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China’s Nuclear Power Industry after Fukushima and China's nuclear safety practices

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Talk outline

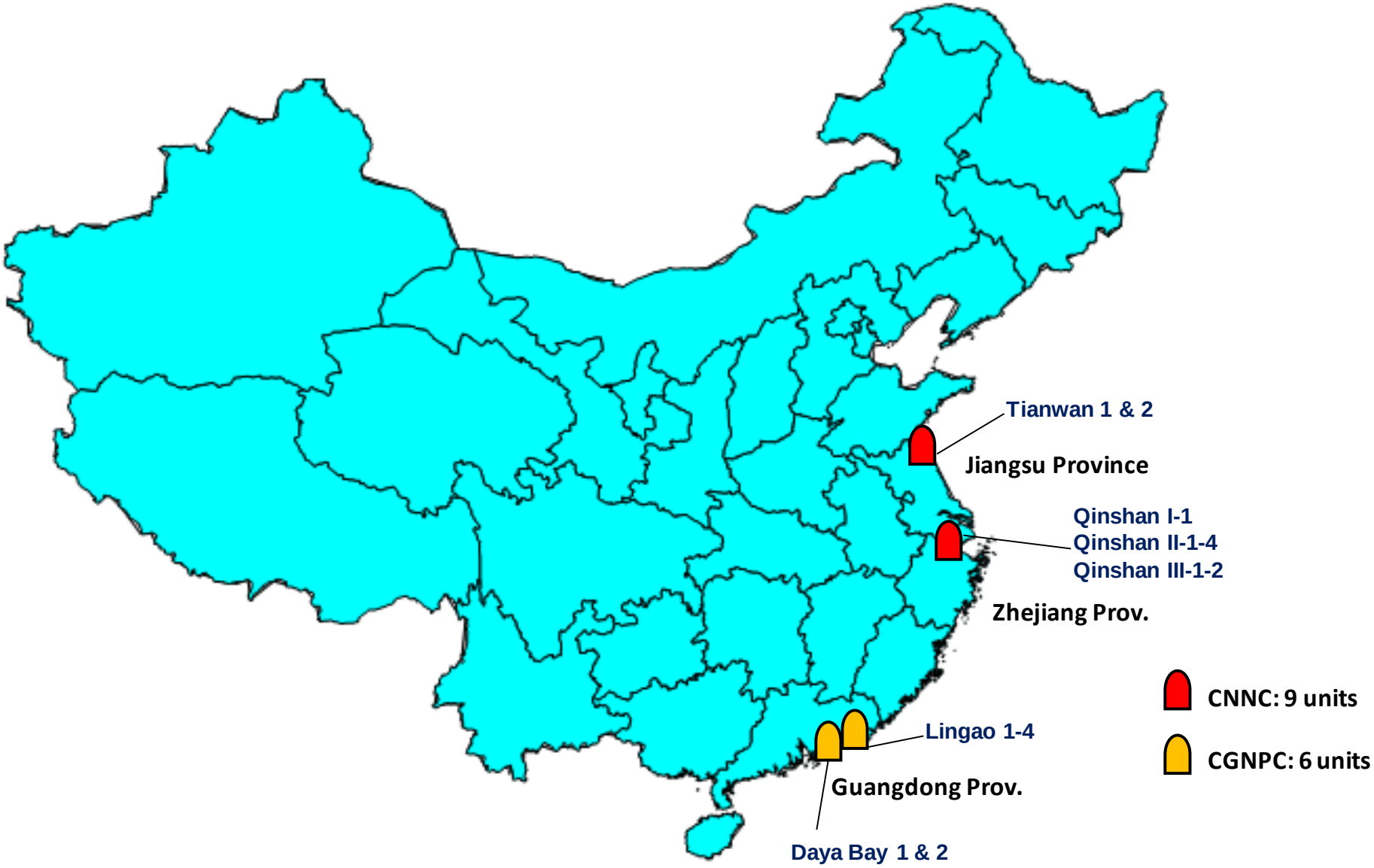
Section 1: China's Nuclear Power Program and policy transformation

