Introduction to Optimization in Occupational Radiation Protection for Nuclear Power Plants in China

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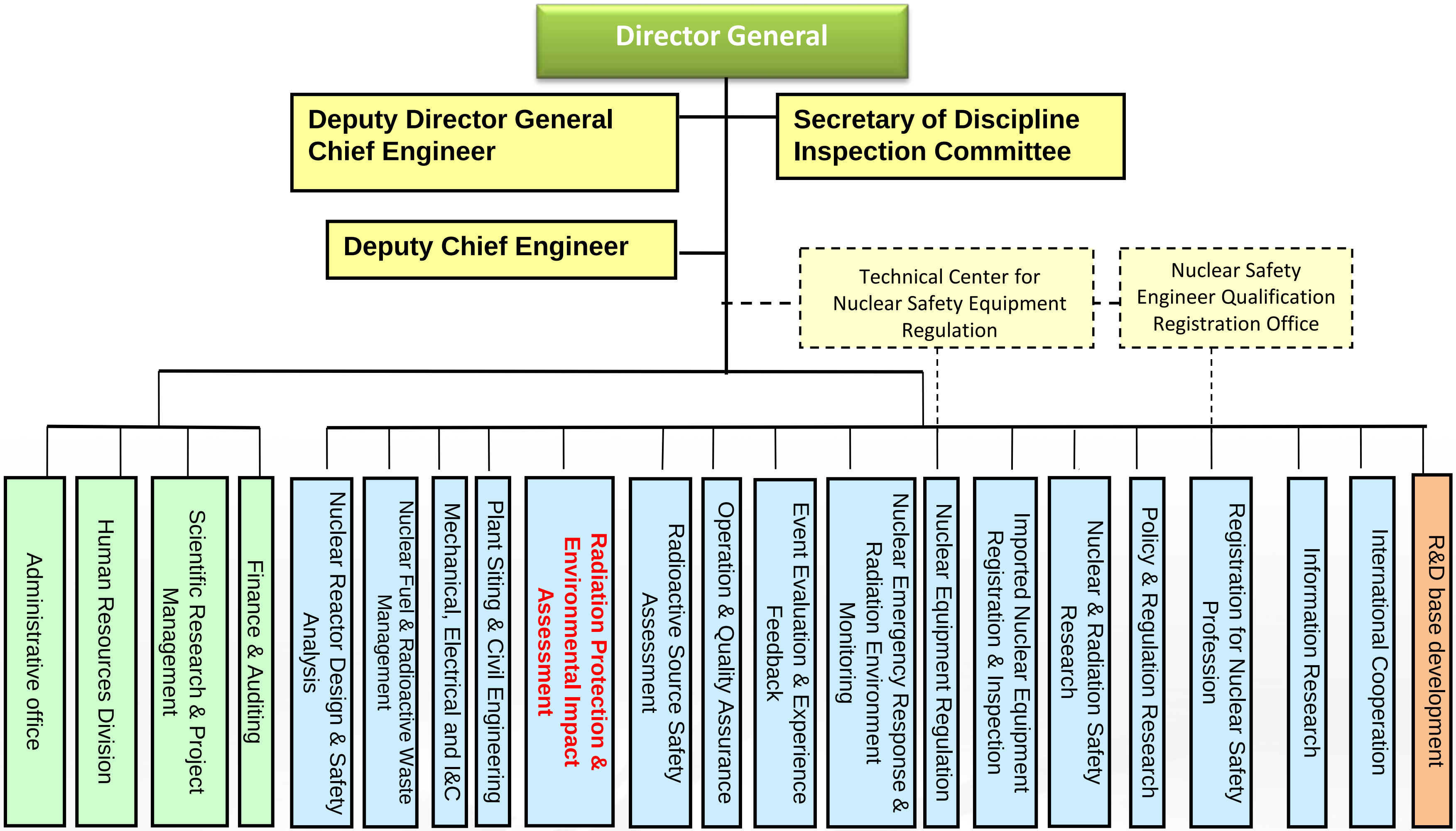
WEBSITE
http://www.chinansc.cn/

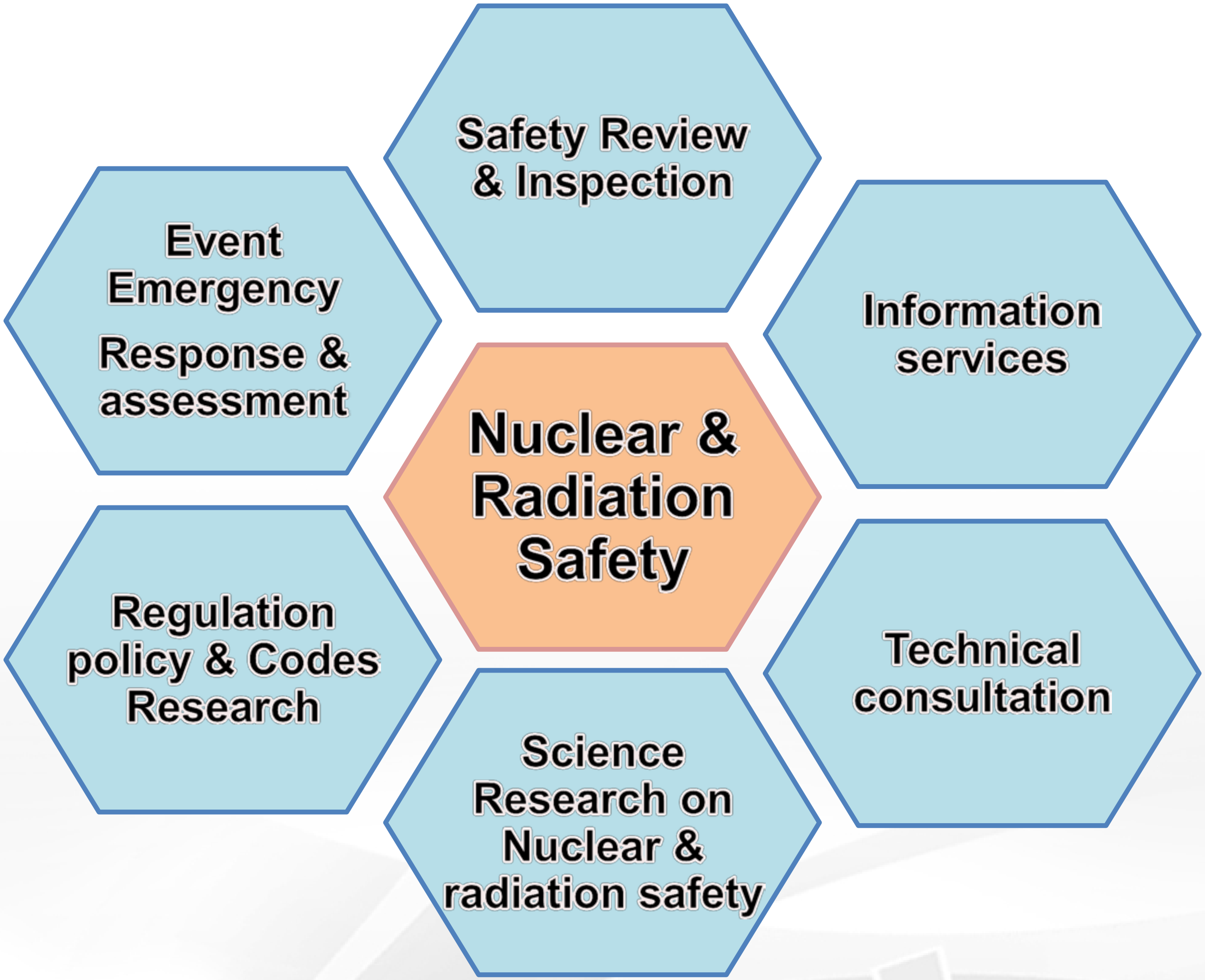
What is NSC?

