

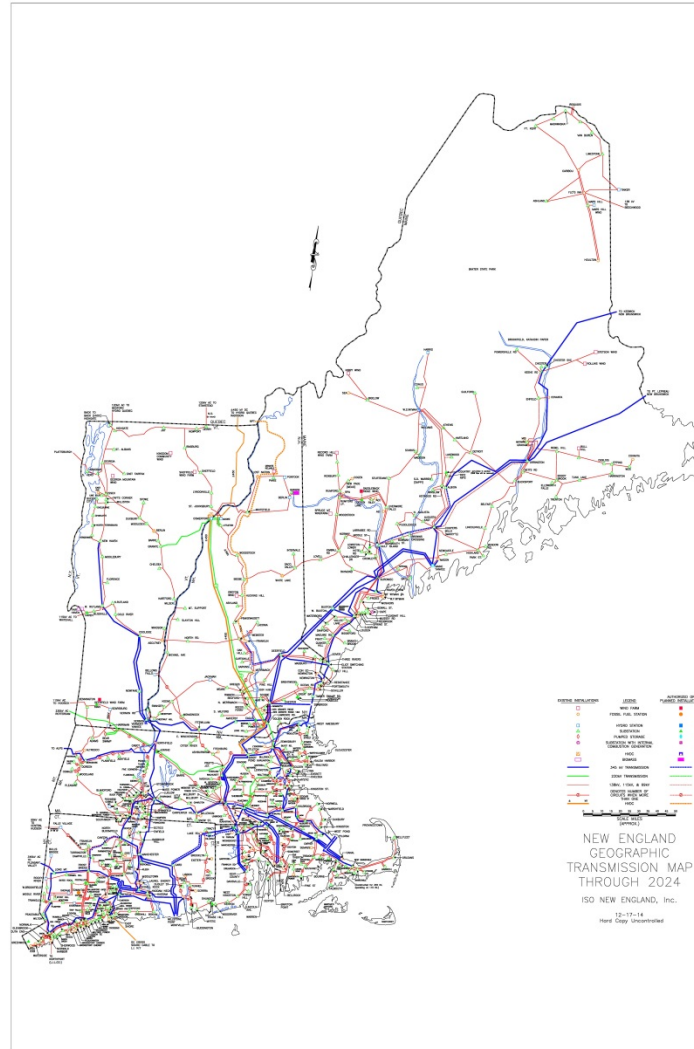
# Refurbishment and Life Extension of Existing Facilities in Vermont



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# Life Extension Projects in Vermont

- Highgate Converter  
BTB HVDC  
Refurbishment  
(2009-2012)
- Essex STATCOM  
Refurbishment  
(2014 – Present)





# **HIGHGATE CONVERTER BTB HVDC REFURBISHMENT**

# Highgate Converter BTB HVDC Refurbishment

## Reasons for Refurbishment

- Age of the equipment (26+ years)
- Lack of knowledge of control system industry wide
- Lack of spare parts
- Increased control system failures
- Increased utilization of the converter
- The desire to increase nominal import rating from 200 MW to 225 MW under max temperature rating (40°C)
- The desire for 30 more years of operation
- Upgrading of North Bus (HQ Side) for protection against TOV events



# Highgate Converter BTB HVDC Refurbishment

## Basic Ratings of the Converter - *Prior to Refurbishment*

- 200 MW Back-to-Back Interconnection between Hydro Quebec and VELCO
- Commissioned in 1985
- Recognized as the fastest constructed HVDC Substation from Drawing Board to Commissioning
- Continuous Overload Capacity of 225 MW rated (up to 30°C)
  - Due to the HQ System we are limited to 218 MW
- North AC bus is connected to the HQ System (120kV)
- South AC bus is connected to the VELCO system (115kV)

# Highgate Converter BTB HVDC Refurbishment

## Basic Ratings of the Converter – *After Refurbishment*

- Continuous Capacity of 225 MW rated (up to 40°C)
  - North to South
  - Requires transformer cooling fans and pumps
  - Requires 4 cooling towers in-service
    - 5<sup>th</sup> tower added for redundancy, does not increase power transfer rating
- Continuous Capacity of 170 MW rated (up to 40°C)
  - South to North (System not converter constraint)

# Highgate Converter BTB HVDC Refurbishment

## Controls & Protections

- One of the first HVDC digital control systems based on circa 1984 ASEA PLM language
- Limited options using today's technology to continue to communicate and modify code when needed
- Increased failures of the control system resulted in deteriorated reliability and greater exposure for extended forced outages.
  - Control System A experienced four (4) complete stalls one (1) internal fault over the last year
  - Control System B experienced nine (9) stalls and three (3) internal faults over the last year
  - One event on the Control System led to both systems to fail resulting in a forced outage over this last year.
- Increased utilization of and reliance on the facility to serve load and ensure transmission network reliability.



