Capacity Building To Meet The Responsibilities Of Nuclear Power Plant Owner/Operators

A Presentation For:

IAEA Technical Meeting on the Responsibilities of Owners/Operators in New and Expanding Nuclear Power Programmes

IAEA
International Atomic Energy Agency

13 December 2016
Presentation Agenda

- Overview of Goodnight Consulting
- Responsibilities of NPP Owners/Operators
- Mechanisms To Execute Responsibilities
- Requirements Needed For Capacity Building
- Summary
Goodnight Consulting Has Conducted **Over 120 Engagements** For Global Nuclear Power Industry Clients Since 2001

Over 30 nuclear power clients in over 20 countries

Select Non-Fleet Clients

- AmerenUE
- DTE Energy
- NUCLEARNETICA
- E.ON
- Eskom
- Luminant
- Southern California Edison

Select Fleet Clients

- British Energy
- Exelon
- FENOC
- NMC
- Ontario Power Generation
- PSEG Nuclear LLC
- Wolf Creek

Select Clients

- IAEA International Atomic Energy Agency
- TerraPower
- Electric Power Research Institute
- AREVA
- Westinghouse
- Hitachi
- B&W
- GE
- KEPCO
- BLACK & VEATCH

Nearly every US nuclear operator

International nuclear operators

NSSS reactor designers

EPCs and technical firms
We Have A Consulting Team With Extensive Nuclear Power Experience, Many As Senior Executives

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<tr>
<th>Former Title(s)</th>
<th>Former Organization(s)</th>
<th>Corp Governance</th>
<th>Nuclear Operations</th>
<th>Maintenance</th>
<th>Engineering</th>
<th>Construction</th>
<th>Decommissioning</th>
<th>T&amp;D</th>
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% of Team w/Prior Experience

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Former job titles - highlights:

- Manager
- Operations
- Maintenance
- Engineering
- Support
- Director of Operations, Plant Manager
- Manager, Site VP, Plant Manager
- Director
- Maintenance
- Engineering
- Support
- Former titles - highlights:
  - Utility COO
  - Nuclear CEO
  - CNO
  - Nuclear COO
  - Site VP
  - Plant Manager
Goodnight Consulting Helps Nuclear Industry Clients Pursue The Seven Common Traits Shared By *Top Performers*

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<th>Safety</th>
<th>Management System</th>
<th>Leadership</th>
<th>Culture</th>
<th>Processes</th>
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<td>• Nuclear, personal, and industrial safety</td>
<td>• Integrates all systems and processes into one complete framework, providing the ability to work as a single unit with unified objectives</td>
<td>• Strong leaders with a strategic vision and the fortitude to see it through</td>
<td>• A single, unified culture</td>
<td>• Work processes and procedures that emphasize safety, effectiveness, and efficiency</td>
<td>• An efficient organizational model</td>
<td>• Appropriate numbers of suitably qualified and experienced personnel in the right places at the right times</td>
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*We* Assess Save Comply

You

2016 US Nuclear Power Industry Top Performers

![Graph showing 2016 US Nuclear Power Industry Top Performers](image-url)

IAEA Technical Meeting on the Responsibilities of Owners/Operators in New and Expanding Nuclear Power Programmes, Atlanta, Georgia, USA 12-16 December 2016
Goodnight Consulting Also Offers *Additional Services* That Help Our Clients Optimize Performance

**Executive FIN Team**
- Senior team will provide an assessment of your site and identify areas where we can assist
- Executive-level support available on call

**HR Services**
- Labor relations
- Change Management
- Employee Retention Programs
- HR Strategy
- Program Implementation
- Plant Shutdown
- Staffing Adjustments

**Cultural Assessments**
A detailed, quantitative assessment of your organizational culture with actionable steps to fix problems and drive improvements

**Shutdown Strategy**
- Human Resources
- Communications
- Key Employee Retention
- Employee Displacement
- Employee Re-Absorption
- Phased Staffing & Organizational Models for Shutdown
Goodnight Consulting Has Also Developed Staffing and O&M Cost Models For New NPP Reactor Designs

We have developed proprietary staffing and/or O&M models for a range of new Gen III+ and Gen IV designs:

• Areva (EPR)
• B&W (Generation mPower SMR)
• GE Hitachi (ESBWR)
• GE Hitachi (PRISM)
• KEPCO (APR1400)
• TerraPower (TWR)
• Westinghouse (AP1000)
Goodnight Consulting Developed And Presents The New Nuclear International Conference Series (NNIC)

