Current status of NPP development & research programs in China

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Contents

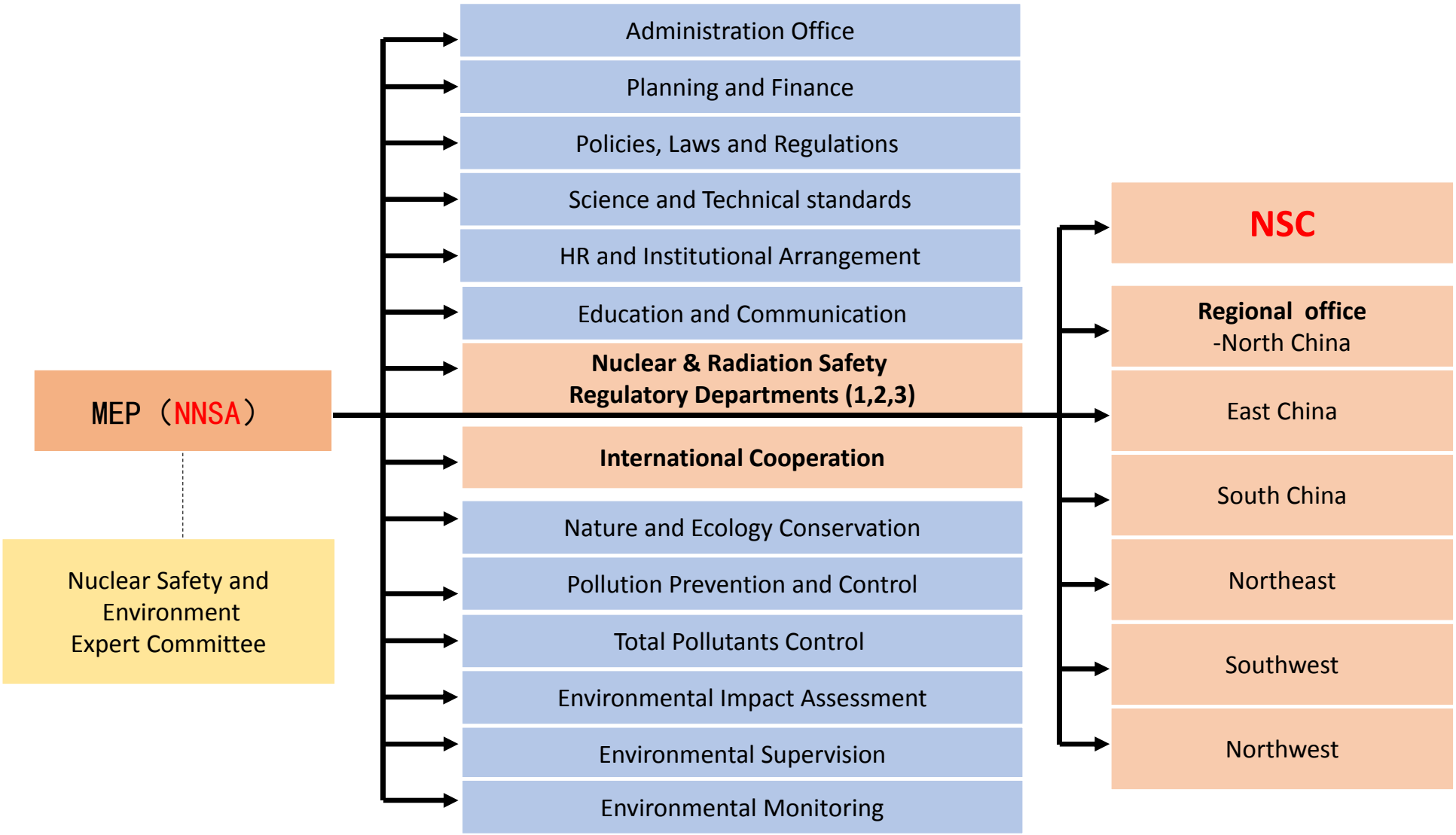
PART ONE

General Situation of Nuclear Safety Regulation

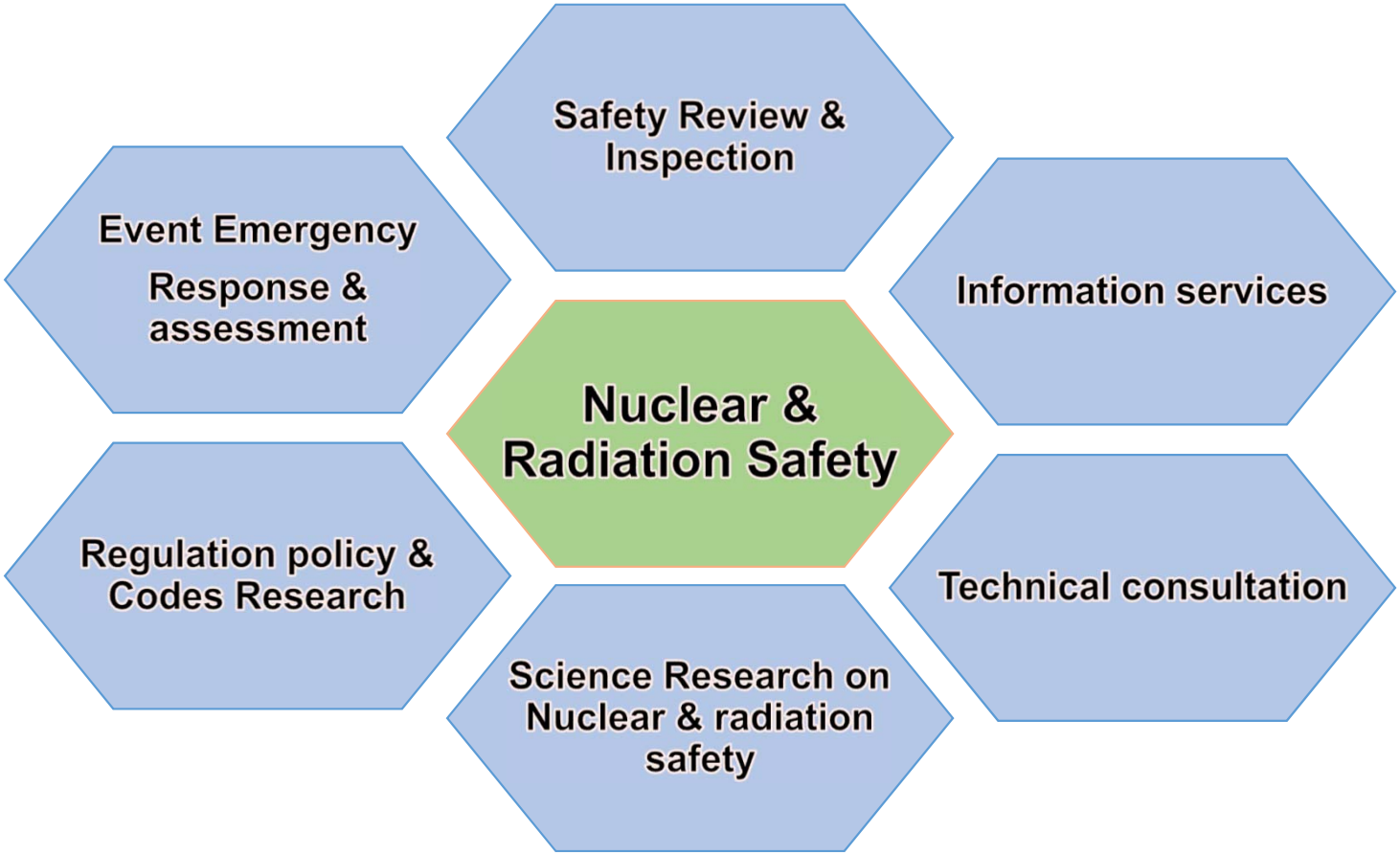
General Situation of Nuclear Safety Regulation

