Q. Further to the response to PUB-NLH-041, provide the name of the external resource completing each investigation or review that is referred to, the scope or terms of reference for each review and the anticipated date of completion of each.

A. The information requested is provided below for each of the investigation activities identified in PUB-NLH-041 that involve the engagement of external resources.

Transmission/Terminal Station Failures

A Terminal Stations Equipment Failures Root Cause Analysis Team (TSEF.RCAT) has been formed to review the root cause(s) of the various failures identified in PUB-NLH-041. Specifically, these include the following:

1. B1L17 breaker failure in Holyrood;
2. T1 transformer failure in Sunnyside;
3. 230 kV bus lockout in Sunnyside; and
4. T5 transformer lockout at Western Avalon.

The purpose of this team is to determine why each piece of equipment malfunctioned over the period January 4 and 5, 2014, and their specific objectives are to: a) analyze and document the root causes, and b) identify the corrective actions required to reduce the likelihood of recurrence. The team expects to complete all four reports by the end of February.

The TSEF.RCAT includes internal resources from both Transmission and Rural Operations (TRO) and Project Execution and Technical Services (PETS); OEM

representatives from ABB; and an external TapRoot causal analysis expert. The TSEF.RCAT team members are as follows:

Perry Taylor	Co-Team Lead/Electrical Investigator (Electrical Design Engineer, PETS)
Brian Tink	Co-Team Lead/TapRoot facilitator (External Consultant)
Brad Eddy	TapRoot Coach (Equipment Engineer, Long-Term Asset Planning, TRO)
Ryan Steele	Protection and Control Investigator (P&C Supervisor, TRO)
Ed teNyenhuis	OEM Technical Representative, Transformers (ABB)
Scott Morris	OEM Technical Representative, Circuit Breakers (ABB)[1]

Mr. Brian Scott, an electrical engineer with AMEC, has also been engaged by Hydro to assist with the sequence of events overview from a transmission perspective, and to support the root cause work being done by the TSEF.RCAT. Mr. Scott's background includes extensive experience with both New Brunswick Power and Nova Scotia Power in both transmission and power systems engineering. Copies of resumés are attached for Brian Scott as PUB-NLH-075 Attachment 1, and for Brian Tink as PUB-NLH-075 Attachment 2.

<u>Thermal Generation Operations and Asset Management</u>

Mr. Blair Seckington, Director of Power Technology Consulting with AMEC, has been engaged by Hydro to provide independent, expert oversight to Hydro in relation to Hydro's review of its thermal generation operations and asset management and maintenance practices. Prior to joining AMEC in 2007, Mr. Seckington worked in

[1] Resumes for Ed teNyenhuis and Scott Morris are not currently available.

various senior capacities with both Ontario Power Generation and Ontario Hydro, predominantly in electricity production. Mr. Seckington is a recognized authority in the design; operation; economic and environmental performance; life extension; and condition assessment of electricity generation assets, and his credentials and background related to hydroelectric and alternative generation programs are extensive. Mr. Seckington's engagement will likely span the duration of Hydro's internal review and conclude in the mid-March time frame. A copy of Mr. Seckington's resumé is attached to this response as PUB-NLH-075 Attachment 3.

Protection and Control and Overall System Reliability

Mr. Charles Henville of Henville Consulting Inc. has been engaged by Hydro to provide independent, expert oversight to Hydro in relation to the Company's detailed review of the sequence of events that led to the system events which occurred on January 4 and 5, 2014 and Hydro's review of its protection and control systems generally. Prior to moving into private consulting in 2005, Mr. Henville worked for over 35 years as a System Protection Engineer with BC Hydro. Mr. Henville's experience in the economic and reliability analysis of protective relay applications; power system disturbance analysis; protective relay computer modeling; relay testing; and generation/transmission interconnections is extensive.

Mr. Henville's engagement will likely span the duration of Hydro's internal review and conclude in the mid March timeframe. A copy of Mr. Henville's resumé is attached to this response as PUB-NLH-075 Attachment 4.

Load Forecasting and Generation Planning

Ventyx (ABB Technology Ltd.) have been engaged to perform an independent review of Hydro's generation planning and load forecasting processes. Ventyx

began its review on February 3, 2014 and is expected to complete its work in the next six weeks.

The review will be completed by Mr. Norman Lee and Mr. Charles Adkins (resumés attached as PUB-NLH-075 Attachments 5 and 6). The scope of work is as follows:

Task 1 – Planning and Forecast Process Review

- Review of previous Planning process review results; and
- Compare Hydro practices with current standard practices.

Previous independent reviews of Hydro's practices will be reviewed. Once the review has taken place, Ventyx will compare the results with current standard practices in planning and forecasting.

Task 2 – Generation Planning Criteria

- Review of the overall planning process and assumptions used by Hydro in developing their current long range and strategic forward looking plans; and
- Provide commentary on the existing planning processes and criteria and make recommendations as to specific improvements as required.

Based on the review performed in this task, Ventyx will develop a report with commentary of the results as to the state of the Hydro processes and provide any recommendations as to changes it considers appropriate to improve the process.

Task 3 – Load Forecasting Process

- Review of the process and assumptions used by Hydro in developing its current long-range load forecast and short term operational forecasts; and
- Provide commentary on the load forecasting processes, criteria and assumptions and make recommendations as to specific improvements as required.

Based on the review performed in this task, Ventyx will develop a report with commentary of the results as to the state of the Hydro load forecast processes, assumptions and criteria and provide any recommendations as to changes it considers appropriate to improve the process.

Task 4 – Strategist Model Review

- Review of the Strategist model assumptions used by Hydro in developing their current long-range and strategic forward looking plans;
- Provide commentary on the existing planning processes and criteria and make recommendations as to specific improvements as required; and
- Ventyx is the owner and provider of the Strategist software being used by Hydro. Ventyx will review the current database and comment on the appropriateness of the current database and how it is being used by Hydro.

Brian Scott, P.Eng.

Electrical Engineer

Professional summary

Mr. Scott is an electrical engineer with over 34 years of power utility experience specializing in the areas of transmission system planning and operations, energy market development, transmission tariffs and power industry regulation. He has demonstrated leadership, management and project management skills enhanced by strong, effective verbal and written communications skills. He is a proven strategist who applies strong conceptual and critical thinking to complex problems, developing long-term strategies and goals.

