# CU HVDC Refurbishment

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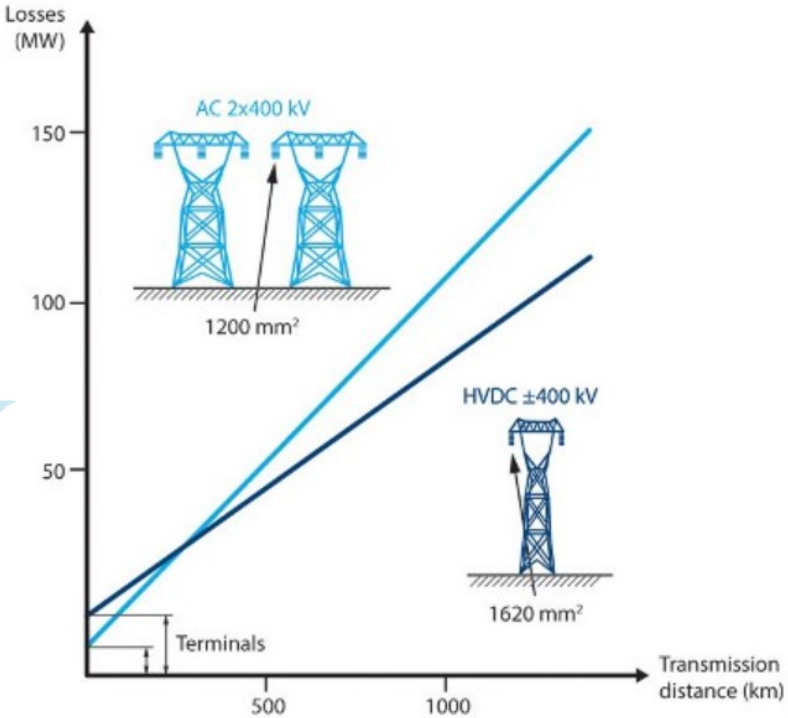
11/7/18

# Why HVDC?

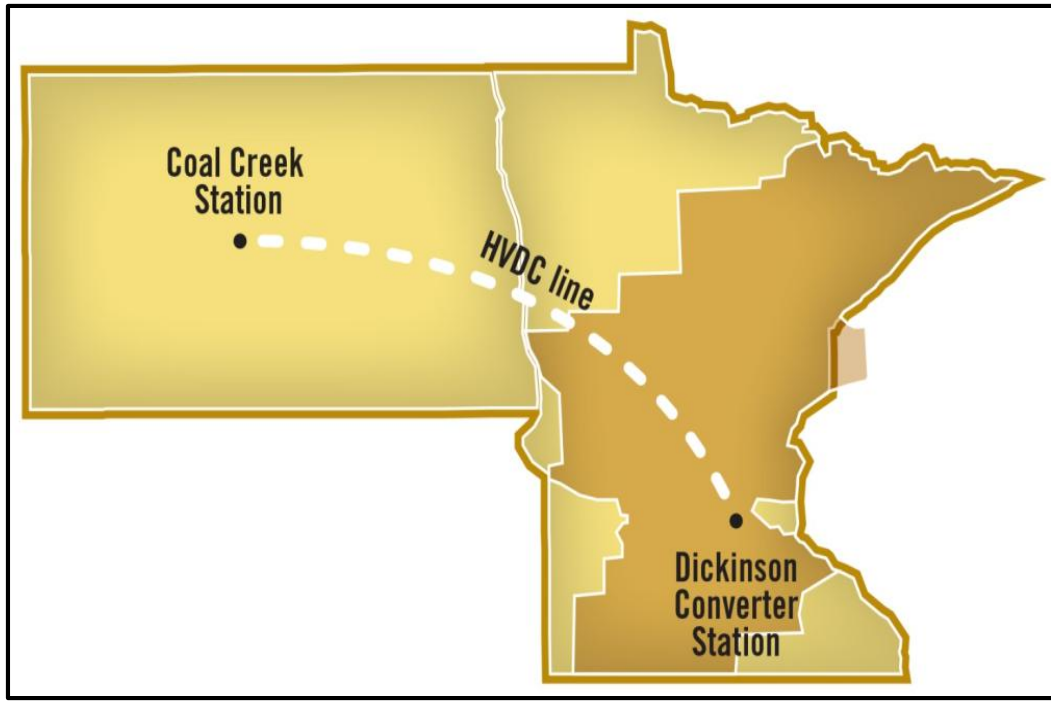
- Less right-of-way than AC
- Flexibility with reliability
- 400 miles +/- break even point
- Losses are less than AC

