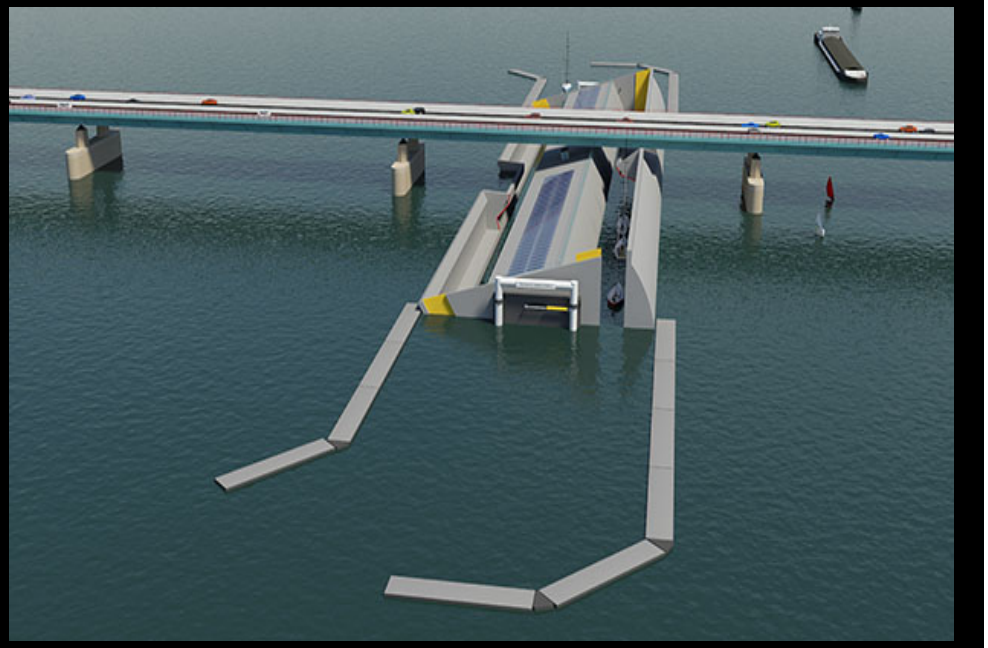
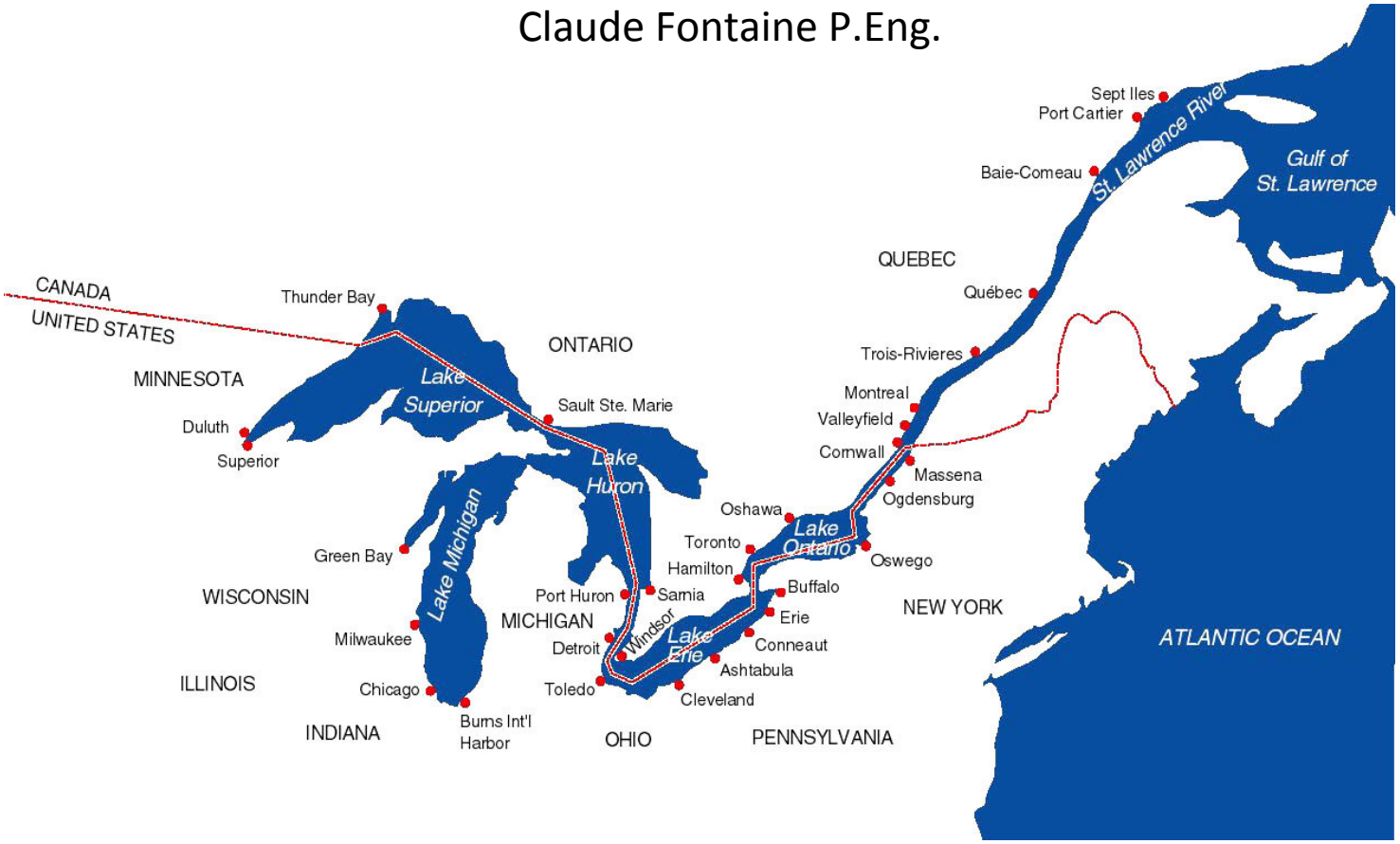


