February 18, 2020

Date:	February 18, 2020
Project:	OSU Energy Center Steam Turbine Upgrades
Project Number:	19-1105
To:	John Gremmels
From:	PAE
Subject:	MEP Scoping Document - Draft

Existing Conditions

MECHANICAL

The Energy Center currently has a 1.0 MW Elliott backpressure steam turbine generator (STG) that is bypassed for extended periods of time due to variations in the campus demand for thermal energy and resultant difficulties experienced in maintaining the overall system control. The existing turbine is supplied 200 psig saturated steam from the central campus steam system.

When the connection to the utility grid opens the existing Combustion-Turbine backs down to parasitic load, but the Steam-Turbine is not able to back down production which then causes the breakers to open to protect the distribution system. Simultaneously the main steam pressure spikes causing the steam boiler high pressure relief to open and/or boiler drum high pressure trip since the main campus pressure reducing valves cannot react quick enough

Amines are used for chemistry control in the steam system and currently injected in the 65 psi steam heat to campus, ensure all equipment exposed to this steam source are constructed of materials suitable for contact with amines. The main boilers use a non-volatile chemistry control (phosphates and sulfites) and will not impact turbine operation.

Cooling water is available from a plant cooling water system. The system as the capacity to condense approximately 30,000 lbm/hr of steam. Cooling water is currently piped to the existing steam dump condenser and auxiliary plant cooling loads.

There are two condensate storage tanks with blank flanged connections.

The roof structure is not capable of carrying the load for supporting piping.

ELECTRICAL

The existing CTG and STG are currently connected to the utility feeder via the 20kV switchgear MVSG-001 located in the Energy Center. The two generators are paralleled together on the 13.8kV bus within the MVSG-002 switchgear. The step-up transformer TR-R, 13.8kV DELTA to 20.8kV WYE, 15/16.8/20/22.4 MVA, provides the voltage matching between the generators and the utility distribution system voltage. No changes to these two switchgear line-ups are contemplated to support the upsizing of the STG from 1.2 MW to 2.0 MW. The only change that may be required is an upgrade to the 13.8kV circuit conductors from the STG to breaker 52-13 in the MVSG-002 switchgear to accommodate an increase in the current from the 2.0 MW generator.

The existing STG is currently served by a large grounding transformer. This transformer sits on the Energy Center floor near the existing STG and may be reused by the new STG. There is also an existing CT cabinet that sits on the floor near the existing STG. This CT cabinet may also be reused for the new STG. The reuse of these two large electrical components of the existing STG will be the new STG supplier's choice.

The electrical controls consist of low voltage power and signal cabling routed in tray and conduit from the 1.2 MW control cabinet mounted very near the existing STG to the existing 480V motor control center, the synchronizing panel, the PIU's and the control room PLC and operator workstation displays.

Mechanical Requirements

GENERAL SYSTEM REQUIREMENTS

Install new dual-pressure steam turbine system (STG) or full condensing steam turbine in the location where old 1MW STG was removed. The new turbine system shall be sized to maximize electrical production from the available steam provided by the existing Heat Recovery Steam Generator or auxiliary boilers limited by available cooling water capacity from the existing cooling tower system. The basic system requirements are summarized below.

- All demolition, changes to existing system and equipment removal by contractor. Salvage value will be evaluated during design development period.
- Vender(s) to supply preliminary sequence of operations (SOO) for review as part of the selection process. Final approval of the SOO will be completed during design development.
- Training shall be provided for all shifts during their normal operating hours. The training implementation plan shall be developed and submitted for approval during the design development phase,
- Turbine selection options (condensing vs back pressure) shall be developed and reviewed with the Owner during the design development phase.
  - If a back-pressure turbine is recommended it shall be designed for 200 psig entering saturated steam pressure and outlet press of 65 psig.
- System shall remain fully functional during power outage events. Electrical power production needs to drop out to accommodate the existing utility connection.
- System shall interface with current DDC
- System shall have easy start-up, shut-down, and maintenance procedures.
- System shall have a turning gear or protection during extended down time or power outages
- System shall include all necessary steam & condensate meters (OSU's preferred equipment is Foxboro). Final meter selections shall be coordinated with the Owner during the design development phase.
- System shall operate with lube oil temperatures between 160-180 F.
- System shall include all necessary mechanical seals
- System should include one Human Interface (HMI) Controls system on or at unit.
- System should include all necessary taps for oil sampling
- All system traps shall return to condensate tanks

Electrical Requirements

Install new control cabinet at STG location and modify control center to allow remote operation. Provide new feeder to control cabinet from branch panels, modify existing below slab conduit to connect all power and control wiring between new control cabinet and control room remote operation workstations.

Add any new motor controls for STG auxiliaries such as turning gear motor, pumps or heaters. MCC-001, MCC-002 or MCC-003 have spare units and space for new units to satisfy the need for any new motor control starters or breakers or fuse units.

Route conduit and wire to new loads using existing circuiting methods. Connect any circuits from STG control panel to existing Synchronizing Panel as required.

If new STG requires greater ampacity than the existing conductor can provide, upgrade medium voltage conductor in existing conduit and any new conduit that will be required to reach the generator terminal enclosure from new STG to breaker 52-13 in the MVSG-002 Switchgear.

Provide a short-circuit and coordination study with the upsized steam turbine generator and wire sizes to ensure that proper interrupting ratings are maintained. Provide an arc flash hazard study per the requirements set forth in NFPA 70E and provide updated arc flash warning labels. Labels shall be 3-1/2" x 5" and include, at a minimum: location designation, nominal voltage, flash protection boundary, hazard risk category, incident energy, working distance, issue date.

CONTROLS

The existing control system is an Allen Bradley PLC based with pneumatic actuation and E/P transducer interface, all new controls shall utilize the same system with modifications to the existing workstations in control room to represent the new system components and related control logic.

Provide the ability to trend all system control points.

