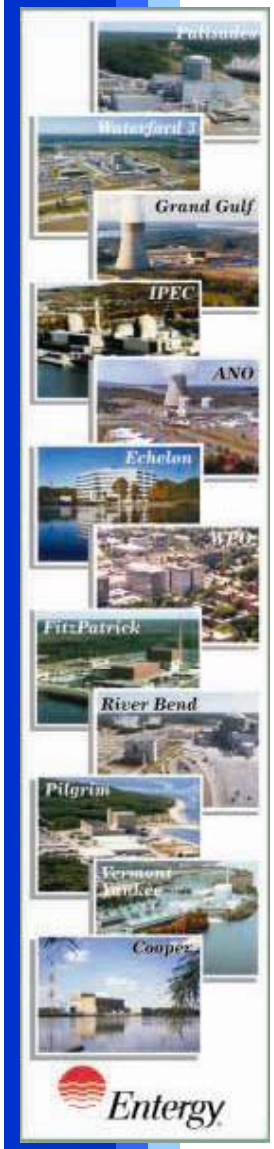
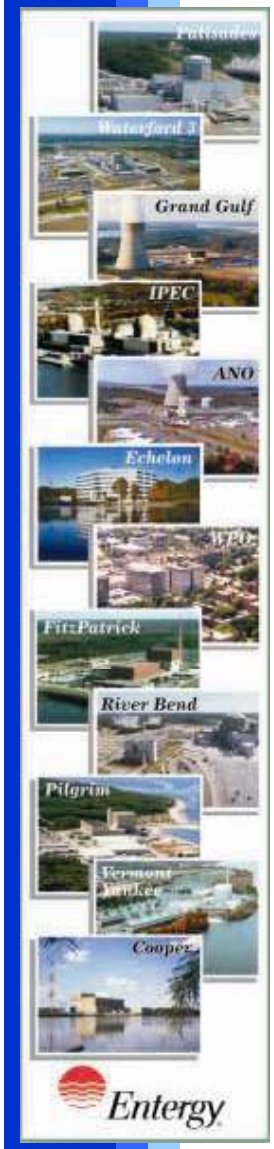


Digital I&C Assist Visit to Hongyanhe

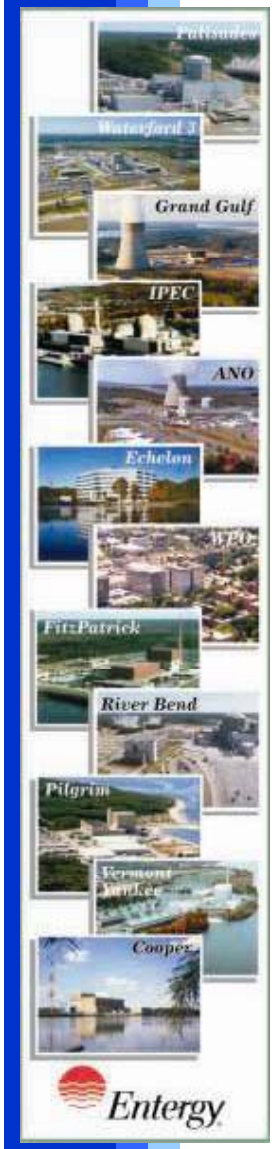
How sustainability can be viewed in light of new reactors



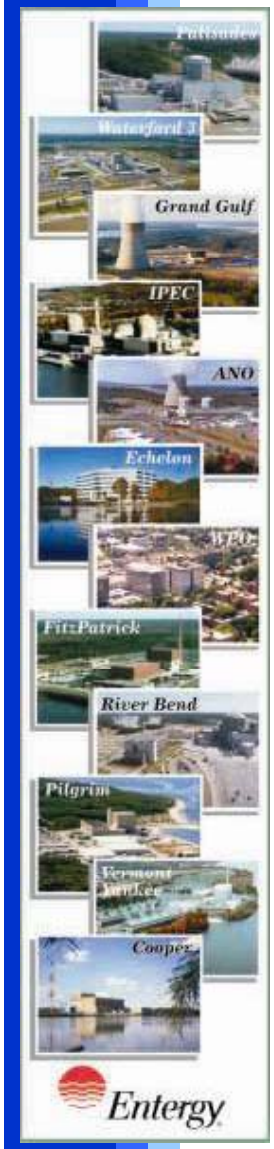
Rate of Construction

- Fact - The rate of construction of the nuclear plants at the Hongyanhe site in China is overwhelming.
- For example, there were 14 skycranes operating on Unit number 2, alone, at Hongyanhe.

