BAY AREA AIR QUALITY MANAGEMENT DISTRICT

# Engineering Evaluation

# Enterprise Carbon Dioxide Capture Pilot Project at Los Medanos Energy Center

Pittsburg, CA
Plant Number 11866

Bay Area Air Quality Management District
Application 30974



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**Engineering Evaluation**

**Los Medanos Energy Center**
**Enterprise Carbon Dioxide Capture Pilot Project**

This document is the Air District's Engineering Evaluation for the Enterprise Carbon Dioxide Capture Pilot Project, a project to install and demonstrate a pilot carbon dioxide ($CO_2$) capture process at the Los Medanos Energy Center (LMEC). LMEC has submitted a Petition to Amend its California Energy Commission (CEC) license for this project. The Air District has prepared this Engineering Evaluation for the CEC to use in evaluating LMEC's Petition. As explained herein, the Air District has evaluated how the project will comply with applicable air quality laws and regulations, and has developed a set of proposed conditions to ensure that the project will comply. The Air District will submit this Engineering Evaluation to the CEC and will recommend that the Commission impose the proposed permit conditions discussed below as conditions of approval.

In addition, LMEC has applied to the Air District for an Authority to Construct and Permit to Operate for the project. Under the Warren-Alquist State Energy Resources Conservation and Development Act (Pub. Res. Code §§ 25000 *et seq*.), the CEC has plenary jurisdiction over power plants over 50 MW such as the Los Medanos Energy Center. The CEC's exclusive jurisdiction preempts the Air District's regulatory authority. Once the CEC has licensed a project such as this, no other local or regional public agency can require any permit or approval for the project that conflicts with the CEC's license. The Air District is the primary enforcement authority with respect to air quality issues, however, under a Memorandum of Agreement with the CEC. To take enforcement action, the Air District needs to incorporate the CEC's conditions of approval into an Air District permitting document, which gives the Air District the legal authority to enforce those conditions under the Health & Safety Code. The Air District's Authority to Construct and subsequent Permit to Operate serve as the permitting documents that do so. The Air District anticipates that the CEC will incorporate the proposed permit conditions into LMEC's CEC license, and they will then form the basis of the Air District Authority to Construct and Permit to Operate.

# I Background

Los Medanos Energy Center (LMEC) is seeking authorization to implement the Enterprise Carbon Dioxide Capture Pilot Project using a new carbon dioxide ($CO_2$) capture process invented by ION Clean Energy (ION):

**S-8 Carbon Capture System: ION Solvents with Absorber and Stripper**

LMEC is a 500-megawatt, natural-gas-fired, combined cycle power plant that started commercial operation in 2001.

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 solvent to make a transformational reduction in the levelized cost of electricity while limiting $CO_2$ emissions from natural gas-fired power plants.

The proposed project will install a carbon dioxide capture island, which is comprised of a direct contact cooler, an absorber, a stripper, pumps, various heat exchangers, and a solvent management system located within the LMEC fence line. The proposed carbon capture process starts with routing a slip stream of post-abatement flue gas from the existing stack into the island. 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 CO2 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 following figures present the generalized process flow diagram (Figure 1), and the proposed project/process layout at LMEC (Figure 2).

