MTR CARBON CAPTURE

LARGE PILOT TESTING OF THE MTR MEMBRANE CAPTURE PROCESS

2024 FECM / NETL Carbon Management Research Project Review Meeting

August 5, 2024

DE-FE0031587

DE-FE0031587 (FOA-1788) – Phase III Overview

Award Name: Large Pilot Testing of the MTR Membrane Post-Combustion CO_2 Capture Process

Phase III Project Period: 10/1/21 to 9/30/26

Phase III Funding: $58,078,814 DOE + $28,211,718 cost share = $86,290,542 total

DOE-NETL Project Manager: Nicole Shamitko-Klingensmith

Project Team: MTR (prime), WITC (Host), Sargent & Lundy, Trimeric, Graycor

Overall Goal: To demonstrate the performance and abilities of MTR's membrane-based capture system through the operation of a Large Pilot as a final step of commercialization.

Project Plan for Phase III: Perform final design, then procure, fabricate, install and commission the Large Pilot plant at the WITC. Conduct long term operations of a 10 MWe fully featured membrane-based CO_2 capture plant.

MTR's Objectives for Large Pilot Project

- Demonstrate MTR's carbon capture technology at the small commercial scale
- Gain experience with dynamic operation of balance-of-plant equipment
- Determine fate of all minor flue gas species and quantify co-capture capabilities
- Characterize the water streams captured throughout the capture process
- Obtain long-term steady-state operational data under optimized process conditions

Wyoming Integrated Test Center (ITC)

- Dedicated post-combustion carbon capture test center; opened 2018
- Facility sponsored by the State of Wyoming; Tri-State Generation and Transmission Association; National Rural Electric Cooperative Association; and Basin Electric Power Cooperate
- DFS supplies the Large and Small Test Centers with a slipstream of flue gas
- Power, water, utilities and flue gas connections are in place

MTR CARBON CAPTURE

Wyoming

BASIN ELECTRIC POWER COOPERATIVE
A Touchstone Energy® Cooperative

NRECA
America's Electric Cooperatives

TRI-STATE

DE-CD0000015 - Phase 1 Demonstration Project
A Full-scale, Fully-integrated CCUS Project at Dry Fork Station