Professional qualifications/Registration(s)

Association of Professional Engineers and Geoscientists of New Brunswick
Institute of Electrical and Electronics Engineers (IEEE)

Education

Bachelor of Science (Electrical Engineering), University of New Brunswick, 1976
Masters of Applied Science (Electrical Engineering), University of Waterloo, 1985

Languages

English

Employment history

AMEC, Electrical Engineer, Atlantic Canada (2010 to present)
NB Power, (1979 to 2010)

- Various Director Level Positions with Transmission (2000 to 2010)
- Management Position at Energy Control Centre (ECC) (1991 to 2000)
- Power System Applications Engineer with Transmission System Operations (pre 1991)

NS Power, Power System Engineer (1976 to 1979)

Representative projects

NB Power (1979 to 2010)

Various director level positions within Transmission – broad ranging responsibilities (2000 to 2010)

- Director, Operations and Reliability – managed team of engineers responsible for transmission planning, system protection, telecommunications and regulatory compliance
- Director, Technical Services – managed transmission engineering staff responsible for engineering including transmission line design, substation and terminal design and civil.
- Director, Business Development – responsible for transmission tariff and major transmission project developments

Management position at Energy Control Centre (ECC) – responsible for IT systems and providing technical and strategic direction to the operation of the centre. (1991 to 2000)

- Studied and analyzed the industry moves toward a deregulated competitive market
- Provided expertise, advice and guidance on NB Power's response to market development

- Actively participated in the development of strategic operational plans
- Managed operational plan implementation
- Continued responsibilities for IT staff and system development and sustainment including automation of many of the transmission and distribution systems at ECC
- Identified and managed impact of industry development on system development and sustainment

Power System Applications Engineer with Transmission System Operations (pre 1991)
- Conducted operational engineering studies and developed operational guidelines, requirements and limitations
- Developed transmission plans to meet projected needs

NS Power

Power System Engineer (1976 to 1979)

Key Accomplishments:

- Directed development of the International Power Line (IPL), a 345 kV interconnection between NB and Maine. This was the first major interconnection between Canada and the US in over 20 years. My involvement included shepherding the project through various regulatory and business processes in Canada and participating in the US process until the IPL got firmly established as a construction project. As such I was a witness at the National Energy Board hearing and at Environmental and PUC hearings in Maine.
- Led the initial NB Power application for the Open Access Transmission Tariff (OATT) in 2002. This Tariff was compliant with the FERC industry standard.
- Project manager, SCADA – SCADA has been used to monitor and control the power system in real-time since the in-service date of 1992; a recent decision has been made to replace this system.
- Led in-house development and subsequent modifications of energy dispatch and pricing program for inter-utility transactions with an annual value of $ millions. This program was in-service from about 1980 until the New Brunswick System Operator (NBSO) was formed at which time it was modified / rewritten to become the market optimization and dispatch program.

Industry Involvement

At the time of my retirement from NB Power in June, 2010 I was actively involved in a number of committees:

- Canadian Electrical Association
  - Committee on Performance Excellence (COPE) – a national benchmarking group
  - Transmission Council (alternate member)
  - Regulatory Development Task Group (RDTG) – a working group under Transmission Council responsible for regulatory affairs with US and Canadian entities (e.g. National Energy Board, Natural Resources Canada, North American Electric Reliability Council, US Federal Energy Regulatory Commission, US Department of Energy)
- Northeast Power Coordinating Council
  - alternate member for NB Power Transmission
  - Reliability Coordinating Committee – senior level operations committee
- New Brunswick Market Advisory Committee – charter member representing transmitters sector

Brian Scott, P.Eng.

Other Activities

- Participated in two missions trips to Bolivia with Pioneers Canada (2009, 2010)
- Raised funds and ran in Bruce Hadley Heart and Stroke marathon (2010)
- Raised funds for The Arthritis Society and ran marathon in Honolulu through Joints in Motion (JIM) program (2005)
- Former coach youth sports – basketball, soccer and baseball (about 1995-2005)
- Woodworking, running, biking, reading, hiking, camping, photography

BRIAN W. TINK CRSP, CUSA- Electrical Utility Endorsement
Watershape Safety Analysis Inc.
1092 Church Lane
Algonquin Highlands, Ontario, Canada K0M-1J1 (705) 644-4006
Brian.Tink@Watershape.ca

SUMMARY OF PROFESSIONAL STRENGTHS

I am a conscientious and self-motivated Health, Safety, and Environment Professional willing to welcome and promote change with the ability to take on new and different responsibilities. The following professional strengths were developed:

- Experience dealing with many cultures worldwide.
- Ability to lead and manage work programs/projects, incident investigations and audits internationally.
- Competencies in Health, Safety, and Environmental processes and systems.
- Experience in the development and assessing of Safety & Environmental Management Systems
- Extensive training development and delivery knowledge.

WORK HISTORY

2008 to Present — **WATERSHAPE SAFETY ANALYSIS INC.-PRESIDENT**

Responsibilities:

- Consult on various Health & Safety activities and programs internationally.
- Develop and deliver Culture related training.
- Lead and support investigations, root cause analysis and audits.
- Lead, develop and assist with system and program implementation.

1999 to 2008 — **HYDRO ONE - MANAGER, HEALTH SAFETY & ENVIRONMENT SUPPORT**

Responsibilities:

- Conduct and monitor investigation standards on behalf of operations and line.
- Manage all aspects of the HS& E Systems within Hydro One Networks.
- Develop and implement cutting edge management programs.
- Liaise with Line Management of all levels to achieve targets
- Work with external Government agencies as required to achieve results and on behalf of line management
- Manage a Safety Department of 35 people across the province of Ontario

1997 to 1999 — **ONTARIO HYDRO - HEALTH, SAFETY & ENVIRONMENT SPECIALIST**

Responsibilities:

- Development and Implementation of Safety & Environmental Managed Systems.
- Provide Health, Safety, and Environment support to all levels of the organization.
- Perform assessments and resultant action plans.
- Help develop and suggest improvements to existing performance targets and processes.
- Involved in Canadian Electricity Association and other outside Health, Safety, & Environment organizations.