— Local Control
  - Local HMI on new control cabinet
  - Start Up/Shut Down
  - Automated and manual sync
  - Inlet or exhaust pressure control with power output limiting
  - Electronic overspeed protection to backup mechanical turbine protection
  - Lube oil pump control
  - Turbine generator monitoring including alarming, tripping and data display on digital touch screen interface
  - Turning gear motor control
— Control Room
  - Like local controls, except cold startup is local only
  - HMI screens are not yet developed for remote control of the new STG

New Steam Turbine Requirements

All demolition, changes to exsiitng system and equipment removal by contractor. Salvage value will be evaluated during development period.

Vender(s) to supply SOO's for review and approval

Training all shifts (hours) – implementation plan for approval during development phase,

Development phase will develop with owner options, pros and cons on condensing turbine vs back pressure turbine.

If a condensing turbine is usedSystem should be capable of condensing 100% of system flow.

If a back-pressure 200 lb inlet 65 lb out only if a back-pressure/ cond. turbine is considered

System should remain fully functional during power outage events.

System will interface with current DDC

System should have an easy start up / down procedures.

System should have a turning gear or protection during extended down time / power outages

System includes all necessary steam & condensate meters (OSU's preferred equipment is Foxboro)

System should operate with lube oil temperatures between 160-180 F for slow down condensation

Includes all necessary mechanical Seals

System should include one Human Interface (HMI) Controls on or at unit.

System should include all necessary taps for oil sampling

All system traps should return to condensate tanks

Cooling Water Schematic Piping Diagram | **OREGON STATE UNIVERSITY ENERGY CENTER**

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ROUTE COOLING WATER TO STEAM CONDENSER, AIR EJECTOR INTERCOOLERS, LUBE OIL COOLER AND OTHER COMPENENTS THAT REQUIRE COOLING WATER.

COOLING WATER TO PLANT AUXILIRY COOLERS AND EQUIPMENT.

RELOCATE EQUIPMENT AS REQUIRED TO MAINTAIN ACCESS TO EXISTING AND NEW EQUIPMENT

STEAM TURBINE GENERATOR SET. APPROXIMATE DIMENSIONS ARE 20' LONG, 10' WIDE. AND 12' TALL

STEAM CONDENSER, AIR EJECTORS, INTERCOOLERS, AND HOGGING EJECTOR SKID. APPROXIMATE DIMENSIONS ARE 10' LONG, 8' WIDE, AND 8' TALL.

COOLING WATER TO PLANT AUXILIRY COOLERS AND EQUIPMENT.

INSTALL NEW COOLING WATER PIPING ON EXISTING PIPE RACK. ROUTE PIPING TO NEW STG EQUIPMENT. ANTIPCATED PIPE SIZE IS 8".

CONNECT TO EXISTING COOLING WATER SYSTEM.

COOLING WATER TO PLANT DUMP CONDENSER

COOLING WATER FROM EXISTING COOLING TOWERS.

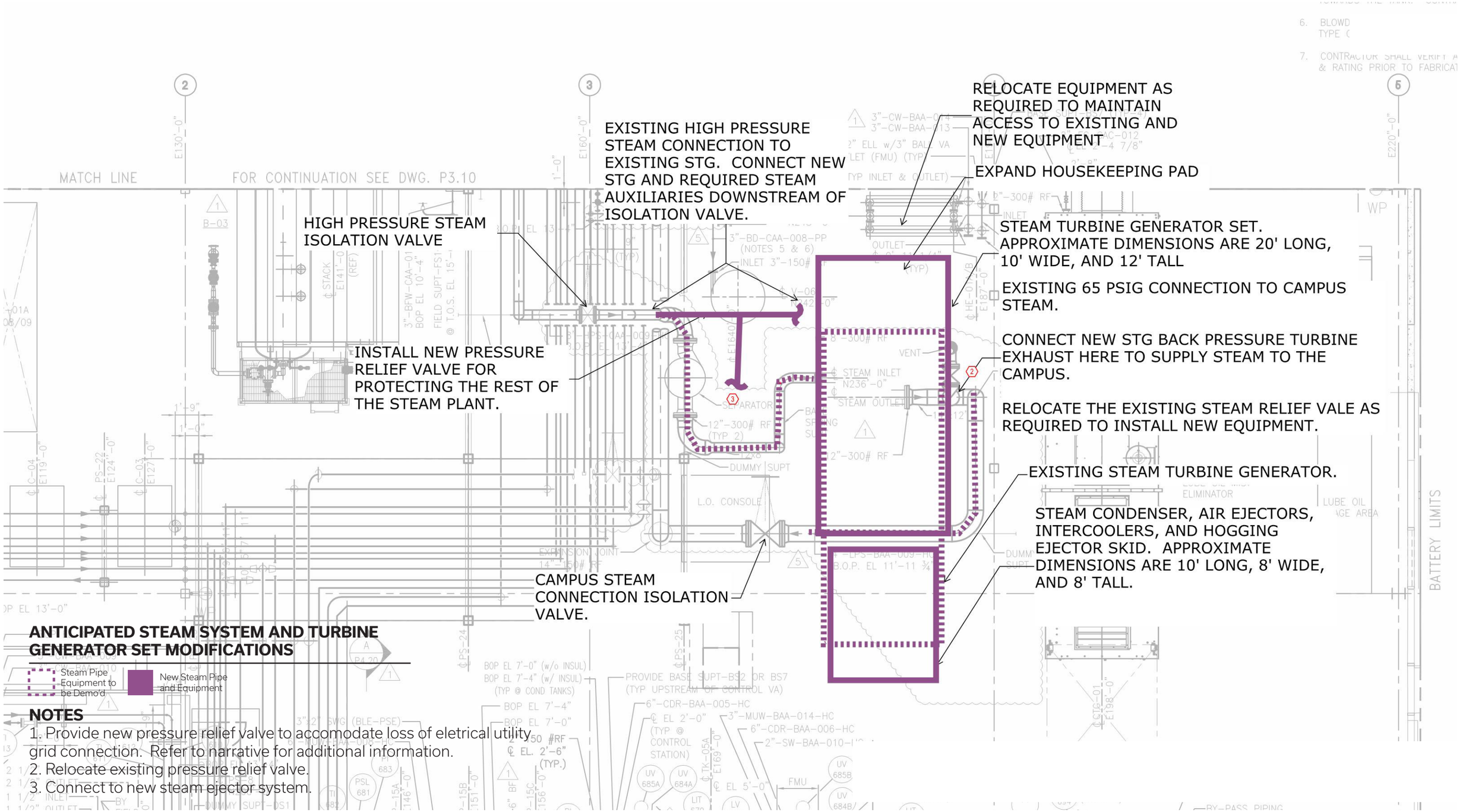
ANTICIPATED COOLING WATER SYSTEM MODIFICATIONS

