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APPENDIX 2A

Engineering Design Criteria
Hydrostor A-CAES Project
Gem Energy Storage Center
Civil & Structural Engineering Design Criteria

Document Number: 21-5291-00-3332-001

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Design Criteria

1 CIVIL ENGINEERING DESIGN CRITERIA

This document summarizes the design criteria, standards codes and practices which will be used for civil engineering for the Gem Energy Storage Center. During the detail engineering phase, further specific project information will be developed to support the detailed design, engineering, material procurements, specifications, and construction specifications.

1.1 Codes and Standards

Civil design will be in accordance with the laws, ordinances, and regulations of the federal government, State of California, Kern County as well as applicable industry standards. The required part of the current issue or edition of the codes and standards at the time of filing this Application for Certification (AFC) will apply unless noted otherwise. In case of any conflict between codes and standards, the most stringent standard will govern.

1.1.1 Civil Engineering Codes and Standards

The following codes and standards will be applied in whole or in part:

- Occupational Safety and Health Administration (OSHA)
- International Building Code (IBC)
- California Building Code (CBC)
- American National Standards Institute (ANSI) – Standards
- American Concrete Institute (ACI) – Standards and Recommended Practices
- Concrete Reinforcing Steel Institute (CRSI) – Standards
- Precast Prestressed Concrete Institute (PCI)
- American Institute of Steel Construction (AISC) – Standards and Specifications
- American Association of State Highway and Transportation Officials (AASHTO) – Standards and Specifications
- American National Standards Institute (ANSI) – Standards
- Process Industry Practices (PIP)
  PIP CVC01015 Civil Design Criteria
- Asphalt Institute (AI) – Asphalt Handbook
- State of California Department of Transportation (Caltrans) Standard Specification
- California Energy Commission (CEC) – Recommended Seismic Design Criteria for Non-Nuclear Generating Facilities in California
- National Fire Protection Association (NFPA) and International Fire Code
- International Plumbing Code (IPC)
- Association of Dam Safety Officials (ASDSO)
2 STRUCTURAL ENGINEERING DESIGN CRITERIA

This document summarizes the design criteria, standards codes and practices which will be used for structural engineering for the Gem Energy Storage Center. During the detail engineering phase, further specific project information will be developed to support the detailed design, engineering, material procurements, specifications, and construction specifications.

2.1 Codes and Standards

Structural design will be in accordance with the laws, ordinances, and regulations of the federal government, State of California, Kern County as well as applicable industry standards. The required part of the current issue or edition of the codes and standards at the time of filing this Application for Certification (AFC) will apply unless noted otherwise. In case of any conflict between codes and standards, the most stringent standard will govern.

2.1.1 Structural Engineering Codes and Standards

The following codes and standards will be applied in whole or in part:
- Occupational Safety and Health Administration (OSHA)
- International building Code (IBC)
- California Building Code (CBC)
- American Institute of Steel Construction (AISC):
  - Manual of Steel Construction
  - Specification for Structural Steel Buildings
  - Specification for Structural Joints Using High-Strength Bolts
  - Code of Standard Practice for Steel Buildings and Bridges
- American Concrete Institute (ACI)
  - ACI 351-18, Foundations for Dynamic Equipment
  - ACI 318-19, Building Code Requirements for Structural Concrete and Commentary
  - ACI 301-20, Specifications for Concrete Construction
  - ACI 530, Building Code Requirements and Specification for Masonry Structures and Related
  - 224, Control of Cracking in Concrete Structures
- Commentaries
- American Society of Civil Engineers (ASCE)
  ASCE 7-16, Minimum Design Loads for Buildings and Other Structures
  ASCE 37-14, Design Loads on Structures During Construction
  Design of Blast Resistant Buildings in Petrochemical Facilities
  Guidelines for Seismic Evaluation and Design of Petrochemical Facilities
  Wind Loads on Petrochemical Facilities
  ASCE 59-11, Blast Protection of Buildings
- American Petroleum Institute (API)
  API 650/620 Welded Steel Tanks
  API 686 Recommended Practice for Machinery Installation and Installation Design
- American Society of Mechanical Engineers (ASME)
  STS-1-2016 Steel Stacks
  A17 Safety Code for Elevators and Escalators
- American Welding Society (AWS)
  D1.1-20—Structural Welding Code—Steel
  D1.3-18—Structural Welding Code—Sheet Steel
  D1.4-18—Structural Welding Code—Reinforcing Steel
- National Association of Architectural Metal Manufacturers (NAAMM)—Metal Bar Grating Manual
- Steel Deck Institute (SDI)—Design Manual for Floor Decks and Roof Decks
- American Association of State Highway and Transportation Officials (AASHTO)
- Precast Prestressed Concrete Institute (PCI), PCI Design Handbook, 8th Edition
- American Society for Testing and Materials (ASTM)
  All applicable standards including but not limited to A36/A36M, A193/193M, A307, A500/A500M, A615/A615M, A992/A992M, F1554 and F3125/3125M
  D7380 Standard Test Method for Soil Compaction
- Portland Cement Association (PCA)
  EB075 Concrete Floors on Ground
- Crane Manufacturers Association of America, Inc. (CMAA)
  CMAA No.70 Specifications for Top Running Bridge and Gantry Type Multiple Girder Electric Overhead Traveling Cranes
  CMAA No. 74 Specifications for Top Running and Under Running Single Girder Electric Traveling Cranes Utilizing Under Running Trolley Hoist
- Process Industry Practices
  PIP STC 01015 Structural Design Criteria
- Steel joist Institute (SJI)
  SJI-CJ - Standard Specification for Composite Steel Joists CJ-Series
  SJI-K - Standard Specification for Open Web Steel Joists, K-Series
2.2 Datum

A topographical survey will be provided for entire site. The existing ground elevations will be based on an elevation survey conducted using known elevation benchmarks.

2.3 Frost Penetration

Bottom of all foundations for the structures and equipment will be extended below the frost line of the locality. The frost depth will be determined by Geotechnical Engineer.

3 DESIGN LOADS

Design loads for structures and foundations will comply with all the applicable building code requirements.

3.1 Dead Load

3.1.1 The dead load for structures shall consist of the self-weight of the structure, the weight of all materials of construction permanently incorporated into the structure, including insulation, fireproofing, fixed partitions, and permanent fixtures.

3.1.2 The dead load for equipment shall consist of the weight of all machinery, equipment, and/or vessels permanently supported by the structure, including insulation, fireproofing, partitions, permanent fixtures, and attachments.