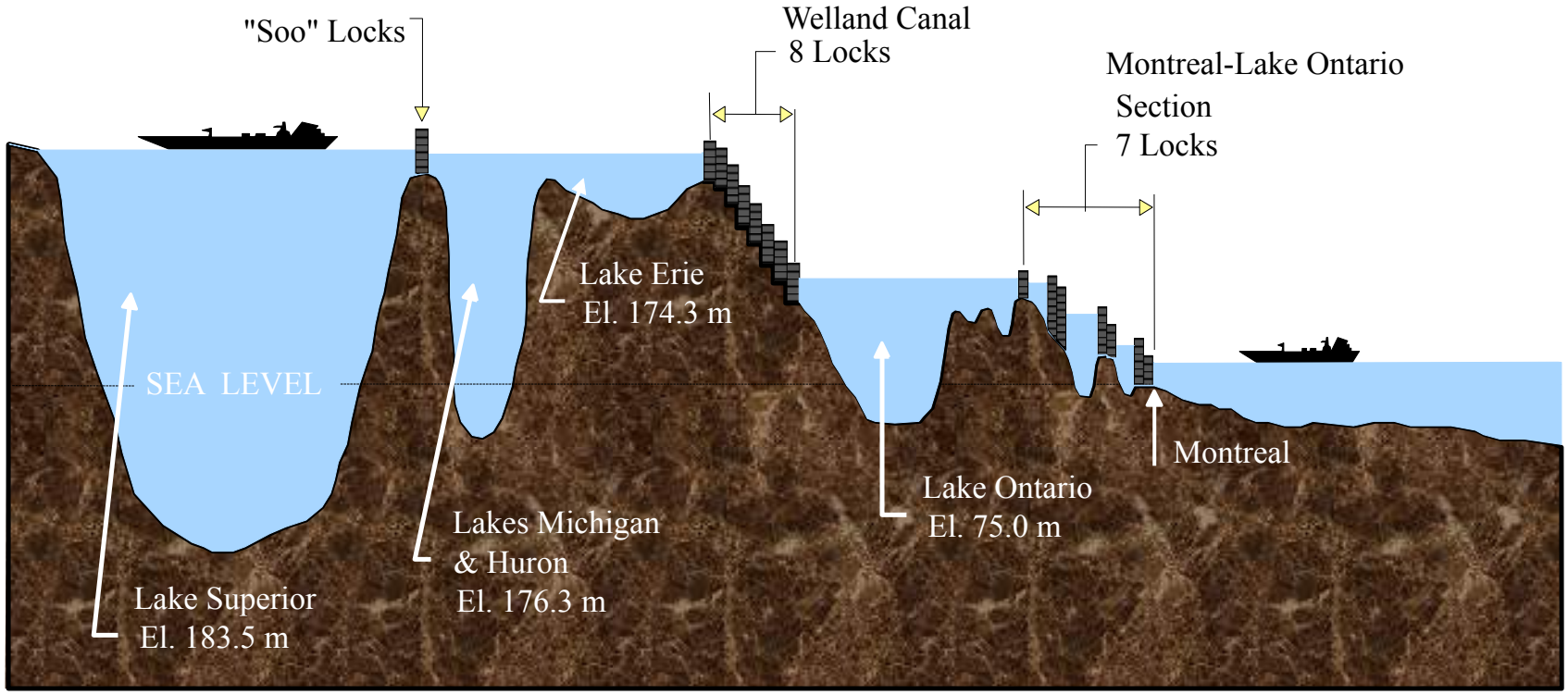
The Great Lakes St. Lawrence Seaway System

Claude Fontaine P.Eng.



Transport Canada Transports Canada
Canada

The Great Lakes
St. Lawrence Seaway Profile



REPLACEMENT OF MOTORS AND STARTER PANELS IN BRIDGES AND LOCKS

By Claude Fontaine P.Eng.

2015-02-10

Saint Lawrence Seaway Management Corporation

Presentation plan

- Seaway structures
- Project objectives
- Project challenges and strategies
  - Electric
  - Mechanic
  - Safety
  - Budget
- Project improvements
- Lessons learned
- Conclusion

