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Powering Up: Inside the Design for the Fastest University Supercomputer Installation

Juan Ontiveros, P.E. - University of Texas-Austin

Tarek Tousson, P.E. - Stanley Consultants, Inc.

CampusEnergy2020
THE POWER TO CHANGE
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Texas Advanced Computing Center (TACC); World Leader in Academic Supercomputing

Frontera Supercomputer

Facts

- Fastest academic supercomputer in the world
- Fifth-fastest supercomputer in the world
- Achieved 23.5 PetaFLOPS with theoretical peak of 38.7 PetaFLOPS

Frontera Supercomputer

Speed

- A human would have to complete one calculation every second for one billion years to match Frontera's output in just one second

Image Source: https://www.ibm.com/ibm/history/ibm100/us/en/icons/petaflopbarrier/

Frontera Supercomputer

Academic Projects

- Global Warming
- Cancer
- Molecular Dynamics
- Algorithms & Libraries
- Bio Informatics
- Cloud Computing & Interface Tech Experimental Systems
- Next Generation Portals
- Machine Learning & Analytics
- Health Informatics & Compliance
- Computing Systems
- Software Defined Visualization

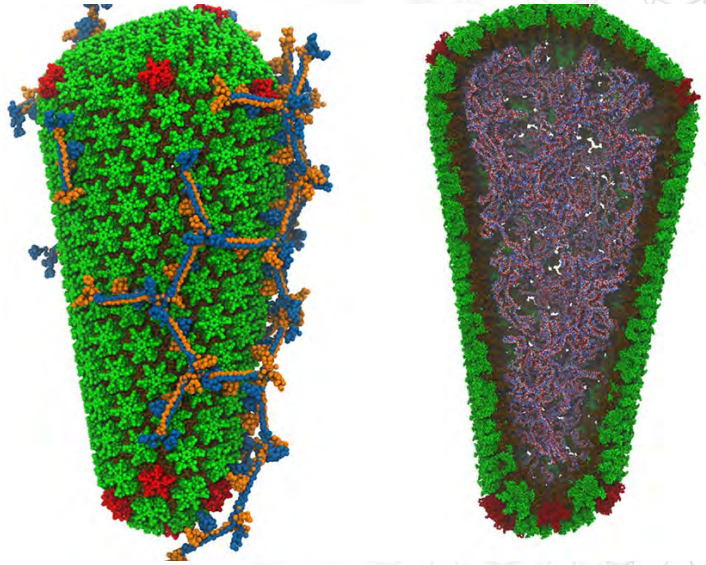

Photo:
Still from a simulation of an HIV capsid computed on Frontera by Gregory Voth, from the University of Chicago.

$60M NSF Project including power and cooling for the new supercomputer in existing building

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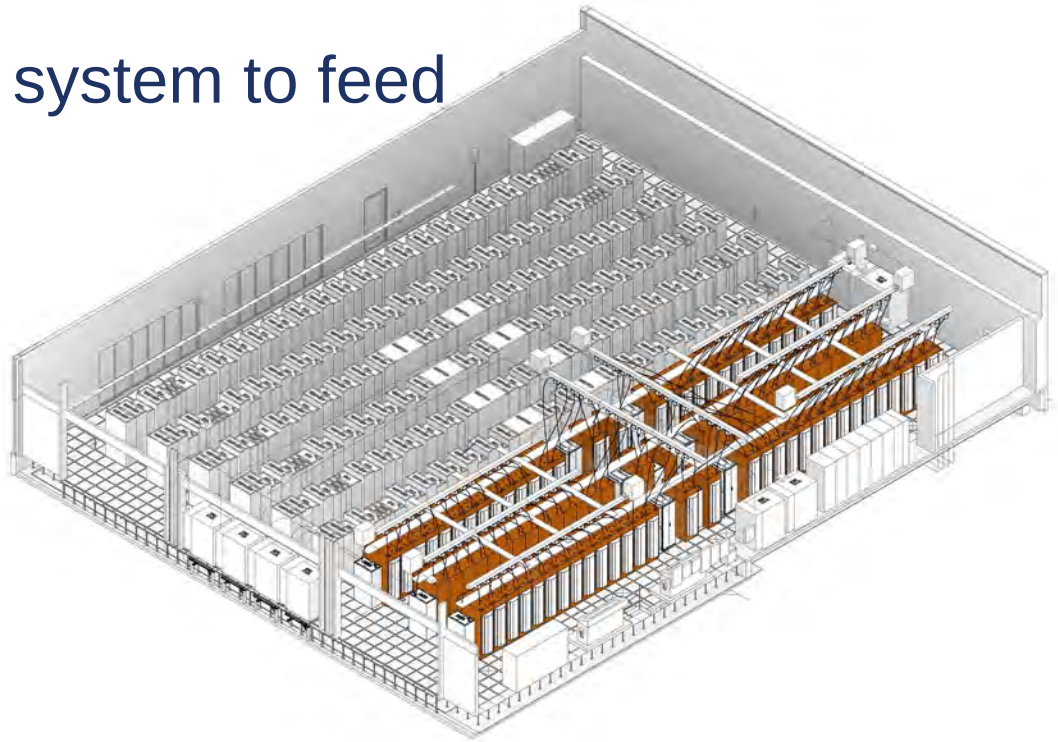
Project Features