3.1.3 Unless more determinate load information is available and requires otherwise, dead loads for the following items shall be estimated as follows:
   a. Uniformly distributed loads for grating, checkered plate, and concrete decking:
      Grating: 9.1 psf for 1-1/4 inches x 3/16 inch plain grating
      Checkered Plate: 10.23 psf for 1/4-inch checkered plate
      Concrete Deck: based upon deck manufacturer’s tables
   b. Guard systems and ladders and cages
      Angle Guard Systems with Toe Plate: 15 lbs/ft of guard length (L 2 ½ x 2 ½ x ¼)
      Pipe Guard Systems with Toe Plate: 11 lbs/ft of guard length for pipe guard (NPS 1 ½ STD or HSS 1.900 x 0.145)
      Ladders with Cages: 30 lbs/ft of ladder length
      Ladders without Cages: 11 lbs/ft of ladder length
3.2 Live Load

Live loads are loads produced by the use and occupancy of the building or structure. These include the weight of all movable loads (e.g., personnel, tools, miscellaneous equipment, movable partitions, wheel loads, parts of dismantled equipment, stored material).

Lateral earth pressures, hydrostatic pressures, and wheel loads from trucks will be considered as live loads.

The minimum uniform live loads will be in accordance with ASCE SEI 7-16, Chapter 4; CBC 2019 Section 1607; IBC 2021 Section 1607; as applicable or other applicable codes and standards but will not be less than the following:

<table>
<thead>
<tr>
<th>Table 1- Minimum Live Loads</th>
<th>Uniform (psf)</th>
<th>Concentrated (lbs) (1)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stairs and Exitways</td>
<td>100</td>
<td>1000</td>
</tr>
<tr>
<td>Operating, Access Platforms and Walkways (3)</td>
<td>100 (framing design)</td>
<td>1000 (Framing and Grating Design)</td>
</tr>
<tr>
<td>Platforms Used for Bundle/Equipment Repairs</td>
<td>150</td>
<td>1000</td>
</tr>
<tr>
<td>Control, I/O, HVAC Room Floor</td>
<td>100</td>
<td>1000</td>
</tr>
<tr>
<td>Manufacturing Floors and Storage Areas:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Light</td>
<td>125</td>
<td>2000</td>
</tr>
<tr>
<td>Heavy</td>
<td>250</td>
<td>3000</td>
</tr>
<tr>
<td>Elevator Machine room and control room grating</td>
<td>100</td>
<td>300</td>
</tr>
<tr>
<td>Control or Electrical Enclosure or Module Floor</td>
<td>150</td>
<td>-</td>
</tr>
<tr>
<td>Pipe Racks (4)</td>
<td>50 (Average)</td>
<td>As Identified by Engineer</td>
</tr>
<tr>
<td>Hand Railing</td>
<td>- (2)</td>
<td>200 applied at any point in any direction</td>
</tr>
<tr>
<td>Slab on Grade</td>
<td>250</td>
<td>-</td>
</tr>
<tr>
<td>Truck Loading Surcharge Adjacent to Structure</td>
<td>250</td>
<td>-</td>
</tr>
</tbody>
</table>
Truck Support Structure | AASHTO-HS-20-44 | -
---|---|---
Laboratories | 100 | -
Roof | 20 | -
Fire Escapes | 200 | -
Office Buildings:
Corridor above first floor | 80 | 2000
Lobbies and First Floor Corridors | 100 | 2000
Office – Ground and 1st floor | 100 | 2000
Offices above first floor | 50 | 2000

(1) Uniform and concentrated live load listed in Table 1 shall not be applied simultaneously. Use of either uniform or concentrated live loads shall be based on whichever produces the greater load effect. Unless otherwise specified, the indicated concentration shall be assumed to be uniformly distributed over an area 2.5 ft by 2.5 ft and shall be located to produce the maximum load effects in the members.

(2) Handrail and guardrail system shall also be designed to resist a load of 50 lb/ft (pound-force per linear foot) applied in any direction along the handrail or top rail and to transfer this load through the supports to the structure. This load need not be assumed to act concurrently with the concentrated load.

(3) In addition, a uniform load of 50 psf will be used to account for piping and cable trays, except that where the piping and cable loads exceed 50 psf, the actual loads will be used.

(4) Where the piping and cable tray loads exceed the design uniform load, the actual loads will be used. In addition, a concentrated load of 8 kips will be applied concurrently to the supporting beams for the walkways to maximize the stresses in the members, but the reactions from the concentrated loads will not be carried to the columns.

(5) Laydown loads from equipment components during maintenance and floor areas where trucks, forklifts, or other transports have access will be considered in the design of live loads.
3.3 Wind Loads

Wind loads shall be computed and applied in accordance with ASCE/SEI 7-16, Chapters 26 through 30; IBC 2021, Section 1609; or CBC 2019, Section 1609 as applicable, and the recommended guidelines in ASCE Wind Loads for Petrochemical and Other Industrial Facilities.

3.4 Snow Load

Snow Load will be calculated according to CBC Section 1603.1.3, Section 1608 and Chapter 7 of ASCE 7.

Rain Load will be applied if concentration on the roof is expected.

The design roof load shall not be less than that determined by CBC Section 1607.

3.5 Seismic Loads

Structures and the reservoir will be designed and constructed to resist the effects of earthquake loads and possible liquefaction as determined in CBC 2019. Site class and liquefaction measures for susceptible soil will be determined by geotechnical investigation report. The occupancy category of the structure is III (per CBC Table 1604.5) and the corresponding important factor is 1.25.

3.6 Earth Pressure

Earth passive and active pressures will be calculated based on geotechnical investigation report recommendations.

3.7 Groundwater Pressure

Based on the depth of groundwater, the hydrostatic pressure attributable to groundwater will be considered. Geotechnical investigation report will provide average depth of the groundwater within the site at the present and historical data.

3.8 Turbine-Generator/Compressor Loads

The heavy equipment loads (for generators/compressors) for platform/foundation design will be furnished by their manufacturers and will be applied according to the equipment manufacturer’s specifications, criteria, and recommendations.

3.9 Steel Stacks

Steel stacks will be designed by manufacturer’s Engineer to withstand normal and abnormal operating condition in combination with design wind loads and seismic loads and will include the
along-wind and across-wind effects on the stacks. The design will meet the requirements of ASME/ANSI STS-1-2000, “Steel Stacks,” using allowable stress design method, except that increased allowable stress for wind loads as permitted by AISC will not be used. Supporting foundation will be designed according to stack manufacturer's footprint and loads, specifications, criteria, and recommendations.

