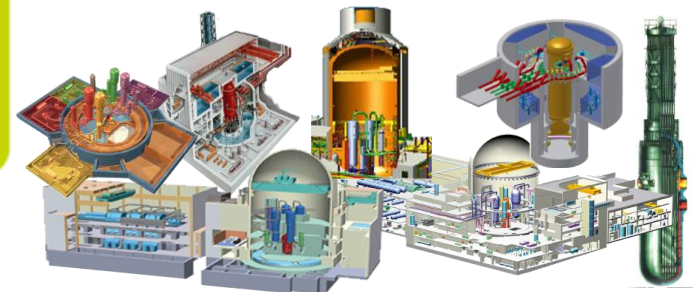


# The Critical Importance of Automation in the Control & Safety of Nuclear Power Plants life-cycle & licensing

Paul DaCruz  
Vice President Power Industries



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# Invensys Company Overview

Invensys is a global technology listed on London Stock Exchange and controls group focused on industrial automation, rail transportation and appliance controls.



## **inven.sys** Operations Management

- Annual revenue 1.147 Billion GBP
- 8897 employees serving 35,000 customers, in more than 200,000 locations across 180 countries
- Leaders in Industrial Automation, Operations Management



## **inven.sys** Rail

- Annual revenue 0.772 Billion GBP
- 4009 employees
- Multinational leaders in rail signalling and control software and systems



## **inven.sys** Controls

- Annual sales 0.567 Billion GBP
- 7404 employees
- Leaders in appliance controls electronic controls



**Sir Nigel Rudd**  
Group Chairman



**Wayne Edmunds**  
Group Chief Executive



**Sudipta Bhattacharya**  
CEO and President, IOM

**We enable 20% of the World's electricity generation  
And 36% of Nuclear electricity generation**

Logos of major global energy and utility companies include:

- Xcel Energy
- FirstEnergy
- Entergy
- BC Hydro
- VECTREN
- Bruce Power
- ELEXON
- VATTENFALL
- RWE
- EDF
- Iberdrola
- GE Energy
- JPS
- CGTEE
- Eletrobrás
- Colbún
- PETROBRAS
- Eskom
- Reliance Energy
- NTPC
- CESC
- TATA POWER
- Doosan
- CLP
- KOPEC
- PT PLN (Persero)
- Ansto
- NRG
- Austrian Energy & Environment
- Mitsubishi Heavy Industries, Ltd.
- Taiwan Power Company
- China Huaneng
- DTP
- CNNE

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# Where we are today in Nuclear

Invensys has a significant global nuclear installed base

- Foxboro (Spec 200 & I/A) & Triconex
- Growing opportunities with SimSci, Wonderware, M&I



Pacific Gas and Electric Company®



Taiwan power company



SOUTHERN CALIFORNIA  
EDISON®  
An EDISON INTERNATIONAL® Company



AECCL  
Atomic Energy of Canada Limited



FPL



GE Energy

Our solution portfolio is the most comprehensive among our competitors in this market space

- Plant Computer & Balance of Plant Control (I/A)
- NRC 1E Qualified Safety Related COTS Platform (Tricon)
- Engineering & Simulation (SimSci)
- Risk, Compliance & Cyber security Management
- Human Machine Interface (Wonderware)
- Measurement & Instrumentation (M&I)

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Foxboro

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Triconex

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SimSci-Esscor

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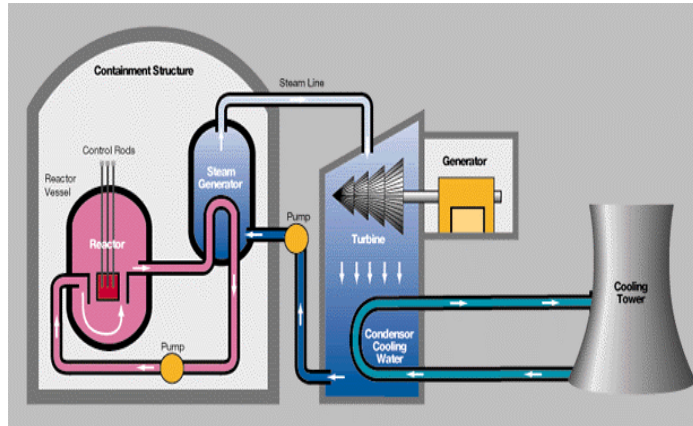