The Regulatory Authority

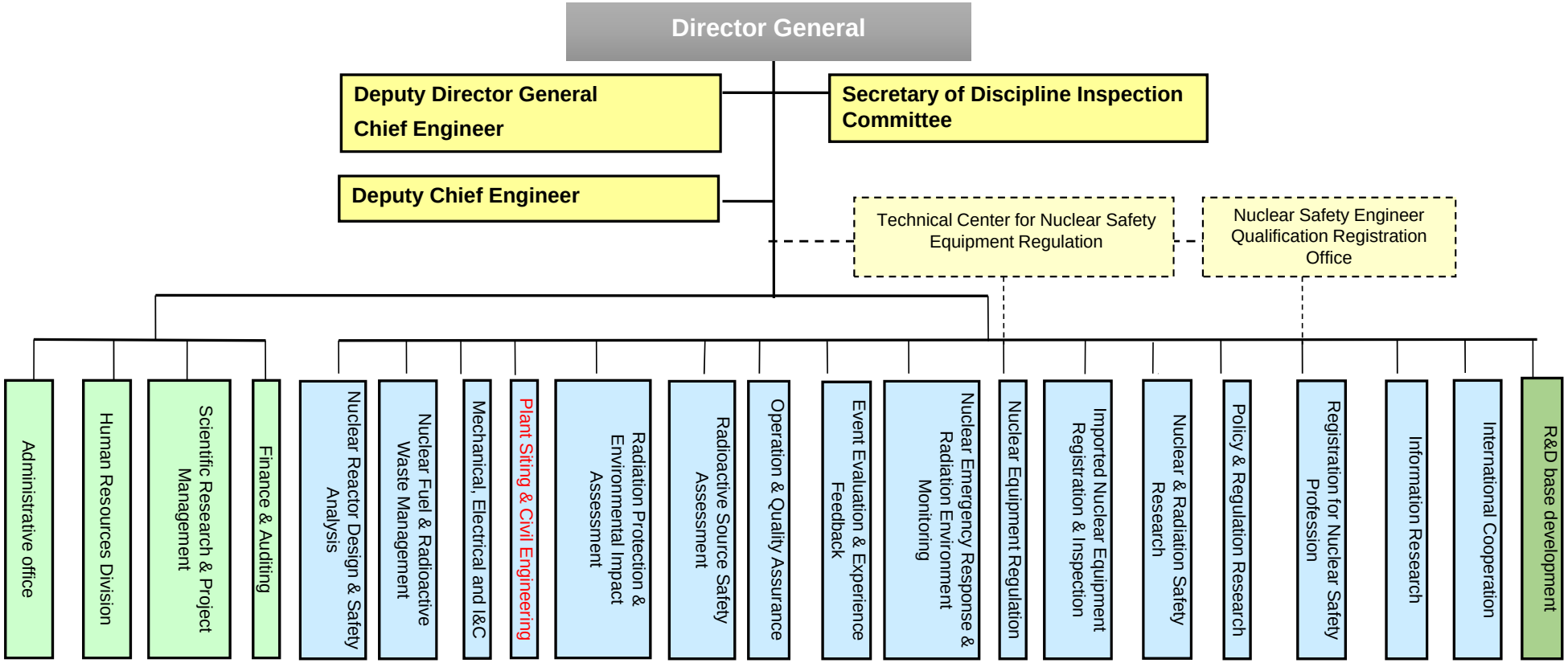
- **MEP (NNSA) is the regulatory department of Central Gov.**
- **MEP(NNSA) is responsible for nuclear safety and radiation safety supervision, and radioactive environment management .**
- **NSC is the technical support for NNSA.**


MEP（NNSA）
Nuclear Safety and Environment Expert Committee
Administration Office
Planning and Finance
Policies, Laws and Regulations
Science and Technical standards
HR and Institutional Arrangement
Education and Communication
Nuclear & Radiation Safety Regulatory Departments (1,2,3)
International Cooperation
Nature and Ecology Conservation
Pollution Prevention and Control
Total Pollutants Control
Environmental Impact Assessment
Environmental Supervision
Environmental Monitoring
NSC
Regional office -North China
East China
South China
Northeast
Southwest
Northwest

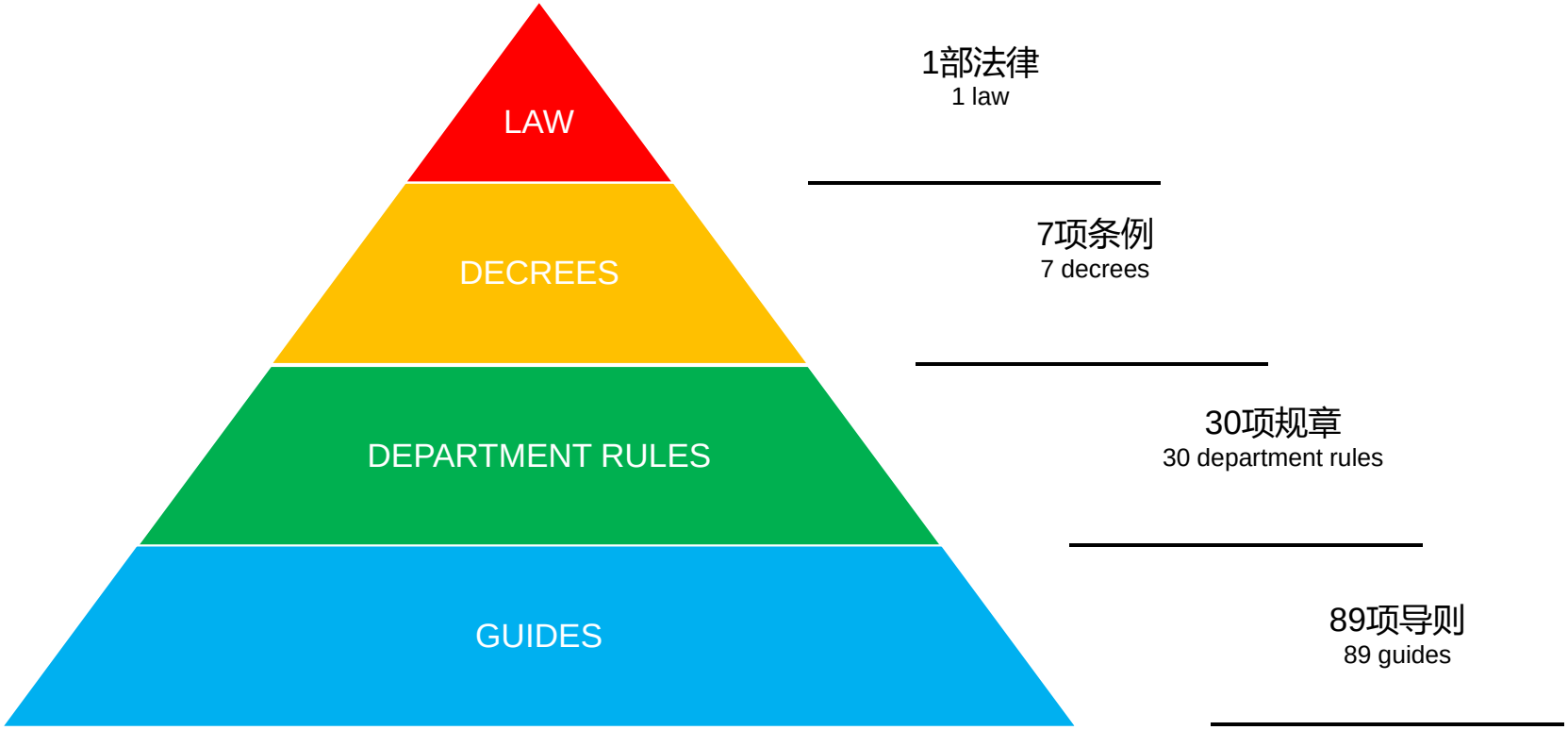
Main Tasks


Safety Review & Inspection
Event Emergency Response & assessment
Information services
Nuclear & Radiation Safety
Regulation policy & Codes Research
Technical consultation
Science Research on Nuclear & radiation safety

MEP/NSC Organization



Nuclear Safety Regulation Hierarchy



Chinese nuclear safety requirements & guides for siting & civil engineering

- China has established its regulations concerning nuclear and radiation safety largely by adopting and adapting IAEA safety standards.
- China is committed to improve its regulatory system on the nuclear and radiation safety by reflecting domestic experiences combined with the latest international practices.