### 3.10 Impact Loads

For structures carrying live loads which induce impact, the static live loads shall be increased sufficiently to cover the impact load.

Crane runways shall be designed for the crane stop forces provided by manufacturer's recommendations or specification.

<table>
<thead>
<tr>
<th>Category</th>
<th>Vertical Impact (%)</th>
<th>Lateral Impact (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>For Support of Elevators</td>
<td>100</td>
<td>-</td>
</tr>
<tr>
<td>For Support of Light Machinery, Shaft or Motor Driven</td>
<td>20</td>
<td>-</td>
</tr>
<tr>
<td>For Support of Reciprocating Machinery or Power-Driven Units</td>
<td>50</td>
<td>-</td>
</tr>
</tbody>
</table>

*Lateral impact based on the manufacturer recommendation (e.g., lateral impact for cranes = 20%)*
4 DESIGN BASIS

Reinforced concrete structures shall be designed (strength design method) in accordance with the CBC 2019 and the ACI 318.

Allowable soil bearing pressure for foundation design will be in accordance with the geotechnical investigation report.

Steel structures will be designed by using strength design or allowable strength design methods according to CBC 2019 and AISC Specification for Structural Steel Buildings.

Earthen and rockfill structures will be designed in accordance with the recommendations provided in the geotechnical investigation report; where required, impermeable membranes will be installed on the wetted surface side of water retention structures. Reservoir structures that meet jurisdiction requirements under the Division of Safety of Dams (DSOD) will meet the applicable DSOD requirements.

4.1 Following items shall be considered during the design in accordance with CBC 2019

4.1.1 Serviceability and Stability
4.1.2 Deflection and Drift Criteria
4.1.3 Load Factors and Load Combinations
4.1.4 Important Factors
4.1.5 Clearances

4.2 Factor of Safety

4.2.1 Against overturning: 1.50
4.2.2 Against sliding: 2.0 for wind loads, 1.10 for seismic loads
4.2.3 Against uplift due to wind: 1.50
4.2.4 Against buoyancy: 1.25

4.3 Construction Materials

4.3.1 Concrete (f’c as measured at 28 days):
   Structural concrete (f’c) = 4,000 psi (min.), electrical duct bank encasement (f’c) = 2,500 psi and structural grout (f’c) = 5,000 psi
   
   The concrete or grout classes to be determined by design drawings or design specifications

4.3.2 Concrete Reinforcement
   Reinforcing steel shall be deformed bars of billet steel conforming to ASTM A615, Grade 60 or A706, Grade 60
4.3.3 Structural Steel
Structural steel shall conform to the standards listed in Table 3.

Table 3 (Structural Steel Standards)

<table>
<thead>
<tr>
<th>Category</th>
<th>Applicable Standard</th>
</tr>
</thead>
<tbody>
<tr>
<td>Structural and Miscellaneous steel</td>
<td>ASTM A36, ASTM A572 or ASTM A992</td>
</tr>
<tr>
<td>High Strength Structural Bolts, Nuts and Washers</td>
<td>ASTM A325, ASTM A490 or ASTM F1554 As Applicable</td>
</tr>
<tr>
<td>Bolts other than high-strength structural bolts</td>
<td>ASTM A307, Grade A or As Indicated in Design Drawings</td>
</tr>
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</table>

4.3.4 Concrete Masonry
Concrete masonry units will be hollow, normal weight, non-load-bearing Type I, conforming to ASTM C90, lightweight. Mortar will conform to ASTM C270, Type S. Grout will conform to ASTM C476.
APPENDIX 2A

Control Engineering
Hydrostor Pecho/ Gem Energy Storage Center - AFC Inputs

Appendix 2.5 – Control Engineering

Project Number: 21-5375

TWD Document Number: 21-5375-00-3536-001

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4 CONTROL SYSTEM DESIGN CRITERIA .......................................................................................... 3
1 OBJECTIVE

1.1 Hydrostor is investigating two potential sites in California for their Advanced Compressed Air Energy Storage (A-CAES) technology. The two sites are Pecho (near Morro Bay), and Gem (near Rosamond).

1.2 TWD is working with Hydrostor and Golder to prepare an Application For Certification (AFC) to the California Energy Commission (CEC) for the two sites. Golder is preparing and will submit the overall AFC, with technical input from TWD.

1.3 This document provides technical input for Golder to develop the following AFC sections for both Pecho and Gem sites:
   - Appendix 2.5 - Control Engineering

2 INTRODUCTION

2.1 This appendix summarizes the codes, standards, criteria, and practices that will be generally used in the design and installation of instrumentation and controls. More specific project information will be developed during execution of the project to support detailed design, engineering, material procurement specifications, and construction specifications.

3 CODES AND STANDARDS

3.1 The design specification of all work will be in accordance with the laws and regulations of the federal government, the State of California, local County, and City, as well as applicable industry standards. A summary of general codes and industry standards applicable to design and control aspects of the power facility follows:
   - American National Standards Institute (ANSI)
   - American Society of Mechanical Engineers (ASME)
   - The Institute of Electrical and Electronics Engineers (IEEE)
   - International Society of Automation (ISA)
4 CONTROL SYSTEM DESIGN CRITERIA

4.1 General Requirements

All signals to and from the Central Control Room shall be electric / electronic. The standard signal shall be analogue 4-20 mA using 2-wire system, standard thermocouple, RTD output, and / or suitable pulse signal.

Instruments located on control panels and central control room (CCR) shall be microprocessor based.

On platforms with processing facilities, a Distributed Control System (DCS) shall be provided for monitoring and controlling the process, and for generating alarms in case of process upsets.

4.2 Process Control System

The process control system will provide all monitoring and control of the facility. The process control system configuration will be justified with the plant engineering contractor based on the facility complexity.

The facility will function automatically with minimum operator intervention. Emphasis will be given to automating routine actions so that the operator has more time to analyse and identify short and medium-term plant performance, efficiency and imminent failures.

Adequate instrumentation shall be installed to enable operations personnel to monitor plant performance from the central control room with minimum field intervention. Field operators will only assist in visual surveillance and intervene only when critical equipment and systems warrant immediate attention. All field functions will require a permissive signal from the control system.

