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Nuclear Staffing Benchmarking Analysis

A Report For:

ONTARIO POWER GENERATION

February 3, 2012

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Report Agenda – *Executive Summary*

- ***Executive Summary***
- **Objectives**
- **Approach**
- **Establishing Benchmarks**
- **Findings**
- **Appendices**

Tasking And OPG Employee Counts

- **Goodnight Consulting was tasked with:**
  - **Benchmarking OPG nuclear staffing levels against other North American nuclear operators**
  - **Identifying significant differences in staffing levels from the benchmarks**
  - **Analyzing the nature of the differences**
  - **Reviewing and commenting on the direction of the current business plan as it relates to nuclear staffing levels**

- **5,574 OPG employees were included in the study (as of July 2011) consisting of: 2,176 at Pickering, 1,352 at Darlington, and 1,858 Nuclear Support and 188 Dedicated Corporate Support**

- **2,101 OPG Employees in the following groups were excluded from benchmarking (see pgs. 14-16 for more detail)**

Group	Total FTEs
CANDU-Specific	1,031
OPG-Specific	285
Generic	732
Other	53
Total	**2101**

Contractor And Benchmark Counts

- **OPG's total contractor spend was assessed, and 382 additional FTEs were identified for a total functional staffing count of 5,956**
- **OPG's employee staffing and contractor support for the nuclear program were analyzed and adjusted to align with available benchmark data**
- **An OPG CANDU benchmark was developed totaling 5,090 FTES based on large (>800 Mwe) Pressurized Water Reactors**
- **CANDU vs. PWR differences are also addressed in derivation of OPG Nuclear Staffing to be benchmarked (see slides 14-16)**
- **OPG staffing levels were compared to the industry benchmark data on a functional and process area basis, and gaps were identified**

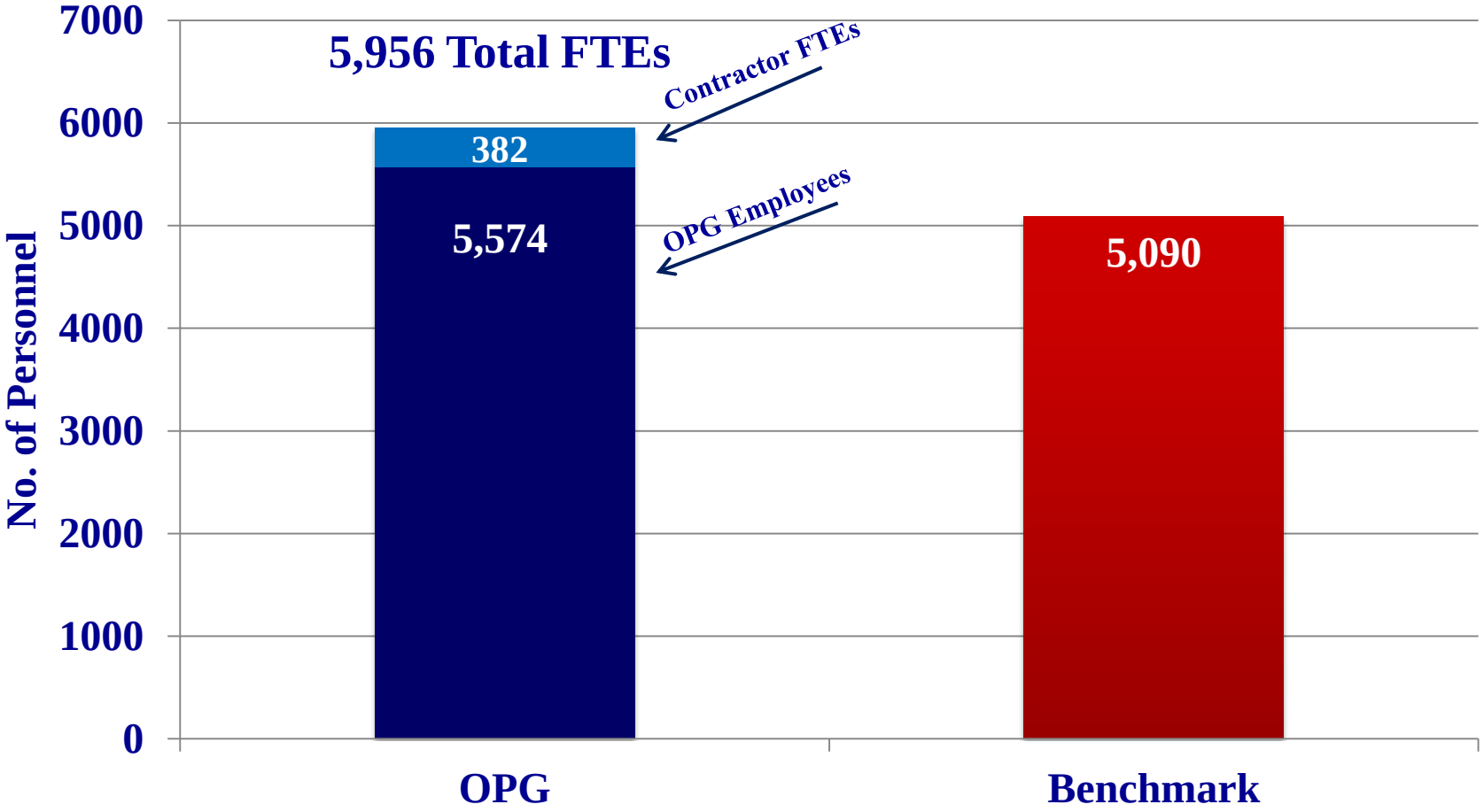
Benchmarking Summary: Total OPG Nuclear Benchmark is 5,090

- A benchmark of 965 was derived from Large 2-Unit US PWR staffing
- Adjustments were applied for:
  - Net differences in CANDU vs. PWR technologies[1]
  - OPG work week differences
  - Workload requirements for Units 2 & 3 at Pickering A[2]
- Scaling factors were applied to identify 4-Unit CANDU benchmarks
- These benchmarks include contractor FTEs and corporate nuclear support

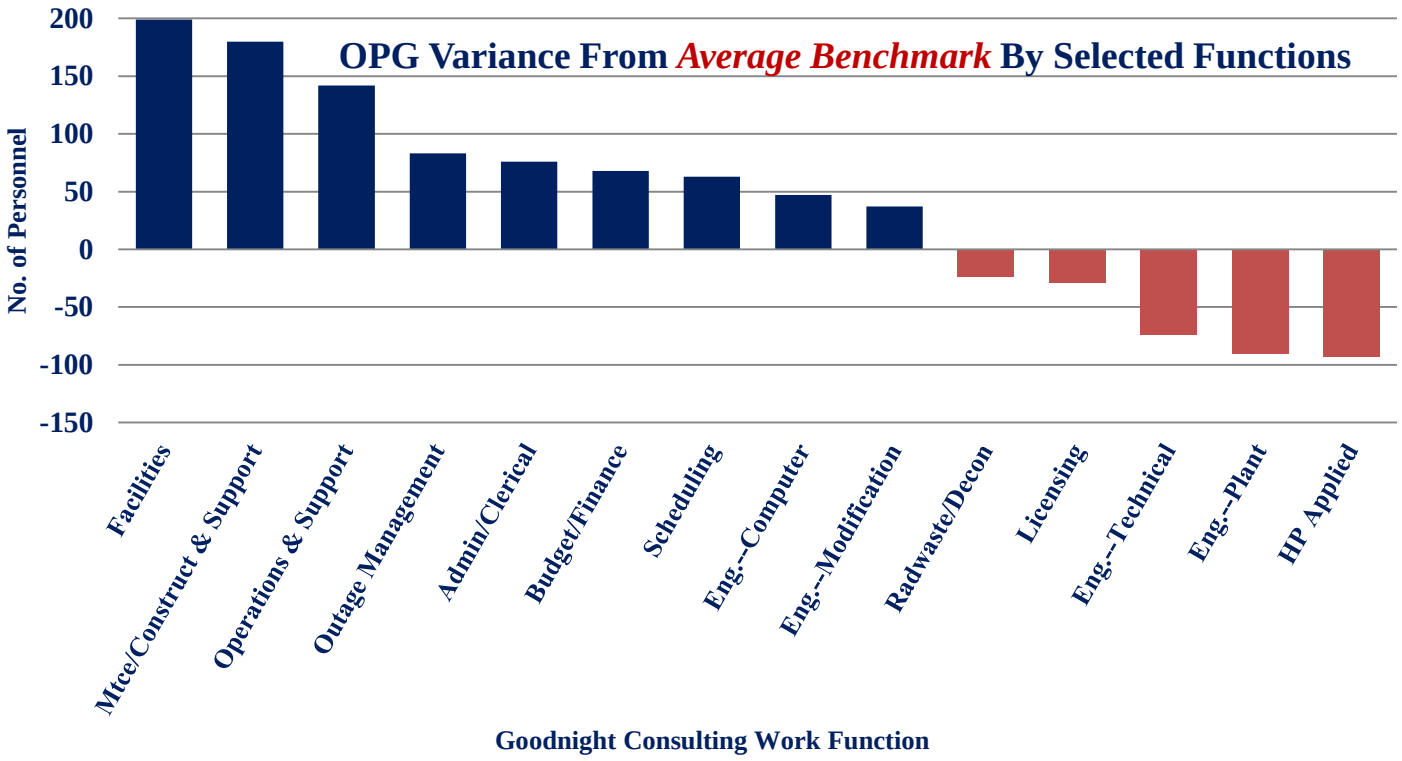
	2-Unit PWR	PA	PB	DN	Total
2-Unit U.S. PWR Benchmarks	965				
Adjustment for 2-Unit CANDU	82				
Preliminary 2-Unit CANDU Benchmark	1,047	1,047	1,047	1,047	
Adjustment for 35 Hour Week		58	58	58	
Adjustment for Pickering A Units 2 & 3		17			
Adjustment for Scaling 2 to 4-Units			879	879	
Total		1,122	1,984	1,984	5,090

