

Panel discussion on

# Advanced Monitoring and Diagnostic Technologies in NPPs (I&C Systems)

International Conference on Opportunities and Challenges for  
Water Cooled Reactors in the 21st Century

Vienna, Austria, Wednesday, 28 October 2009



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International Atomic Energy Agency

# Why Plenary Discussion on Instrumentation and Control (I&C)

- I&C is the fastest changing technology in NPPs
- Digital is the only choice available
- Relevant to NPP modernization and new designs
- Significant challenges in licensing digital I&C
- Ageing NPPs will need more monitoring & diagnostics
- Building into new designs

## Scope of I&C:

- Process measurements
- Actuators
- Logic and decision making – digital
- Human-system interface (HSI, HMI, MMI) – Control rooms
- Monitoring and Diagnostic Systems

# Panellists

- Mr. Hash Hashemian, AMS Corporation, USA
- Mr. Kook Hun Kim, Doosan Heavy Industries, Republic of Korea
- Mr. Bela Bechtold, Areva NP GmbH, Germany
- Mr. Jean-Paul Bouard, EdF and IEC SC45A, France
- Mr. Gary Johnson, Department of Nuclear Safety and Security, IAEA
- Mr. Oszvald Glöckler, Department of Nuclear Energy, IAEA

# I&C Issues

- Short opening statements from panellists
- List of I&C related challenges relevant to NPP design, licensing, and operation
- Questions from the audience
- Summary to be published

- Licensing digital I&C used in safety systems
- Possible common-cause failures in digital I&C systems for safety
- Cyber security of digital I&C systems
- Use of pre-qualified commercial-off-the-self products in I&C
- New sensing technologies



- Wireless communication in diagnostics and monitoring applications
- Modernization of I&C systems and control rooms
- New I&C systems supporting power uprates and license renewals
- I&C cable ageing and equipment qualification
- Capture and transfer I&C knowledge



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- 1. INTRODUCTION
- 2. OVERVIEW OF TRADITIONAL PERFORMANCE TESTS
- 3. OVERVIEW OF ON-LINE MONITORING
- 4. CHARACTERISTICS OF DATA ACQUISITION SYSTEMS FOR
- 5. DATA ANALYSIS FOR ON-LINE MONITORING
- 6. INSTRUMENT RELIABILITY AND ACCEPTANCE CRITERIA FC
- 7. IMPLEMENTATION GUIDELINES FOR ON-LINE MONITORING
- 8. BENEFITS AND CHALLENGES OF ON-LINE MONITORING
- 9. REGULATORY ASPECTS
- 10. STANDARDS AND GUIDELINES
- 11. TRENDS AND DIRECTIONS
- 12. KEY RECOMMENDATIONS
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- Annex II --- ON-LINE MONITORING OF ACCURACY AND RELIAE
- Annex III --- CONDITION BASED CALIBRATION/MAINTENANCE
- Annex IV -- INSTRUMENT CALIBRATION REDUCTION THROUGH
- CONTRIBUTORS TO DRAFTING AND REVIEW

# IAEA Nuclear Energy Series

No. NP-T-1.1

## On-line Monitoring for Improving Performance of Nuclear Power Plants Part 1: Instrument Channel Monitoring



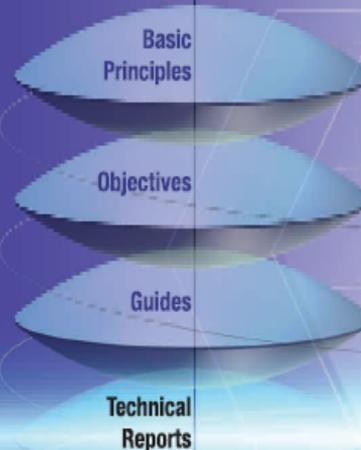
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- 1. INTRODUCTION
- 2. BENEFITS OF ON-LINE CONDITION MONITORING
- 3. DESCRIPTION OF CONDITION MONITORING TECHNIQUES
- 4. MODELLING TECHNIQUES
- 5. ON-LINE MONITORING IMPLEMENTATION STRATEGY
- 6. ENABLING TECHNOLOGIES
- 7. FUTURE TRENDS
- 8. CONCLUSIONS AND RECOMMENDATIONS
- REFERENCES
- CONTRIBUTORS TO DRAFTING AND REVIEW