For standalone control packages within the facility where operator action is entirely local, a package common alarm will be connected to the process control system to direct an operator to examine local indicators or panels in order to determine equipment status.
4.3 Monitoring and Controls

The Process Control System shall use solid-state equipment and Programmable Logic Controllers (PLC) or Distributed Control Systems (DCS) to increase reliability and flexibility.

The use of electromechanical control relays shall be avoided, except when required for safety interlocks.

Communications between the PLC and HMI, and PLC to PCS shall be Ethernet TCP/IP or ProfaNet.

Communications to MCC’s and VFD’s to be Ethernet based. Communications to discrete field contacts to be AS-I complete with limit switch indications.

Wireless communication devices shall be used for communication between control room and operators in the plant.

4.4 Field Instruments

Electronic instruments rather than pneumatic are preferred for operation of the equipment. Electronic instruments shall use 4-20 mA, 24 V DC signals for transmission and control. Smart Transmitters with ‘Hart protocol’ shall be used as much as possible. The remainder of the transmitters will preferably be of the two-wire type, and each transmitter shall be separately fused.

All instruments shall be rated for the hazardous environment in which they are located. When appropriately rated equipment is not available, intrinsically safe barriers must be provided and installed in the control panel.

Auxiliary power supplies for instruments shall in the first instant be 24 V DC, however where increased power consumption is required, 120 V AC shall be used. Each instrument shall have its own power disconnect device, and each motorized and solenoid actuated valve shall be separately fused.

4.5 Pressure Instruments

In general, pressure instruments will have linear scales with units of measurement in pounds per square inch, gauge. Pressure gauges will have either a blowout disk or a blowout back and an acrylic or shatterproof glass face. Pressure gauges on process piping will be resistant to plant atmospheres. Pressure test points will have isolation valves and caps or plugs. Pressure devices on pulsating services will have pulsation dampers.
4.6 Temperature Instruments

In general, temperature instruments will have scales with temperature units in degrees Fahrenheit. Exceptions to this are electrical machinery resistance temperature detectors and transformer winding temperatures, which are in degrees Celsius.

Bimetal-actuated dial thermometers will have 4.5- or 5-inch-diameter (minimum) dials and white faces with black scale markings and will consist of every angle-type. Dial thermometers will be resistant to plant atmospheres.

Temperature elements and dial thermometers will be protected by thermowells except when measuring gas or air temperatures at atmospheric pressure. Temperature test points will have thermowells and caps or plugs.

Resistance temperature detectors will be 100-ohm platinum, three-wire type. The element will be spring-loaded, mounted in a thermowell, and connected to a cast iron head assembly. Thermocouples will be Type J or K dual-element, grounded, spring-loaded, for general service. Materials of construction will be dictated by service temperatures. Thermocouple heads will be the cast type with an internal grounding screw.

4.7 Level Instruments

Reflex-glass or magnetic level gauges will be used. Level gauges for high-pressure service will have suitable personnel protection. Gauge glasses used in conjunction with level instruments will cover a range that includes the highest and lowest trip/alarm set points.

4.8 Flow Instruments

Flow transmitters will typically be of the differential pressure-type. Alternate type flow transmitters may be used where required to ensure high accuracy measurements. In general, linear scales will be used for flow indication and recording. Magnetic type flow transmitters may be used for liquid flow measurement below 200°F.

4.9 Control Valves

Control valves in throttling service will generally be the globe-body cage type with body materials, pressure rating, and valve trims suitable for the service involved. Other style valve bodies (e.g., butterfly, eccentric disk) may also be used when suitable for the intended service.

Valves will be designed to fail in a safe position.
Control valve body size will not be more than two sizes smaller than line size, unless the smaller size is specifically reviewed for stresses in the piping.

Control valves in 600-Class service and below will be flanged where economical.

Critical service valves will be defined as ANSI 900 Class and higher in valves of sizes larger than 2 inches.

Severe service valves will be defined as valves requiring anti-cavitation trim, low noise trim, or flashing service, with differential pressures greater than 100 pounds per square inch (psi).

In general, control valves will be specified for a noise level no greater than 85 decibels, A-rated (dBA) when measured 3 feet downstream and 3 feet away from the pipe surface.

Valve actuators will use positioners and the highest pressure, smallest size actuator, and will be the pneumatic-spring diaphragm or piston type. Actuators will be sized to shut off against at least 110 percent of the maximum shutoff pressure and designed to function with instrument air pressure ranging from 80 to 125 pounds per square inch gauge.

Hand wheels will be furnished only on those valves that can be manually set and controlled during system operation (to maintain plant operation) and do not have manual bypasses.

Control valve accessories, excluding controllers, will be mounted on the valve actuator unless severe vibration is expected.

Solenoid valves supplied with the control valves will have Class H coils. The coil enclosure will normally be a minimum of NEMA 4 but will be suitable for the area of installation.

Valve position feedback (with input to the supervisory control system for display) will be provided for all control valves.

4.10 Instrument Tubing and Installation

Tubing used to connect instruments to the process line will be seamless stainless steel for primary instruments and sampling systems.

Instrument tubing fittings will be the compression type.

Differential pressure (flow) instruments will be fitted with three-valve manifolds; two-valve manifolds will be specified for other instruments as appropriate.
Instrument installation will be designed to correctly sense the process variable. Taps on process lines will be located so that sensing lines do not trap air in liquid service or liquid in gas service. Taps on process lines will be fitted with a shutoff (root or gauge valve) close to the process line. Root and gauge valves will be main-line class valves.

Instrument tubing will be supported in both horizontal and vertical runs as necessary. Expansion loops will be provided in tubing runs subject to high temperatures. The instrument tubing support design will allow for movement of the main process line.

4.11 Pressure and Temperature Switches

Field-mounted pressure and temperature switches will have either NEMA Type 4 housings or housings suitable for the environment.

In general, switches will be applied such that the actuation point is within the center one-third of the instrument range.

4.12 Field-Mounted Instruments

Field-mounted instruments will be of a design suitable for the area in which they are located. They will be mounted in areas accessible for maintenance and relatively free of vibration and will not block walkways or prevent maintenance of other equipment.

Field-mounted instruments will be grouped on racks. Supports for individual instruments will be prefabricated, off-the-shelf, 2-inch pipe stand type. Instrument racks and individual supports will be mounted to concrete floors, to platforms, or on support steel in locations not subject to excessive vibration.

Individual field instrument sensing lines will be sloped or pitched in such a manner and be of such length, routing, and configuration that signal response is not adversely affected.

Liquid level controllers will generally be the non-indicating, displacement-type with external cages.