Section 2: China's activities after Fukushima, reasons and implications

Section 3: China's nuclear safety practices and challenges

China's Current Nuclear Program

- 15 nuclear reactors in operation (12 GWe)
  - Qinshan Phase I, II III (7 reactors - indigenous & Canada)
  - Daya Bay (2 reactors - France)
  - Ling Ao Phase 1 (2 reactors - France)
  - Tianwan (2 reactors - Russia)
  - Ling Ao Phase II (2 reactors - localized CPR-1000)
- 27 reactors under construction (29.5 GWe)
- Nuclear power target: 60-70 GWe by 2020


Tianwan 1 & 2
Jiangsu Province
Qinshan I-1
Qinshan II-1-4
Qinshan III-1-2
Zhejiang Prov.
Lingao 1-4
Guangdong Prov.
Daya Bay 1 & 2
CNNC: 9 units
CGNPC: 6 units

CPIC:

- 1 Haiyang – 1 & 2

CNNC:

- 1 Fangjiashan – 1 & 2
- 2 Sanmen – 1 & 2
- 3 Fuqing – 1, 2 & 3
- 4 Changjiang – 1 & 2

CGNPC:

- 1 Taishan – 1 & 2
- 2 Yangjiang – 1, 2 & 3
- 3 Ningde – 1, 2, 3 & 4
- 4 Hongyanhe – 1, 2, 3 & 4
- 5 Fangchenggang – 1 & 2

Policy Transformation

- A nuclear weapon era (1955 ~ 1978)
  - A military-oriented nuclear industry and management system
- A Slow Transition (1978 ~2004)
  - A policy transition from military uses only to combining military and civilian uses
- A Booming future (2004 ~ present)
  - Integrating nuclear power into the Chinese electric power strategic plan

What causes this policy transformation?

- Huge electricity demand
- Coal cannot suffice to meet China's growing energy needs
  - Transportation capacity
  - Price
  - Safety
  - Emissions
- China's Energy Policy
  - Self-sufficiency
  - Energy diversity

China's nuclear expansion plan

- The medium and long-term plan (2004)
  - Officially 40 GW by 2020
- The "Rapid growth" reality
  - 80 GW by 2020 (March 2010)
  - Possibly 70 GW (March, 2012)
- Steady development with safety concerns

Section 2: Reactions to Fukushima, Reasons, and Implications

- Response from the State Council on nuclear safety and development in March (four guidelines)
- Premier's speech on China's continuing nuclear energy development policy and call for international cooperation in May
- Safety inspections on reactors in operation and under construction
- Release of new safety standards/plans
- Renewed push on China's atomic energy law
- Temporary adjustment of NPP development pace

Reasons Behind China's Reactions

- China sees the shortcomings of Gen II designs from Fukushima accidents and China has 25+ Gen II reactors planned
- China needs more time to see how the first AP1000 projects develop
- China realizes it still has an incomplete regulatory system
- China's government is more risk-averse now considering public safety and opinions

Current status of post-Fukushima activities

- China officially completed safety inspections for commercial reactors under construction in August 2011
- National Nuclear Safety Administration is still working on the nuclear safety plan and the first draft was not approved by the state council in Feb 2012.
- National Development Reform Commission is working on setting a new goal for China's Medium and Long-term Nuclear Power Development by 2020.

Implications of post-Fukushima activities

- All units under construction were not affected without any construction halt, which signals that those units under construction will very likely move forward without major delay.
- Planned units have to face major design changes to comply with the stricter safety standards.
- The Chinese nuclear industry already appears the urgency to develop domestic next generation technologies after Fukushima
- The trend to shift from the old generation designs to newer next generation domestic designs might occur much quicker

