Massachusetts Bay Transportation Authority

System-wide Power Assessment – Capital Needs

Fiscal and Management Control Board

October 7, 2019

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Summary

- **This presentation summarizes recent assessments of system wide MBTA electrical power system infrastructure**
- Objective of the assessment: identify power system infrastructure needing replacement or rehabilitation and prioritize over a 15 year period based on current asset information and identify best approaches for future asset condition assessments
- Identified as a task during the Capital Needs Assessment as an open action to better define the needed investment into the MBTA power network
- Replacement/rehabilitation plan including modernizations is broken into:
  - Short-term (5 years)
  - Mid-term (6-12 years)
  - Long Term (13-15 years)
- The following will be discussed:

1. Overview of MBTA power system assets
2. Findings of power system infrastructure assessment
3. Current power system capital needs and implementation schedule
4. Future power system capital needs/modernizations and implementation schedule

Overview of Power System Assets

1. Extensive power system supplying facilities including passenger stations, substations, third rail, and overhead contact systems for the Red, Orange, Green, Blue, and Silver Lines dating back as far as 100 years.
2. System and equipment redundancy is being utilized to maintain operations, but investment is required to reestablish reliable working levels.
3. The power facilities include the following major assets:
   - 45 traction power substations, 82 unit substations, 3 switching stations
   - Over 130 miles of overhead contact and third rail systems
   - Over 200 miles of 13.8 kV ac power distribution network
   - South Boston Power Complex is the heart of the system containing 115 kV transmission lines, step-down power transformers, 68 MW generator and a central 13.8 kV switching station
   - Over 1,000 miles of 600 V DC power distribution system cables and ductbanks
   - 46 Stationary emergency generators
   - System wide Supervisory Control and Data Acquisition (SCADA) system
4. Current Power Usage:
   - FY19 Total Power Consumption = 417,152.10 KWh for the year
   - FY19 Peak Power Load = 78 MW
   - Average daily load = 47.6 MW

Overview of Power System Assets

EVERSOURCE
115kV

1

2

To Eversource on Demand

MBTA Power Complex

- 115 kV Bulk Power Yard
- Jet Engine (2)
- 68MW Generator (1)
- 40MVA Transformers (4)
- 13.8kV Switching Station

MBTA 13.8kV Cable Network

Unit Substations

480V AC

Passenger Stations and Facilities

Traction Power Substations

600V DC

nationalgrid BELD
EVERSOURCE
13.8kV/23kV

1

2

Traction Power Substations

600 V DC

3rd Rail, Trolley - OCS

Unit Substations

480V AC

Passenger Stations and Facilities

Key Factors for Condition Assessment

1. Age:
   - Expected life 30-35 years for most electrical equipment
   - 50 years expected for structures.
   - 30-50 years for ductbanks and cables
2. Installed conditions:
   - Substations and electrical rooms are generally clean and dry, but some have experienced leaks impacting equipment condition causing premature failure
   - Ductbank materials, age and vehicle loading in city streets has led to failures
3. Obsolescence:
   - Replacement parts for maintenance of old equipment not available impacting operations
4. Operation Critical Equipment
5. Equipment Failures