1994 to 1997 — **ONTARIO HYDRO - SENIOR SAFETY CONSULTANT**

Responsibilities:

- Developed and facilitated the development of Safety Management Systems
- Lead several Retail safety assessments
- Lead or participated in audits
- Introduced the TapRooT incident investigation process to Ontario Hydro
- Provided safety support to all Business Units

1991 to 1994 **ONTARIO HYDRO - TRAINING SPECIALIST**

Responsibilities:

- Liaise with the Ontario Ministry of Transportation on driver programs
- Develop programs for delivery
- Coordinate activities for group of six instructors
- Consult with customers on safety and environmental transportation
- Participate in the Canadian Electricity Association Health & Safety Group

1989 to 1991 **ONTARIO HYDRO - INSTRUCTOR – VEHICLE & EQUIPMENT TRAINING**

Responsibilities:

- Develop and deliver training material for Utility staff
- Instruct Ontario Hydro and Municipal Electrical Association staff

1987 to 1989 **ONTARIO HYDRO - TRAINING TECHNICIAN – Transport & Work Equipment**

Responsibilities:

- Produce material and videos for training as requested by customers
- Deliver work equipment training for all trades staff

1979 to 1987 **ONTARIO HYDRO - TECHNICIAN – ELECTRICAL RESEARCH DEPARTMENT**

Responsibilities:

- Develop new tools and work methods for Lines & Forestry
- Perform Electrical tests on stations and distribution systems

1976 to 1979 **ONTARIO HYDRO - TECHNICIAN – MACHINE SHOP RESEARCH DIVISION**

SPECIAL ACCOMPLISHMENTS

- Certified as a Canadian Registered Safety Professional & Certified Utility Safety Administrator (NSC)
- Introduced the TapRooT investigation process to Ontario Hydro (Currently Hydro One).
- Developed an Electrical Burn Treatment Program for the province of Ontario
- Developed concept of Multi-site JHSC within Hydro One
- Assisted in the development of the current Hydro One Health & Safety Management System.
- Assisted in the Health & Safety transition from Retail to Network Services.
- Advisor to the Wood Pole Climbing Equipment Committee.
- Municipal Councilor, responsible for public works

EDUCATION

1975 to 1976 **Mechanical Program**
Durham College, Oshawa, Ontario

1971 to 1975 **Grade 12 Graduate**
Courtice Secondary School

EXTRA COURSES

- Arthur D Little Auditor Training
- Queens University – School of Business- Team Performance
- Introduction to ISO 14001
- TapRooT Root Cause Analysis Tool - Certified Instructor
- Consulting Programs
- Several Technical Instructors Courses

Blair Seckington, P.Eng.

Director, Power Technology

Professional Summary

Blair has over 37 years experience in the electricity production industry. He is an authority on the design, operation, economic and environmental performance and condition assessment, as well as life management planning aspects of fossil power units, with extensive involvement with OPG's hydroelectric and alternative generation programs. He has extensive knowledge of new generation technology and fossil environmental controls.

Since joining AMEC in August 2007, Blair has been extensively involved with several simple cycle, combined cycle and cogeneration projects and studies in Ontario, British Columbia, Nova Scotia, Saskatchewan, Newfoundland, New Zealand, United Kingdom, Alaska, and Chile, He and his staff have provided clients with life extension capital and OMA life extension plans, alternate fuelling strategies, and environmental control options. Working with other AMEC offices/staff, this includes an assessment of Carbon Capture options for a 400 MW+ coal fired power plant. He has provided third party project witnessing and due diligence assessments for projects ranging from 20 MW biomass cogeneration facilities to 100 MW alternative fuel cogeneration plants to 900 MW combined cycle facilities.

Blair was Ontario Power Generation's (OPG) Program Manager for their $265 million 2003 Selective Catalytic Reduction (SCR) project and their 2006/7 proposed coal plant clean up technology plan ($700 million to $3.5 billion). He provided the technical direction for their 600 MW Portlands and 250 MW Brighton Beach combined cycle projects. Blair also managed OPG's extensive fossil environmental control and clean fossil generation R&D program, specifically focused on mercury and greenhouse gas control. He has extensive backgrounds in Clean Coal technology (IGCC, Zero Emissions coal), as well as biomass cofiring and generation. He represented OPG as part of the Canadian Clean Power Coalition, the Zero Emissions Coal Alliance and involvement in the IEA Clean Coal and Greenhouse Gas R&D Executive Committees. He has consulted while part of OPG and in private consulting on power projects and technology programs in Peru, the Philippines, China, Newfoundland & Labrador, Mexico, the USA, and Chile. He was involved in then Ontario Hydro's international development and asset evaluation programs for fossil plants.

Blair reported directly to various Senior and Executive Vice-Presidents of OPG's Fossil and Fossil & Hydroelectric Business Units over time as the Senior/Chief Technology Advisor. He was responsible to review and provide advice to Senior Management on Business Unit and station capital and life management plans and major capital project proposals. This role required a solid and wide understanding of technology and economic issues, of utility operations and risks, and of external activities globally. He has been required to make presentations to Senior OPG Management, to foreign Corporate Boards, to senior government officials and Ministers, and to international organizations such As the IEA and EPRI.

Professional Qualifications

Professional Engineers Ontario (PEO), #41392010, 1977-2012
Professional Engineers & Geoscientists (PEG), #05227, Newfoundland and Labrador, 2009-2012

Education

Honours B.A. Sc. in Mechanical Engineering, University of Toronto, Ontario, 1975
Post Graduate University Courses
Boiler Design & Operation 1986
Reliability Evaluation of Power Systems 1985

Post Employment Training Courses

Written Communications
Cost Minimization
MD Consulting
Corporate Financial Evaluation
Business Case Workshop
Contract Administration
Risk Management

Memberships/Affiliations

IEA Greenhouse Gas & Clean Coal R&D Committees 1998-2007
IEA Coal Research Advisory Board 2002-2003
Canadian Carbon Sequestration Leadership Forum
Ontario Professional Engineers (PEO) 1975-2012
Canadian Electricity Association 1996-2007
Electrical Power Research Institute (EPRI) 1998-2007, Generation Council 2003-2007
Coal Utilization Research Council (CURC) 2002
Gasification Users Association 1995-2000
Zero Emissions Coal Alliance 1999-2002
Advanced Gas Turbine Cycles Group 1996-1998
Member of Board of Directors, Hydrogen Industry Council 1986-1989