Post-Fukushima Consequences

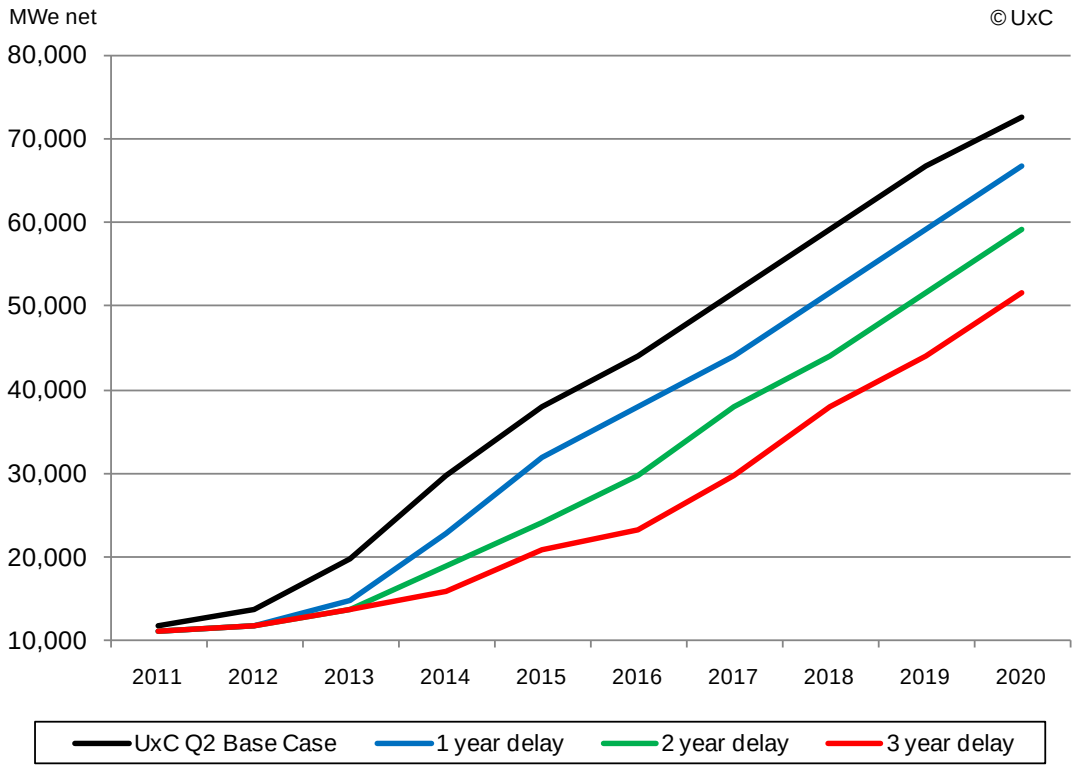
- At least one year delay on its nuclear energy growth
- Updated and upgraded regulatory system
- Atomic Energy Law to regulate all nuclear activities
- Delay in-land projects due to safety and environmental concerns

Post-Fukushima Growth

- With 15 units in operation and 27 units under construction, it is no doubt that China would achieve the 40 GWe capacity goal by 2020
- 16 more projects approved by NDRC before Fukushima are waiting for construction permit