PART TWO

Current status of NPP development in China

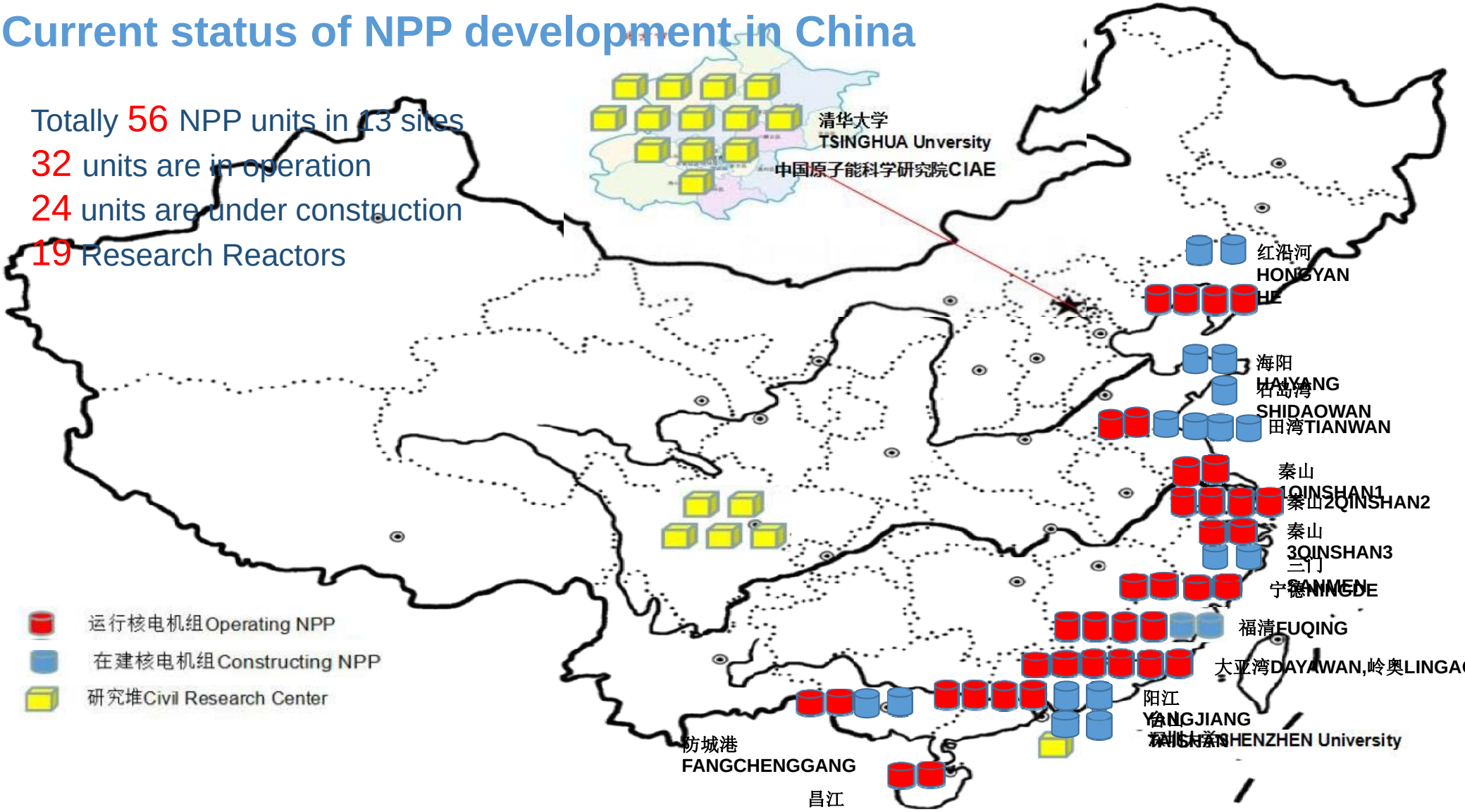
Current status of NPP development in China

Totally 56 NPP units in 13 sites

32 units are in operation

24 units are under construction

19 Research Reactors

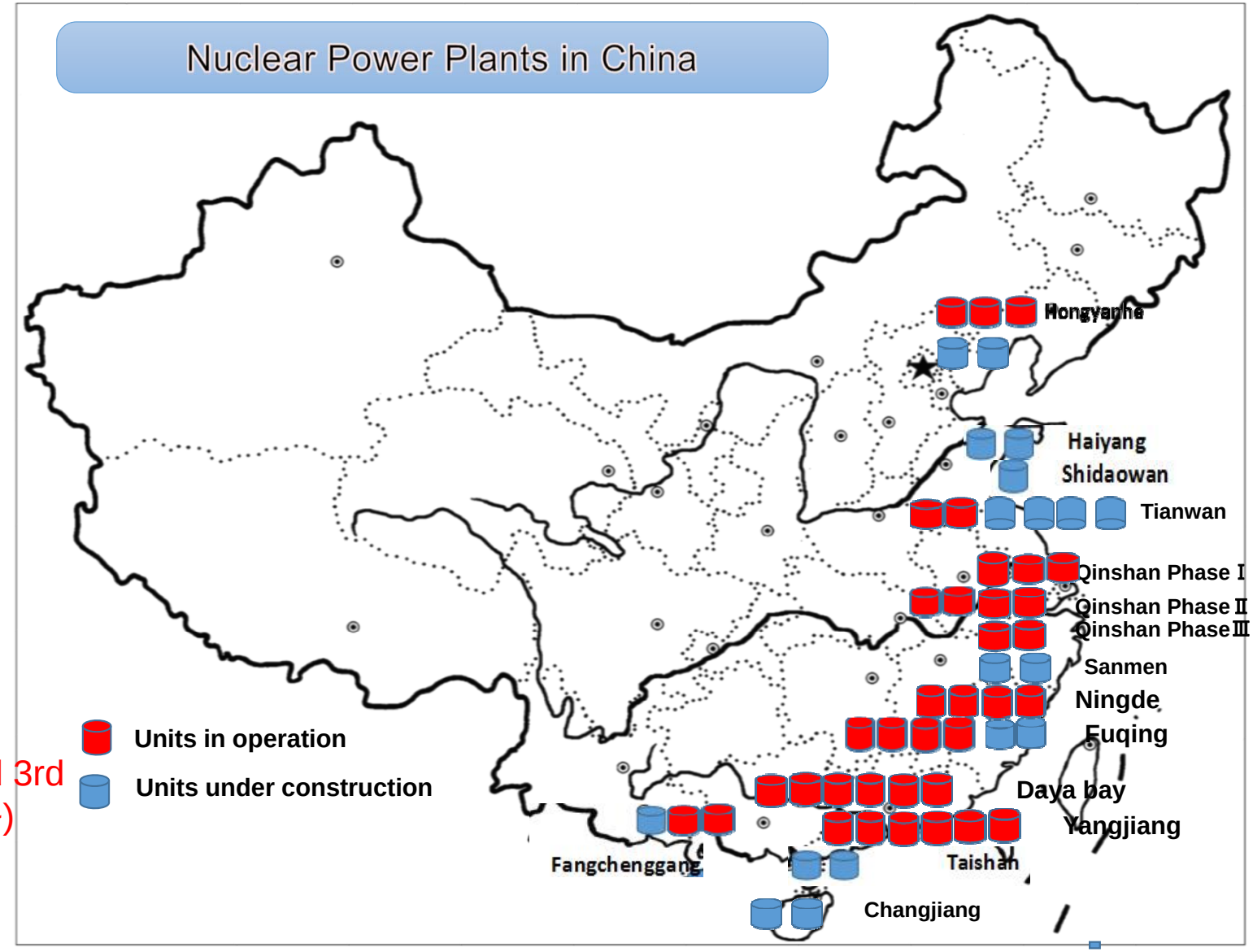


Initial Construction Period: Qinshan + Daya BAY NPP (1985-1994)

Appropriate Development Period: Sea shore project expansion+ several new projects (1994-2005)

Fast development period: amount of reprint projects+ Imported 3rd generation projects (2005- 2011)

Post Fukushima period: Independent design 3rd generation units + imported 3rd generation projects (2011~)



Development Process of the Construction of Chinese NPPs

Periods	Sites	DBE	Field condition
Initial Construction Period: Qinshan + Daya BAY NPP (1985 -1994)	**Qinshan NPP**	**0.15g**	**Hard rock foundation**
	Daya Bay NPP	**0.20g**	**Hard rock foundation**
Fast development period: amount of reprint projects + Input 3rd generation projects (2005-2011)	**Fangjiashan NPP**	**0.15g**	**Hard rock foundation**
	Changjiang NPP		
	Ningde NPP		
	Sanmen NPP		
	Shidaowan HTR-PM NPP		
	Fangchenggang NPP		**soft rock foundation**
	Fuqing NPP	**0.19g**	**Hard rock foundation**
	Hongyanhe NPP		
	Yangjiang NPP		
	Haiyang NPP		
	Taishan NPP	**0.20g**	