# IAEA Nuclear Energy Series

No. NP-T-1.2



## On-line Monitoring for Improving Performance of Nuclear Power Plants Part 2: Process and Component Condition Monitoring and Diagnostics

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- CONTENTS
- 1. INTRODUCTION TO POWER UPGRATING
- 2. LIMITS, MARGINS AND THEIR RELEVANCE TO INSTRUMENTATION
- 3. CALCULATION OF THERMAL POWER
- 4. IMPACT OF POWER UPGRATING ON PLANT INSTRUMENTATION
- 5. HUMAN AND TRAINING ASPECTS
- 6. REGULATORY ASPECTS
- 7. INSTRUMENTATION AND CONTROL IMPLEMENTATION GUIDELINES
- 8. INSTRUMENTATION AND CONTROL BENEFITS AND LESSONS LEARNED
- 9. KEY RECOMMENDATIONS
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# IAEA Nuclear Energy Series

No. NP-T-1.3



## The Role of Instrumentation and Control Systems in Power Upgrading Projects for Nuclear Power Plants

- FOREWORD
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- 1. INTRODUCTION
- 2. RELATED DOCUMENTATION
- 3. OVERVIEW OF IMPORTANT CONSIDERATIONS FOR I&C SYSTEMS
- 4. I&C PROJECT EXECUTION
- 5. CONCLUSIONS, RECOMMENDATIONS, AND FUTURE CHALLENGES
- REFERENCES
- ABBREVIATIONS
- CONTRIBUTORS TO DRAFTING AND REVIEW

# IAEA Nuclear Energy Series

No. NP-T-1.4



## Implementing Digital Instrumentation and Control Systems in the Modernization of Nuclear Power Plants



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D-NP-T-3.12

***Core Knowledge on  
Instrumentation and Control  
Systems in Nuclear Power Plants:  
A Reference Book***

*Report prepared within the framework of the Technical Working Group  
on Nuclear Power Plant Control and Instrumentation*



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October 2009

**D-NP-T-3.14**

***Results of the Coordinated Research  
Programme titled***

***Advanced Surveillance,  
Diagnostics, and Prognostics  
Techniques Used for Health  
Monitoring of Systems,  
Structures, and Components in  
Nuclear Power Plants***

*Report prepared within the framework of the Technical Working Group  
on Nuclear Power Plant Control and Instrumentation*