- A nonprofit affiliated institution to the Ministry of Environmental Protection / National Nuclear Safety Administration (MEP / NNSA) ;
- The only public technical guarantee organization mainly focus on nuclear safety regulations and radiation environment monitoring ;
- Provides overall and comprehensive science & technical support for nuclear and radiation safety regulations ;
- Up to now, NSC has 4 administrative divisions and 17 technical divisions with 504 staff.

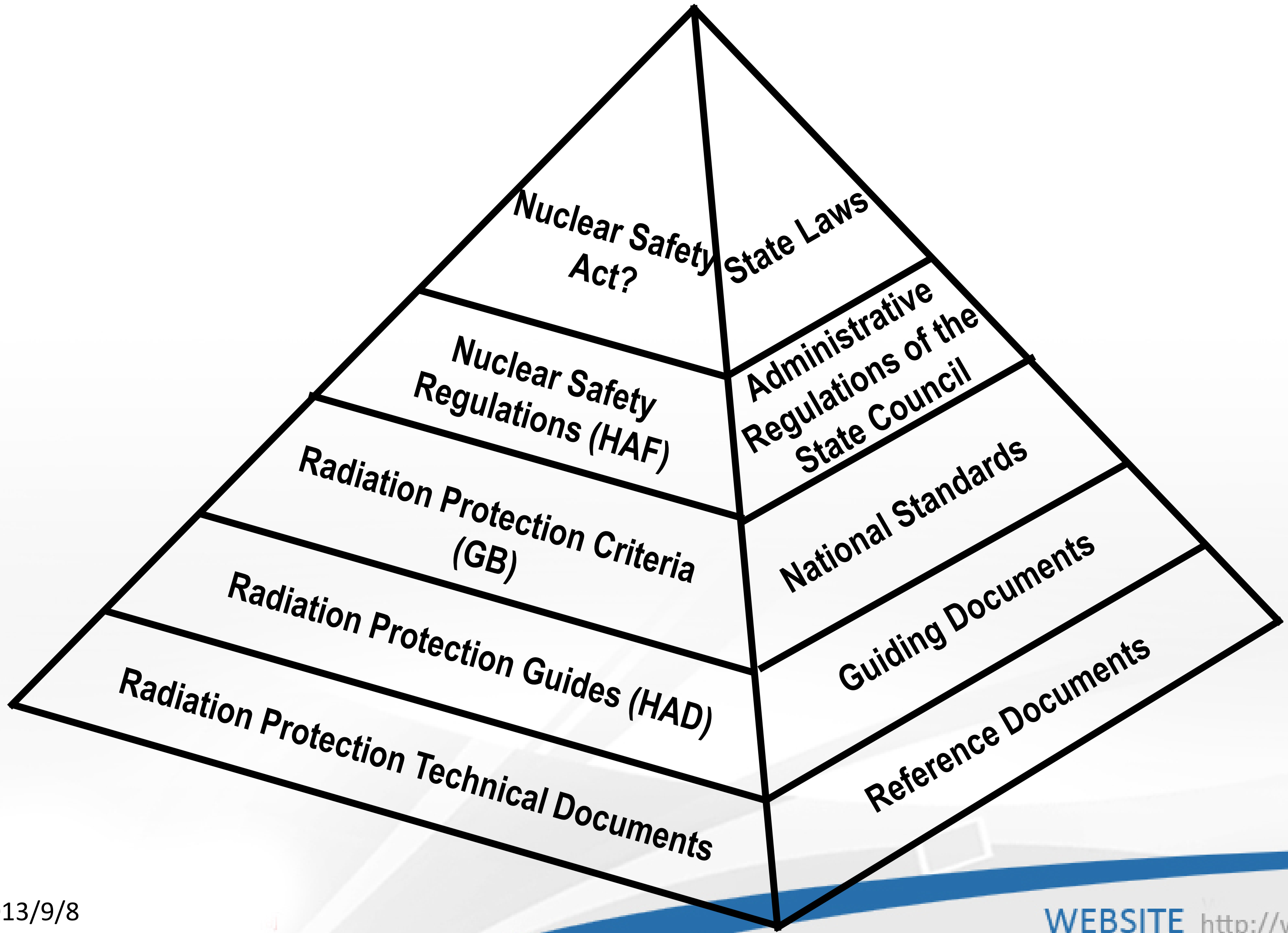
NSC Organization



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

Legislative and Regulation Framework



Legislative System

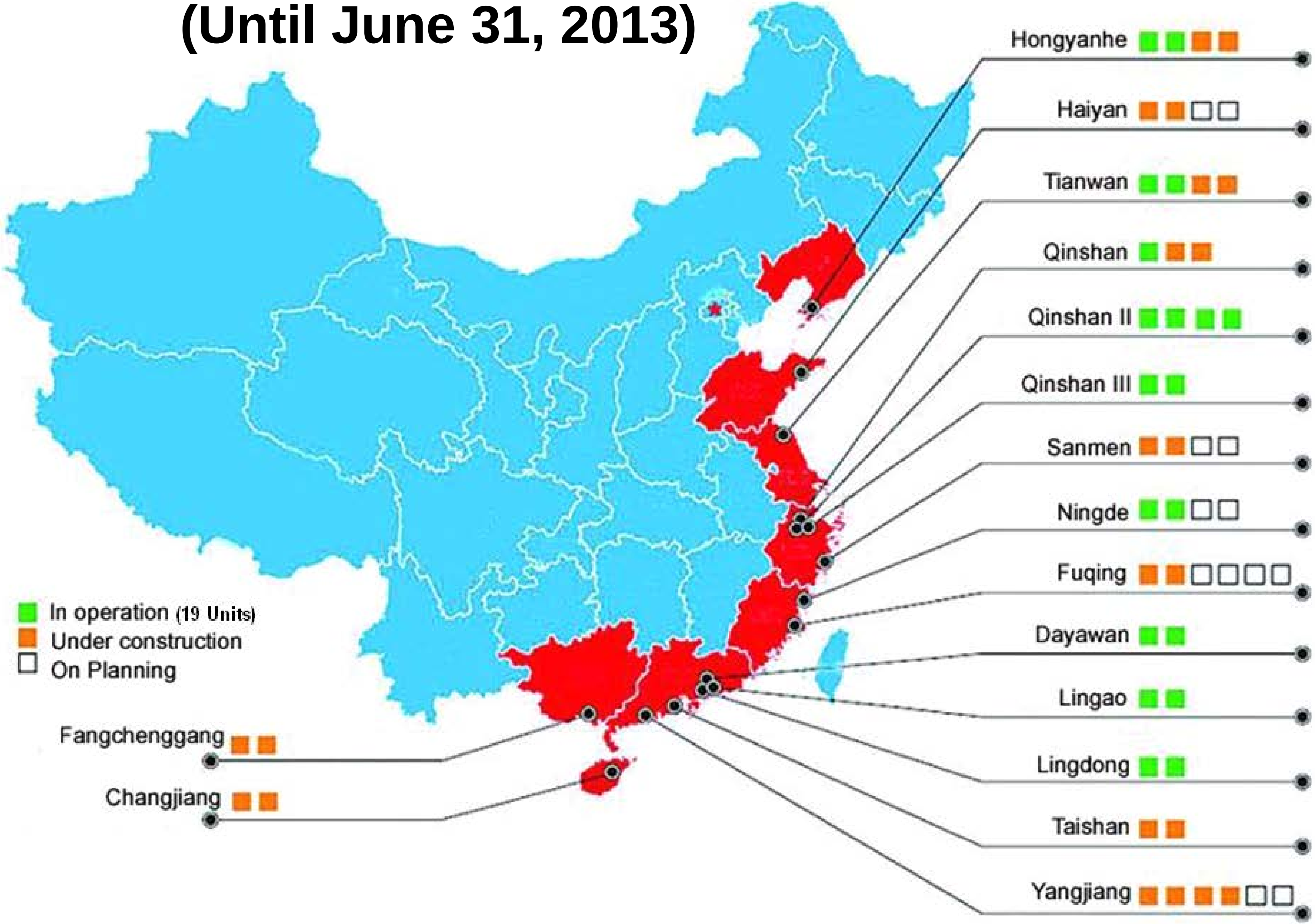
- **Nuclear Safety Law?**
- **Regulations on Surveillance and Control of Civilian Nuclear Installations, HAF001, 1986**
- ***Regulations on Safety for Nuclear Power Plant Design, HAF102, 1991***
- ***Regulations on Safety for Nuclear Power Plant Operation, HAF103, 1991***

- Full consideration should be given to radiation protection requirements, such as optimized facility deployment, installation shielding, in such a way to make the activities and occupancy time of persons within radiation areas as less as possible.