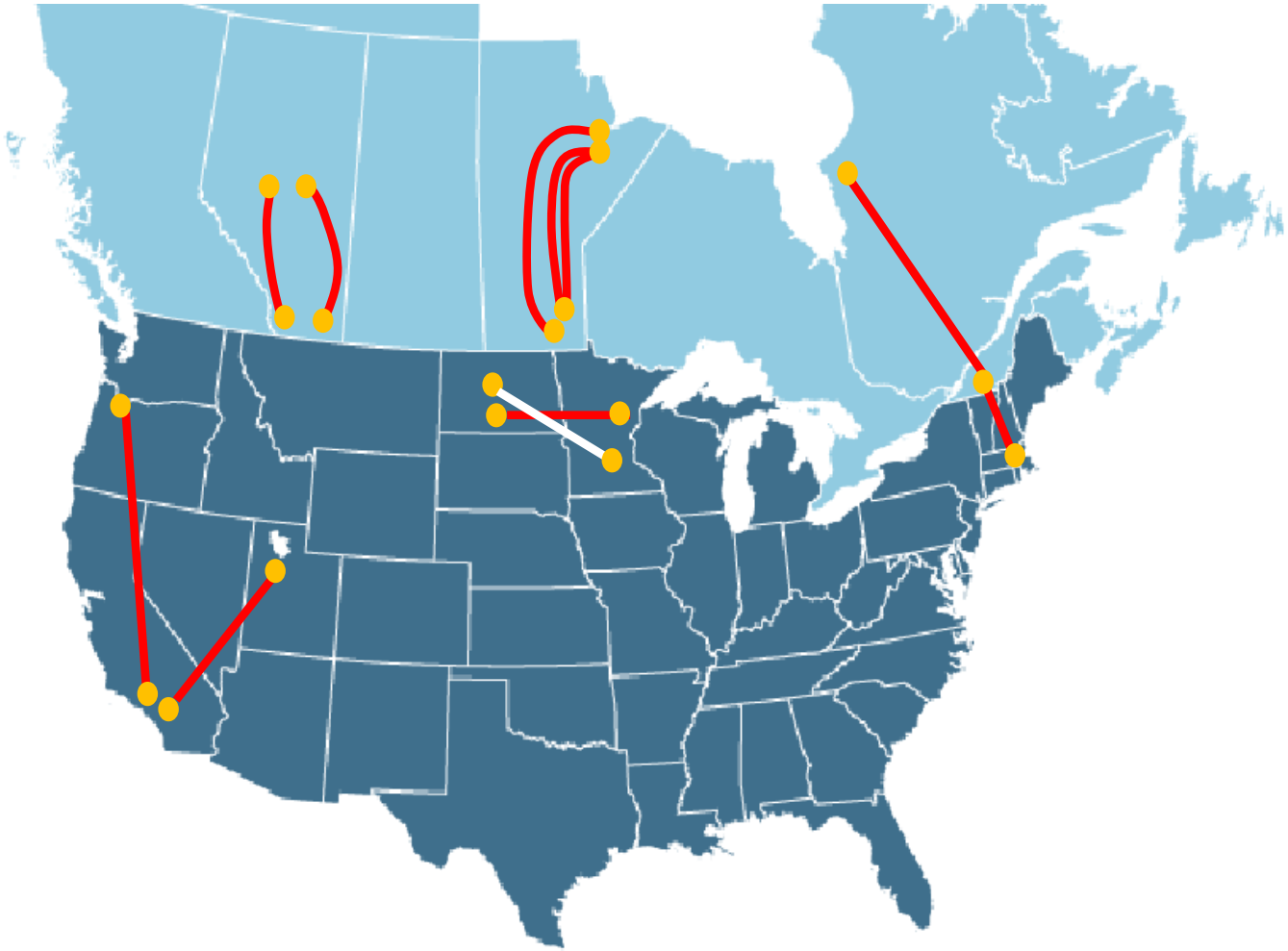

courtesy of ABB

# CU HVDC system key facts

- Voltage: 405 kV
- Capacity: 1,115 MW
- Mileage: 436 miles
- Energized: 1978 (40 yrs)
- Original cost: $250 million
- World class reliability