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December 2010

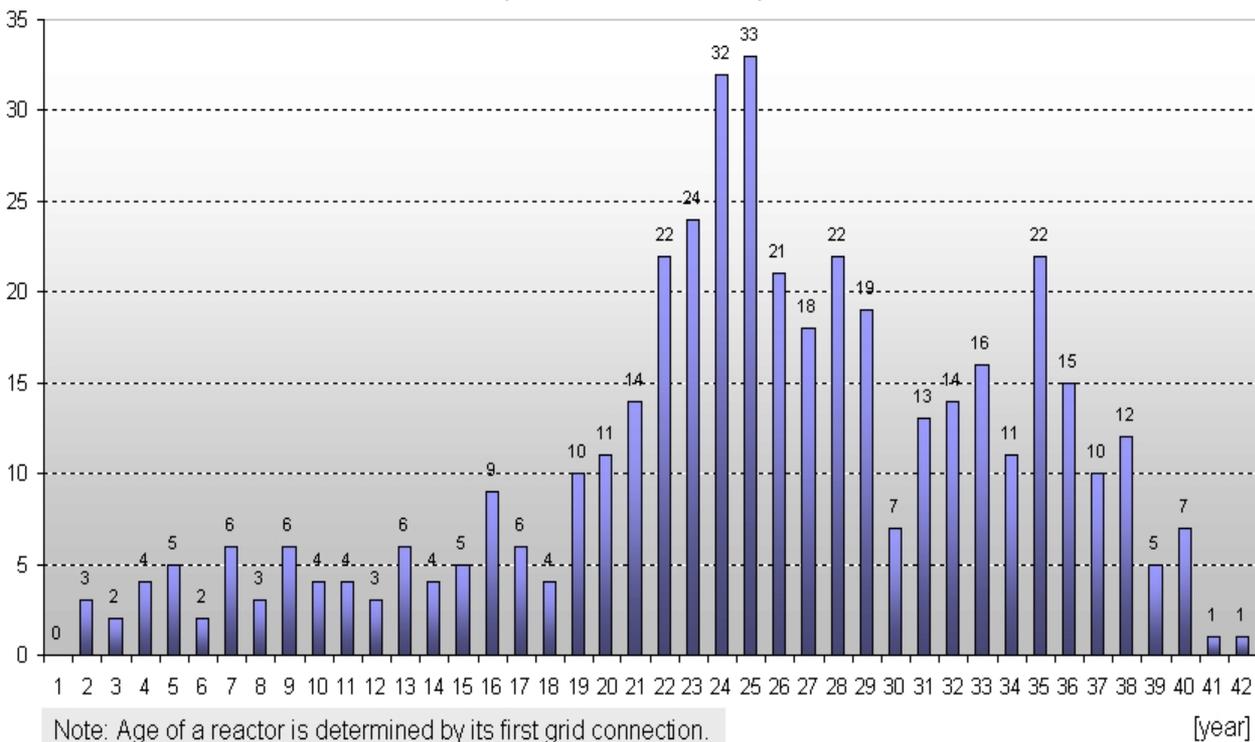


POWER REACTOR INFORMATION SYSTEM



NUCLEAR POWER PLANTS INFORMATION

Number of Operating Reactors by Age  
(as of March 2009)



WHAT IS PRIS  
PUBLICATIONS  
SERVICES  
HOW TO ORDER  
PRIS PC SOFTWARE

NUCLEAR POWER PLANT INFO  
WORLD SUMMARY  
REACTOR DETAILS

Select Country  
[Dropdown]  
Sorting Order  
alphabetically [Dropdown]

SEARCH

(\*) Information on nuclear power plants in Taiwan, China can be provided on request.

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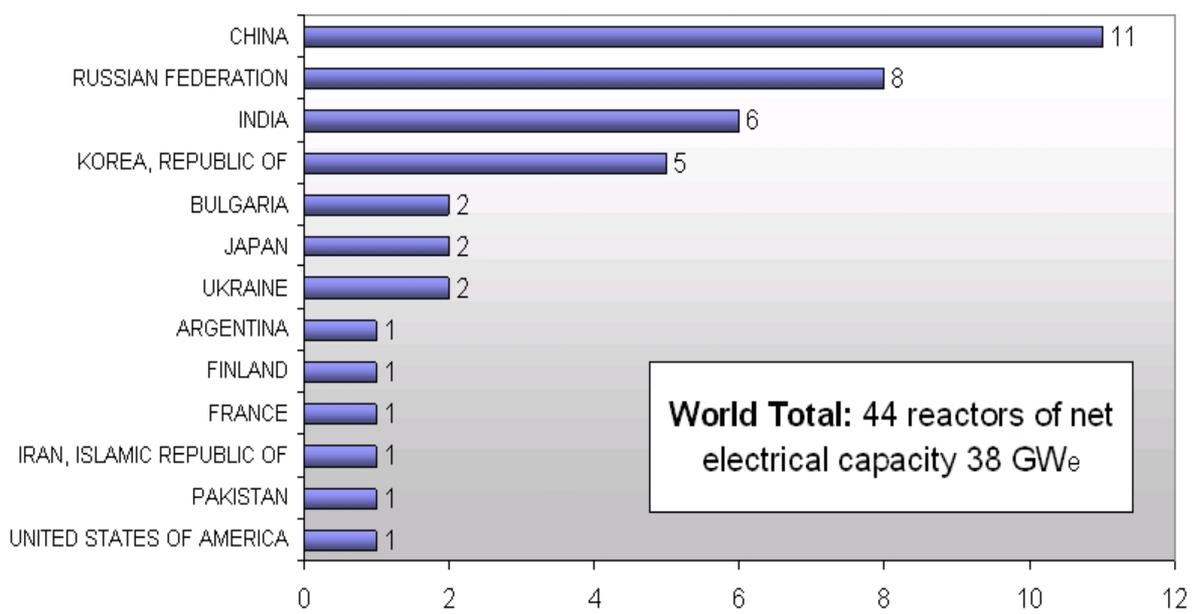


# POWER REACTOR INFORMATION SYSTEM



## NUCLEAR POWER PLANTS INFORMATION

### Number of Reactors under Construction Worldwide



**World Total: 44 reactors of net electrical capacity 38 GWe**

Note: The World Total includes also 2 reactors under construction in Taiwan, China.

