



# Oklahoma State University's New Central Plant From Master Plan to Completion

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# Introductions

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# Overview

- Why a new Central Plant?
- Program Summary
- Design Review
- Commissioning
- Pre Construction Services
- Utility Distribution Construction
- Central Plant Construction
- Successes and Challenges
- Next Steps
- Q&A



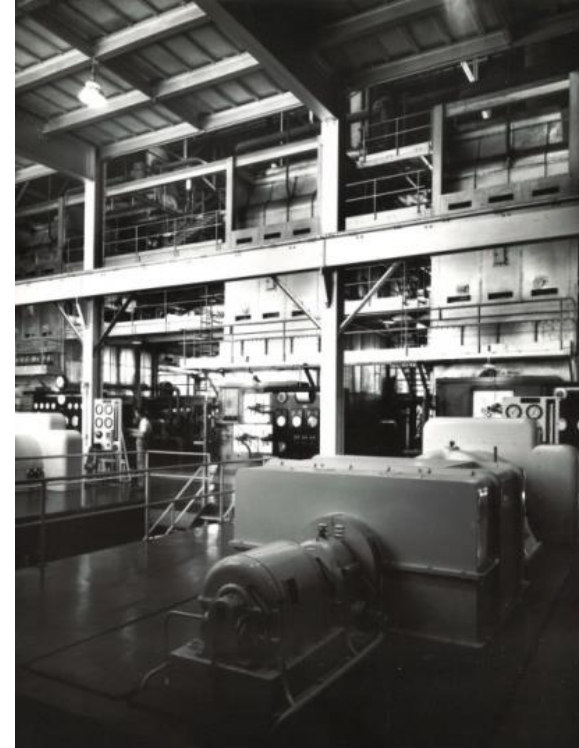
# Why a new plant?

## ■ Central Plant Replacement Necessities

- Wind power agreement
- Utility production capacity
- Power plant condition
- Power plant location

## ■ Central Plant Replacement Opportunities

- Tie to education
- Energy Efficiency
- Consolidation of Energy Services





# Program Summary

## ■ Utility Master Plan

- Plan for correcting existing deficiencies
- 5-year plans for steam, chilled water, and electrical
- 20-year plans for steam, chilled water, and electrical

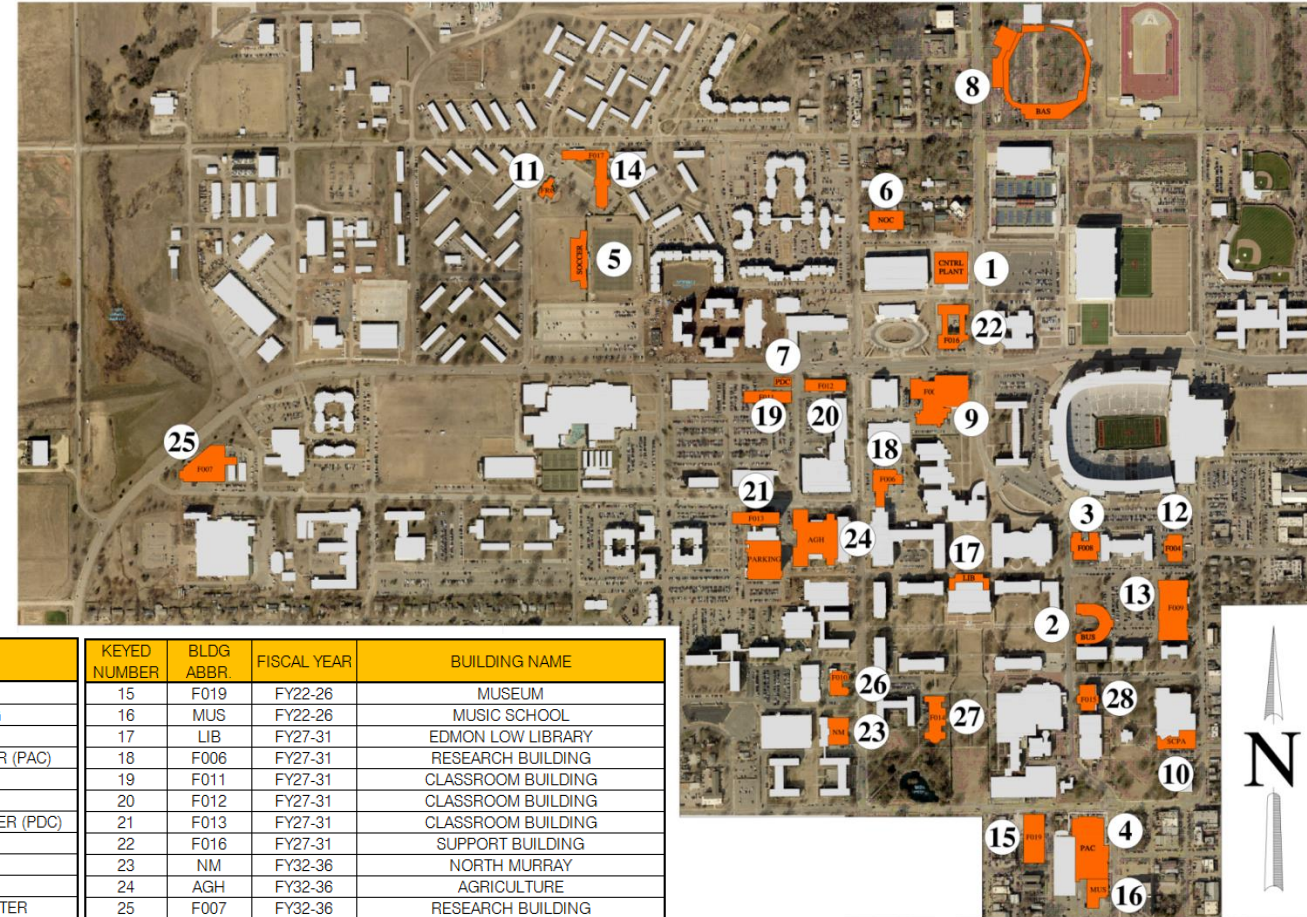
## ■ Campus Planning Tools

- KY Pipe steam and chilled water models
- SKM Power Tools electrical model
- Utility Geographic Information System (GIS)