4.13 Instrument Air System

Branch headers will have a shutoff valve at the takeoff from the main header. The branch headers will be sized for the air usage of the instruments served but will be no smaller than 3/8 inch. Each instrument air user will have a shutoff valve, filter, outlet gauge, and regulator at the instrument.
Hydrostor Pecho/ Gem Energy Storage Center - AFC Inputs

Appendix 2.4 – Electrical Engineering

Project Number: 21-5375

TWD Document Number: 21-5375-00-3636-002

Date (y/m/d) | Revision | Description of Revision | Prepared | Checked | Approved
--- | --- | --- | --- | --- | ---
25/08/21 | 0 | Issued for Use | CAB | TME | SEP

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1 OBJECTIVE

1.1 Hydrostor is investigating two potential sites in California for their Advanced Compressed Air Energy Storage (A-CAES) technology. The two sites are Pecho (near Morro Bay), and Gem (near Rosamond).

1.2 TWD is working with Hydrostor and Golder to prepare an Application For Certification (AFC) to the California Energy Commission (CEC) for the two sites. Golder is preparing and will submit the overall AFC, with technical input from TWD.

1.3 This document provides technical input for Golder to develop the following AFC sections for both Pecho and Gem sites:

   - Appendix 2.4 – Electrical Engineering

2 INTRODUCTION

2.1 This appendix summarizes the codes, standards, criteria, and practices that will be generally used in the design and construction of electrical engineering systems. More specific project information will be developed prior to construction of the project to support detailed design, engineering, material procurement, and construction specifications as required by CEC.

3 CODES AND STANDARDS

3.1 The design specification of all work will be in accordance with the laws and regulations of the federal government, the State of California, local County, and City, as well as applicable industry standards. The current issue or revision of the documents at the time of the filing of this AFC will apply unless otherwise noted. If there are conflicts between the cited documents, the more conservative requirement shall apply.

   The following codes and standards are applicable to the electrical aspects of the power facility:

   - American National Standards Institute (ANSI)
   - American Society for Testing and Materials (ASTM)
   - Anti-Friction Bearing Manufacturers Association (AFBMA)
4 SUBSTATION AND TRANSFORMERS

4.1 Substation

The substation will be located on the western end of both sites and will interconnect via a 230kV Overhead line to Whirlwind Substation and Morro Bay Substations for Gem and Pecho Sites respectively. The substation will be of the tubular IPS bus type with interconnecting conductors and will consist of high-voltage SF6-insulated dead-tank circuit breakers and no-load switches.

Connections to the aerial conductor cable will be provided from the two dual-winding transformers for the intertie to the utility grid. The high-voltage circuit breaker will be equipped with a no-load break, air-insulated, disconnect switch. A transformer circuit breaker and isolating disconnect switch will also be installed in each transformer connection to allow for transformer protection and isolation when the corresponding transformer is out of service. Tubular IPS bus type with interconnecting conductors will be used as the primary interconnection material within the switchyard. The IPS and conductors will be attached to post-insulator columns on structural steel supports. The main substation transforms power from/to 230kV to/from 69kV.

Current and voltage transformers will be located at points within the substation to provide for metering and relaying. Control, protection, and monitoring for the substation will be located in the substation protection and control building. Monitoring and alarms will be available to the supervisory control system operator workstations in the control module. All protection and circuit breaker control will be powered from the station battery-backed 125VDC system.

- Insulated Cable Engineers Association (ICEA)
- Institute of Electrical and Electronics Engineers (IEEE)
- Illuminating Engineering Society (IES)
- California Electrical Code
- National Electrical Manufacturers Association (NEMA)
- National Electrical Safety Code (NESC)
Each motor/generator substation will have two dual-winding transformers with wye-delta for the generator and delta-wye for the motors. The HV (69kV) side will be fed with underground cables and the 13.8kV side will be ISO Phase Bus Duct connections with SF6 circuit breakers.

The substation designs will meet the requirements of the National Electrical Safety Code—ANSI C2.

A grounding grid will be provided to control step and touch potentials in accordance with IEEE Standard 80, Safety in Substation Grounding. All equipment, structures, and fencing will be connected to the grounding grid of buried copper conductors and ground rods, as required. The substation ground grid will be tied to the main distribution and plant ground grid.

Lightning protection will be provided by shield wires and/or lightning masts for any overhead lines. The lightning protection system will be designed in accordance with IEEE 998 guidelines. All faults will be detected, isolated, and cleared in a safe and coordinated manner as soon as practicable for the safety of equipment, personnel, and the public. Protective relaying will meet IEEE requirements and will be coordinated with PG&E’s requirements.

There will be a 10.5-mile-long (approximately) tie-line to the utility substation 230-kilovolt (kV) bus for Gem and a 3.5-mile-long (approximately) tie-line to the utility substation 230kV bus for Pecho. The high-voltage circuit breaker will be provided with a breaker failure relay protection scheme. Breaker failure protection will be accomplished by protective and timing relays. The high-voltage breaker will have two redundant trip coils.

Interface with PG&E’s supervisory control and data acquisition system will be provided. Interface will be at the interface terminal box and remote terminal unit. Communication between the facility switchyard and the control building to which it is connected will be included.

Revenue metering will be provided on the 230kV outgoing lines recording net power to or from the PG&E switchyard (bi-directional). The revenue meters and a metering panel will be located in the main switchyard protection and control building.

4.2 Transformers

All generators and motors will be rated for 13.8kV and connect to a 69kV distribution system which in turn feeds the 230kV switchyard through step-up transformers. The step-up transformers will be designed in accordance with ANSI/IEEE standards C57.12.00, C57.12.90, and C57.116. The transformers will be dual-winding, delta-wye, ONAN/ONAF, 65°C rise. Grounding of the transformers will be suitable for both generation and motor function. The main substation will be equipped with lightning arrestors and will have manual de-energized ("no-load") tap changers located in the HV windings.
Facility power will be supplied through unit auxiliary transformers connected to the 69kV distribution system. Four two-winding, delta-wye 69kV to 4.16kV transformers with low impedance grounding resistors will be provided.
APPENDIX 2B

Construction Schedule
Heat and Mass Balance Average Temperature Case
## Heat and Material Balance - Gem Unit - Case Average Temperature