[1]CANDU vs. PWR differences also addressed in derivation of OPG Nuclear Staffing to be benchmarked (see slides 14-16)
[2]Maintenance of common facilities with the two shutdown units

OPG Staffing, Including Contractor FTEs Is 866 Above the Benchmark



Total Staffing: 23 Functional Areas Are Staffed Above the *Average Benchmark*, 14 are Below



All Functions by Variance	
Maint/Construct Support	251
Facilities	199
Operations Support	189
Outage Management	83
Admin/Clerical	76
Budget/Finance	68
Scheduling	63
Contracts/Purchasing	60
Warehouse	51
Project Management	50
Eng.--Computer	47
Management	41
Eng.--Modification	39
Training	28
Human Resources	23
Materials Management	21
Eng.--Procurement	19
QC/NDE	17
Management Assist	13
Safety/Health	12
QA	7
Document Control	3
Eng.--Reactor	1
Design/Drafting	0
Communications	0
Chemistry	0
Fire Protection	-1
Environmental	-6
Nuclear Fuels	-15
Nuclear Safety Review	-17
ALARA	-19
Emergency Planning	-20
HP Support	-21
Radwaste/Decon	-24
Licensing	-29
Maintenance/Construction	-34
Operations	-47
Eng.--Technical	-76
HP Applied	-93
Eng.--Plant	-93
Grand Total	866

OPG Staffing Analysis Conclusions

- **Benchmark analysis indicates OPG exceeds benchmark by 866 FTEs**
- **OPG is generally headed in the right direction by taking action to reduce their headcount; more than half of the staffing above the benchmark will be reduced by end of 2014 based on OPG's business plan**
- **A comprehensive workforce plan will be necessary to ensure staff reductions are appropriately pursued by functional area, and to direct backfilling after attrition to the appropriate areas**

Report Agenda – *Objectives*

- **Executive Summary**
- ***Objectives***
- **Approach**
- **Establishing Benchmarks**
- **Findings**
- **Appendices**

Objectives of the Study

- **Benchmark OPG nuclear staffing levels against other North American nuclear operators**
- **Identify the source of any significant differences in staffing levels**
- **Analyze the nature of the differences**
- **By referencing the OPG 2012 business plan, analyze OPG's planned 2014 staffing levels and compare them with the benchmarks**
  - ***Note: Major project staffing, (e.g. the Darlington Refurbishment project and the Darlington New Nuclear Project) was excluded from this study***

Report Agenda – *Approach*

- **Executive Summary**
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Approach To Nuclear Staffing Benchmarking

- **Count OPG nuclear staffing supporting steady-state operations**
  - **Identify applicable OPG personnel supporting steady-state operations**
    - **Outage planning/scheduling and preparation are included, outage workforce are excluded**
  - **Exclude non-nuclear and/or non-benchmarkable OPG personnel (examples provided on slides 14-16)**
  - **Identify applicable contractors (those providing baseline support) as Full-Time Equivalents (FTEs)**
  - **Assign OPG and contractor personnel/FTEs to standardized nuclear work functions to allow for comparisons that are not driven by job or organization titles**
- **Develop staffing benchmarks reflecting steady-state operations**
  - **Identify applicable nuclear plants/nuclear organizations as the benchmarking source**
  - **Identify staffing benchmarks from functional staffing data using selected nuclear plants/organizations for comparison**
  - **Adjust for technical/design differences (i.e. PWR vs. CANDU)**
  - **Adjust for regulatory and/or work rule differences (i.e. 35 vs. 40 hour work week)**
  - **Apply adjustments and develop final functional staffing benchmarks**
  - **From functional benchmarks, identify organizational benchmarks (site vs. corporate)**
- **Compare OPG and industry benchmark staffing levels**

We Apply Several Key Assumptions In Our Staffing Benchmarking Methodology

Benchmarks Are From Steady State, On-Power Activities

Plants are considered to be in steady state operation:

- **Short-term & outage contractors *excluded***
- **Baseline contractors are *included***
- **Major initiatives (i.e. Darlington Refurbishment, PWR Steam Generator Replacement, PWR Vessel Head replacements, etc.) are *excluded***

Average Productivity Is Assumed

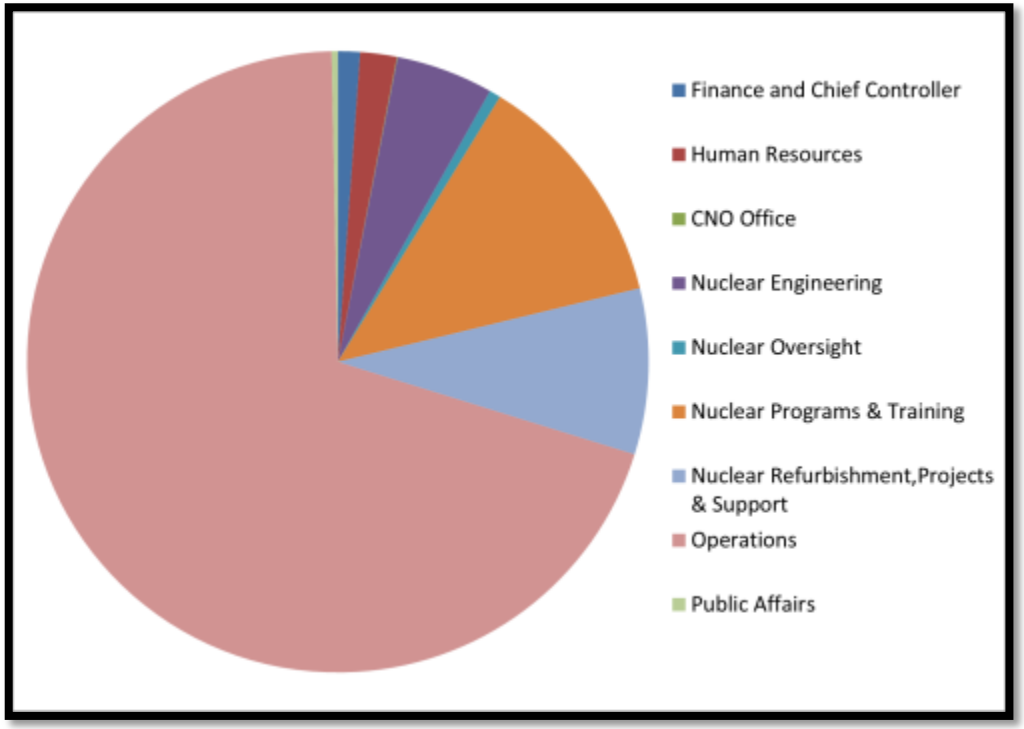
No productivity adjustments are applied to the benchmarks or OPG staffing; *however the benchmarks were adjusted for 35 vs. 40 hr work weeks where applicable*

Current Vacancies Excluded

Benchmark staffing levels do not include permanent vacancies, i.e. vacancies not expected to be filled in the next 30 days are not counted. Regular staff absences (e.g. maternity leave or long term disability leave) are not counted as "regular staff", but may be captured as non-regular staff i.e. temporary backfills

5,574 OPG Employees Were Analyzed For Benchmarking

	Employees
Finance and Chief Controller	64
Human Resources	106
CNO Office	2
Nuclear Engineering	282
Nuclear Oversight	33
Nuclear Programs & Training	694
Nuclear Refurbishment,Projects & Support	481
Operations	3,894
Public Affairs	18
Grand Total	**5,574**



CANDU-Unique, Refurbishment, New Build, & OPG-Unique Activities Were Excluded (1 of 2)

- **CANDU-Specific (i.e. unique to CANDU design) Exclusions [1,031 FTEs]:**
  - **Fuel Handling - On-line fuel handling is unique to CANDU design; comparable function in PWR reactors occurs during outages - hence excluded**
  - **Heavy Water Handling - Unique to CANDU design and has no comparable light water reactor activity**
  - **Tritium Removal Facility - Unique to CANDU design and has no comparable light water reactor activity**
  - **Feeder and Fuel Channel Support - Unique to CANDU design and has no comparable light water reactor activity**
  - **Other CANDU-Specific - support to excluded functions**
- **OPG Specific Exclusions [285 FTEs]:**
  - **Units 2 & 3 Safe Store Support - Out of Scope**
  - **Major Projects/ One time initiatives (e.g. Darlington Refurbishment, New Build, Pickering B Continued Operations) - Out of Scope**

CANDU-Unique, Refurbishment, New Build, & OPG-Unique Activities Were Excluded (2 of 2)

- **Generic Exclusions (Both CANDU & PWR activities but excluded as non baseline/non steady state) [732 FTEs]:**
  - **Nuclear waste and used fuel - These functions are not performed by the nuclear operators in the industry benchmark database**
  - **Outage execution activities - Most work is performed during outages, which are not in our benchmark data; remaining portion (less than 10%) were applied as "on-line" support to various functions (Quality Control/Non Destructive Examination and Maintenance/Construction Support)**
  - **Water treatment - These functions are not performed by the nuclear operators in the industry benchmark database**

Other Personnel Were Excluded Based On A Lack Of Comparable Benchmarks

- **Other [53 FTEs]:**
  - **Security - excluded consistent with OPG Security policy**
  - **Information Management - that provides direct support to Nuclear was also excluded as a majority of this service is provided via an outsourced contract that cannot be readily translated into an accurate number of baseline FTEs**
  - **Legal - no benchmark data is available for this function**
  - **Long Term Leave - personnel are not included in the benchmark data**

