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Project Title:	Pittsburg District Energy Facility - Commission Adoption Order (Order No. 99-0817-01)
TN #:	237531
Document Title:	Petition for Modification regarding CO2 Capture Pilot Project
Description:	N/A
Filer:	Deric Wittenborn
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Submitter Role:	Applicant
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LOS MEDANOS ENERGY CENTER, LLC

717 TEXAS AVENUE
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HOUSTON, TX 77002

April 23, 2021

John Heiser
Compliance Project Manager
Siting, Transmission and
Environmental Protection (STEP Division)
California Energy Commission
1516 Ninth Street, MS-15
Sacramento, CA 95814
E-Mail: John.heiser@energy.ca.gov

RE: Los Medanos Energy Center (98-AFC-01C): Petition for Modification
CO_2 Capture Pilot Project

Dear Mr. Heiser:

Los Medanos Energy Center, LLC ("Project Owner") submits this petition for modification of the Los Medanos Energy Center ("LMEC") to install a temporary carbon capture demonstration project ("CO_2 Capture Pilot Project"). The CO_2 Capture Pilot Project will not result in any significant environmental impacts, and LMEC will continue to comply with all applicable laws, ordinances, regulations, and standards ("LORS").

If you have any questions regarding the proposed modification, please contact Barbara McBride at 925-570-0849 or Barbara.McBride@calpine.com.

Sincerely,

/S/

Victor Shaw
Plant Manager
Los Medanos Energy Center

LOS MEDANOS ENERGY CENTER
(98-AFC-01C)
PETITION FOR MODIFICATION
CO_2 CAPTURE PILOT PROJECT

Pursuant to Section 1769 of the California Energy Commission's ("CEC's") Regulations, Los Medanos Energy Center, LLC ("Project Owner") hereby submits this petition for modification to the Los Medanos Energy Center ("LMEC"). The Project Owner is working with ION Clean Energy (ION) to demonstrate, on a pilot scale, their solvent technology to capture carbon dioxide (CO_2) from a small portion of flue gas from a single turbine exhaust at LMEC ("CO_2 Capture Pilot Project"). The CO_2 Capture Pilot Project will not result in any significant environmental impacts, and LMEC will continue to comply with all applicable laws, ordinances, regulations, and standards ("LORS"). The CO_2 Capture Pilot Project is being conducted under a grant from the US Department of Energy. Therefore, it is critical that this Petition be approved by July 2021 to meet planned construction milestones.

1. **Section 1769 (a)(1)(A): Description of the proposed change, including new language for any conditions of certification that will be affected.**

The Project Owner proposes installation of equipment on-site that will allow LMEC to supply approximately 0.04% of its stack gas from a single turbine to an engineering scale carbon capture and utilization pilot.

The CO_2 Capture Pilot Project will consist of an 80-foot absorber column, a wet sac cooling unit, chemical delivery tanks, and supporting pumps and diagnostic equipment. Most of the project components will be constructed off-site then delivered to the LMEC site over a seven-to-ten-day period for installation on a new concrete pad. The dimensions of the concrete pad will be approximately 40 by 40 feet. Construction of the CO_2 Capture Pilot Project is planned to commence in Q3 of 2021, with operation commencing in Q2 or Q3 2022. The CO_2 Capture Pilot Project will be in operation for approximately 15 months and then the equipment will be removed from the site. LMEC will supply steam, natural gas, and water for the project.

The CO_2 Capture Pilot Project will draw a small amount of flue gas from the LMEC heat recovery steam generator (HRSG) stack number one (1). This flue gas will be withdrawn after the air pollution control equipment but prior to discharge from the stack ("ION process"). The flue gas will move through the ION process with no potential effects on the criteria pollutants in the cleaned flue gas, i.e., emissions in the flue gas slip stream will pass through the process with no further abatement by the ION process (except for CO_2 capture). Estimated amounts for the flue gas draw-off are presented in Table 1.

TABLE 1 LMEC Flue Gas Draw-off Data for the ION Process

Stream Number	**101**	**102**	**103**	**502**
Location	**DCC**	**ABS**	**UWW**	**LP Comp**
Description	**FG In**	**FG In**	**FG Out**	**CO_2 Suct**
Mass Flow (lb/hr)				
H_2O	907	513	497	12
CO_2	977	977	56	922
ION Solvent	0.00	0.00	0.008	0.0
N_2	12287	12287	12286	0
O_2	2330	2330	2330	0
NaOH	0	0	0	0
Total Flow (lb/hr)	16500	16106	15170	934
Temperature (F)	239	90	89	95
Pressure (psia)	15.71	15.16	14.80	26.2
Vapor Fraction (%)	100.0%	100.0%	100.0%	100.0%
Density (lb/cuft)	0.063	0.074	0.071	0.19
Gas Flow (ACFM)	4366	3641	3580	81

FG In = Flue Gas Input
FG Out = Flue Gas Output
This data is keyed to the process drawing which accompanies this table as Figure 1.

The exhaust flue gas draw-off from GT/HRSG Stack #1 represents approximately <=0.04% vol (0.365% vol) of the total average hourly exhaust flow, based on the following LMEC source test data reports from 2017 and 2019:

- Average turbine/HRSG exhaust flow: 817,400 dscfm = 49,044,000 dscfh
- Average turbine/HRSG exhaust temperature: 239 F^o
- Average turbine/HRSG exhaust moisture content: 9.8% vol
- Proposed exhaust gas draw-off: 4,366 acfm = 2,986 dscfm = 179,160 dscfh

Note: based on BAAQMD Standard Conditions of 70F and 1 ATM.

The CO_2 Capture Pilot Project will consist of two (2) operations years, segmented as follows:

Year 1 – will have emissions generated by three (3) separate campaigns. Each campaign will evaluate a specific solvent as follows:

- Solvent MEA - 20-day evaluation period
- Solvent ICE-21 - 30-day evaluation period
- Solvent ICE-31 - 300-day evaluation period

Year 2 – will have emissions generated by only a single solvent (Solvent ICE-31) for a maximum of 75 days.

Based on the design characteristics of the ION process, potential emissions from the CO_2 Capture Pilot Project will be comprised of the following: ammonia and VOCs, including acetaldehyde and formaldehyde. Tables 2 and 3, below, present the estimated emissions data for the 1st and 2nd years of the proposed pilot project. Based on tables 2 and 3, only formaldehyde will exceed the annual significance thresholds under BAAQMD Regulation 2, Rule 5 (Toxics New Source Review).

The regulatory analysis is based on the following parameters:

- The CO_2 Capture Pilot Project will require the following physical changes to LMEC: (1) a 16-inch port will be cut in exhaust stack #1 to allow for a flue gas slip stream to be withdrawn and sent to the ION process facility, and (2) a steam supply line will be installed from the aux boiler to the ION process facility.

- A slip stream of flue gas in the amount of <=0.04% by volume will be withdrawn from LMEC Exhaust Stack #1 and will be the primary raw material input to the CO_2 reduction process.

- This slip stream will be withdrawn downstream of the emissions control systems on HRSG Stack #1. The withdrawn flue gas, based on process design, and what is known presently, will not undergo any conversion or further control reductions in NO_x, CO, VOC, SO_x, and PM10/2.5 emissions, but will simply be re-emitted at the absorber stack exit subsequent to CO_2 removal.