**FIGURE 1 Generalized Process Diagram**

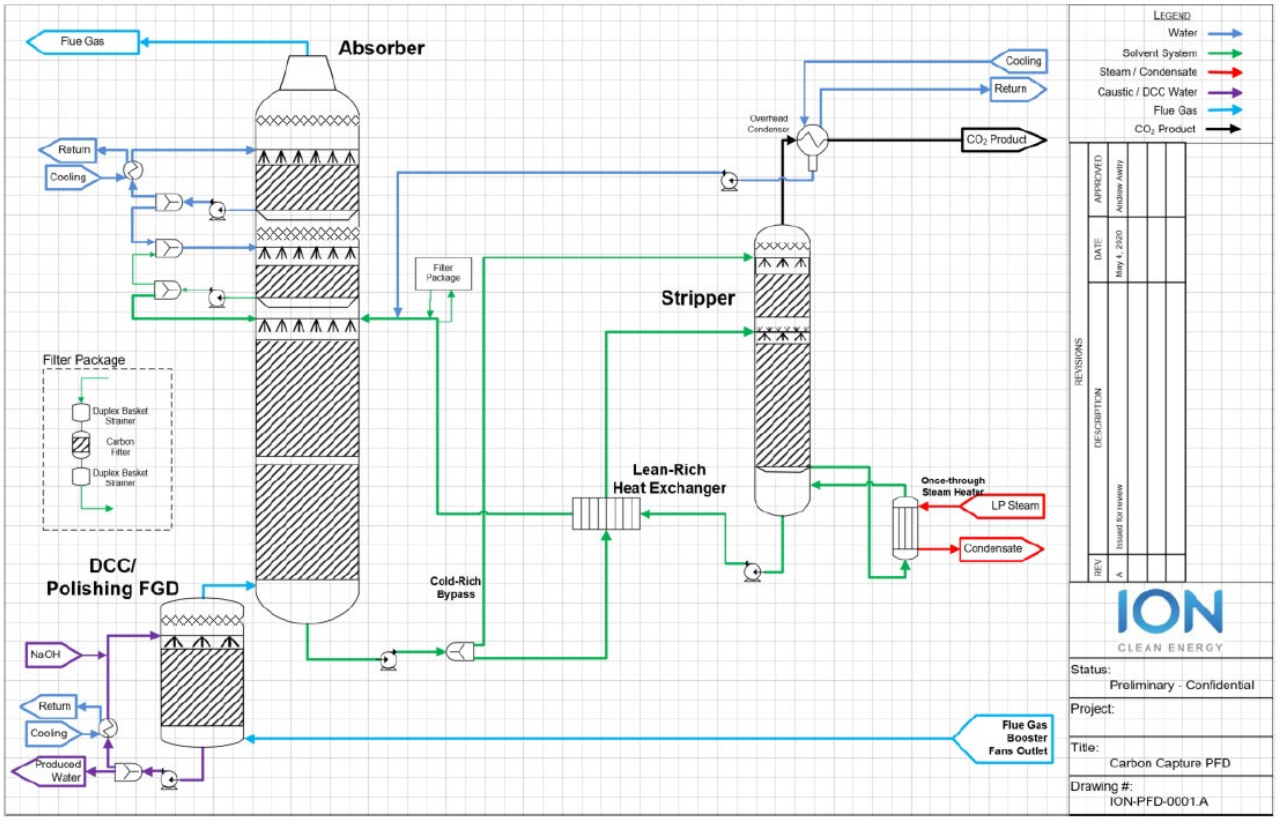
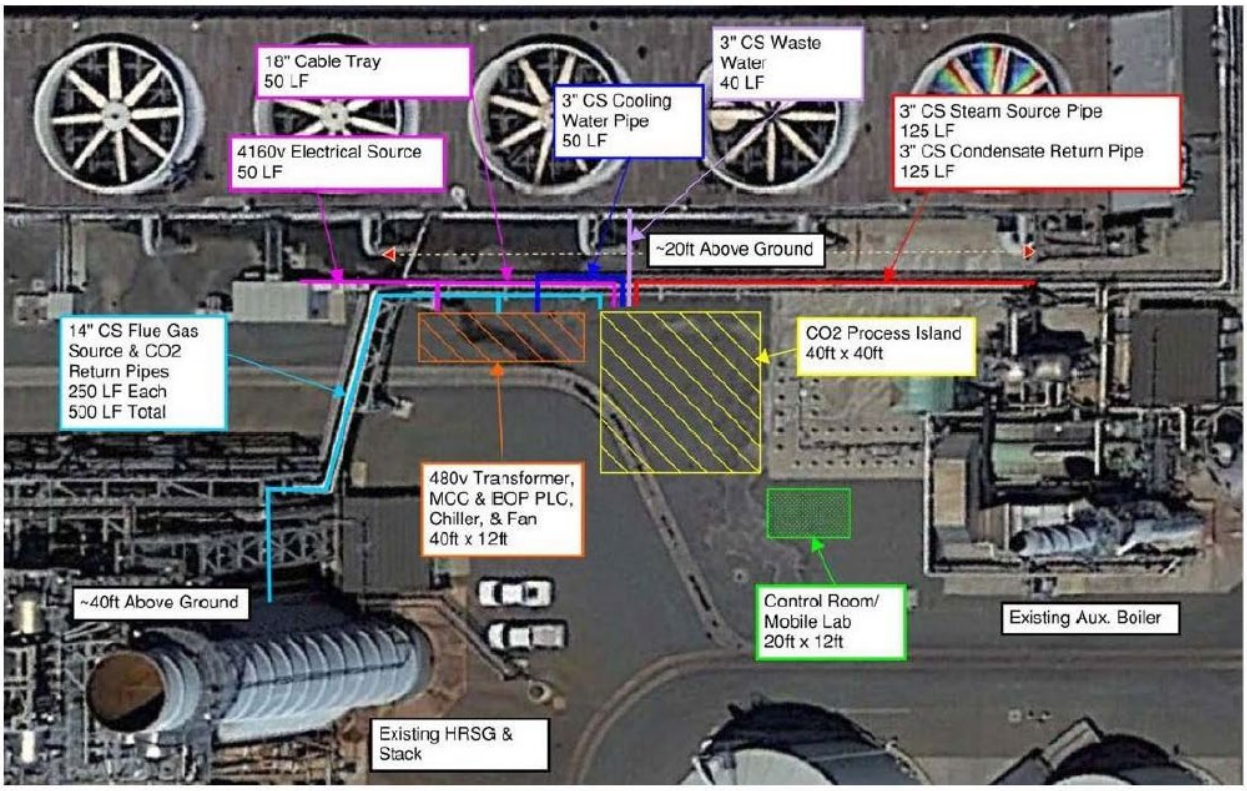