- **Total Exclusions: 1,031 + 285 + 732 + 53 = 2,101 FTEs**
  - ***NOTE: Corporate Support i.e. Treasury, Tax, etc. that are not direct support to the nuclear program are not included except for dedicated Corporate Support (e.g. "Nuclear" Finance; "Nuclear" HR that directly supports nuclear operations, etc.)***

Contractor & Overtime Data Were Reviewed And Selected Portions Were Applied

- **To accurately portray contractor FTE assignments to functional areas, relevant contractor information was analyzed:**
  - **Non-regular staff: temporary OPG staff backfilling for regular staff absences, e.g. maternity leave, or regular staff assigned to outage work**
  - **Staff augmentation contractors: professional staff providing specialized skills, including authorized training contractors or peak work support**
  - **Other purchased services: specialized contractors, such as nuclear safety analysis, and maintenance/construction trades**
  - **Outage contractors and outage overtime were excluded**
  - **Only those contractors that supported steady-state operations ("baseline contractors") were selected and assigned to applicable nuclear staffing functions**
- **OPG overtime data was also analyzed to determine if overtime was being used as a replacement for additional personnel**

Contractor Information Was Converted From Hours or Costs Into FTEs

- OPG provided (July-August 2011 YTD) contractor data in either contractor billed YTD costs, or cumulative contractor YTD hours
- Cumulative contractor billed YTD dollar values were first divided by an average hourly cost that include wages plus benefits, and then by a value to pro-rate the YTD data into annual hours
- Cumulative contractor YTD hours were also divided by the same value to prorate the YTD data into annual hours
- The YTD data was assessed to determine an appropriate annual level of baseline contractor utilization, which resulted in the establishment of 382 baseline contractor FTEs

Applicable Baseline Contractors Includes 382 FTEs

Function	DN	PA	PB	Other	Total
Admin/Clerical	0	0	0	12	12
Chemistry	1	0	0	0	1
Document Control	0	0	0	9	9
Eng. --Computer	0	0	0	2	2
Eng. --Plant	1	0	0	0	1
Eng. --Reactor	0	1	1	10	12
Eng. --Technical	0	0	0	27	27
Eng.--Modification	0	2	0	20	22
Environmental	0	0	0	2	2
Facilities	0	0	0	40	40
Fire Protection	0	0	0	1	1
HP Support	0	0	0	1	1
Maintenance/Construction	9	27	10	122	168
Maintenance/Construction Support	5	0	0	20	25
Management	0	0	0	1	1
Materials Management	0	0	0	1	1
Nuclear Fuels	0	0	0	10	10
Nuclear Safety Review	2	0	0	0	2
Project Management	0	0	0	10	10
Training	0	0	0	21	21
Warehouse	0	0	0	14	14
Total	**18**	**30**	**11**	**323**	**382**

Note: Some of these staff may be used to fill long-term vacancies

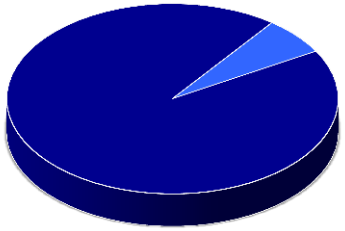
OPG Overtime Does Not Appear Unusual, And Did Not Impact Our FTE Count

- **Overtime calculations are used to determine which functions are consistently recording above average levels of overtime**
- **Typically, we have observed an average level of 5% to 6% at plants**
- **The average overtime levels for OPG are 7% in 2010, and 6% in 2011 YTD (Outage overtime was excluded), so no FTE adjustment was made**

	2010	2011
Darlington	8%	7%
Inspection & Maintenance Svcs.	5%	4%
Nuc Programs and Training	4%	2%
Nuclear Engineering	1%	1%
Nuclear Oversight	1%	1%
Nuclear Supply Chain	4%	4%
Pickering A	10%	9%
Pickering B	6%	6%
Projects & Modifications	5%	5%

OPG Nuclear Staffing of 5,956* Was Categorized Into 40 Work Functions

382 Contractors



5,574 OPG Employees

TOTAL STAFF: 5,956

CNO

- Site VP
- Engineering
- Operations
- Etc.

Functional Staff

- Operations
- Engineering - Plant
- HP Applied
- Management
- Budget/Finance
- Others . . . . .

** Security, IMS, Fuel Handling, Heavy Water, Waste Mgt., TRF, Darlington Refurb, Info Management, Legal and Non-Nuclear Corporate were excluded*

OPG Staffing Was Analyzed By 40 Functions Which Are Arranged in 7 Process Areas

Operate the Plant

- Chemistry
- Environmental
- Operations
- Operations Support

Equipment Reliability

- Engineering - Computer
- Engineering - Plant
- Engineering - Technical
- QC/NDE

Materials & Services

- Contracts/Purchasing[1]
- Materials Mgt
- Warehouse

Support Svcs & Training

- Admin/Clerical
- Budget/Finance
- Communications
- Document Control
- Facilities
- Human Resources
- *Information Mgmt (Excluded)[3]*
- Management
- Management Assist
- Training

Work Management

- ALARA
- HP Applied
- HP Support
- Maint/Construction
- Maint/Constr Support
- Outage Management
- Project Management
- Radwaste/Decon
- Scheduling

Configuration Management

- Design/Drafting
- Engineering - Mods
- Engineering - Procurement
- Engineering - Reactor
- Nuclear Fuels

Loss Prevention

- Emergency Prep
- Fire Protection
- Licensing
- Nuclear Safety Review
- QA
- Safety/Health
- *Security (Excluded)[2]*

[1] Contracts and Purchasing functions were combined due to overlap within the benchmark plant set

[2] The Security function was excluded consistent with OPG Security Policy

[3] Information Mgmt. was excluded due to OPG's inability to derive an accurate contractor FTE headcount for this function

Report Agenda – *Establishing Benchmarks*

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Our Approach Begins With Current Staffing Data From Large PWRs (Complex Designs)

NUCLEAR PLANT STAFFING BENCHMARKING

73 OPERATING UNITS

44 NUCLEAR PLANTS
28 Dual-Unit Plants
16 Single-Unit Plants

STAFFING DATA INDEPENDENT OF ORGANIZATION STRUCTURE

ELIMINATE SIGNFICANTLY DIFFERENT PLANTS

	# Units 1	2
Large > 800 MWe	X	✓
Small <=800 MWe	X	X

Apply Functional Staffing Data From U.S. Large (>800 MWe) PWRs[1]

DETERMINE BENCHMARK FUNCTIONAL STAFFING

BENCHMARK STAFFING

40 FUNCTIONS

Apply Adjustments For PWR to CANDU Design Differences

Apply Adjustments For OPG Conditions

FUNCTIONAL STAFFING

FUNCTIONAL STAFFING COMPARISON

ORG STAFFING

ORGANIZATIONAL STAFFING COMPARISON

[1]See Slide 25 for more detail

Large 2-Unit PWRs Provide The Closest Comparison to CANDUs For Benchmarking

- Goodnight Consulting's approach to benchmarking is to apply current information from plants that are the most similar in design to the client's operating plants
- CANDU plants are similar to PWRs in that there are steam generators with similar primary and secondary loops
- Larger capacity PWRS are later model designs, i.e. post TMI. These are more complex designs than either early model PWRs
- This increased complexity in design is closer to the CANDU design than smaller PWRs of an earlier vintage
- Thus, the "most similar" plants in our staffing database are large (over 800 MWe) 2-Unit PWRs
- Using these as the basis for the benchmarks, we were able to:
  - a) identify technology differences between these plants and CANDUs (which are relatively less different than small, older PWRs and all BWRs)
  - b) develop scaling factors for 2 up to 4 units to develop modeled 4-Unit CANDU staffing levels

To Determine Adjustments For CANDU Design Differences, We Reviewed Many Technical Areas

Design & Operational Consideration Areas – PWR to CANDU Benchmark Conversion

- Vacuum Building
- Gadolinium Nitrate Injection
- Liquid Zone Control System
- Health Physics / ALARA / Environmental
- Annulus Gas Systems
- Inspection and Testing
- In Service Inspection / Non-Destructive Examination
- Surveillance Testing
- Materials
- Carbon Steel Primary Heat Transport System
- Fuel Channels (Zr Alloy)
- Systems and Major Components
- 12 steam generators & 16 Main HTS Pumps/unit at Pickering
- Engineering and Maintenance Programs
- PM Program Tasks / Activities
- Mechanical Components
- Electrical Components
- Instrumentation and Controls /Computers
- Reactivity Management in Calandria design, Fuels
- Corrective / Elective / Preventive Maintenance Backlogs
- Radioactive Source Term
- Building and Support Systems Maintenance
- Canadian Nuclear Safety Commission (CNSC)
- OPG as initial point of contact for CANDU Generic Issues
- Nominal 5-year License Interval
- Supply Chain
- Demineralized Water Consumption
- Design Philosophy Differences
- Separation of Control and Safety Channels
- PWR Systems, Programs, and Issues
- Turbine Driven Auxiliary Feedwater
- Condensate Polishing
- Boric Acid Corrosion
- Etc.