Development Process of the Construction of Chinese NPPs

	Approved sites	DBE	Field condition
Post Fukushima period: Independent 3rd generation units (HL1000) + import 3rd generation projects + (2011~)	**Xudapu NPP**	**0.15g**	**Hard rock foundation**
	Shidaowan NPP		
	Lufeng NPP	**0.19g**	
	Potential sites	**DBE**	**Field condition**
	Cangzhou Site	**0.27g**	**Soil site foundation**
	Zhangzhou site	**0.30g**	**Hard rock foundation**

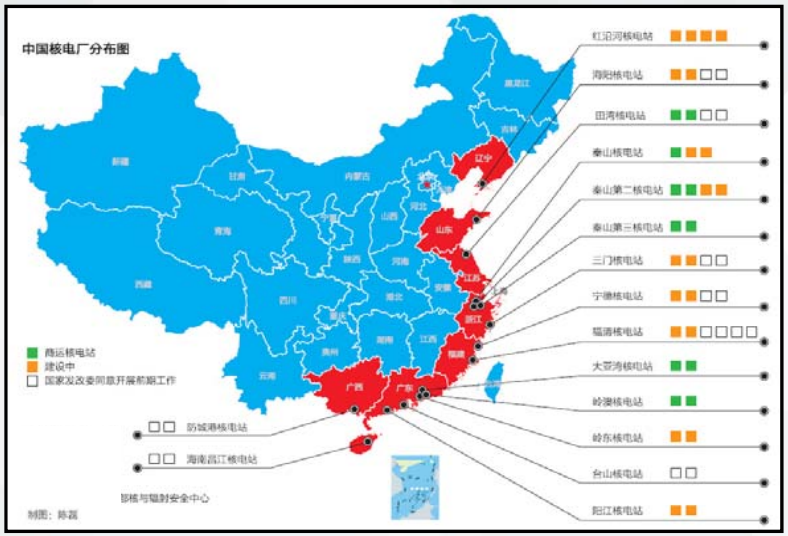
Safety improvements after Fukushima

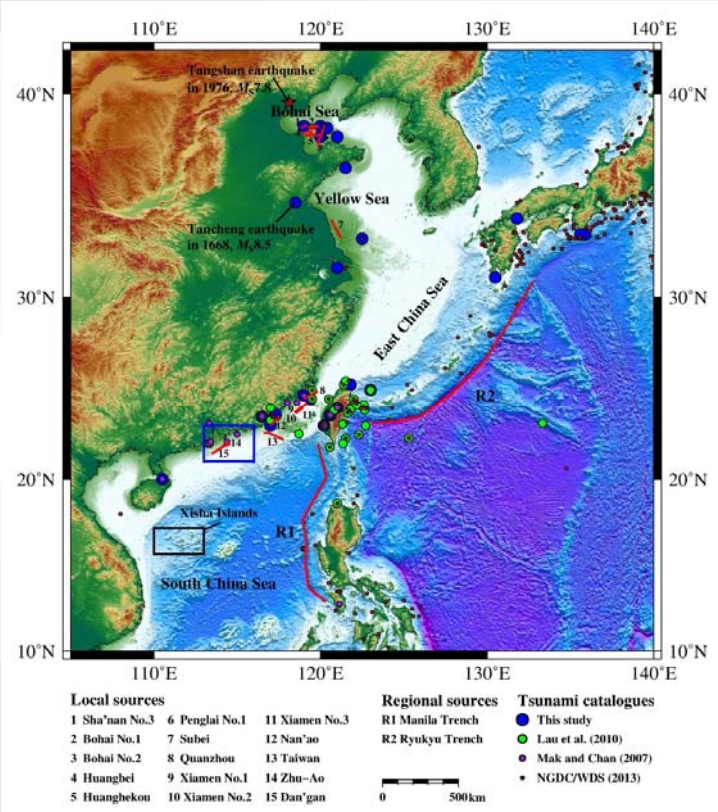
- **Comprehensive safety inspection and evaluation to nuclear installation national wide**
- **Issued *Generic Technical Requirements on Improvement Actions of Nuclear Power Plants* *After Fukushima Nuclear Accident***
- **Experience feedback from the Fukushima Accident**
- **Optimized organizational structure, improved the regulatory standards, put forward new nuclear safety requirements, etc.**