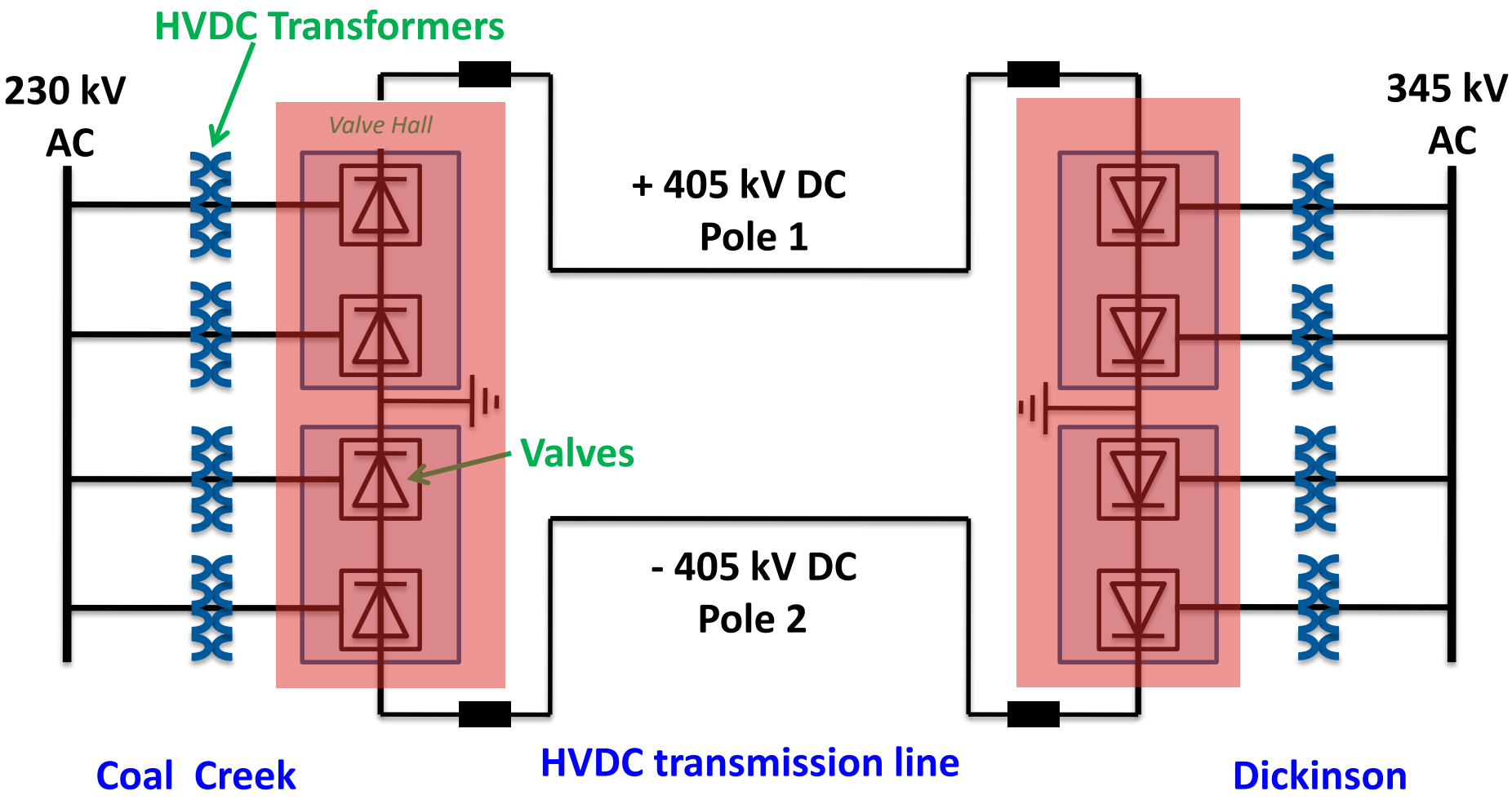
# HVDC systems are unique



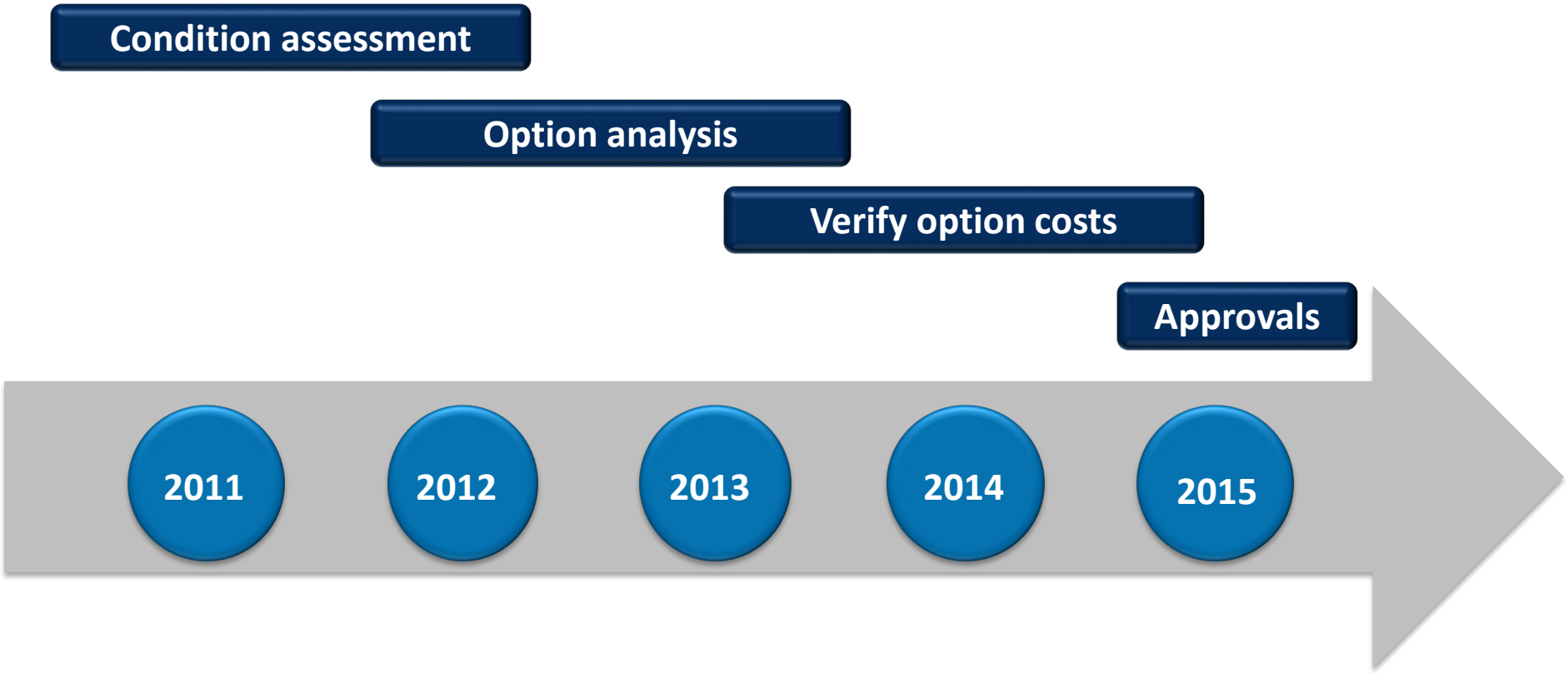
# Coal Creek Energy Park

# Dickinson Converter Station

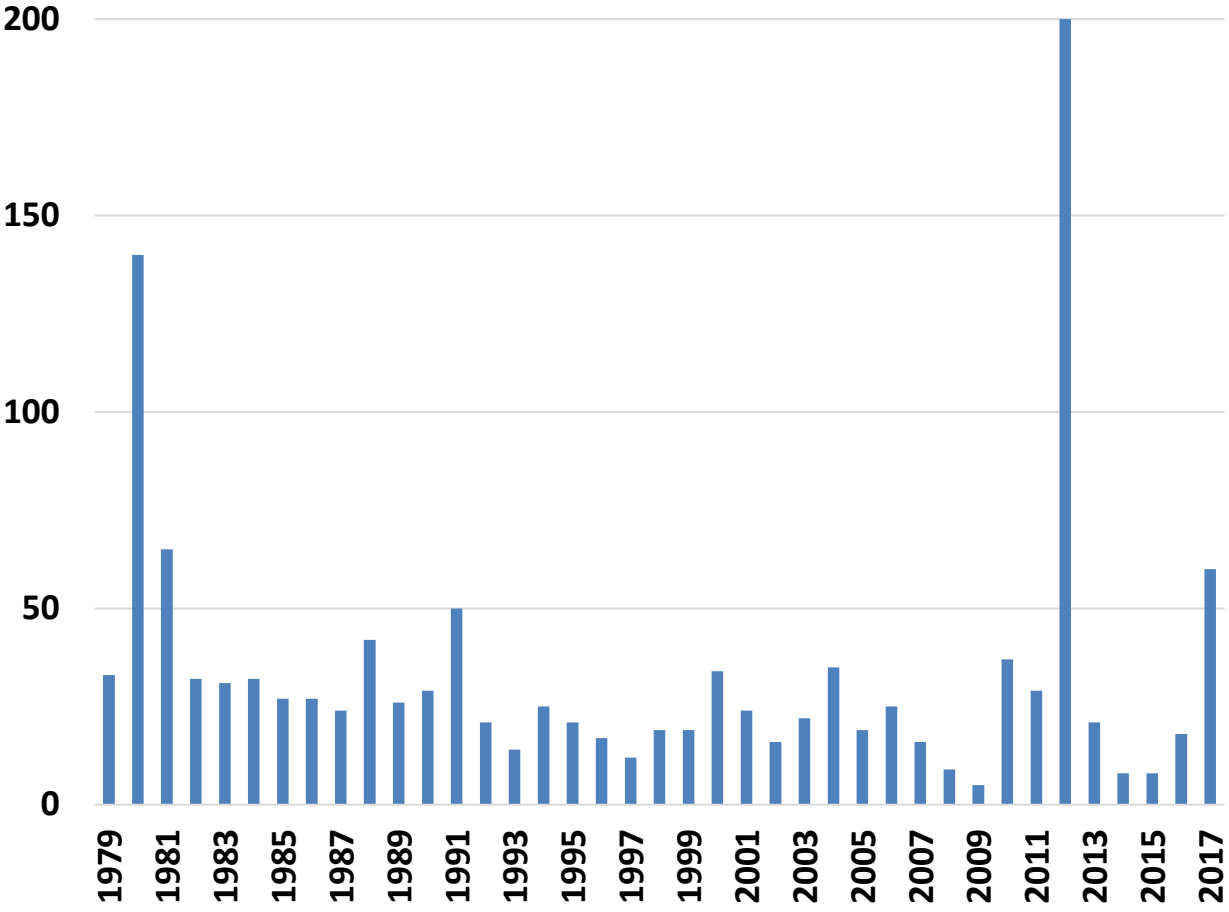
# HVDC system diagram



# HVDC project path



# Thyristor failures



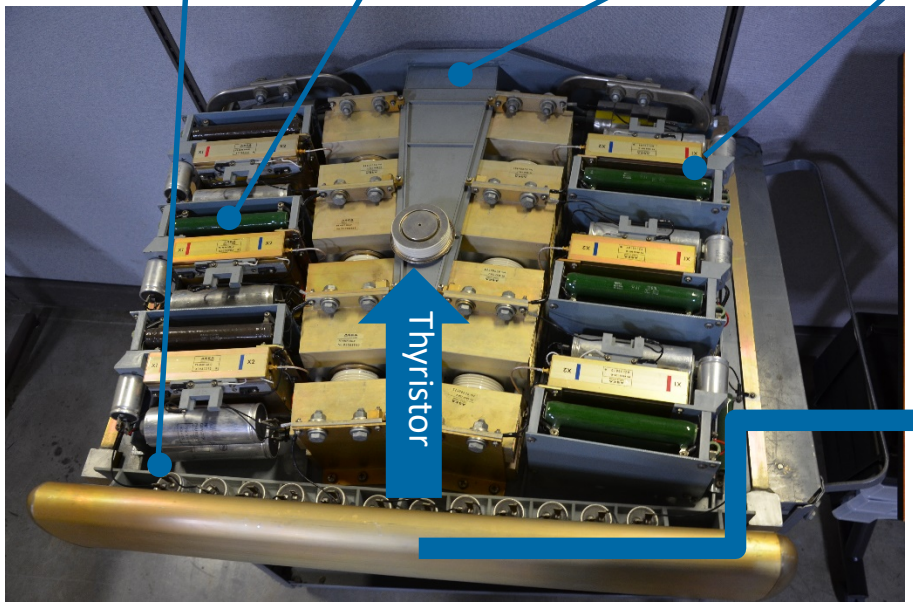

# Operational risks

#2 – Thyristor protection

#4 – 1970's components obsolescence