### Table 1. Heat and Material Balance Table - Air Streams

| Description                      | Unit | Air to IP Compressors | Air to LP Compressors | Air to LP Compressors | Air is to IP HP Exchanger | Air is to LP Exchanger | Air to LP Exchanger | Air to LP Exchanger | Air from LP Turbine | Air from IP Turbine | Air from IP Turbine | Air from IP Turbine | Air from LP Turbine | Air from LP Turbine | Air from LP Turbine | Air from LP Turbine | Air from LP Turbine | Air from LP Turbine | Air from LP Turbine | Air from LP Turbine |
|----------------------------------|------|-----------------------|-----------------------|-----------------------|---------------------------|-------------------------|-----------------------|-----------------------|---------------------|---------------------|---------------------|---------------------|---------------------|---------------------|---------------------|---------------------|---------------------|---------------------|---------------------|
| Inlet Frac.                      | 1.00 | 1.00                  | 1.00                  | 1.00                  | 1.00                      | 1.00                    | 1.00                  | 1.00                  | 1.00                | 1.00                | 1.00                | 1.00                | 1.00                | 1.00                | 1.00                | 1.00                | 1.00                | 1.00                |
| Waterfloe                       | 1.24 | 18.9%                 | 18.9%                 | 18.9%                 | 18.9%                     | 18.9%                   | 18.9%                 | 18.9%                 | 18.9%               | 18.9%               | 18.9%               | 18.9%               | 18.9%               | 18.9%               | 18.9%               | 18.9%               | 18.9%               | 18.9%               |

### Table 2. Heat and Material Balance Table - Thermal Fluid Streams

| Description                      | Unit | Cold Thermal Fluid to Air | Cold Thermal Fluid to Air | Cold Thermal Fluid to Air | Cold Thermal Fluid to Air | Cold Thermal Fluid to Air | Cold Thermal Fluid to Air | Cold Thermal Fluid to Air | Cold Thermal Fluid to Air | Cold Thermal Fluid to Air | Cold Thermal Fluid to Air | Cold Thermal Fluid to Air | Cold Thermal Fluid to Air | Cold Thermal Fluid to Air | Cold Thermal Fluid to Air | Cold Thermal Fluid to Air | Cold Thermal Fluid to Air | Cold Thermal Fluid to Air | Cold Thermal Fluid to Air | Cold Thermal Fluid to Air |
|----------------------------------|------|---------------------------|---------------------------|---------------------------|---------------------------|---------------------------|---------------------------|---------------------------|---------------------------|---------------------------|---------------------------|---------------------------|---------------------------|---------------------------|---------------------------|---------------------------|---------------------------|---------------------------|---------------------------|
| Inlet Frac.                      | 0.00 | 0.00                      | 0.00                      | 0.00                      | 0.00                      | 0.00                      | 0.00                      | 0.00                      | 0.00                      | 0.00                      | 0.00                      | 0.00                      | 0.00                      | 0.00                      | 0.00                      | 0.00                      | 0.00                      | 0.00                      | 0.00                      |
| Waterfloe                       | 18.9 | 18.9%                     | 18.9%                     | 18.9%                     | 18.9%                     | 18.9%                     | 18.9%                     | 18.9%                     | 18.9%                     | 18.9%                     | 18.9%                     | 18.9%                     | 18.9%                     | 18.9%                     | 18.9%                     | 18.9%                     | 18.9%                     | 18.9%                     | 18.9%                     |

### Table 3. Heat and Material Balance Table - Cooling Medium Streams

| Description                      | Unit | Cooling Medium to Cooling Medium | Cooling Medium to Cooling Medium | Cooling Medium to Cooling Medium | Cooling Medium to Cooling Medium | Cooling Medium to Cooling Medium | Cooling Medium to Cooling Medium | Cooling Medium to Cooling Medium | Cooling Medium to Cooling Medium | Cooling Medium to Cooling Medium | Cooling Medium to Cooling Medium | Cooling Medium to Cooling Medium | Cooling Medium to Cooling Medium | Cooling Medium to Cooling Medium | Cooling Medium to Cooling Medium | Cooling Medium to Cooling Medium | Cooling Medium to Cooling Medium | Cooling Medium to Cooling Medium | Cooling Medium to Cooling Medium |
|----------------------------------|------|---------------------------------|---------------------------------|---------------------------------|---------------------------------|---------------------------------|---------------------------------|---------------------------------|---------------------------------|---------------------------------|---------------------------------|---------------------------------|---------------------------------|---------------------------------|---------------------------------|---------------------------------|---------------------------------|---------------------------------|---------------------------------|---------------------------------|
| Inlet Frac.                      | 0.00 | 0.00%                           | 0.00%                           | 0.00%                           | 0.00%                           | 0.00%                           | 0.00%                           | 0.00%                           | 0.00%                           | 0.00%                           | 0.00%                           | 0.00%                           | 0.00%                           | 0.00%                           | 0.00%                           | 0.00%                           | 0.00%                           | 0.00%                           |
| Waterfloe                       | 18.9 | 18.9%                           | 18.9%                           | 18.9%                           | 18.9%                           | 18.9%                           | 18.9%                           | 18.9%                           | 18.9%                           | 18.9%                           | 18.9%                           | 18.9%                           | 18.9%                           | 18.9%                           | 18.9%                           | 18.9%                           | 18.9%                           | 18.9%                           | 18.9%                           |

**NOTES:**

(*) Letters C and D denote Charge and Chargeback Cycle, respectively.
Heat and Mass Balance Diagrams
**CHARGE CYCLE**

**SYSTEM PARAMETERS (NOTE 1)**
- Air Flow (lb/hr) per Train: 1.26E6
- System Discharge Energy (MWh): 4000
- Round Trip Efficiency (%): 56
- Charge Duration (hrs): 14.4

**LOAD TABLE – CHARGE (CONSUMED POWER)**
- Compressor Auxiliaries (kW): 685
- Pumps (kW): 784
- Cooling Loads (kW): 3281
- Other Auxiliaries per Train (kW): 208
- Total Charge Load per Train - Incl. 30% Contingency (kW): 6563

**POWER LOSSES**
- Transformer Losses (kW): 1,000
- Comp. Gear Losses (kW): 1812

**MAIN HEAT EXCHANGERS (PER TRAIN)**
- **Stage**
  - LP
  - IP
  - HP
- **Type**
  - Shell & Tube
  - Shell & Tube
  - Shell & Tube
- **No. Shells**
  - 4
  - 2
  - 1
- **Air Flow Side**
  - Tube
  - Tube
  - Tube
- **Duty (MMBtu/hr)**
  - 156.6
  - 78.2
  - 84.5