New Cooling Water Piping

Existing Cooling Water Piping

NOTES

1. Install new shutoff valves allowing for isolation of plant cooling water. Coordiante shutdown requirements with OSU.



ANTICIPATED STEAM SYSTEM AND TURBINE GENERATOR SET MODIFICATIONS

Steam Pipe Equipment to be Demo'd

New Steam Pipe and Equipment

NOTES

1. Provide new pressure relief valve to accomodate loss of eletrical utility grid connection. Refer to narrative for additional information.
2. Relocate existing pressure relief valve.
3. Connect to new steam ejector system.

Condensate Return Schematic Piping Diagram | **OREGON STATE UNIVERSITY ENERGY CENTER**

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EXISTING STEAM TURBINE GENERATOR.

STEAM CONDENSER, AIR EJECTORS, INTERCOOLERS, AND HOGGING EJECTOR SKID. APPROXIMATE DIMENSIONS ARE 10' LONG, 8' WIDE, AND 8' TALL.

CONDENSATE PIPING FROM STG CONDENSER SYSTEM.

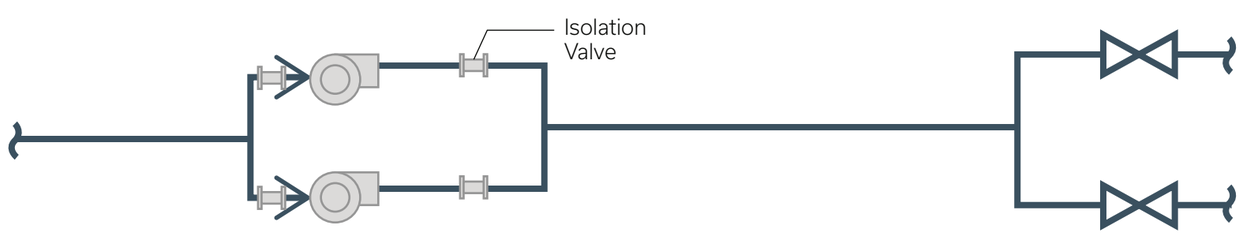
INSTALL PIPING IN EXISTING PIPE RACKS.

THE DISCHARGE OF STG CONDENSER PUMPS SHALL BE ROUTED TO THE EXISTING CONDENSATE STORAGE TANKS. INSTALL PIPING AS HIGH IN THE SPACE AS POSSIBLE TO MAINTAIN CLEAR ACCESS FUR FUTURE BOILER REMOVAL. CONNECT TO THE EXISTING BLANKED FLANGED CONNECTIONS AT THE TOP OF EACH TANK. PROVIDE ISOLATION VALVES AT EACH TANK TO ALLOW FOR ONE TANK AT A TIME TO BE TAKEN OUT OF SERVICE FOR MAINTENANCE.

ANTICIPATED CONDENSATE RETURN SYSTEM

Steam Turbine Generator

Condensate Piping



ANTICIPATED CONDENSATE RETURN SYSTEM

Steam Turbine Generator

Condensate Piping

Steam System Schematic Piping Diagram | **OREGON STATE UNIVERSITY ENERGY CENTER**