Remote SCADA Power Control

Key Issues/Findings

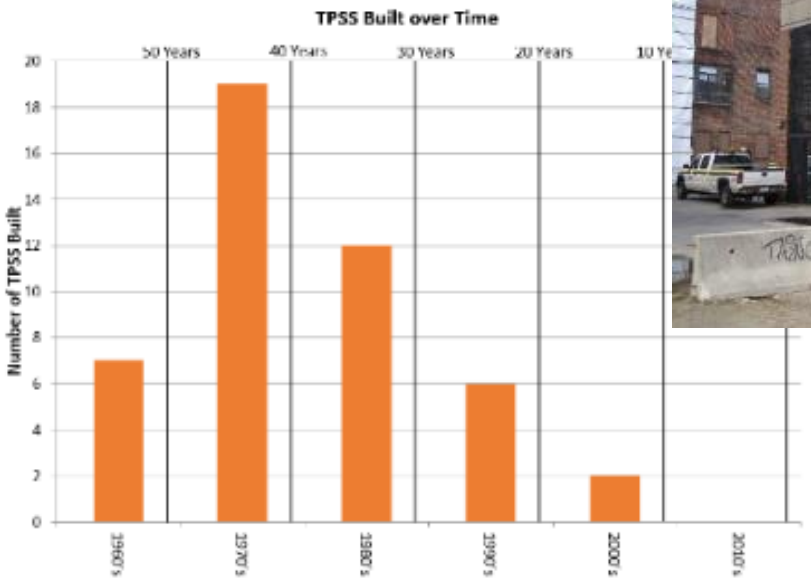
1. 13.8 kV AC Cable Network: many are 80+ years old and located in city and municipal streets
2. 600 V DC Cable Distribution System: Provides power to third rails and OCS via ROW ductbanks which are difficult to access
3. Traction Power Substations: Generally in reasonable condition, but aging
4. Unit Substations: many are older than expected service life, with equipment obsolescence concerns but in generally fair condition due to effective maintenance
5. AC Power Switching Stations: generally in fair condition due to effective maintenance, but past expected service life with equipment obsolescence concerns
6. Power Complex: 68 MW generator requires replacement due to age and operational wear & tear
7. Station and Portable Generators: Regularly maintained, but aging and many have exceeded expected service life. Replacement will ensure operation and availability when needed in emergencies
8. SCADA System: Future modernization in the short to mid-term plan
9. Overhead Catenary System (OCS): much of the initial infrastructure installed in between 1932 and 1960 with some equipment (pole, foundations, fittings, supports, etc.) replacements in the mid 1980's, and contact wire replaced as needed

Examples of Issues / Findings

Traction Power Substations

45 traction power substations. Most are past normal service life but in reasonable working condition

- Short Term: Cost $61M
- Mid Term: Cost $155M
- Long Term: Cost $265M



Overhead Contact System (OCS)

OCS infrastructure is subject to environmental deterioration over time

- Short Term - Replace OCS for the Blue Line, Green Line B, C, D and E Branches and Green Line Charles (Tremont Street Subway) to Haymarket, plus replacement of Green Line D branch OCS poles: Cost $28M
- Mid Term - OCS needs replacement for the Mattapan to Ashmont Line, Green Line D branch non-critical OCS components require rehabilitation, and abandoned OCS poles on the Arborway Line should be removed: Cost $50M

Examples of Issues / Findings

AC Power Distribution and Transmission

The 13.8 kV AC distribution system replacement cost is exceptionally high because duct banks, manholes, and cables are installed in major city streets.

- Short Term - Capital Needs coupled with system modernizations for AC distribution circuits: Cost $250M
- Mid Term (6-12 years) - Capital Needs coupled with system modernizations for replacement of AC distribution circuits: Cost $265M

DC Power Traction Power Distribution

The 600 V DC distribution system consists primarily of aging cables installed in original duct bank systems.

- The average age of many of these cables 30+ years old
- Rehabilitation or replacement of duct banks, cables and manholes in the subway tunnels will impact train operations, limit available working hours, and make the work difficult and costly
- Short Term - DC cable replacement for the Red, Orange, Blue and Green Lines in the subway tunnels. Cost: $325M

Ongoing Power Projects

$200M+ Power upgrades programmed in CIP and are underway:

Orange Line Traction Power Substation Upgrades:

- AC & DC Upgrades to four Traction Power Substations - $53M

Red Line Traction Power Substation Upgrades:

- DC Upgrades to four Traction Power Substations - $10.5M

System Wide Transformer Replacements:

- Replacement upgrades for 19 AC rectifier transformers at six Traction Power Substations - $26M

Causeway Street Ductbank Replacement:

- New AC and DC separated ductbanks - $13M

System Wide Duct Bank Replacement Phase 1:

- New AC ductbanks at eight critical locations - $22.6M

System Wide SCADA Network Upgrade:

- Complete redesign for SCADA equipment and fiber network - $3.8M

Red/Orange Transformation – Power Improvements:

- Cabot Yard, Wellington Yard, OL Test Track, and RL Test Track - $66M

South Boston to Forest Hill Duct Bank Assessment

OL/RL DC cable replacement

Summary of Capital Needs

Asset Category Summaries — SYSTEM-WIDE

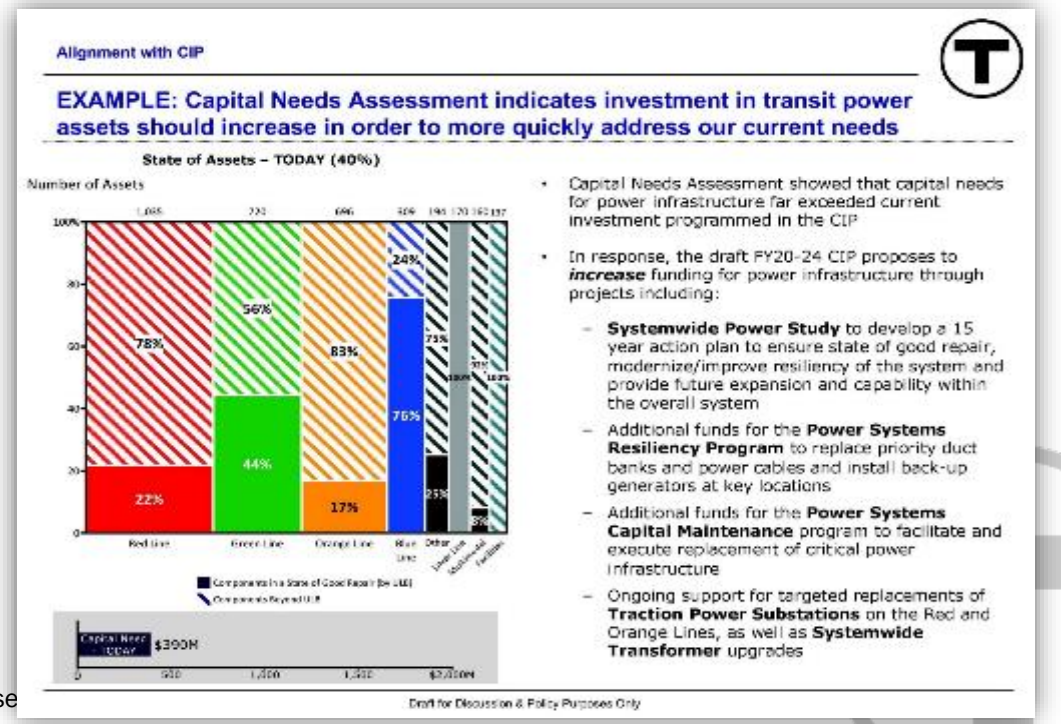
The total estimated capital need is ~$10B.

Asset Category	Estimated Capital Need ($ 2019)	Currently Programmed in CIP[1]	Confidence	Total Count of Assets	Percentage in poor condition or beyond ULB	Note
Revenue Vehicles	~$2,159M	~$2,419M	HIGH	2,946	32%	
Non-Revenue Vehicles	~$34M	~$82M	HIGH	1,678	23%	
Track / ROW	~$618M	~$565M	MEDIUM	N/A	N/A	Transit estimate; Commuter Rail placeholder[3]
Power	~$1,070M	~$178M	MEDIUM	N/A	N/A	Transit estimate/placeholder; Commuter Rail placeholder[3]
Signals	~$504M	~$1,245M	MEDIUM	N/A	N/A	Transit estimate; Commuter Rail placeholder[3]
Bridges	~$913M	~$488M	HIGH	459	11%	
Culverts	~$57M	N/A	HIGH	860	41%	Total count represents ~64% of assets
Tunnels	~$500M	~$88M	LOW	147	N/A	Placeholder value[2]
Parking	~$312M	~$134M	HIGH	125	10%	
Stations	~$2,162M	~$740M	MEDIUM	267	42%	
Administrative & Maintenance Facilities	~$1,813M	~$1,019M	MEDIUM	194	59%	
Total[4]:	~$10,142M	~$6,958M				