#1 – Capacitors oil filled/fire risk

#3 – Cooling system complexity

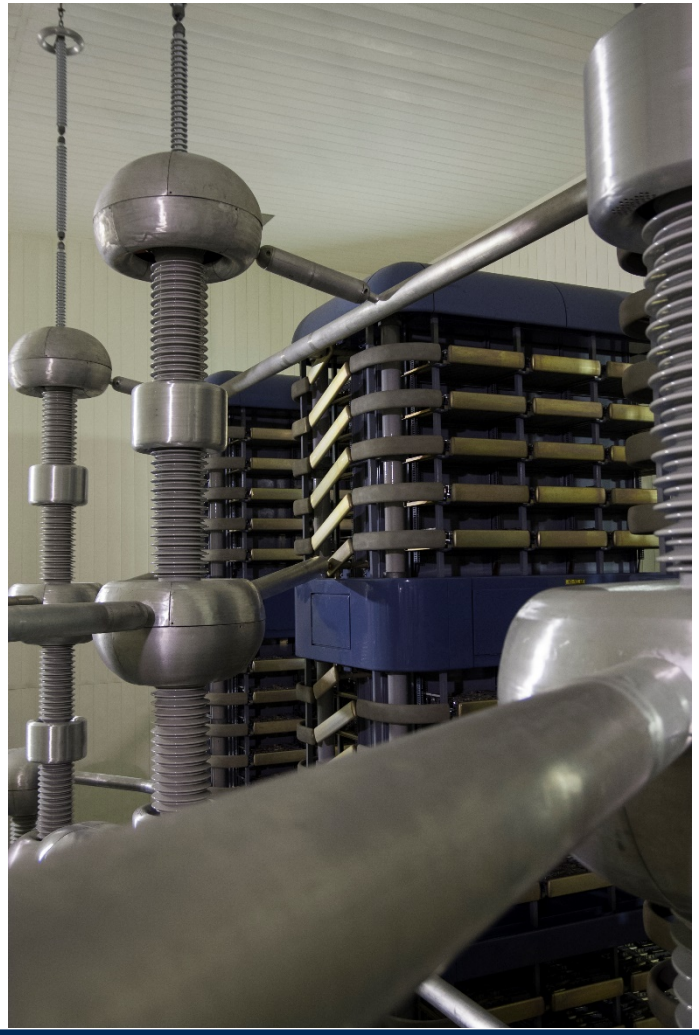



# Cooling simplification



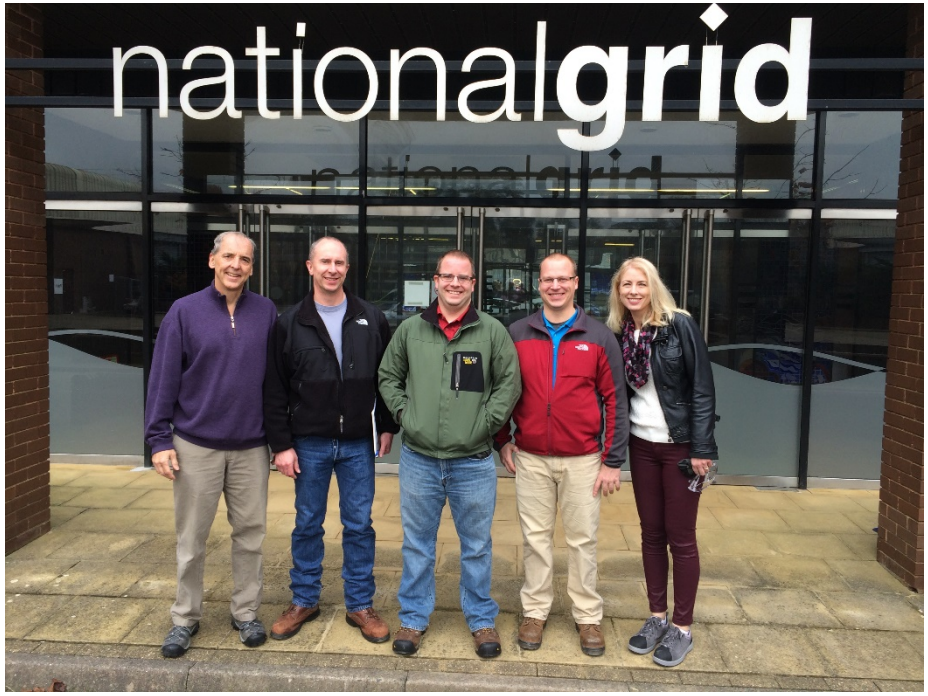

# Identify options

- Minimum Maintenance
  - Reliability
  - Spare Parts
- Refurbishment
  - Transformers/Valves
  - Generation outage timing
- Build new
  - Higher up front cost
  - Outage independent