Languages

English

Employment History

AMEC, Director, Power Technology Consulting, Oakville, Ontario, (2007 to present)
Ontario Power Generation (OPG) Inc., Chief & Senior Advisor – Technology, Fossil Business Unit, Fossil and Hydroelectric Business Unit, Electricity Production (Fossil and Hydroelectric), Toronto, ON, (2003 to 2007, 1997 to 2002)
Blair Seckington & Assoc., President, Mississauga, Ontario (2005 to 2007)
ZECA Corp., Chair of Board of Directors/Director, Phoenix, Arizona, (2001 to 2002)
ZECA Alliance, Executive Director – Zero Emissions Coal Alliance (ZECA), Phoenix, Arizona, (2001 to 2002)
Ontario Hydro, Toronto, Ontario, (1975 to 1999):

- Special Advisor – NE USA Asset Procurement Project, Toronto, ON, (1998)
- Special Advisor – Bruce Cogeneration Assessment Study, Toronto, ON, (1998)
- Senior Advisor – Technology Programming, Fossil Business, Toronto, ON, (1997 to 1999)

- Consultant (Assignment) – Newfoundland & Labrador Power Studies, Toronto, ON, (1997)
- Senior Advisor – Technology, Business Programming & Development, Toronto, ON, (1995 to 1997)
- CEBU/Clarke Base, Toronto, ON, (1993)
- Section Head - Combustion, Environmental Controls, & Generation Concepts Department, Fossil Business Unit, Toronto, ON, (1993 to 1995)
- Supervising Engineer – Energy Studies & Development, Toronto, ON, (1989 to 1993)
- Supervising Design Engineer - Alternate Energy, Power Equipment, Toronto, ON, (1986 to 1989)
- Planning Engineer/Planner - BES Resources, System Planning Division, (1985 to 1986)
- Design Engineer Specialist, Power Equipment, Design & Construction, (1976 to 1985)
- Thermal Program Graduate Trainee – RL Hearn, Lakeview, (1975 to 1976)

Representative Projects

AMEC

Oakville lead technical specialist for power generation technologies. Work on generation plant analyses and development in British Columbia, Nova Scotia, Ontario, Alaska, Chile, and UK.

- New Zealand Utility Due Diligence Review and Report – Hydro Components (2012-2013)
- Holyrood Generating Station U1 Steam Turbine Generator Failure Condition Assessment, Newfoundland & Labrador Hydro, Newfoundland, (2013)
- Newfoundland Private Forest Industry Hydro Generation Due Diligence Condition Assessment (2012)
- Holyrood Generating Station Condition Assessment & Life Extension Level 2, Newfoundland & Labrador Hydro, Newfoundland, (2012)
- New Zealand Utility Due Diligence Review and Report – Thermal and Hydro Components (2011-2012)
- Power Supply – Saskatchewn Potash Mine Steam Turbine FEL Study, Saskatchewan, (2012)
- Power Supply Trade-Off Analysis and Pre-feasibility, Vale Voisey's Bay, Labrador, (2011/12)
- Holyrood Generating Station Gas Turbine Condition Assessment & Replacement Options Study, Newfoundland & Labrador Hydro, Newfoundland, (2011)
- Power Supply Trade-Off Analysis, Western Potash Feasibility Studies, Saskatoon, Saskatchewan, (2011)
- Power Supply Options Feasibility Analysis, Donlin Creek Mine, Alaska, (2008-2009, 2011)
- Alliance Pipeline/NRGreen Organic Rankine Cycle Project Technical Review, Alberta (2011)
- County Power Biomass Cogeneration project development Support. County Power Biomass Limited, Toronto (2010-2011)
- Holyrood Generating Station Condition Assessment & Life Extension, Newfoundland & Labrador Hydro, Newfoundland, (2010-2011)
- VALE Inco Newfoundland & Labrador, Power Supply Options RFP, Newfoundland & Labrador

(2010-2011)

- Toronto Hydro - Laframboise Contractors Engineering Support – 10 MW Ashbridges Bay Biogas Engine Cogeneration Project, Toronto (2010-2011)
- Becker 20 MW Biomass Cogeneration RBC Banker's Engineer Project Review and Assessment, RBC, Toronto (2010)
- OPG Small Biomass Technology Review and Assessment, OPG, Toronto (2010)
- Mercury Control Technology Review and Assessment, Seagel Investments, Toronto (2009)
- Goreway Third Party OPA Performance Review and Certification, Sithe Goreway, Toronto (2008-2009, 2010)
- Essar Algoma Cogeneration 77 MW Industrial Syngas Third Party OPA Performance Testing and Review and Certification, Algoma Energy, Sault Ste Marie (2009)
- New Page Biomass 60 MW Steam Turbine Cogeneration Retrofit – Project Development Technical Support, Nova Scotia (2009-2010).
- Burrard Generating Station - Life Plan (2007-2008), Burrard Generation Alternatives (2008), 2010 Investment Plan (2009-2010), BC Hydro, Vancouver, British Columbia
- North Dumfries SCGT and Nanticoke CCGT Owner Engineer Studies and Definition Work, CPV Canada, Toronto. (2008-2011)
- Tufts Cove LM6000 CCGT Retrofit – Technology Suppport. Nova Scotia Power, Halifax, Nova Scotia (2009-2011).
- Enbridge Third Party Project Reviews – Organic Rankine Cycle Project Assessment, Existing Cogen Project Procurement Reviews (2009, 2010, 2011)

Ontario Power Generation (OPG) Inc.

Toronto, ON, 2003–2007, 1997 to 2002

- Fossil Clean Coal Plan technology concepts (costs, schedules) - $3Billion
- Thunder Bay Gas Conversion & Lambton Combined Cycle Gas Turbine (CCGT) concept study and definition
- Ministry of Energy Generation Options & Health Impacts Study
- Thunder Bay Biomass Co-firing Resource Assessment Co-ordination
- Manley Team Generation Options Study Technology Options
- Canadian Clean Power Coalition OPG Representative
- OPG Mercury Baghouse Concept Study & Field Tests
- EPRI Gasification Users Association Member
- OPG/TransCanada Energy Portlands CCGT OPG project technology advisor
- $2-4M/Yr. R&D program – Electric Power Research Inst (EPRI), Canadian Electricity Assoc (CEA), International Energy Agency (IEA), CANMET, universities, other Fossil technology programming:
- fossil/hydro asset management, environmental upgrade plans and business cases

- new generation technology concepts; and projects
- implement fleet wide projects – Revenue Metering, Selective Catalytic Reduction
- implement Fossil R&D demos - Fuel Lean Gas Reburn (FLGR) ($10M)
- manage $2-4M/Yr. R&D program – EPRI, universities, internal
- support/direct corporate projects - 500 MW Brighton Beach CCGT; Decontrol project

Major positions/tasks held:

- Mgmt. & Technical Committee – Canadian Clean Power Coalition (CCPC)
- Managing Partner Director – Zero Emissions Coal Alliance (ZECA)
- OPG/CEA/Canada Rep. IEA Greenhouse Gas (GHG) & Clean Coal R&D Committees
- Program Manager – $240 Million Selective Catalytic Reduction (SCR) Project & Revenue Metering Retrofit
- OPG EPRI R&D Program Manager of Technology Transfer

Blair Seckington & Associates
Mississauga, Ontario (2005 – 2007)
Technology advice to non-Ontario/OPG-competitive clients (OPG permission): fossil performance/process and new generation assessment - Eastern Canada, Mexico and Southern USA.