Seaway structures

Seaway Structures

- Bridges

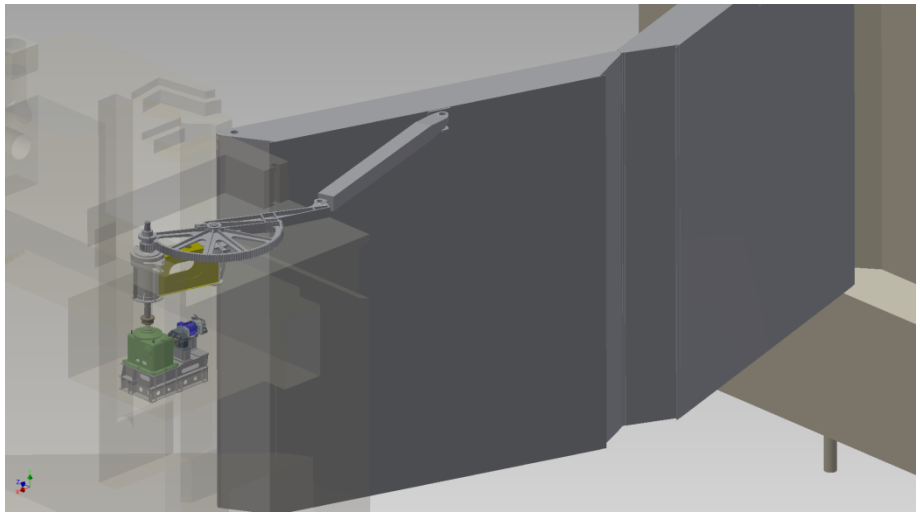
Lifting Bridges

Bascule Bridges

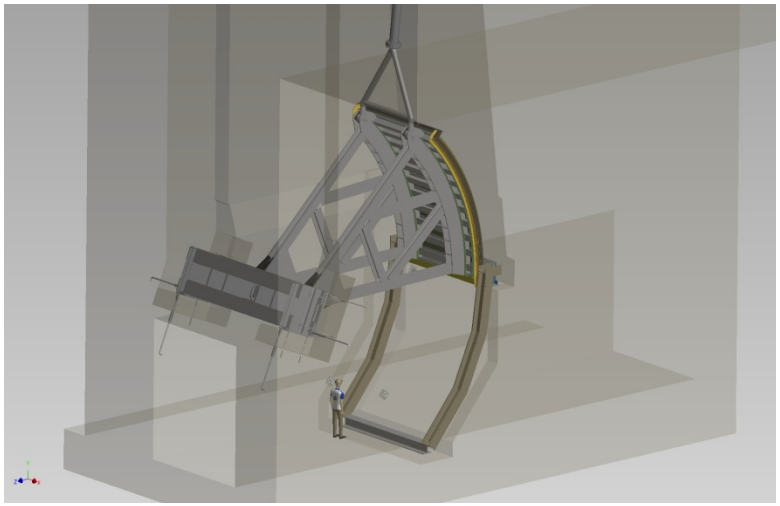
Seaway Structures

- Locks

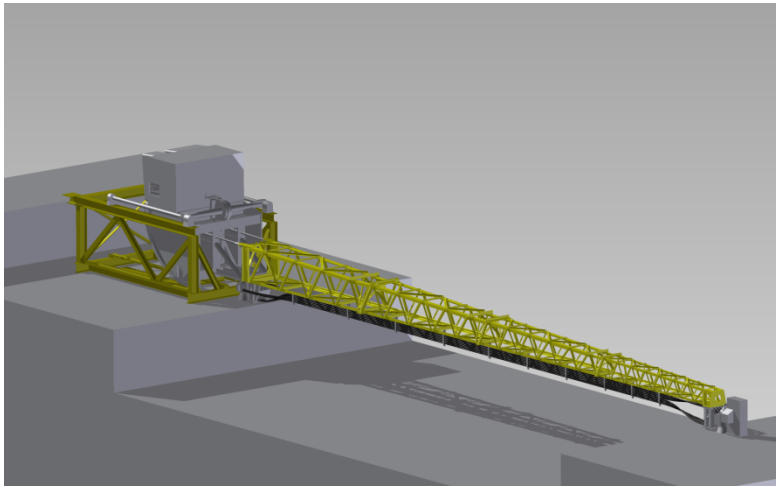
Gates



Valves



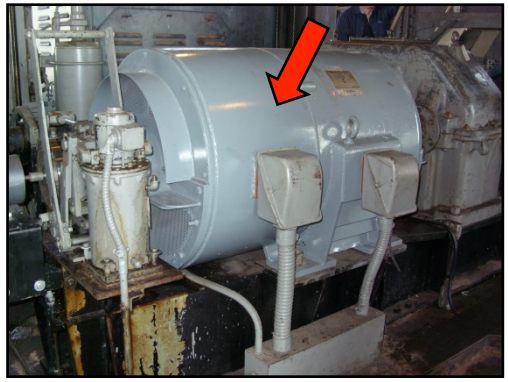
Ship arrestors



Project objectives

Project objectives

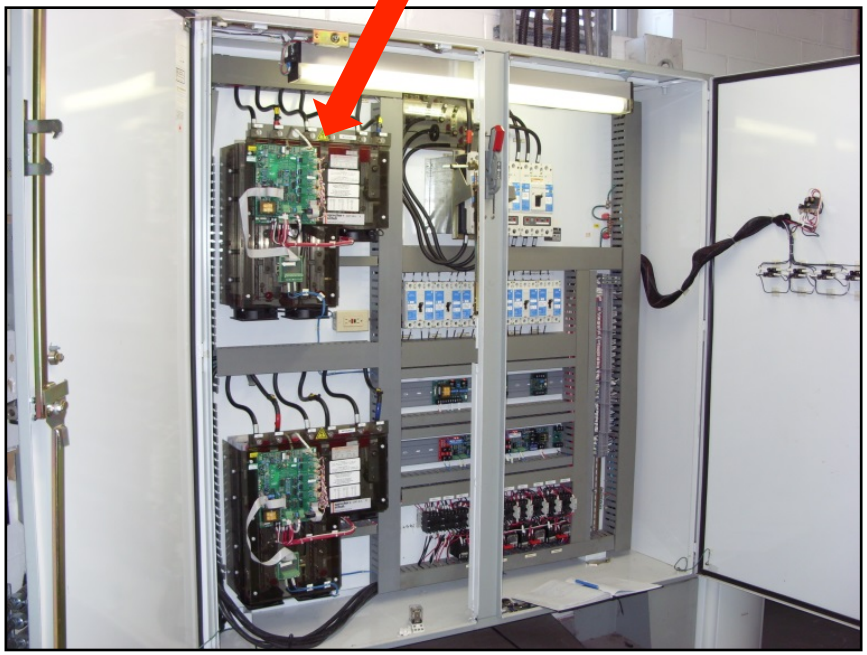
- Replace the main motors and the starter panels on ship arrestors, gates, valves and bridges.



Bridge wound rotor motor

Lock wound rotor motor

Soft starter



Starter panel

Project objectives

- Replace the external rotor resistances and all the cabling associated to that change.

Bridge wound
rotor resistances

Lock wound
rotor resistances

Project challenges and strategies

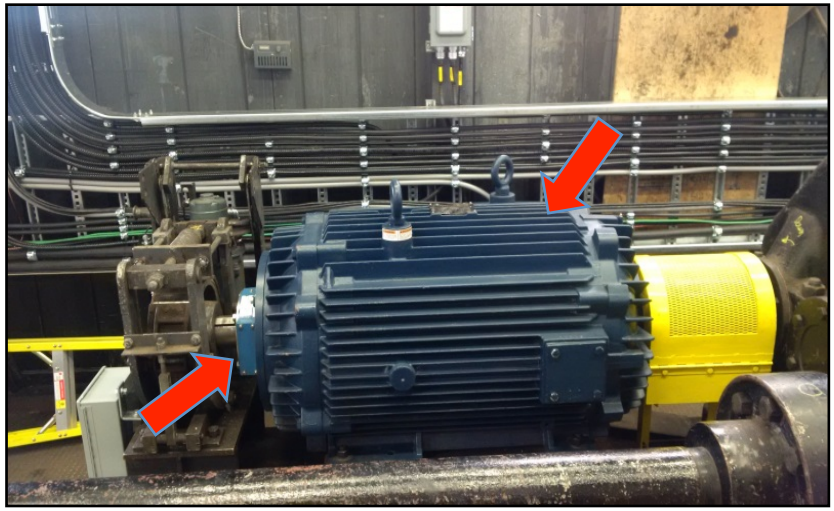
Project challenges and strategies

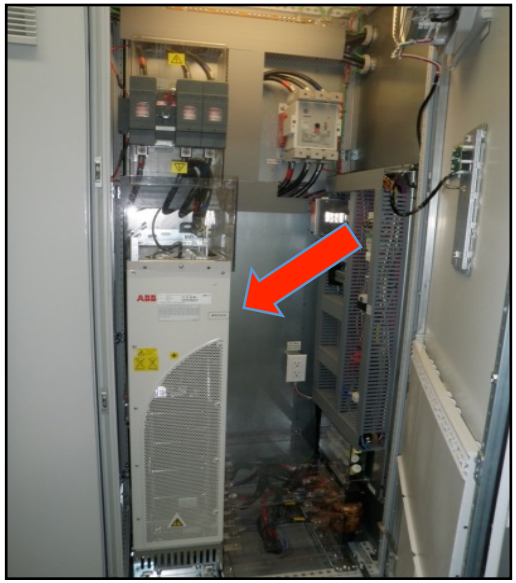
- Electric
  - Make a study
    - Define the torque requirements and the mechanical limits