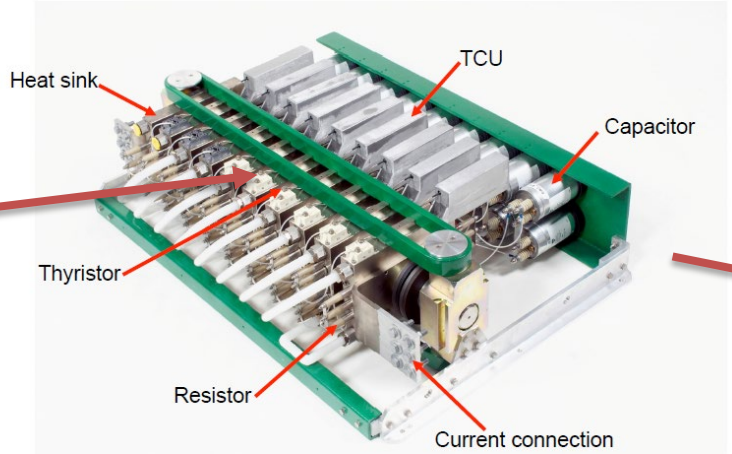
# GRE due diligence

- Plan for 30+ years of operation
  - Opportunity to push reset on the stations
  - Need to think long term needs
  - GRE is an active participant
- Project specification
  - Over 1,500 pages
  - 1 year to complete
- Learn from others
  - Build relationships
  - Administrative burden



# Upgrading the HVDC system

New technology




# HVDC project budget

- Project Contract
  - 1 year to negotiate
- Payment schedule
  - Removes unknowns
- Contract is key
  - Sets expectations

## ABB wins $130 million order to upgrade HVDC power transmission link in the US

Converter station life extension will enhance grid reliability and facilitate efficient power transmission.

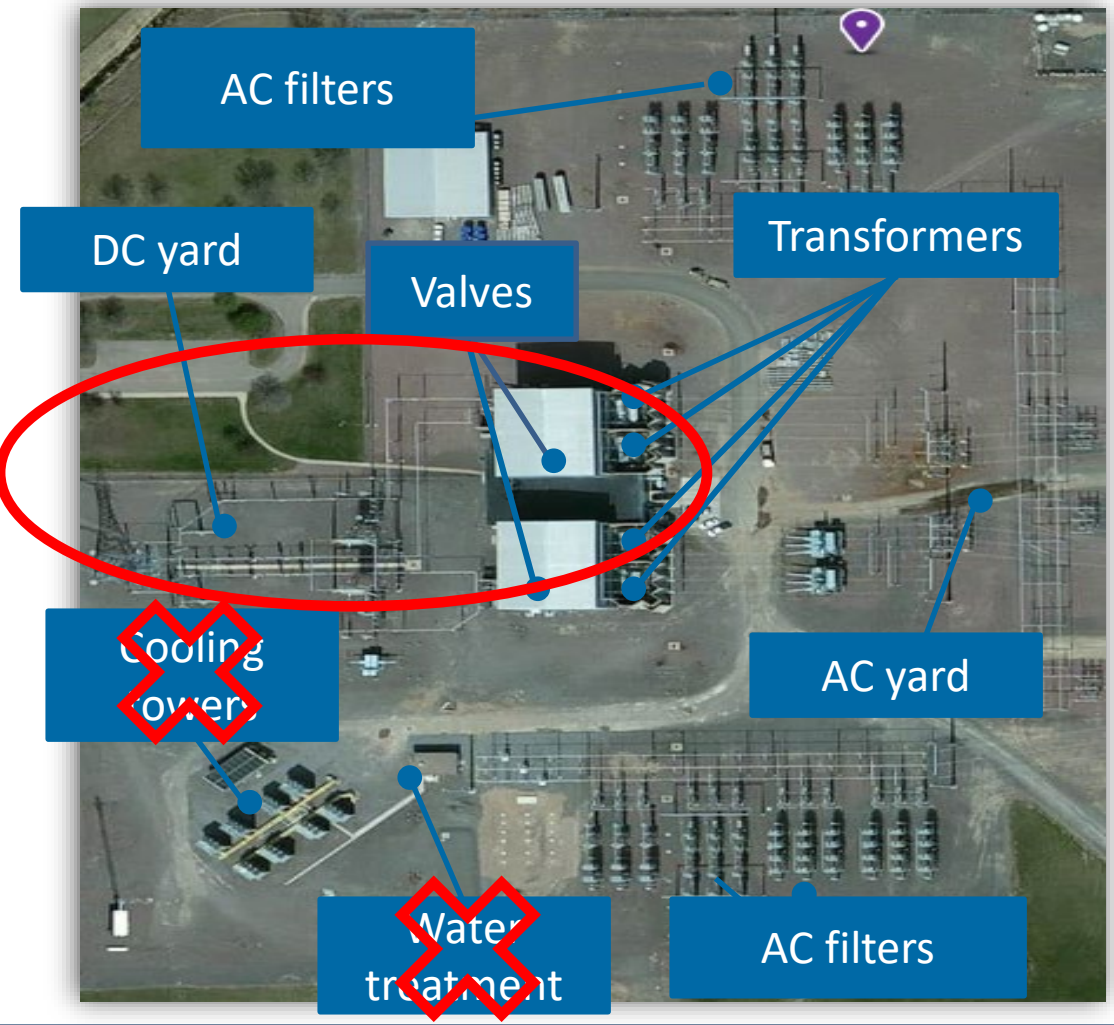

Map of the HVDC power transmission link

Zurich, Switzerland, February 3, 2016 – ABB, the leading power and automation technology group, has received an order worth around $130 million from electric cooperative Great River Energy to upgrade an existing HVDC (high-voltage direct current) connection in the US. The ± 400 kilovolt HVDC transmission system provides a vital link for transferring 1,000-megawatts of electricity between Underwood, North Dakota and Buffalo, Minnesota, a distance of 700 kilometers. The order was booked in the fourth quarter of 2015.