- VOC emissions generated by the ION process will be on the order of 0.25 lbs/hr, and 6 lbs/day. VOC emissions in year one will be approximately 2,100 lbs/yr or 1.05 tpy. VOC emissions during year two of operation will be 0.25 lbs/hr, 6 lbs/day, and 450 lbs/yr or 0.225 tpy.

- Formaldehyde is the only HAP emitted by the ION process that will exceed the Regulation 2 Rule 5 chronic threshold value of 14 lbs/yr (the acute threshold value of 0.12 lbs/hr will not be exceeded).

Figure 1 Process Flow Keyed to Table 1

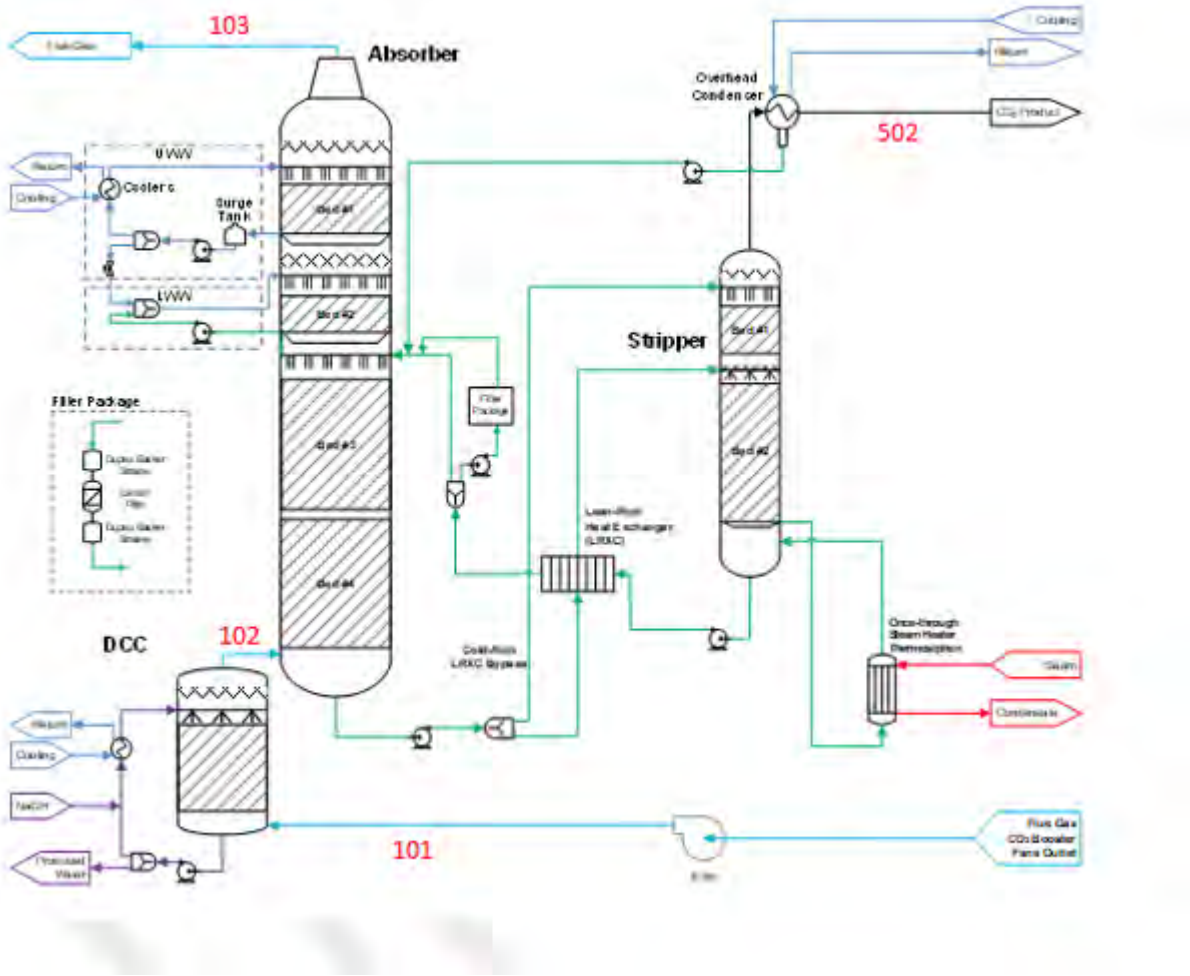


Table 2 Emissions Estimates for the 1st Operational Year

Solvent	Component	ppm*	lb/hr	lb/day	lb/period
MEA	VOC	3-5	0.25		
	Acetaldehyde	0.1-0.3	0.007	0.168	3.4
	Ammonia	15-20	0.191	4.574	91.5
	Formaldehyde	<0.01	0.000	0.004	0.1
ICE-21	VOC	3-5	0.25		
	Acetaldehyde	0.02-0.4	0.009	0.224	6.7
	Ammonia	0.5-1.0	0.010	0.229	6.9
	Formaldehyde	1.0-1.9	0.030	0.725	21.8
ICE-31	VOC	3-5	0.25		
	Acetaldehyde	<0.02	4.66E-4	0.011	3.4
	Ammonia	8-15	0.143	3.431	1029.2
	Formaldehyde	0.5-1.0	0.016	0.382	114.5
First Year Total	VOC	-	-	-	2,100 lbs/yr
	Acetaldehyde	-	-	-	13.4 lbs/yr
	Ammonia	-	-	-	1,127.6 lbs/yr
	Formaldehyde	-	-	-	136.3 lbs/yr

* VOCs and NH_3 concentrations will vary in each of the three solvent campaigns to account for operations at non-optimal conditions during this pilot phase. However, the maximum potential VOC and NH_3 concentrations were used in the analysis.
MEA Campaign = 20 days.
ICE-21 Campaign = 30 days
ICE-31 Campaign = 300 days
Total first year operations = 350 days
Total Flow from the Absorber vented to atmosphere:
2.09E-01 MMSCFH
3480 SCFM
3580 ACFH (70F, 1 atm = Standard)
25.3 L/mol
4011 mol/min
240658 mol/hr

Table 3 Emissions Estimates for the 2nd Operational Year

Solvent	Component	ppm*	lb/hr	lb/day	lb/year
ICE-31	VOC	3-5	0.25		450
	Acetaldehyde	<0.02	4.66E-4	0.011	0.8
	Ammonia	8-15	0.143	3.431	257.3
	Formaldehyde	0.5-1.0	0.016	0.382	28.6

***** VOCs and NH_3 concentrations will vary in the second year ICE-31 solvent campaigns to account for operations at non-optimal conditions during this pilot phase. However, the maximum potential VOC and NH_3 concentrations were used in the analysis.
ICE-31 Campaign = 75 days
Total 2nd year operations = 75 days
Total Flow from the Absorber:
2.09E-01 MMSCFH
3,480 SCFM
3,580 ACFH (70F, 1 atm = Standard)
25.3 L/mol
4,011 mol/min
240,658 mol/hr