**Note:** HVDC Control System



**Note:** Computer used to reset local alarms.



**Note:** New Control Desk



# Highgate Converter BTB HVDC Refurbishment

## Valve Hall Equipment

- Original oil-filled snubber capacitors replaced with SF6/Nitrogen filled
- Spare thyristors from storage were purchased and placed into service for verification of operation under warranty period
- Thyristor Control Units were all replaced with standard technology which provided additional information back to the control system



**Note:** Oil Filled Snubber Capacitors



**Note:** New TCU's and SF6 Filled Snubber Capacitors

# Highgate Converter BTB HVDC Refurbishment

## Conclusions

- Reliable and safe service for the next 30 years
- Allow for operation of 225 MW up to 40°C
- Intelligent dynamic runback controls
- Protection from TOV conditions on the North Bus
- Reduction in maintenance costs
- Reduction in forced outages
- Increased associate knowledge of the Converter



## ESSEX STATCOM REFURBISHMENT

# Essex FACTS Life Extension Project

## Background

- Commissioned in 2001
- Rated for -65 MVAR/+85 MVAR
  - Additional 24 MVAR Shunt Capacitors Banks available for Offset
  - One 24 MVAR Shunt Capacitor Bank required due to TIFF issues
- Consist of two independent STATCOM units
  - Each STATCOM contains:
    - 3 Inverters (+/- 12.5 MVAR Each)
    - 1 Non-switchable 5 MVAR Filter Bank
    - Upgraded from GTO to GCT technology in 2004
- Installed to provide dynamic system voltage support during heavy load conditions coincident with outages of transmission or other transmission equipment
- Provide continuous steady state voltage regulation and power quality improvement for the Vermont Transmission System

# Essex FACTS Life Extension Project

## Reasons for Refurbishment

- Compromised reliability and availability as a result of the following:
  - Obsolescence of the hardware and operating system software
  - Aging digital firing control boards and electronics
  - Increasing cost and longer wait times for spare parts
    - Not possible to identify alternative suppliers apart from the OEM for the critical equipment.
  - Increasing numbers of callouts to service mostly minor items
  - Cooling Related Issues
    - System leaks and inadequate design resulting in requiring outages for servicing equipment
    - The cooling system is comprised of a mixture of deionized water and ethylene glycol which is regulated by the state of Vermont and cause environmental issues and long term health issues for service staff



# Essex FACTS Life Extension Project

## Scope of Work

### Vendor

- Inverter Equipment Replacement
- Cooling System Replacement
  - New Efficient Cooling Towers
  - Replacement of Ethylene Glycol with Propylene Glycol
  - New Cooling Controls and MCCs
- Control & Protections
- Replacement of HVAC system and addition of redundancy to valve halls
- Address known TIFF issues
- Address known issues with extended gateblocks due to overcurrent and DC Capacitors
- Studies

### VELCO

- Fire System Upgrades
  - Consolidate Vendors
  - Bring up to Code
  - Properly protect equipment from GE
- Building/Storage Upgrades
  - Waterline added to upper yard to aid in cleaning HVAC units and Cooling Towers
- Transformer Upgrades
  - Addition of DGA
  - Swap In-Service Interface Transformer with Spare Interface Transformer

# Essex FACTS Life Extension Project

## Conclusions

- Reliable and safe service for the next 35 years
- Reduction in TIFF interference issues
- Reduction in Extended Gate blocking due to Overcurrent and DC Capacitor Charging
- Reduction in maintenance costs
- Reduction in forced outages
- Increased associate knowledge of STATCOM Technology



# QUESTIONS & ANSWERS

vermont electric power company