OCED
Office of Clean Energy Demonstrations

BASIN ELECTRIC POWER COOPERATIVE
A Touchstone Energy® Cooperative

WYOMING ENERGY AUTHORITY

TRIMERIC CORPORATION

Kiewit

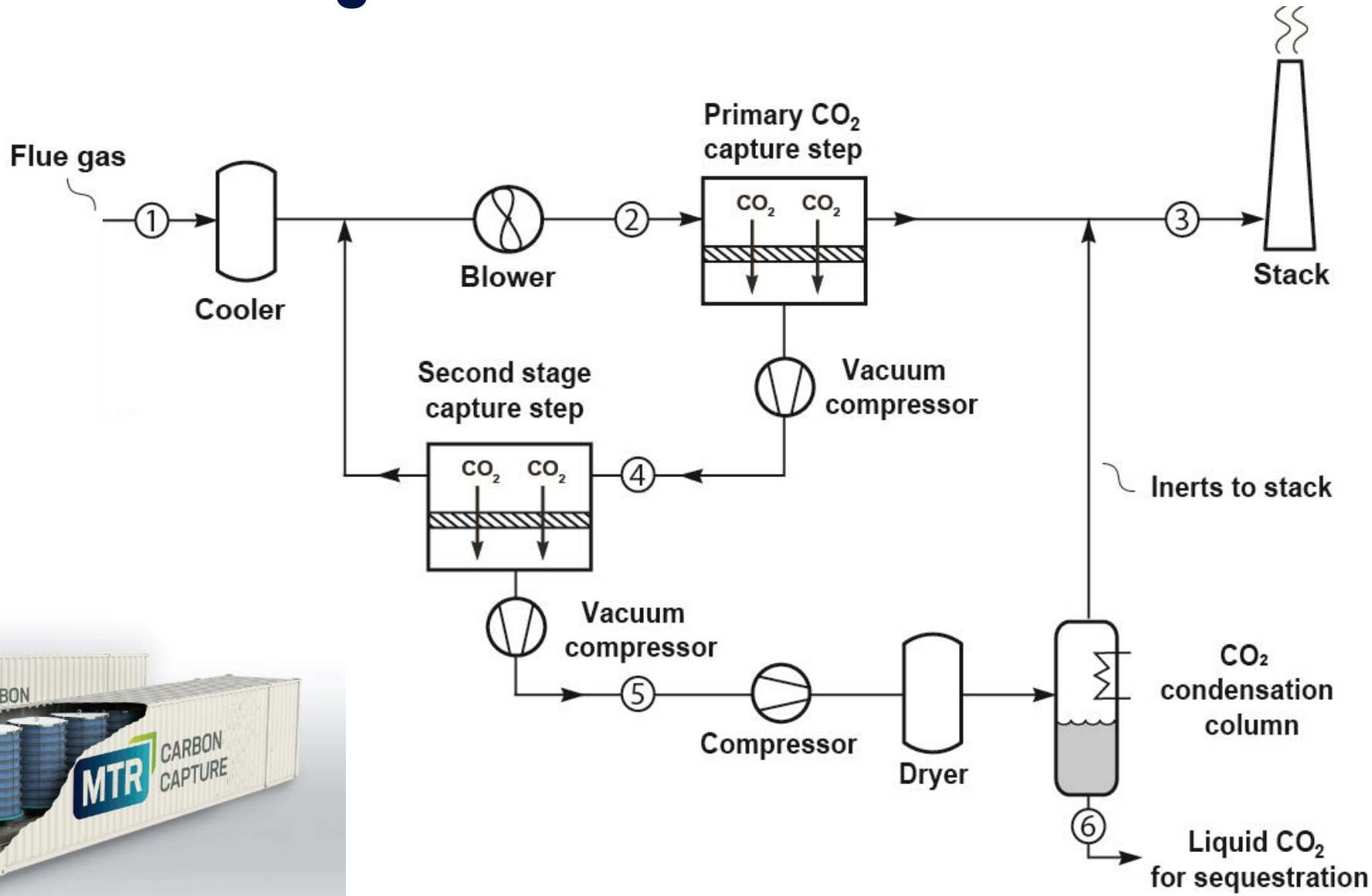