# HVDC core team

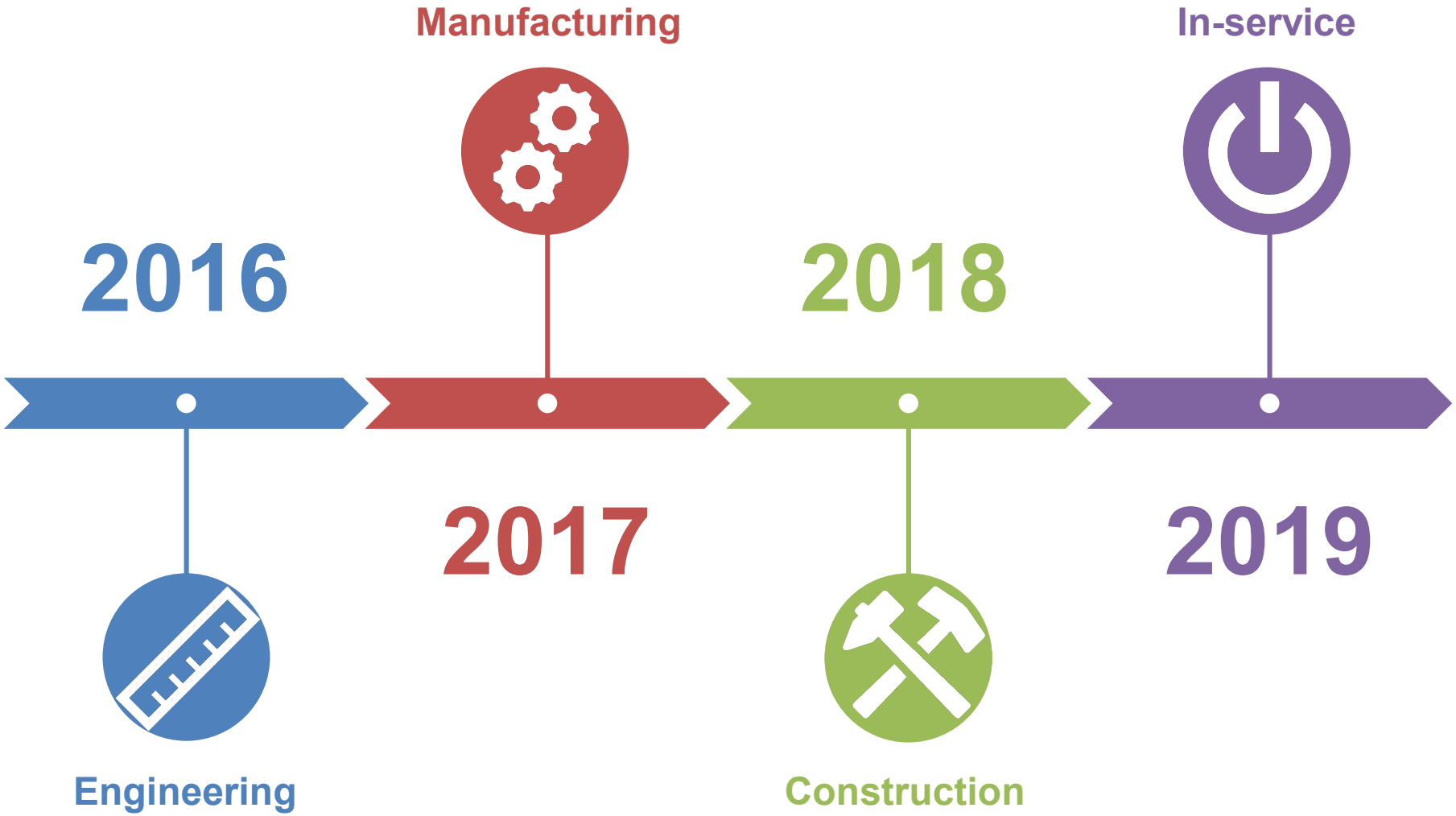
- Great River Energy team
  - Everyone is unique and has a specific role
  - Every department in GRE is helping
  - 32,000 engineering hours
- Teshmont
  - Owners engineer