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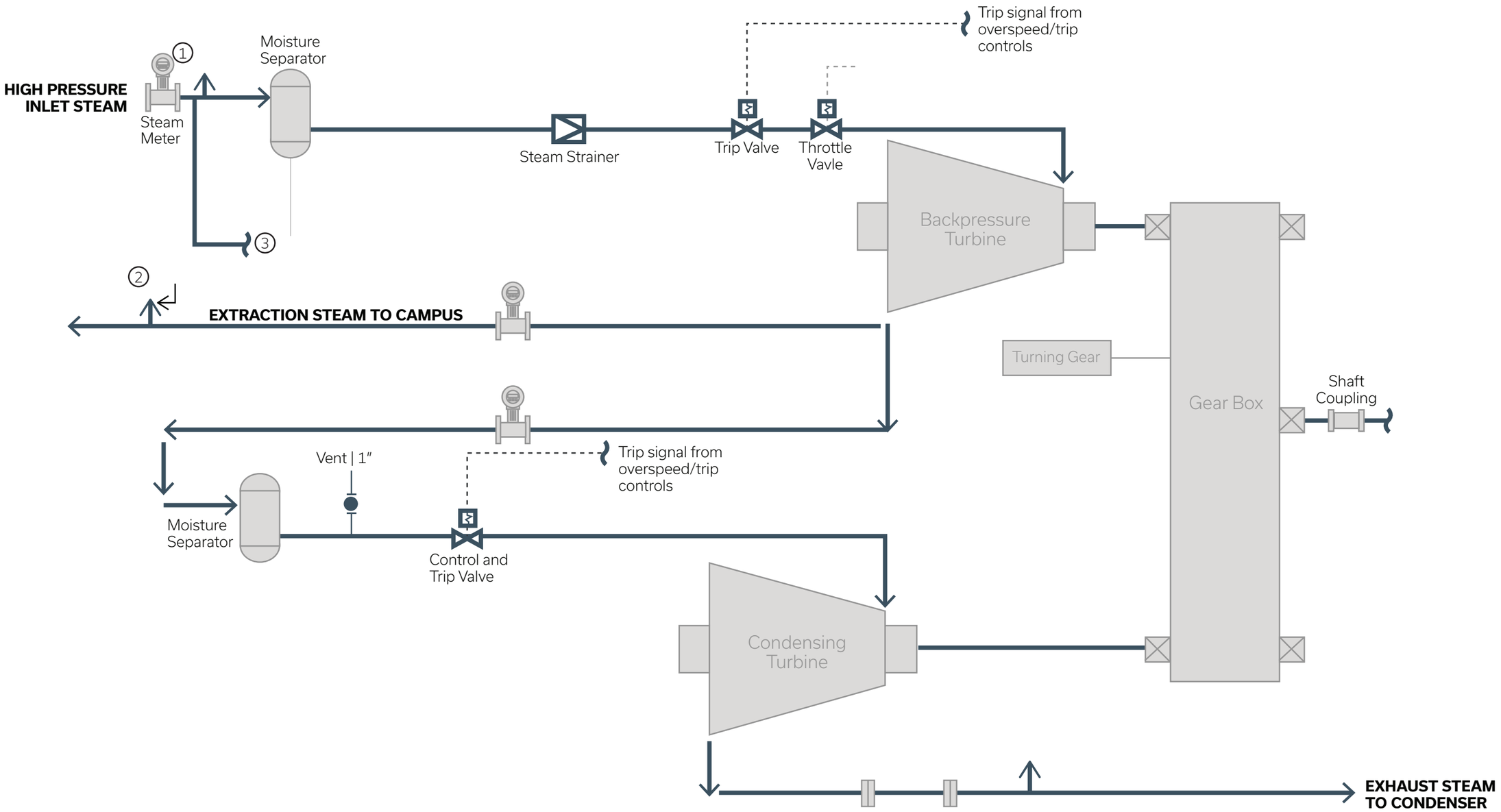
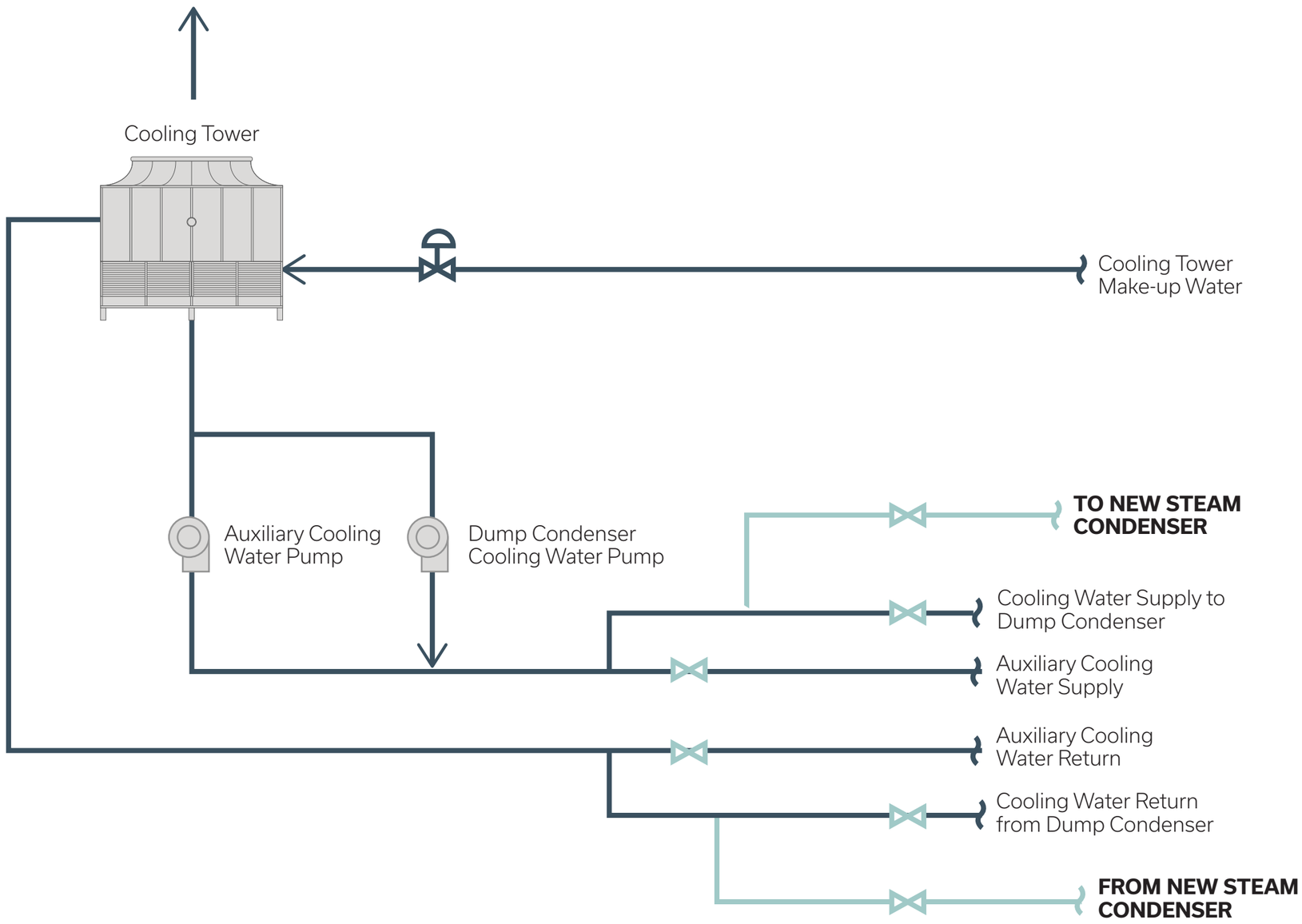
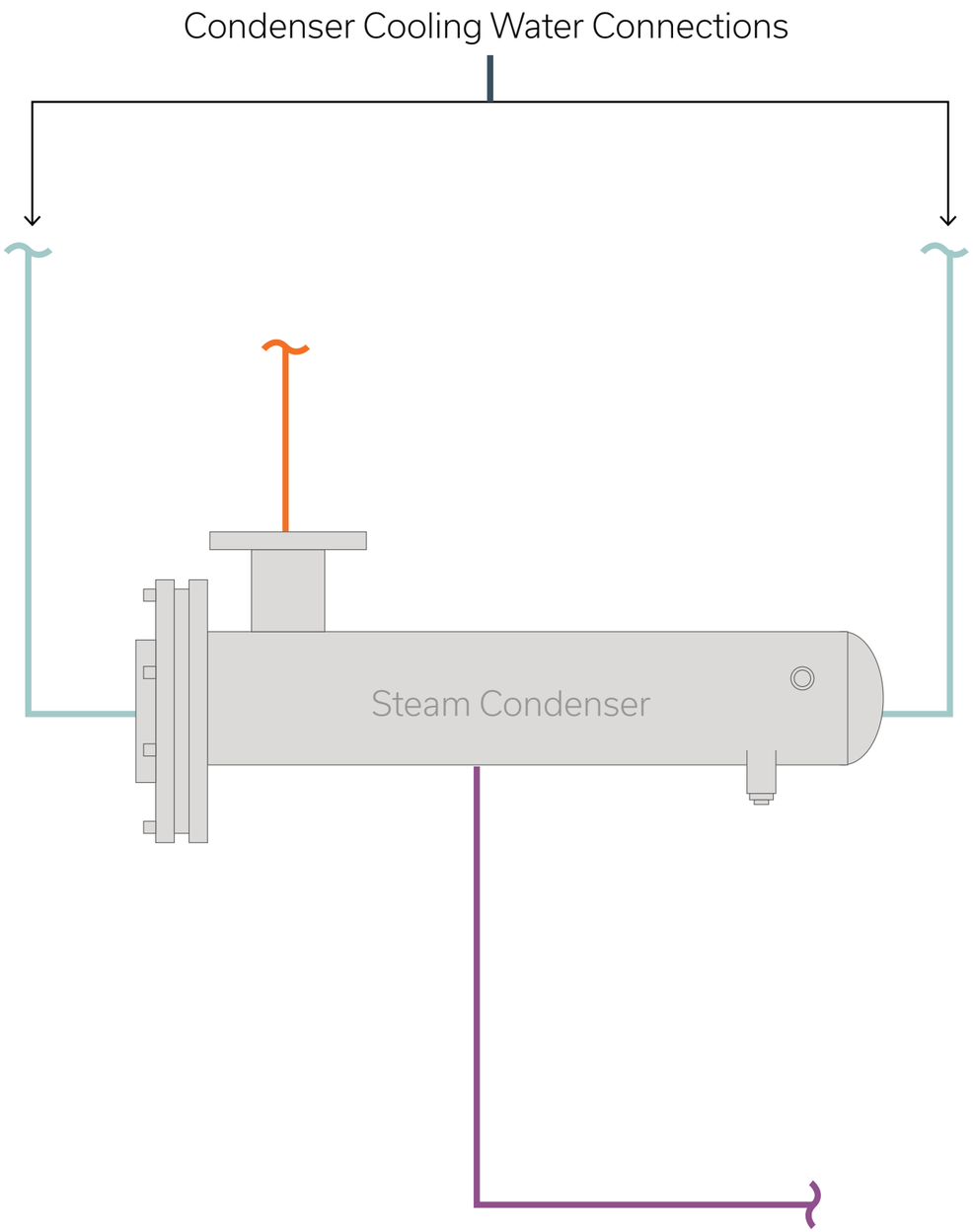