**POWER SUMMARY – CHARGE SYSTEM**
- Shaft Power at Rotor (MW): 88.8
- Gear Efficiency: 98.0%
- Power at Motor (MW): 90.6
- Motor Efficiency: 98.0%
- Motor Consumed Power (MW): 92.4
- Turbomachinery Efficiency: 90% (LP), 85% (IP), 85% (HP)
- Total Import Power (MW): 100
- Motor Consumed Power + Aux. Loads + Transmission Losses

**POWER LOSES**
- Transformer Losses (kW): 1,000
- Comp. Gear Losses (kW): 1812

**THERMAL FLUID TANKS**
- **HOT**
  - Water
  - Temperature (°F): 358
  - Pressure (PSIA): 240
  - Vessel Type: Spheres
  - Reg. Volume (FT³): 1,523,122
- **COLD**
  - Water
  - Temperature (°F): 115
  - Pressure (PSIA): ATM
  - Vessel Type: Fixed Roof
  - Reg. Volume (FT³): 1,334,188
  - Thermal Fluid (lb/hr): 2.06E6

**GRID CONNECTION**
- 230 KV 60 Hz

**LEGEND**
- MECHANICAL DRIVE
- ELECTRICAL FLOW
- HOT THERMAL FLUID
- COOLING MEDIUM
- COLD THERMAL FLUID
- AIR
- COOLING MEDIUM

**UTILITY AND AUXILIARY SYSTEMS**
- Chemical Injection
- Drains
- N2 Generation
- Instrument Air
- Lube Oil
- Water Treatment

**COMPENSATION WATER RESERVOIR**

**CAVERN DESIGN**
- Depth (FT): 1968
- Pressure (PSIA): 870
- Over Pressure (%): 0
- Volume (FT³): 2.04E7

**HYDROSTOR A-CAES GEM**

**OVERALL BLOCK FLOW DIAGRAM**
- Man LP Axial (100MW) – 500MW / 4000MWh
- Peak Case
1. A single nominal 100MW compression/expansion train is shown. 4 x 100 MW trains make up the system as a whole. Thermal fluid, cavern, and utility systems based on 500MW facility.

2. LP, IP, and HP heat exchanger operation is reversible. The same exchangers are used on both the charge and discharge cycles. The exchanger block shown represents multiple exchangers. Refer to main heat exchanger table for number of exchangers.

3. All values shown on this drawing are taken from the Hysys simulation model –
   a) Average case: HMB case 6 IU – 420 Psig – REF case – 7.3 bara – MAN axial – 100MW_GEM
   b) Peak case: HMB case 5 IU – 420 Psig – REF case – 7.3 bara – MAN axial – 100MW_GEM

4. This block flow diagram is based on the following parameters
   a) Discharge duration 8 hours
   b) LP compressor type – axial
   c) Turbomachinery vendor – MAN

5. Discharge exhaust frequency expected to be 8 hrs per day
Heat and Mass Balance Maximum Temperature Case
# Heat and Material Balance - Gem Unit - Case Peak Temperature

## Table 1. Heat and Material Balance Table - Air Streams

<table>
<thead>
<tr>
<th>Stream Number</th>
<th>PFD</th>
<th>Unit</th>
<th>Description</th>
<th>Unit</th>
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<td>Air to LP Compressors</td>
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<td>104</td>
<td></td>
<td></td>
<td>Air to IP Heat Exchangers</td>
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<td>105</td>
<td></td>
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<td>Air to IP Compressors</td>
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<td>Air from IP</td>
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<td>Air from IP Heat Exchangers to Air to LP Compressors</td>
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<td>Air from LP</td>
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<td>Air from LP Heat Exchangers to Air to IP Compressors</td>
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<td>Cavern Air to IP</td>
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<td>Cavern Air to IP Train 1</td>
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<td>112</td>
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<td>Cavern Air to IP Train 2</td>
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<td>113</td>
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<td>Cavern Air to LP</td>
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<td>Cavern Air to LP Train 1</td>
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<td>115</td>
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<td>Cavern Air to LP Train 2</td>
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<td>116</td>
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<td>Air  to LP</td>
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<td>Air  to HP</td>
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<td>Air from HP</td>
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<td>All Trains Air to Exchanger to Air</td>
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<td>All Trains Cavern Air to Cavern Train 1</td>
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### Notes:
- (*) Letters C and D denote Charge and Discharge Cycle, respectively.
- Heights and material balance

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## Table 2. Heat and Material Balance Table - Thermal Fluid Streams

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## Table 3. Heat and Material Balance Table - Cooling Medium Streams

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<td>Cooling Medium from Cooling Medium Circulation Pumps</td>
<td></td>
</tr>
<tr>
<td>310</td>
<td></td>
<td></td>
<td>Cooling Medium from Cooling Medium Circulation Pumps</td>
<td></td>
</tr>
</tbody>
</table>

### Notes:
- Letters C and D denote Charge and Discharge Cycle, respectively.

---

**Hydrostor Rosamond**

**Project Number:** 21-5291-00-3438-002

**Rev. Date:** 2021-07-29

**Chk'd App'd:** 21-5291
Gem Average Water Balance
Gem Construction Water Use
| Table 2 - Construction Water by Month |

**Site:** Gen

Hydrostor Power & Gen Energy Storage Center Project - JFK Peconic Bay - Sheet 4 of 4

### 1. Potable Water

<table>
<thead>
<tr>
<th>Source</th>
<th>Flow, Total period (US gal)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Piping</td>
<td>7640000</td>
</tr>
</tbody>
</table>

### 2. Non-potable Water

<table>
<thead>
<tr>
<th>Source</th>
<th>Flow, Total period (US gal)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Piping</td>
<td>7640000</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Source</th>
<th>Flow, Total period (US gal)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shaft</td>
<td>11,690,850</td>
</tr>
</tbody>
</table>

Notes:
Gem Water Balance – Dry Scenario
Overall BFD for Water Balance

Gem Peak Dry Case (very low rainwater production case)
30% Plant Utilization
90% Evaporation Reduction From Cover
5th Percentile Precipitation (i.e. DRY conditions)

Values in Red are with a Reservoir Cover (90% Evaporation Reduction)

Negative Values are losses

Note:
For “Excess”, a negative value represents excess water, and a positive value represents required makeup

Equations:
1. Precipitation + Produced Water + Evaporation + From Reservoir + Excess = 0
2. From Reservoir = washdown water + RO Reject + closed loop losses + evaporative losses