Now and the Future



- In China, now with 13 operating reactors on the mainland, the country is well into the next phase of its nuclear power program.
- Some 27 reactors are under construction and many more are likely to be so by the end of 2011. Those under construction include the world's first Westinghouse AP1000 units, and a demonstration high-temperature gas-cooled reactor plant is due to start construction.
- Many more units are planned, with construction due to start within three years. But most capacity under construction will be the largely **indigenous** CPR-1000.
- China aims at least to quadruple its nuclear capacity from that operating and under construction by 2020.
- http://www.world-nuclear.org/info/inf17.html



Localization

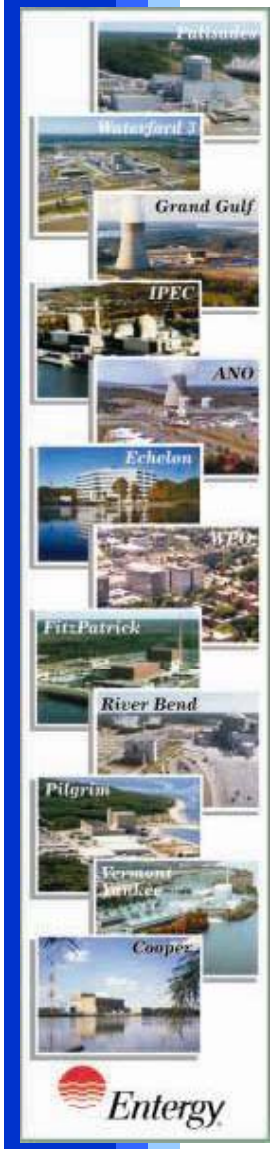
- Fact - Localization is a part of the Chinese 5 year plan. The Chinese are in their eleventh 5-year plan. These plans budget for nuclear plants. Four plants are already budgeted for at Hongyanhe. Two more are in the next 5-year plan and 4 more are to follow with a total of ten reactors generating electricity at Hongyanhe in the near future.

  - 2012 China, CGNPC Hongyanhe 1 PWR 1080 MW
  - 2013 China, CGNPC Hongyanhe 2 PWR 1080 MW
  - 2014 China, CGNPC Hongyanhe 3 PWR 1080 MW
  - 2014 China, CGNPC Hongyanhe 4 PWR 1080 MW
  - 2016 China, CGNPC Hongyanhe 5 PWR 1080 MW
  - 2016 China, CGNPC Hongyanhe 6 PWR 1080 MW

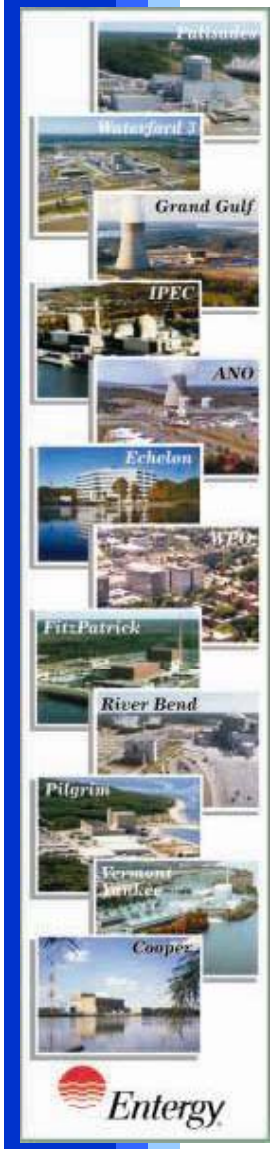
GOBI
JILIN
Microsoft MapPoint
Changchun
Ussuriysk
Siping
Jilin
RUSSIA
CHINA
HEBEI
Shenyang
Baotou
Anshan
Ch'ŏngjin
Kimch'aek
40°
Beijing
Tangshan
N. KOREA
Sea of Japan
Taiyuan
Tianjin
Tientsin
P'yŏngyang
P'och'ŏn
Yantai
SOUTH KOREA
Changzhi
Jinan
Zibo
Tottori
35°
Zhengzhou
Yellow Sea
Pusan
Ōsaka
Xi'an
Suixian
Kwangju
Cheju
Xuzhou
Kōchi
JAPAN
Nanyang
KYŪSHŪ
Huainan
Nanjing
Jingmen
Kagoshima
Wuxi
30°
Shanghai
Wuhan
Jiujiang
Hangzhou
East China Sea
PACIFIC OCEAN
Nanchang
Jingdezhen

HNP

Digital I&C Platform



- Fact - Hongyanhe will be the first plant to use MELTAC N plus R in China. Several plants will start using the DCS system in Japan. Tomari #3 should be using the system now.