- Taking necessary measures to reduce quantity and concentrations of radioactive materials within plant area.
- Carrying out, on the part of operating nuclear facilities, assessment and analysis of radiation protection requirements and their implementation, making and implementing radiation protection programs to ensure the implementation of such programs and the verification of their goal achievement, and if necessary taking necessary corrective actions
- radiation protection program shall be reviewed and amended in accordance with experiences gained

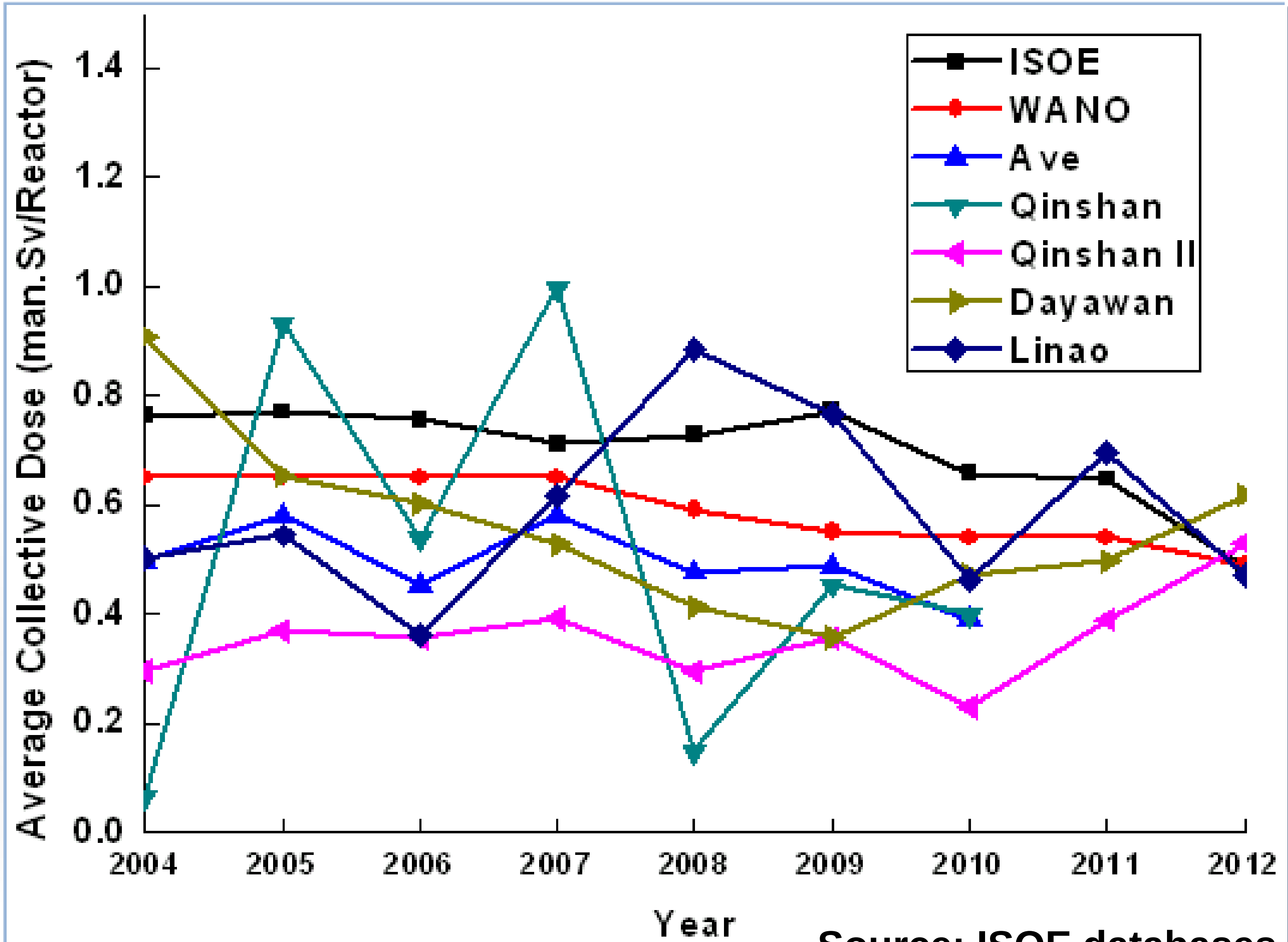
Name	Code
BSS against Ionizing Radiation and for Safety of Radiation Sources	GB11871-2002
Rules for Operational Radiation Protection in NPP	EJ/T270-2005
Requirements of Radiation Protection Program for Decommissioning Operations of Nuclear Facilities	EJ/T1203-2006
Radiation Protection Design for NPP	HAD101/12-1990
Radiation Protection during Operation of NPP	HAD103/4-1990