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Eurotherm

# Nuclear Plant Applications

## Pressurized Water Reactor



### Turbine Generator Control

Off-Line Speed Control  
On-Line Droop Control  
Throttle Valve Demand  
Governor Valve Positioning  
Protective Overrides  
Auto Latch and Main Breaker Logic  
Throttle-to-Governor Valve Transfer  
AVR

### Information Technology

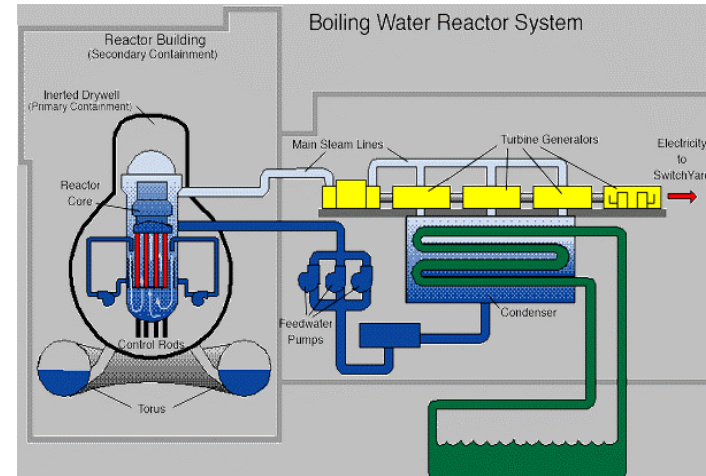
### Data Acquisition Systems

Process Computer System  
SPDS  
ERFDADS  
TSC  
Calorimetric Calculations  
SOE  
TDR/TDA  
Historian  
Trending

## Boiling Water Reactor

### NSSS & BOP Safety & Control Systems

Reactor Protection	ESFAS
Reactor Regulating	HVAC
Recirculation Control	Emergency Diesel
Feedwater Control	Auxiliary Feedwater
Steam Dump & Bypass	Steam Dump
Reactor Power Cutback	Process Computer System
Rod Control	Condensate Polishing
Rod Position	Condensate
Pressurizer Pressure	Feedwater Heater
Pressurizer Level	Main Steam Reheat
CVCS	Deaerators
Saturation Margin	Component Cooling
RVLIS	ATWS
Remote Shutdown	In-Core Monitoring



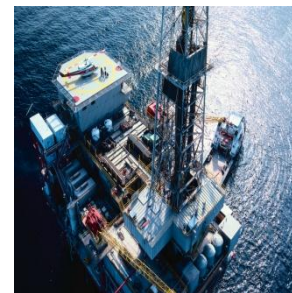
## CANDU Reactor and others ...



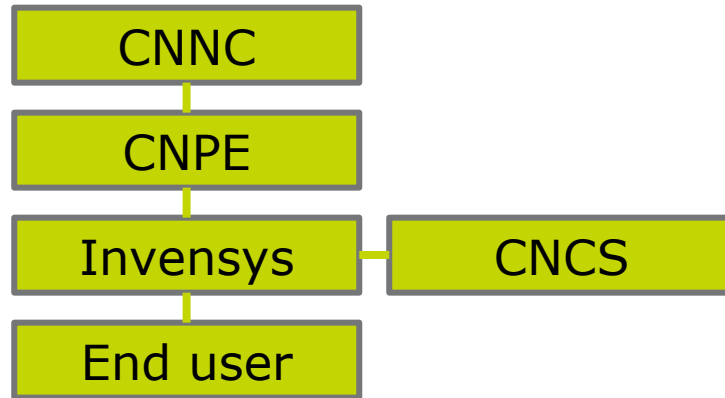
# Not Alone

Invensys products are built for many industries providing access to a large and diverse user community

- Has a large installed base throughout various industries
  - Invensys commitment to continue supply
  - No one-of-a-kind products as previously experienced in nuclear
- Over 9000 Tricon systems installed and 500,000,000 hours of safe operation in safety critical and critical process applications
- Over 15000 I/A systems installed in non-safety control
- “Proven in Use” commercial off the shelf product