Theoretical calculations		Bridges					
		2	3	9	10	7A	7B
Bridge torque (ft-lbs) (normal operation/motor)	Starting	1116	1116	1410	1510	1430	1430
	Acceleration	1134	1134	1285	1370	1235	1235
	Running	844	844	970	1040	978	978
Bridge torque (ft-lbs) (excessive operation/motor)	Starting	1516	1516	1730	1855	1680	1680
	Acceleration	1371	1371	1400	1475	1460	1460
	Running	1212	1212	1255	1335	1205	1205
Motor torque (ft-lbs) per motor	Normal	660	660	945	1030	960	960
	Excessive	800	800	940	1000	925	925
	Existing	970	970	973	973	970	970

Project challenges and strategies

- Electric
  - Make a study
    - Select the best value for the motor and the drive





Marathon motor (Bleu Max) with Avtron encoder
- Class H insulation (195ºC)
- 200 % of the rated value (1 min.)
- Vector duty
- Speed ratio 2000:1 (0,8 to 1750 rpm)
- Bearing life time (100k hours)
- Squirrel cage

ABB (ACS800) drive
- Master/slave and individual control
- High peak current (200%, 10 sec.)
- Precise speed (0,01%) and torque loop (±1%)
- Brake control

Project challenges and strategies

- Electric
  - Make a study
    - Define the control strategy
      - Speed control by the drive
      - Brakes control by the drive
      - PLC supervise the drive
      - Ethernet communication
    - Define the safety requirement
      - Overspeed detection
      - Communication lost detection
      - Emergency device selections