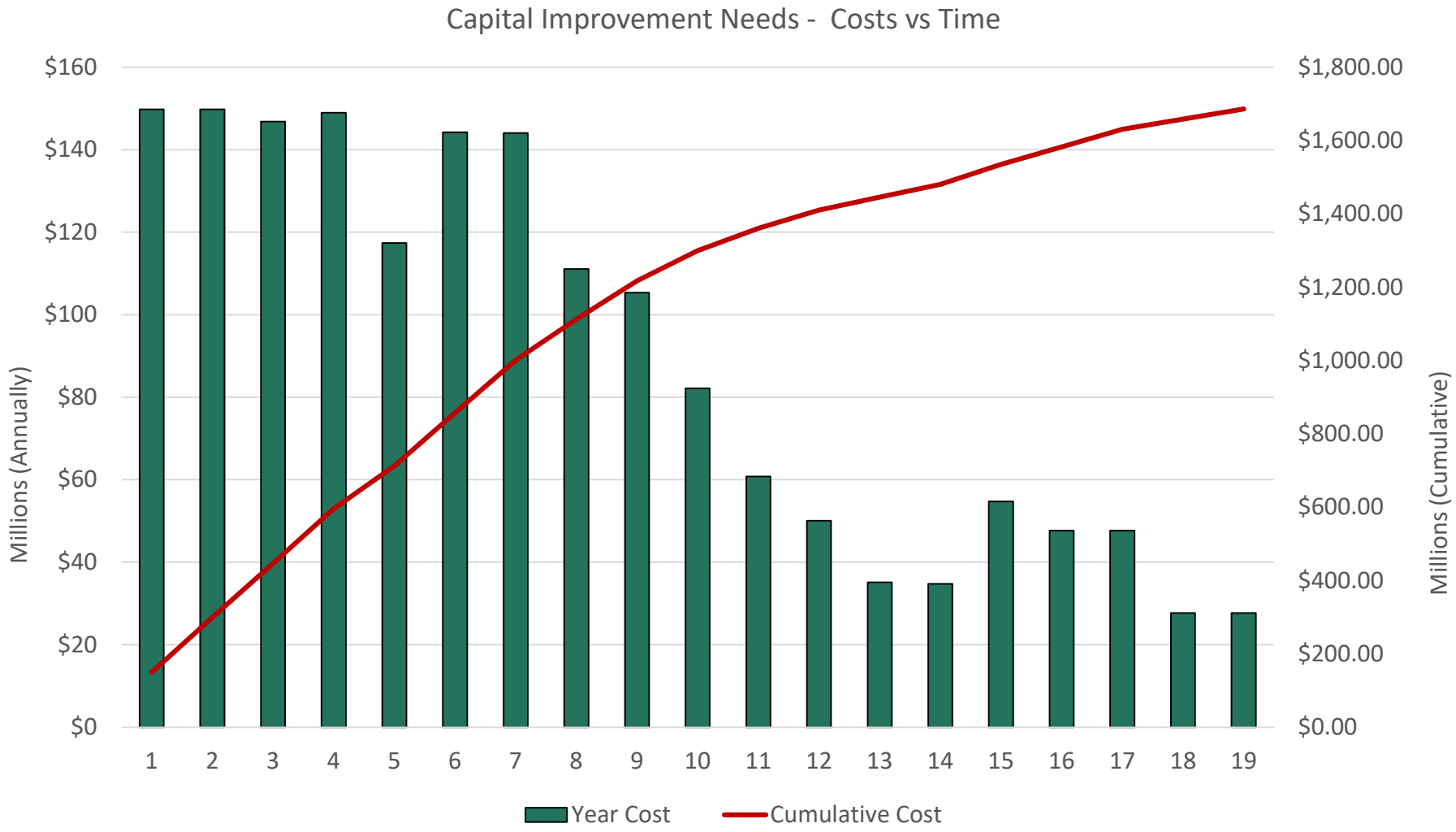
1 – Remaining budget, in fiscals years FY19 through and including years after FY23 in the FY19-23 Capital Investment Plan; 2 – Totals represent the sum of both Transit and Commuter Rail assets. 3 – Commuter Rail Track, Signals, and Power and Tunnel placeholder values were provided by the Office of the Chief Engineer.

Draft for Discussion & Policy Purposes Only

- May 2019 capital need update included a power investment estimate of $1,070M as part of the ~$10B backlog estimate
  - New estimate reflects an approximate $500M - $600M increase
- Current estimate for power investment is more informed, building off of the recommendations laid out in May 2019 to perform a Systemwide Power Study to develop a 15 year Action Plan
- 15 Year Power Capital Needs includes investments that are beyond the backlog capital need



Summary of Capital Needs



Power System Requires:

- Strategic investment over short, mid and long terms to provide reliability, resiliency and to restore critical systems.
- Current capital needs and integral system modernizations.
- Costs reflect 2019 estimates, and will increase with inflation

Investment:

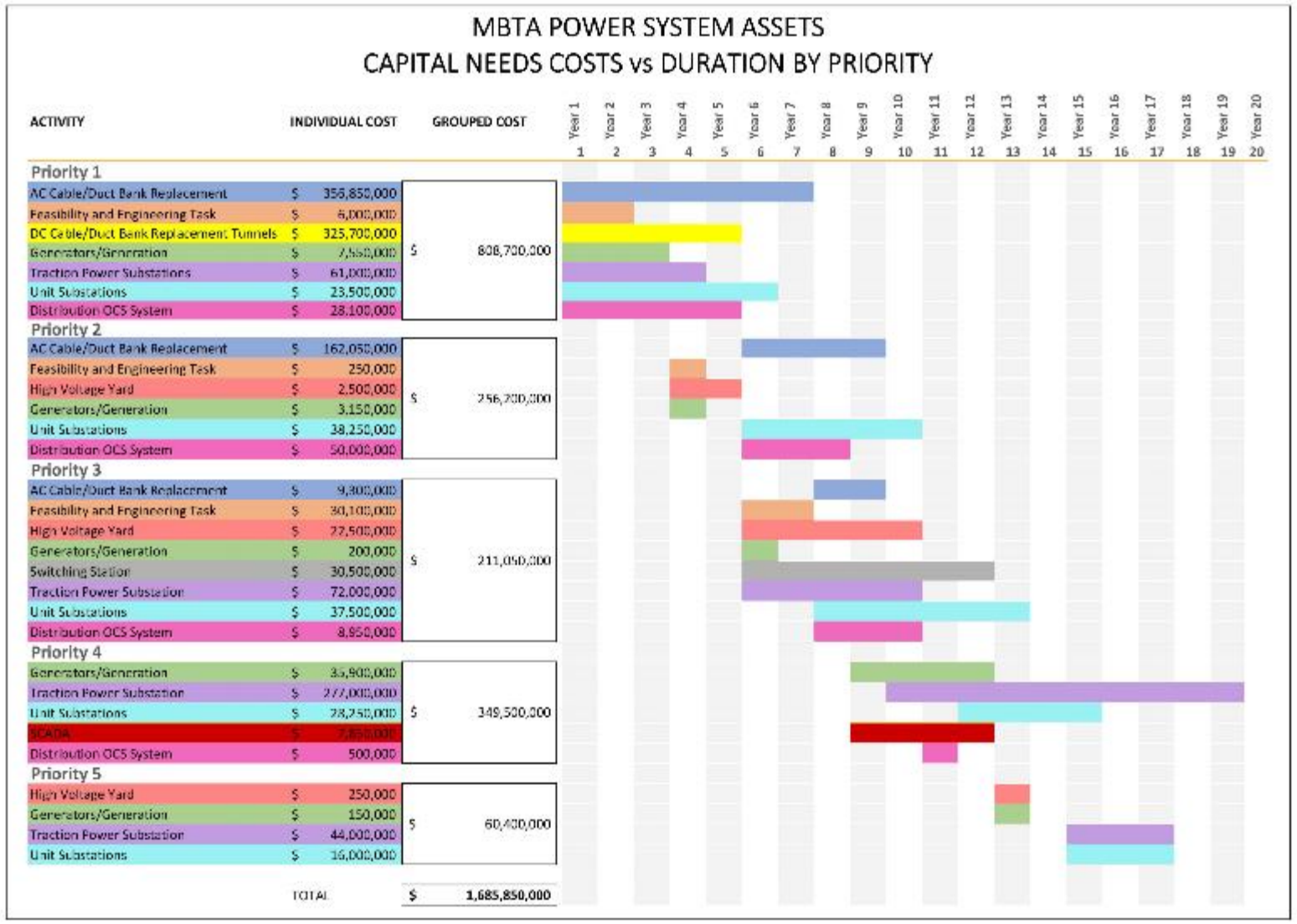
- Short Term = $710M
- Mid Term = $700M
- Long Term = $240M

Next Steps

- **Consider for future electrical demand:**
  - Increased number of trains with reduced headways
  - Future Type 10 Green Line Fleet
  - Future use of Battery Electric Buses – build out of new bus maintenance facilities will support future electrification
  - Possible Future Commuter Rail Electrification
  - Power consumption could be significantly higher than current levels
- **Programming of Power Capital Needs into future Capital Investment Plans based on priority of need**
- **Coordinate investments into the power system with other projects planned or in development**
- **Build an project strategy to make the needed investments into the power system**
- **Work beyond investments into the existing power infrastructure Capital Needs will be shaped by further studies:**
  - System resiliency review
  - Green Line Type 10 Power Study (December)
  - 13.8 kV distribution feasibility and alternate power sources and reconfiguration
  - System wide short circuit capacity study and protection device study
  - Main MBTA Power Complex 115 kV system alternatives
  - DC system re-sectionalizing

Appendix

Appendix - Summary of Capital Needs



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