Under the GB18871-2004, the principles and requirements of radiation protection are the same as the basic safety standards recommended by ICRP 60 Recommendations and BSS 115 issued by IAEA together with other international organizations.

Nuclear Power Plants in China (Until June 31, 2013)

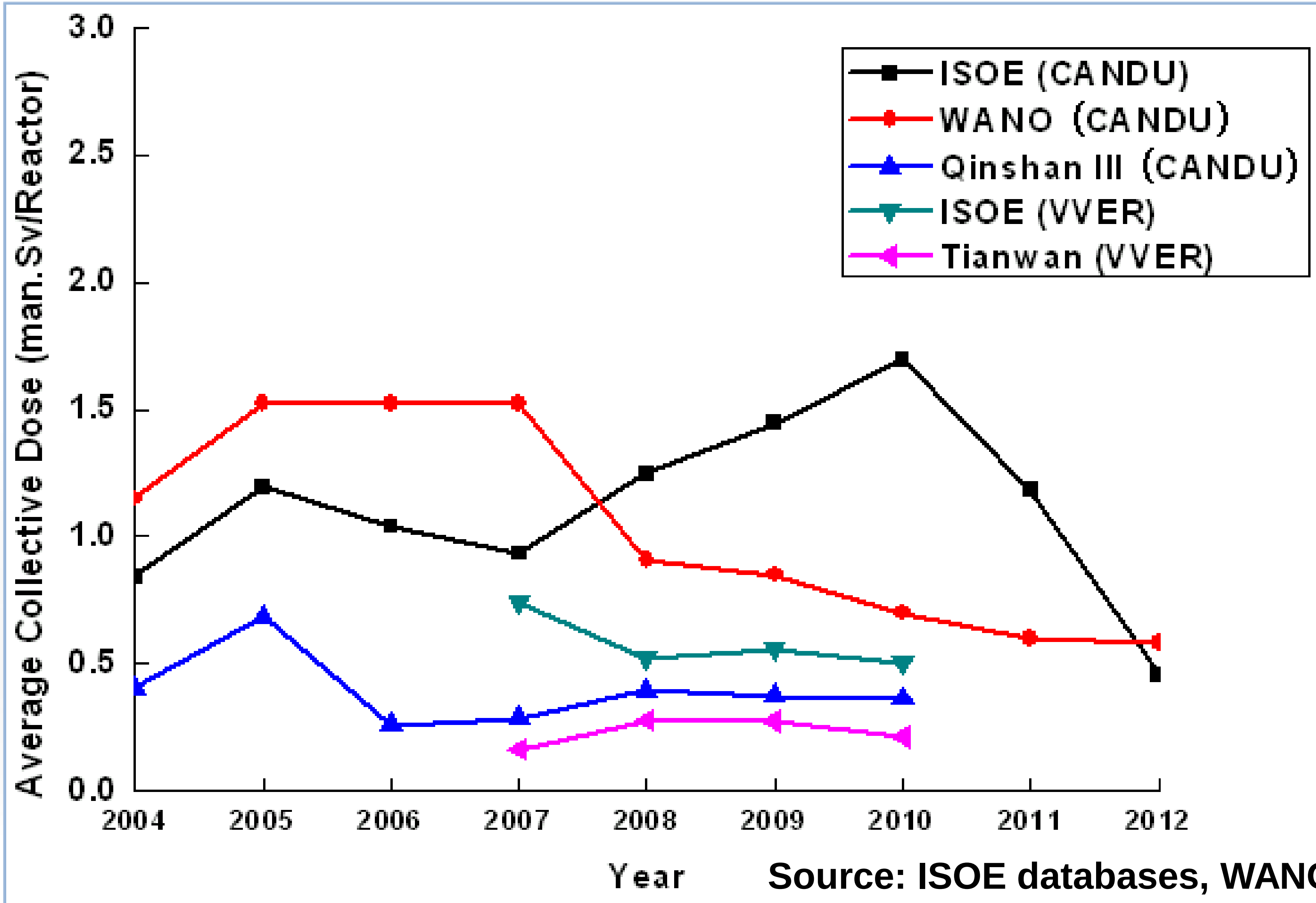


Average Collective Dose Per Reactor (M310)