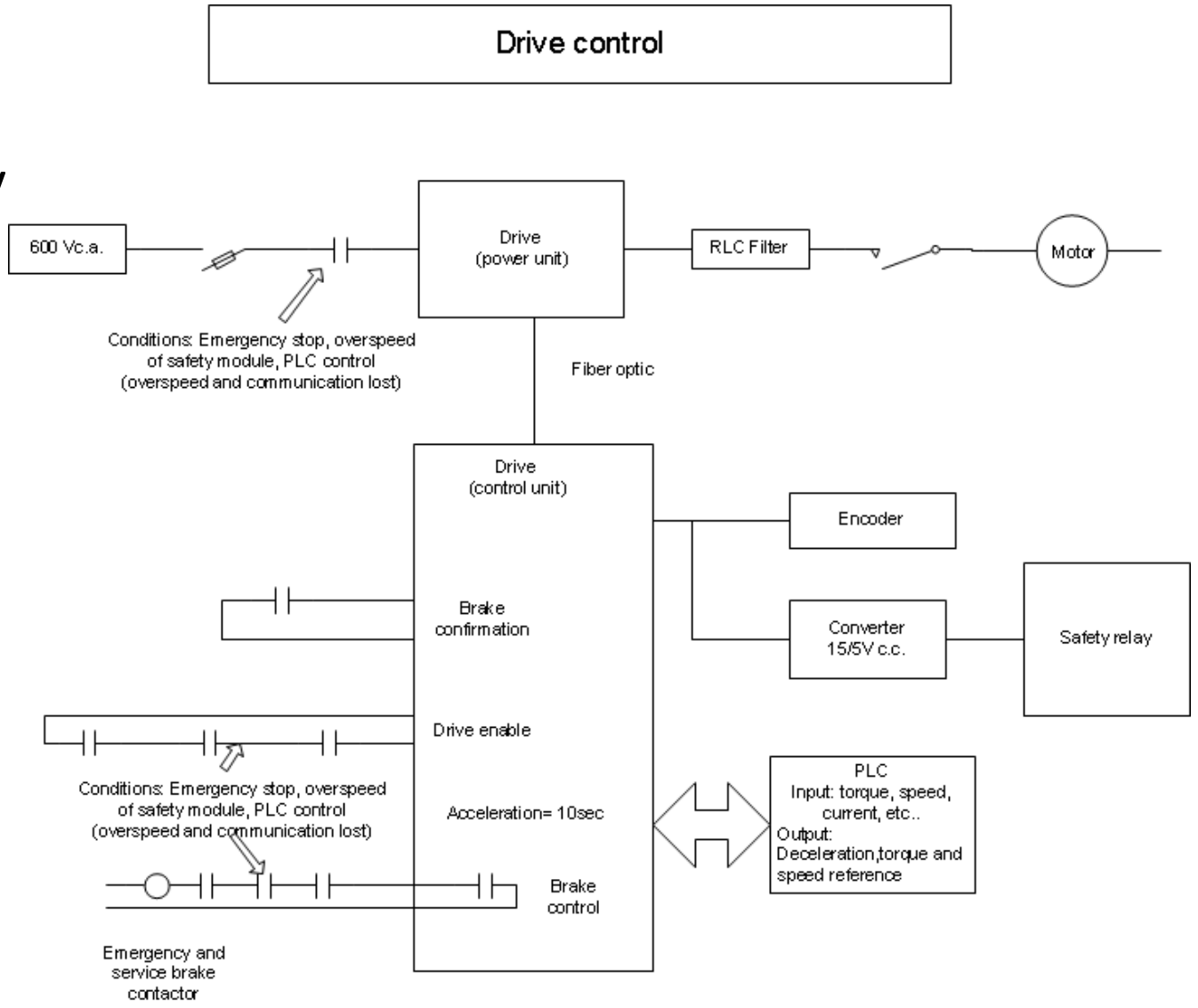
Safety Contactor

Safety
Overspeed relay

Project challenges and strategies

- Electric

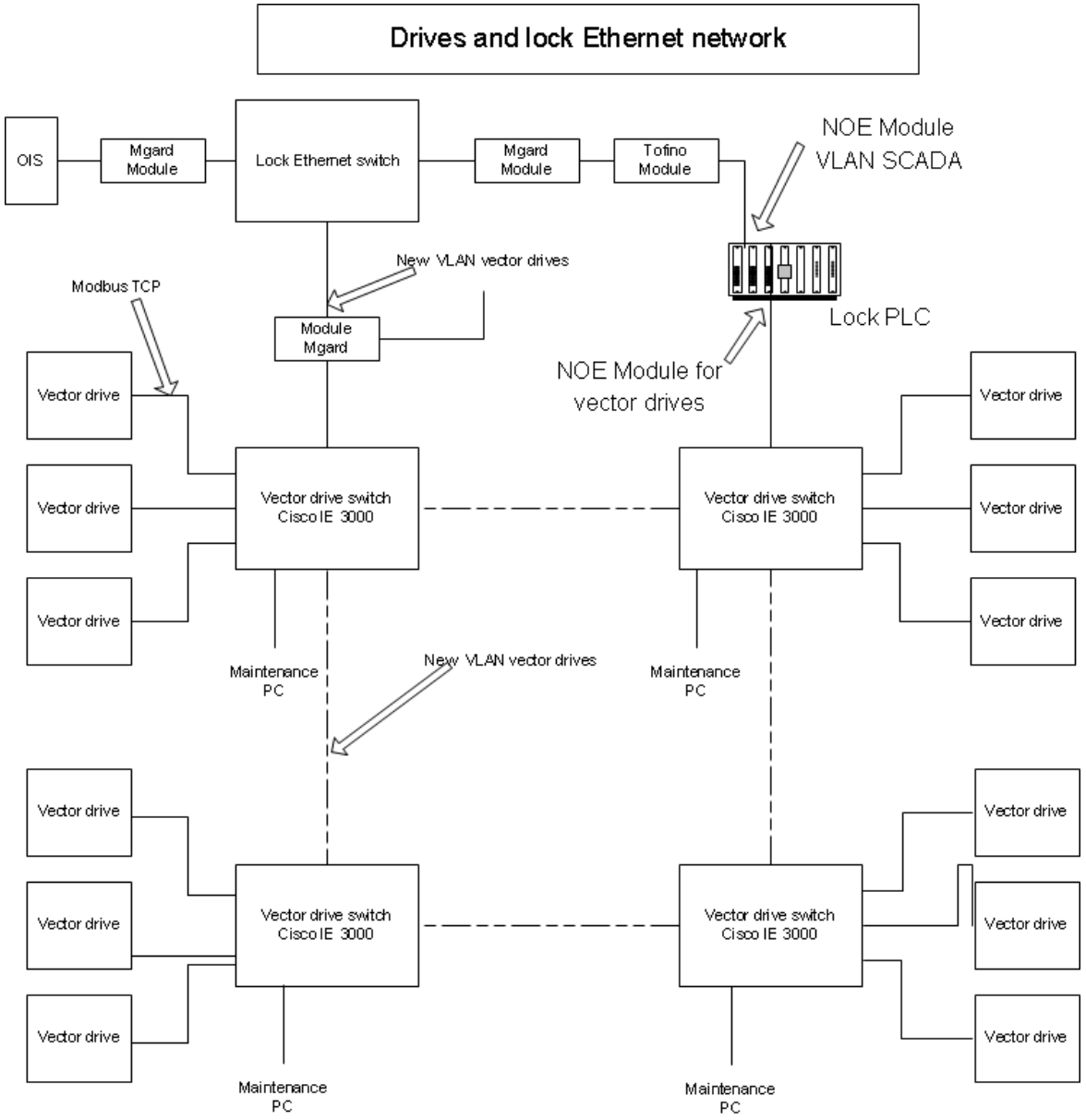
- Make a study
  - Control strategy
  - Safety requirement