- High efficiency transformers
- Busways and associated electrical components for liquid cooled server racks and cooling system
- Mechanical modification for chilled water system to feed cooling distribution units (CDU)



Frontera will consume almost 6.5 MW of power

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Challenges

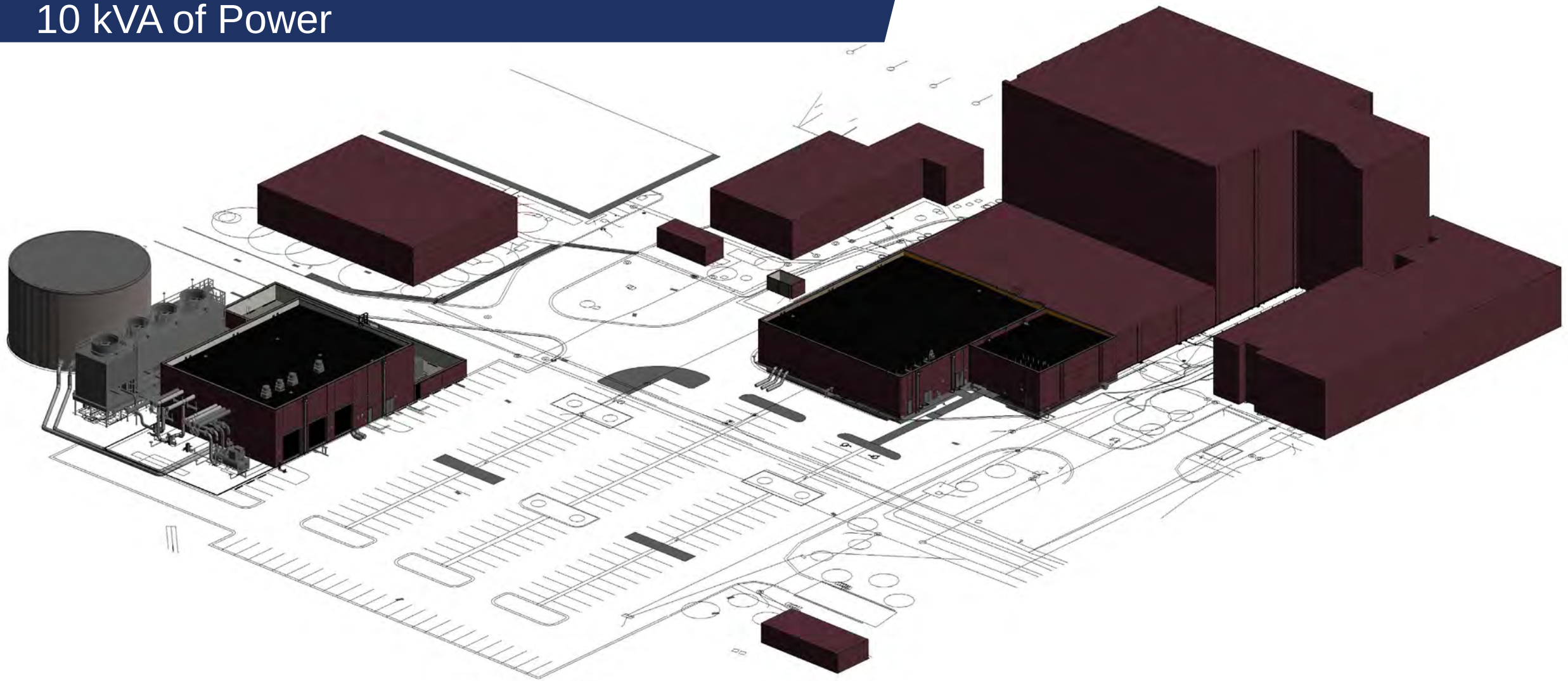
- Tight schedule
- Working in tight physical confines
- Limited budget
- Construct in active data center

Frontera Supercomputer

Challenges

- Optimizing electrical distribution and calculating transformer feeder busways
- Optimizing chilled water distribution system
- Incorporating equipment built to international standards into design meeting U.S. standards

Central Plant
3750 Cooling Tons
10,500 Ton-Hours Thermal Energy Storage
10 kVA of Power



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Solutions

- Electrical & mechanical upgrade
  - Power for the new equipment from the central utility plant via a power distribution system
  - Cooling for the new equipment by chilled water from the central utility plant via a chilled water distribution system
- Careful planning
  - Isolate, relocate and be sensitive to key equipment and assets while the data center was still operating and powered up