FIGURE 2 ION Process Layout on LMEC Site




The applicant proposed to withdraw approximate 0.04% (by volume) of the post-abatement flue gas from the existing stack of a single turbine. The proposed pilot project will last two years. During the first year, three ION solvents, MEA, ICE-21, and ICE-31, will be used and evaluated for a total of 350 days. During the second year, Solvent ICE-31 will be used and evaluated for up to 75 days.

# II Emissions Summary

The slip stream of the post-abatement flue gas withdrawn from the existing stack of the gas turbine and HRSG has NOx, CO, POC, PM, $SO_2$, ammonia, and other toxic air contaminant emissions from the combustion of natural gas. Combustion emissions other than $CO_2$ in the slip stream are not expected to be affected by the $CO_2$ capture process and will be re-emitted in the new absorber stack.

$CO_2$ in the slip stream is expected to be reduced by about 94% by weight or 0.5 tons per hour. However, the reduction efficiency is not guaranteed as this project is a pilot project to demonstrate the efficiency and cost-effectiveness of this new $CO_2$ capture system. Therefore, the $CO_2$ reduction efficiency is not a permit limit for this project.

In the new absorber stack, ammonia and VOCs emissions are also expected from the use of ION solvents based on the design characteristics of the proposed pilot project,

Assuming the slip stream of the abated flue gas from S-1, Natural Gas Turbine and Heat Recovery Steam Generator (HRSG), has 0.04% of mass emissions of the maximum permitted emissions for S-1 in LMEC's permit, the slip stream will pass through the following emissions to the new absorber stack as shown in Tables 1a and 1b below.

For criteria pollutants, daily and annual permitted emissions are specified as limits in the permit conditions for S-1. For toxic air contaminants, daily or annual permitted emissions are not specified as limits, so maximum hourly and annual permitted emissions are calculated based on the maximum permitted natural gas firing rate at 2,262 MMBtu per hour and an operation schedule of 24 hours a day and 350 days per year.