LOS MEDANOS ENERGY CENTER
(98-AFC-01C)
PETITION FOR MODIFICATION
CO_2 CAPTURE PILOT PROJECT

For the CO_2 Capture Pilot Project, the Project Owner is proposing to temporarily modify Condition of Certification AQ-34 as follows:

> The maximum projected annual toxic air contaminant emissions from the Gas Turbines, HRSGs, and the Auxiliary Boiler combined (S-1, S-2, S-3, S-4, and S-5) shall not exceed the following limits:
>
> (a) ~~3,817~~ 3,953 pounds of formaldehyde per year
>
> (b) 460.9 pounds of benzene per year
>
> (c) 78.5 pounds of Specified polycyclic aromatic hydrocarbons (PAHs) per year
>
> unless the owner/operator meets the requirements of (d), (e), and (f) below:
>
> (d) The owner/operator shall perform a health risk assessment using the emission rates determined by source test and the most current Bay Area Air Quality Management District (District) approved procedures and unit risk factors in effect at the time of the analysis. The calculated excess cancer risk shall not exceed 1.0 in one million.
>
> (e) The owner/operator shall perform a second risk analysis using the emission rates determined by source test and the procedures and unit risk factors in effect when the Determination of Compliance was issued. The calculated excess cancer risk shall not exceed 1.0 in one million.
>
> (f) Both of these risk analyses shall be submitted to the District and the CEC CPM within 60 days of the source test date. The owner/operator may request that the District and the CEC CPM revise the carcinogenic compound emission limits specified above. If the owner/operator demonstrates to the satisfaction of the APCO that these revised emission limits will satisfy the conditions stated in parts (d) and (e) above, the District and the CEC CPM may, at their discretion, adjust the carcinogenic compound emission limits listed above. The Title V operating permit shall be amended to reflect these adjustments. (Regulation 2, Rule 5)

A similar request has been submitted to the Bay Area Air Quality Management District ("BAAQMD"). A copy of the BAAQMD permit application is provided as Attachment A to this petition.

2. **Section 1769 (a)(1)(B): Discussion of the necessity for the proposed change and an explanation of why the change should be permitted.**

The proposed change should be approved as the CO_2 Capture Pilot Project supports California's greenhouse gas emissions reductions goals. The CO_2 Capture Pilot Project is anticipated to capture 11 tons of CO_2 per day (tpd). Experience gained from this pilot will further the maturation of technologies for the beneficial use of sequestered carbon. In particular, the proposed change will serve as a vital step of piloting an ION-optimized process with actual NGCC flue gas prior to design, engineering, and construction of a commercial scale CO_2 capture plant. The CO_2 Capture Pilot Project will provide a first-hand opportunity to learn about the implications of integrating post combustion carbon capture ("PCC") with power plant operations prior to progressing into a commercial-scale path for use at other natural gas fueled power plants.

3. **Section 1769(a)(1)(C): Description of any new information or change in circumstances that necessitated the change.**

The change is to support a carbon capture and utilization pilot project that will be constructed on on-site at LMEC.

4. **Section 1769(a)(1)(D): An analysis of the effects that the proposed change may have on the environment and proposed measures to mitigate any significant environmental effects.**

The proposed change will not result in an adverse change to the environment. The BAAQMD is currently evaluating the permit application and potential health risk impacts. The expected increase in formaldehyde emissions will likely not cause the existing annual limit to be exceeded as source test data has demonstrated that the existing LMEC formaldehyde emissions are less than the currently permitted limit of 3,817 lbs/year. The amount of formaldehyde emitted as a result of the CO_2 Capture Pilot Project would be a minor increase to existing baseline emissions from the LMEC, and likely below permitted levels. However, out of an abundance of caution, the Project Owner is requesting modification of the AQ-34 to reflect the potential for increased formaldehyde emissions. Thus, LMEC will continue to comply with existing emissions limits, and there are no expected potential impacts to public health. There will only be minor increases to the use of tertiary treated water by LMEC to accommodate the CO_2 Capture Pilot Project, which will be supplied by the existing system and within the authorized LMEC supply from Delta Diablo Sanitation District. The CO_2 Capture Pilot Project will not increase existing noise levels at the LMEC. Compliance with existing conditions and best management practices governing construction and maintenance activities on site will ensure that there are no significant adverse impacts, and no other additional mitigation measures are proposed.

5. **Section 1769(a)(1)(E): Analysis of how the proposed change would affect the project's compliance with applicable laws, ordinances, regulations, and standards.**

The proposed change will not impact LMEC's ability to comply with applicable laws, ordinances, regulations, and standards. The height of the absorber will be no taller than 82 feet. The height will be finalized during the detailed design stage and is consistent with local land use LORS. LMEC is located in an IG District (General Industrial District), which allows structures up to 75 feet high as long as they are located more than 75 feet beyond the minimum 10-foot setback (see City of Pittsburg Ordinances Sections 18.54.115 and 18.54.120). In addition, tower-like structures are allowed an additional 20 feet of height (see City of Pittsburg Ordinances Section 18.080.020), for a total maximum height of 95 feet. The CO_2 Capture Pilot Project is located on the south side of the existing cooling tower, approximately 120 feet from Third Street, so the entire CO_2 Capture Pilot Project is allowed in the IG District, and as a tower-like structure, the absorber falls under the additional height limits provided by Section 18.080.020.

6. **Section 1769(a)(1)(F): Discussion of how the proposed change would affect the public.**

The proposed change will not adversely affect the public. The proposed change does not result in significant impacts to the environment and does not negatively impact air quality or public health. The proposed pilot project is temporary. There are no significant adverse effects on property owners that will result from the adoption of the change proposed.

7. **Section 1769(a)(1)(G): provide a list of current assessor's parcel numbers and owners' names and addresses for all parcels within 500 feet of any affected project linears and 1000 feet of the project site.**

The Project Owner can provide a list of property owners upon request.

8. **Section 1769(a)(1)(H): discussion of the potential effect on nearby property owners, residents, and the public.**

The proposed change will have no significant environmental effects and will be in compliance with applicable LORS. Therefore, the proposed change will have no impact on property owners, residents, or the public.

9. **Section 1769(a)(1)(I): discussion of exemptions from the California Environmental Quality Act that may apply to approval of the proposed change.**

The proposed change is categorically exempt pursuant to Title 14, Section 15301 of the California Code of Regulations as an activity that constitutes a minor, temporary alteration of existing facilities involving negligible or no expansion of the existing use of facilities for power generation. The proposed change is also categorically exempt from CEQA pursuant to

Section 15061(b)(3), the "Common Sense Exemption." This exemption provides that "[w]here it can be seen with certainty that there is no possibility that the activity in question may have a significant effect on the environment, the activity is not subject to CEQA." (14 C.C.R. § 15061(b)(3).) In this case, the changes are minor and temporary. The amount of formaldehyde emitted as a result of the CO_2 Capture Pilot Project would be a minor increase to existing baseline emissions from the LMEC, and likely below permitted levels. Further, there would be no substantial adverse changes to existing baseline conditions at the LMEC site from the proposed change. Therefore, the CO_2 Capture Pilot Project is categorically exempt from CEQA pursuant to the "Common Sense Exemption."