Further detail provided in Appendix D

Some Functional Staffing Is Independent Of Nuclear Plant Design/Technology Type

- **Several functional staffing areas are support activities where the staffing level is a ratio of other total staff:**
  - ***Admin/Clerical***
  - ***Budget/Finance***
  - ***Human Resources***
  - ***Information Management***
  - ***Management***
  - ***Safety/Health***
- **Other functional staffing benchmarks are determined first, then the respective ratios for these functional areas are applied to identify total staffing requirements**

2-Unit CANDU Staffing Benchmark Is 1,047 Personnel (Includes Corp & Contractors)

Staffing Function	2-Unit U.S. PWR Bmk	Raw Adjustments	Benchmark Ratio %	Ratio Adjustments	Total Adjustments	Total Bmk
Admin/Clerical	37	Ratio	3.76%	3	3	40
ALARA	6	2			2	8
Budget/Finance	11	Ratio	1.12%	1	1	12
Chemistry	28	0			0	28
Communications	3	0			0	3
Contracts/Purchasing	10	0			0	10
Design/Drafting	7	1			1	8
Document Control	16	2			2	18
Emergency Planning	7	0			0	7
Engineering - Computer	5	0			0	5
Engineering - Mods	28	3			3	31
Engineering - Plant	51	8			8	59
Engineering - Procurement	7	2			2	9
Engineering - Reactor	8	2			2	10
Engineering - Technical	36	5			5	41
Environmental	5	2			2	7
Facilities	25	0			0	25
Fire Protection	23	0			0	23
HP Applied	28	3			3	31
HP Support	12	1			1	13
Human Resources	4	Ratio	0.41%	0	0	4
Licensing	9	1			1	10
Mtce/Construct	194	22			22	216
Mtce/Construct Suppt	47	4			4	51
Management	37	Ratio	3.76%	3	3	40
Management Assist	3	0			0	3
Materials Management	6	0			0	6
Nuclear Fuels	6	2			2	8
Nuclear Safety Review	11	0			0	11
Operations	126	0			0	126
Operations Support	30	0			0	30
Outage Management	8	3			3	11
Project Management	13	1			1	14
QA	14	0			0	14
QC/NDE	8	1			1	9
Radwaste/Decon	12	3			3	15
Safety/Health	5	Ratio	0.51%	0	0	5
Scheduling	17	2			2	19
Training	46	3			3	49
Warehouse	16	2			2	18
Total	**965**	**75**		**7**	**82**	**1047**

- Refer to Appendix D for additional information on the technical adjustments applied

Technical Adjustments Were Utilized To Derive The 2-Unit CANDU Staffing Benchmark

Staffing Function	2-Unit U.S. PWR Bmk	Total Bmk	Rationale
Admin/Clerical	37	40	Ratio of these functiional staff is related to the total final staffing level
ALARA	6	8	"Hotter shop" tritium, alpha radation pervasive, more opportunities for ALARA-more equipment, bigger source of radiation and more space.
Budget/Finance	11	12	Ratio of these functiional staff is related to the total final staffing level
Chemistry	28	28	No basis for adjustment
Communications	3	3	No basis for adjustment
Contracts/Purchasing	10	10	No basis for adjustment
Design/Drafting	7	8	Higher number of systems
Document Control	16	18	Higher number of systems, more control documents to manage
Emergency Planning	7	7	No basis for adjustment
Engineering - Computer	5	5	No basis for adjustment
Engineering - Mods	28	31	Higher number of systems
Engineering - Plant	51	59	Higher number of systems
Engineering - Procurement	7	9	Higher number of commercial parts dedications due to a smaller vendor market, lower availability of conforming parts
Engineering - Reactor	8	10	Adjusted to 2-unit equivalent of OPG CANDU stated requirements
Engineering - Technical	36	41	Higher number of systems, diversity instead of redundancy design philosphy
Environmental	5	7	Tritium monitoring, Canadian regulatory requirements
Facilities	25	25	No basis for adjustment
Fire Protection	23	23	No basis for adjustment
HP Applied	28	31	Additional radiation sources, differences in staffing are due to choices in program structures
HP Support	12	13	Additional radiation sources, differences in staffing are due to choices in program structures
Human Resources	4	4	Ratio of these functiional staff is related to the total final staffing level
Licensing	9	10	Different regulatory scheme, greater number of saftey systems, design philosophy of diversity over redundancy
Mtce/Construct	194	216	Higher number of systems, diversity instead of redundancy design philosphy-track IMS impacts on numbers
Mtce/Construct Suppt	47	51	Higher number of systems, diversity instead of redundancy design philosphy
Management	37	40	Ratio of these functiional staff is related to the total final staffing level
Management Assist	3	3	No basis for adjustment
Materials Management	6	6	No basis for adjustment
Nuclear Fuels	6	8	Adjusted to 2-unit equivalent of OPG CANDU stated requirements
Nuclear Safety Review	11	11	No basis for adjustment
Operations	126	126	Additional systems to monitor= increases, common systems = decreases
Operations Support	30	30	Additional systems to monitor= increases, common systems = decreases
Outage Management	8	11	Non fueling outages=decreases, more systems to deal with during an outage=increase
Project Management	13	14	Higher number of systems, diversity instead of redundancy design philosphy
QA	14	14	No basis for adjustment
QC/NDE	8	9	Due to additional maintenance work, additional QC/NDE work is required, "Innage" IMS counted here,
Radwaste/Decon	12	15	"Hotter shop" tritium, alpha radation pervasive, more opportunities for deconning-more equipment, bigger source of radiation and more space. Larger volumes of I&LLW generated and packaged.
Safety/Health	5	5	Ratio of these functiional staff is related to the total final staffing level
Scheduling	17	19	Greater number of systems resulting in more scheduling work
Training	46	49	Additional trainers required to handle additional maintenance training requirements
Warehouse	16	18	Additional parts and components needed for more systems and to overcome more materials kept on hand due to a smaller vendor base
Total	965	1047	

- Refer to Appendix D for additional information on the technical adjustments applied

2-Unit *OPG* CANDU Benchmark Is 1,105
4-Unit *OPG* CANDU Benchmark Is 1,984

2-unit to 4-unit Scaling Factors, by Functional Area								
Staffing Function	2-Unit CANDU Benchmark	35 hour week	Adjustment for 35 hour week	Scaling Factor From 2 to 4-Units	Initial 4-Unit CANDU Benchmark	Benchmark Ratio %	Ratio Staffing	4-Unit CANDU Benchmark
Admin/Clerical	40	1	46	Ratio		3.76%	68	68
ALARA	8		8	1.8	14			14
Budget/Finance	12	1	14	Ratio		1.12%	20	20
Chemistry	28		28	1.8	50			50
Communications	3		3	1.8	5			5
Contracts/Purchasing	10	1	11	1.8	20			20
Design/Drafting	8	1	9	1.8	16			16
Document Control	18	1	21	1.9	40			40
Emergency Planning	7	1	8	1.5	12			12
Engineering - Computer	5	1	6	2	12			12
Engineering - Mods	31	1	35	1.8	63			63
Engineering - Plant	59	1	67	1.8	121			121
Engineering - Procurement	9	1	10	1.8	18			18
Engineering - Reactor	10	1	11	2	22			22
Engineering - Technical	41	1	47	1.8	85			85
Environmental	7	1	8	1.8	14			14
Facilities	25		25	1.8	45			45
Fire Protection	23		23	1.8	41			41
HP Applied	31		31	1.8	56			56
HP Support	13	1	15	1.8	27			27
Human Resources	4	1	5	Ratio		0.41%	7	7
Licensing	10	1	11	1.8	20			20
Maintenance/Construction	216		216	1.8	389			389
Maintenance/Construction Suppor	51		51	1.8	92			92
Management	40	1	46	Ratio		3.76%	68	68
Management Assist	3	1	3	1.8	5			5
Materials Management	6	1	7	1.8	13			13
Nuclear Fuels	8	1	9	1.8	16			16
Nuclear Safety Review	11	1	13	1.8	23			23
Operations	126		126	2	252			252
Operations Support	30		30	2	60			60
Outage Management	11		11	1.8	20			20
Project Management	14	1	16	1.8	29			29
QA	14	1	16	1.8	29			29
QC/NDE	9		9	1.8	16			16
Radwaste/Decon	15		15	1.8	27			27
Safety/Health	5	1	6	Ratio		0.51%	9	9
Scheduling	19		19	1.8	34			34
Training	49		49	1.8	88			88
Warehouse	18	1	21	1.8	38			38
Total	1047		1105		1812			1984

- Where applicable, adjustments were made for OPG's 35 Hour Work work week vs. 40 hours at U.S. plants
- The net increase in the 2-Unit benchmarks is 58 FTEs (5.5%)
- CANDU 2-Unit was then scaled up to a 4-Unit model
- Additional scaling information is provided in Appendix D

Adjustments For Pickering Units 2 & 3 Increase The OPG 2-Unit CANDU Benchmark To 1,122

Adjustments to 2-Unit OPG CANDU for Pickering A						
Staffing Function	2-Unit CANDU Benchmark	35 hour week	Adjustment for 35 hour week	Adjustments for Units 2 & 3	Pickering A Benchmark	Rationale
Admin/Clerical	40	1	46		46	
ALARA	8		8		8	
Budget/Finance	12	1	14		14	
Chemistry	28		28		28	
Communications	3		3		3	
Contracts/Purchasing	10	1	11		11	
Design/Drafting	8	1	9		9	
Document Control	18	1	21		21	
Emergency Planning	7	1	8		8	
Engineering - Computer	5	1	6		6	
Engineering - Mods	31	1	35		35	
Engineering - Plant	59	1	67	4	71	One additional System Engineer per discipine (M, E, I&C, Civil)
Engineering - Procurement	9	1	10		10	
Engineering - Reactor	10	1	11		11	
Engineering - Technical	41	1	47		47	
Environmental	7	1	8		8	
Facilities	25		25		25	
Fire Protection	23		23		23	
HP Applied	31		31	1	32	One additional Rad Pro technican to conduct surveillances
HP Support	13	1	15		15	
Human Resources	4	1	5		5	
Licensing	10	1	11		11	
Maintenance/Construction	216		216	5	221	Estimated Additional staff (FIN-like)
Maintenance/Construction Suppor	51		51	1	52	Ratio of support to additional Maintenance/Construction
Management	40	1	46	1	47	1 Additional Management person to oversee units 2 & 3 Activities
Management Assist	3	1	3		3	
Materials Management	6	1	7		7	
Nuclear Fuels	8	1	9		9	
Nuclear Safety Review	11	1	13		13	
Operations	126		126	5	131	1 Additional Ops person per shift crew for rounds
Operations Support	30		30		30	
Outage Management	11		11		11	
Project Management	14	1	16		16	
QA	14	1	16		16	
QC/NDE	9		9		9	
Radwaste/Decon	15		15		15	
Safety/Health	5	1	6		6	
Scheduling	19		19		19	
Training	49		49		49	
Warehouse	18	1	21		21	
Total	1047		1105	17	1122	