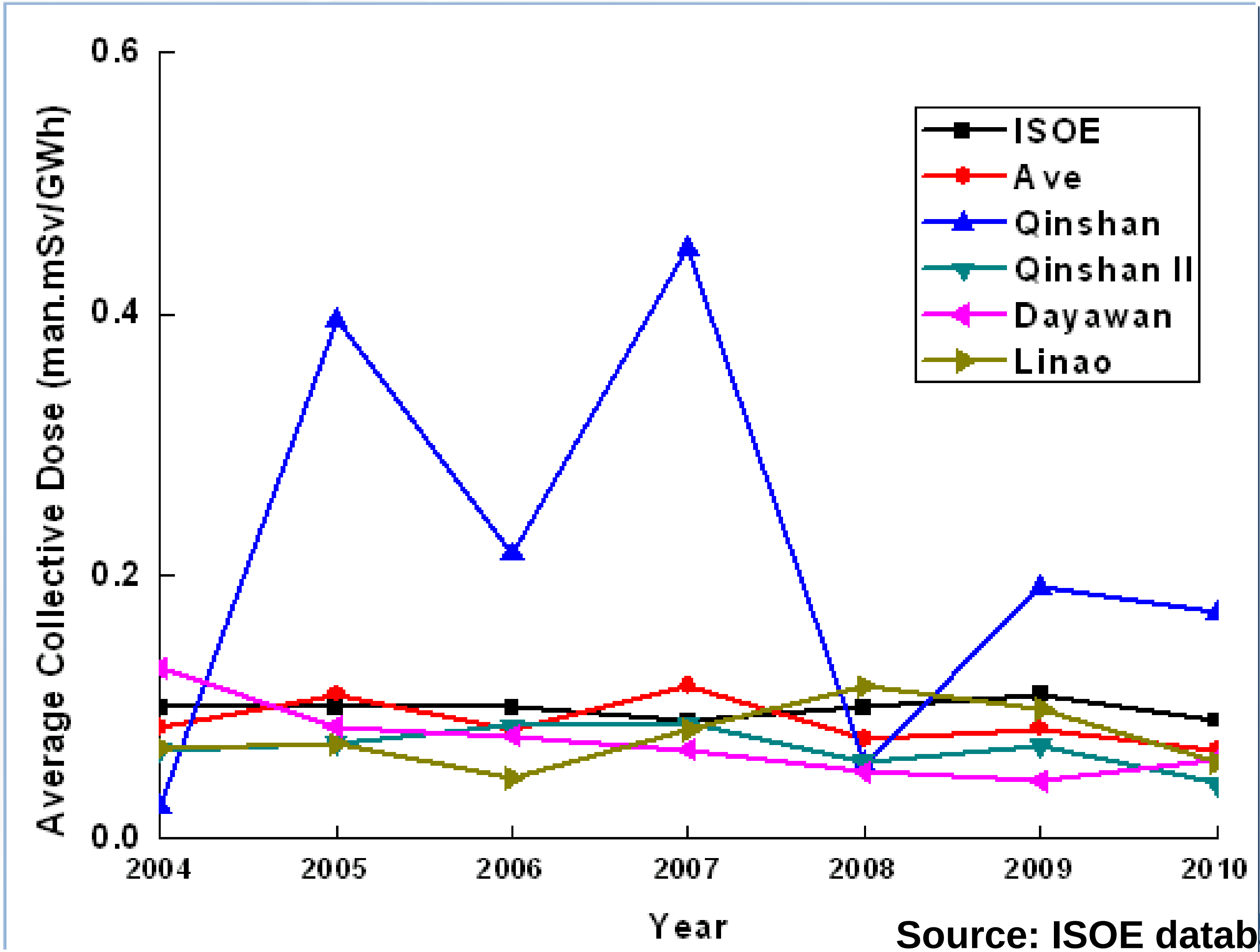
Source: ISOE databases, WANO 2012 and Annual Reports of NNSA

Average Collective Dose Per Reactor (no M310)



Source: ISOE databases, WANO 2012 and Annual Reports of NNSA

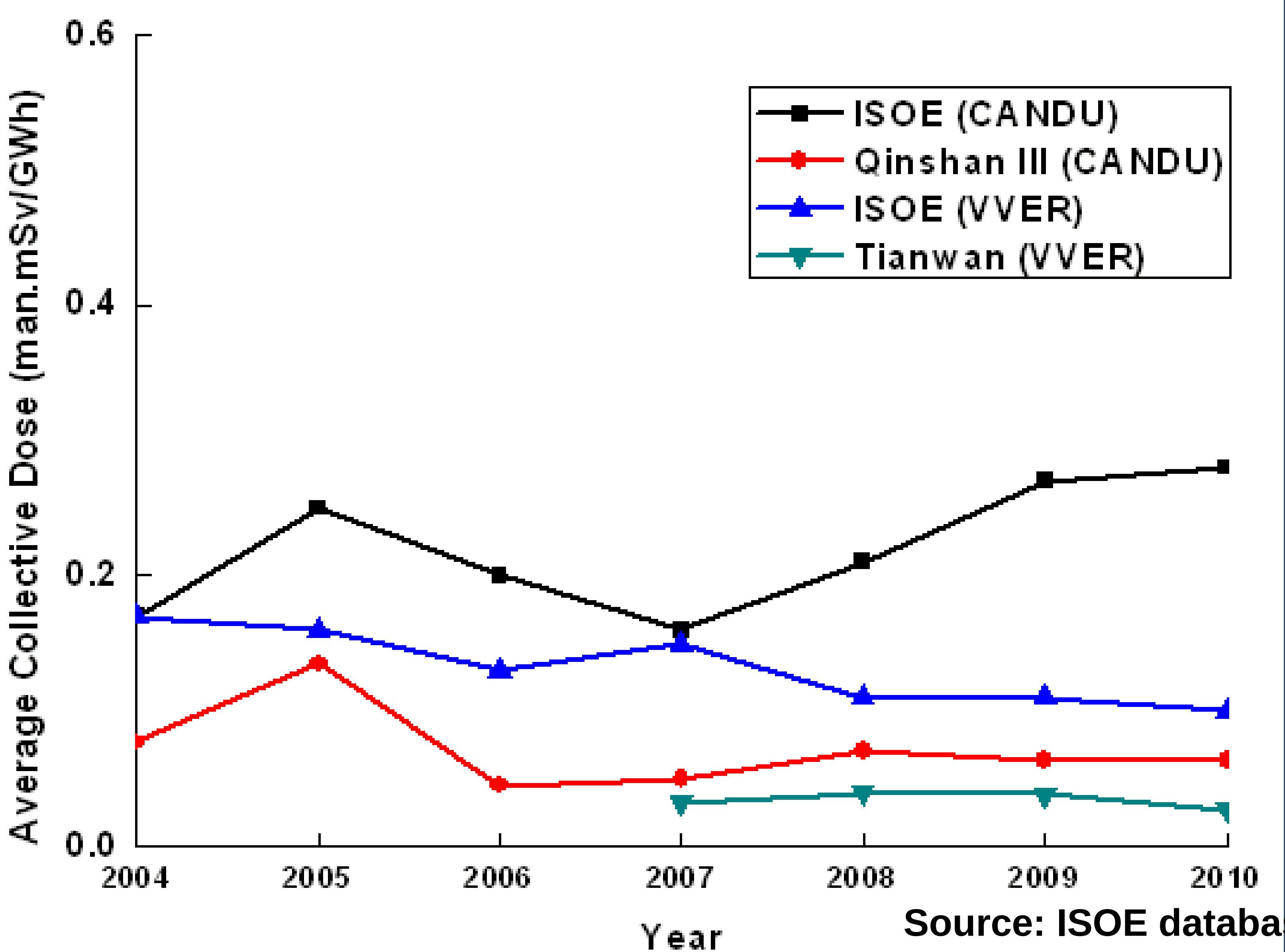
Average Collective Dose Per Energy (M310)