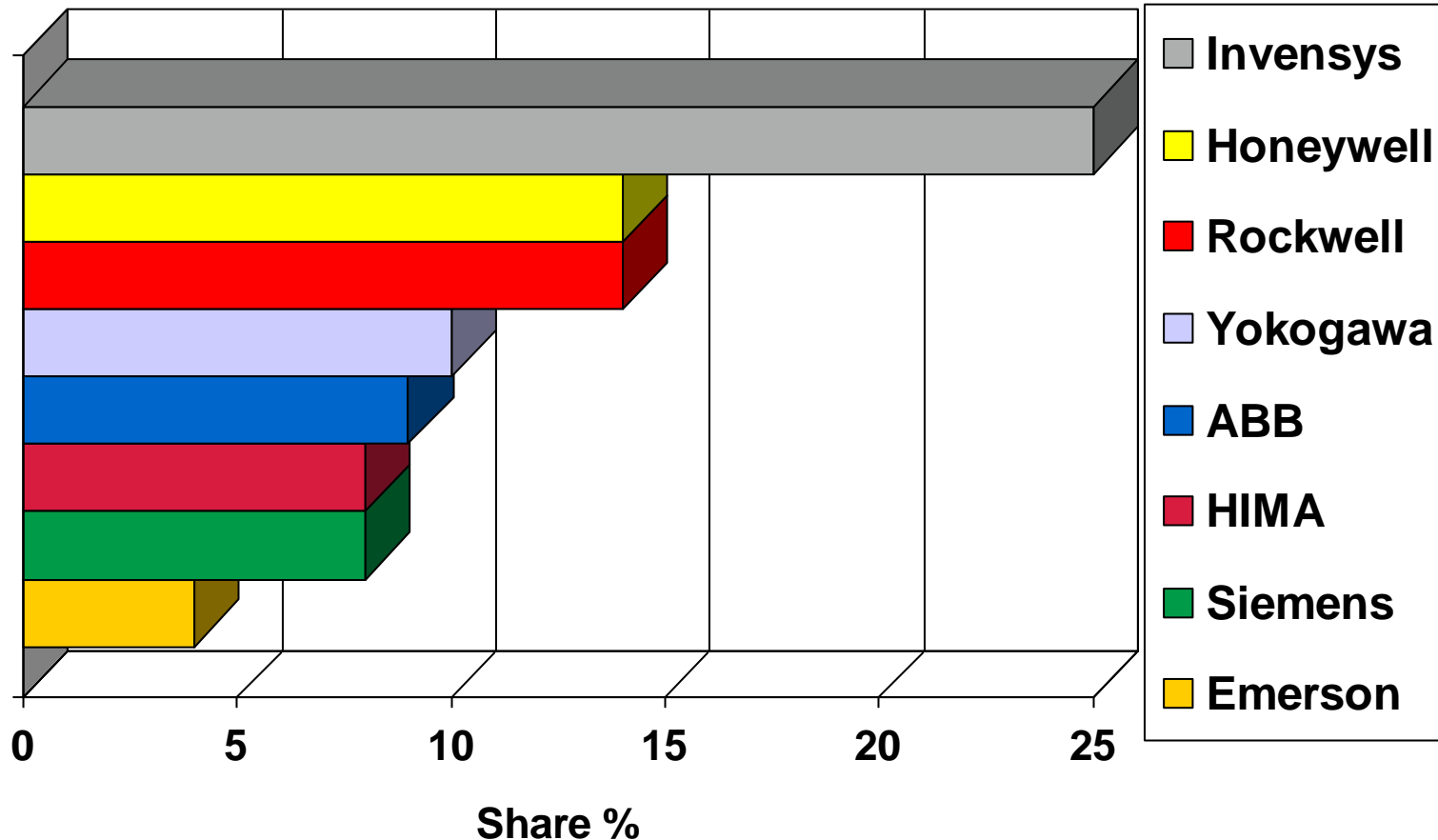


# China nuclear



- Good relationship with Chinese customers
- Recent successes with China Nuclear Power Engineering Corporation (CNPE) for the supply for safety and control systems:
  - **January 2009 – 4 reactors:** cUS\$250 million contract to automate the Fuqing 1&2 and Fangjashan 1&2 nuclear power plants
  - **May 2010 – 2 reactors:** Contract to automate the Changjiang nuclear power plant under construction on Hainan Island
  - **Feb 2011 - 2 reactors:** Contract to automate the Fuqing 3&4 nuclear power plant