## ■ New Central Plant

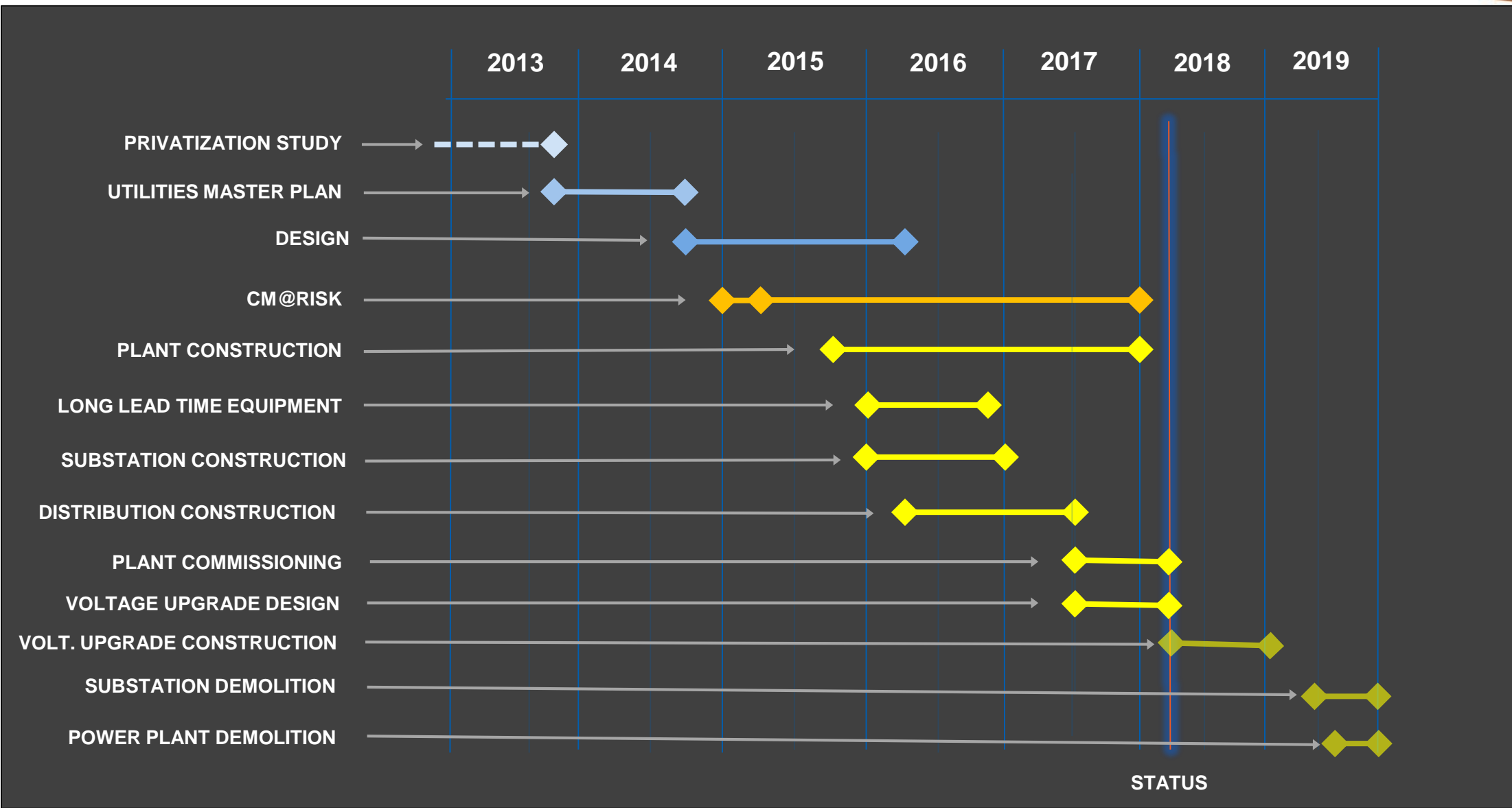
## ■ Electrical Distribution

- New substation
- Voltage upgrade
- Power distribution center



KEYED NUMBER	BLDG ABBR.	FISCAL YEAR	BUILDING NAME	KEYED NUMBER	BLDG ABBR.	FISCAL YEAR	BUILDING NAME
1	CP	FY16	CENTRAL PLANT	15	F019	FY22-26	MUSEUM
2	BUS	FY17	BUSINESS BUILDING	16	MUS	FY22-26	MUSIC SCHOOL
3	F008	FY17	CEAT LAB BUILDING	17	LIB	FY27-31	EDMON LOW LIBRARY
4	PAC	FY18	PERFORMING ARTS CENTER (PAC)	18	F006	FY27-31	RESEARCH BUILDING
5	SOC	FY18	SOCCER STADIUM	19	F011	FY27-31	CLASSROOM BUILDING
6	NOC	FY18	NOC BUILDING	20	F012	FY27-31	CLASSROOM BUILDING
7	PDC	FY18	POWER DISTRIBUTION CENTER (PDC)	21	F013	FY27-31	CLASSROOM BUILDING
8	BAS	FY19	BASEBALL STADIUM	22	F016	FY27-31	SUPPORT BUILDING
9	F005	FY21	FUTURE BUILDING	23	NM	FY32-36	NORTH MURRAY
10	SCPA	FY22-26	SERETEAN CENTER	24	AGH	FY32-36	AGRICULTURE
11	FRC	FY22-26	FAMILY RESOURCE CENTER	25	F007	FY32-36	RESEARCH BUILDING
12	F004	FY22-26	CLASSROOM BUILDING	26	F010	FY32-36	CLASSROOM BUILDING
13	F009	FY22-26	CLASSROOM BUILDING	27	F014	FY32-36	CLASSROOM BUILDING
14	F017	FY22-26	RESIDENCE HALL	28	F015	FY32-36	CLASSROOM BUILDING

