and systematic review
  - Based on the current activities of AMAT and SALTO projects

6. Conclusion

- **From the past experiences, ageing is believed to be manageable**
- **Much efforts should be made to deal with the whole spectrum of technical, societal and global issues of ageing**
- **International cooperation should be more consolidated to assure safety and security of ageing reactors**