ATTACHMENT A

Application to Bay Area Air Quality Management District

BAAQMD Authority to Construct Application

Regulation 2, Rule 2 Application Submittal

Enterprise CO_2 Capture Pilot Project

Pittsburg, California

Prepared for

Los Medanos Energy Center, LLC.

Prepared by

Atmospheric Dynamics, Inc.

ATMOSPHERIC DYNAMICS, INC
Meteorological & Air Quality Modeling

February 2021

1.1 Introduction-Proposed Project

ION Clean Energy (ION) is proposing to demonstrate the low capital and operating costs for ION's transformational ICE-31 solvent with revolutionary stability technology on a one (1) Megawatt equivalent (MWe) slipstream from the flue gas from a single turbine at Calpine Corporation's (Calpine) indirect subsidiary Los Medanos Energy Center, LLC's Los Medanos Energy Center (LMEC). To accomplish this, the project team will design, construct, and operate an engineering-scale carbon dioxide (CO_2) capture pilot that will capture 11 tons CO_2 per day (tpd). The pilot will build on ION's successful and extensive lab, bench, and small pilot-scale testing of solvent technologies and will serve as the vital step of piloting an ION-optimized process with actual NGCC flue gas prior to design, engineering, and construction of a commercial scale CO_2 capture plant.

Calpine is working with ION to assess the implications of post-combustion carbon capture (PCC) on its commercial combined cycle facilities through the engineering, development, and operation of a pilot plant at LMEC. The pilot design will directly validate the performance characteristics of ION's process and solvent technologies to yield a CO_2 product flow with >95% purity that is suitable for compression and dehydration into a CO_2 pipeline. Piloting at LMEC will provide a first-hand opportunity to learn about implications of integrating post combustion carbon capture (PCC) with power plant operations prior to progressing into a commercial-scale path to use at at LMEC and other Calpine natural gas combined cycle fleet sites.

ION's pilot project at LMEC will demonstrate CO_2 capture from natural gas combined cycle projects by utilizing the flue gas from a single turbine at LMEC to demonstrate the benefits of ION's innovative ICE-31 solvent to make a transformational reduction in the levelized cost of electricity (LCOE) while dramatically limiting CO_2 emissions from natural gas-fired power plants. ION has developed significant process expertise through numerous demonstration projects with its 2nd generation, state-of-the-art solvent, ICE-21, at existing bench, small-scale, and large-scale pilots that were designed and constructed for flue gases from coal-fired sources. Additionally, ION has shown dramatic advances in other key performance indicators such as emissions, solvent make-up rates, and material compatibilities [(2)]. In parallel with the rapid scale-up of the ICE-21 solvent, ION has continued developing its suite of solvent technologies to include the transformational solvent, ICE-31, which is currently at Technology Readiness Level (TRL) 5 and is queued for a DOE-funded (DE-FE0031727) campaign at the National Carbon Capture Center (NCCC) for validation with coal-fired and natural gas-fired flue gas.

The proposed project will utilize modular design and fabrication to deliver an engineering-scale CO_2 capture pilot which will be fully optimized for the 3rd generation ICE-31 solvent in combination with process-intensification improvements focused specifically on NGCC flue gas. A 12-month long-term test with ICE-31 on LMEC turbine flue gas will establish both solvent and process performance to de-risk future investment in the previously untested NGCC market. The long-term test campaign will include demonstration of end-to-end process optimization, comprehensive chemical costs of the NGCC carbon capture facility, and further validation of ION's rigorous, rate-based process model on NGCC flue gas. Upon completion of this program,

ION's solvent technology will be ready for commercial use as defined in the technology maturation plan. Finally, results from this engineering-scale demonstration will provide ION with critical information to be incorporated in a full Front-End Engineering and Design (FEED) evaluation at an NGCC utility company.

This submittal is the permit application to the BAAQMD. Based on the project size and design, the proposed sources at the Project will be subject to New Source Review (NSR) under the BAAQMD Regulation 2, Rule 1 exemptions. This application will provide the information necessary for the BAAQMD to prepare and issue an Authority to Construct (ATC) permit.
Application support information is presented in the following Appendices:

- Appendix A: LMEC Title V Permit
- Appendix B: BAAQMD Permit Application Forms

1.2 General Description of the Process

The CO_2 Capture Island is mainly comprised of a direct contact cooler (DCC), an absorber, a stripper, pumps, various heat exchangers, and a solvent management system (Figure 1). First, in the DCC, recirculating process water cools the flue gas from the NGCC and removes relatively clean water. The pH is balanced through caustic addition, and heat is indirectly rejected through a cooling water loop. The flue gas passes to the absorber where the ION solvent selectively absorbs CO_2 via an exothermic, reversible reaction. A two-stage water wash above the CO_2 absorption zone recovers practically all solvent vapors and maintains overall water balance. The lower water wash stage is optimized for solvent recovery while the upper water wash is optimized for water recovery through indirect water cooling. The CO_2-rich solvent collects at the base of the absorber column, where it is then pumped through the lean-rich heat exchanger to the stripper. A portion of the rich solvent bypasses the heat exchanger and enters directly into the top of the stripper. At the bottom of the stripper, low-grade steam from the HRSG indirectly heats the solvent via the once-through thermosyphon reboilers to release CO_2 and stripping steam. The stripping steam re-condenses throughout the stripper by counter-currently contacting the hot-rich and cold-rich solvent respectively, thus evolving the remainder of absorbed CO_2 while minimizing reboiler duty. The CO_2-lean solvent recycles to the absorber, through the lean-rich heat exchanger, for further capture; the CO_2 exits the top of the stripper to the overhead condenser. This CO_2 product will then either be emitted to atmosphere, re-combined with the absorber effluent gas, or provided to a third-party user. A carbon filter package and electrodialysis reclaimer process a slipstream of lean solvent to remove accumulated salts, particulates, and thermal decomposition products.

The CO_2 Island battery limits include the design, procurement, and installation of:

1. All flue gas handling equipment downstream of the tie-in point to the generation unit
2. All solvent handling equipment including waste disposal
3. All stripping/conditioning equipment to bring the CO_2 stream to a purity > 95%
4. Instrument air, Nitrogen, and makeup water to operate the CO_2 Island

5. Dedicated control room and operator facilities for the CO_2 Island
6. Steam conditioning and delivery to the CO_2 Island
7. Heat rejection systems for the various cooling water loops
8. Electrical tie-in and systems to provide the necessary power to the capture system

The following figures present the generalized process flow diagram (Figure 1), the proposed project/process layout at LMEC (Figure 2) and the proposed construction schedule (Figure 3).