ZECA Alliance
Phoenix, Arizona, (2001–2002)
Collaborative development (17 industrial and government co-funders) and execution re: new, long-term, low cost, high efficiency coal-fuelled generation - basic research, pilot development, and commercial demonstration. OHII Project Support Assignment – Peru Utility New Generation Review, Ontario Hydro International Inc., Toronto, ON, 1998. Consulting on fossil generation additions in Lima, Peru.

Ontario Hydro

NE USA Asset Procurement Project
Ontario Hydro, Toronto, ON, (1998)
Technology team leader - Step 1 purchase proposal of Northeast US Generating Stn.

Bruce Cogeneration Assessment Study
Ontario Hydro, Toronto, ON, (1998)
Assess new CCGT/cogeneration at Douglas Point – with private sector investor.

Technology Programming, Fossil Business
Ontario Hydro, Toronto, ON, (1997 – 1999)
Consultant (Assignment) – Newfoundland & Labrador Power Studies, Ontario Hydro International Inc., Toronto, ON, 1997. Consulting on new fossil, cogeneration, renewables, and hydro additions to N&LP's system.

Technology, Business Programming & Development

Ontario Hydro, Toronto, ON, (1995–1997)
OHII Expert – G7 Environmental Technology Training Mission for Chinese, Ontario Hydro International Inc., Toronto, ON, 1994. Consulting training various Chinese technical staff on fossil environmental control. Project Assignment – Philippines New Generation Studies –

CEBU/Clarke Base

Ontario Hydro International Inc., Toronto, ON, (1993)
Consulting on new fossil generation - review of previous generation plans; b) existing and new project and environmental requirements; c) technology configuration and costs, and siting recommendations; and d) a going forward plan.

Combustion, Environmental Controls, & Generation Concepts Department, Fossil Business Unit

Ontario Hydro, Toronto, ON, (1993 to 1995)
Managed 10 technical staff in Combustion; Environmental Control; and Generation Concepts providing technical service to fossil stations and corporate groups. Project Assignment – Southern China New Generation Studies, Ontario Hydro International Inc., Toronto, ON, 1993: Consulting on new fossil generation to private Hong Kong partner.

RESUME of Charles F. Henville

Date of Birth: 11, May, 1948 **Nationality:** Canadian

Skills

- Modelling of electric power systems in steady state, during short circuits and during other transients.
- Application and setting of power system protective relays
- Design of special protection systems and power system emergency controls
- Application and type testing of protection systems
- Disturbance analysis
- Training in power system protection

Academic Qualifications:

Bachelor of Arts (Electrical Sciences), University of Cambridge, England, 1969
Master of Arts, University of Cambridge, England, 1974
Master of Engineering, University of British Columbia, 1996,

Professional Associations:

- Member Association of Professional Engineers and Geoscientists of BC
- Member Association of Professional Engineers and Geoscientists of Newfoundland and Labrador
- Member Association of Professional Engineers and Geologists and Geophysicists of Alberta
- Fellow, IEEE, (member, Power Engineering Society)
- Member IEEE Power System Relaying Committee (PSRC)
- Past Chair PSRC, Past Chair Substation Protection subcommittee, PSRC
- Member several IEEE PSRC working groups
- Past Chair, Vice Chair, Secretary, Treasurer, Chapter Chair, Education Chair, Awards Chair, Membership Committee Chair, IEEE Vancouver Section
- Past member CIGRE working group on "Protection Against Voltage Collapse" for Study Committee 34
- Technical paper reviewer for IEEE Transactions on Power Systems, IEEE Transactions on Power Delivery, IEEE letters to PE Review, and IEEE Power Engineering Society conferences.
- Past member, Western Electricity Coordinating Council, Remedial Action Scheme Reliability Task Force.
- IEEE Power and Energy Society Distinguished Lecturer

Specialization Courses and Academic Activities:

- Adjunct Faculty, University of Wisconsin, Madison, and Institute Nationale Polytechnique de Grenoble, France, for short course “Advanced Topics in Power System Protection”.
- Sessional Instructor, University of British Coumbia (BC). Teaching undergraduate course in Power System Protection.
- Adjunct Faculty Gonzaga University, teaching graduate course in Power System Protection.
- Post graduate courses at the University of BC (1991-1996, Part of Master of Engineering Program Listed above) Advanced Power System Control and Dynamics, Wave Propagation in Multiconductor Transmission Circuits, Advanced Power Systems Analysis, Network

Analysis and Simulation, High Voltage Engineering parts I and II, Power Electronics Control, Computer Applications in Power Systems, Power System Protection.
- Undergraduate course Economic Evaluation of Engineering Projects (University of BC 1992)
- Advances in Microprocessor Based Protection and Communication - IEEE Tutorial, July 1996.
- Certified trainer for ASPEN OneLiner ™ Short Circuit and Relay Coordination software.