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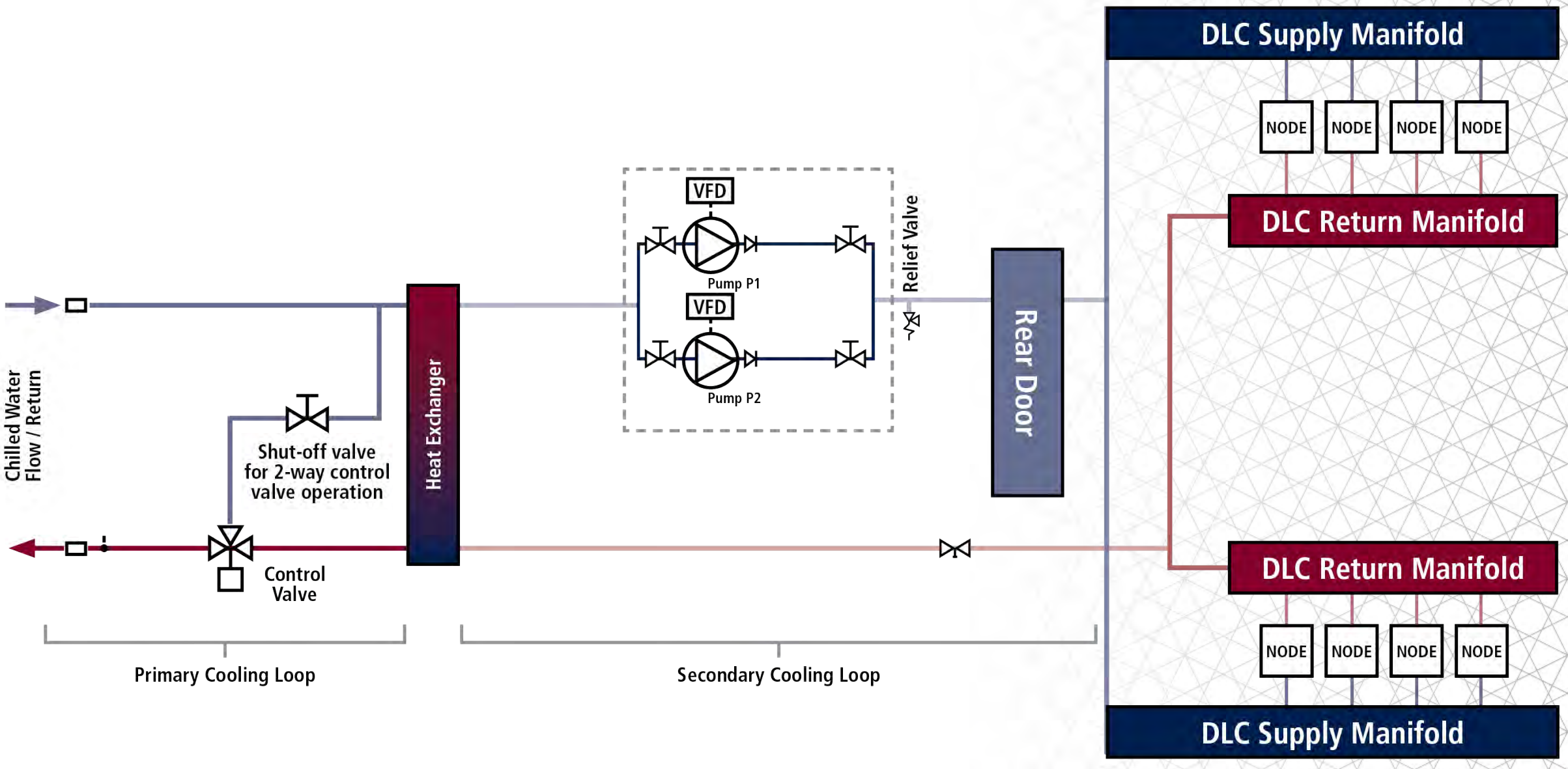
Solutions

- Mechanical
  - Analyzed existing chilled water system
  - Use existing two 6” and new 6” branch chilled water loop
  - Feed Cooling Distribution Units (CDU)


DLC Supply Manifold
NODE
NODE
NODE
NODE
DLC Return Manifold
VFD
Pump P1
VFD
Pump P2
Relief Valve
Rear Door
Heat Exchanger
Chilled Water
Flow / Return
Shut-off valve
for 2-way control
valve operation
Control
Valve
DLC Return Manifold
NODE
NODE
NODE
NODE
DLC Supply Manifold
Primary Cooling Loop
Secondary Cooling Loop