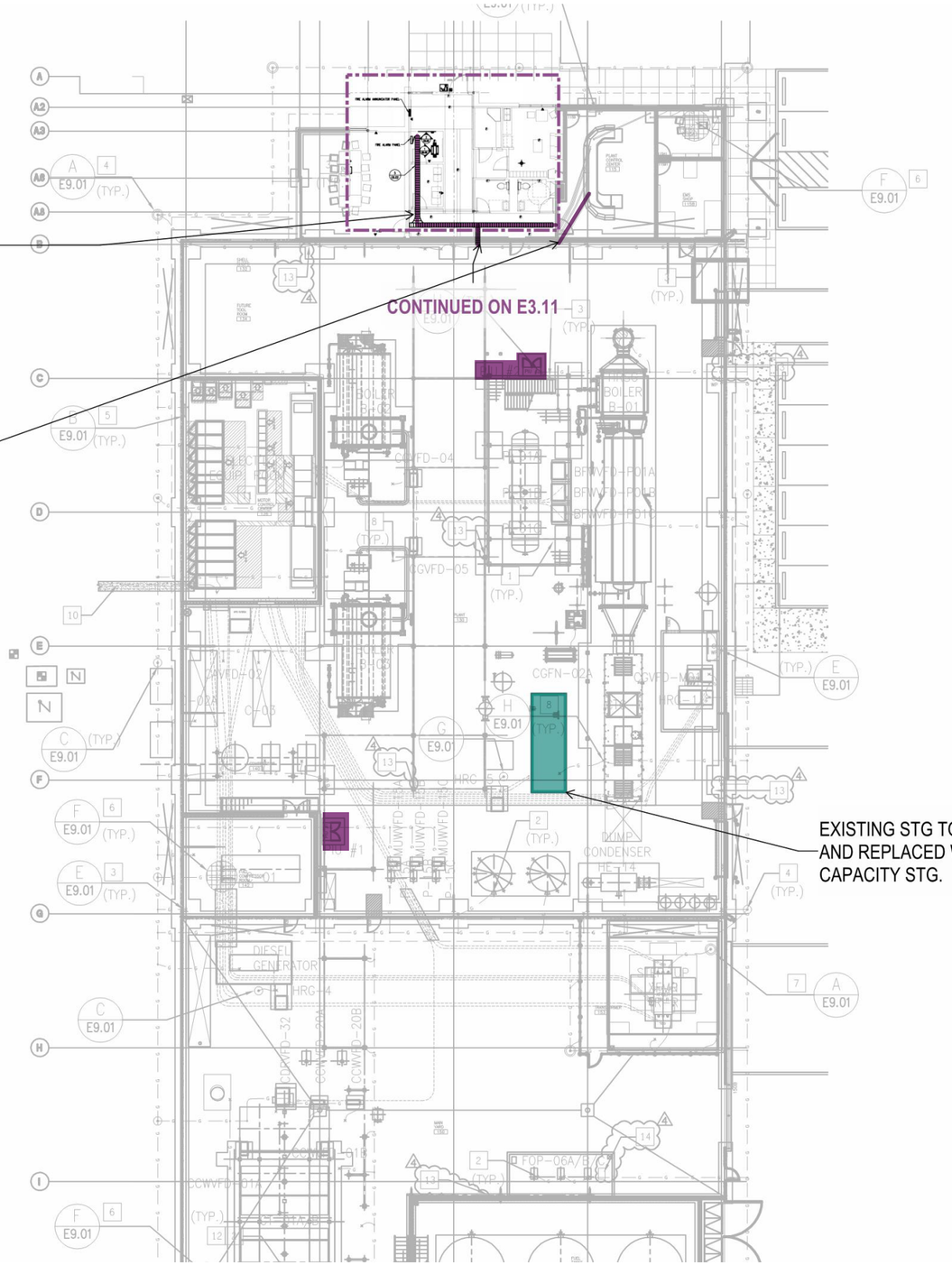
Cooling Water Schematic Piping Diagram | **OREGON STATE UNIVERSITY ENERGY CENTER**