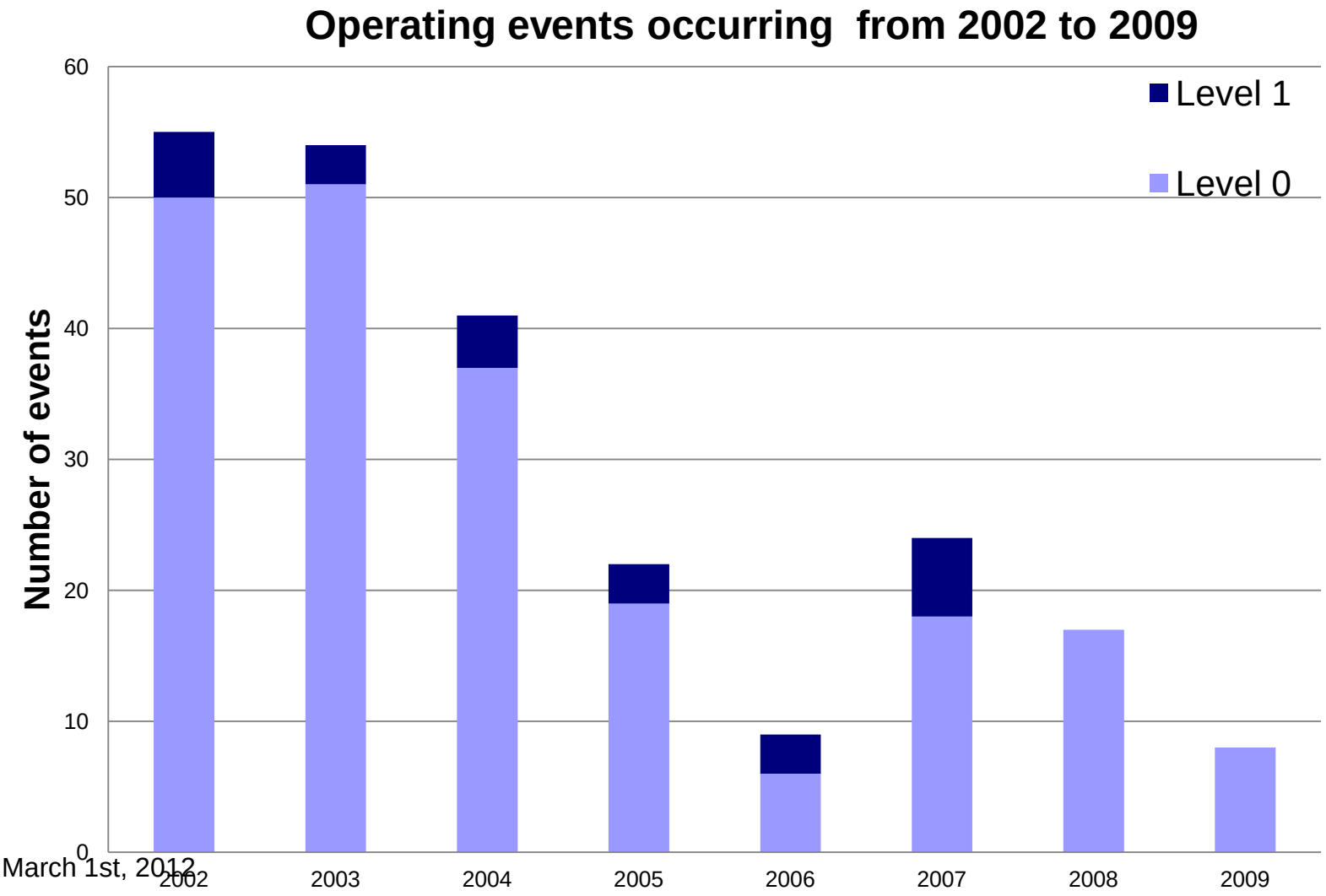
Post-Fukushima Growth Scenarios

- 1 year delay: 67 GWe by 2020
- 2 year delay: 60 GWe by 2020
- 3 year delay: 52 GWe by 2020