Source: ISOE databases and Annual Reports of NNSA

Average Collective Dose Per Energy (no M310)

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



Source: ISOE databases and Annual Reports of NNSA

Collective Dose for Operational NPPs

(From 2004 to 2012)

Plants	PWR		PHWR
	M310	VVER	CANDU
Units	7	2	2
man·Sv/unit	0.376	0.2323	0.3544
man·mSv/GWh	0.1069	0.0344	0.0610

Annual Average Individual Effective Dose

环境保护部核与辐射安全中心
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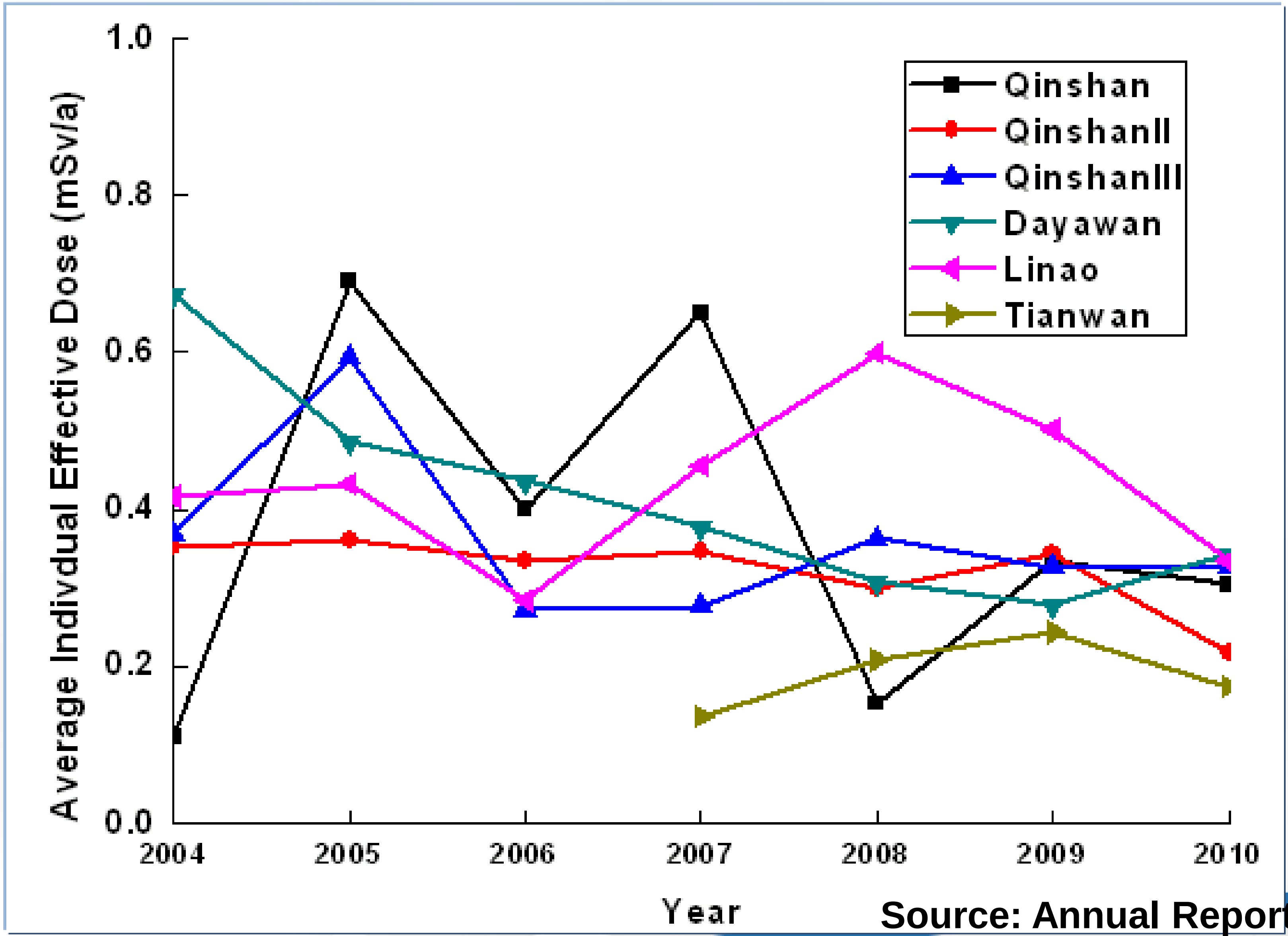
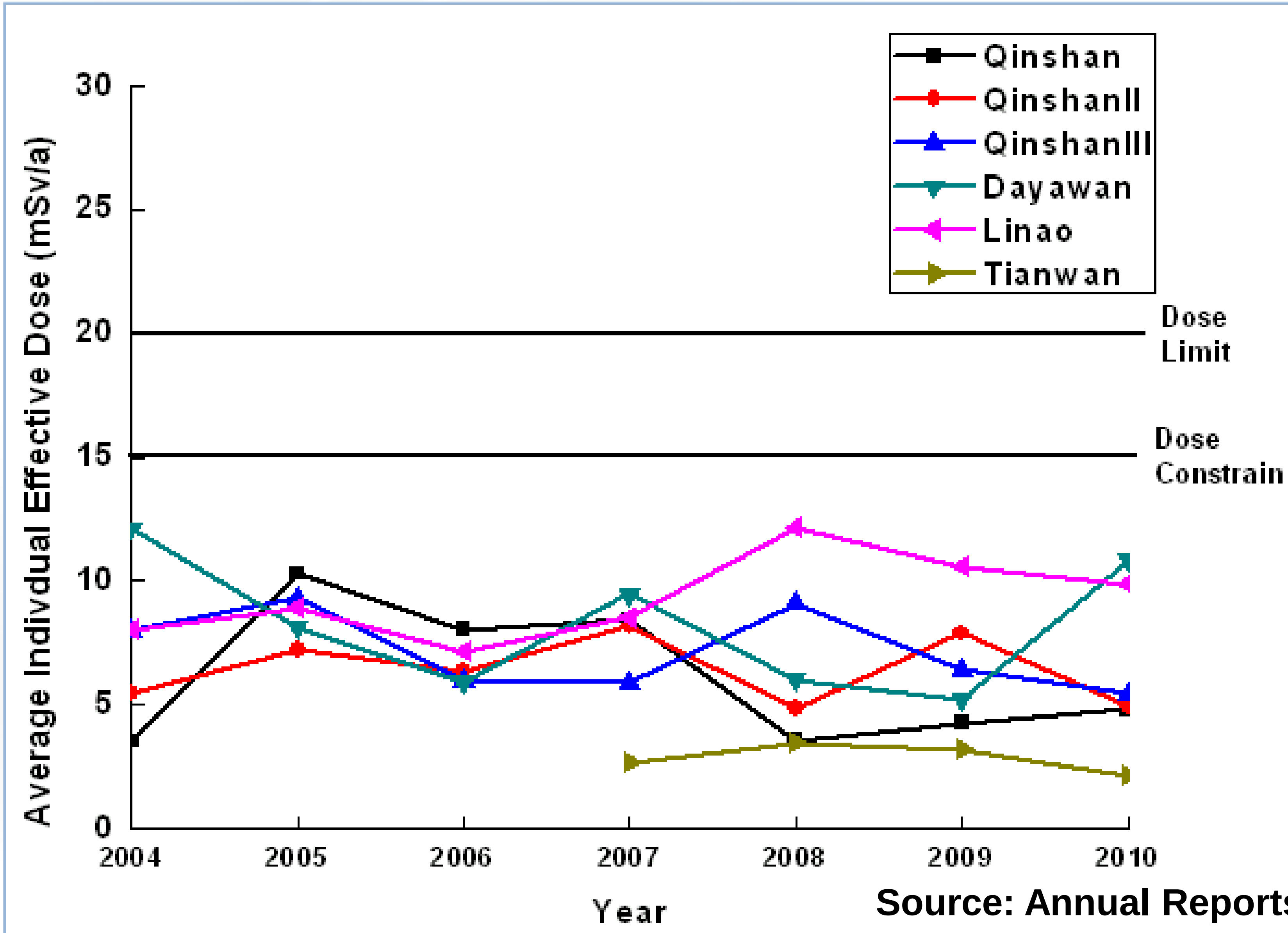