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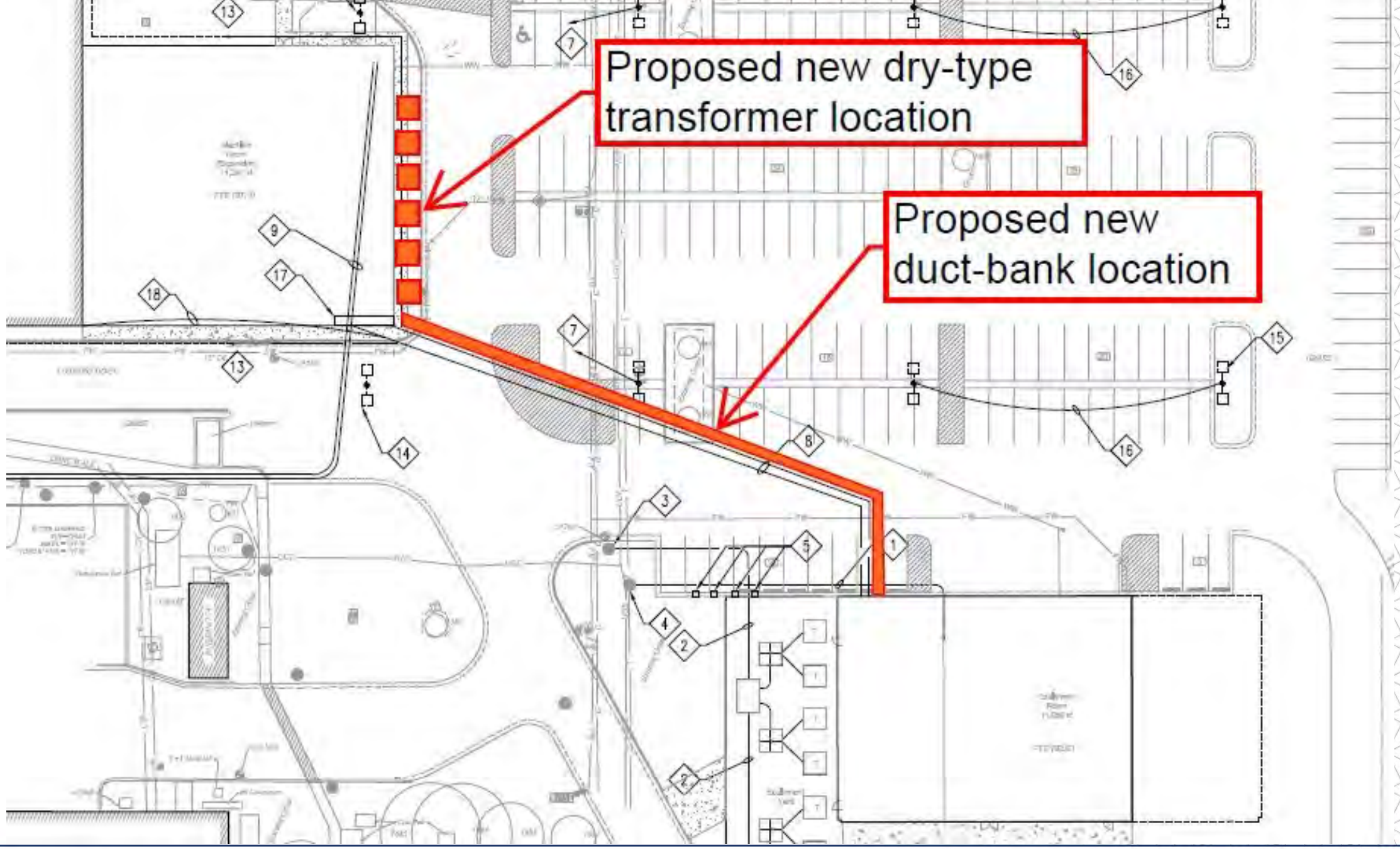
Solutions

- Electrical Option #1
  - Use existing two 2000A feeders and provide new four 2000A feeders from Central Plant
  - Provide six 1350 kVA transformers, outdoor dry-type

  - Disadvantages:
    - Extended shutdown and interruption of Data center operation
    - Complex scope of work
    - Over budget construction cost


Proposed new dry-type transformer location
Proposed new duct-bank location

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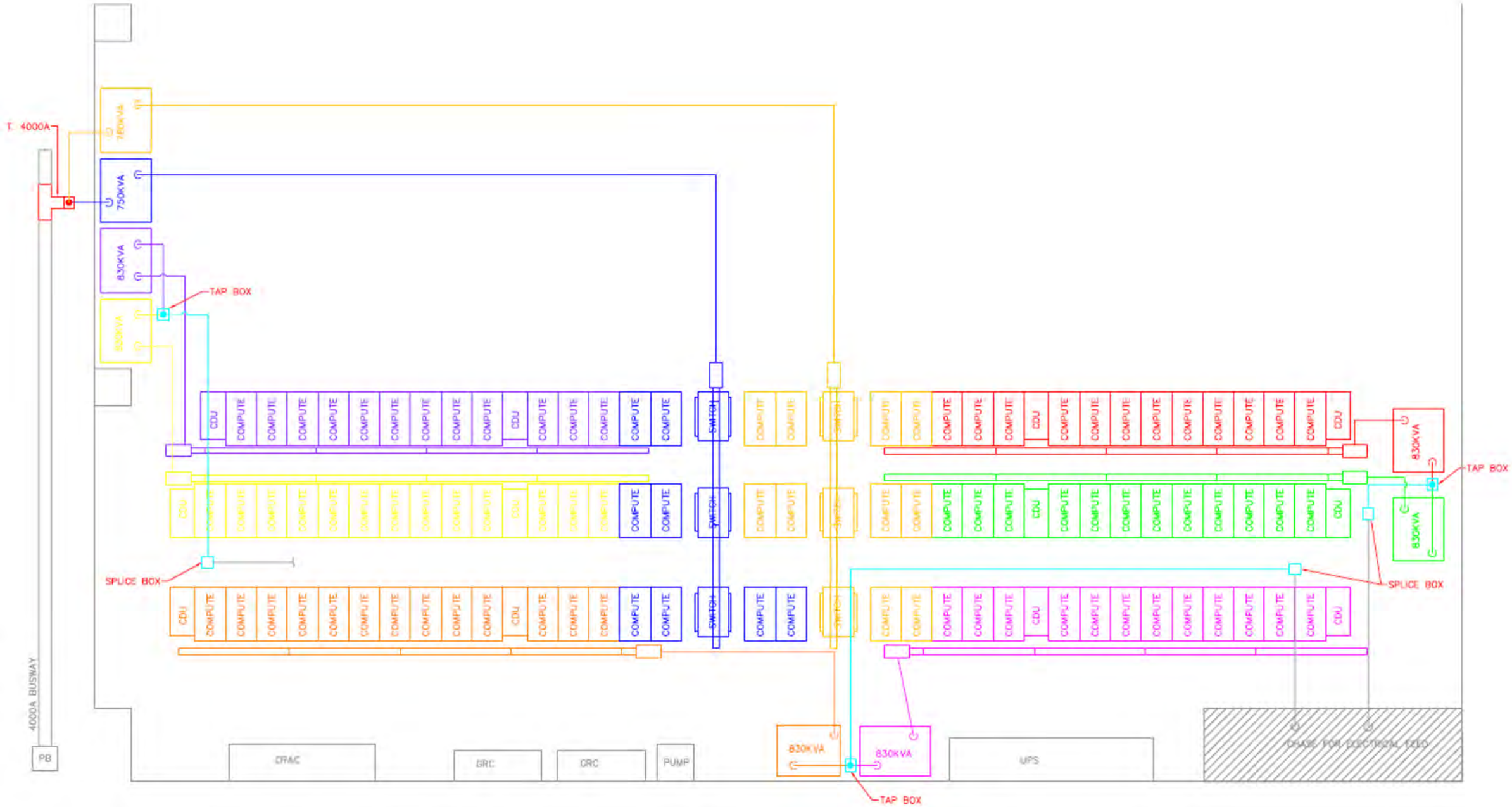
Solutions