# Program Schedule





# Central Plant Design Summary

## ■ Cooling

- 12,000 tons expandable to 16,000 tons
- 3900 HP of pumps with VFDs
- 750 HP of cooling tower fans with VFDs

## ■ Heating

- 220,000 lbs/hr expandable to 280,000 lbs/hr
- Heating water loop to serve buildings near plant
- Stack gas economizers

## ■ Education

- 80 seat classroom
- Public observation room





# Electrical Distribution



NEW OG&E  
UNIVERSITY  
SUBSTATION

- 2 X 20MVA TRANSFORMERS
- 1 X 20 MVA FUTURE

ELECTRICAL  
DISTRIBUTION  
UPGRADES

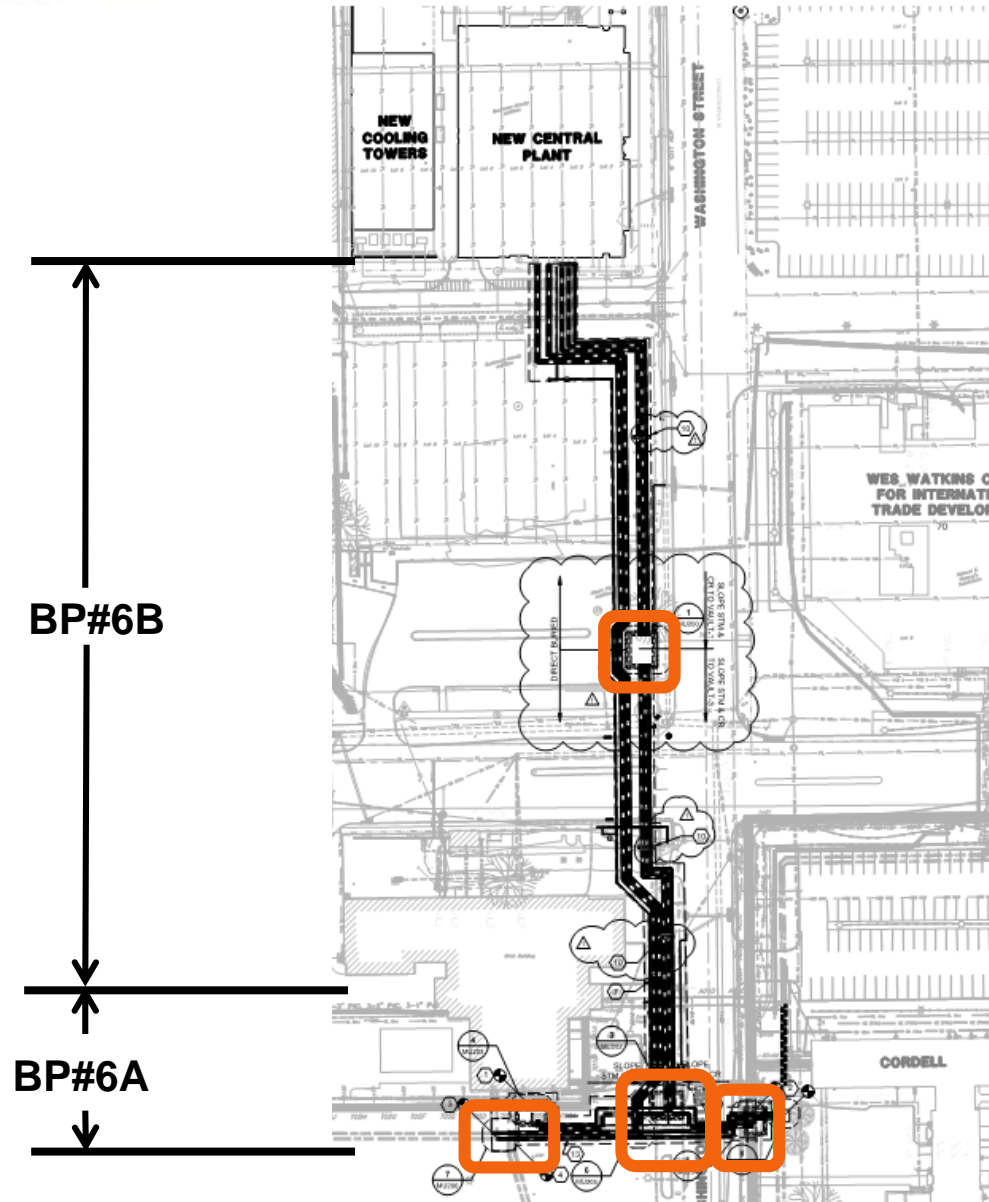
- 8027 LF DUCTBANK
- 21 VAULTS

NEW CENTRAL  
PLANT