Languages: English (native), Spanish (small amount)

Experience:
- Principal, Henville Consulting Inc. Providing expert services in application and setting of protective relays and power system protection and training services to Canadian and international utilities and industries. Client list includes,
  Yukon Energy Corporation, Fortis BC, BC Hydro, BC Transmission Corporation, AltaLink, Newfoundland and Labrador Hydro, Churchill Falls (Labrador) Corporation Ltd., Catalyst Paper, Aspen Inc. Tesoro Refining and Marketing Company Inc., Abu Dhabi Transmission and Despatch Company, Transpower New Zealand, Eskom South Africa, Memphis Light, Gas and Water Division, San Diego Gas and Electric, ZE Power, Lapointe Engineering, Hawaiian Electric Company, Centre for Energy Advancement through Technological Innovation (CEATI), Portland General Electric, Hydro Quebec, ITC Transmission, National Grid Corporation of Philippines, Northeast Utilities, Puget Sound Energy, Saskatchewan Power, Ameren, Schweitzer Engineering Laboratories, Manitoba Hydro, AMEC Americas, Virelec, Solvina AB
- System protection engineer for a major Canadian Utility (1977 to January 2005). Extensive and continuous experience in:
  - ⇒ Short circuit studies (classical, and including load flow and transient components using electromagnetic transients programs (emtp))
  - ⇒ Protective relay application and coordination studies for rotating and static electric power equipment (voltages ranging from 0.6 to 500 kV) and for small and large electric power systems, including series compensated and single phase tripping and reclosing transmission lines.
  - ⇒ Calculation of protective relay settings
  - ⇒ Economic and reliability analysis of protective relay applications.
  - ⇒ Electric Power System Disturbance analysis
  - ⇒ Power system and equipment and protective relay computer modelling.
  - ⇒ Testing of protective relays
  - ⇒ Interconnection of generators with transmission and distribution systems
- Leader of system protection applications and settings review for a major offshore oil production company in Indonesia
- Leader or participant in analysis of complex system disturbances, including Malaysian Peninsular disturbance August 1996, and various disturbances in the BC Hydro network. Analysed complex disturbances using protective relay disturbance records or fault recorder data. Recreated disturbances on appropriate models of the electric system
- Leader or participant in specification and implementation of type tests for new designs of protective relays such as digital distance relays, digital transformer protection relays and digital generator protection relays to check for suitability of application (1977 to date).
- Leader or participant in short circuit studies on large electric power systems (up to 1500 busses). Specific skills in operation of PTI PSS/E load flow and short circuit program, and ASPEN One Liner ™. Uses hand calculations to determine unbalanced short circuit

quantities in simple systems. Uses electromagnetic transients programs (EMTP) in multi-frequency analysis of short circuits and other system abnormalities (1977 to date).

- Prepared project justifications for protective relay upgrade and replacement projects valued up to US $4,000,000. Evaluated risks associated with retaining existing systems. Evaluated benefits associated with upgrading projects.
- Commissioning and acceptance engineer for a major Canadian utility. (1974-1977). Checking correct construction and installation of power electrical equipment. Field testing of circuit breakers, automatic reclosers, power transformers, power capacitor and reactors, and diesel generators. (Equipment rating ranges from 2.4 kV to 500 kV).
- Commissioning engineer for gas turbine driven generators and compressors (1970-74). Checking correct construction and installation of power electrical and mechanical generating and pumping equipment. Commissioning and troubleshooting instrumentation, protection and control equipment for power rotating equipment (capacity up to 44 MW, voltages up to 13.8 kV).
- Professional Engineering apprenticeship, Associated Electrical Industries, Trafford Park, Manchester England. Assisted in the manufacture and testing of large power equipment such as generators and transformers (1964-1970).

Present position:
President, Henville Consulting Inc.

Years of Professional Engineering Experience:
Forty four (44) Years

Employment History:

2005 to Date	President and principal engineer, Henville Consulting Inc.
1977-2004	System Protection engineer with BC Hydro, Vancouver, BC (starting as intermediate engineer, retiring as principal engineer)
1974-1977	Commissioning and acceptance engineer with BC Hydro, Vancouver, BC
1970-1974	Commissioning Engineer, GEC Gas Turbines, Whetstone, Leicester, England.
1966-1970	Professional Engineering Apprenticeship, Associated Electrical Engineering, Manchester, England.

Publications authored or co-authored
"Back to Back Switching of Large 230 kV, Grounded Wye Capacitor Banks, Field Tests, Analysis of Results and Application Guidelines", 1983, Canadian Electrical Association
“Protection of the BC Hydro High Power Laboratory”, 1985 Western Protective Relay Conference, Spokane, WA.
"Type Tests on Distance Relays", 1987, Western Protective Relay Conference, Spokane, WA.
"Spreadsheet Help for the Protection Engineer", 1989, Western Protective Relay Conference, Spokane, WA.
"Discover Relay Design and Application Problems Using Pseudo-Transient Tests", 1990, IEEE PES Winter Power Meeting. 1990 Georgia Tech Protective Relaying Conference.
“The Effects of Solar Magnetic Disturbances on Protective Relaying”, IEEE Special Publication No 90 TH 0357-4-PWR, 1990
"Relay Replacement and Upgrading Projects", 1991, Canadian Electrical Association and 1991 Western Protective Relay Conference, Spokane WA.
"Combined Use of Definite and Inverse Time Overcurrent Elements Assist in Transmission Line Ground Relay Coordination", 1992 IEEE PES Summer Meeting, and 1993 Western Protective Relay Conference, Spokane WA.