# Worldwide Safety Market Share

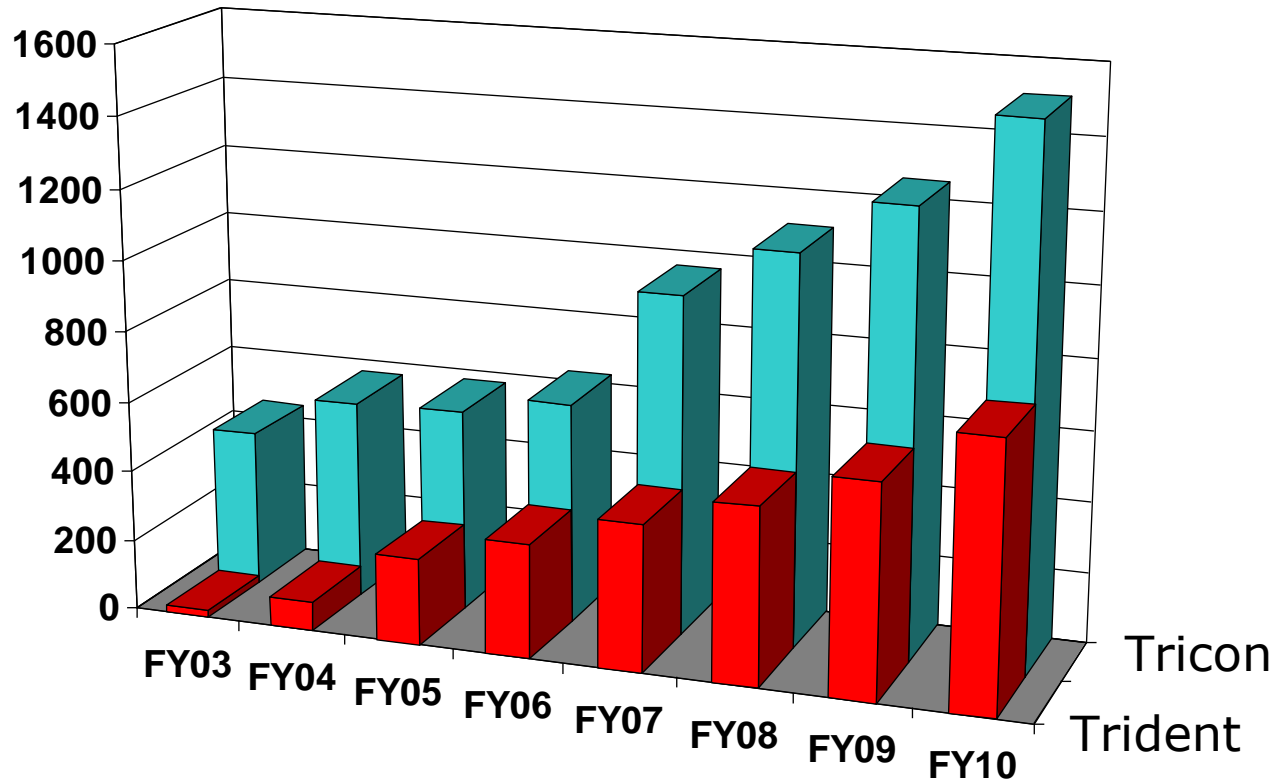


Source: ARC Safety and Critical Control Outlook 2008



# Invensys Installed Safety Systems

Current installed base is estimated in excess of 9000 systems with more than 4000 systems installed in the last 3 years



# TRICONEX, 15 years consecutive Award

## Control Magazine, 2011

*The Triconex family of products has consistently placed #1 in Control Magazine's Reader's Choice awards as the preferred controller for SIS/ESD applications since 1997.*