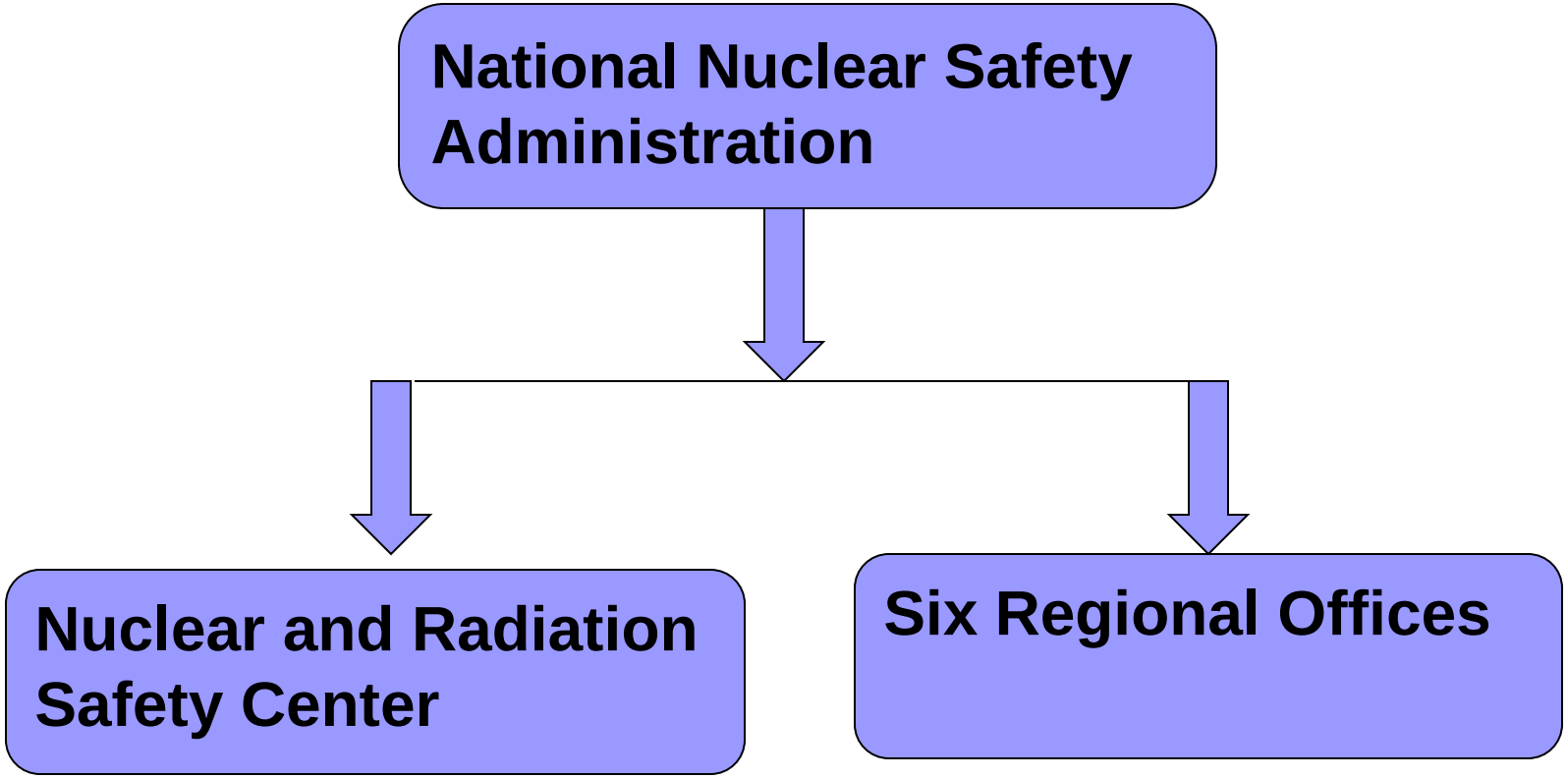
Key Uncertainties:
1) Start of new approvals
2) Future of CPR-1000
3) NPP siting

Section 3: Nuclear safety practices & challenges



China's Nuclear Regulatory System

- Organization Chart



China's Nuclear Regulatory System

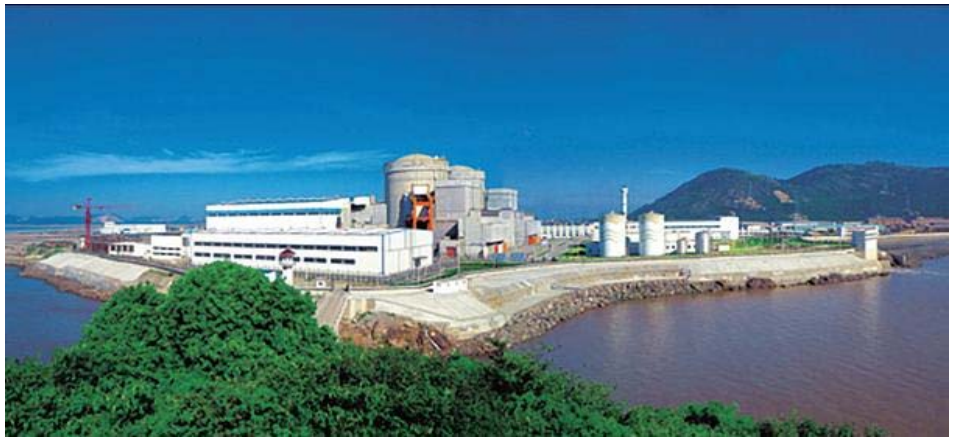
- National Nuclear Safety Administration (NNSA)
  - Ensure the supervision and management of radiation and nuclear safety
  - 12 sub-divisions with 30-40 staff members
- Nuclear and Radiation Safety Center
  - NNSA's technical support and assurance body
  - Technical assessment and evaluation
  - 200+ staff members
- Regional Offices
  - NNSA's supervising and enforcement body
  - Daily supervision activities
  - 6 offices with 331 staff members