"Survey of Generator Protection Practices", IEEE Power System Relaying Committee report, 1993
"System Protection and Voltage Stability", IEEE Power System Relaying Committee Special Publication No. 93 THO 597-7-PWR
“Computer Based Relay Models Simplify Relay Application Studies”, 1993, Western Protective Relay Conference, Spokane, WA
“IEEE Tutorial on the Protection of Synchronous Generators”, IEEE Power System Relaying Committee Special Publication No. 95 TP 102.
“The Effects of GIC on Protective Relaying”, IEEE Power System Relaying Committee Paper No. 95 SM 430-9 PWRD, presented at the IEEE Power Engineering Society Summer meeting, 1995.
“Relay Performance Testing”, IEEE Power System Relaying Committee Special Publication No.96 TP 115-0. 1996.
“Low Level Testing of Protective Relays”, Canadian Conference on Electrical and Computer Engineering, University of Calgary, May, 1996
“Digital Relay Reports Verify Power System Models”, IEEE Transactions on Power Delivery Vol. 13, No. 2, April 1998, p.p. 386-393
“Voltage Collapse Mitigation”, IEEE Summer Power Meeting 1997, Western Protective Relaying Conference, 1997, and Georgia Tech Relay Conference, May, 1997.
“Protection Against Voltage Collapse”, CIGRE SC34.08 Report, Electra, Volume 179, page 110-126 - 1998.
“Transmission Line Relay Loadability”, IEEE Power System Relaying Committee report presented to Western Protection Relaying Conference, 2001, and other technical conferences.
“Wide Area Protection and Emergency Control” IEEE Power System Relaying Committee report
“Protective Relay Impacts on Power Quality - and Vice Versa”, IEEE PES Summer Meeting, Vancouver, BC, July, 2001
“System Protection and PQ Go hand in Hand”, Power Quality Magazine, December 2001.
Standard C37.95-2002 “IEEE Guide for Protective Relaying of Utility-Consumer Interconnections”
Standard C37.113-1999 “IEEE Guide for Protective Relay Applications to Transmission Lines”
“Software Models for Relays” IEEE Power System Relaying Committee, IEEE Transactions on Power delivery, 2001
“EMTP Applications to Power System Protection, IEEE Power System Relaying Committee Tutorial and special publication, IEEE PES Summer Meeting, Seattle 2000, Vancouver 2001.
“Dynamic Simulations Challenge Protection Performance”, Western Protective Relaying Conference, October, 2003
“Early Experiences with Protection Applications of Optical Current and Voltage Transformers” ”, Western Protective Relaying Conference, October, 2003
“Design of a Special Protection System to Maintain System Security at High Import”, IEEE Power Engineering Society Summer Meeting July, 2003, Toronto, Canada.
“Real Consequences Follow Imaginary Power Deficiencies”, Western Protective Relaying Conference, October, 2004
“Performance of Generator protection during major system disturbances” IEEE Transactions on Power Delivery, Volume 19, Issue 4, Oct 2004 Page(s):1650 - 1662
“Wide Area Protection and Emergency Control”, Proceedings of IEEE, Volume 93, Number 5, May 2005, pp 876-890.
“How Low Can You Go – More on Sensitivity of Transmission Line Protection”, Western Protective Relaying Conference, October, 2005.
“RAS and Strectched Power Systems”, Western Protective Relaying Conference, October, 2006.
“A Trial Application of Optical Transducers for Protective Relaying”, IEEE Power Systems Conference and Exposition, 2006.

"One Utility's Experience in Justification and Implementation of Relay Replacement projects". IEEE Power Systems Conference and Exposition, 2006.
"An Out-of-Step Event in the Peruvian Power System", Western Protective Relaying Conference, October, 2007
"Blackout Experiences and Lessons, Best Practices for System Dynamic Performance, and the Role of New Technologies", IEEE Task Force Report, May 2007
IEEE Standard C37.109 "Guide for the Protection of Shunt Reactors", 2008
"Secondary Arc Extinction and Detection – Real and Simulated", IET 9th International Conference on Developments in Power System Protection (DPSP 2008)
"SIPS and Stretched Power Systems" Carilec conference July, 2008
"Main 1 and Main 2 Protection – Same or Different?", Western Protective Relaying Conference, October, 2008
"Application of Overvoltage Protection to the Peruvian power system" , Western Protective Relaying Conference, October, 2008
"One Utility's Experience with Class TPY Gapped Core Current Transformers" Omicron International Conference on Testing of Current Transformers, October, 2009
"An Example Distance Protection Application with Complicating Factors", Western Protective Relaying Conference, October, 2009
"Transients (Old and New) Affect Protection Applications", Western Protective Relaying Conference, October, 2009
"Multifunctional Protection IEDs – How Much Functionality is Too Much?", PAC World Conference, Dublin, Ireland, June 2010 and ISA Jornadas, Medellin, Colombia, August 2010.
"Best Practices in System Simulation for Relay Testing", Omicron International Conference on Protection Testing, Salzburg, Austria, October, 2010
"Evolution of Backup Protection in BC Hydro" Western Protective Relaying Conference, Spokane, WA, October, 2010
"Disturbance Analysis Enhances the Art of Protective Relaying", Western Protective Relaying Conference, Spokane, WA, October, 2011
"Interconnecting Non-Utility Generators to BC Hydro's Transmission Network" Western Protective Relaying Conference, Spokane, WA, October, 2012 and Innovative Smart Grid Technologies Asia 2013 conference.
"End-to-End tests of Transmission Line Protection Systems with Single Phase Tripping and Reclosing" Western Protective Relaying Conference, Spokane, WA, October, 2012

Awards

- Recipient BC Hydro, Outstanding Accomplishment award, 1992
- Chairman, IEEE Power System Relaying Committee Working Group "Protection Aids to Voltage Stability" which won the IEEE Power Engineering Society 1997 and Power System Relaying Committee 1996 outstanding working group awards.
- Recipient of IEEE Power System Relaying Committee 1998 prize paper award for paper entitled "Digital Relay Reports Verify Power System Models" and IEEE Power Engineering Society 1999 prize paper award for the same paper.
- Recipient Association of Professional Engineers and Geoscientists of BC President's Year 2000 Award for Professional Service.
- Recipient IEEE Millenium medal award, 2000
- Recipient IEEE Canada Outstanding Engineer Award, 2003
- Appointed Fellow IEEE January 2004 "for contributions to power system protection"

Norman R. Lee Jr.
Principal Advisor

Career Summary

Norm Lee is a Principal Consultant within the Advisors group of Ventyx an ABB Company. He has more than 36 years of experience in many aspects of the utility industry. During his career he has served on numerous national and regional Integrated Resource Planning task forces and committees. He was also the Director of Planning for Oglethorpe Power Corporation where he was responsible for the development of the corporation's planning processes and products. Some of the areas Norm has worked during his career include power plant construction, system operations, engineering, SCADA operations, corporate and system planning. Norm was also on the faculty of Keller Graduate School of Management where he taught project management and statistics.

Experience

- **Most recent expertise/projects at Ventyx**

  Principal Advisor, Advisors, Ventyx, (2004 - Present)
  As Principal Advisor for Resource Planning within the Ventyx Advisors, Norm is responsible for performing consulting services including subject matter expertise in IRP and RFP analysis, DSM evaluation, financial analysis, risk analysis and the design and execution of both supply- and demand-side resource planning projects.