- Electrical Option #2
  - Use existing three 2000A feeders and provide new 2000A feeder from adjacent space
  - Provide six 830 kVA and two 750 kVA transformers, indoor dry-type
  - Advantages:
    - Minimum shutdown and interruption of data center operation
    - Limited scope of work
    - 49% reduction in construction cost


T 4000A
750KVA
750KVA
830KVA
830KVA
TAP BOX
SPLICE BOX
CDU
COMPUTE
SWITCH
4000A BUSWAY
PB
CRAC
GRC
CRC
PUMP
830KVA
830KVA
UPS
TAP BOX
830KVA
830KVA
TAP BOX
SPLICE BOX

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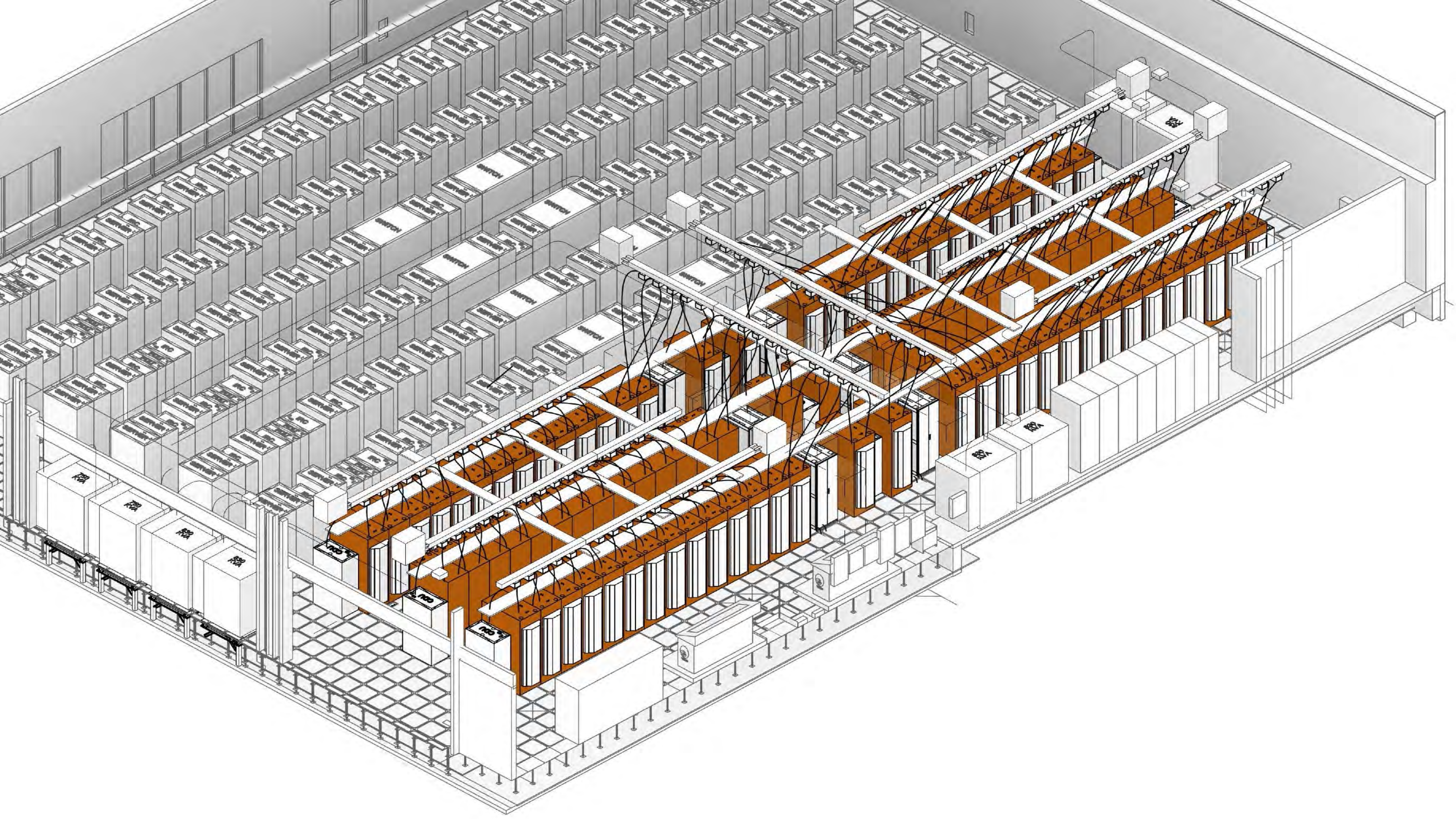
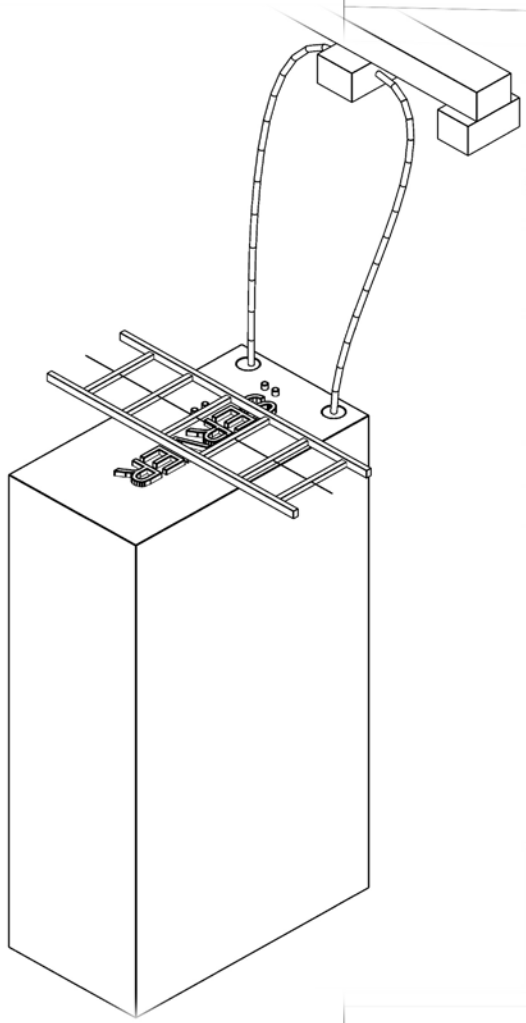
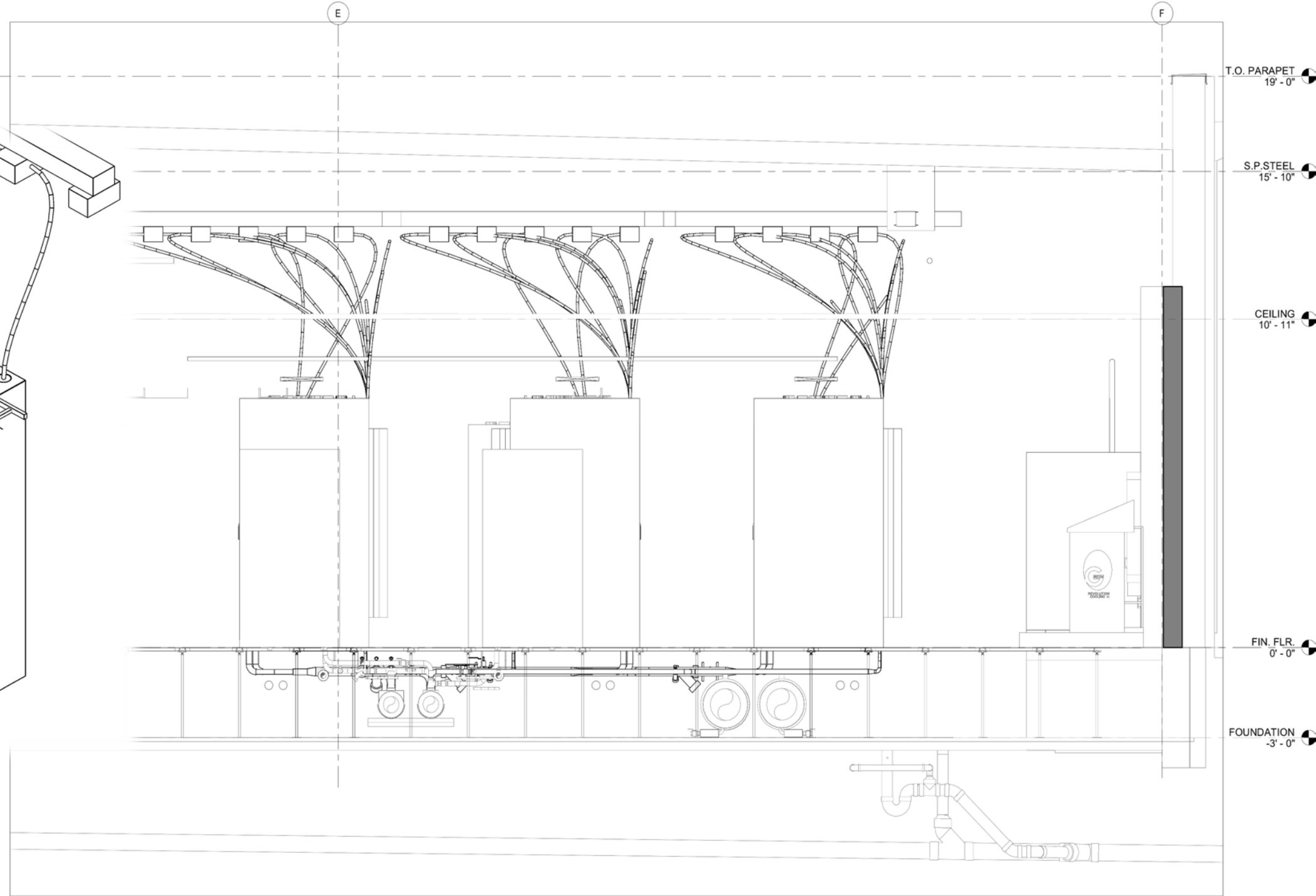
Solutions