**Table 1a: Estimated Pass-Through Combustion Emissions – Criteria Pollutants**

| Pollutant | Max. Daily Emissions (lb./day) | Max. Annual Emissions (lb./year) |
|---|---|---|
| NOx (as NO2) | 0.27 | 70.28 |
| CO | 1.29 | 202.56 |
| POC (as CH4) | 0.05 | 13.56 |
| PM10 | 0.09 | 27.68 |
| SO2 | 0.06 | 18.84 |

**Table 1b: Estimated Pass-Through Combustion Emissions – Toxic Air Contaminants**

| Toxic Air Contaminant | Max. Hourly Emissions, lb./hr. | Max. Annual Emissions, lb./yr. |
|---|---|---|
| Acetaldehyde | 6.06E-05 | 5.09E-01 |
| Acrolein | 8.37E-06 | 7.03E-02 |
| Ammonia | 4.07E-03 | 3.42E+01 |
| Arsenic | 2.00E-08 | 1.68E-04 |
| Benzene | 4.03E-05 | 3.39E-01 |
| Beryllium | 4.35E-08 | 3.66E-04 |
| 1,3-Butadiene | 2.75E-08 | 2.31E-04 |
| *Cadmium* | 1.70E-07 | 1.43E-03 |
| *Chromium (hexavalent)* | 1.66E-08 | 1.40E-04 |
| *Copper* | 1.59E-06 | 1.34E-02 |
| Ethylbenzene | 7.96E-06 | 6.69E-02 |
| Formaldehyde | 3.05E-03 | 2.56E+01 |
| Hexane | 1.15E-04 | 9.65E-01 |
| Lead | 4.77E-07 | 4.01E-03 |
| Manganese | 1.33E-06 | 1.12E-02 |
| Mercury | 1.33E-06 | 1.12E-02 |
| Naphthalene | 1.47E-06 | 1.24E-02 |
| Nickel | 1.70E-07 | 1.43E-03 |
| PAH (As B(a)P-EQUIV) | 1.92E-08 | 1.61E-04 |
| Propylene | 3.42E-04 | 2.87E+00 |

| Toxic Air Contaminant | Max. Hourly Emissions, lb./hr. | Max. Annual Emissions, lb./yr. |
|---|---|---|
| Propylene Oxide | 8.82E-06 | 7.41E-02 |
| Selenium | 3.37E-07 | 2.83E-03 |
| Toluene | 3.15E-05 | 2.64E-01 |
| Xylene (mixed isomers) | 1.16E-05 | 9.73E-02 |
| Sulfuric Acid Mist | 1.29E-03 | 1.08E+01 |

Estimated emissions from the use of solvents are summarized in Table 2 below. The applicant provided the hourly emission rates based on the testing data of similar process using ION solvents at the Technology Center Mongstad in Norway. The maximum daily emissions are based on 24 hours per day of operation, and the annual emissions are calculated using maximum daily emissions and the maximum number of days of using each solvent in the two-year operation and testing plan at LMEC.

**Table 2: Estimated Solvent Emissions**

| Solvent | Pollutant | Hourly Emissions (lb./hour) | Max. Daily Emissions (lb./day) | 1st Year Emissions (lb./year) | 2nd Year Emissions (lb./year) |
|---|---|---|---|---|---|
| MEA | POC | 0.250 | 6.000 | 120.00 | - |
| | Acetaldehyde | 0.007 | 0.168 | 3.36 | - |
| | Ammonia | 0.191 | 4.584 | 91.68 | - |
| | Formaldehyde | 1.00E-04 | 0.002 | 0.05 | - |
| ICE-21 | POC | 0.250 | 6.000 | 180.00 | - |
| | Acetaldehyde | 0.009 | 0.223 | 6.70 | - |
| | Ammonia | 0.010 | 0.240 | 7.20 | - |
| | Formaldehyde | 0.030 | 0.720 | 21.60 | - |
| ICE-31 | POC | 0.250 | 6.000 | 1800.00 | 450.00 |
| | Acetaldehyde | 4.66E-04 | 0.011 | 3.36 | 0.84 |
| | Ammonia | 0.143 | 3.432 | 1029.60 | 257.40 |
| | Formaldehyde | 0.016 | 0.384 | 115.20 | 28.80 |
| Annual Total | POC | | | 2100.00 | 450.00 |
| | Acetaldehyde | | | 13.41 | 0.84 |
| | Ammonia | | | 1128.48 | 257.40 |
| | Formaldehyde | | | 136.85 | 28.80 |