  - Led and participated in the writing of and independent review of the Consumers Energy 2013 IRP. Review included all of the data and Strategist modelling techniques, Mr. Lee took the results and information from Consumers and wrote the actual IRP document used in the CPCN that ultimately led to the successful negotiation of the purchase of an existing gas fired Combined Cycle plant.
  - Led implementation and integration of Strategist Financial and Rates module into the New Brunswick Power Integrated Planning processes. Provided both the basic and financial Strategist training and performed the implementation of the multi-company Strategist modules.
  - Performed the Strategist modeling analysis efforts for the Atlantic Energy Gateway initiative in 2012 examining the regional benefits of joint resource planning efforts aimed at optimizing renewable resource additions across a four province area of Canada spanning the Maritime Provinces. This study was a joint effort of the power companies of Nova Scotia, New Brunswick, Prince Edward Island, and Newfoundland and Labrador, as well as several Canadian federal and provincial government agencies.
  - Participated in the analytical modeling for a joint resource planning process during 2011 for Emera / Nova Scotia Power Company and New Brunswick Power Company to assess the benefits of joint resource planning and potential commercial agreements that would benefit both companies and their customers.
  - Contributor to the modeling and writing of the "2009 Electric Power Horizons: Scenarios of the Global Energy Future" publication. A long range look ahead at the impact of five scenarios of possible energy futures on electric utility market sales and cost.

- Performed in an assessment of resource economic lifespan for Louisville Gas & Electric Company in late 2011 and early 2012. This analysis determined the potential end of economic life for multiple resources on the LG&E system that might reach the end of their useful economic lives over a 30 year time horizon.
- Participated in analytical and modeling activities spanning much of 2010 in support of a joint study with Nalcor Energy and Emera to assess the range of potential benefits for the Lower Churchill Project and a proposed Undersea DC tie line between Newfoundland and Nova Scotia.
- Co-developed a comprehensive Advanced Resource Planning Course covering all aspects of economic resource analysis and decision making. The four day course includes discussion and case studies covering the essentials of resource planning, integrated Resource Planning,
- Participated on a team that performed a 2009 analysis for Nalcor Energy of the potential for joint savings through a cooperative arrangement between Nalcor and NSPI.

Education

MSEE, Mercer University, Atlanta, GA, 1994, Focus: Use of Artificial Intelligence, Expert Systems, and Neural Networks in Utility Planning Processes

BSEE, Lamar University, Beaumont, TX, 1977

Testimony/Publications/Presentations

“Definition and Issues on Stranded Cost - Oglethorpe Power Corporation for the Focus Group on Stranded Cost” Georgia Public Service Commission Stranded Cost Focus Group June 13, 1997

“Application of Neural Networks to Integrated Resource Planning”, Mercer University, 1994

“Application of IRP in a Cooperative Environment” GEMC Annual Convention, Savannah, GA, 1990

“Integrated Resource Planning: An Evolution” with G Stanley Hill Georgia State University Conference on Least Cost Planning 1990

“Integrated Resource Planning in a REA Cooperative”, NRECA Conference on Rates, August 1992.

Member Southern States Energy Board IRP Task Force 1996-1998

Member G&T Managers Association Task Force on Global Climate Challenge Initiatives.1997-1998

Member Georgia Public Service Commission Stranded Cost focus Group 1997

Charles Adkins
Vice President

Career Summary

Mr. Adkins is a Vice President in Ventyx Advisors and has more than 25 years of experience in the energy industry. Mr. Adkins is responsible for providing strategic consulting services to the electric and gas industry. His primary areas of expertise include economic and financial analysis, corporate restructuring, and power supply agreements.

Mr. Adkins' experience covers a wide range of the energy supply chain—from the procurement and generation of energy, to delivery at the end user. Mr. Adkins' skill set includes economic analyses of energy industry decisions, risk and uncertainty management and assessment, retail choice infrastructure, software product design and implementation, financial planning, technology consulting, corporate restructuring, power marketing, and power supply contracts.

Experience

Vice President, Advisors, Ventyx, (1996-Present)

Mr. Adkins is primarily responsible for integrated resource planning ("IRP") and request for proposal ("RFP") projects. Mr. Adkins has provided expert testimonies for government agencies regarding study results.

- Administered RFP processes for Northern Indiana Public Service Company ("NIPSCO"), from 2007 to present, including four RFP's for supply-side resources and one RFP for renewable/demand-side management. These projects resulted in the acquisition of one gas plant and two renewable wind farms.
- Administered IRP process for NIPSCO's 2007, 2009, 2011, and 2013 Integrated Resource Plans.
- Managed the analytical process in support of NIPSCO's CPCN for environmental projects at NIPSCO's Michigan City Generating Station. In support of this process, Mr. Adkins was responsible for managing and sharing information between NIPSCO and the Joint Intervenors to ensure a thorough and transparent evaluation. *See table below for expert testimony details.*
- Provided direct and rebuttal testimony for NIPSCO's filing for a CPCN for two wind purchase power agreements and acquisition of Sugar Creek Combined Cycle facility. Testimony covered broad range of issues related to RFP and IRP development and addressed a number of evolving market issues related to the development of and inclusion of Midwest ISO long-term congestion pricing in the IRP process. *See table below for expert testimony details.*
- Negotiated a total of three purchase power agreements for wind resources located in the Midwest ISO.
- Developed and implemented IRP infrastructure for Dominion Virginia Power as result of reregulation in State of Virginia. Project solution included coordination of production planning and resource planning data, financial modeling, and revenue requirements forecasting.
- Directed NIPSCO's 2006/2007 All Source and Combined Cycle RFP and associated IRP to procure adequate and cost effective resource additions. Acted as independent consultant for NIPSCO's RFP process to make sure design and

implementation of RFP process were consistent with the FERC's views and standards regarding solicitation processes.

- Managed update process for the Michigan Public Service Commission's 21st Century initiative. Responsible for developing data assumptions; supply- and demand-side resource alternatives; and developing an integrated supply plan to meet the State of Michigan's needs over the next 20 years.
- Facilitated and managed a collaborative industry wide IRP for the State of Michigan to address future power supply needs in both the upper and lower peninsulas of Michigan. The study identified a broad range of traditional and nontraditional generation alternatives, renewable options, demand-side options, and transmission options to meet the state's energy needs under both normal and aggressive emissions scenarios.
- Restructured Nebraska Electric Generation & Transmission Cooperative's power supply agreement to provide greater flexibility and greater control over power supply costs.

Expert testimony

Regulatory Body	*Case Number*	*Company*
IURC	Cause 44339	IPL
CPUC	Advice 4216E	PGE
IURC	Cause 44242	IPL
CPUC	Advice 4546E	PGE
IURC	Cause 44012	NISPCO
CPUC	Advice 4489E	PGE
VA. SCC	Case No. PUE-2008-00014	Dominion
IURC	Cause 43393	NISPCO
IURC	Cause 43396	NISPCO

Education

B.I.E., Industrial Engineering, Georgia Institute of Technology, Atlanta, 1985