Source: Annual Reports of NNSA WEBSITE http://www.chinansc.cn/

Annual Maximum Individual Effective Dose



Source: Annual Reports of NNSA

Individual Dose for Operational NPPs

(From 2004 to 2010)

Plants	PWR		HWR
	M310	VVER	CANDU
Units	7	2	2
Average (mSv/a)	0.366	0.191	0.324
Max (mSv)	12.169	3.460	9.102

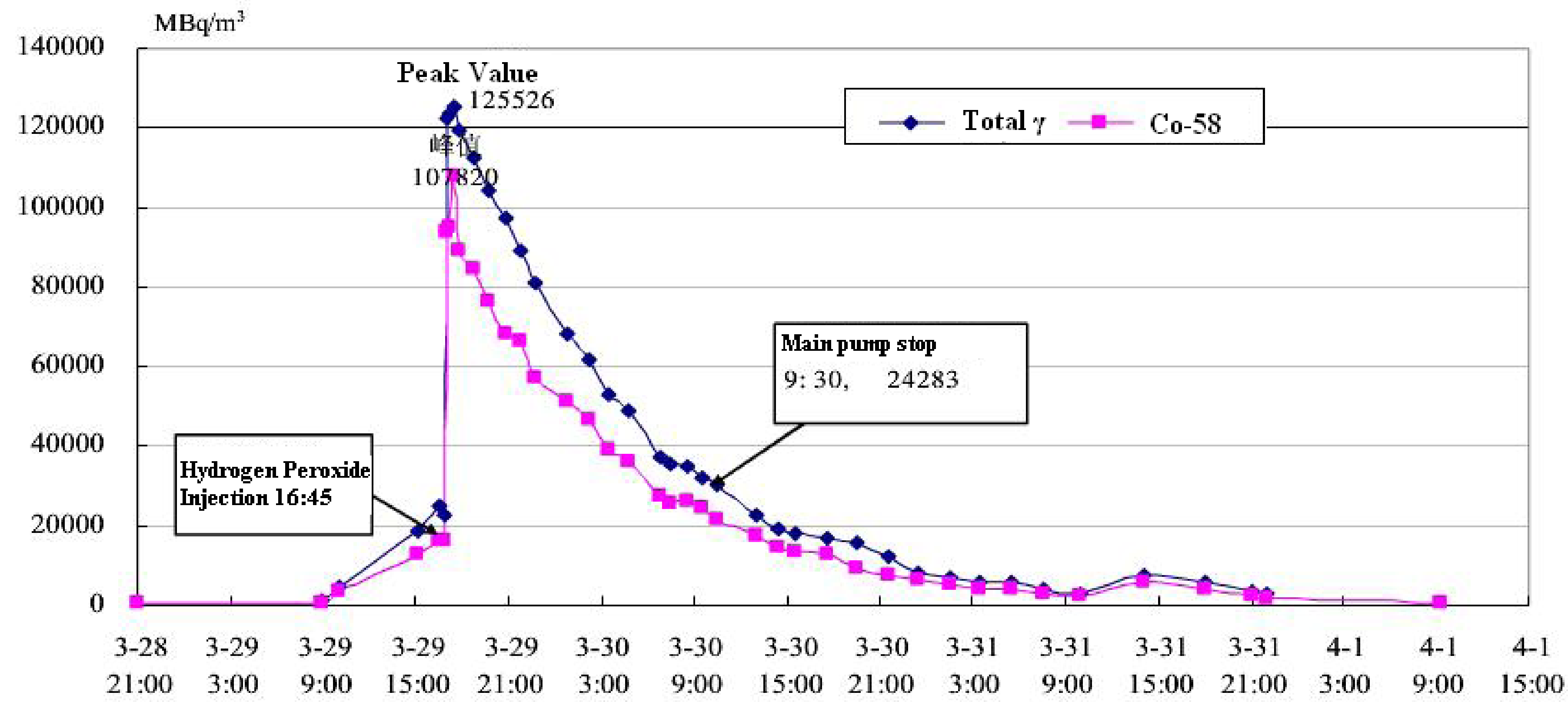
Detailed Measures for Optimization

- **Optimization process is dependent deeply on the different phase of nuclear power plants**
- **New plants at the design stage are affording more opportunities for eliminating hazards and engineered control**
- **Operational plants are often constrained in the control options available and plants undergoing clean up**
- **Decommissioning also need be considered in the design and operation stage**