- FTEs assigned to SAFESTORE activities at Pickering 2 & 3 were also removed from the count of OPG staff
- The SAFESTORE activities and the adjustments shown here are both applicable, thus increasing the benchmark and reducing the number of benchmarked OPG personnel

Benchmarking Summary: Total OPG Nuclear Benchmark Is 5,090

- A benchmark of 965 was derived from Large 2-Unit US PWR staffing
- Adjustments were applied for:
  - Net differences in CANDU vs. PWR technologies[1]
  - OPG work week differences
  - Workload requirements for Units 2 & 3 at Pickering A[2]
- Scaling factors were applied to identify 4-Unit CANDU benchmarks
- These benchmarks include contractor FTEs and corporate nuclear support

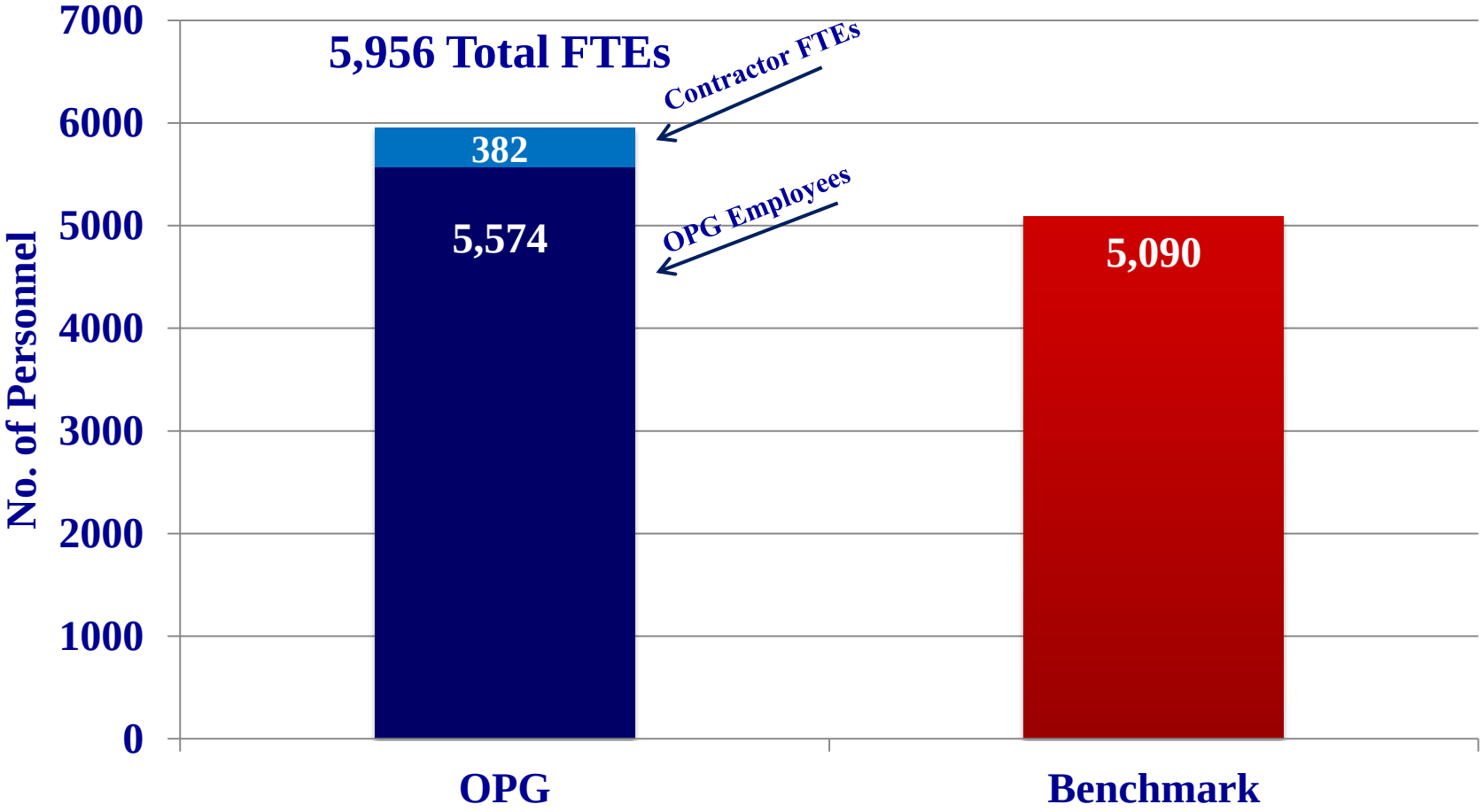
	2-Unit PWR	PA	PB	DN	Total
2-Unit U.S. PWR Benchmarks	965				
Adjustment for 2-Unit CANDU	82				
Preliminary 2-Unit CANDU Benchmark	1,047	1,047	1,047	1,047	
Adjustment for 35 Hour Week		58	58	58	
Adjustment for Pickering A Units 2 & 3		17			
Adjustment for Scaling 2 to 4-Units			879	879	
Total		1,122	1,984	1,984	5,090

[1]CANDU vs. PWR differences also addressed in derivation of OPG Nuclear Staffing to be benchmarked (see slides 14-16)
[2]Maintenance of common facilities with the two shutdown units

Report Agenda – *Findings*

- **Executive Summary**
- **Objectives**
- **Approach**
- **Establishing Benchmarks**
- **Findings**
  - ***OPG Staffing Benchmark Comparisons***
  - ***OPG Organizational Structure Benchmark Comparisons***
  - ***OPG 2012 Business Plan Review***
- **Appendices**

OPG Staffing, Including Contractor FTEs Is 866 (17%) Above the Benchmark



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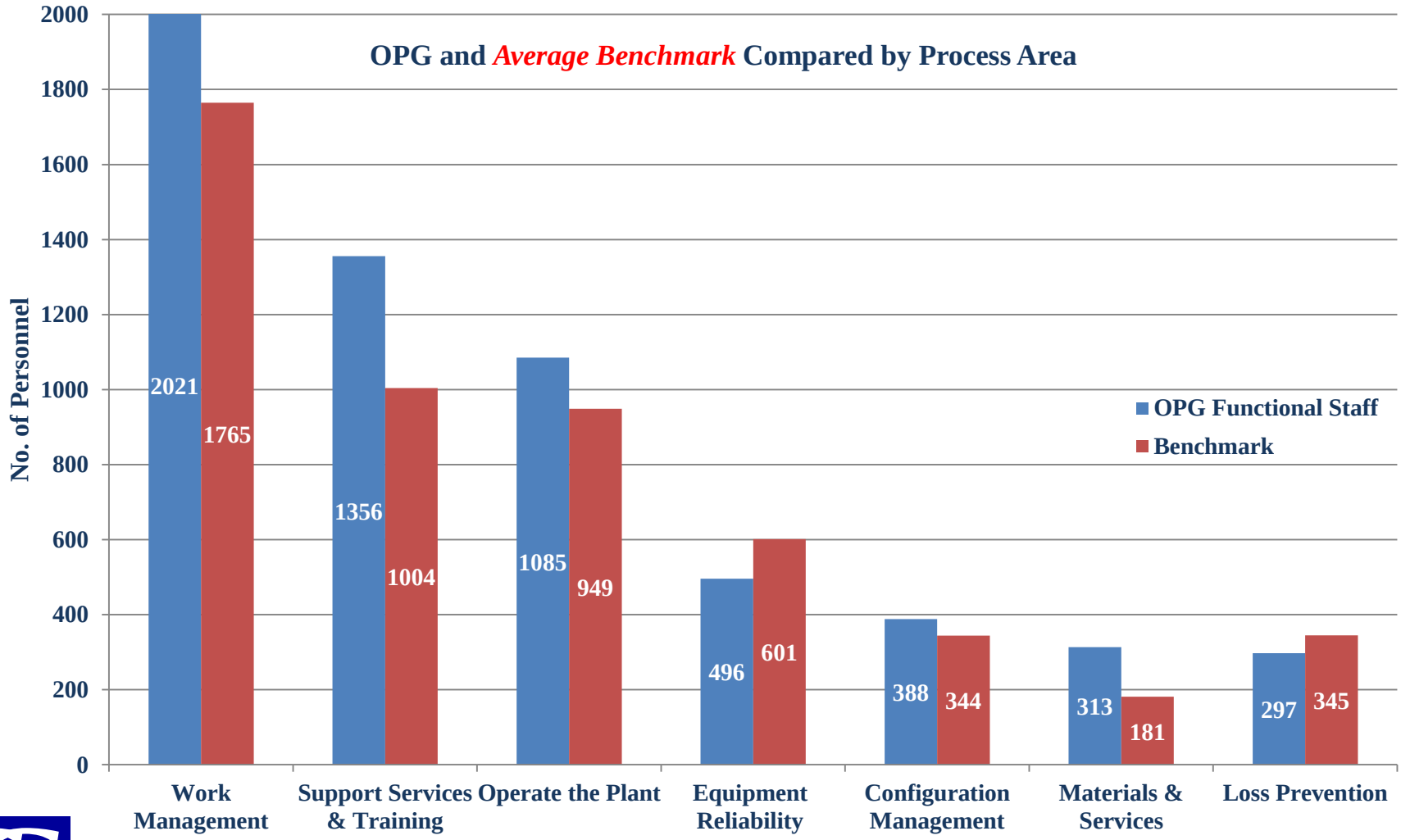
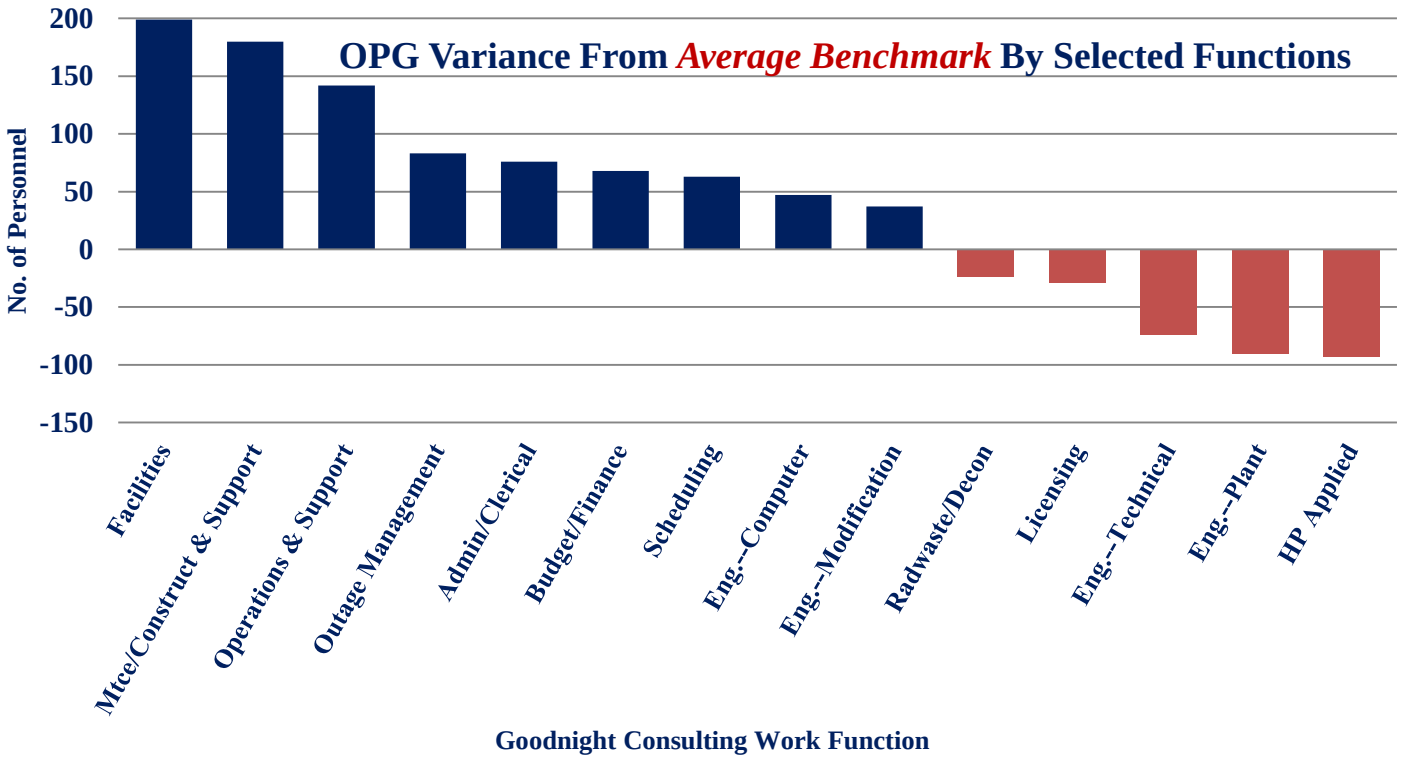
Greatest Process Area Variances Are In Work Management And Support Services/Training