PART THREE

Resent research programs of NPP site & structure safety in China

NPPs and Potential tsunami sources along Chinese Coast

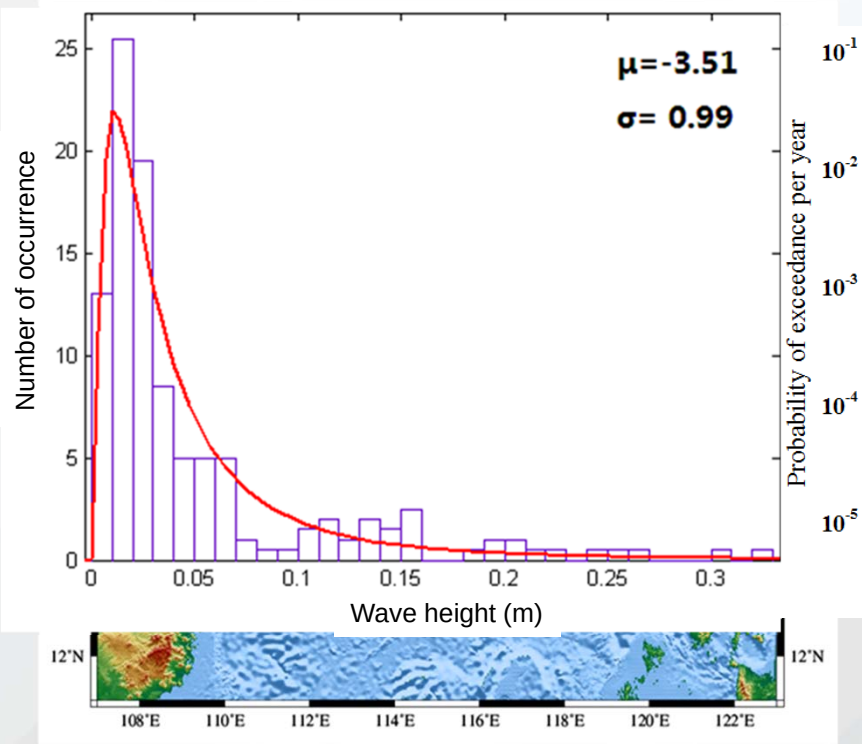


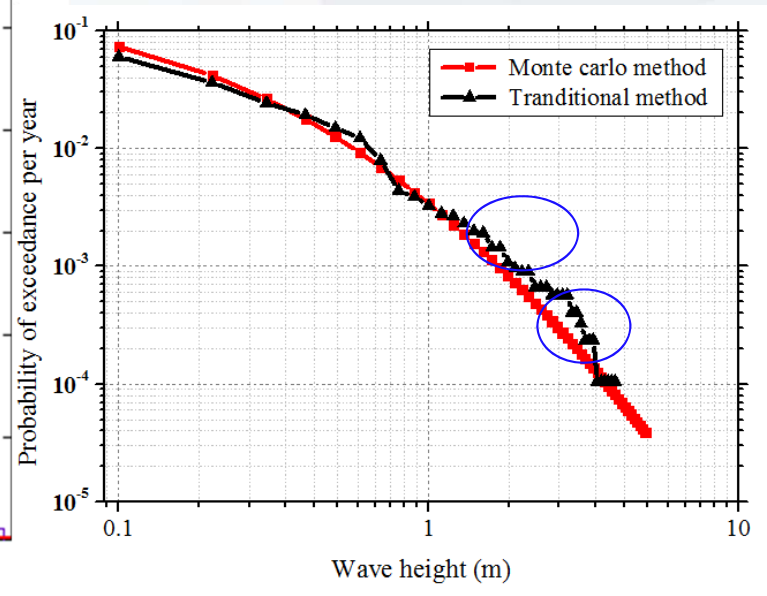


NPPs and Potential tsunami sources along Chinese Coast

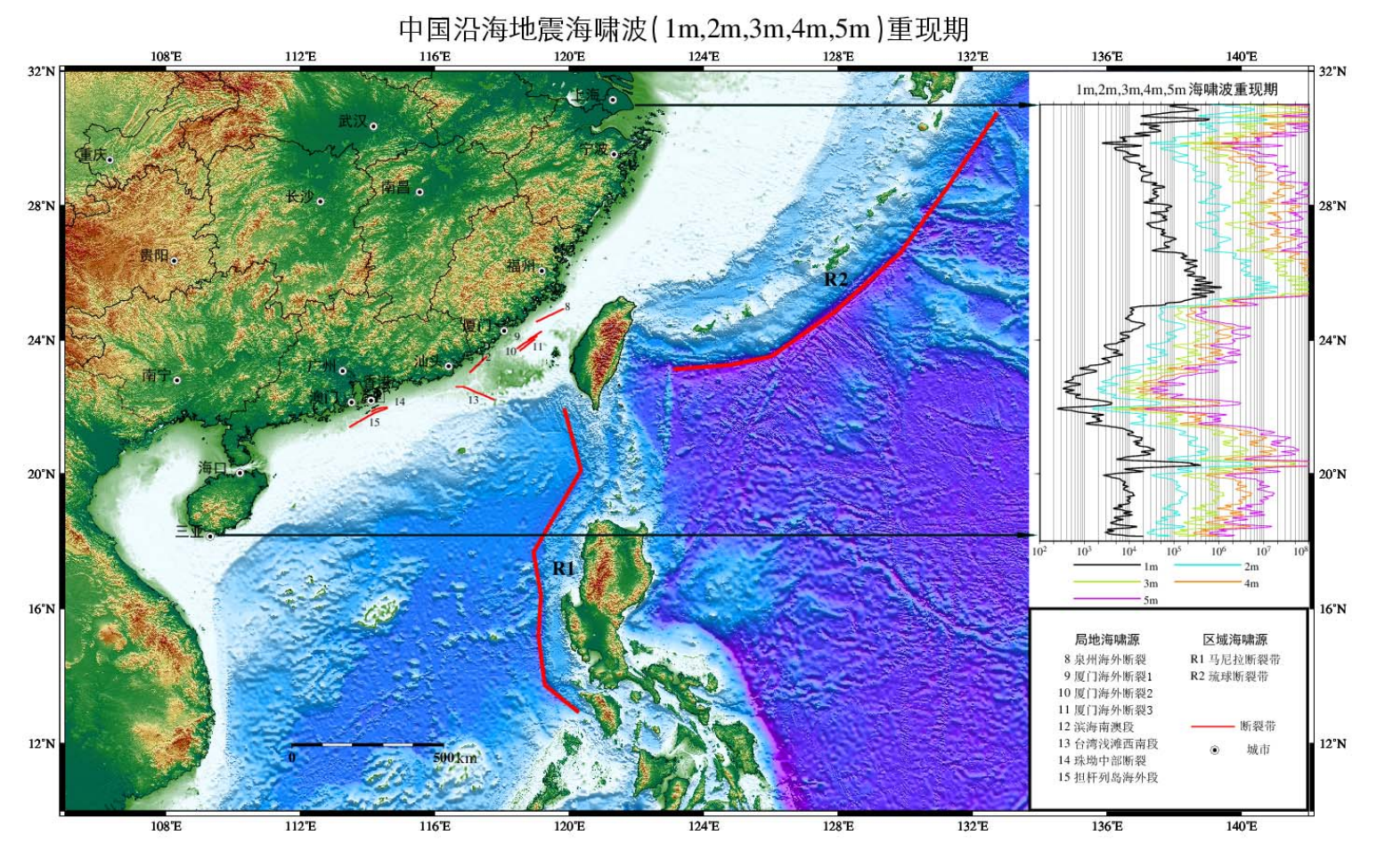
$$f(x \mid \mu, \sigma) = \frac{1}{\sqrt{2\pi}\, x \sigma} \exp\left(-\frac{(\log x - \mu)^2}{2\sigma^2}\right)$$

$$P(\mathrm{H} \geq \mathrm{h}) = 1 - \prod_{n}^{N} (1 - P_n(H \geq h))$$



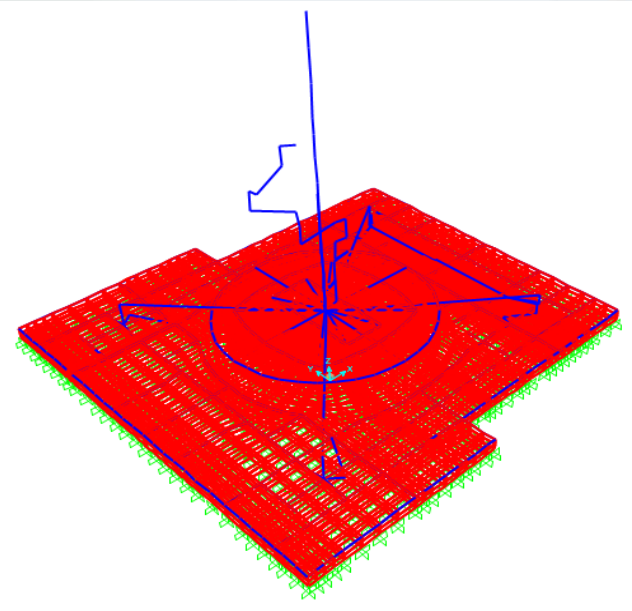


NPPs and Potential tsunami sources along Chinese Coast



Hybrid Simulation to Assess Performance of Seismic Isolation in Nuclear Power Plants

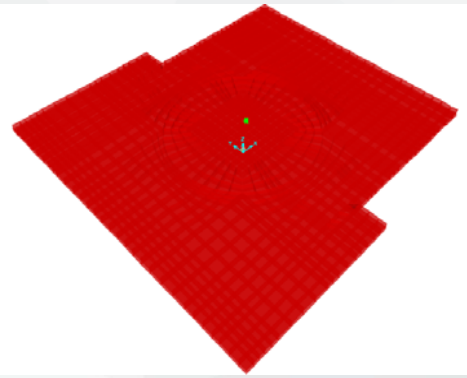
Computational Models

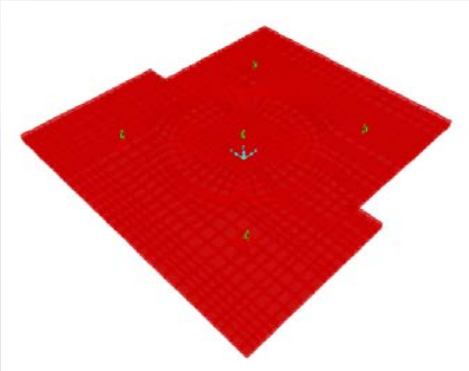


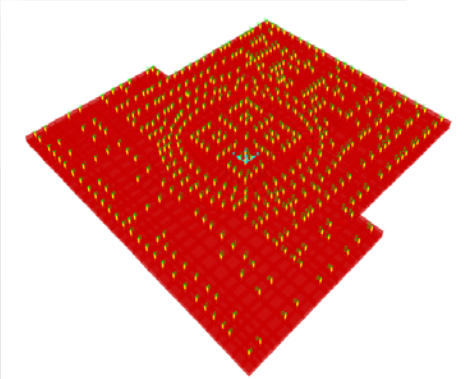
1-bearing equivalent model

5-bearing equivalent model

486-bearing model







Hybrid Simulation to Assess Performance of Seismic Isolation in Nuclear Power Plants