# Project overview

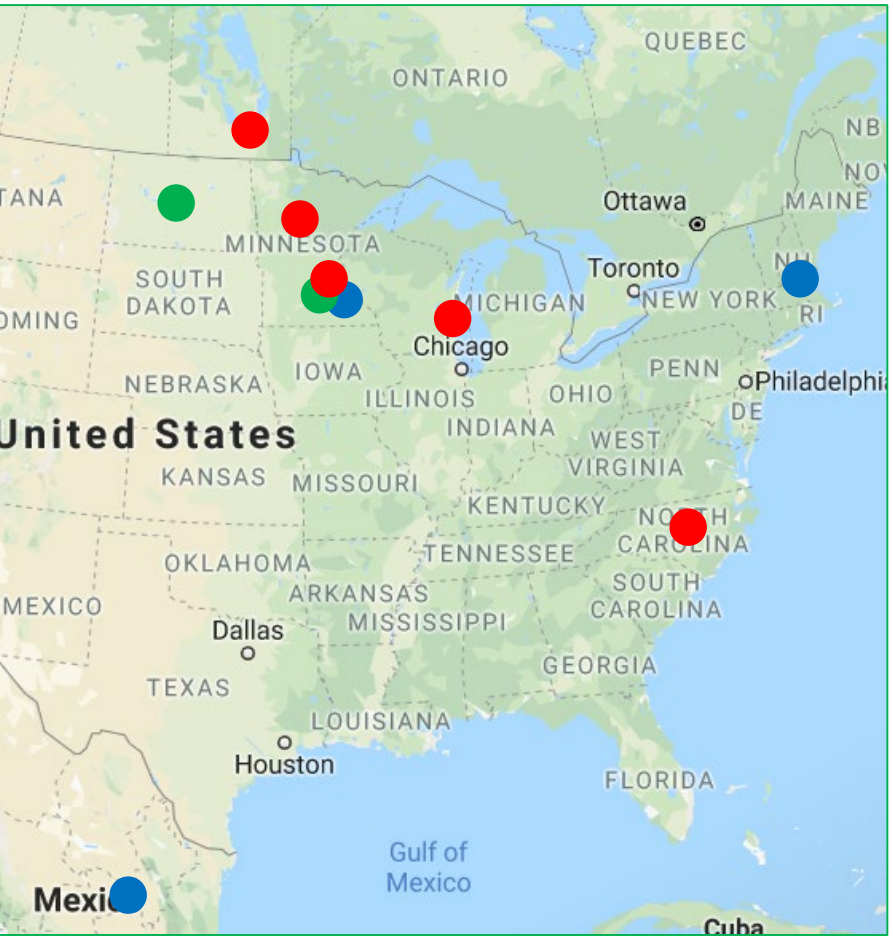


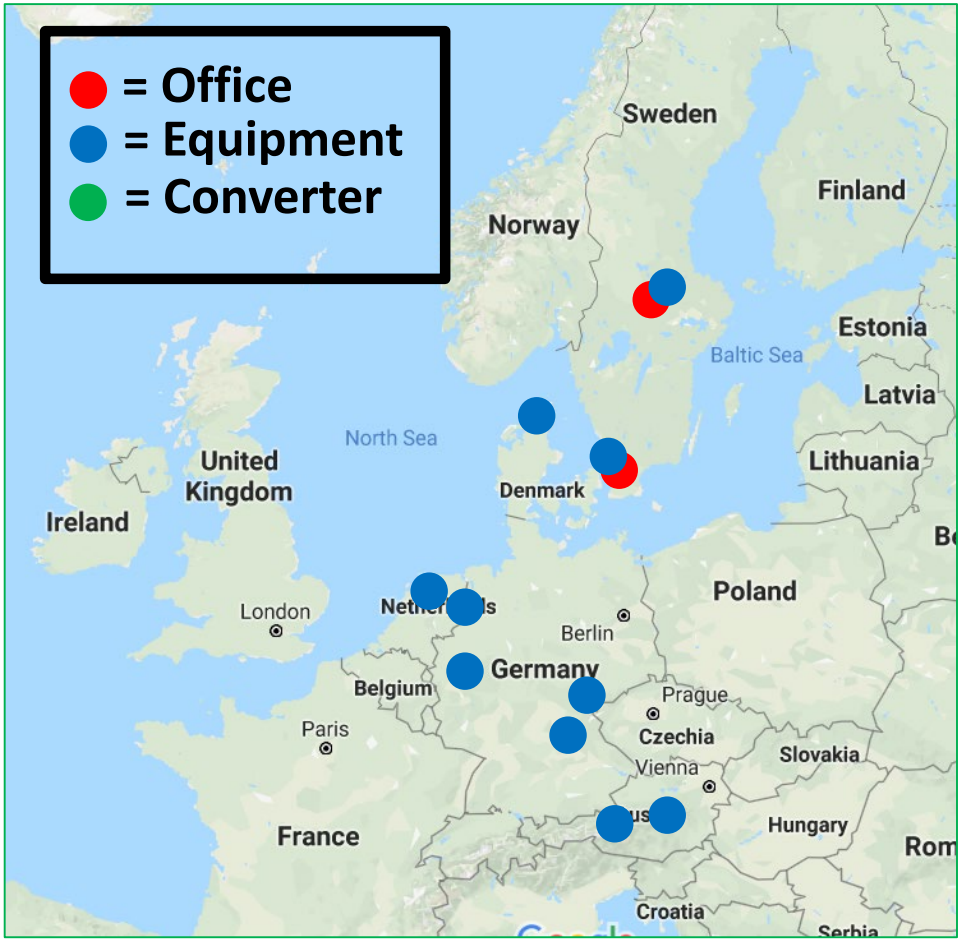

- In-scope: 2019 timeframe
  - Conversion equipment - valves
  - Controls
  - Cooling towers
  - DC yard
  - 7MW efficiency gains
  - 74 day outage
- Out of scope: transformers

# Project schedule



# Project communication



# Engineering

- Total documents 1,638
  - Total pages 16,475 and counting
  - Closed documents 90%

- Significant overseas travel
  - 345 person days

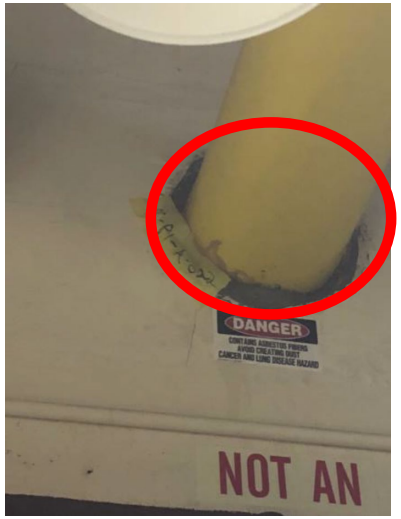
- SharePoint helps the administrative burden

# Plan ahead

- Put the tools in place for success
  - Action items list
  - Contract deliverables
  - Interface agreement
- Build relationships
  - ABB / GRE / Teshmont / etc.

# Safety

- What can be done better
  - Specific health, safety, and environmental plan for each site
  - Station lighting
  - Station communication
- Environmental risks
  - Two independent reports
    - Lead paint
    - Asbestos



# Valve – old vs. new

# Cooling system overview

# Smoothing reactor

- Dry-core Smoothing reactors
  - 5 each site, one is spare
  - 30 ton each
  - 40’ in the air
  - 200mH each coil