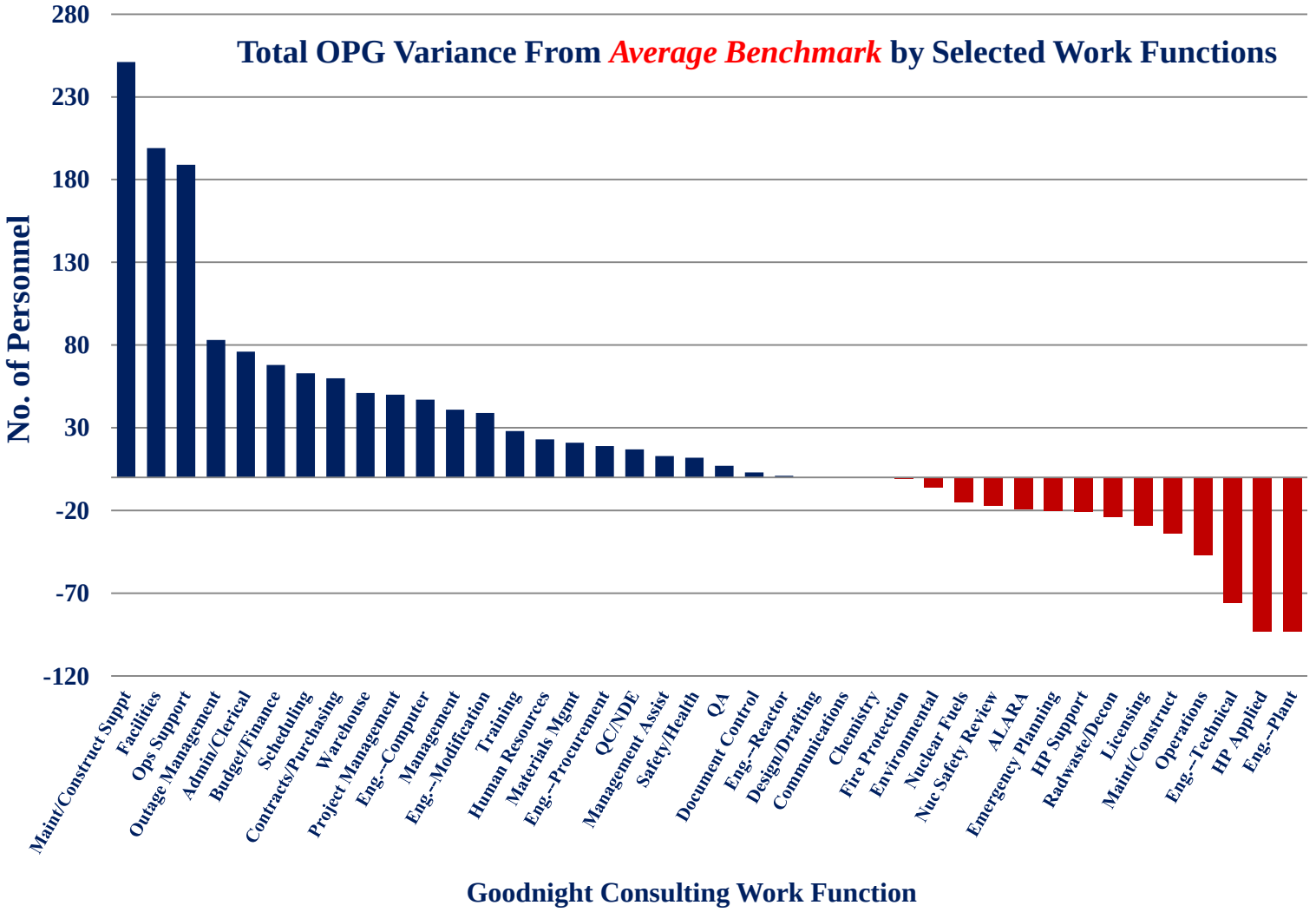


Total Staffing: 23 Functional Areas Are Staffed Above the *Average Benchmark*, 14 are Below



All Functions by Variance	
Maint/Construct Support	251
Facilities	19[illegible]
Operations Support	18[illegible]
Outage Management	83
Admin/Clerical	76
Budget/Finance	68
Scheduling	63
Contracts/Purchasing	60
Warehouse	51
Project Management	50
Eng.--Computer	47
Management	41
Eng.--Modification	39
Training	28
Human Resources	23
Materials Management	21
Eng.--Procurement	19
QC/NDE	17
Management Assist	13
Safety/Health	12
QA	7
Document Control	3
Eng.--Reactor	1
Design/Drafting	0
Communications	0
Chemistry	0
Fire Protection	-1
Environmental	-6
Nuclear Fuels	-15
Nuclear Safety Review	-17
ALARA	-19
Emergency Planning	-20
HP Support	-21
Radwaste/Decon	-24
Licensing	-29
Maintenance/Construction	-34
Operations	-47
Eng.--Technical	-76
HP Applied	-93
Eng.--Plant	-93
Grand Total	866

Total Staffing: 23 Functional Areas Are Staffed Above the *Average Benchmark*, 14 are Below



5,956 OPG Employees And Contractor FTEs Were Compared To A Benchmark Of 5,090

	OPG Employees	Baseline Contractors	Functional Staff	Benchmark	Total Variance
Mtce/Construct Suppt	462	25	487	236	251
Facilities	274	40	314	115	199
Operations Support	339	0	339	150	189
Outage Management	134	0	134	51	83
Admin/Clerical	246	12	258	182	76
Budget/Finance	122	0	122	54	68
Scheduling	150	0	150	87	63
Contracts/Purchasing	111	0	111	51	60
Warehouse	134	14	148	97	51
Project Management	114	10	124	74	50
Eng.--Computer	75	2	77	30	47
Management	223	1	224	183	41
Eng.--Modification	178	22	200	161	39
Training	232	21	253	225	28
Human Resources	42	0	42	19	23
Materials Management	53	1	54	33	21
Eng.--Procurement	65	0	65	46	19
QC/NDE	58	0	58	41	17
Management Assist	26	0	26	13	13
Safety/Health	36	0	36	24	12
QA	81	0	81	74	7
Document Control	95	9	104	101	3
Eng.--Reactor	44	12	56	55	1
Design/Drafting	41	0	41	41	0
Communications	13	0	13	13	0
Chemistry	127	1	128	128	0
Fire Protection	103	1	104	105	-1
Environmental	28	2	30	36	-6
Nuclear Fuels	16	10	26	41	-15
Nuclear Safety Review	40	2	42	59	-17
ALARA	17	0	17	36	-19
Emergency Planning	12	0	12	32	-20
HP Support	47	1	48	69	-21
Radwaste/Decon	45	0	45	69	-24
Licensing	22	0	22	51	-29
Maintenance/Construction	797	168	965	999	-34
Operations	588	0	588	635	-47
Eng.--Technical	114	27	141	217	-76
HP Applied	51	0	51	144	-93
Eng.--Plant	219	1	220	313	-93
Grand Total	5574	382	5956	5090	866

Process Areas Can Help Management Decide Where To Place Their Focus

A	B	C	D	E
	OPG Employees	Baseline Contractors	Functional Staff	Benchmark

A - Function being analyzed (e.g. operations, training, etc.)