The maximum hourly POC emissions from the use of ION solvents are estimated to be no more than 0.25 lbs. per hour, and the maximum daily POC emissions from the use of ION solvents will be no more than 6 lbs. per day.

The project will not affect the POC mass emissions from the turbine and HRSG, but POC will be emitted from the use of solvent at S-8. The Potential to Emit POC for the facility is calculated to

determine whether the offset requirements are triggered for this project. A summary of the potential to emit of POC is shown in the Table 3 below:

**Table 3: Potential to Emit POC at Los Medanos Energy Center**

| Source | Source Description | POC (tons/year) | Basis |
|---|---|---|---|
| S-1 thru 5 | Turbines, HRSGs, Auxilary Boiler | 33.900 | Permit limit in Condition 16676 |
| S-6 | Diesel Fire Pump | 0.013 | Max. fuel rate at 2.1 MMBtu/hour, 34 hours/year limit for reliability-testing, 0.36 lbs./MMBtu (TOC emission factor) from EPA AP-42 Table 3.3-1 for Diesel Engine. |
| S-7 | Natural Gas Standby Generator | 0.063 | Max. fuel rate at 7.1 MMBtu/hour, 50 hours/year limit for reliability-testing, 100 hours/year for emergency operation, 0.118 lbs./MMBtu (VOC emission factor) from EPA AP-42 Table 3.2-2 for 4-Stroke Lean Burn Natural Gas Engine |
| | **Existing Total PTE =** | 33.976 | |
| | | | |
| S-8 | Carbon Capture Sysem using ION Solvents | 1.050 | Applicant proposed permit condition limit. |
| | **New Total PTE =** | 35.026 | |

# III Statement of Compliance

The following discussion outlines how the carbon capture system, Source S-8, will comply with applicable air quality laws and regulations. The Air District has undertaken this analysis to provide to the CEC for that agency to use in evaluating the Petition to Amend LMEC's CEC license to authorize the project.

Source S-8 will be a new source at Los Medanos Energy Center. As such, it is subject to all applicable requirements in Regulation 2-2, New Source Review.

***Public Notice (Regulation 2-1-412)***
The proposed Source S-8 is located within an Overburdened Community as defined in Regulation 2-1-243 and requires a Health Risk Assessment pursuant to Regulation 2-5-401. Therefore, the proposed source is subject to the public notification requirements of Regulation 2-1-412. The Air District will prepare public notice and sent it to all addresses within 1,000 feet of the proposed source, and will provide a 30-day public comment period.

***BACT***
Based on the emission calculations, Best Available Control Technology is not triggered for POC since the maximum daily emissions of POC from S-8 due to the use of ION solvents is less than 10 lbs. per day.

***Offsets***
The project is subject to the offset requirements in District Regulation 2-2 for POC. Pursuant to Regulation 2-2-302, facilities that will have the potential to emit 10 tons per year or more of POC must offset their emissions of POC. For facilities that will have the potential to emit more than 10 tons per year but less than 35 tons per year of POC, offsets must be provided at a ratio of 1 to 1.

For facilities that will have the potential to emit more than 35 tons per year of POC, offsets must be provided by the applicant at a ratio of 1.15 to 1.