Condenser Cooling Water Connections
Steam Condenser

USE THIS CABLE TRAY FOR ANY NEW OR REPURPOSED INSTRUMENTATION AND COMMUNICATION CABLES BETWEEN CONTROL ROOM (115), EF/MDF ROOM (108) AND PLANT FLOOR EQUIPMENT ASSOCIATED WITH THE NEW STG. THIS CABLE TRAY INTERSECTS WITH THE CABLE TRAY LEADING TO THE PLANT FLOOR AT COLUMN LINE 3.2. PLEASE NOTE THAT WIRE AND CABLE TO THE CONTROL ROOM CONSOLE LEAVE THE CABLE TRAY AROUND COLUMN LINE B AND BETWEEN COLUMN LINES 3 AND 4 AND ARE INSTALLED IN CONDUIT UNDER THE CONTROL ROOM FLOOR. THE UNIVERSITY DESIRES THAT THE LEAST COST ALTERNATIVES ARE USED FOR ESTABLISHING ALL OF THE NEW INTERCONNECTIONS BETWEEN THE NEW STG CONTROLS AND THE EXISTING SWITCHGEAR, PLC'S, PIU'S AND CONTROL ROOM CONSOLES.

CONDUITS FROM THE CONTROL ROOM ENTER THE PLANT FLOOR FROM UNDER THE CONTROL ROOM FLOOR AND TURN UP JUST AS THEY ENTER THE PLANT. THEY RISE TO THE LEVEL OF THE CABLE TRAY AND THROUGH CONDUIT TO TRAY TRANSITION FITTINGS ENTER THE TRAY SYSTEM. SEE DRWG E3.11 FOR CONTINUATION OF TRAY SYSTEM.