Seismic input motions

Two ground motions: provided by IAEA

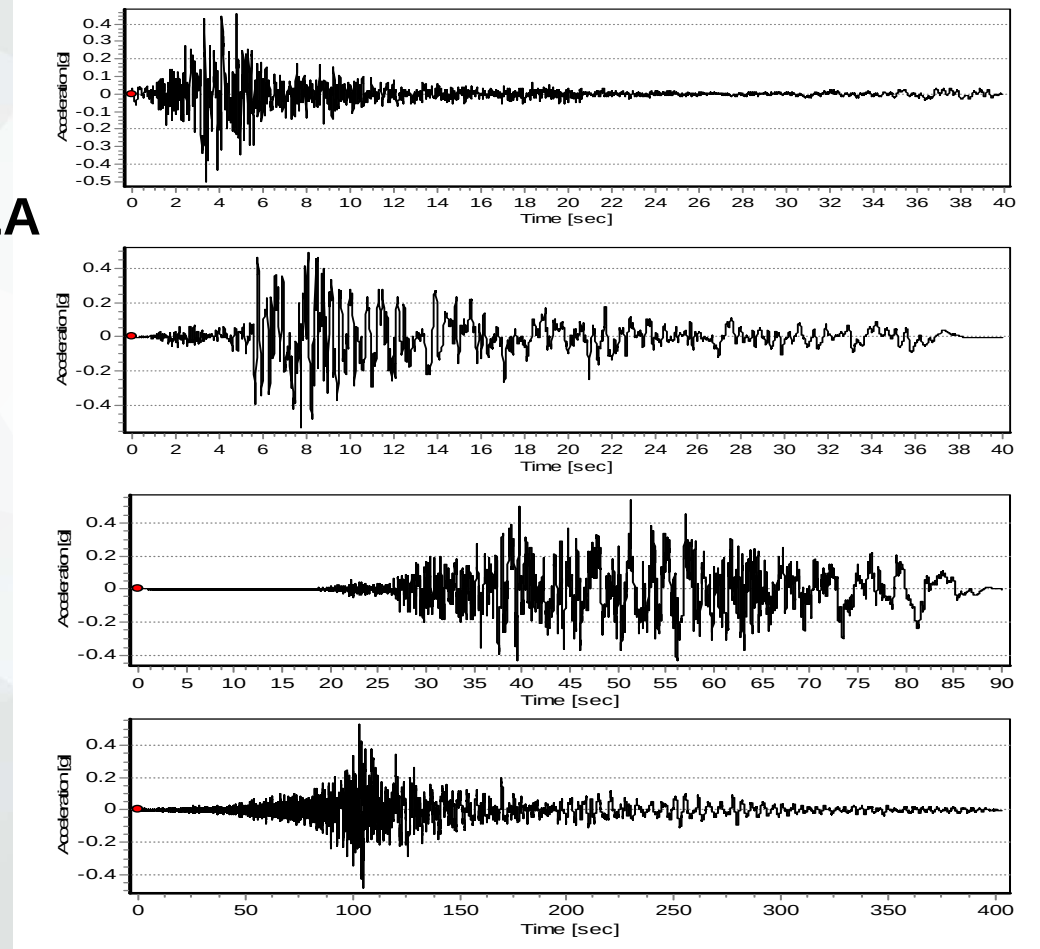
NRC RG 1.60 (IMPERIAL VALLEY)

EUR (LOMA PRIETA)

Another two ground motions: with characteristics of long period and long duration

NGA 1200 (CHICHI)

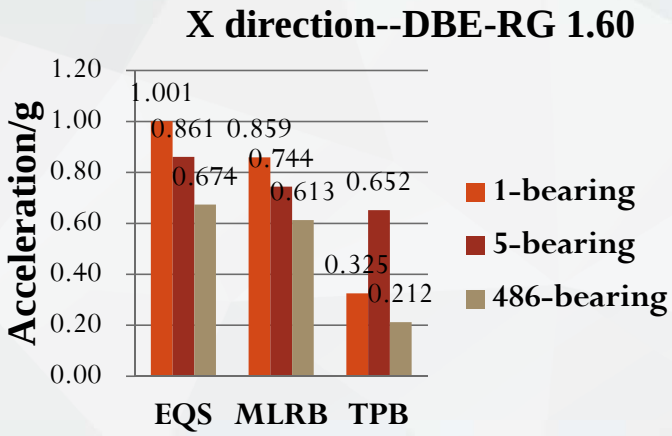
XIAN (WENCHUAN)

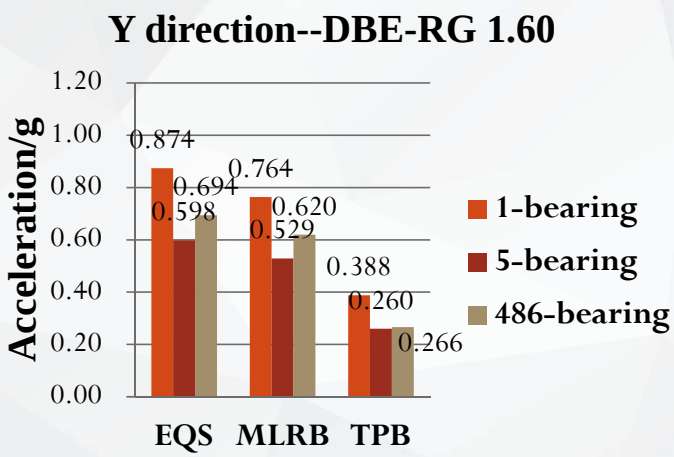


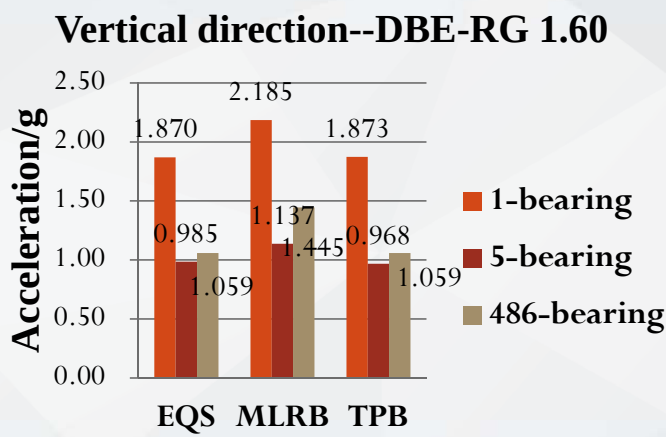
Hybrid Simulation to Assess Performance of Seismic Isolation in Nuclear Power Plants

Peak acceleration of structures

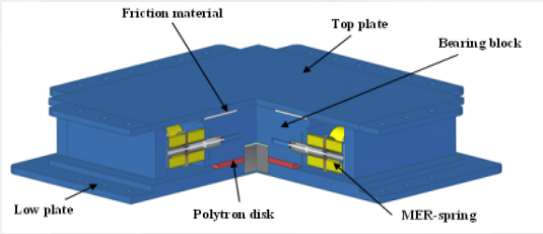
Taking the results of top node as example under the input of DBE-RG 1.60





