



环境保护部核与辐射安全中心
Nuclear and Radiation Safety Center

Regulatory Information Conference (RIC)2015

Overview of Nuclear Safety Research on Reactors in China

ZHANG Qinghua
Nuclear and Radiation Safety Center (NSC), Ministry of Environmental Protection (MEP)/National Nuclear Safety Administration (NNSA)

2015/2/24



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- 2 Introduction of MEP/NNSA and NSC
- 3 Regulatory R&D in NSC

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Research Institute overview in China

- Industries:CNNC, CGN, SNPTC
- Chinese Academy of Sciences(CAS)
- Universities
- Nuclear and Radiation Safety Center (NSC), Ministry of Environmental Protection (MEP)/National Nuclear Safety Administration (NNSA)

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Industries(1/3)



China National Nuclear Corporation(CNNC)
中核集团

China Institute of Atomic Energy (CIAE)

fundamental, strategic and forward-looking research



China Institute for Radiation Protection (CIRP)

research, development and application in aspects of radiation protection



Nuclear Power Institute of China (NPIC)

reactor engineering research, design, test, operation and small batch production.



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Industries(2/3)

China General Nuclear Power Group (CGN)



China Nuclear Power Technology Research Institute

- Common technology service for Nuclear power plant, e.g. fuel management, engineering modifications, simulator, ISI&PSI R&D innovation, equipment R&D,etc.

Suzhou Nuclear Power Research Institute (SNPI)

- Nuclear power plant construction and operating service, life management and aging, ISI, etc.

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Industries(3/3)

State Nuclear Power Technology Corporation(SNPTC)



Shanghai Nuclear Engineering Research and Design Institute (SNERDI)

Research Institute

Overall research and experimental verification

Software development center

build high confidence software for NPP

Technology R&D Center

Light water reactor NPP R&D

NPP design and service

introduction, digestion, absorption and innovation of Generation III NPP, AP1000 follow-up projects and Advanced Large Size PWR projects.

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Chinese Academy of Sciences(CAS)



- Shanghai Institute of Applied Physics (SINAP)**
 - TMSR
 - Nuclear Physics
 - Nuclear technology and application
- Lanzhou Institute of Modern Physics (IMP)**
 - Heavy ion sciences and applications
 - Accelerator physics and technology R&D
 - ADS Transmutation
- Hefei Institute of Nuclear Energy Safety Technology (INEST)**
 - Basic research of nuclear energy safety
 - ADS Transmutation
 - ITER related projects

Strategic leading science and technology projects:
Accelerator Driven Subcritical System(ADS) transmutation & Thorium Molten Salt Reactor (TMSR)

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Universities

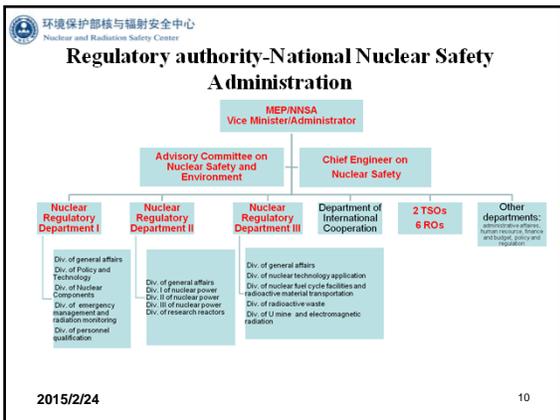
- Tsinghua University
- Shanghai Jiaotong University
- Xi'an Jiaotong University
- Harbing Engineering University
-etc.

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2. Introduction of MEP/NNSA and NSC

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**Technical and Scientific Support Organization(TSO)
-Nuclear and radiation Safety Center (NSC)**

NSC-WHAT WE DO

1. Review and assessment of license application in the stages of siting, construction, commissioning, operation, decommissioning of civilian nuclear facilities;
Review of environmental impact evaluation report in all stages of civilian nuclear facilities;
Nuclear safety R&D.

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NSC-WHAT WE DO

2. Review on nuclear technology application projects, uranium (thorium) mines, mines associated with radioactivity, radioactive wastes, transport of radioactive articles, nuclear materials control and physical protection,electromagnetic radiation devices.