- NNIC conferences have been organized and presented to “bring the nuclear world together”

- 2013 Abu Dhabi, UAE
  - Under the Patronage of the UAE Minister of Energy, and in Partnership with the Emirates Nuclear Energy Corporation; Included a site tour of the Barakah NPP construction site

- 2015 Dead Sea, Jordan
  - Under the Patronage of the Jordan Ministry of Energy, and in Partnership with The Jordan Atomic Energy Commission (JAEC) and The Jordan University of Science & Technology; Included a site tour of the Jordan Research & Training Reactor construction site

- 2016 Warsaw, Poland
  - Under the Patronage of the Polish Ministry of Energy, and with Polska Grupa Energetyczna (PGE) serving as the Platinum Sponsor; Included a site tour of the operational MARIA research reactor facility

NewNuclearInternational.com
Presentation Agenda

Overview of Goodnight Consulting

Responsibilities of NPP Owners/Operators

Mechanisms To Execute Responsibilities

Requirements Needed For Capacity Building

Summary
There Are Three Main Responsibilities Of NPP Owners/Operators

**Ensure Safety**
Nuclear, Environmental, Industrial, & Personnel

**Optimize Operability**
Market Demands, Baseload / Load Following

**Respond To Stakeholders**
Regulators, Grid & Customers, Private owners

**Success**
Ensuring Safety

Nuclear
Develop & implement nuclear materials protocols, physical and cyber security programs, and a nuclear safety culture

Environmental
Develop & implement an environmental protection program (Soil, Water, & Air Sampling, testing, and reporting)

Industrial
Develop & implement an industrial safety program

Personnel
Educate, train, & hold responsible individuals accountable

Safety
Optimizing Operability  
(Keeping the NPP Running *At A Reasonable Cost*)

- Meet market demands for the price of power
  - Optimize plant operability conditions
  - Ensure adequate numbers of appropriately trained and qualified personnel

- Meet market demands for the volume/frequency of power
  - Baseload / Load Following
  - Level of availability to meet demand requirements

- What will it take to operate, maintain, and provide on-going capital to meet market requirements for electricity?
  - Skilled personnel
  - Those personnel will require development = *Capacity Building*
Responding To Stakeholders

• Regulators
  ➢ Understand and implement programs to ensure regulatory compliance, including national nuclear regulations, environmental, industrial safety, and personnel safety, as well as labor-related regulations

• Grid & Customers
  ➢ Work with Grid organization to ensure grid stability in the event of plant trips or extended forced/planned outages

• Private owners
  ➢ Ensure costs do not exceed revenues so long as safety is not compromised
Presentation Agenda

Overview of Goodnight Consulting
Responsibilities of NPP Owners/Operators
Mechanisms To Execute Responsibilities
Requirements Needed For Capacity Building
Summary
Mechanisms to Execute Owner/Operator Responsibilities

- Safety focus
- Focus on "core" activities (Ops, Maint, Engr)
- Develop an Integrated Management System
- Ensure regulatory compliance (safety, operations, and financial)
- Identify info collection and reporting requirements & develop plans
- Stakeholder management programs
Presentation Agenda

Overview of Goodnight Consulting
Responsibilities of NPP Owners/Operators
Mechanisms To Execute Responsibilities
Requirements Needed For Capacity Building
Summary
Initial Issues Related To Capacity Building

- Define the national nuclear energy program
  - Uranium extraction?
  - Research reactor?
  - Medical isotope production?
  - Electric power production?
  - Spent fuel disposition?
  - Regulatory Approach?

- Define the scale of each program element
  - Uranium Extraction
    - Volume
    - Duration
    - Disposition
  - Research reactor:
    - Capacity Building/Training and development
    - Nuclear research
  - Medical Isotope production
    - Types of Isotopes
    - Quantities
    - National use and/or export
  - Electric Power Production
    - Volume (Giga/Mega Watts)
    - Location of NPP(s)?
  - Spent Fuel Disposition
    - Return to Source Country?
    - Interim Storage?
    - Long-Term Repository?
  - Regulatory Approach
    - Interim Storage?
    - Long-Term Repository?
Requirements For Capacity Building To Support NPP Operations

- Identify personnel requirements, including pipelines
- Identify current capacity-building capabilities
- Conduct gap analysis vs. requirements and develop a gap closure plan
- Develop recruiting plans
- Recruit/Hire/In-Process
- Train/Qualify/Certify
- Develop Experience
- Manage Pipelines
The IAEA Has Provided Guidance For Resource Requirements For New NPP Operating Organizations