B - Total OPG Employees performing the function

C- Baseline contractor FTEs (more than 6 months or providing recurring non-outage services)

D - Functional staff is the sum of B plus C

E - Benchmark is the average benchmark for the applicable function

- *NOTE: Where applicable, comments follow each table with function-specific observations made during on-site interviews with OPG personnel and from Goodnight Consulting nuclear industry experience. These comments are not intended to serve as recommendations to OPG as to any actions it should or should not take.*

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Total *Operate The Plant* Staffing Is Above The Average Benchmark Level

Process Area	Operate the Plant			
	OPG Employees	Baseline Contractors	Functional Staff	Benchmark
Chemistry	127	1	128	128
Environmental	28	2	30	36
Operations	588	0	588	635
Operations Support	339	0	339	150
Grand Total	1082	3	1085	949

- **Operations: The number of personnel in Operations training who graduate will reduce the current shortfall in the Operations function; however, when combined, current Operations and Operations Support aggregate staffing is 142 above the combined Operations and Operations Support benchmark level**

Total *Work Management* Staffing Is Above The Average Benchmark Level

Process Area	Work Management			
	OPG Employees	Baseline Contractors	Functional Staff	Benchmark
ALARA	17	0	17	36
HP Applied	51	0	51	144
HP Support	47	1	48	69
Maintenance/Construction	797	168	965	999
Mtce/Construct Suppt	462	25	487	236
Outage Management	134	0	134	51
Project Management	114	10	124	74
Radwaste/Decon	45	0	45	69
Scheduling	150	0	150	87
Grand Total	1817	204	2021	1765

- Maintenance/Construction: We typically observe higher levels of contractor participation in this function than currently counted at OPG-typical contractor support for this function is 25-30 FTEs per reactor; equating 250-300 at OPG.

- Without these typical levels of contractor support, OPG maintenance/construction staffing (including I&C Technicians, Electricians, Mechanics, and Construction craft) is 3.5% below the benchmark level

Total *Work Management* Staffing Is Above The Average Benchmark Level (cont.)

- **Maintenance/Construction Support: Some of the overage in the M/C Support function can be attributed to current planning activities, including the use of Legacy tools- maintenance planners spend 74% of their time planning for outages instead of in online operations due to current outage programs; M/C Support personnel also expend more time characterizing conventional waste using outdated/handheld technology: available technologies used at benchmarked plants could reduce this workload; when combined, the M/C and M/C Support functions are 180 above their combined benchmark levels**

- **Project Management: Staffing above the benchmark reflects OPG's current capital equipment replacement program, this condition is also reflected in the Modification Engineering Function**

- **HP Applied: Low staffing is offset by line personnel qualified to provide self monitoring and also, if certified, to monitor the activities of groups**

Total *Work Management* Staffing Is Above The Average Benchmark Level (cont.)

- <u>Outage Management</u>: Staffing above the benchmark reflects that Pickering A units are subject to long outages to address material conditions following their return to service and Pickering B units are subject to long outages due to enhanced life cycle management maintenance and inspections to support Pickering B Continued Operations. These long outages likely have an impact on steady state staffing levels at Pickering (i.e., system and design engineering, task planners, and supply chain) in addition to outage management staffing
- A similar condition existed in the US nuclear power industry in the past. The US nuclear industry average outage duration from 2005-2010 was 26 days per reactor per year (39.3 days per 18 month reactor cycle*) which is down from 43 days per reactor per year (65.6 days per 18 month reactor cycle) during the period 1990-2004, reflecting intensive focus on outage scope and duration in the US nuclear industry.
- By comparison, average current and near term outage duration (2009-2014) at Pickering A is 37 days per reactor per year and at Pickering B is 43 days per reactor per year. Darlington is currently operating better than the US industry at 21 days per reactor per year, reflecting the implementation of a three year outage cycle.

*Per the Nuclear Energy Institute (NEI)

Total *Equipment Reliability* Staffing Is Below The Average Benchmark Level

Process Area	Equipment Reliability			
	OPG Employees	Baseline Contractors	Functional Staff	Benchmark
Eng.--Computer	75	2	77	30
Eng.--Plant	219	1	220	313
Eng.--Technical	114	27	141	217
QC/NDE	58	0	58	41
Grand Total	466	30	496	601

- Eng.--Computer: Lack of OEM support forces OPG into development of replacements for obsolete computers, software, and programmable logic controllers: this condition helps explain the variance above the benchmark
- Eng.--Technical: Below the benchmark staffing may reflect technical analyses being performed by Modification Engineers

Total *Configuration Management* Staffing Is Above The Average Benchmark Level

Process Area	Configuration Management			
	OPG Employees	Baseline Contractors	Functional Staff	Benchmark
Design/Drafting	41	0	41	41
Eng.--Modification	178	22	200	161
Eng.--Procurement	65	0	65	46
Eng.--Reactor	44	12	56	55
Nuclear Fuels	16	10	26	41
Grand Total	344	44	388	344

- **Eng.--Modification: Staffing above the benchmark reflects OPG's current capital equipment replacement program, this condition is also reflected in the Project Management Function—it also appears that Modification Engineers are performing technical analyses typically performed by Technical Engineers**

- **Eng.--Procurement: Equipment obsolescence and OPG's capital equipment replacement program increased the workload of Procurement Engineers which helps explain the variance above the benchmark**

Total *Materials & Services* Staffing Is Above The Benchmark Levels

Process Area	Materials & Services			
	OPG Employees	Baseline Contractors	Functional Staff	Benchmark
Contracts/Purchasing	111	0	111	51
Materials Management	53	1	54	33
Warehouse	134	14	148	97
Grand Total	298	15	313	181

- Contracts/Purchasing: OPG Supply Chain processes appear significantly more complex for procurement of parts and services than those at benchmark plants; Recent initiatives are aimed at reducing complexity and becoming more efficient
- Materials Management: Obsolescence of necessary parts requires long lead time and planning cycles. For example, 25% of the parts are obsolete and can no longer be ordered to fit into the system; 5 – 10% of valves and computer boards take approximately 2 years notice to fill an order; 15% of replenishment items can be obtained after only 6 to 8 months; OPG does not utilize automated picking technology

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Total *Loss Prevention* Staffing Is Below The Average Benchmark Level

Process Area	Loss Prevention			
	OPG Employees	Baseline Contractors	Functional Staff	Benchmark
Emergency Planning	12	0	12	32
Fire Protection	103	1	104	105
Licensing	22	0	22	51
Nuclear Safety Review	40	2	42	59
QA	81	0	81	74
Safety/Health	36	0	36	24
Grand Total	294	3	297	345

- Emergency Planning: Resource requirements are often driven by the number of jurisdictions within the plant's emergency planning zone (EPZ) and the local requirements for emergency response plans required by those jurisdictions—Darlington's relative isolation helps explain the staffing below the benchmark

- Licensing: Benchmarked plants have higher staffing due to regulatory requirement differences– In the US many plant modifications require license amendment requests—the size and variety of the US nuclear fleet creates events that drives the regulator to create a broader regulatory scheme affecting all US plants

Total *Loss Prevention* Staffing Is Below The Average Benchmark Level (cont.)

- **QA: Requirements apply to most installations within the plant, not only nuclear safety, and requires more personnel**
- **Safety/Health: Conventional Safety function reports to HR only to maintain separation and independence from operating decisions. All Worker's Comp claims handled internally by Safety/Health personnel--Safety/Health also handles contractor safety management oversight and oversight of hazardous materials—MSDS, etc.**

Total *Support Services & Training* Staffing Is Above The Average Benchmark Level

Process Area	Support Services & Training			
	OPG Employees	Baseline Contractors	Functional Staff	Benchmark
Admin/Clerical	246	12	258	182
Budget/Finance	122	0	122	54
Communications	13	0	13	13
Document Control	95	9	104	101
Facilities	274	40	314	115
Human Resources	42	0	42	19
Management	223	1	224	183
Management Assist	26	0	26	13
Training	232	21	253	225
Grand Total	1273	83	1356	905

- Admin/Clerical: Higher staffing in the Management function drives higher admin staffing; Admin/clerical staff at OPG operate three separate printing shops-this activity normally does not occur at nuclear plant sites, and is also reflected in the staffing level above the benchmark

- Management Assist: OPG uses more technical specialists to support managers than we normally find

Total *Support Services & Training* Staffing Is Above The Average Benchmark Level (cont.)

- **Budget/Finance: A variety of conditions help explain the variance above the benchmark:**
  - **OPG has Budget/Finance staff centralized and in line organizations, which is different from benchmark companies**
  - **OPG has a larger number of individual contracts than the benchmarked plants, which require additional budgetary tracking**
  - **OPG nuclear staffing is 17% above the benchmarks in the aggregate, which requires additional support personnel, including Budget/Finance**
  - **OPG has more contracts, more contractor companies to manage, and contracts of a larger value to manage, also requiring more Budget/Finance personnel**
  - **Benchmarked staffing reflects mature fleet efficiencies that have applied many years of effort to centralize personnel, standardize processes, and reduce the number and variety of contracts**

- **Human Resources: HR has representatives scattered throughout the business functions; HR staff are both centralized and decentralized**

Total *Support Services & Training* Staffing Is Above The Average Benchmark Level (cont.)