Sargent & Lundy

EERC
Energy & Environmental Research Center®
Putting Research into Practice

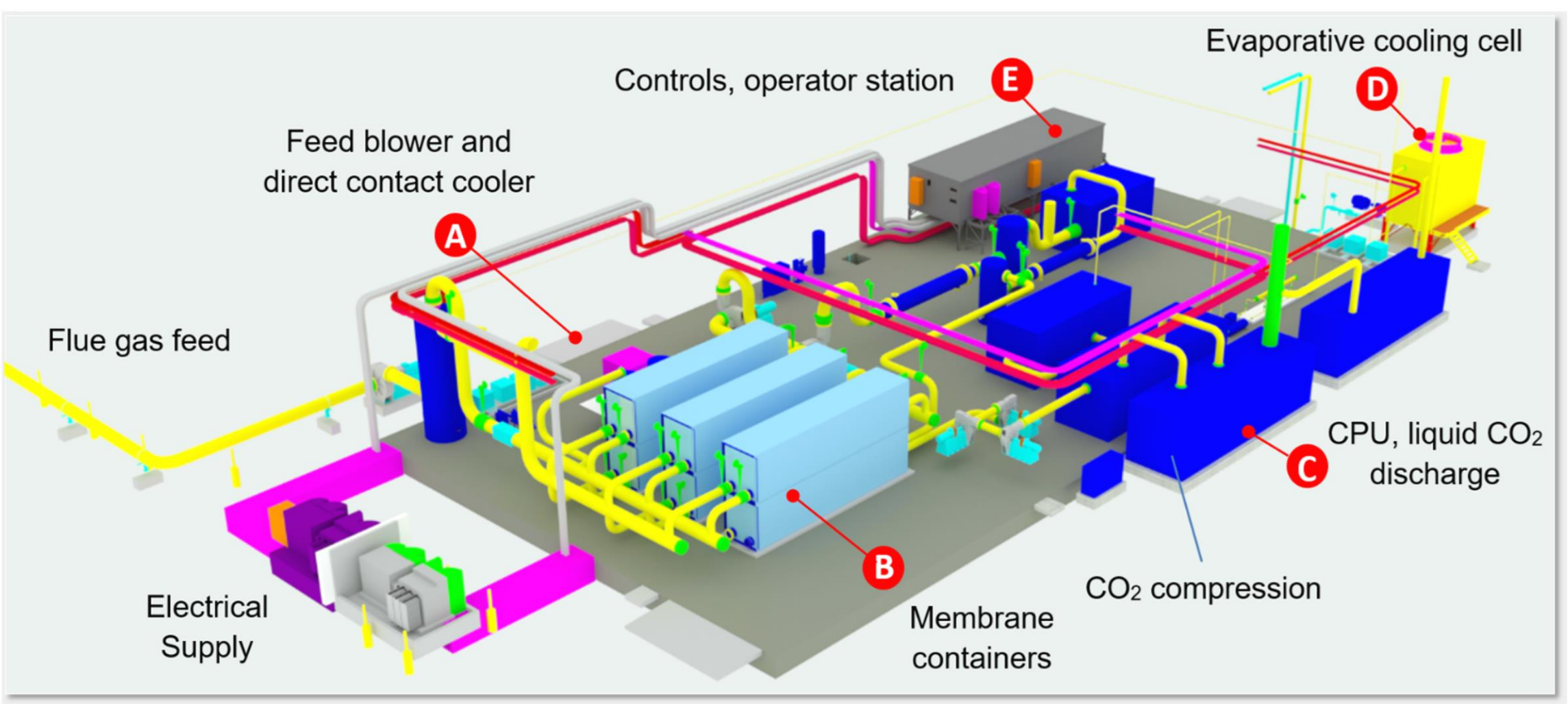
UNIVERSITY OF WYOMING
School of Energy Resources