History of Main Control Board

- ❑2001: Main Control Board Replacement at Genkai 1/2
- ❑2008: Digital Main Control Board employed at <u>new built</u> plant Tomari 3
- ❑2009: Digital Main Control Board replacement at <u>operating</u> plant Ikata ½

加圧水型原子力発電所向け新型中央制御盤

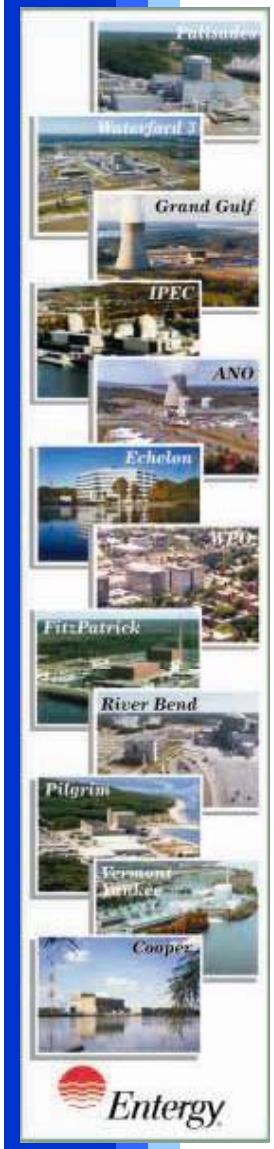
Digital Main Control Board

Tomari Unit 3 & Ikata 1/2 Digital Main Control Board

加圧水型原子力発電所向け新型中央制御盤

http://www.mitsubishielectric.co.jp/news/2006/1004.htm

17



Some issues with upgrading to a digital control board

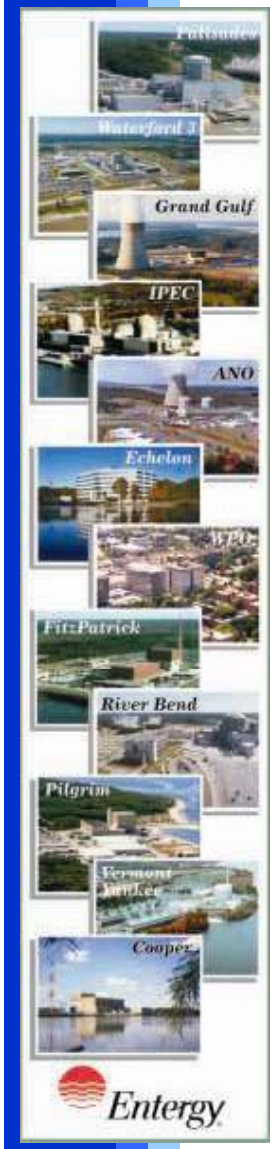
Q1:What is the most difficult part for Control Board replacement?

A1: Cable identification. We spent 5 outages for cable identification because it can't be done during operation due to safety concern.

Q2: How many years for preparation?

A2: 3 to 5 years was spent for system design before plant walkdowns and cable identification. Development of Digital Main Control Board was started late '80s in joint development project with all Japanese utilities.

18



Some issues with upgrading to a digital control board

Q3: How many stations have employed this new digital control board?

A3: Tomari Unit3 (Hokkaido EPCo) that has just started hot functional test in last month is the first unit. Ikata ½ (commercial operation started in ‘77, ’82) replacement project will be started in this march.

Q4: How will the station deal with the accelerated obsolescence cycle for the new digital equipment (some estimates that the supported lifetime of digital components is only 20% of comparable analog equipment)?