# Steam and Chilled Water Distribution



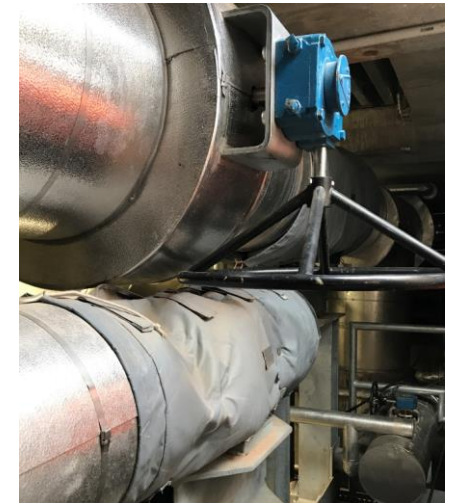
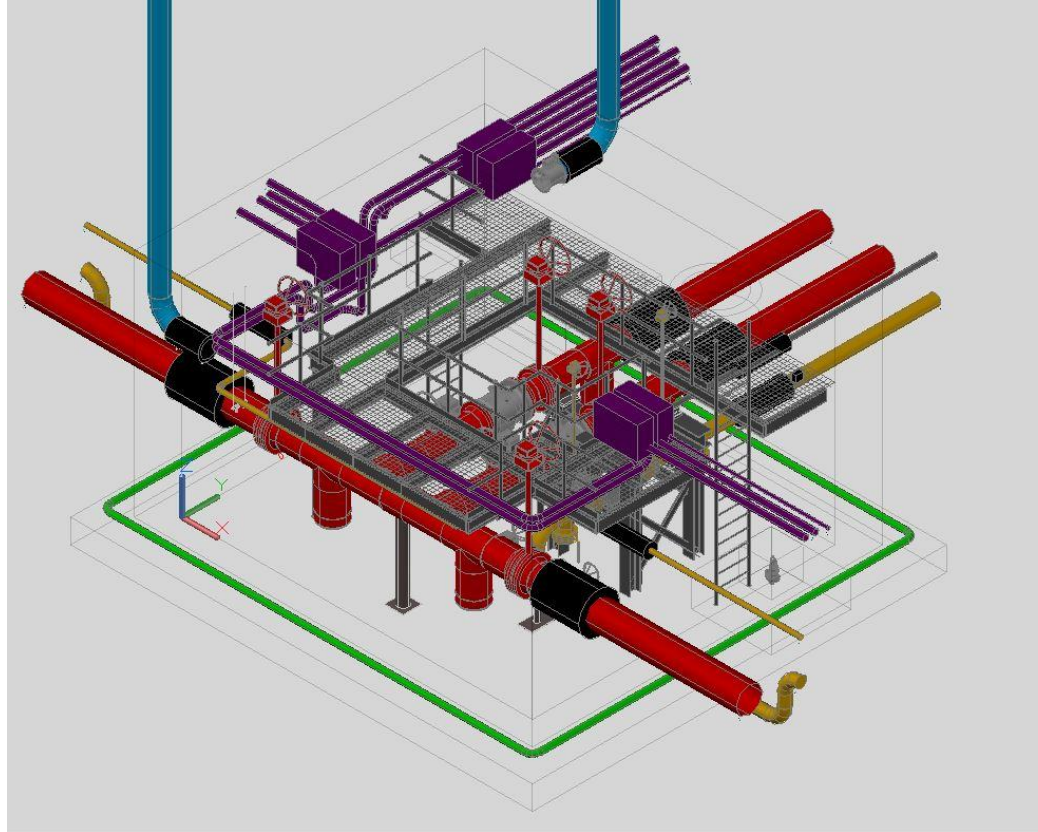
- Over 12,000 total LF of steam, condensate return, and chilled water
- Design considerations
  - Direct buried vs. walkable tunnel
  - Open cut vs. trenchless installation
- Pre-insulated Class A piping system
- Separate steam mains leaving plant
- Variety of complex construction methods required

# Steam and Chilled Water Distribution



Four vaults for steam traps, valves, and expansion joints

- Replace/interface with existing tunnel
- Robust design
- Access, safety, and maintainability is critical