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- WHAT IS PRIS
- PUBLICATIONS
- SERVICES
- HOW TO ORDER
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#### NUCLEAR POWER PLANT INFO

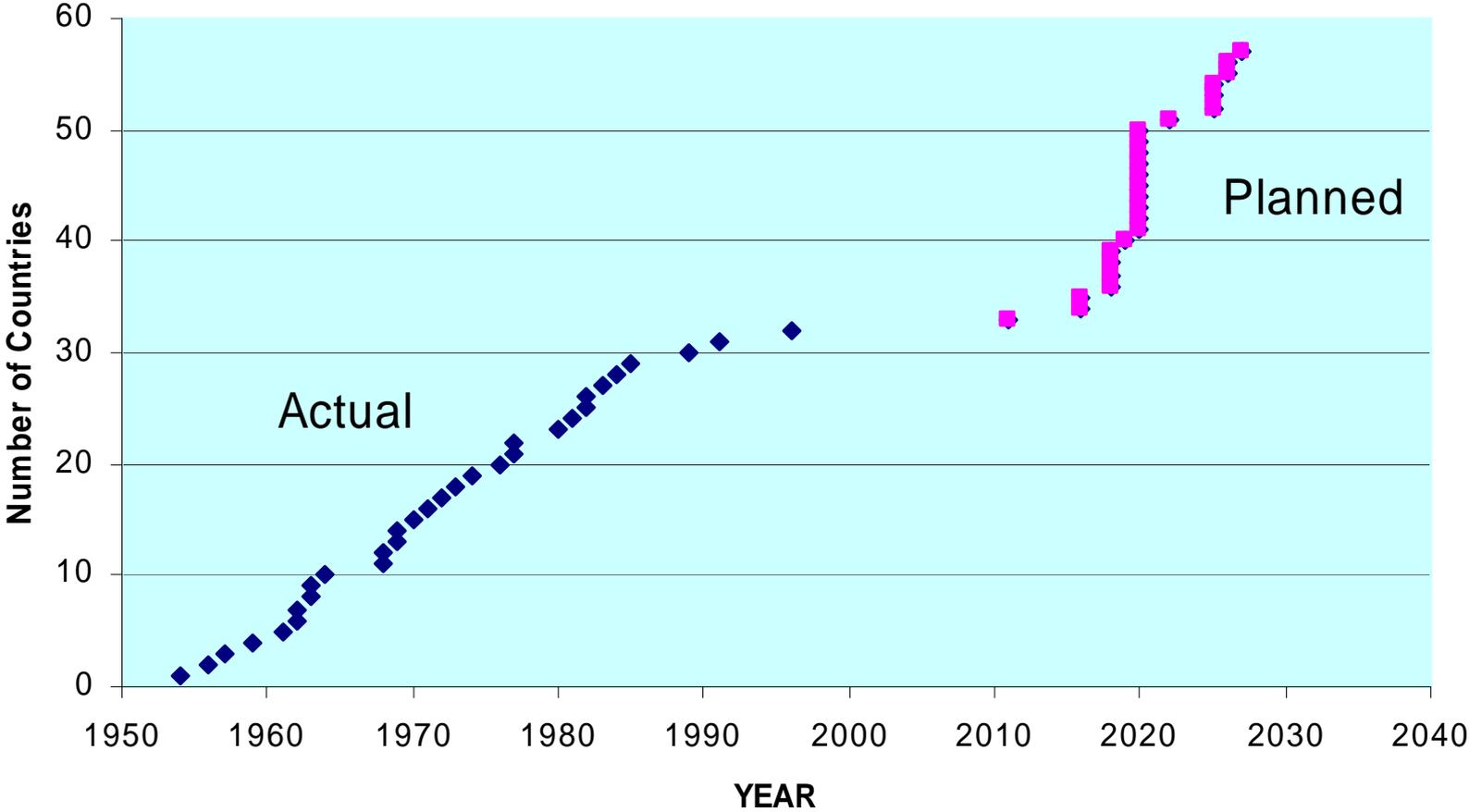
WORLD SUMMARY  
 REACTOR DETAILS ▼  
 Select Country  
  
 Sorting Order  
 alphabetically ▼

SEARCH

(\* Information on nuclear power plants in Taiwan, China can be provided on request.

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# Countries introducing their first NPP



Thank you

[O.Glockler@iaea.org](mailto:O.Glockler@iaea.org)