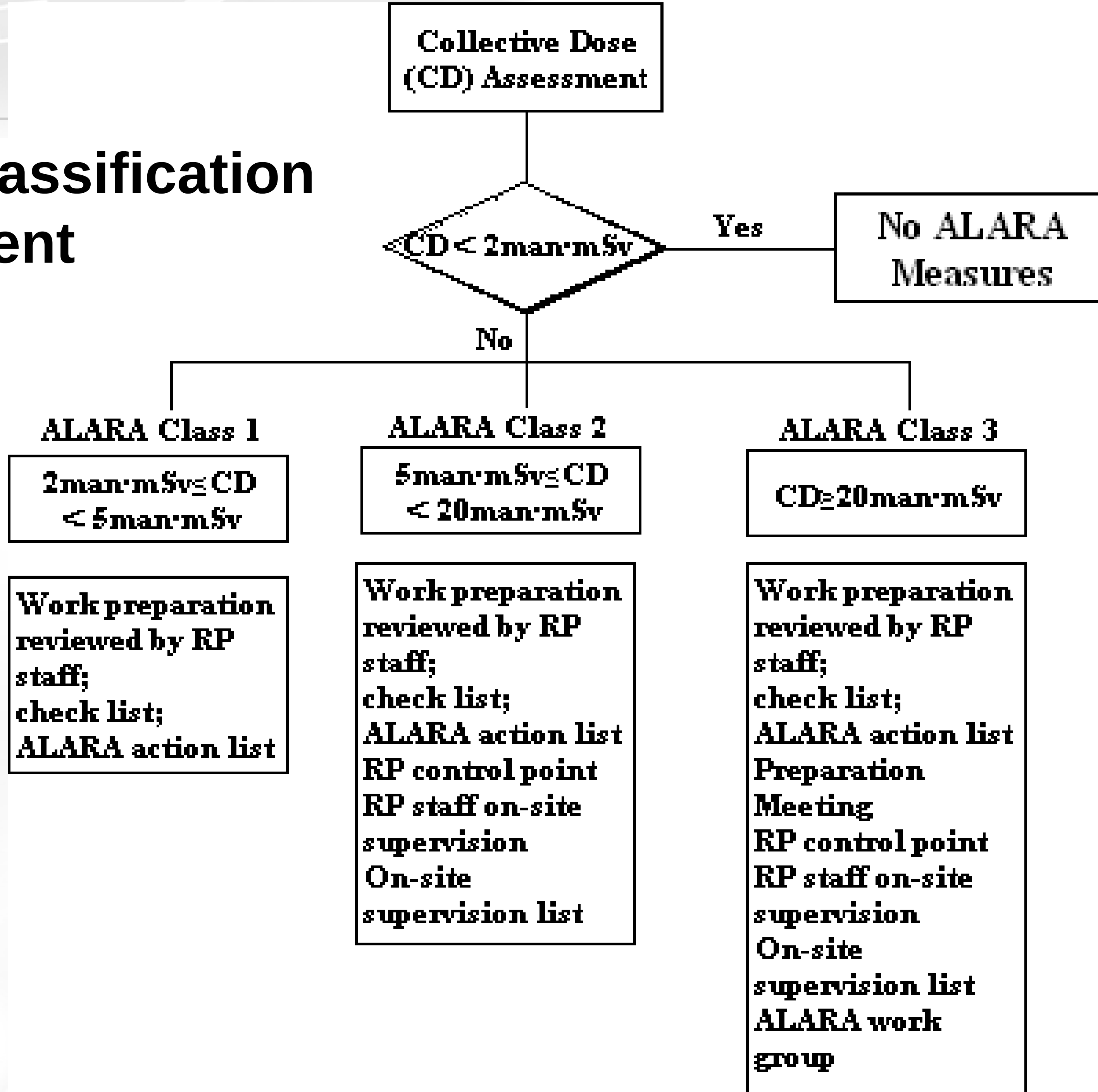
Detailed Practices for Operational Plants

- Control of the gaseous radioactive source, such as ventilation, negative pressure devices, individual positive pressure oxygen breathing apparatus
- Control of the corrosion product in coolant:
  - ✓ Hydrogen Peroxide (H_2O_2) injection
  - ✓ Maintaining proper pH level
  - ✓ Increasing reactor coolant letdown flow rate (purification)
  - ✓ Washing and decontamination
  - ✓ Reducing the concentration of tritium in the coolant (limitation of)

Concentration of radioactive nuclides in reactor coolant changes after Hydrogen Peroxide (H_2O_2) Injection



ALARA Classification Management



Detailed Measures for New Plants

- Zinc injection can reduce the concentration of corrosion product in the reactor coolant
- Reducing interval between each refueling and maintenance (namely from 12 months fuel cycle to 18 months fuel cycle)

Learning from Experience

- Lacking clear guidance from international and national standards, NNSA have a difficult task in assessing performance at nuclear plants.
- Same comparative activities that have assisted in reducing nuclear plant dose have also created a dilemma in the comparison of one plant to another
- Information systems are very important for management of occupational exposure for contractors

Guideline values of control level for emergency

Category	Emergency Task	Effective Dose (mSv)	External Exposure Dose(mSv)
1	Undertaking actions of saving life or preventing core damage or radioactive material large release when core damage happened only when the expected benefits to others would clearly outweigh the risks to the emergency workers.	＞500	＞250
	Preventing core damage or radioactive material large release.	＜500	＜250
2	Avoiding to avert a large collective dose or preventing the development of severe or catastrophic accidents; Recovery safety systems of reactor	＜100	＜50
3	Short term recovery operation; Implementing emergent protection action	＜50	＜25
4	Long term recovery operation; Work without directly relevant to accident	20	10

谢 谢！

Thank you for your attention!