- Perform system analysis
- Optimize electrical distribution
- High-efficiency transformers
- Calculate feeder busways
- Match international standards into U.S. standards
- Work with vendors to provide equipment without compromising the intent of the design and equipment performance
- Two options were provided to modify existing distribution system
- Power sources feed 480 volts to the transformers, which step down electricity to a still-powerful 415 volts to the supercomputer







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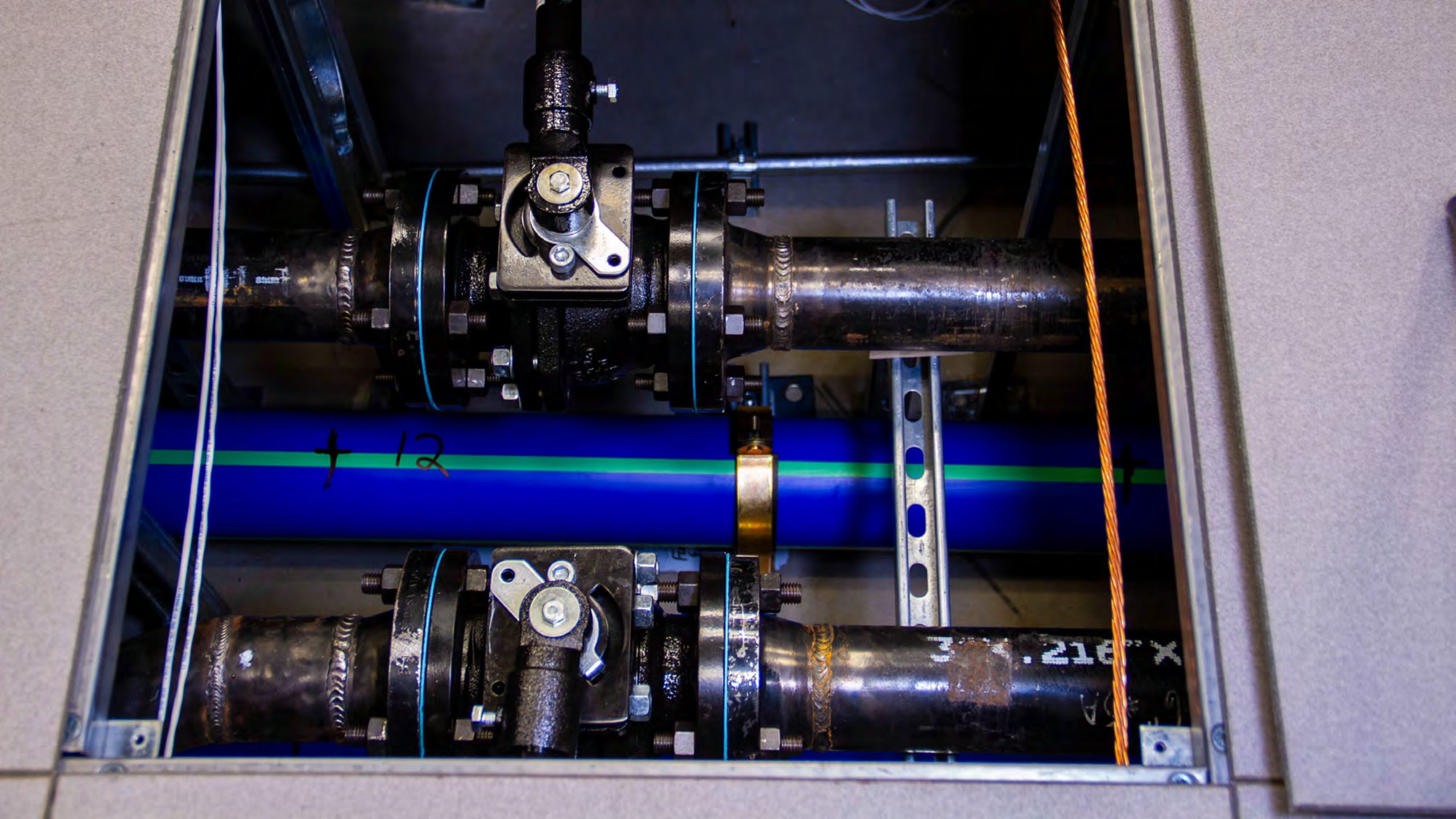
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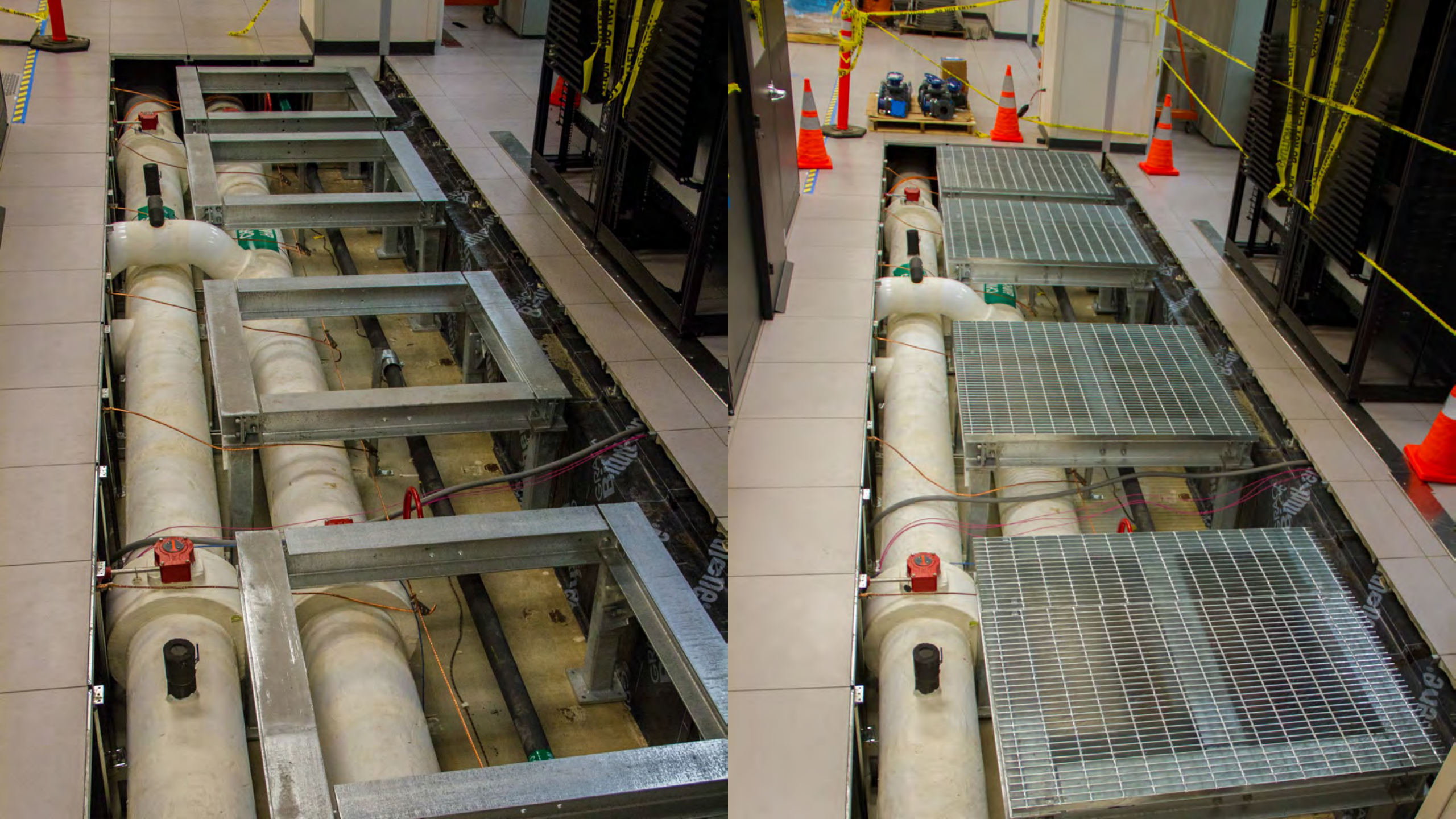

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Lessons Learned

- Fast track projects are a collaborative effort that involves the client, engineers, vendors and contractors
- Design analysis is as good as documenting existing conditions
- Leveraging existing distribution infrastructure reduces investment needs
- Present creative design ideas


Questions?

Thank You for Your Time

Juan Ontiveros, P.E.
Associate Vice President for
Utilities, UT-Austin
512.232.4191
juan.ontiveros@austin.utexas.edu

Tarek Tousson, P.E.
Principal Electrical Engineer
Stanley Consultants, Inc.
512-427-3606
ToussonTarek@stanleygroup.com