MTR CARBON CAPTURE

Simplified Process Diagram

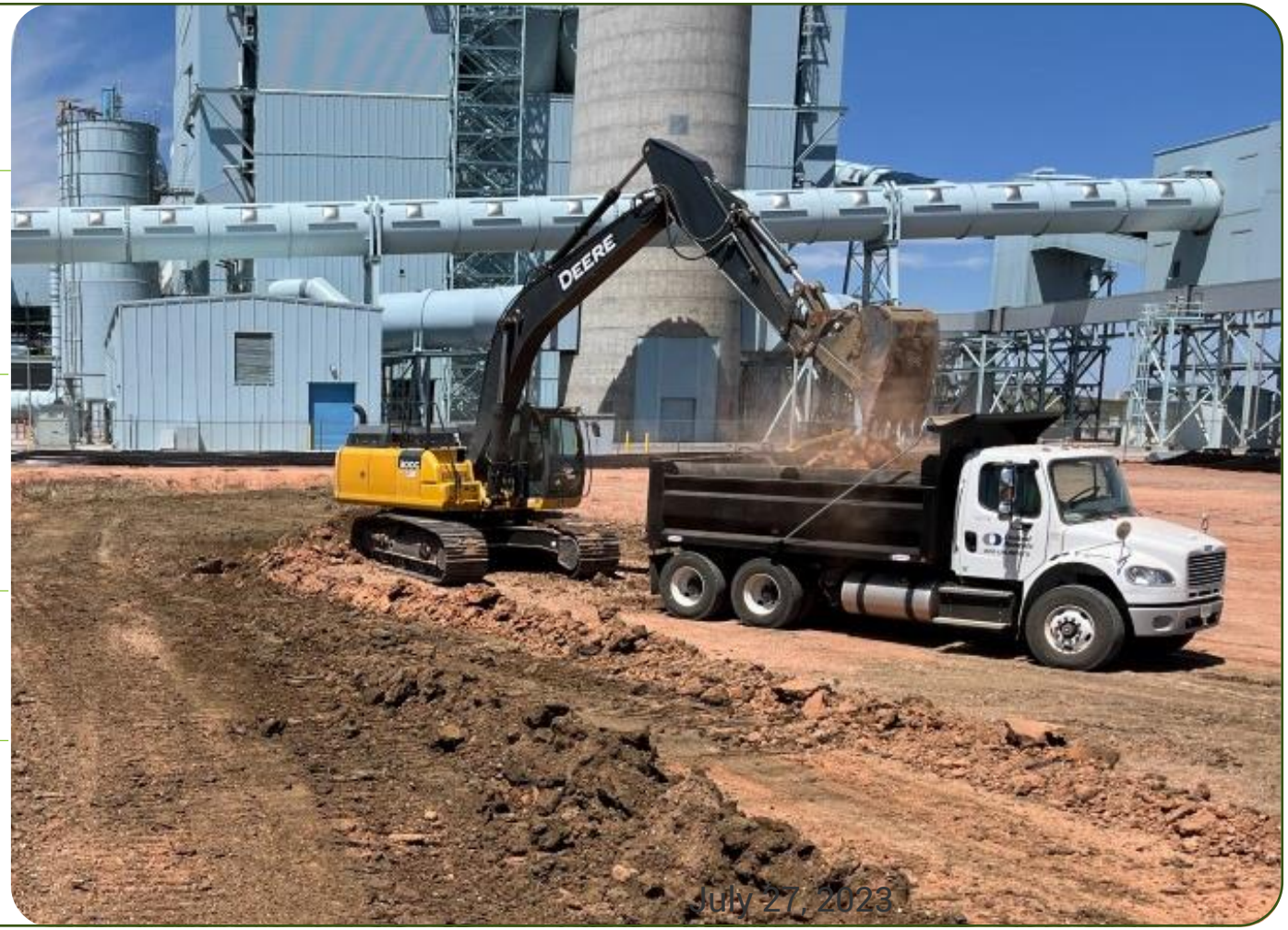


General Arrangement of Process Equipment



Construction Progress – Activities During This Time Last Year

Host	ITC Wyoming Integrated Test Center
Technology Provider	MTR
EPCm	Sargent & Lundy
Constructor	GRAYCOR
Engineering Services	Trimeric Corporation



July 27, 2023

Pouring Foundations for the Capture Plant

AUG | SEP | OCT | NOV | DEC | '24 JAN | FEB | MAR | APR | MAY | JUN | JUL | AUG

Process Equipment Begins to Arrive and Assembly of the Capture Building Begins

Process Equipment arrives – Flue gas blower

Steel members for the building are erected

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AUG SEP OCT NOV DEC '24 JAN FEB MAR APR MAY JUN JUL AUG

Placing First Pieces of Process Equipment & Building Dry-In

Direct Contact Cooler

Large Pilot Capture Building

Arrival and Placement of First Skidded System; the CPU

Compression and Dehydration

CO_2 Liquefaction and Distillation

Large- and Small-Bore Pipe Spools Arrive & Cooling Tower Placed

Evaporative Cooling Tower

DCC Placed and Auxiliary Steel (Pipe Racks) Installed

Direct Contact Cooler - Feb

Direct Contact Cooler - April

Installing process piping

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First and Second Stage Vacuum Fans

Permeate Vacuum Fans

Flue Gas Tie-in to the ITC and Duct Run to the Capture Building

Duct run from ITC tie-in to the flue gas blower

ITC tie-in and transition section

Electricians Installing Cable Trays and Preparing for the PDC Building

Electrical cable trays and piers for the PDC building

Cable tray waterfalls and penetration towards PDC building

Electricians Installing Cable Trays and Preparing for the PDC Building

Placement of PDC building

PDC building installed with stairs and walkways

DCC Placed and Auxiliary Steel (Pipe Racks) Installed

PDC Interior – electrical switchgear and motor controllers

Electricians terminating cables

MTR CARBON CAPTURE

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Running Electrical Conduits/Cables to the Cooling Tower

Electrical connections to the cooling tower

Interior of Capture Building Showing CPU and Rotating Equip.

Interior of Capture Building Facing Permeate Flanges

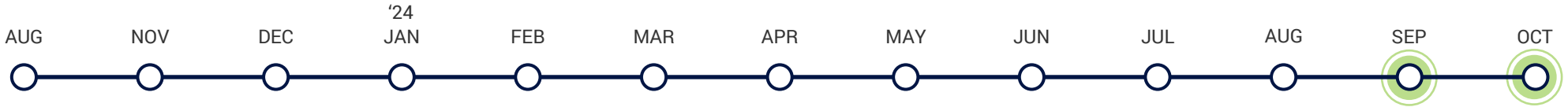
Delivery of Container #1 & ITC Showcase Event (May 8)