# New controls

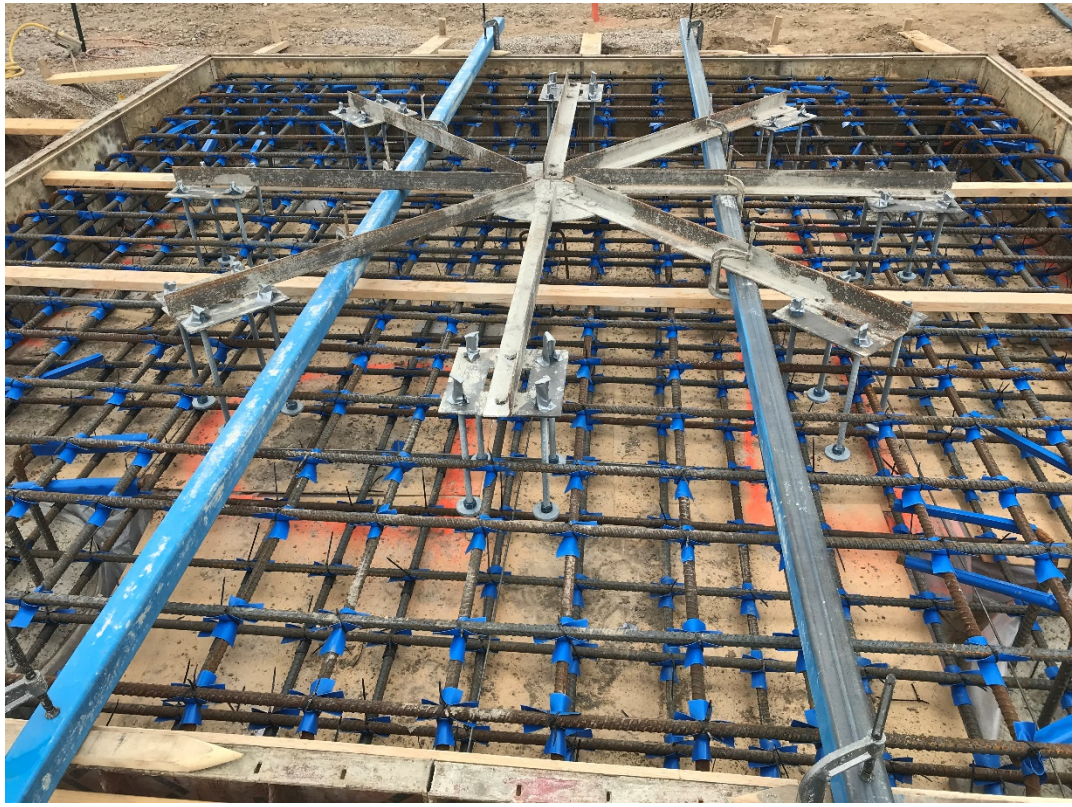
# 2018 outage plan

- Complete work safely and on time
- Reduce risks related to 2019
- Complete all underground outage dependent work
- Gain lessons learned

# Construction begins….

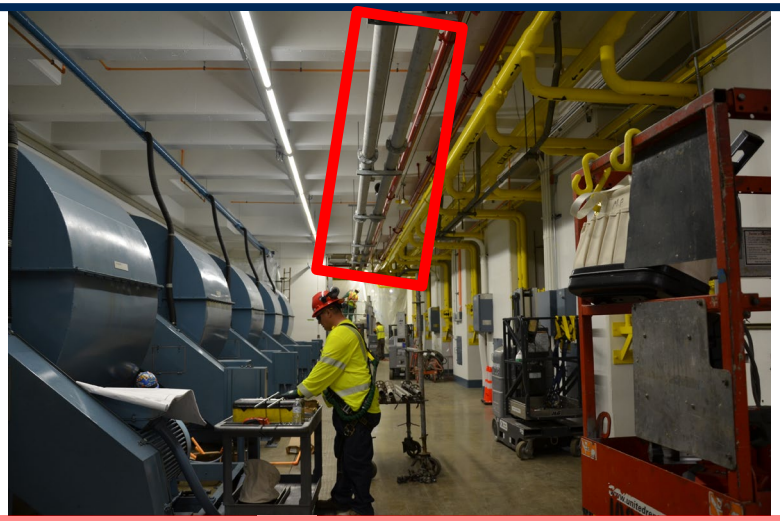
- Have a detailed plan
  - Have a plan for B, C, D
  - Things will not always go to plan
  - Level of preparedness depends on risk
  - Safety, Safety, Safety

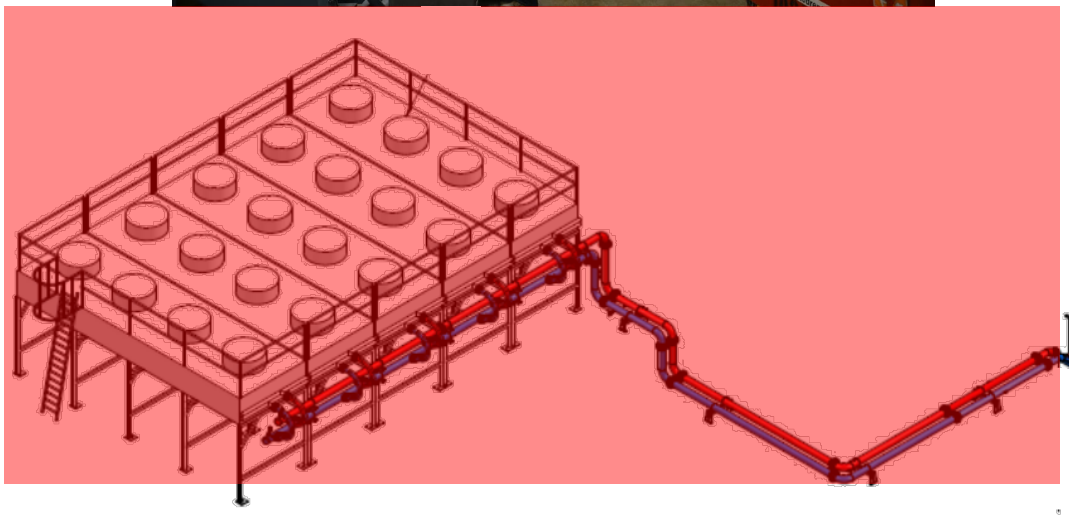
# Dickinson pipes/foundations

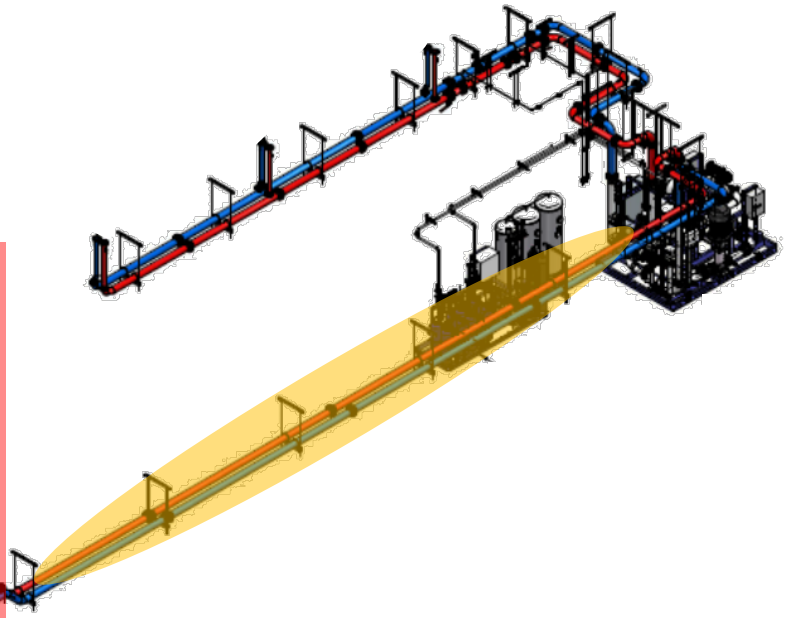



# Coal Creek saw cutting

# Cooling system overview







# Basement wall

# 2018 Dickinson work

# 2018 Coal Creek work

# 2019 outage plan

- 74 day total outage
- Schedule is critical, no stone left unturned
- Build in safety measures
- Weigh risks and plan, plan, plan

# Questions