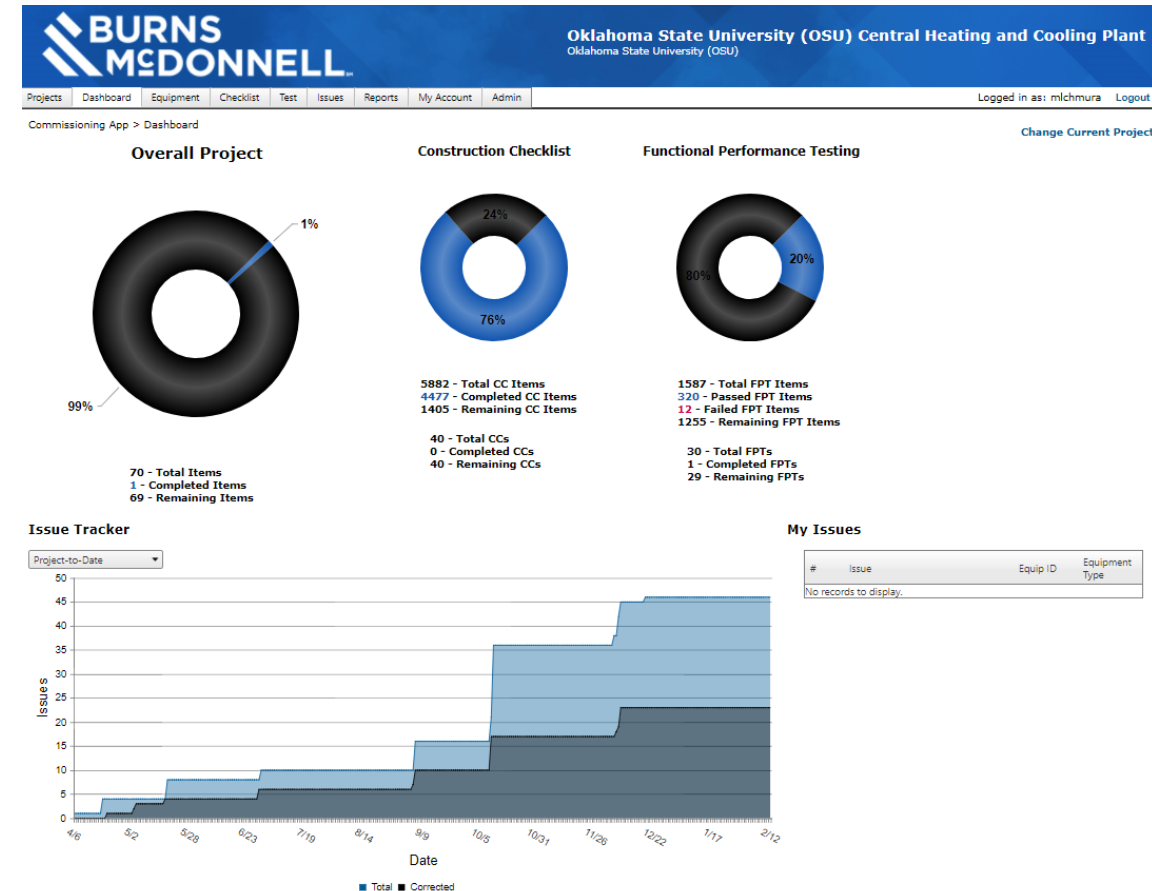
# Commissioning

## Pre-Functional Checklists

- PFCs for major mechanical and electrical equipment reviewed prior to startup
- Incomplete tasks were identified and corrected prior to scheduling startup activities

## Functional Tests

- Spurred great conversations on the controls sequences and resolved some issues early



# Commissioning

## Regular site visits

- Adequate budget to perform regular site visits
- Visits coupled with weekly Cx and startup meetings helped keep the team on track, coordinated, and gave visibility to project issues.

## Involvement from the plant operations staff

- Plant ops spent a good deal of time onsite
- Witnessed portions of the functional testing
- Provide early look at plant operations
- Time for questions and input in the process

### Commissioning Site Observation Report

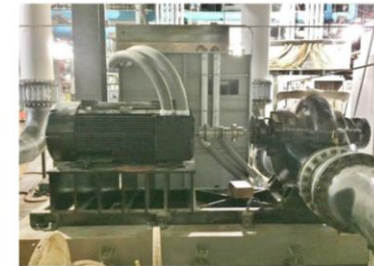


Entry #: 001  
Category: Witness Startup  
Equipment/Systems: CDPs

Photos:

Observations and notes from CDP (Secondary CHW distribution pumps):

- CDPs were filled and purged of air 6.28.17
- Coupling guards were installed 6.28.17
- BMcD witnessed startup of the CHPs (notes on next page)
- CHPs were previously aligned and bumped for rotation
- At approximately 4pm, isolation valves were open to the main distribution system to run the CDPs (BMcD did not witness)



Picture to the left: The CHW pipe stanchions with vibration isolation springs are not yet installed. A temporary pipe has been welded. This installation must be completed prior to running the pumps consistently

Pictured above: The motor shaft to driven pump shaft connection is pictured. The alignment was completed to within .005" accuracy for each angle/offset. The manufacturer's representative performed the alignment. OSU Utilities took their own baseline alignment and was present during the initial run of the pumps