- **Facilities: OPG has employees located at more than 20 different facilities (see table below) throughout the area. Benchmarked fleets typically have 1-2 non-plant sites, which increases staffing efficiency as compared to distributing over many sites. It should be noted that some of these facilities are leased, and no additional OPG facilities staff are required for those areas. The new Energy Center on the Darlington Campus will house about 450 OPG employees which will help reduce the current Facilities staffing requirement.**

700 University (Corp HQ)	Kipling Ave Toronto
777 Brock Road (Projects & Constr)	L&ILW (Bruce)
889 Brock Road (Corp Nuclear)	NPT-1480 Bailey Road Pickering
Annadale (IMS)	Nuclear Waste and Projects Pickering Town Center -Pickering
Bell Building- Oshawa	Pickering
Clements road	Pickering Training Center -Pickering
Contract Management & Security office-1600 Champlain Whitby	Radiation Safety & IMS Divers-Victoria Street Whitby
Darlington	TMB
GM Building Sub-Lease	TRF
IMS -1610 Clements Pickering	Westlyville
IMS Warehouse	Whitby Warehouse
IMS Whitby	

The Current OPG Business Plan Will Bring Staffing Within ~350 of the Benchmark by 2014

- **The OPG Business Plan is generally headed in the right direction, reducing more than half of the benchmark variance by the end of 2014**
  - **Staffing is 866 above the benchmark.**
  - **Potential reasons for staffing above the benchmarking include material condition issues at Pickering A, and life cycle management and inspection initiatives to support continued operations at Pickering B.**
  - **Planned reductions are 498 for benchmarked staff out of 625 total planned reductions (127 are in non-benchmarked areas such refurbishment, IMS, etc.). OPG claims an additional 25 planned reductions in dedicated corporate support.**
  - **Staffing above the benchmark (866) minus planned reductions (498), minus additional planned corporate support reductions (25), results in 343 positions remaining above the benchmark at the end of 2014.**
  - **Assuming these reductions occur, OPG will be 6.7% above the 2011 benchmark at the end of 2014.**

Report Agenda – *Appendices*

- **Executive Summary**
- **Objectives**
- **Approach**
- **Establishing Benchmarks**
- **Findings**
- ***Appendices***

Report Agenda – *Appendices*

- **Appendix A: OPG Staffing by OPG Business Group**
- **Appendix B: OPG Staffing by Work Function**
- **Appendix C: Staffing Benchmarks and Comparisons with OPG**
- **Appendix D: Benchmark Development Details**

Note: Appendices A, B and C are electronic data files (spreadsheets) which are provided under separate cover

Appendix D – Benchmark Development Details

Factors In Adjusting Staffing From 2-Unit PWRs To A 2-Unit CANDU (1 of 5)

Topics, Programs, and Activities	Related Function(s)	Justification	Staffing Adjustments for 2-Units
Canadian Nuclear Safety Commission (CNSC)			
OPG as IPOC for CANDU Generic Issues			
Nominal 5-year License Interval	Licensing	More frequent licensing interval compared to US increases workload, but most licensing work is driven by changes to the design basis (or proof of lack of change). Total adjustment to increase nominally 10%	1
Supply Chain	Warehouse	More parts, components, and systems in CANDU design, increases workload of warehouse. Nominal adjustment of between 10-15%, settled at 12.5%	2
Demineralized Water Consumption	N/A	No basic difference with comparable systems in PWRs	0
Design Philosophy Differences			
Separation of Control and Safety Channels	Maintenance, Plant Engineering, Technical Engineering, Mods Engineering, etc.	See notes in Mechanical, Electrical, I&C components sections above impacts are included in those sections's adjustments	0

Factors In Adjusting Staffing From 2-Unit PWRs To A 2-Unit CANDU (2 of 5)

Inspection and Testing			
ISI / NDE	N/A	Discussed above in IMS Non-Destructive Examination	0
Surveillance Testing	N/A	Discussed above in IMS Non-Destructive Examination	0
Materials			
Carbon Steel Primary Heat Transport System	N/A	No basic difference with comparable systems in PWRs	0
Fuel Channels (Zr Alloy)	N/A	Excluded as part of the Non-Benchmarked Fuel Handling activities, which exludes FH operations, maintenance, and engineering	0
Systems and Major Components			
12 steam generators & 16 Main HTS Pumps/unit @ Pickering	Maintenance, Plant Engineering, Technical Engineering, Mods Engineering, etc.	See notes in Mechanical, Electrical, I&C components sections below, impacts are included in those sections's adjustments	0

Factors In Adjusting Staffing From 2-Unit PWRs To A 2-Unit CANDU (3 of 5)

Engineering and Maintenance Programs			
PM Program Tasks / Activities	Maintenance, Plant Engineering, Technical Engineering, Mods Engineering, etc.	See notes in Mechanical, Electrical, I&C components sections below, impacts are included in those sections's adjustments	0
Mechanical Components	Maintenance/Construction, Maintenance/Construction Support, Mods Engineering, Desig/Drafting, Plant Engineering, Procurement Engineering, and Technical Engineering	Additional parts, systems, and components at CANDUs estimated to be between 10-15% higher in quantity than PWRs. Additionally, more interconnections between units in contiguous 4-unit CANDU layout than compared to most 2-unit PWRs	43
Electrical Components	Maintenance/Construction, Maintenance/Construction Support, Mods Engineering, Desig/Drafting, Plant Engineering, Procurement Engineering, and Technical Engineering		
I&C / Computers	Maintenance/Construction, Maintenance/Construction Support, Mods Engineering, Desig/Drafting, Plant Engineering, Procurement Engineering, and Technical Engineering		
Reactivity Management in Calandria design, Fuels	Reactor Engineering, Nuclear Fuels		4
Corrective / Elective / Preventive Maintenance Backlogs	Maintenance/Construction, Maintenance/Construction Support, Plant Engineering	No significant difference identified. End of life issues driving PM programs at Pickering are similar to US plants facing end of life in the next decade	0
Radioactive Source Term	N/A - Covered Under ALARA above	N/A - Covered Under ALARA above	0
Building and Support Systems	Facilities	No significant difference identified. Non-Power block building maintenance for two units appears similar	0

Factors In Adjusting Staffing From 2-Unit PWRs To A 2-Unit CANDU (4 of 5)

Canadian Nuclear Safety Commission (CNSC)			
OPG as IPOC for CANDU Generic Issues		E - Not mentioned. D - Not mentioned in my interviews.	
Nominal 5-year License Interval	Licensing	More frequental licensing interval compared to US increases workload, but most licensing work is driven by changes to the design basis (or proof of lack of change). Total adjustment to increase nominally 10%	1
Supply Chain	Warehouse	More parts, components, and systems in CANDU design, increases workload of warehouse. Nominal adjustment of between 10-15%, settled at 12.5%	2
Demineralized Water Consumption	N/A	No basic difference with comparable systems in PWRs	0
Design Philosophy Differences			
Separation of Control and Safety Channels	Maintenance, Plant Engineering, Technical Engineering, Mods Engineering, etc.	See notes in Mechanical, Electrical, I&C components sections above impacts are included in those sections's adjustments	0

Factors In Adjusting Staffing From 2-Unit PWRs To A 2-Unit CANDU (5 of 5)

PWR Systems, Programs, and Issues			
Condensate Polishing	Maintenance, Plant Engineering, Technical Engineering, Mods Engineering, etc.	See notes in Mechanical, Electrical, I&C components sections above impacts are included in those sections's adjustments	0
TDAFW	Maintenance, Plant Engineering, Technical Engineering, Mods Engineering, etc.	See notes in Mechanical, Electrical, I&C components sections above impacts are included in those sections's adjustments	0
Boric Acid Corrosion	N/A	No basic difference with comparable systems in PWRs	0
Other: Support functions driven by core line organizational activities	Document control	Increase due to larger support requirements for more mods and maintenance activities identified above	2
	Project Management	Increase due to larger support requirements for more mods and maintenance activities identified above	1
	Scheduling	Increase due to larger support requirements for more mods and maintenance activities identified above	2
	Training	Additional maintenance technical training and overall GET training due to staff increases shown in all functions	3
	Outage Management	Additional preparation required for outage scope development and refinement driven by larger number of components and systems	3
Total FTE Adjustments for 2-Units from PWR to CANDU			75

Factors In Scaling From 2-Units to 4-Units

- To scale up 2-Units to 4-Units, we examined current functional staffing at 1-Unit, 2-Unit, and 3-Unit U.S. reactors
- We expected to identify functionally-based scaling factors going from 1 to 2, and from 2 to 3 units, that could be applicable; the analysis results showed inconsistent relationships for individual functions, including some cases where staffing levels were lower at a 2-Unit plant for the same function at a 1-Unit plant (this is an example of a "less efficient" Stand-Alone plant with no fleet economies of scale compared to a "very efficient" 2-Unit fleet plant that had optimized through centralization and standardization)
- These analysis results were too inconsistent to apply to scaling
- As a consulting team, which included experienced nuclear plant engineers and operators, we developed the scaling factors based on our experience and best estimates – for most functions, we applied a scaling factor of 1.8 times the 2-unit level for a 4-unit plant, which was based on staffing levels we have observed at several international 4-unit sites relative to our benchmark 2-unit sites
- Several exceptions from the 1.8x scaling factor were applied, and are shown in the body of this report (Operations, for example, requires fully staffed shift crews for each reactor or 2-unit set of reactors from our international observations)