Project challenges and strategies

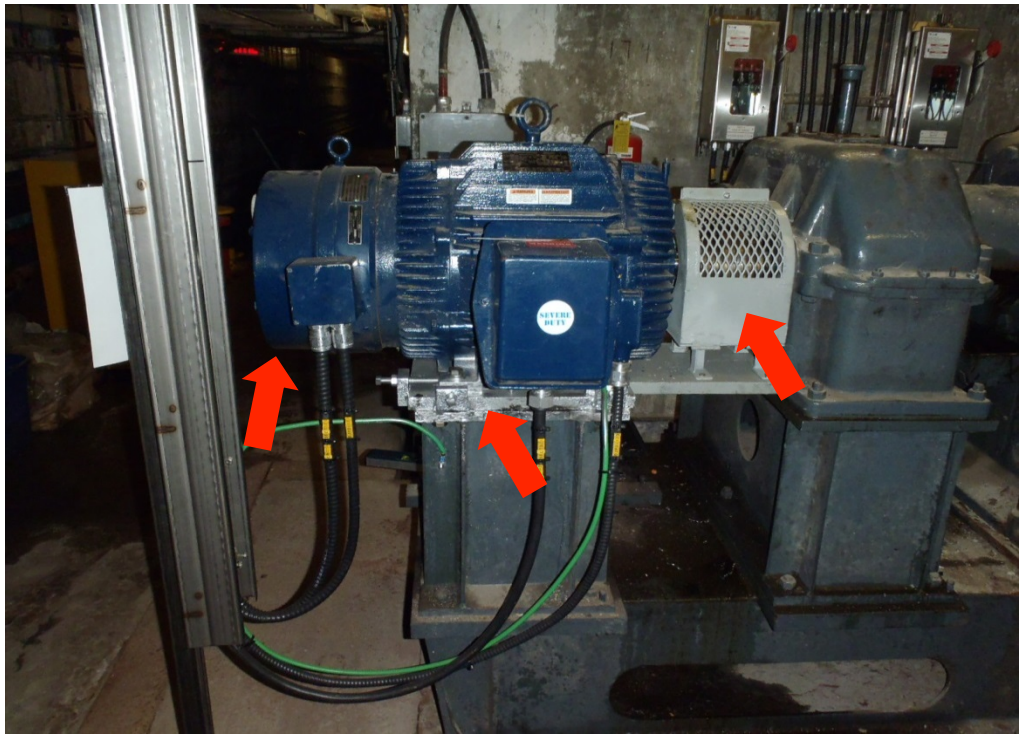
- Electric

- Make a study
  - Ethernet communication



Project challenges and strategies

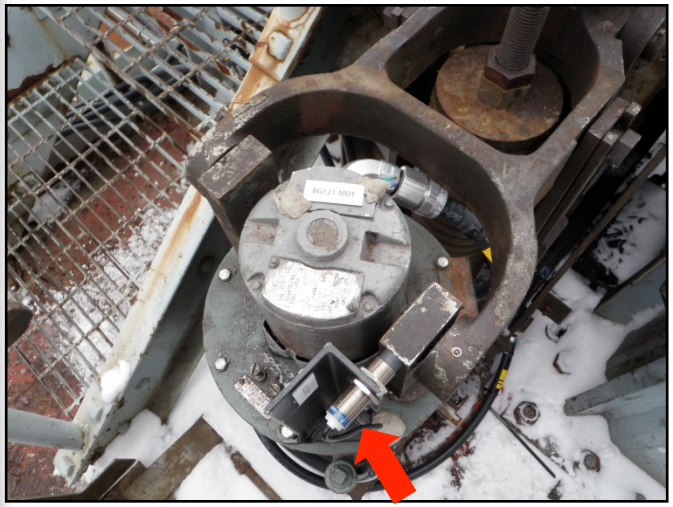
- Mechanic
  - Design a standard transition base incorporating the service brake and improve the protection



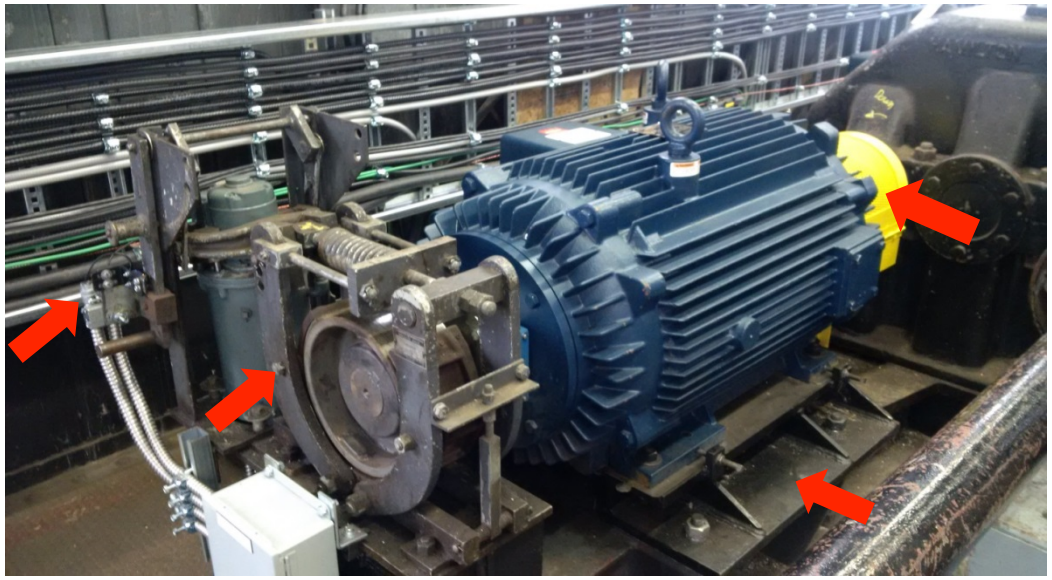
Lock motor transition base and brake assembly

Project challenges and strategies

- Mechanic
  - Design a standard transition base incorporating the service brake and the position detector



Brake position detector



Bridge motor transition base and brake assembly

Project challenges and strategies

- Mechanic
  - Use the same motor couplings

Project challenges and strategies

- Safety
  - Optimize the security and work sequence to the worksite

Bridges 7A and 7B equipment rail transportation

Project challenges and strategies

- Safety
  - Optimize the security and work sequence to the worksite

Bridge equipment transportation security

Project challenges and strategies

- Safety
  - Optimize the security and work sequence to the worksite

Bridge machine room congestion

Project challenges and strategies

- Budget

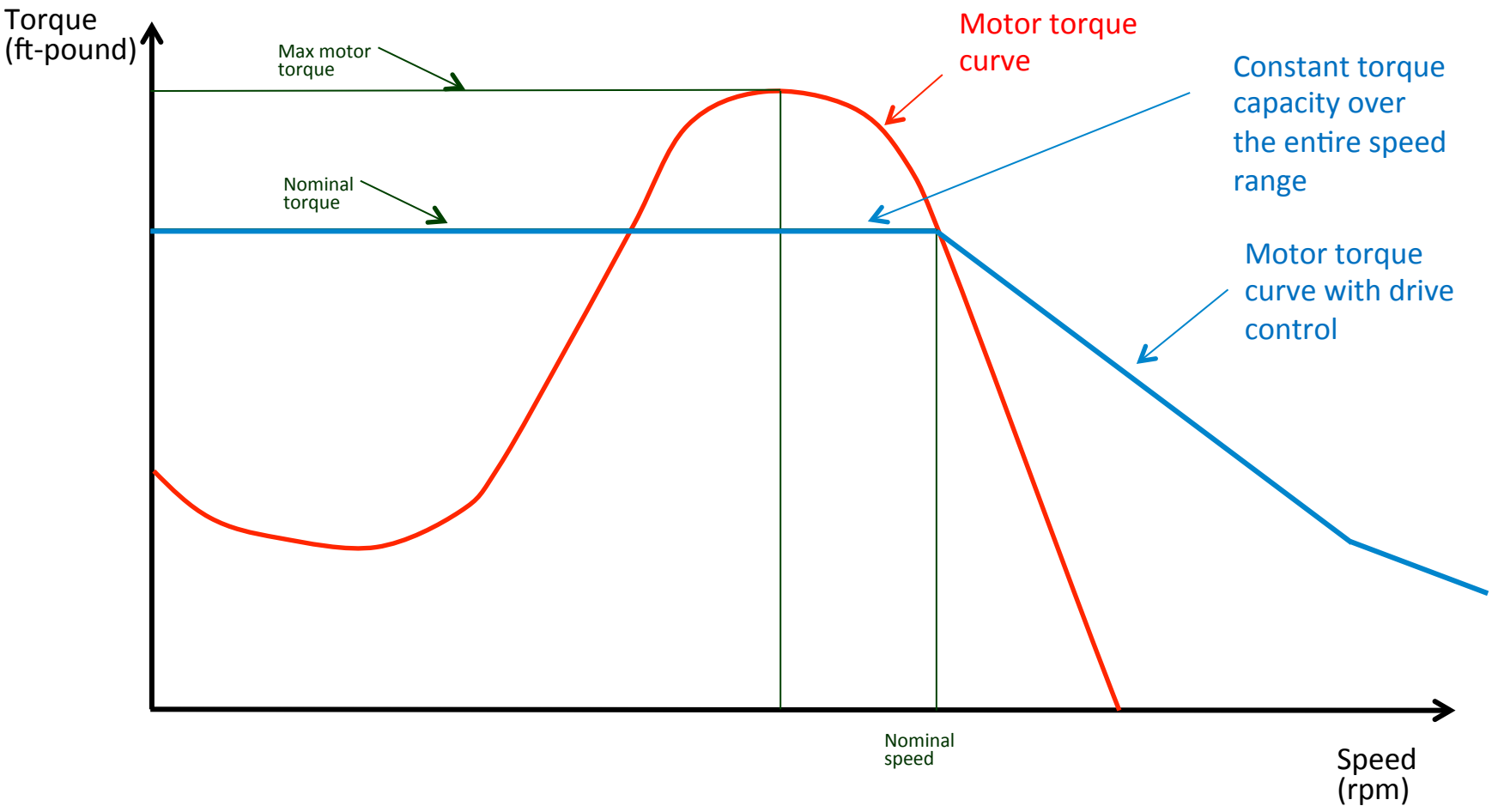
	Maisonneuve region budget			
Structure	Contract	Material	Engineering	Total
Lifting bridge (one (1) 175hp motor)	190 000 $	245 000 $	158 000 $	593 000 $
Lifting bridge (two (2) 175hp motors)	286 000 $	220 000 $	125 000 $	631 000 $
Bascule bridge (one (1) 75hp motor)	239 000 $	120 000 $	127 000 $	486 000 $