FIGURE 1 Generalized Process Diagram

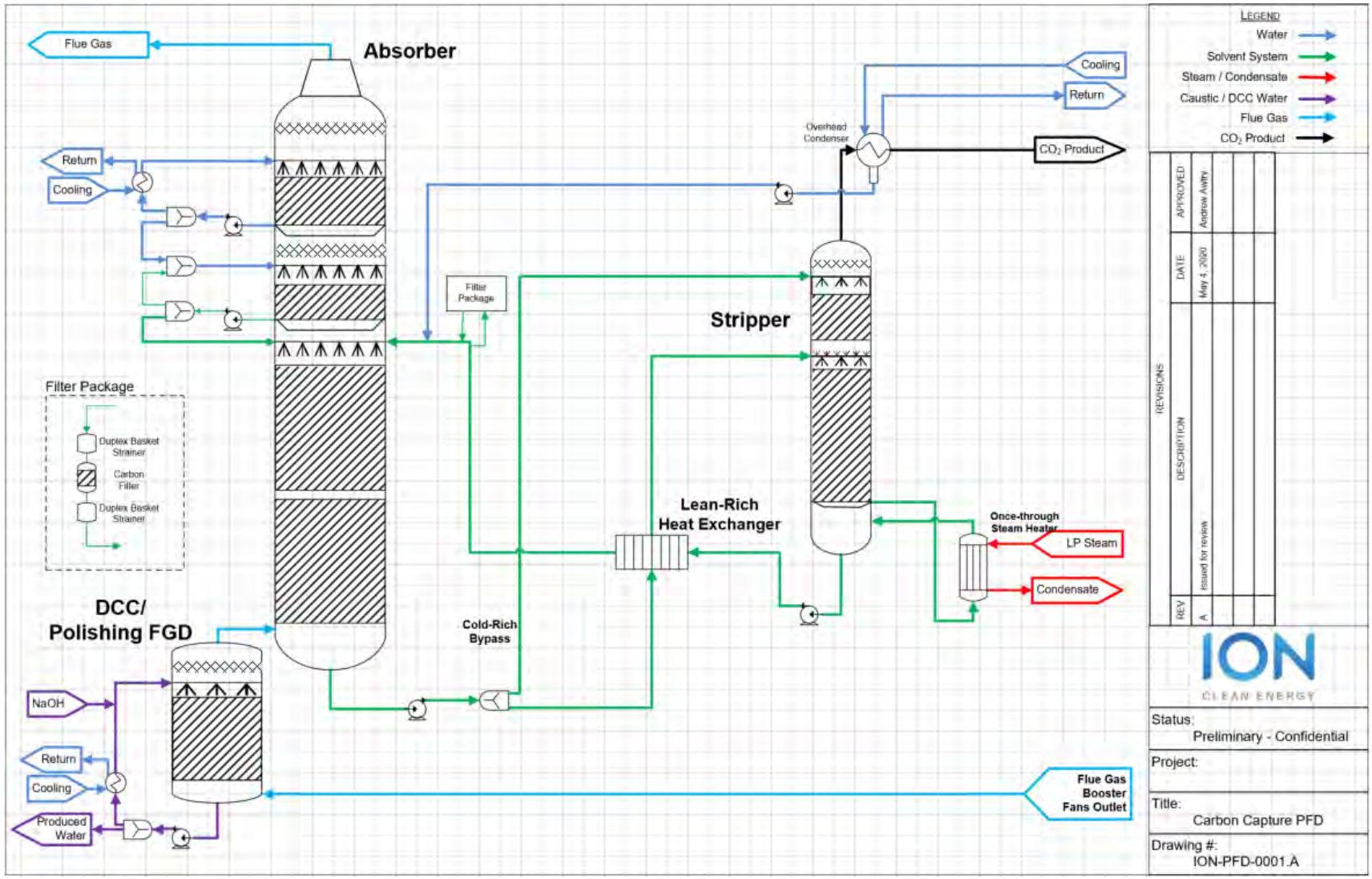


FIGURE 2 ION Process Layout on LMEC Site

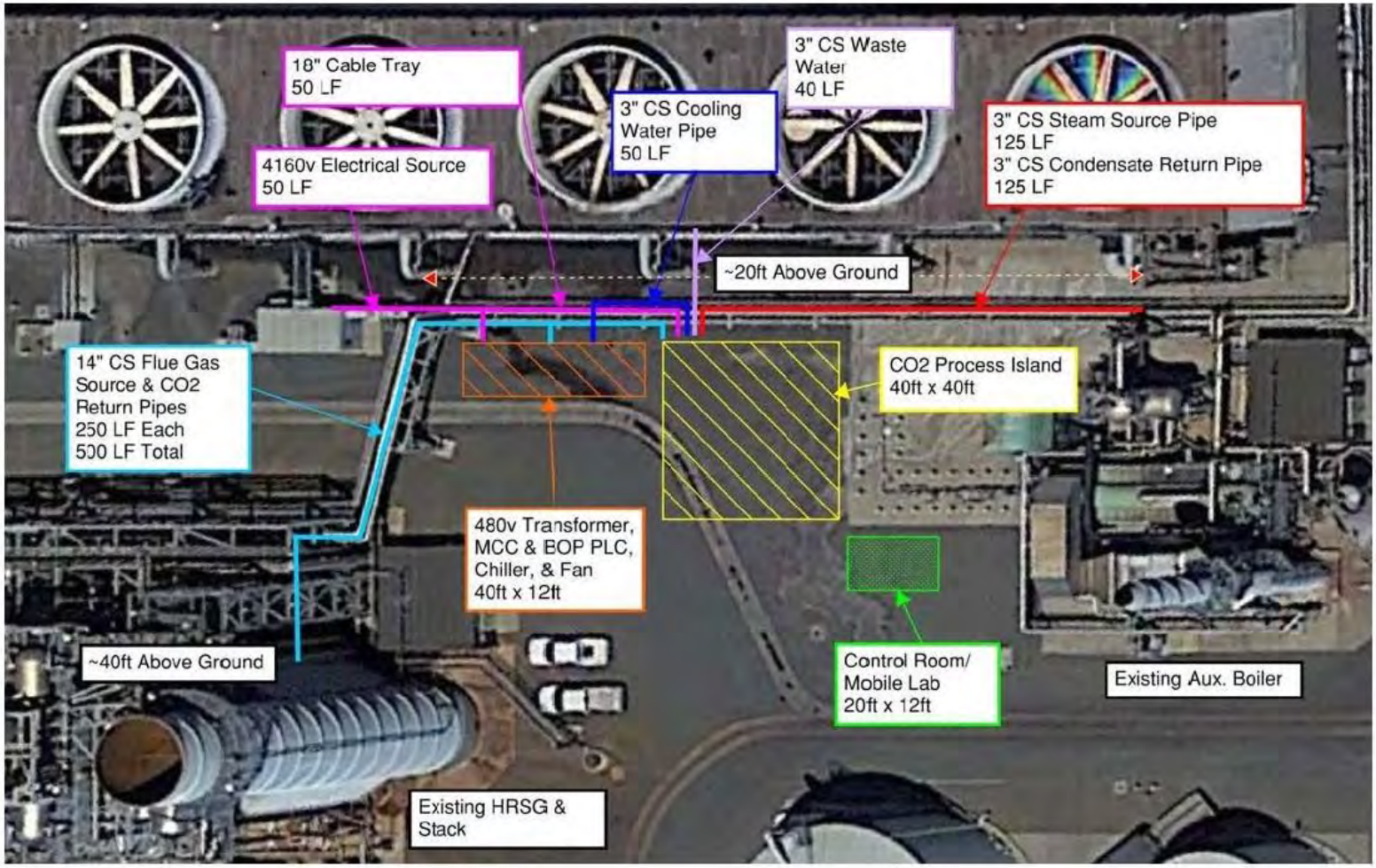
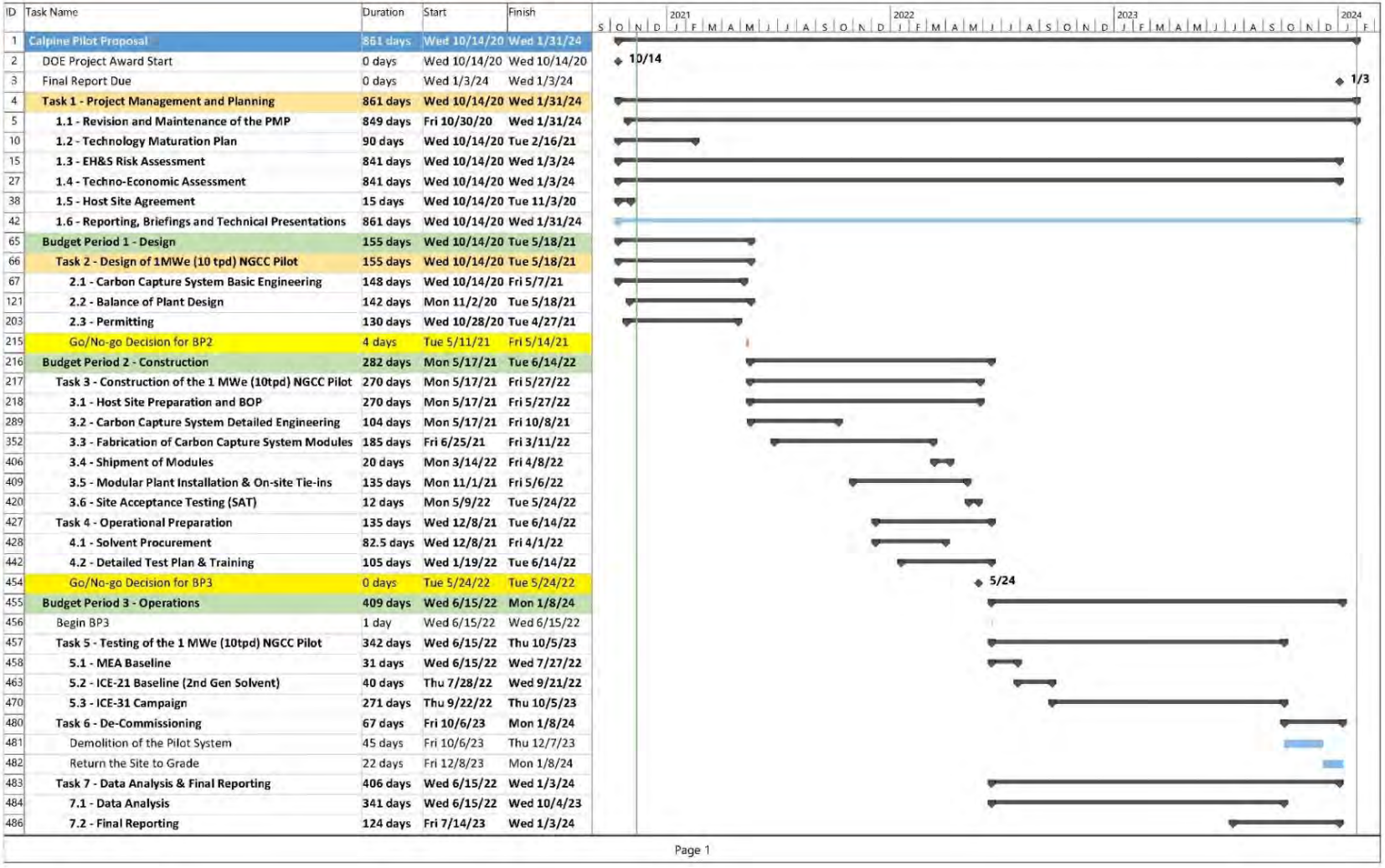