Source: IAEA Nuclear Energy Series NG-T-3.1, "Workforce Planning For New Nuclear Power Programmes"
Average US 2-Unit Staffing Is ~ 1,200 Personnel; Average 1-Unit Staffing Is ~860 Personnel (Gen II Examples)

Total Staff and Staff/MWe Compared by NSSS Technology and Number of Reactor Units

Source: Goodnight Consulting Nuclear Plant Staffing Database; Goodnight Consulting analysis
Our Models Show Gen III/III+ and Gen IV Reactors Will Have Lower Staffing Than Gen II Plants

Each new plant staffing model is proprietary, however the range of results is portrayed to provide newcomers a perspective that new plant designs will require fewer personnel

Source: Goodnight Consulting analysis
Many Staffing Functions Have Multiple Drivers That Must Be Taken Into Consideration For New NPPs

Each staffing function may have more than one major site, plant, or organizational driver:

- Plant Design
- Site Layout
- Regulatory Requirements
- Outsourcing Options
- Ability to Centralize (in a “fleet”)

Careful labor planning can save significant costs over a plant’s lifecycle.
There Are Many Complexities Related To NPP Staffing Requirements

<table>
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<tr>
<th>Area</th>
<th>Function</th>
<th>Plant Design</th>
<th>Site Layout</th>
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</table>

Example: Modifications Engineering is impacted by all 5 drivers
Lead Times Must Be Considered
And Vary Significantly Depending On The Job Function

• Lead time requirements for Human Resources vary from a minimum of a few months to 5+ years (See IAEA Nuclear Energy Series (NG-T-3.10) Workforce Planning for New Nuclear Power Programs, 2011)

• Admin/Clerical (0-3 Months Lead Time): Basic computer software competence such as word processing, presentations, etc.

• Document Control/Records Management (0-3 Months Lead Time): Basic computer competence; understanding of document control and records management

• Quality Assurance (6 Year Lead Time): Experience in NPP design, operations, maintenance or other nuclear related activities; experience in quality assurance programs and concepts; senior reactor operator license or certification preferred for operations area; design or system engineering experience preferred for engineering area; maintenance or work control experience preferred for the maintenance area.

• Nuclear Fuels (5 Year Lead Time): Experience in engineering economics or other formal financial experience; nuclear fuel cycle and financial analysis experience.

Staffing Ramp Up For Nominal 1-Unit NPP

IAEA Technical Meeting on the Responsibilities of Owners/Operators in New and Expanding Nuclear Power Programmes, Atlanta, Georgia, USA 12-16 December 2016

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Planning To Meet HR Requirements For New Nuclear Power Programs Must Begin Early

- Many years of preparation are required before the “Right Number of the Right People” … will be … “In the Right Place at the Right Time”

- Seven key steps which must be taken include:
  - Identify detailed Human Resources requirements, based on the selected site and reactor design
  - Conduct an assessment of national capacity to develop and/or provide those resources
  - Conduct a Gap Analysis to determine what additional steps will be needed to fill any capacity shortfalls
  - Develop initial and recurring recruiting and training plans
  - Begin recruiting and training
  - Review and adjust as personnel move and/or leave
  - Ensure adequate relationships are in place for sources of future recruiting

Begin this process about 9-10 years prior to expected reactor commissioning
Develop Recruiting Plans

The Recruiting Funnel

1. **SCREEN**
   - 20x

2. **INTERVIEW**
   - 5x

3. **HIRE**
   - 1.2x

4. **TRAIN**
   - 1.1x

5. **RETAIN**
   - 1

**Recruiting, Interviewing, Hiring & Training Is Demanding**

Hiring a single new employee typically requires screening about 20 people. The average new hire typically results from screening about 20 applicants, and interviewing about 6 of those 20 applicants.

Additionally, some new hires will be lost to other opportunities or to an inability to meet screening requirements.

**INTERVIEWING**

Depending on the position to be filled, about 5 new interviews are required before the ideal new candidate is identified.

**HIRING**

Some new recruits will be lost to different opportunities, a better offer from their current employer, or inability to meet screening requirements.

**TRAINING**

Technical positions require training. Some recruits will not “make the cut.” This typically equates to about 10%, depending on the position in question.

**RETAINING**

Recruiting and retaining “the one” right person for a new job requires enduring a number of obstacles and investing the time and resources needed to succeed.
While Often Overlooked, Total Plant Staffing Is A Significant Life Cycle Cost Factor

- In the USA, typical fully burdened labor costs are ~$100,000 per person
  - Fully burdened costs include salary, bonuses, and company overheads for each employee, e.g., health care, retirement, computers, office space, etc.