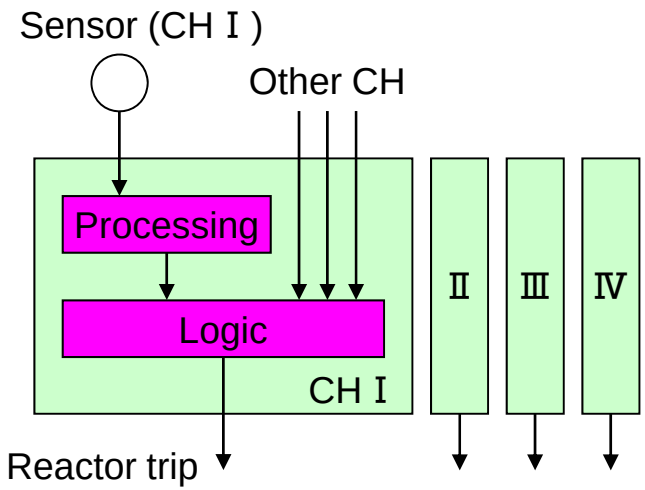
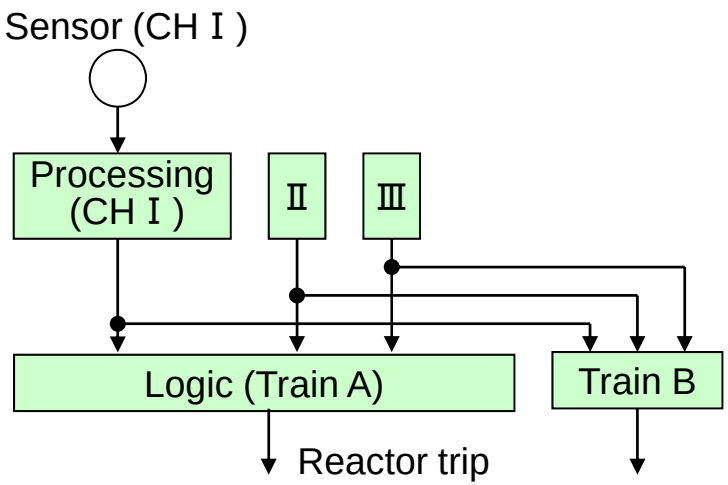
A4: The warranty period of our MELTAC (Mitsubishi Electric Total Advanced Control Platform: digital platform of reactor control protection system) is 15years. Also we support maintenance for 10 years after the warranty period.

Q5: Is simulator for new plant in US available?

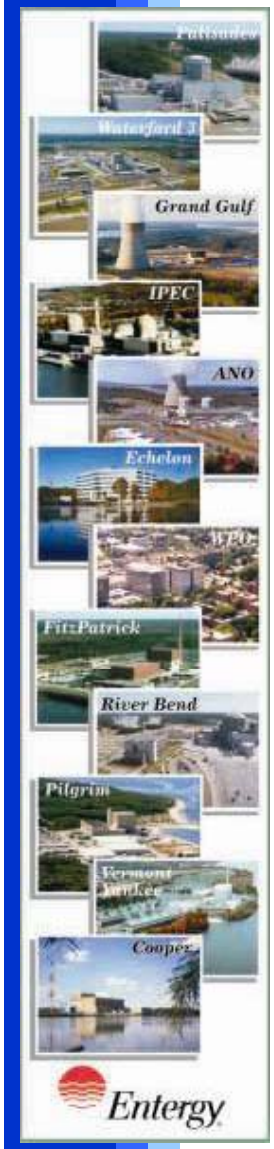
A5: Mitsubishi Electric Co. has built Digital Control Board simulator for Comanche Peak ¾ at Monroeville, PA. Mitsubishi as SPAC member is going to invite some INPO employees for demonstration.

System Architecture

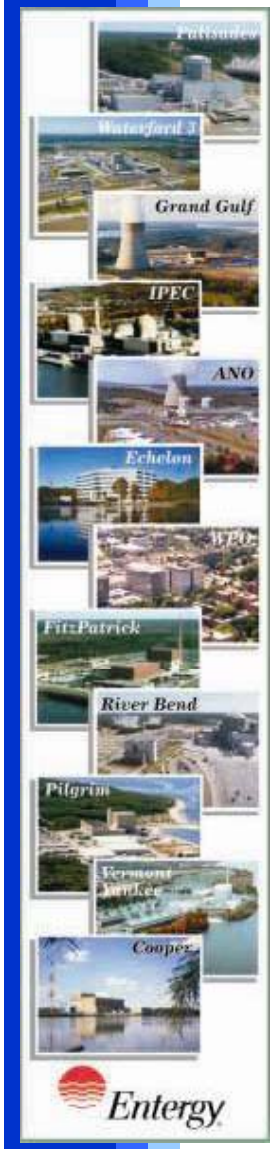
Differences between Constructing and Operating Plants

	Constructing plant	Operating plant
Redundancy	Processing: 4 channels Logic: 4 channels RT Switchgear: 4 channels	Processing: 3 channels Logic: 2 trains RT Switchgear: 2trains
Logic		
Interface	Communication	Hard-wired
Number of Cabinet	Reactor Protection Cabinet 4 cabinets / channel	Signal Processing Cabinet 2 to 4 cabinets / channel

China Techenergy Co., Ltd. (CTEC)