For facilities that have already provided offsets for their full potential to emit, additional offsets are required for any increase in potential to emit resulting from a subsequent modification. LMEC provided offsets for the full potential to emit POC when the plant was initially permitted. Additional offsets are required for the proposed annual emission increase in POC for this project.

LMEC will provide the offsets using its Banking Certificate 856. The certificate currently has 26.522 tons per year of POC credit. Because the facility will have the potential to emit more than 35 tons per year of POC, the applicant will provide (1.050)(1.15) = 1.208 tons per year of POC offsets.

***PSD Project***

This facility will not have the potential to emit 100 tons or more of any Prevention of Significant Deterioration (PSD) pollutant. Therefore, this project is not a PSD project.

***Health Risk Assessment***

Two sources of Toxic Air Contaminant (TAC) emissions will be emitted at the stack of S-8. TAC emissions from the combustion of natural gas in the slip stream of flue gas from S-1. The use of ION solvents will also result in emissions of three TACs, acetaldehyde, ammonia, and formaldehyde. The project emission rate for formaldehyde exceeds the chronic TAC trigger level (14 lbs./year) set forth in Regulation 2-5, Table 2-5-1 (Amendments Adopted 12/7/2016), so a health risk assessment is required.

Results from the health risk assessment indicate that the project cancer risk is estimated at 0.051 in a million, the project chronic hazard index is estimated at 0.0088, and the project acute hazard index is estimated at 0.044. In accordance with the District's Regulation 2-5-301, this project does not require Best Available Control Technology for Toxics because the estimated source risk is a cancer risk less than 1.0 in a million, and/or a chronic hazard index less than 0.20. Per Regulation 2-5-302, the project risk limits for this project are a cancer risk of 10 in million, a chronic hazard index of 1.0 and an acute hazard index of 1.0. This project complies with all of these project risk requirements.

***Title V Permitting***

This project will require a minor revision to the Title V permit for Los Medanos Energy Center. The facility is required to submit a Title V permit application to incorporate the changes into their Title V permit.

***CEQA***

As noted above, the Warren-Alquist State Energy Resources Conservation and Development Act (Pub. Res. Code §§ 25000 *et seq*.) gives the CEC plenary jurisdiction over power plants of greater than 50 MW such as the Los Medanos Energy Center. The CEC's exclusive jurisdiction preempts the Air District's regulatory authority. Once the CEC has licensed a project at such a facility, no other local or regional public agency can require any permit or approval for the project that conflicts with the CEC's license.

The Air District is the primary enforcement authority with respect to air quality issues, however, under a Memorandum of Agreement with the CEC. To take enforcement action, the Air District needs to incorporate the CEC's conditions of approval into an Air District permitting document, which gives the Air District the legal authority to enforce those conditions under the Health & Safety Code. The Air District's Authority to Construct and subsequent Permit to Operate are the Air District permitting documents that do so. In issuing these permitting documents, the Air District does not have any discretion to alter the CEC's conditions of approval or impose any new or different conditions. The Air District's only action is to copy the Energy Commission conditions verbatim to give the Air District legal authority to enforce those conditions as Air District permit conditions.

Given that the Air District has no discretion to approve or disapprove the project or impose any conditions beyond just copying the CEC conditions of approval into an Air District permitting project, the issuance of the District's Authority to Construct and Permit to Operate are ministerial actions that are exempt from CEQA under CEQA Section 21080(b)(1). Accordingly, when the Air District issues its Authority to Construct and Permit to Operate following the CEC's approval of the project, it will not be subject to CEQA.

# IV Permit Conditions

The Air District recommends that Source S-8 should be subject to the following permit conditions in order to ensure compliance with applicable air quality laws and regulations:

1. The owner/operator of S-8 shall ensure that the POC emissions resulting from the use of ION solvents at S-8, Carbon Capture System, do not exceed 1.050 tons during any consecutive twelve-month period. (Basis: Cumulative Increase; Offsets).