Delivery of first membrane container

Part of the ITC tours given during their May 8 Showcase event

Commissioning Schedule

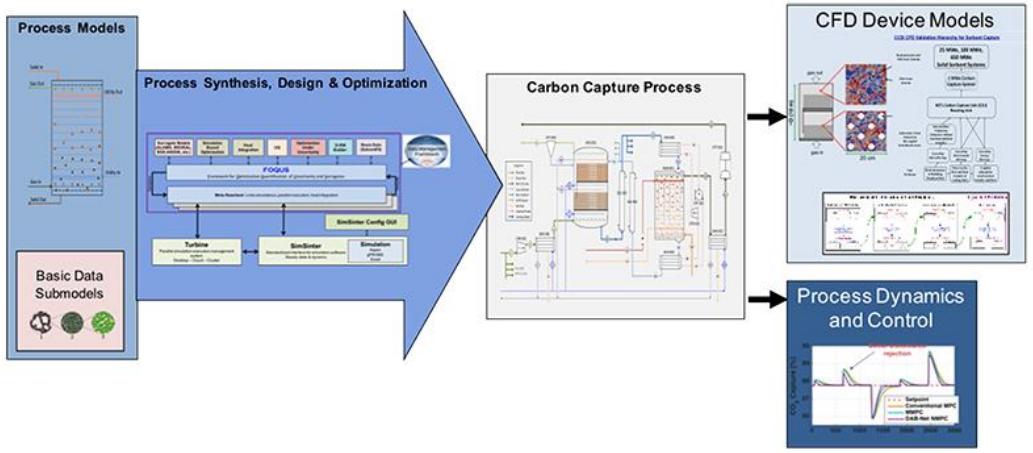
Equipment	Vendor	Pre-Commissioning		Commission (Air)		Commission (Flue Gas)	
		Start	End	Start	End	Start	End
Instrument Air Compressor	###	28-Aug	30-Aug				
UPS	###	26-Aug	28-Aug				
Membrane A Fans	###	9-Sep	20-Sep	23-Sep	27-Sep	14-Oct	18-Oct
Membrane B Fans	###	9-Sep	20-Sep	23-Sep	27-Sep	14-Oct	18-Oct
Membrane A Compressor	###	9-Sep	20-Sep	23-Sep	27-Sep	14-Oct	18-Oct
Flue Gas Booster Fan	###	16-Sep	18-Sep	18-Sep	20-Sep	14-Oct	18-Oct
Direct Contact Cooler	###	18-Sep	20-Sep			14-Oct	18-Oct
VFD's (FGBF/CW Fans)	###	16-Sep	18-Sep			14-Oct	18-Oct
VFD's (Piller Fans)	###	16-Sep	19-Sep			14-Oct	18-Oct
CPU	###	14-Oct	18-Oct			24-Oct	25-Oct



MTR Collaboration with Carbon Capture Simulation for Industry Impact (CCSI²)

- Regular meetings started earlier this summer
  - CCSI² team creating a reduced order membrane process model that will reduce uncertainty
  - MTR has provided input and output data from the MTR proprietary model under anticipated field test conditions
  - MTR providing process model assumptions
- CCSI² assisting parametric test plan by developing Design of Experiments framework
  - CCSI² providing feedback on draft parametric test plan
  - MTR and CCSI² team to have Large Pilot site visit on September 25

CCSI
Carbon Capture Simulation Initiative



MTR Large Pilot Field Test Monitoring Capabilities

Extensive analytical characterization tools will be used to quantify co-capture potential

Emission Item	Characterization Capabilities
Gas Composition	Rosemount Quantum Cascade Laser analyzer will continuously measure **CO_2, O_2, H_2O, SO_2, NH_3, NO, NO_2, and N_2** for all process streams for the duration of the field test
Gas Composition	Extended gas composition analysis of various process streams will occur on a limited basis. Test will quantify minor species, such as HCl and speciated volatile hydrocarbons, sulfur compounds, or oxygenates
Particulate Matter	EPA Method 5 & 202 test will quantify particulate matter amounts, size and concentration distribution of various process streams
Water Quality Analysis	Water samples from 8 process locations will tested monthly
Water Recovery	Water flow through 8 process lines will be measured and logged throughout the field test to quantify the water recovery rates within the capture plant

Lessons Learned

Engineering / Design

- Involve your Constructor during the development of the 3D model

Procurement

- Evaluate the option to procure used or existing new-unused equipment
- Include schedule contingency for overseas shipments
- Negotiating terms and conditions with equipment OEMs is not straight forward nor fast

Construction

- Constructors can be quick to generate change orders but slow to identify credits
- A quality and experienced on-site construction project manager is critical
- Constructor should be a flexible, inventive, and creative scheduler

Acknowledgements

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