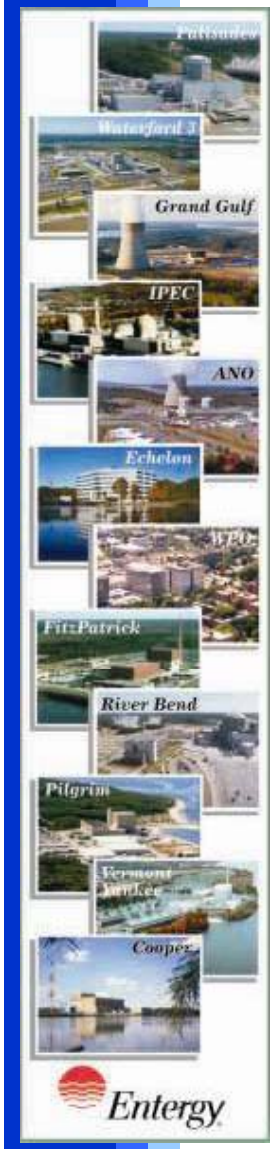
- China Techenergy Co., Ltd. (CTEC), a joint venture co-funded by China Guangdong Nuclear Power Group (CGNPC) and Beijing Hollysys Co., Ltd. (HOLLYSYS), does engineering design of digital I&C systems, system manufacturing, and technical service for nuclear power plants.



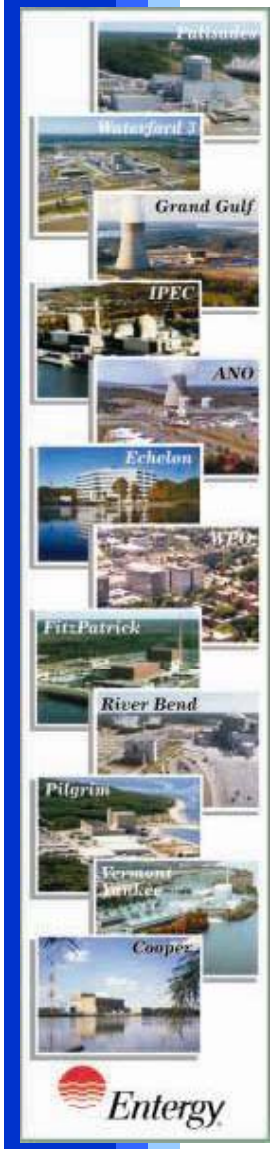
CTEC's Mission

- CTEC sees the **localization** and self-reliance in nuclear power I&C systems as its mission. Under the development strategy of professionalization, self-reliance and internationalization, it provides full-life-cycle and end-to-end digital I&C system solutions, covering sections of engineering design, product manufacturing, system integration, user-oriented R&D, technical support and service outsourcing, involving every nuclear power plant, either under construction or already in service in China.

CTEC's Examples



- Researched and developed the 1st safety grade process control digital monitoring system of CEFR (China Experimental Fast Reactor), a breakthrough which has filled in the country's gap in nuclear-safety digital safety monitoring system.
- Set up the 1st DCS prototype system for mega-kilowatt nuclear power units with its own independent intellectual properties.
- Established the 1st company standard of **digital I&C system** for nuclear power plants with its own intellectual property in China.
- Be responsible for the formulation of one national standard and two Industrial Standards.
- Be responsible for the R&D of three key sub-tasks of the National High-Tech R&D Program of China (863 Program)
- Be responsible for the establishment of the 1st Digital I&C System R&D Center for Nuclear Power Plants in China.