- Thus, every 100 people = $10 M/year

Assuming a 60 year lifecycle for a new plant and 4.5% average inflation, 100 personnel will cost over $2.5 Billion

![Graph showing present value of 60 year labor costs. At 4% inflation, 60 year labor costs exceed $2.5 Billion. At 6% inflation, 60 year labor costs exceed $6 Billion.](image)
Key Considerations
For Recruitment Of Personnel

Attracting expatriate personnel who have worked in the nuclear sector abroad

Attracting experienced foreign personnel, either as employees (if permitted by national labour laws/regulations) or as consultants

Recruiting experienced personnel from appropriate national industries such as fossil fired power generation, process/production, oil and gas industries, who will already have many of the required competencies to work in the nuclear industry

Remember recruitment is a two-way process – allow for loss of staff to other industries/countries
Pipeline And Attrition Must Be Managed In Tandem To Ensure Continued And Optimized Operation

Over the past half-decade, Cumulative Impacts have drastically increased the need to manage and balance Attrition and Pipeline. As the industry workforce ages, and as regulatory burden increases, potential disruption from attrition increases.
## Seven Functions Require A Formalized Pipeline In Some Form

These seven functions have enough specialized training or regulatory requirements that they have a formal pipeline.

Most functions do not require a formal pipeline in order to balance attrition. There are a number of reasons for this:

- Many functions don’t require specialized training
- Some functions (e.g., Security) have integrated continuous training into their tasks, eliminating an observable pipeline
- Some functions pull their personnel from the pipeline functions, where they already have been trained. For example, planners in Maintenance/Construction Support are often experienced technicians that move into planning

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<th>Chemistry</th>
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<tbody>
<tr>
<td>Engineering – Mods</td>
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<td>Engineering – Plant</td>
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<td>Engineering – Technical</td>
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<td>Maintenance/Construction</td>
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GOODNIGHT CONSULTING
A Number of Different Methods Are Used To Train And Develop Personnel In The Pipeline Functions

**Engineering**
- Some plants use Co-Op and internship programs to train new Engineers

**HP Applied**
- Plant type, unionization, and utility policy can have significant impacts on Radiation Protection pipeline, beyond typical regulatory requirements

**Chemistry**
- Chemistry pipeline methods vary widely from plant to plant, and over time, i.e. some plants combine Chemistry and RP training, some plants have only Chemistry OJT

**Operations Support**
- In the USA, Operations training methodologies are driven by INPO and the US Nuclear Regulatory Commission
Presentation Agenda

- Overview of Goodnight Consulting
- Responsibilities of NPP Owners/Operators
- Mechanisms To Execute Responsibilities
- Requirements Needed For Capacity Building
- Summary
Summary – Supporting The Responsibilities Of NPP Owners/Operators

• There are three main requirements of NPP Owners/Operators:
  ➢ Ensure Safety
  ➢ Optimize Operability
  ➢ Respond To Stakeholders

• Mechanisms will be needed to execute those responsibilities:
  ➢ Safety focus, Focus on “core" activities (Operations, Maintenance, Engineering),
    an Integrated Management System, regulatory compliance programs, information
    management programs, and stakeholder management programs

• Identify the requirements needed for capacity building:
  ➢ Identify personnel requirements, including pipelines
  ➢ Identify current capacity-building capabilities
  ➢ Conduct gap analysis vs. requirements and develop a
    ➢ gap closure plan
  ➢ Develop recruiting plans
  ➢ Recruit/Hire/In-Process
  ➢ Train/Qualify/Certify
  ➢ Develop Experience
  ➢ Manage Pipelines
Summary – Capacity Building Has Significant Challenges, But They Can Be Overcome

- Hundreds of skilled workers with different education and training will be required; *the final staffing count is very plant-design specific*

- Lead times for some jobs at new nuclear plants can be up to 6-7 years before plant start-up, testing, and commercial operations, *but 9-10 years may be required from the creation of the Operating Organization to commissioning*

- Several different staffing approaches can be effective, efficient, and safe for nuclear power plant operations; *however there are minimum staffing levels for each job function and for total plant staffing*

- Fleets of plants operated by one centralized entity can realize economies of scale and therefore be more efficient in their application of human resources

- Different outsourcing approaches can be successfully applied, from a small percentage, up to more than half of total staffing

- Labor will be a significant part of total lifecycle costs