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NSC-WHAT WE DO

3. Review of the design, manufacture, installation and nondestructive detection of nuclear safety equipment and to be responsible for the safety examination of imported nuclear safety equipment;

4. Engaged in the on-site inspection of nuclear facilities, nuclear equipment and nuclear technology application projects organized by MEP/NNSA and its six regional offices;

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NSC-WHAT WE DO

5. Nuclear and radiation emergency preparedness, emergency response, investigation and management required in emergency program;
Engaged in the prevention and management of nuclear and radiation terrorism events;

6. Carry out environmental radiation monitoring, and supervision monitoring of nuclear facilities and key radioactive sources as well as emergency monitoring;

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Vision

Review center R&D center

Information center Human Resource & Training base

To be the best TSO

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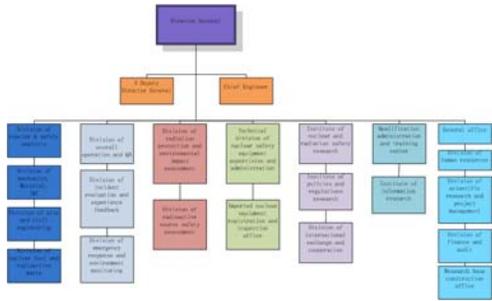

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NSC at a glance

- Established in March, 1989.
- Mission: Provide overall and comprehensive technical and scientific support for nuclear and radiation safety regulation.
- Staffs:613
- Budget:110 million rmb per year (for the last 3 years, equivalent 17million US\$)
- 16 technical divisions categorized into 6 areas

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Policy and R&D divisions

- Institute of nuclear and radiation safety research (R&D, independent audit calculation,experiment witness,etc., 63 staffs) ;
- Institute of policy and regulation Research(research on policies, regulations, standards,etc., 36 staffs);
- Division of international exchange and cooperation(14 staffs).
- ❖ staffs in other divisions are also engaged in policy and R&D,but in a part-time way.

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Missions of R&D and policy research

- To provide technical base for review, and further more, for regulatory decision making through R&D and policy research.
- Independent experimental verification or site witness to support technical review findings.
- Independent audit calculation to address the issues of concerns in review.
- To Prepare for the future challenges induced by introduction of new designs and methodologies.
- Research in regulatory policies, laws, regulations and standards.

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3. Regulatory R&D in NSC

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01	Large-scale Passive PWR(LPP CAP1400) Ministry of Science and Technology(MOST), National Energy Administration(NEA),and NNSA.
02	Fund for Environmental Protection, MEP/NNSA.
03	Policy and Regulation research,NNSA.
04	Future reactors:TMSR,ADS.
05	International cooperation research activities, NNSA
06	Instruments and equipment development, MOST and MEP
07	Youth scientists fund, National Natural Science Foundation of China, State Council.

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01. Large-scale Passive PWR(LPP CAP1400)
 Research on CAP1400 safety review-(1/7)

Research on regulations of CAP1400 safety review	Development of CAP1400 regulatory guide and technical insights.
	Development of principles of regulation.
	Development of standard review plan.

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01. Research on CAP1400 safety review-(2/7)

Software aquirement for CAP1400 safety review	Aquirement of a series of software for CAP1400 safety review and independent verifying calculation. (thermal-hydraulic, core physics, pipeline and equipment, structures)
	Verification of software
	Development of simulation platform

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01. Research on CAP1400 safety review-(3/7)

Special safety concerns in review (10 subjects)	Large commercial aircraft malicious collision
	Containment sump screen blockage
	Fatigue curve and design lifetime
	Safety classification
	Representativeness of airborne effluents Monitoring & Sampling
	Realistic source terms and design source terms
	Severe accident phenomena and management
	Etablissement of PSA reliability data base
	Research on key technique for NPP seismic safety
	Research on anti-seismic technique of steel concrete structure

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01. Research on CAPI400 safety review-(4/7)

research on review techniques	Reactor physics analysis
	Performance evaluation for certain critical Improvement items and review
	Integrity assessment for Safety related welded pipeline
	Fire hazard PSA and review
	Audit calculation for severe accident and review

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01. Research on CAPI400 safety review-(5/7)

Development of advanced review technique.(9 subjects)	Research on uncertainty of RELAP5' s application
	Radiation protection review and software development
	Research of Risk-informed regulation
	Seismic safety assessments of NPP engineering sites and applicability evaluation
	Environmental impact assessment methods of NPP cooling water discharge and discharge control
	Key radionuclides migration and Environmental effects evaluation system
	Research on NPP site atmospheric dispersion modeling based on Lagrangian method.
	Radioactive liquid waste treatment system review
Radioactive waste disposal system and process monitoring	

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01. Research on CAPI400 safety review-(6/7)

Experimental research on critical parameter	The dynamic load characteristics research of shielding building under large commercial aircraft malicious collision.
Independent experimental research on critical systems	Test for residual heat removal capability of Passive core cooling system under station blackout condition.
	Test for heat removal capability of Passive containment cooling system.
	Test for impact of In-Vessel Retention channel change on reactor vessel heat transfer characteristic.

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01. Research on CAP1400 safety review-(7/7)

Key softwares development	Research on technical specification for safety review codes
	Development of integral platform for safety review codes
	Development of safety review code for core physics
	Development of safety review code for thermohydraulics and accident analysis
	Development of safety review code for radiation shielding and source terms
	Research on safety review codes testing

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02. Fund for Environmental Protection Research

To support regulatory decision making	
Done	Research on NPP licensing documents standardization
	Research on Nuclear and radiation data exchange standardization
	Research on regulatory system on transport of radioactive articles
Ongoing	Evaluation on earthquake and tsunami risk for coastal NPP in China
	Research on population center around NPP and assessment for human evacuation capability
	Research on technical requirements for the improvement measures for the generation II NPP (modified) post Fukushima
	NPP Assessment on safety margin for external event
Upcoming	Study of the evaluation and pollution treatment for radioactively contaminated soil.