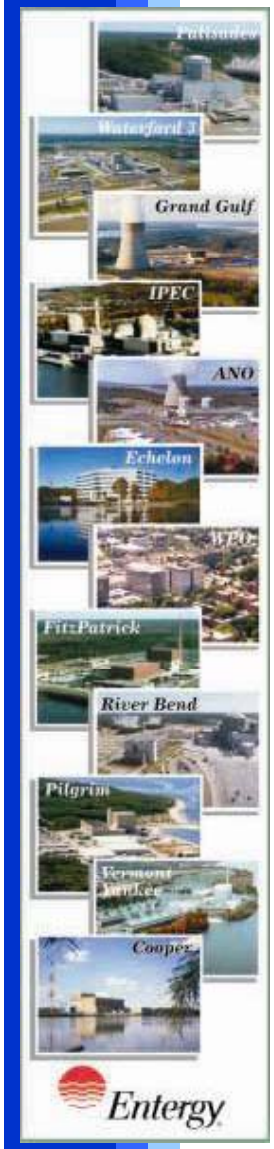


Current Reality in light of Long Range LWR Sustainability

Design Basis

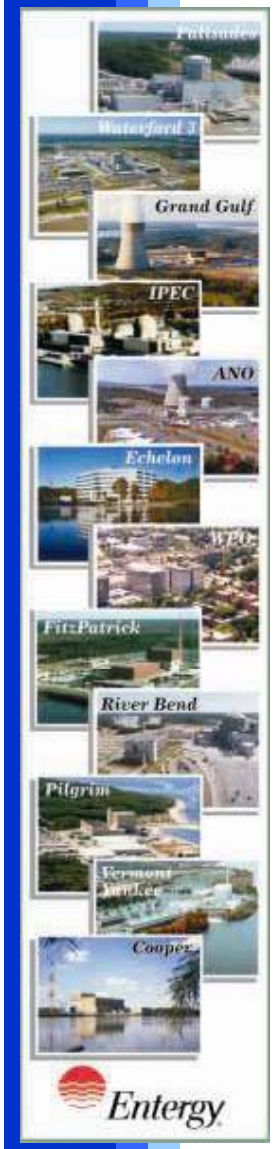
- Fact - There was not an appreciation of the need for having all of the equipment design basis in order to establish routine periodic maintenance.

Equipment Reliability



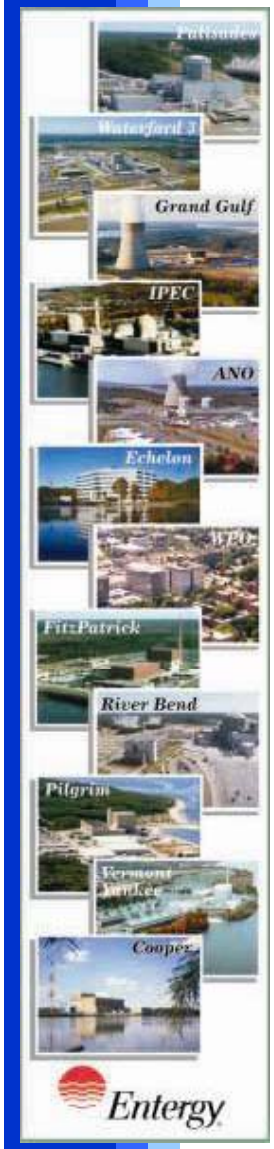
- The Design Basis Story
- The Design Basis issue at Daya Bay to bolster this impression

Training

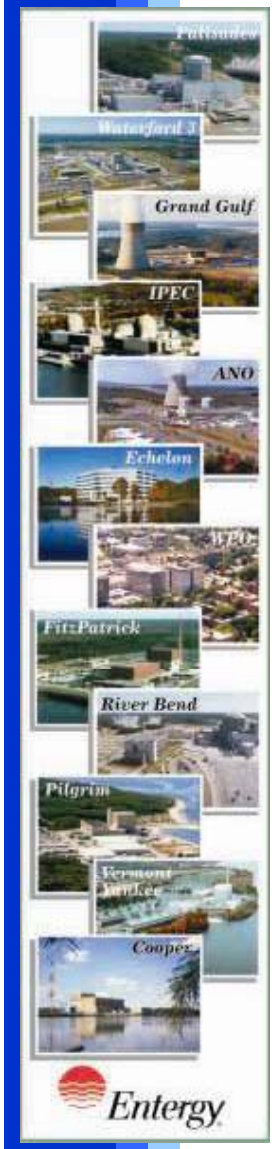


- Fact - Technicians are well educated and well trained.

Learning and Absorbing Information

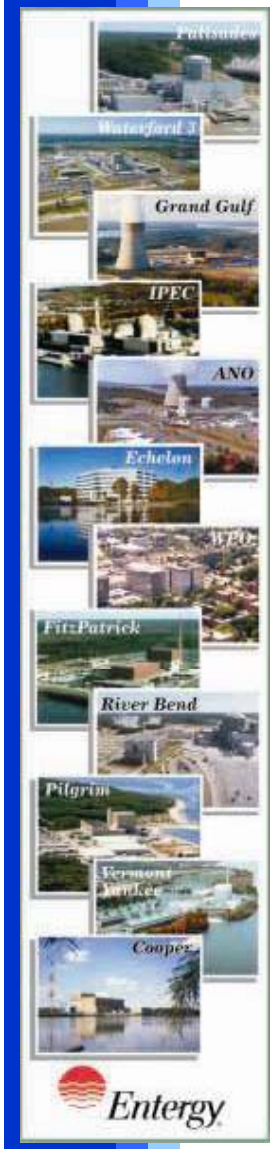


- Time at Mitsubishi - 9 months for an I&C engineer is not uncommon
- College-educated - all
- Fluent, extremely fluent, in the technical language of English