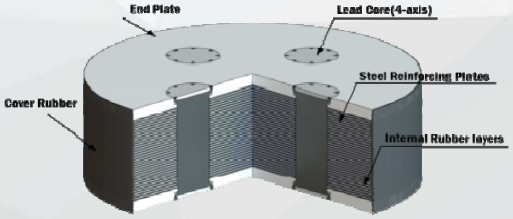


EQS



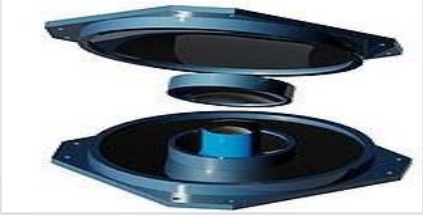
Divided by 150mm

MLRB



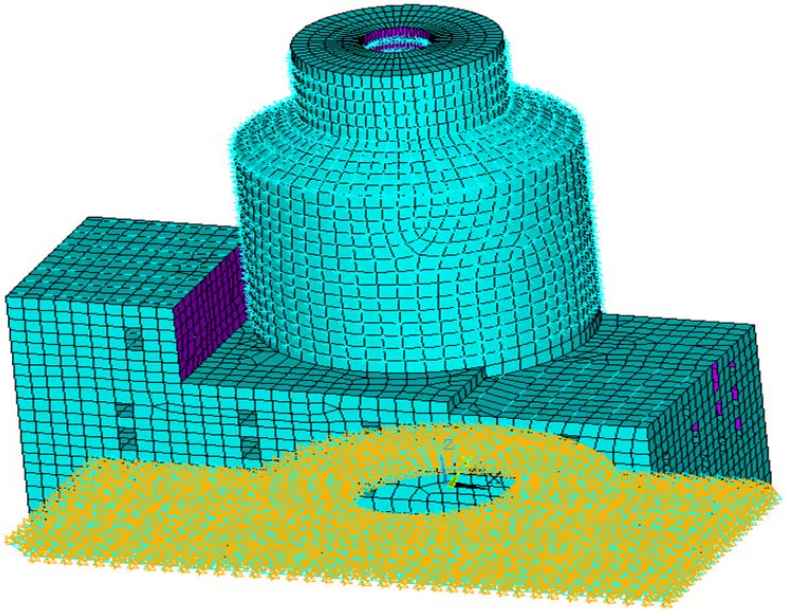
Divided by 210mm

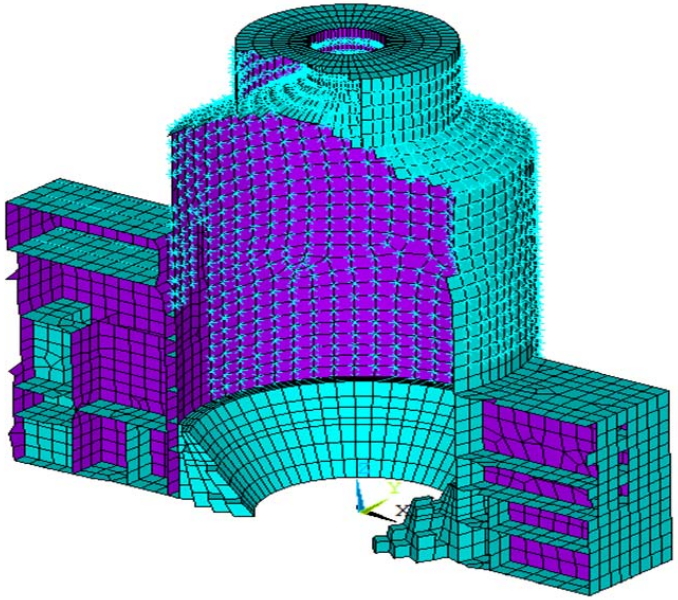
TPB

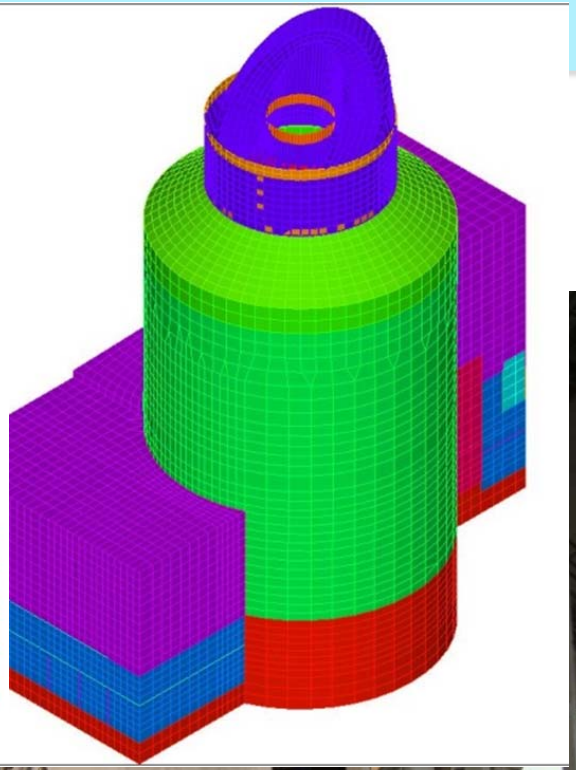


Divided by 1333.5mm

CAP1400 Nuclear island building seismic response tests & analysis



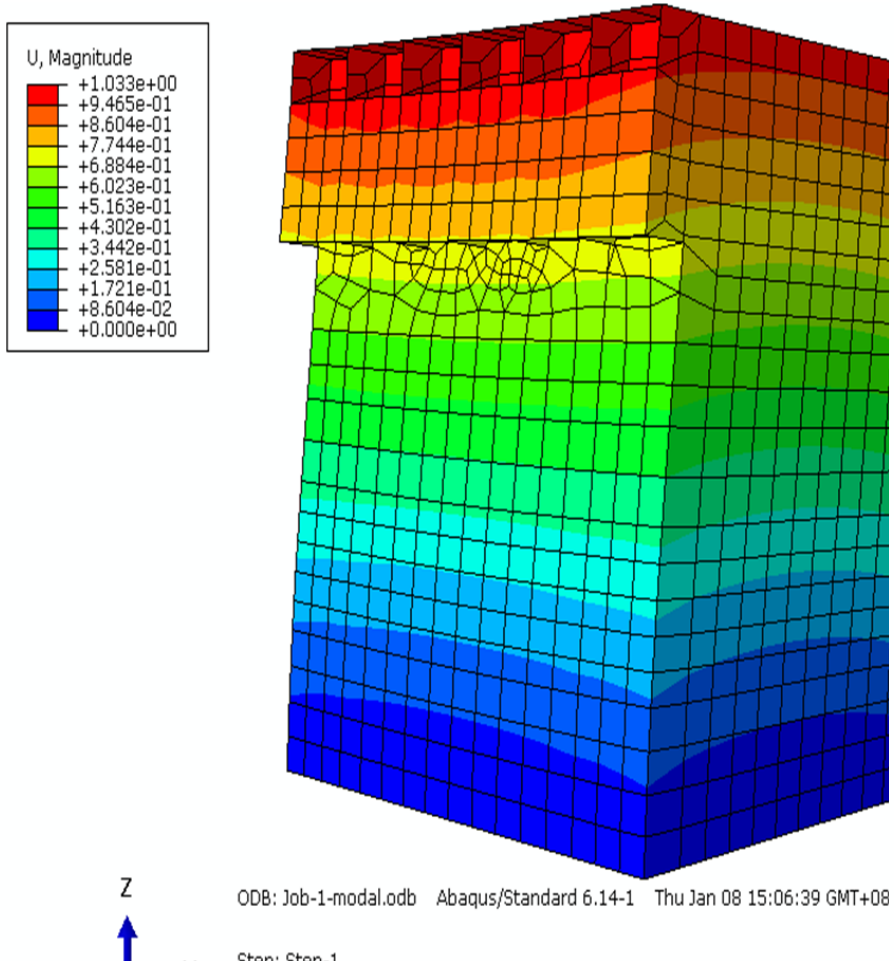


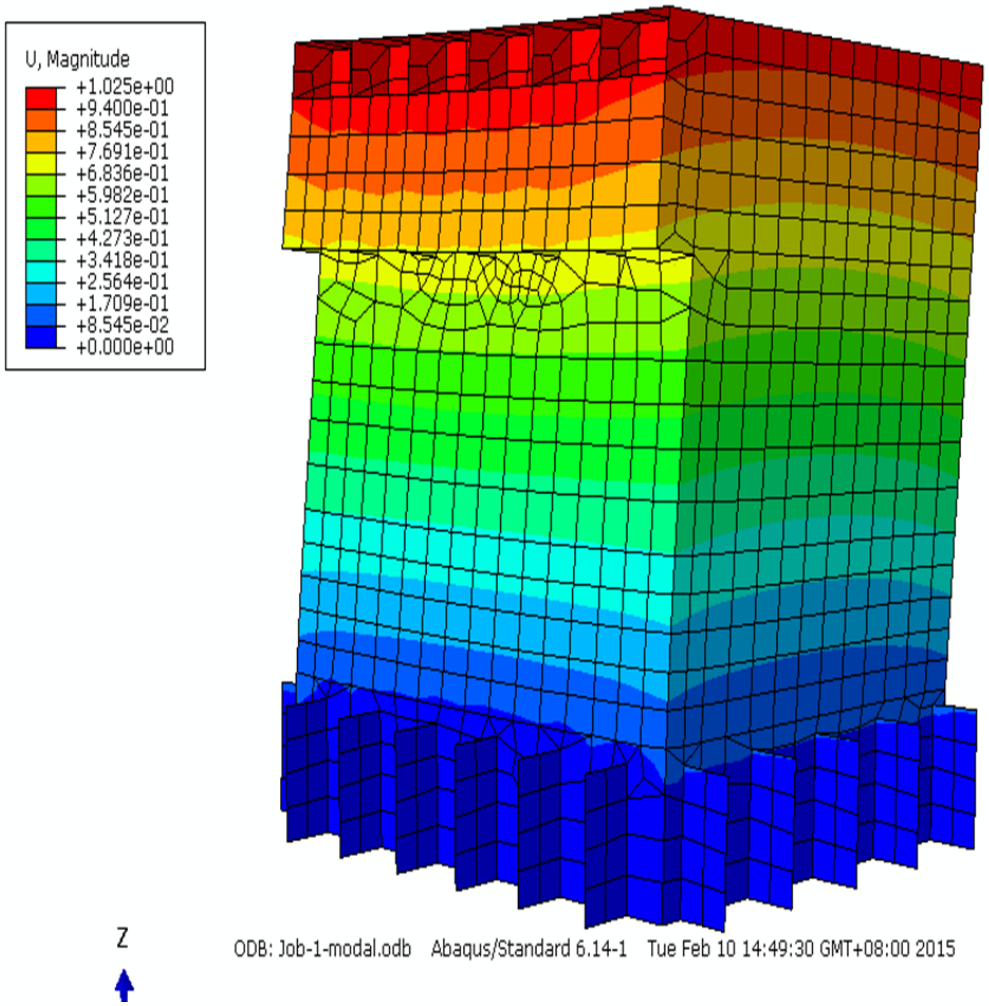


Capacity of Shaking Table

Dimension of shaking table	6×6m	Maximum eccentric moment	60kN.m
Maximum load	60T~80T	Maximum torsion angle	±3 degrees
Maximum displacement	±15cm and ±25cm for two horizontal directions;±25cm for vertical direction	Working Frequency content	0.1~50HZ
Maximum velocity	±100cm/s , and ±125cm/s for two horizontal directions; ±80cm/s for vertical direction.	Control mode	Digital control
Maximum acceleration	±1.5g and ±1.0g for two horizontal directions ; ±0.8g for vertical direction.	Degree of vibration	Six degrees
Maximum moment	180t.m	Input signal	Seismic wave; random wave; harmonic wave.
Maximum eccentricity	100cm		