2. The owner/operator of S-8 shall ensure that formaldehyde emissions at the stack of S-8 do not exceed 162 pounds during any consecutive twelve-month period. (Basis: Regulation 2, Rule 5)

3. The owner/operator of S-8 shall calculate the POC and formaldehyde emissions at the stack of S-8, the POC emissions from the slip steam withdrawn from the exhaust of S-1, and the POC emissions from the use of ION solvents at S-8 using emission rates derived from the most recent source test data and flow rate from the inlet of the absorber. (Basis: Cumulative Increase; Offsets, Regulation 2, Rule 5).

4. Within 90 days from the commencement of operation of S-8, the owner/operator shall conduct source test(s) at the stack of S-8 to measure the emissions of POC and formaldehyde to demonstrate compliance with the emission limits in Parts 1 and 2 of this permit condition. The owner/operator shall ensure the source test data can be used to determine emission rates for each of the ION solvents (MEA, ICE-21, and ICE-31). The owner/operator shall submit the results of the source test to the District within 30 days from the date of the source test. (Basis: Regulation 2-1-403)

5. The owner/operator shall comply with all applicable testing requirements as specified in Volume IV of the District's Manual of Procedures. The owner/operator shall notify the District's Source Test Section, in writing, of the source test protocols and projected test dates required by Part 4 of this permit condition at least 14 days prior to testing. (Basis: Regulation 2-1-403)

6. The owner/operator shall maintain the following records:

    a) The type and amount of each solvent used on a daily basis;
    b) The POC and formaldehyde emissions at the stack of S-8, the POC emissions from the slip steam withdrawn from the exhaust of S-1, and the POC emissions from the use of ION solvents at S-8 on a monthly basis;
    c) Monthly emission calculations shall be totaled for each consecutive twelve-month period;
    d) Source test reports and emission rates derived from source test data.

    The owner/operator shall maintain all records for at least five years and shall make them available for District inspection upon request. (Basis: Recordkeeping; Regulation 2-6-501)

7. In the event that total POC emissions from the use of ION solvents at S-8, Carbon Capture System, exceed 1.050 tons of POC during any twelve-month period, the owner/operator shall submit additional offset credits for the excess emissions according to the procedures set forth in District Regulation 2-2-302.1 through 302.4. (Basis: Regulation 2-2-302).

# V Recommendation

The Air District has reviewed the material contained in the permit application for the proposed project and has determined that, with the imposition of the permit conditions set forth in Section IV above, the project will be expected to comply with all applicable requirements of District, state, and federal air-quality-related regulations. The Air District is forwarding this Engineering Evaluation to the CEC with a recommendation that, if the CEC approves LMEC's Petition to Amend LMEC's license, that the CEC include all of the proposed permit conditions from Section IV as conditions of approval.

Assuming the CEC approves the Petition to Amend, the Air District will then be required to issue an Authority to Construct for the project in accordance with the Warren-Alquist Act. As discussed above, the Warren-Alquist Act gives the CEC plenary authority over power plants such as LMEC, and it prohibits any other agency from requiring a permit or other approval for the project that conflicts with the CEC's license. The Air District has to issue a permit in order to fulfill its role as the primary enforcement authority with respect to air quality issues, however, as the District's enforcement authority applies only to District permit conditions, not CEC license conditions. The Air District therefore incorporates the CEC's license conditions into an Air District Authority to Construct and Permit to Operate in order to make them enforceable by the District, pursuant to a Memorandum of Agreement with the CEC.

The Air District will therefore issue an Authority to Construct for the project if and when the CEC approves LMEC's Petition to Amend, and the District will subsequently issue a Permit to Operate provided that LMEC demonstrates that it has constructed and will operate the project in accordance with emission limits and other requirements in the Authority to Construct. The Air District is providing public notice and beginning the public comment period for issuance of the Authority to Construct, as required by District Reg. 2-1-412, in anticipation that the CEC will approve the Petition to Amend. The Air District will not take final action to issue the Authority to Construct until after the CEC's approval and after the end of the public comment period and consideration of any public comments received.