Note : The engineering include the worksite inspection

Project improvements

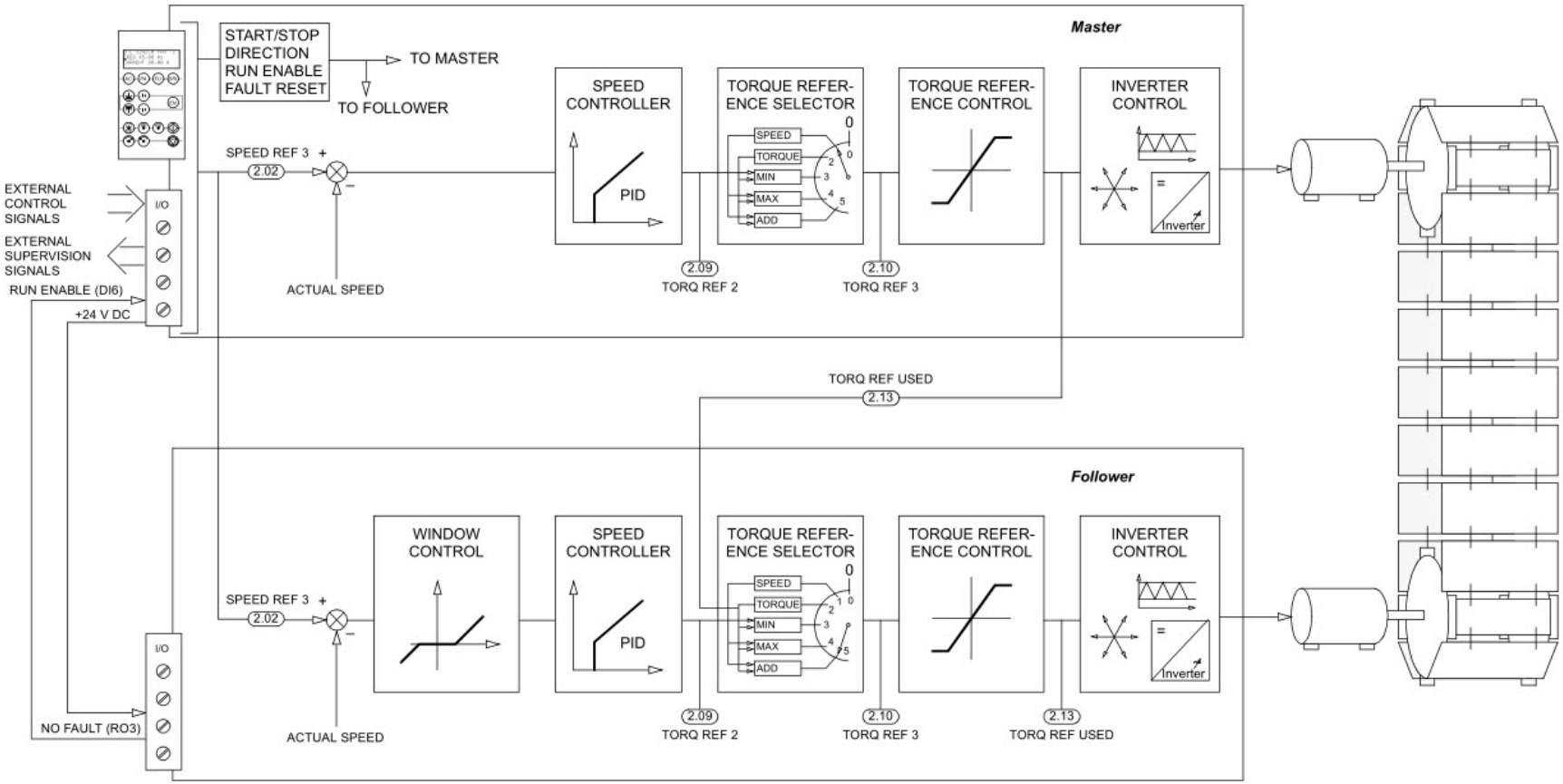
Project improvement

- Better speed, torque and braking control



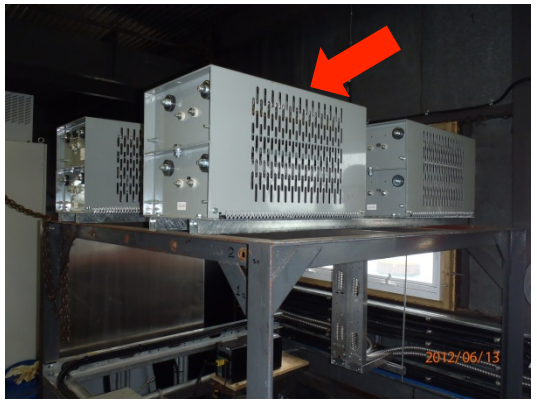
Project improvement

- Better speed, torque and braking control



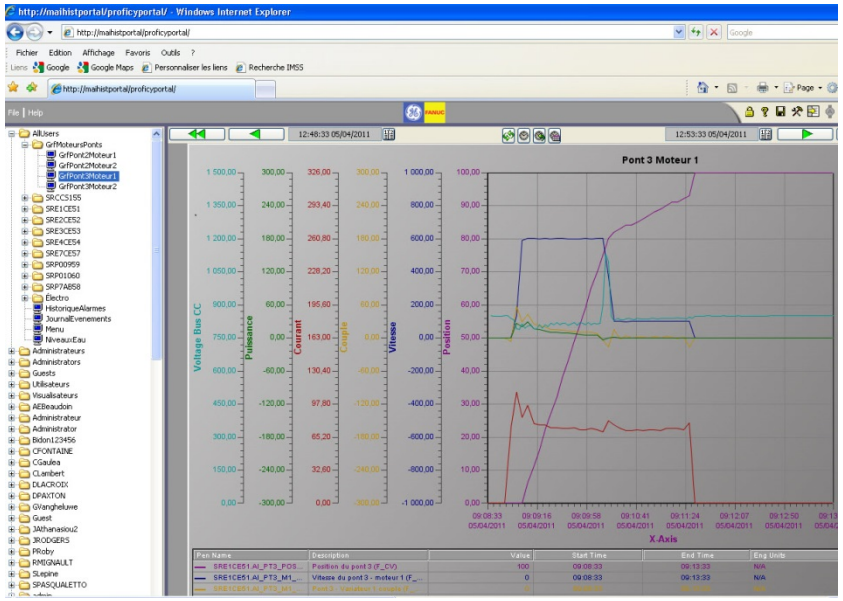
Project improvement

- Reduce mechanical stress and vibration



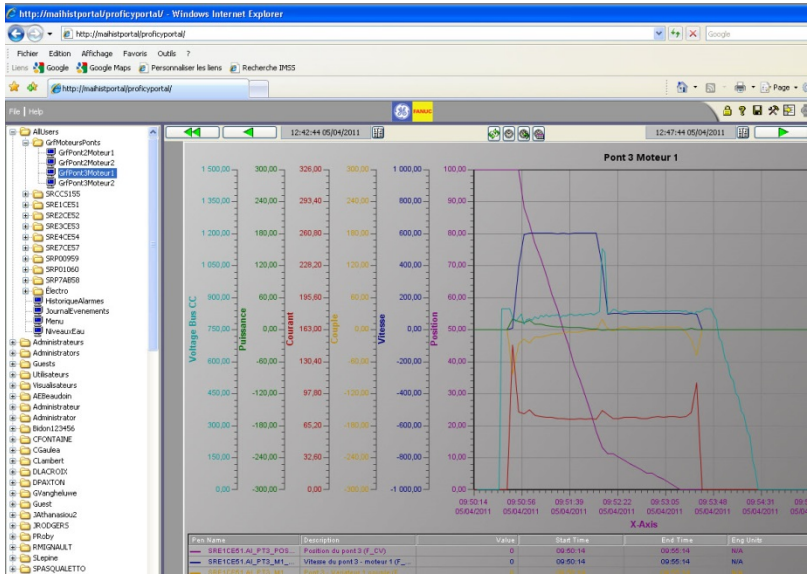
Project improvement

- Provide statistic performance for comparison (Historian)



Bridge moving up

Bridge moving down



Lessons learned

Lessons learned

- Make mechanical and electrical preparation, inspection and verification prior to the installation