- | DESCRIPTION                                | Total Project<br>Base Bid | NOC Utility<br>Extension | Bid Package 4<br>S&G  |                     |               | Bid Package #6A<br>and Basement<br>Backfill |                       |                        | Bid Package #2    | Bid Package #3 |
|--|---------------------------|--------------------------|-----------------------|---------------------|---------------|---|-----------------------|------------------------|-------------------|----------------|
|  |                           |                          | Bid Package #6C       | Bid Package #5      |               |   |                       |                        |                   |                |
| Division 2 - Existing Conditions           | 252,000.00                | 0                        | 0                     | 0                   | 0             | 0   | 0                     | 20,000.00              |                   |                |
| Division 3 - Concrete                      | 6,643,000.00              | 0                        | 180,000.00            | 0                   | 0             | 0   | 529,179.00            | 3,378,442.00           | 2,705.00          |                |
| Division 4 - Masonry                       | 15,370,000.00             | 0                        | 0                     | 0                   | 0             | 0   | 0                     | 1,537,000.00           | 2,034.00          |                |
| Division 5 - Metals                        | 2,844,500.00              | 0                        | 0                     | 0                   | 0             | 0   | 0                     | 807,500.00             |                   |                |
| Division 6 - Wood & Plastics               | 253,300.00                | 0                        | 0                     | 0                   | 0             | 0   | 0                     | 248,300.00             |                   |                |
| Division 7 - Thermal & Moisture Protection | 1,004,700.00              | 0                        | 0                     | 0                   | 0             | 0   | 0                     | 787,500.00             | 285.00            |                |
| Division 8 - Doors & Windows               | 4,422,300.00              | 0                        | 0                     | 0                   | 0             | 0   | 0                     | 568,000.00             |                   |                |
| Division 9 - Finishes                      | 1,672,000.00              | 0                        | 0                     | 0                   | 0             | 0   | 0                     | 1,672,000.00           |                   |                |
| Division 10 - Specialties                  | 116,100.00                | 0                        | 0                     | 0                   | 0             | 0   | 0                     | 116,100.00             |                   |                |
| Division 11 - Equipment                    | 10,000.00                 | 0                        | 0                     | 0                   | 0             | 0   | 0                     | 10,000.00              |                   |                |
| Division 12 - Furnishings                  | 40,000.00                 | 0                        | 0                     | 0                   | 0             | 0   | 0                     | 40,000.00              |                   |                |
| Division 13 - Special Construction         | 256,670.00                | 0                        | 0                     | 0                   | 0             | 0   | 0                     | 256,670.00             |                   |                |
| Division 14 - Elevators                    | 13,100,000.00             | 0                        | 0                     | 0                   | 0             | 0   | 0                     | 13,100,000.00          |                   |                |
| Division 22 & 23 - Mechanical              | 14,118,000.00             | 0                        | 3,655,510.00          | 292,725.00          | 0             | 0   | 0                     | 9,700,400.00           | 255.00            |                |
| Division 24 - Piping                       | 7,918,000.00              | 0                        | 589,250.00            | 0                   | 0             | 2,840,370.00                                | 10,500.00             | 2,205,000.00           | 143.00            |                |
| Division 27 - Communications               | 49,800.00                 | 0                        | 0                     | 0                   | 0             | 0   | 0                     | 49,800.00              |                   |                |
| Division 28 - Electronic Safety & Security | 49,800.00                 | 0                        | 0                     | 0                   | 0             | 0   | 0                     | 49,800.00              |                   |                |
| Division 31 - Earthwork                    | 8,000,400.00              | 0                        | 3,105,000.00          | 0                   | 0             | 0   | 2,018,000.00          | 520,000.40             | 420.00            |                |
| Division 32 - Exterior Improvements        | 100,000.00                | 0                        | 0                     | 0                   | 0             | 0   | 0                     | 100,000.00             |                   |                |
| Division 33 - Utilities                    | 4,923,510.00              | 875,510.00               | 503,000.00            | 0                   | 0             | 0   | 3,450,000.00          | 5,100.00               |                   |                |
| Division 34 - Material Handling Equipment  | 227,000.00                | 0                        | 0                     | 0                   | 0             | 27,000.00                                   | 0                     | 200,000.00             |                   |                |
| Site Requirements                          | 1,116,420.00              | 25,000.00                | 0                     | 0                   | 0             | 0   | 0                     | 0                      |                   |                |
| <b>Subtotal</b>                            | <b>\$3,288,570.00</b>     | <b>993,510.00</b>        | <b>9,301,660.00</b>   | <b>324,665.00</b>   | <b>0.00</b>   | <b>\$4,846,370.00</b>                       | <b>6,097,470.00</b>   | <b>22,941,360.00</b>   | <b>5,777.00</b>   |                |
| Contractor's Contingency                   | 1,037,810.00              | 23,855.00                | 189,070.00            | 5,410.00            | 0.00          | 35,800.00                                   | 1,037,810.00          | 770,000.00             | 115.00            |                |
| Owner's Architectural Contingency          | 181,100.00                | 37,700.00                | 419,430.00            | 3,300.00            | 0.00          | 45,400.00                                   | 1,059,110.00          | 544,500.00             | 17.00             |                |
| Performance & Payment Bond                 | 528,400.00                | 10,180.00                | 77,560.00             | 2,480.00            | 0.00          | 43,520.00                                   | 5,814.00              | 2,806,000.00           | 20.00             |                |
| Performance Fidelity Insurance             | 208,500.00                | 10,200.00                | 1,333,320.00          | 7,750.00            | 0.00          | 74,750.00                                   | 30,340.00             | 507,840.00             | 30.00             |                |
| Builder's Risk                             | 168,000.00                | 3,340.00                 | 25,460.00             | 940.00              | 0.00          | 14,280.00                                   | 48,830.00             | 47,900.00              | 11.00             |                |
| General Liability                          | 202,440.00                | 4,110.00                 | 31,340.00             | 1,050.00            | 0.00          | 10,000.00                                   | 18,000.00             | 107,110.00             | 40.00             |                |
| <b>Direct Construction Cost</b>            | <b>\$56,033,330.00</b>    | <b>\$1,108,550.00</b>    | <b>\$9,159,865.00</b> | <b>\$340,065.00</b> | <b>\$0.00</b> | <b>\$5,135,746.00</b>                       | <b>\$5,755,770.00</b> | <b>\$24,553,720.00</b> | <b>\$6,123.00</b> |                |
| <b>Professional Services</b>               |                           |                          |                       |                     |               |   |                       |                        |                   |                |
| General Conditions                         | 3,698,104.00              | 176,336.00               |                       |                     | -             | -   | -                     | 293,986.00             |                   |                |
| Litigation & Arbitration Contingency       | 170,000.00                |                          |                       |                     |               |   |                       |                        |                   |                |
| Fee  | 4,202,210.00              | 89,943.00                | 840,910.00            | 23,804.00           |               | 390,502.00                                  | 440,905.00            | 1,739,330.00           | 428.00            |                |
| <b>Professional Services Total</b>         | <b>\$8,070,314.00</b>     | <b>\$87,379.00</b>       | <b>\$840,910.00</b>   | <b>\$27,604.00</b>  | <b>\$0.00</b> |   |                       |                        |                   |                |

[illegible]

Construction Manager's Bid Book  
OSU Central Plant

004700 20C 1  
REVISED per CM #2

# Utility Distribution Construction – BP# 6



- Over 12,000 total LF of steam, condensate return, and chilled water
- Two Construction Phases
  - 6a
  - 6b
- Non-Closable Roads
- Campus Schedule Critical Completion Dates
- Washington Street Stadium Access
- Hall of Fame