HTR-PM nuclear island building seismic response tests & analysis





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PART FOUR

Undergoing research programs

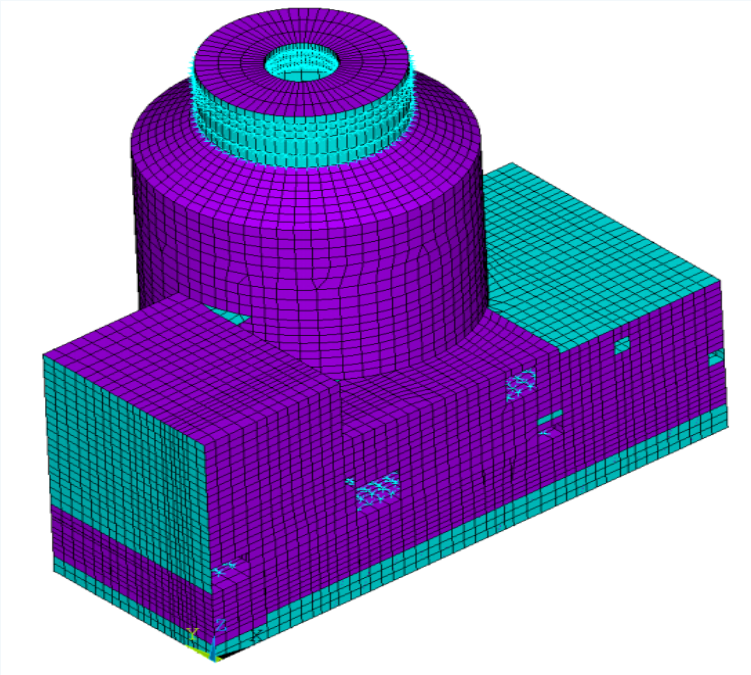
Undergoing research programs

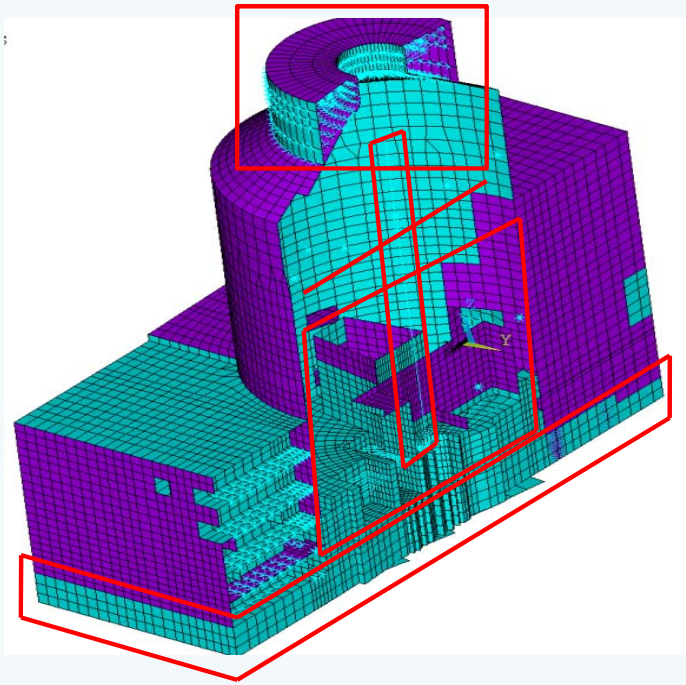
CAP1400 Nuclear island building simplified analysis

CAP1400 Nuclear island building SSI seismic response analysis

NNSA capacity building

Modeling



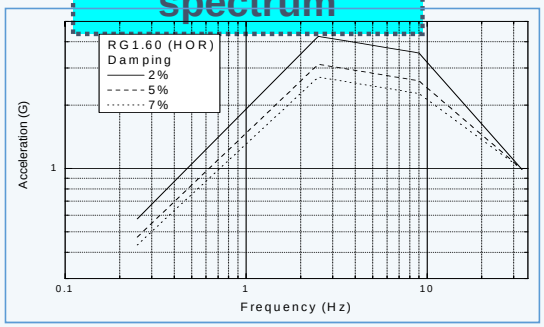


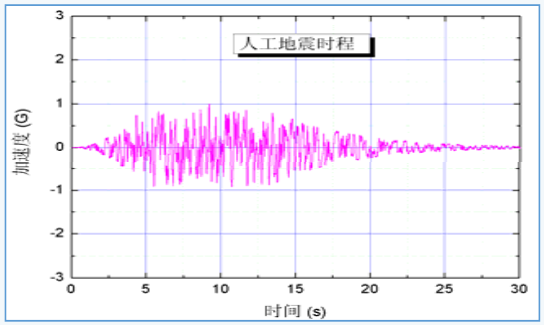
- Tank
- Containment
- Internal structure
- foundation
- other NI structures

CAP1400 NI Building finite element

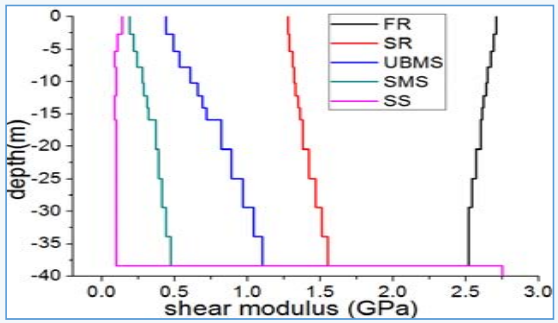
CAP1400 Nuclear island building SSI seismic response analysis

Input response spectrum

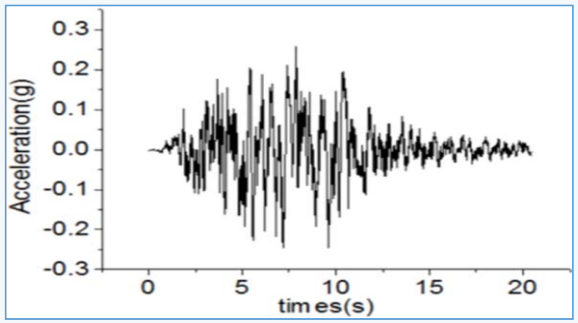




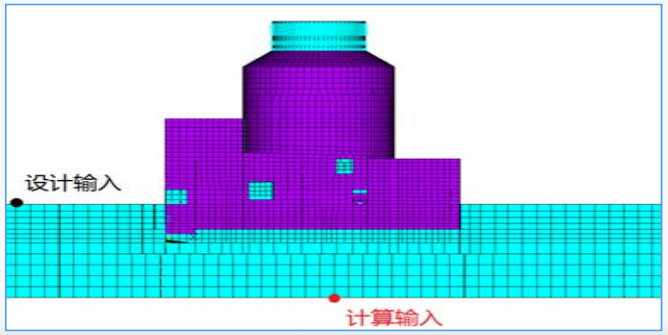
Site field material



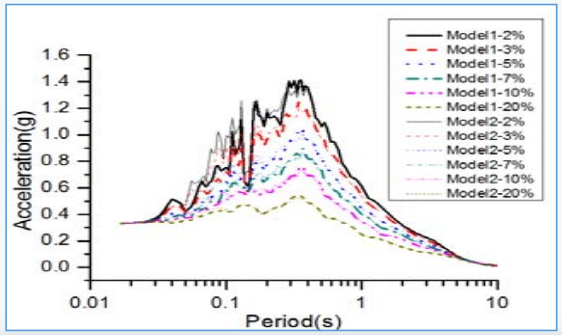
Input time history



SSI



FRS



Capacity Building of NNSA

Construction of the R&D Base

The construction of R&D Base, for the 1st stage

92,957 m^2 building

145,000 m^2 land

Investment 750 M RMB (120 M USD)

Thank you for your time