Nuclear Plant Licensing Process

- New nuclear project licensing process includes three stages and two major permits
  - Siting and feasibility study stage: Project Approval needed from the National Development and Reform Commission (NDRC)
  - Construction stage: Construction Permit (CP) and First Fuel Loading Permit (FFLP) issued by the NNSA
  - Commissioning stage: Operation Permit (OP) issued by the NNSA

Current Practices & Enforcement

- Case 1: “Welding Defects” at primary loop connection pipes at Qinshan Phase II Unit 2
  - Deficiencies in quality assurance
  - Inadequate nuclear safety culture at the utility company and supplier
  - Insufficient experiences of Regulator to make judgment and resolution
  - Regulator’s strict attitudes on regulation enforcement



Current Practices & Enforcement

- Case 2: “Control rod drop time” non-compliance at Daya Bay plant
  - Design Defects from the vendor
  - Regulator’s strict attitude to nuclear safety
  - Insufficient R&D capabilities at NNSA to assess licensee’s technical responses or solutions

Current Practices & Enforcement

- Overall, NNSA fulfills the functions of supervision and enforcement, but not legislation and safety R&D
- NNSA treats safety as a top priority in practice
- No compromise on detected problems
- Safety culture code is on par with IAEA standards
- Good understanding of state-of-art nuclear safety regulation development in other countries, e.g. IAEA, NRC, etc.
- Ambitious program to improve NNSA technical competency

Problems & Challenges

- Insufficient nuclear regulatory professionals and expenditures
  - NNSA's number of permanent staff per GWe installed capacity ratio is still significantly lower than the level in other major nuclear power countries
  - China's current annual budget for NRSC is 10 million RMB, while NRC annual budget has been around 800 million USD on nuclear reactor safety for last several years.

Cont'd

- Insufficient technical capability to maintain and service operating reactors and R&D capability to identify potential technical issues and approve and assess new designs
  - China still mostly relies on foreign venders to solve major technical issues and fix major defects on nuclear equipments.
  - It doesn't have technical capabilities to conduct reactor repair work under radioactive environment
  - China doesn't have any technical capabilities to develop its own software and simulation systems

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- Incomplete integration into international safety regime
  - China has not issued a major law to govern the use of nuclear energy and related activities (something akin to Japan's Japanese Atomic Energy Basic Law).
  - Most current regulations and rules were issued at least a decade ago and need to be updated to meet new requirements
  - NNSA lacks independence and authority

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- Insufficient public participation
  - the Chinese public seems to accept and embrace nuclear technologies before Fukushima for several reasons.
  - In the past, the Chinese public has not been an integral part of nuclear energy decision-making. This situation is changing.
  - The Chinese government will have to improve public participation to make the decision making system more transparent and enforce the regulatory system more effectively.

Cont'd

- Issues remain on safety culture and quality assurance
  - Plant staffs might not necessarily appreciate the necessity of these regulations and laws.
  - With more conventional construction companies beginning to work in nuclear area, compliance with the special safety needs and safety cultures of nuclear power plant construction is likely to become more difficult.

Conclusions

- Overall, China's nuclear safety regime is on par with global standards
- **Some past incidents have** highlighted critical shortcomings (e.g. technical depth)
- **Government and Industry need to work together to ensure that a large nuclear power program can be built and operated safely**
- Current new construction delays may be significant, but this should result in improved safety standards with positive long-term outcomes in public opinion