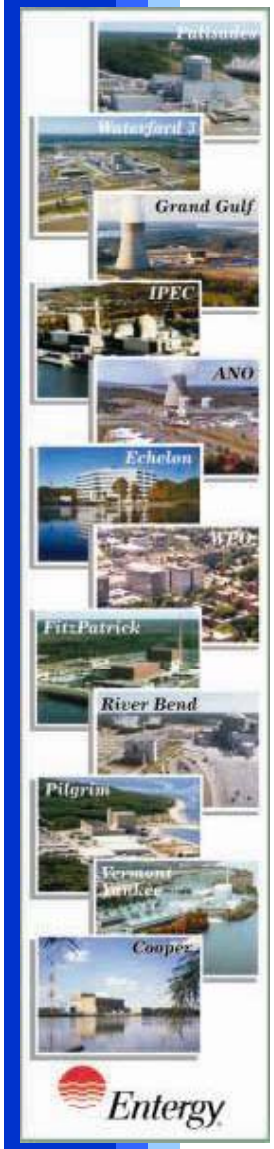
Operating Experience

- Fact - The idea of using operating experience from other plants in China, especially Daya Bay and Ling Ao II, is not appreciated as a valuable tool. Although there were technical representatives from these sites at the meeting, the idea of calling up the other plants to ask for assistance was not a common practice by the maintenance department.



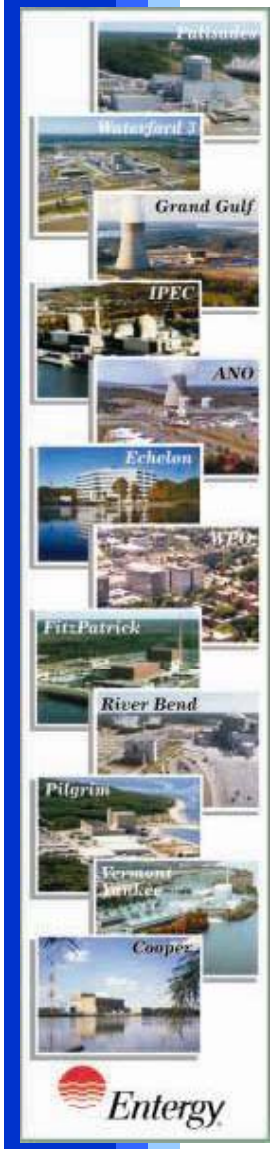
Operating Experience – Key to sustainability

- Little cross-talk between Ling Ao II and Hongyanhe personnel



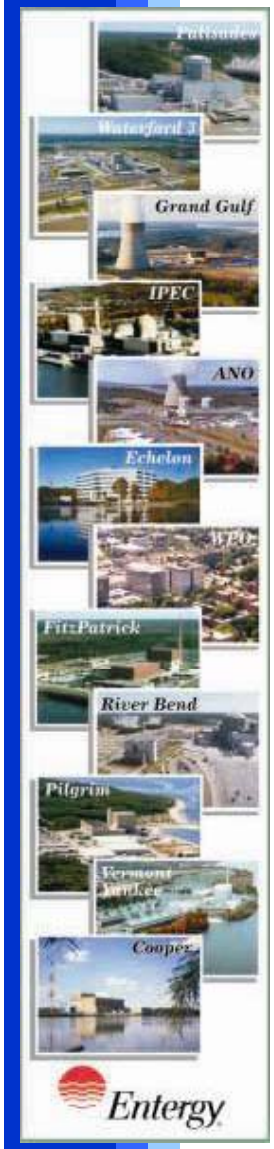
Ownership

- Fact - The need for plant personnel to perform in-depth verification and validation of the digital I&C equipment prior to operations is not appreciated.



Ownership issues

- TurnKey operations are problematic if the customer does not work along side of the vendor during the design and implementation phase



Cyber Security

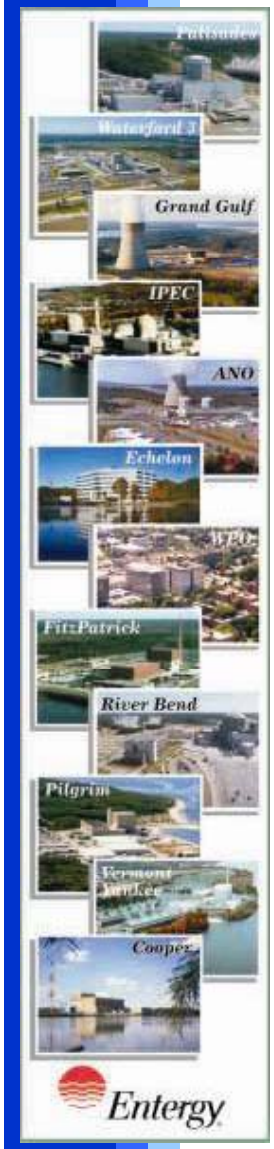
- Fact - The concept of computer security is not well understood as evidence by:

1) a lack of physical control of laptops associated with safety related testing,

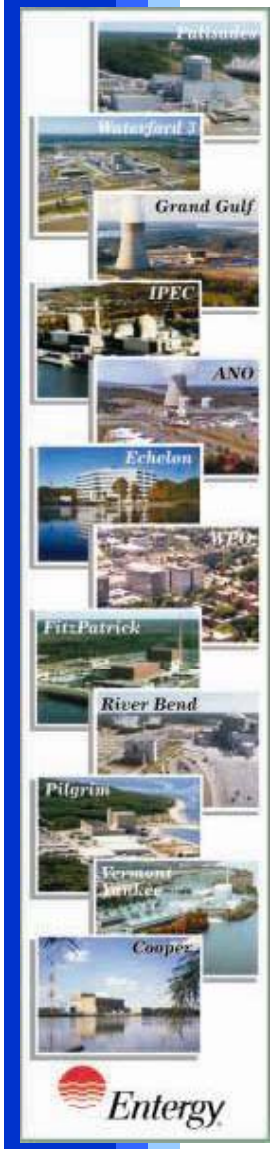
2) the minimal administrative control of access to the safety related DCS system, and

3) the ability of outside entities to enter the safety related DCS system (GPS runs their internal cpu clocks).

Software OE



- Automatic Reactor Scram in U.S. due to digital control system processor shutdown as a result of failed Inter Range Instrument Group, a time code originating from a GPS satellite



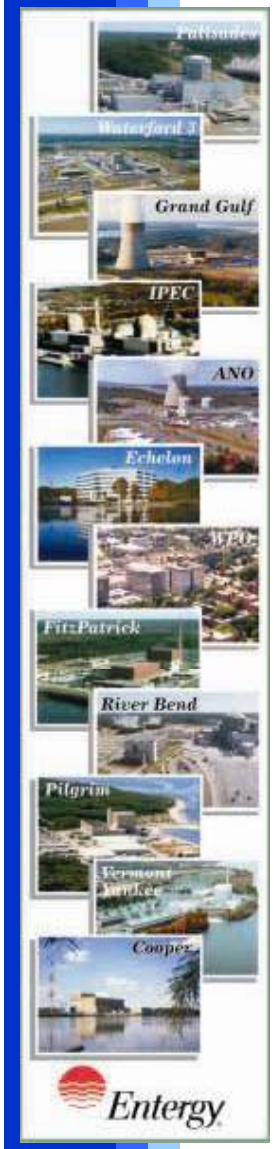
Configuration Management
Life Cycle Management

- Fact - The concept of configuration management is not appreciated (and possibly not understood) by personnel.

Spare Parts

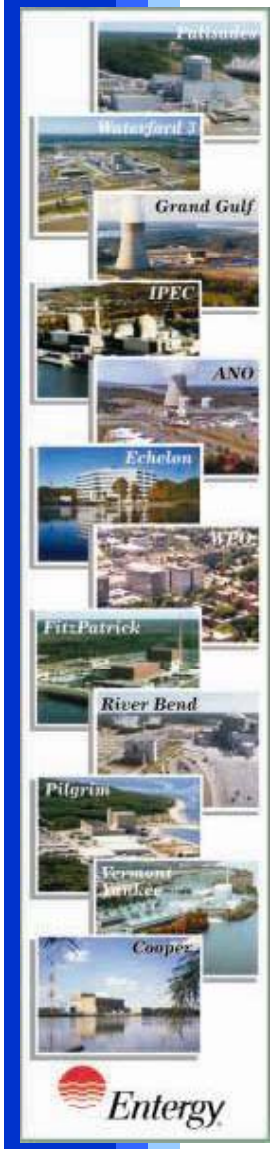
- Fact - The concept of spare parts is not mature at the department level. Technicians would like to have a spare part for each piece of equipment but realize this is too expensive. The idea of ‘critical spares’ is not understood.

Human Performance



- Although the rest of the world is far out-pacing the U.S. in the digital applications in plants, the U.S. still retains a competitive advantage because of a heavy focus on human performance.

- This concept needs to be promulgated world-wide to protect online reactors and therefore sustain the existing world's fleet.



Conclusion

- New builds are a wealth of info for sustainability efforts
- Sustainability includes keeping the reactors online with a high capacity factor as the base load