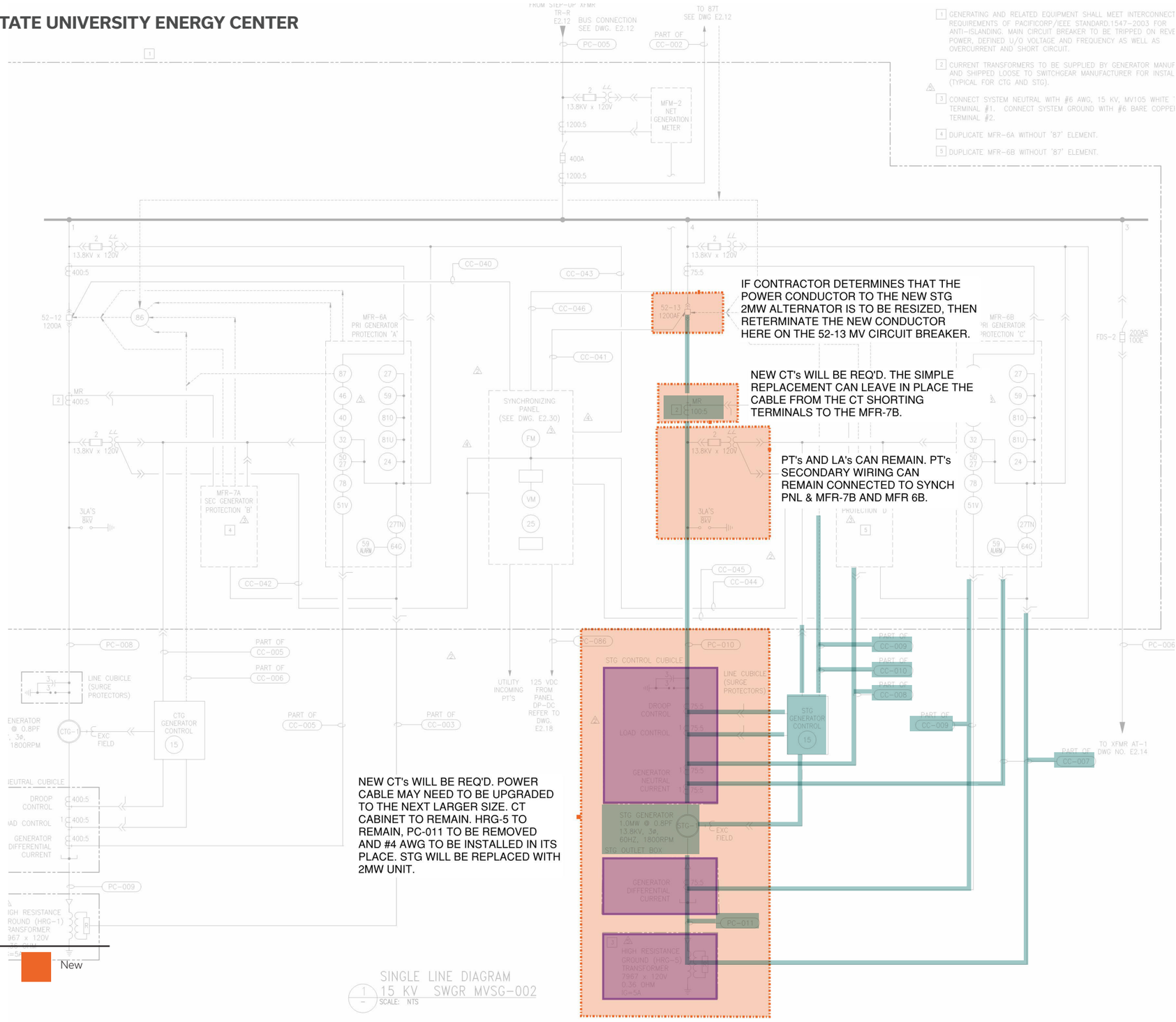


LEGEND

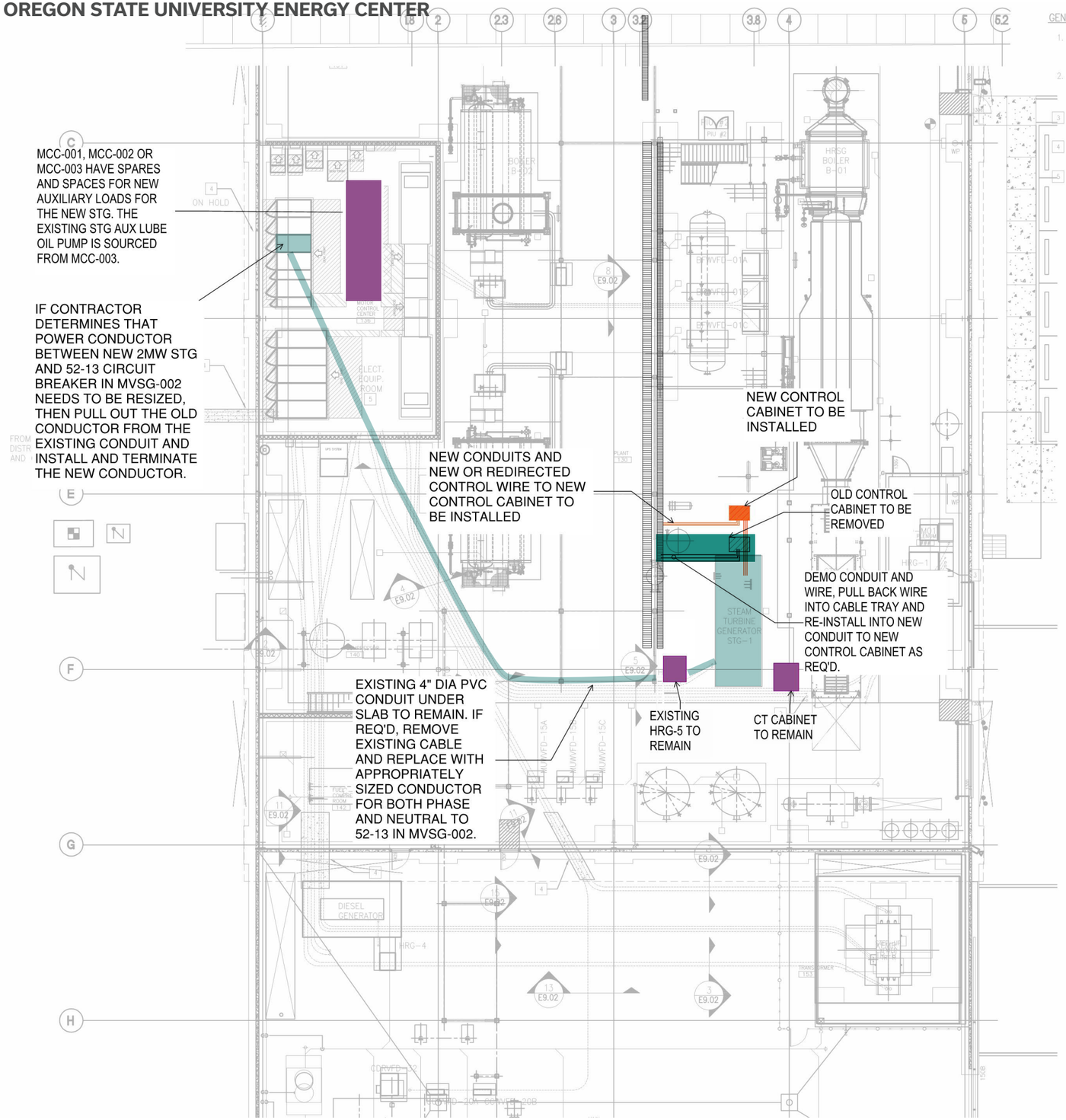
Demolish

Remains

PAE


1 GENERATING AND RELATED EQUIPMENT SHALL MEET INTERCONNECT REQUIREMENTS OF PACIFICORP/IEEE STANDARD 1547-2003 FOR ANTI-ISLANDING. MAIN CIRCUIT BREAKER TO BE TRIPPED ON REVE POWER, DEFINED U/O VOLTAGE AND FREQUENCY AS WELL AS OVERCURRENT AND SHORT CIRCUIT.
2 CURRENT TRANSFORMERS TO BE SUPPLIED BY GENERATOR MANUF AND SHIPPED LOOSE TO SWITCHGEAR MANUFACTURER FOR INSTAL (TYPICAL FOR CTG AND STG).
3 CONNECT SYSTEM NEUTRAL WITH #6 AWG, 15 KV, MV105 WHITE TERMINAL #1. CONNECT SYSTEM GROUND WITH #6 BARE COPPEI TERMINAL #2.
4 DUPLICATE MFR-6A WITHOUT "87" ELEMENT.
5 DUPLICATE MFR-6B WITHOUT "87" ELEMENT.
FROM STEP-UP XFMR TR-R E2.12
BUS CONNECTION SEE DWG. E2.12
PC-005
PART OF CC-002
TO 87T SEE DWG E2.12
MFM-2 NET GENERATION METER
13.8KV x 120V
1200:5
400A
IF CONTRACTOR DETERMINES THAT THE POWER CONDUCTOR TO THE NEW STG 2MW ALTERNATOR IS TO BE RESIZED, THEN RETERMINATE THE NEW CONDUCTOR HERE ON THE 52-13 MV CIRCUIT BREAKER.
NEW CT's WILL BE REQ'D. THE SIMPLE REPLACEMENT CAN LEAVE IN PLACE THE CABLE FROM THE CT SHORTING TERMINALS TO THE MFR-7B.
PT's AND LA's CAN REMAIN. PT's SECONDARY WIRING CAN REMAIN CONNECTED TO SYNCH PNL & MFR-7B AND MFR 6B.
52-12 1200A
52-13 1200AF
MR 400:5
75:5
MFR-6A PRI GENERATOR PROTECTION 'A'