# Utility Distribution BP#6a

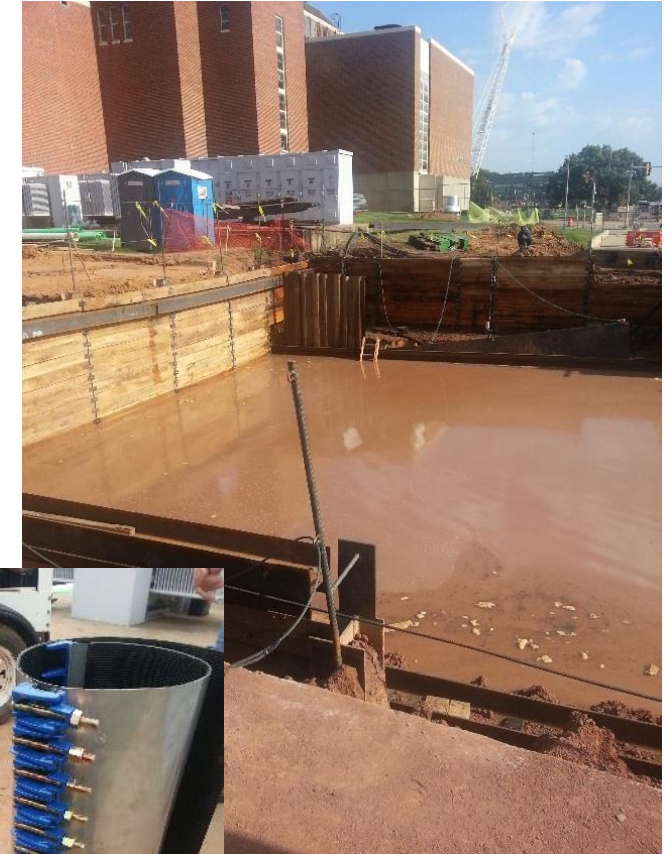
- Campus Schedule Critical
  - Football Gameday
- Innovative Construction Methods





# Utility Distribution BP#6a

- Existing Utilities in Close Proximity
  - ATT duct bank
  - Campus Chilled Water

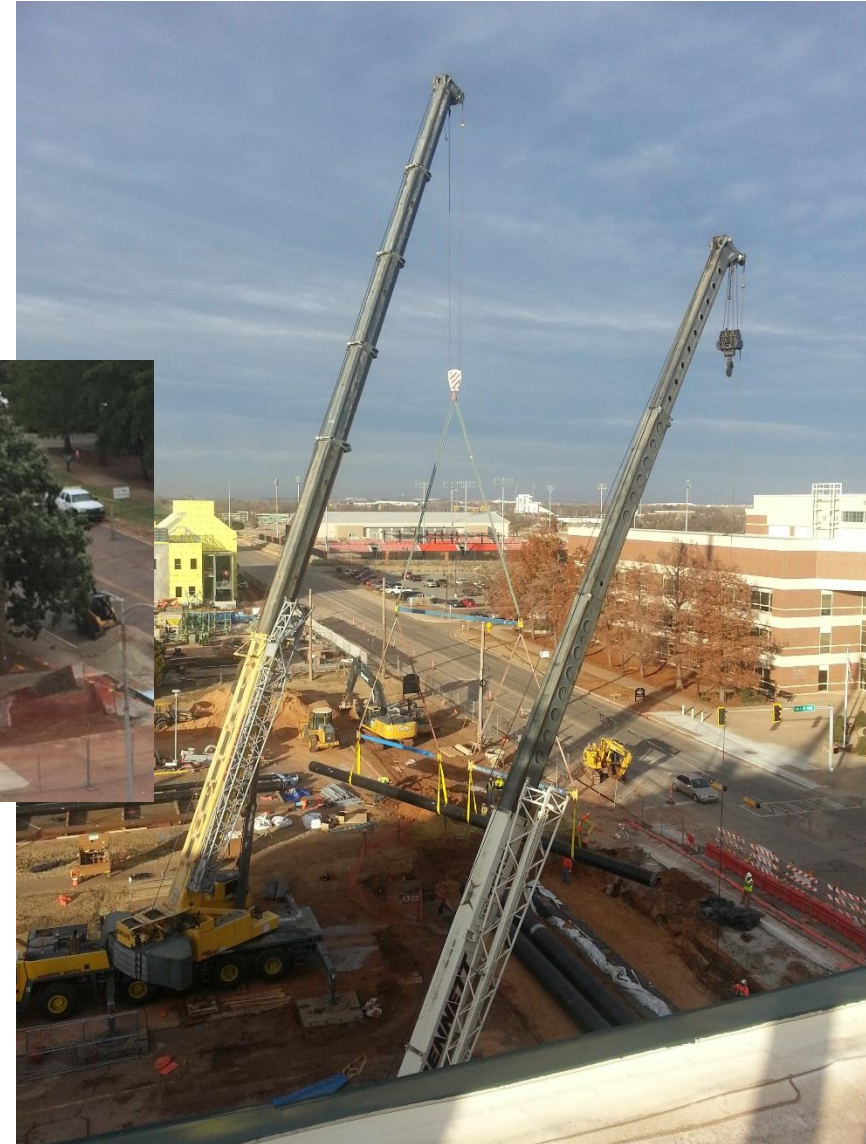
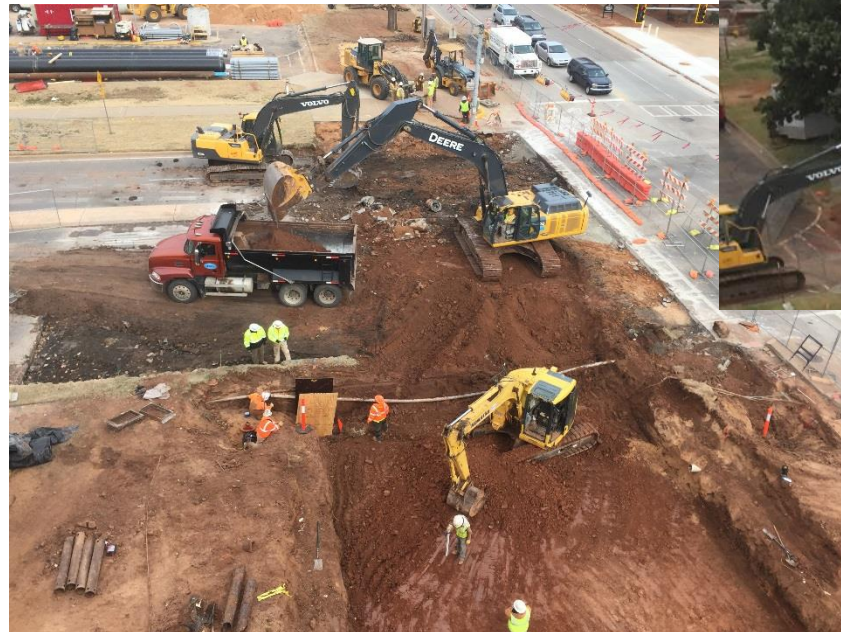