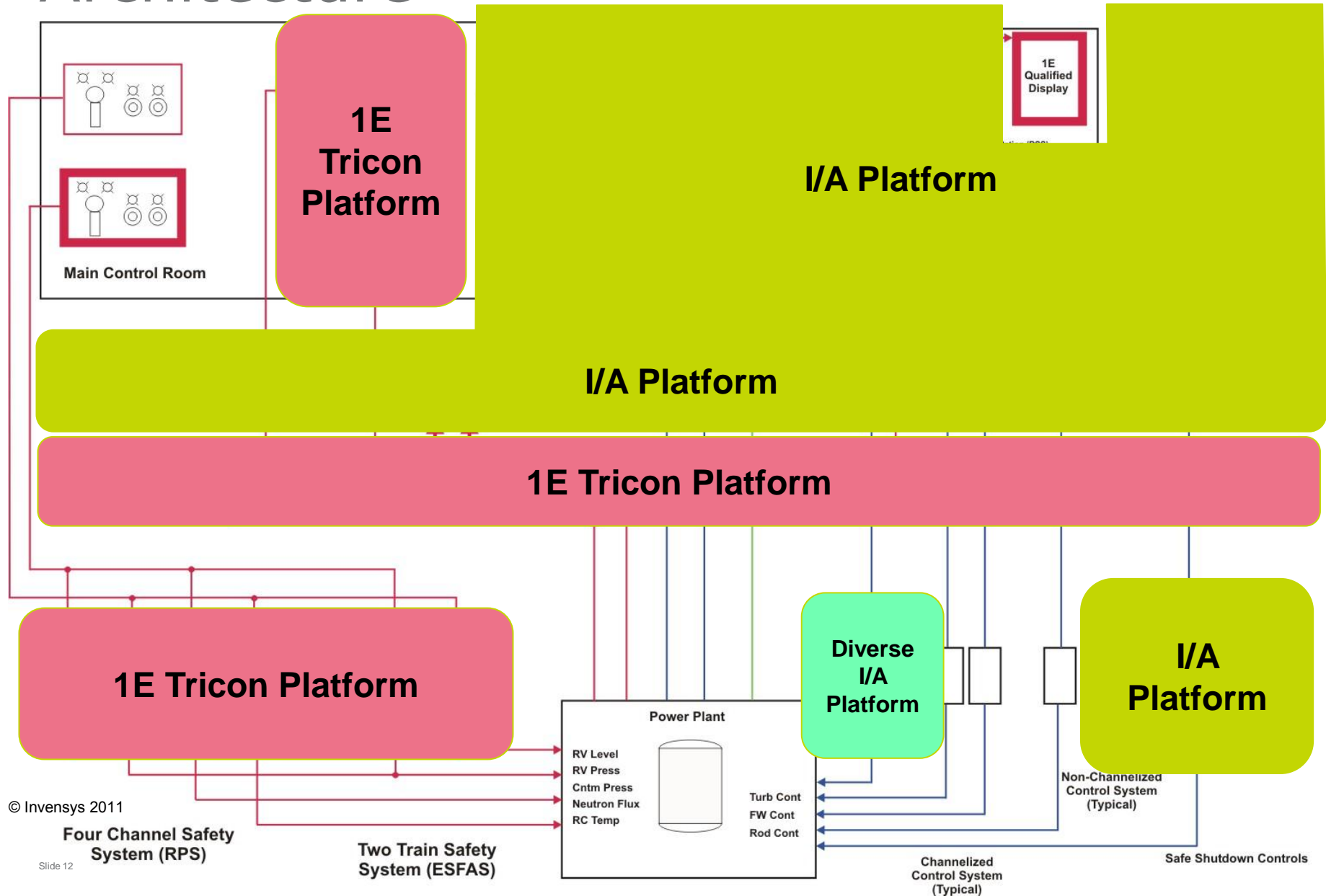


[http://iom.invensys.com/EN/Pages/IOM\\_AwardsAndHonors.aspx](http://iom.invensys.com/EN/Pages/IOM_AwardsAndHonors.aspx)

# Invensys – Upper Level Architecture Overview New Build and Retrofit



# Architecture



# Digital Controls for New Nuclear Plants

- Digital I&C has shown to improve operability and efficiencies of the plant
- Digital I&C – last to be considered in initial license phase
- Unlike analog plants, digital plants are more complex, requiring in-depth review earlier in the design
- Modern technologies need to be applied allowing reduction in operational interruptions, reduced surveillances, no calibrations, high level diagnostics & advanced testing