MFR-6B PRI GENERATOR PROTECTION 'C'
MFR-7A SEC GENERATOR PROTECTION 'B'
SYNCHRONIZING PANEL (SEE DWG. E2.30)
3LA'S 8KV
FDS-2 200AS 100E
CC-040
CC-041
CC-042
CC-043
CC-044
CC-045
CC-046
PC-006
PC-008
PC-009
PC-010
PC-011
PART OF CC-003
PART OF CC-005
PART OF CC-006
PART OF CC-007
PART OF CC-008
PART OF CC-009
PART OF CC-010
LINE CUBICLE (SURGE PROTECTORS)
CTG GENERATOR CONTROL
EXC FIELD
UTILITY INCOMING PT'S
125 VDC FROM PANEL DP-DC REFER TO DWG. E2.18
TO XFMR AT-1 DWG NO. E2.14
STG CONTROL CUBICLE
DROOP CONTROL
LOAD CONTROL
GENERATOR NEUTRAL CURRENT
GENERATOR DIFFERENTIAL CURRENT
STG GENERATOR CONTROL
STG GENERATOR 1.0MW @ 0.8PF 13.8KV, 3ø, 60HZ, 1800RPM
STG OUTLET BOX
HIGH RESISTANCE GROUND (HRG-5) TRANSFORMER 7967 x 120V 0.36 OHM IG=5A
NEW CT's WILL BE REQ'D. POWER CABLE MAY NEED TO BE UPGRADED TO THE NEXT LARGER SIZE. CT CABINET TO REMAIN. HRG-5 TO REMAIN, PC-011 TO BE REMOVED AND #4 AWG TO BE INSTALLED IN ITS PLACE. STG WILL BE REPLACED WITH 2MW UNIT.
LEGEND
Demolish & Replace
Remains
New
SINGLE LINE DIAGRAM
1 15 KV SWGR MVSG-002
SCALE: NTS

Power and Controls Plan - Sheet 2 | **OREGON STATE UNIVERSITY ENERGY CENTER**



LEGEND

- Demolish & Replace
- Demolish
- Remains
- New

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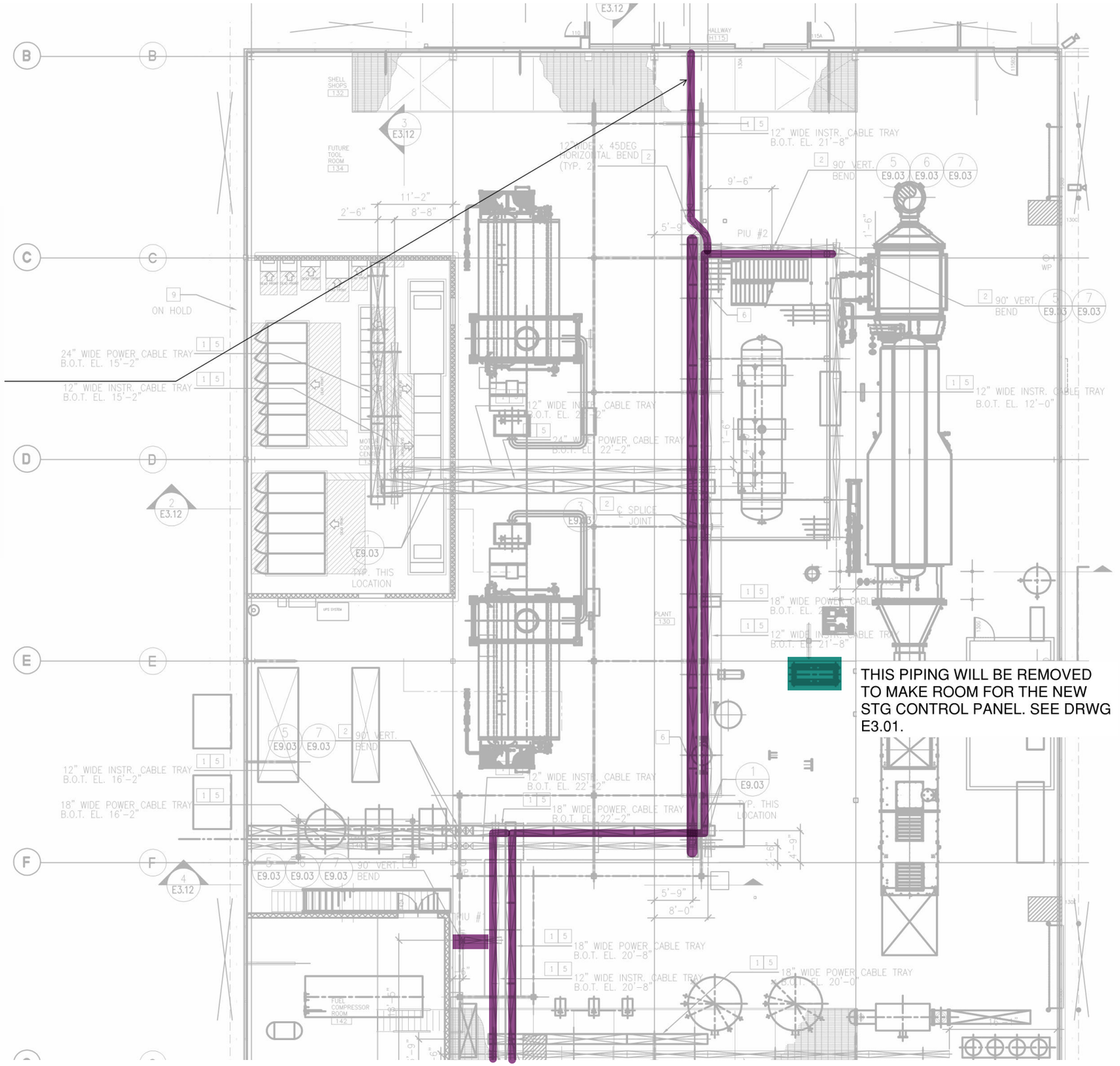

LEGEND

Demolish

Remains