FIGURE 3 Proposed Construction Schedule for ION Pilot Plant



ID	Task Name	Duration	Start	Finish
1	Calpine Pilot Proposal	861 days	Wed 10/14/20	Wed 1/31/24
2	DOE Project Award Start	0 days	Wed 10/14/20	Wed 10/14/20
3	Final Report Due	0 days	Wed 1/3/24	Wed 1/3/24
4	Task 1 - Project Management and Planning	861 days	Wed 10/14/20	Wed 1/31/24
5	1.1 - Revision and Maintenance of the PMP	849 days	Fri 10/30/20	Wed 1/31/24
10	1.2 - Technology Maturation Plan	90 days	Wed 10/14/20	Tue 2/16/21
15	1.3 - EH&S Risk Assessment	841 days	Wed 10/14/20	Wed 1/3/24
27	1.4 - Techno-Economic Assessment	841 days	Wed 10/14/20	Wed 1/3/24
38	1.5 - Host Site Agreement	15 days	Wed 10/14/20	Tue 11/3/20
42	1.6 - Reporting, Briefings and Technical Presentations	861 days	Wed 10/14/20	Wed 1/31/24
65	Budget Period 1 - Design	155 days	Wed 10/14/20	Tue 5/18/21
66	Task 2 - Design of 1MWe (10 tpd) NGCC Pilot	155 days	Wed 10/14/20	Tue 5/18/21
67	2.1 - Carbon Capture System Basic Engineering	148 days	Wed 10/14/20	Fri 5/7/21
121	2.2 - Balance of Plant Design	142 days	Mon 11/2/20	Tue 5/18/21
203	2.3 - Permitting	130 days	Wed 10/28/20	Tue 4/27/21
215	Go/No-go Decision for BP2	4 days	Tue 5/11/21	Fri 5/14/21
216	Budget Period 2 - Construction	282 days	Mon 5/17/21	Tue 6/14/22
217	Task 3 - Construction of the 1 MWe (10tpd) NGCC Pilot	270 days	Mon 5/17/21	Fri 5/27/22
218	3.1 - Host Site Preparation and BOP	270 days	Mon 5/17/21	Fri 5/27/22
289	3.2 - Carbon Capture System Detailed Engineering	104 days	Mon 5/17/21	Fri 10/8/21
352	3.3 - Fabrication of Carbon Capture System Modules	185 days	Fri 6/25/21	Fri 3/11/22
406	3.4 - Shipment of Modules	20 days	Mon 3/14/22	Fri 4/8/22
409	3.5 - Modular Plant Installation & On-site Tie-ins	135 days	Mon 11/1/21	Fri 5/6/22
420	3.6 - Site Acceptance Testing (SAT)	12 days	Mon 5/9/22	Tue 5/24/22
427	Task 4 - Operational Preparation	135 days	Wed 12/8/21	Tue 6/14/22
428	4.1 - Solvent Procurement	82.5 days	Wed 12/8/21	Fri 4/1/22
442	4.2 - Detailed Test Plan & Training	105 days	Wed 1/19/22	Tue 6/14/22
454	Go/No-go Decision for BP3	0 days	Tue 5/24/22	Tue 5/24/22
455	Budget Period 3 - Operations	409 days	Wed 6/15/22	Mon 1/8/24
456	Begin BP3	1 day	Wed 6/15/22	Wed 6/15/22
457	Task 5 - Testing of the 1 MWe (10tpd) NGCC Pilot	342 days	Wed 6/15/22	Thu 10/5/23
458	5.1 - MEA Baseline	31 days	Wed 6/15/22	Wed 7/27/22
463	5.2 - ICE-21 Baseline (2nd Gen Solvent)	40 days	Thu 7/28/22	Wed 9/21/22
470	5.3 - ICE-31 Campaign	271 days	Thu 9/22/22	Thu 10/5/23
480	Task 6 - De-Commissioning	67 days	Fri 10/6/23	Mon 1/8/24
481	Demolition of the Pilot System	45 days	Fri 10/6/23	Thu 12/7/23
482	Return the Site to Grade	22 days	Fri 12/8/23	Mon 1/8/24
483	Task 7 - Data Analysis & Final Reporting	406 days	Wed 6/15/22	Wed 1/3/24
484	7.1 - Data Analysis	341 days	Wed 6/15/22	Wed 10/4/23
486	7.2 - Final Reporting	124 days	Fri 7/14/23	Wed 1/3/24