## You Can't Close Hall of Fame!

- Considerations
  - Direct buried vs. walkable tunnel
  - Open cut vs. trenchless installation
  - There is a **TREE** there





# Electrical Distribution – BP#5

- Understanding Existing Utilities
  - Hydro-Excavation
- Communication
  - Campus updates
  - Direct Communication with Major Stakeholders
- Western and Hall of Fame Intersection
  - 48" RCP
  - Coordination with Paving Contractor





# OSU Central Plant– BP#1

- Excavation
  - 75,500 cu yds
- Shoring
- Dewatering





# OSU Central Plant– BP#2

- Concrete
- Structural Steel
  - 40 Ton Bridge Crane





# OSU Central Plant– BP#3 & 4

- Cooling Tower Structure
- MEP
- Architectural
- Underground Utilities





# OSU Central Plant– BP#3 & 4

Mechanical, Electrical, Plumbing





# OSU Central Plant– BP#3 & 4

## Architectural





# Successes and Challenges

## Successes

- Aggressive timeline
  - Master plan start to plant completion in less than 5 years
- Tie to educational mission of University
- Involvement of plant operators in design, construction, and Cx
- Team approach of University, CMAR, A&Es, and CxA
- BIM coordination
- 50-year vision
- Integration into campus Architecture





# Successes and Challenges

## Challenges

- Timing of OFCI equipment purchases
- Closing non-closable streets
- Transition of steam service from existing plant to new plant
- What to do with 70,000 gallons of fuel oil



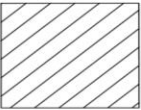


# Next Steps

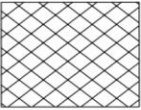
## Next Steps

- Completion of Heating Water Loop Phase I
- Completion of Voltage Upgrade and Power Distribution Center
- Steam & Chilled Water Distribution Upgrades
- SCADA System

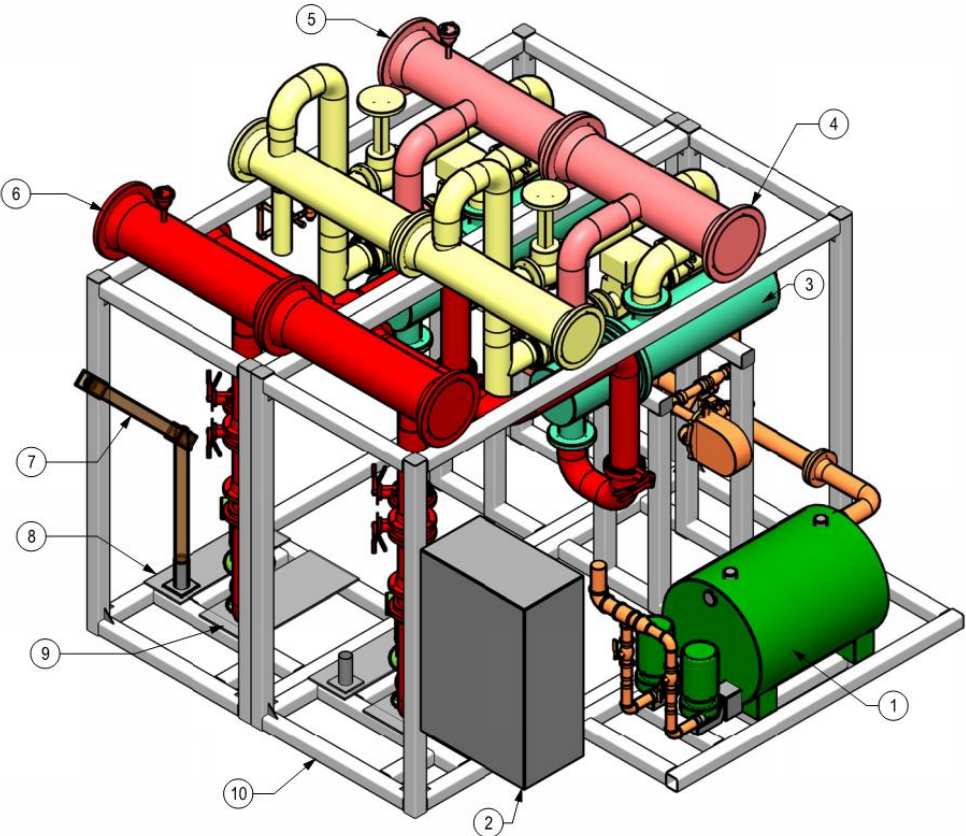
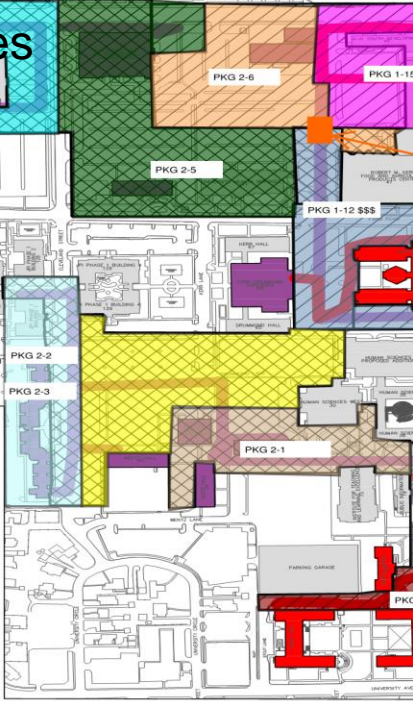
## Low Voltage Upgrades:



Phase 1



Phase 2





# Q&A Period