- Select the right components and the right installation for noise immunity

Vessel
Radar
protection

Lesson learned

- Using drive integrator service on start-up
- The learning curve of the first installation is one year
- Repeatable adjustment
- Proceed with drive training every year to keep the knowledge and the efficiency
- Install vibration protection

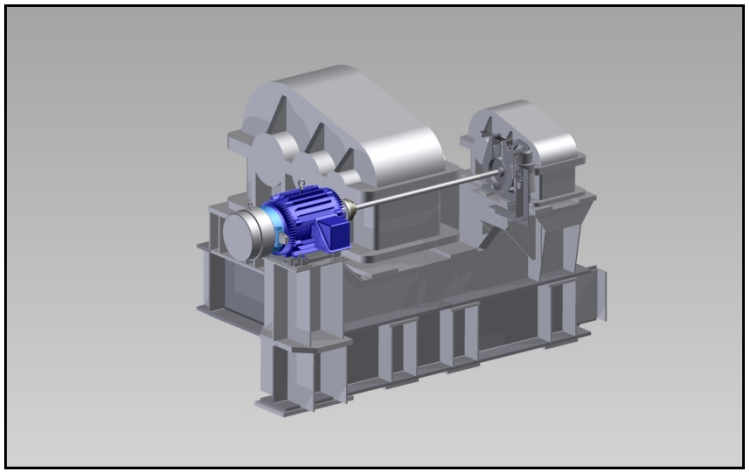
Conclusion

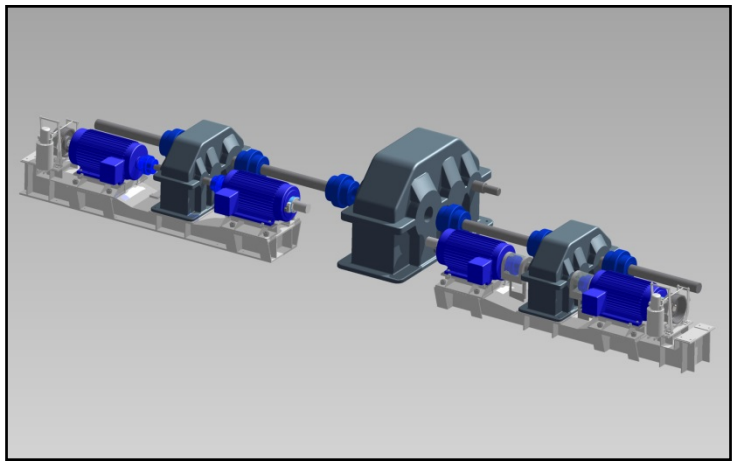
Conclusion

- The drive increases the performance and the flexibly
- Selecting the right strategy and design pays off

(study, engineering one (1) year before installation)

ANY QUESTIONS ?





Saint Lawrence Seaway
Management Corporation

ST-LAMBERT LOCK

Transport Canada Transports Canada
Canada

HWY H2O