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03. Policy and Regulation research,NNSA.(1/2)

proactive research on regulatory policy	nuclear facilities decommissioning and radioactive waste treatment
	third party insurance for nuclear accident
	regulatory policy on small modular reactor
	safety requirement for inland NPP
	NPP Operating License renewal
	safety requirement of underground research laboratory for high-level radioactive waste geological disposal
safety review and evaluation techniques	seismic risk evaluation methodology
	review principles of HTGR
	review principles for the new design fuel loading
	review principles for non-condensable gas accumulation
...	

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03. Policy and Regulation research,NNSA.(2/2)

Small Modular Reactor(SMR) related research	
	Research on license and regulatory policies about SMR
	The development of design safety requirement and review principles
	Siting standards research
	Applicability assessment of current regulations
	Research on severe accident source term, dose consequence impact and evaluation
	Zoning principles of emergency planning zone and planned restricted zone
	Offsite emergency preparedness and response simplification, minimization or abolishment
	Research on the contents of experiment verification

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04. Future reactors (1/2)

Thorium Molten Salt Reactor(TMSR) related research	
Safety analysis technology	Safety analysis methodology and code applicability
	design basis accident list
	critical limit of core nuclear design
	source term analysis method and code applicability
Safety evaluation technology and requirement	safety evaluation acceptance criteria
	The necessary contents of safety analysis
	The format and content of safety analysis report
	The applicability and application requirement of current regulations
	Core limit, source term and accepting criteria of accident analysis
The applicability and V&V for design and safety analysis codes	

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04. Future reactors- (2/2)

Accelerator-Driven Subcritical System(ADS) related research	
	Research on regulatory policies about ADS
	The format and content of safety analysis report
	Applicability assessment of current regulations on ADS
	ADS safety assessment: research on subcritical operating control methodology
	ADS safety assessment:Inherent safety features and engineering safety features
	ADS safety assessment:source term characteristics

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05. International collaborative research activities (1/3)

To promote global nuclear safety.

EU-CHINA: Enhancing the capacity and regulatory capabilities of the Chinese National Nuclear Regulatory Authority and its Technical Support Organizations)

SUPPLIER(EU Contractor):six parties consortium
 Autorité de Sûreté Nucléaire (ASN), France
 Säteilyturvakeskus (STUK), Finland
 Consejo de Seguridad Nuclear (CSN), Spain
 Institut de Radioprotection et de Sûreté Nucléaire (IRSN), France
 Gesellschaft für Anlagen- und Reaktorsicherheit (GRS), Germany
 Bel V,Belgium

Beneficiary End User in China:NNSA and NSC

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05. International collaborative research activities (2/3)

Tasks of EU-China Project

TASK 1: Project Preparation

TASK 2: Independent Review and Assessment of Safety Submissions and Validation and Verification of New Technologies, Processes and Materials

Sub-task 2.1: PWR LOCA analysis with best estimate and uncertainty methods

Sub-task 2.2: Regulatory reviews of analyses of severe accidents in NPPs

Sub-task 2.3: Independent evaluation, validation and verification of the safety of digital instrument and control systems used in nuclear power plants

TASK 3: Safety Culture and the Management of Safety

TASK 4: Operating Experience Feedback (OEF)

TASK 5: Assessment of Flood Hazards

TASK 6: Finalisation of the Project and Dissemination of the Project Results

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05. International collaborative research activities (3/3)

- Agreement on nuclear safety research between USNRC and NNSA.
- USNRC's international Thermal-Hydraulic Code Applications and Maintenance Program(CAMP), and the USNRC's international Cooperative Severe Accident Research Program(SCARP) and radiation protection research.
- Reactor system simulation codes:TRACE, PARC, RELAP5,Symbolic Nuclear Analysis Package(SNAP).
- MELCOR, SNAP, MACCS2.
- Share research result, user experience on code.

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06. Instruments and equipment development program

Instruments and equipment development program
Development of radioactive aerosol & iodine monitoring equipment and airborne gamma ray spectrometer in the low-radiation environment, MOST and MEP.



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07. Youth scientists fund

Youth scientists fund, encouraging free exploration and fundamental research, indirectly to regulatory activities.

- Muon Imaging Monitoring System and Reconstruction Algorithm for Core Debris in Severe Accident
- A Review of Historic Activity Concentration of Pb- 210 and Other Radionuclides in Beijing Atmosphere
- A Study of the Control Parameters of Ground Motion Influencing the Structure Responses of Nuclear Power Plants

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The contents in these slides are completed with the help of Mr. ZUO Jiayu, NSC.

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THANKS

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