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1.3 ION Process Emissions Data

As presented in Table 1, the ION process will draw a small amount of flue gas from the LMEC heat recovery steam generator (HRSG) stack number one (1). This flue gas will be withdrawn after the air pollution control equipment but prior to discharge from the stack. Current understanding of the process is that the flue gas will essentially move through the ION process with no potential effects on the criteria pollutants in the cleaned flue gas, i.e., emissions in the flue gas slip stream will pass through the process with no further abatement caused by the ION process (except for CO_2 capture).

TABLE 1 LMEC Flue Gas Draw-off Data for the ION Process

Stream Number	**101**	**102**	**103**	**502**
Location	**DCC**	**ABS**	**UWW**	**LP Comp**
Description	**FG In**	**FG In**	**FG Out**	**CO_2 Suct**
Mass Flow (lb/hr)				
H_2O	907	513	497	12
CO_2	977	977	56	922
ION Solvent	0.00	0.00	0.008	0.0
N_2	12287	12287	12286	0
O_2	2330	2330	2330	0
NaOH	0	0	0	0
Total Flow (lb/hr)	16500	16106	15170	934
Temperature (F)	239	90	89	95
Pressure (psia)	15.71	15.16	14.80	26.2
Vapor Fraction (%)	100.0%	100.0%	100.0%	100.0%
Density (lb/cuft)	0.063	0.074	0.071	0.19
Gas Flow (ACFM)	4366	3641	3580	81

FG In = Flue Gas Input
FG Out = Flue Gas Output
This data is keyed to the process drawing which accompanies this table as Figure 4.

The exhaust flue gas draw-off from GT/HRSG Stack #1 represents approximately <=0.04% vol (0.365% vol) of the total average hourly exhaust flow, based on the following LMEC source test data reports from 2017 and 2019:

- Average turbine/HRSG exhaust flow: 817,400 dscfm = 49,044,000 dscfh
- Average turbine/HRSG exhaust temperature: 239 F°
- Average turbine/HRSG exhaust moisture content: 9.8% vol
- Proposed exhaust gas draw-off: 4366 acfm = 2986 dscfm = 179,160 dscfh
  Note: based on BAAQMD Standard Conditions of 70F and 1 ATM.

The pilot project will consist of two (2) operations years, segmented as follows:

Year 1 – will have emissions generated by three (3) separate campaigns. Each campaign will evaluate a specific solvent as follows:

- Solvent MEA - 20-day evaluation period
- Solvent ICE-21 - 30-day evaluation period
- Solvent ICE-31 - 300-day evaluation period

Year 2 – will have emissions generated by only a single solvent (Solvent ICE-31) for a maximum of 75 days.

Based on the design characteristics of the proposed ION process, emissions to atmosphere will be comprised of the following: ammonia and VOCs including acetaldehyde and formaldehyde. Tables 2 and 3 present the emissions data for the 1st and 2nd years of the proposed pilot project. Based on the tables 2 and 3, only formaldehyde will exceed the annual significance thresholds under BAAQMD Regulation2, Rule 5 (Toxics New Source Review).