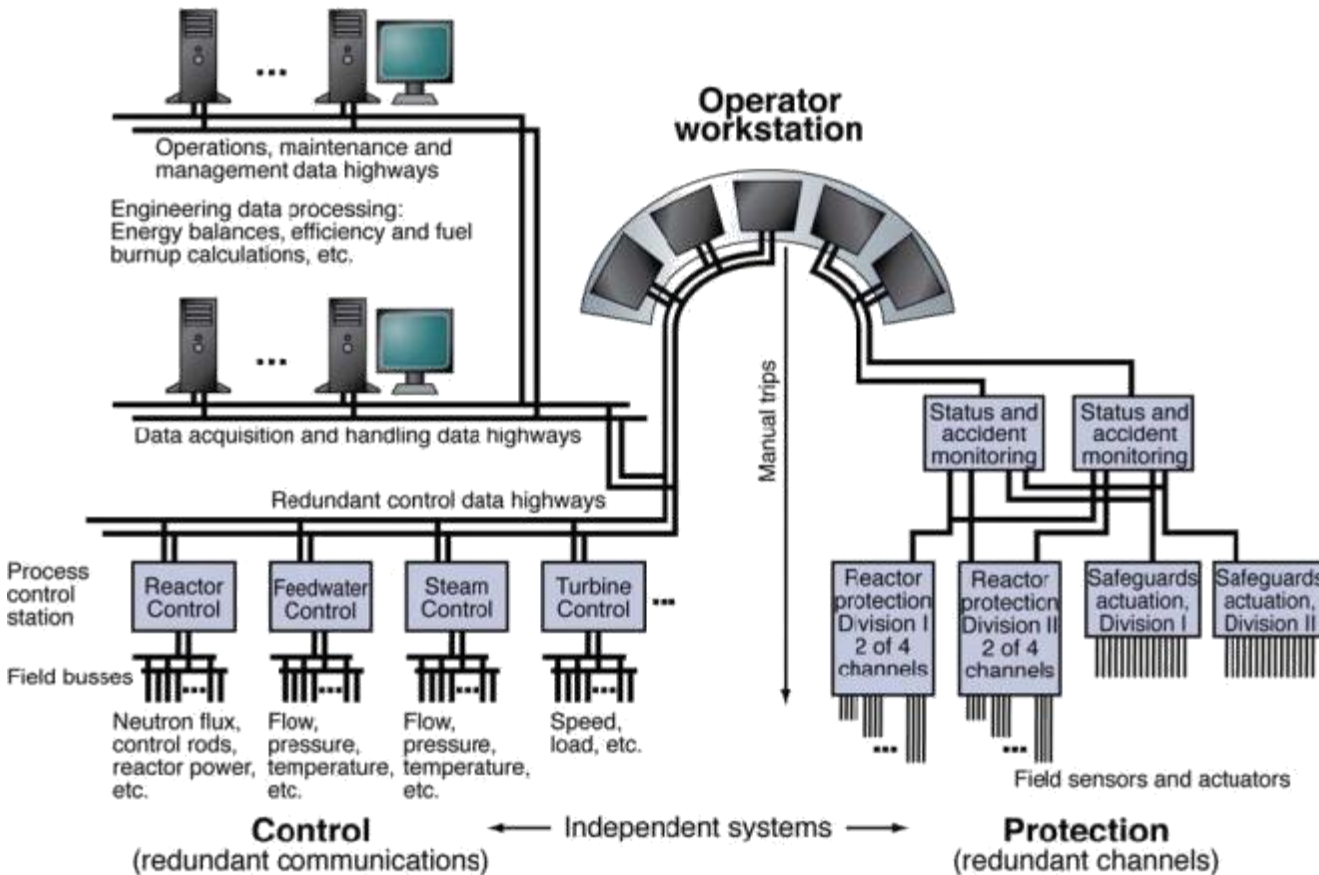


**Lungmen Control Room**



# Digital Control & Safety Increases the Effectiveness of the Plant

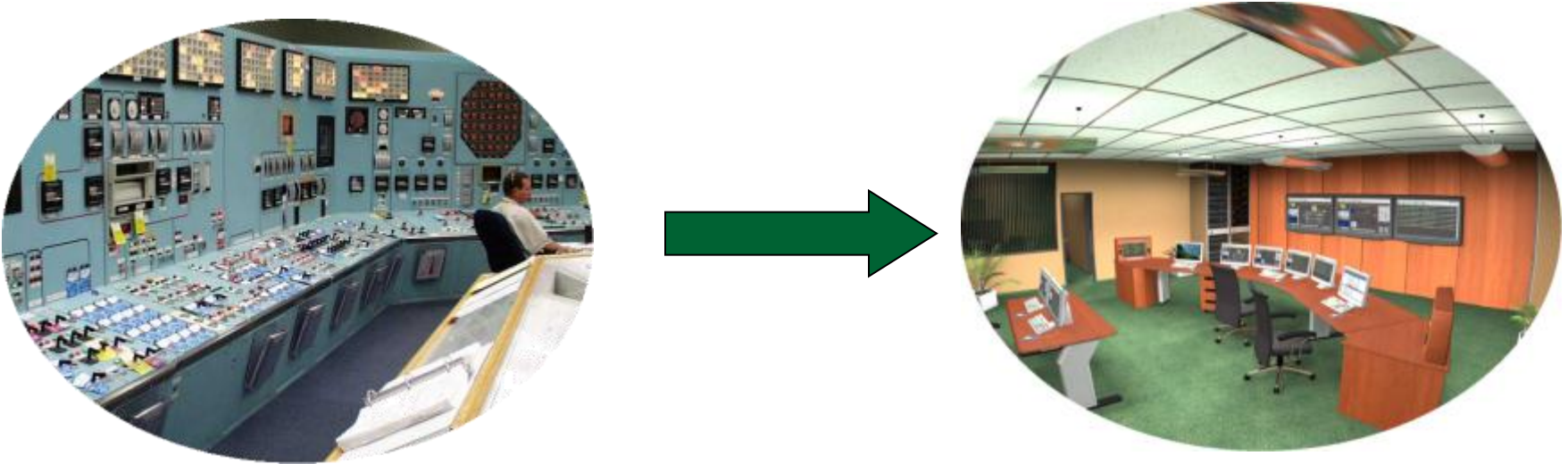
Operations, maintenance, and management data processing: Technical and business performance, maintenance and refueling plans, spare parts inventories, etc.



- All aspects of plant status are immediately available to the operator
- Improved measurement enables operation nearer to component limits (power uprates)
- Plant performance metrics are provided to corporate operations
- Component health status is provided to maintenance staff

06-GA50645-08

# Demonstration of New Technologies Remains A Significant Hurdle



- Only well proven technologies will be accepted by regulators
- Nuclear power safety requirements are more stringent than for other industries (separation of control & safety)
- Nuclear power market has been too small for vendors to develop new NPP specific product lines
- Demonstration facilities can enable adoption of advanced technologies into nuclear power arena

# Invensys in the Nuclear Industry

## Experience

- 50 years in industry
- Systems installed in 160 units incl. digital upgrades in 21 units
- Many new units under constructions
- With most kind of reactors (PWR, BWR, Candu, VVER, ...)

## Best in class automation technology

- Integrated Safety, Non-Safety & Simulation Platform
- Nuclear Safety qualified
- Recent & Proven

## Performance

- Project team experience
- International Reputation
- Long Term Support



Lungmen Control Room (Taiwan)

# Messages

- Our foreseeable future points to a hydrocarbon-based energy economy. Renewables will take long time to increase their share in energy mix.
- Nuclear energy will be increasingly important; with Russia & China leading the way. Projects will be safety-driven, rather than cost-driven and built on schedule – and, on budget – challenging, but achievable!
- Digital Control & Safety systems forms the NPP's Nervous System. It also:
  - Increases the Effectiveness of the Plant
  - Impacts Overall NPP Financial Viability
  - Has to be considered in initial license phase
  - Needs to comply new Cyber-security environment
  - Be available for Plant Life time
- Only well proven technologies will be accepted by regulators
- Czech Republic is a major Nuclear player & market. Whatever happens here will also affect the rest of the projects in the pipeline in the broader region.

# Thank You!