FIGURE 4 Process Flow Keyed to Table 1

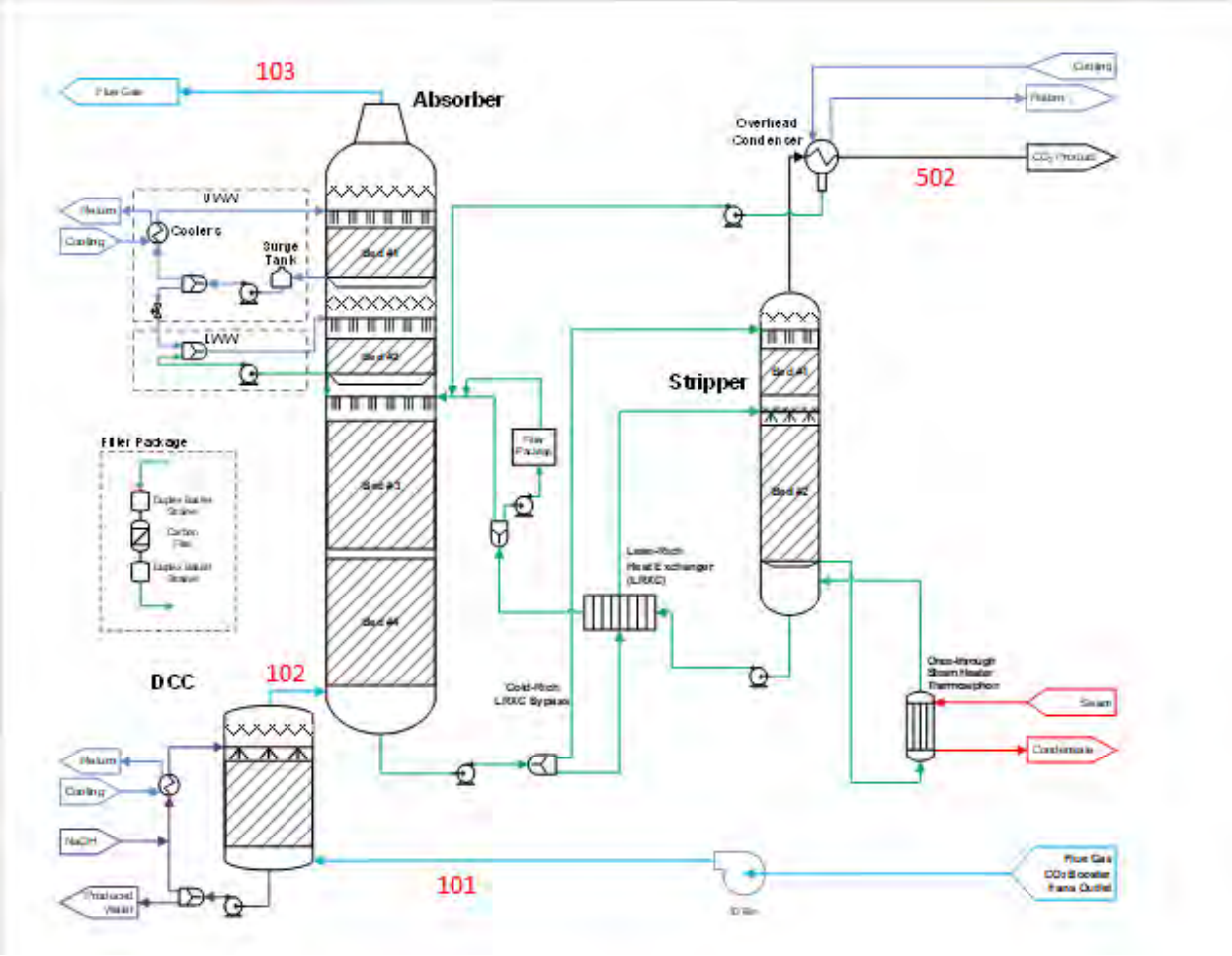

Table 2 Emissions Estimates for the 1st Operational Year					
Solvent	**Component**	**ppm***	**lb/hr**	**lb/day**	**lb/period**
MEA	VOC	3-5	0.25		
	Acetaldehyde	0.1-0.3	0.007	0.168	3.4
	Ammonia	15-20	0.191	4.574	91.5
	Formaldehyde	<0.01	0.000	0.004	0.1
ICE-21	VOC	3-5	0.25		
	Acetaldehyde	0.02-0.4	0.009	0.224	6.7
	Ammonia	0.5-1.0	0.010	0.229	6.9
	Formaldehyde	1.0-1.9	0.030	0.725	21.8
ICE-31	VOC	3-5	0.25		
	Acetaldehyde	<0.02	4.66E-4	0.011	3.4
	Ammonia	8-15	0.143	3.431	1029.2
	Formaldehyde	0.5-1.0	0.016	0.382	114.5
First Year Total	VOC	-	-	-	2,100 lbs/yr
	Acetaldehyde	-	-	-	13.4 lbs/yr
	Ammonia	-	-	-	1,127.6 lbs/yr
	Formaldehyde	-	-	-	136.3 lbs/yr

*** VOCs and NH_3 concentrations will** vary **in** each of **the three solvent campaigns** to account for operations at non-optimal conditions during this pilot phase**.** However, t**he maximum potential VOC** and NH_3 **concentration**s **w**ere **used in the analysis.**
MEA Campaign = 20 days.
ICE-21 Campaign = 30 days
ICE-31 Campaign = 300 days
Total first year operations = 350 days
Total Flow from the Absorber vented to atmosphere:
2.09E-01 MMSCFH
3480 SCFM
3580 ACFH (70F, 1 atm = Standard)
25.3 L/mol
4011 mol/min
240658 mol/hr

Table 3 Emissions Estimates for the 2nd Operational Year					
Solvent	**Component**	**ppm***	**lb/hr**	**lb/day**	**lb/year**
ICE-31	VOC	3-5	0.25		450
	Acetaldehyde	<0.02	4.66E-4	0.011	0.8
	Ammonia	8-15	0.143	3.431	257.3
	Formaldehyde	0.5-1.0	0.016	0.382	28.6

***** VOCs and NH_3 concentrations will vary in the second year ICE-31 solvent campaigns to account for operations at non-optimal conditions during this pilot phase. However, the maximum potential VOC and NH_3 concentrations were used in the analysis.
ICE-31 Campaign = 75 days
Total 2nd year operations = 75 days
Total Flow from the Absorber:
- 2.09E-01 MMSCFH
- 3,480 SCFM
- 3,580 ACFH (70F, 1 atm = Standard)
- 25.3 L/mol
- 4,011 mol/min
- 240,658 mol/hr

1.4 Regulatory Summary

The regulatory analysis is based on the following parameters:

- Physical modifications will take place at LMEC, i.e., (1) a port will be cut in exhaust stack #1 to allow for a flue gas slip stream to be withdrawn and sent to the ION process facility, and (2) a steam supply line will be installed from the aux boiler to the ION process facility.
- A slip stream of flue gas in the amount of <=0.04% by volume will be withdrawn from LMEC Exhaust Stack #1 and will be the primary raw material input to the CO_2 reduction process.
- This slip stream will be withdrawn downstream of the emissions control systems on HRSG stack #1. The withdrawn flue gas, based on process design, and what is known presently, will not undergo any conversion or further control reductions in NO_x, CO, VOC, SO_x, and PM10/2.5 emissions, but will simply be re-emitted at the absorber stack exit subsequent to CO_2 removal.
- VOC emissions generated by the ION process will be on the order of 0.25 lbs/hr, and 6 lbs/day. VOC emissions in year one will be approximately 2,100 lbs/yr or 1.05 tpy. VOC emissions during second year of operation will be 0.25 lbs/hr, 6 lbs/day, and 450 lbs/yr or 0.225 tpy.
- Formaldehyde is the only HAP emitted by the ION process that will exceed the Regulation 2 Rule 5 chronic threshold value of 14 lbs/yr (the acute threshold value of 0.12 lbs/hr will not be exceeded).

Regulatory Summary conclusions:

1. A copy of the Major Facility Review (Title V) permit for the LMEC facility is presented in Appendix A. The permit contains a detailed analysis of applicable regulatory requirements presented in sections III and IV. LMEC is currently in compliance with these applicable requirements and will continue to be in compliance during the ION pilot plant operations.
2. Table 4 below presents a summary of applicable BAAQMD regulations with respect to the ION Pilot Plant.

Table 4 BAAQMD Applicable Regulations for the ION Pilot Plant*

Rule Citation	Description/Comments	Compliance Y/N
Regulation 1	General Provisions and Definitions	Y
Regulation 2 Rule 1	Permitting-General Provisions	Y
Regulation 2 Rule 2	New Source Review (VOCs are the only criteria pollutant to be emitted, at a rate of 6 lbs/day, which is below the NSR rule applicability limit)	Y
Regulation 2 Rule 3	Power Plants (applies to LMEC, but not to ION)	Y
Regulation 2 Rule 5	New Source Review for Toxic Air Contaminants (toxics to be emitted are acetaldehyde, ammonia, and formaldehyde, only	Y

	formaldehyde will be emitted above the annual threshold trigger value of 14 lbs/yr)	
Regulation 2 Rule 6	Title V Permits	Y
Regulation 2 Rule 7	Acid Rain	Y
Regulation 3	Fees	Y
Regulation 6 Rule 1	Particulate Matter Emissions, Opacity, etc.	Y
Regulation 7	Odorous Substances (specifically ammonia will be emitted well below the rule limits)	Y
Regulation 8 Rule 1	Organic Compounds-General Provisions	Y
Regulation 8 Rule 2	Miscellaneous Operations (exempt due to emissions of VOC will be less than 300 ppm)	Y
Regulation 8 Rule 3	Architectural Coatings	Y
Regulation 8 Rule 4	General Solvent Use and Surface Coatings (exempt due to VOC emissions being less than 5 tpy)	Y
Regulation 8 Rule 5	Storage of Organic Liquids (tanks exempt based on VP data of proposed solvents is less than 0.5 psia)	Y
Regulation 10	NSPS (40 CFR 60) (no applicable NSPS identified)	Y
40 CFR 63	No NESHAPs rules were identified as applicable	
*Non-applicable rules are not listed. Rules that apply but an exemption also applies are listed.		