Equation 1 check: 0.0

---

**Diagram Description**

- **Reservoir**
- **Evaporation**
- **Precipitation/Runoff**
- **Produced Water**
- **Excess (see Note)**

**Values**:
- Evaporation: 0.7 usgpm
- Precipitation/Runoff: 2.2 usgpm
- Produced Water: 11.6 usgpm
- Excess: -4.4 usgpm

**From Reservoir**
- Reservoir Maintenance loop: -0.8 usgpm
- Washdown water: -0.1 usgpm

**To Cooling Water Loop**
- RO/UF/IEx Treatment System
- Secondary Treatment: Ion Exchange
- Closed Loop Holding Tank
- Chlorination
- To Points of Use: Domestic Flow to Washrooms, Showers, Kitchen
- RO Reject Stream
- Closed Loop Blowdown Valve, Brine Discharge

**To Thermal Fluid Loops**
- Thermal Fluid Make-up Water
- Cooling Water Make-up
- To Thermal Fluid Loops

**Pretreatment**
- UF or Green Sand Filtration

**Secondary Treatment**
- Ion Exchange

**Closed Loop Holding Tank**
- Oxygen Reduction System

**Potable Water Holding Tank**
- Portable Water Treatment System: Chlorination
- Portable Water Treatment System: Desalination

**Water Make-up**
- Stormwater Pond
APPENDIX 2D

Gem Water Balance – Wet Scenario
Overall BFD for Water Balance

Gem Peak Wet Case (very high excess water production case)
85% Plant Utilization
90% Evaporation Reduction from Cover
No Precipitation (i.e. WET conditions)
Values in Red are with a Reservoir Cover (90% Evaporation Reduction)

Negligible Values are losses

For "Excess", a negative value represents excess water, and a positive value represents required makeup

Equations:
1. Precipitation + Produced Water + Evaporation + From Reservoir + Excess = 0
2. From Reservoir = washdown water + RO Reject + closed loop losses + evaporative losses

Equation 1 check:

<table>
<thead>
<tr>
<th>Project</th>
<th>Calculation No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hydrostor California Gem and Pecho</td>
<td>21-5375-89-004-001</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Project No.</th>
<th>Rev. Date</th>
<th>By</th>
<th>CEA</th>
<th>App.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2021-07-21</td>
<td>AJS</td>
<td>JYK</td>
<td></td>
</tr>
<tr>
<td>21-5375</td>
<td>2021-10-27</td>
<td>AKN</td>
<td>AMcG</td>
<td></td>
</tr>
</tbody>
</table>

Cooling Water Loop Evaporative Losses

Thermal Loop Evaporative Losses

Reservoir

Evaporation

Precipitation/Runoff

Produced Water

Excess

Washdown water

Reservoir Maintenance Loop

Washdown water

0.3 USGPM

Washdown water

0.3 USGPM

Note:

Precipitation = Runoff + Rainfall

Precipitation - Runoff = Excess

Produced Water = RO / UF / IEx Treatment System

Main Reservoir Treatment

Closed Loop Treatment

Potable Water

Source

2,160 USGPM/day

Pretreatment:
UF or Green Sand Filtration

Secondary Treatment: Ion Exchange

Closed Loop Holding Tank

To Points of Use

Domestic Flow to Washrooms, Showers, Kitchen

Portable Water Holding Tank

Portable Water Treatment System: Disinfection

To Stormwater Pond

Oxygen Reduction System

To Thermal Fluid Loops

Thermal Fluid Make-up Water

Cooling Water Make-up Water

To Thermal Fluid Loops

GEM Site

Process Flow Diagram

Note:

For "Excess", a negative value represents excess water, and a positive value represents required makeup

Equations: 1. Precipitation + Produced Water + Evaporation + From Reservoir + Excess = 0

2. From Reservoir = washdown water + RO Reject + closed loop losses + evaporative losses

Equation 1 check:

0.0 USGPM

-0.6 USGPM

-0.1 USGPM

0.0 USGPM

0.0 USGPM

-0.2 USGPM

-0.2 USGPM

-0.3 USGPM

0.0 USGPM
APPENDIX 2E

Gem Construction Truck Traffic Estimates
Table 2 - Haul and Material Truck Quantities

**Site: Gem**

**Hydrostor Pecho & Gem A-CAES Projects – AFC Permitting Inputs**

**Item 5.6 – Haul and Material Truck Quantities**

**Rev: 19 Jul 2021**

<table>
<thead>
<tr>
<th>Task</th>
<th>Duration/Timing</th>
<th>Peak hours/throughout the day</th>
<th>Vehicle Type</th>
<th>Assumptions/Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1. CAVERNS WORKS, Months 1-6</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Site clearing - Months 1-6</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Workforce – 12 people = 12 vehicles @ 3 trips per day each x 4 to 5 days = 16 weeks = 1032 trips</td>
<td>Full duration of phase</td>
<td>Daily peak hours</td>
<td>Passenger Car</td>
<td>No carpooling assumed</td>
</tr>
<tr>
<td>Equipment mobilisation – 10 tractor trailer loads, 1st week of site prep</td>
<td>Week 1</td>
<td>Throughout the day</td>
<td>Tractor Trailer</td>
<td></td>
</tr>
<tr>
<td>Equipment demobilisation – 50 tractor trailer loads, last week of site prep</td>
<td>Week 16</td>
<td>Throughout the day</td>
<td>Tractor Trailer</td>
<td></td>
</tr>
<tr>
<td>Fuel delivery – 1 per day = 80 fuel truck trips, tandem fuel truck</td>
<td>Daily, full duration</td>
<td>Daily peak hours</td>
<td>Fuel truck (tandem)</td>
<td></td>
</tr>
<tr>
<td>Fencing delivery – 2 trucks, tractor trailer</td>
<td>Week 1</td>
<td>Throughout the day</td>
<td>Tractor Trailer</td>
<td></td>
</tr>
<tr>
<td>Concrete trucks – 30 loads, std 10 yd cement mix truck (3 perloads x 10 trucks)</td>
<td>Week 1, Week 6, Week 12</td>
<td>Throughout the day</td>
<td>Cement mix truck (15 yd)</td>
<td></td>
</tr>
<tr>
<td>Gravel delivery for 7 acres = 105,000 cu ft x 1.5 ft thick/27 = 15,300 cubic yards/12 yds/truck = 942 tandem truck loads (7 x 5 weeks)</td>
<td>Week 1, 2, 3</td>
<td>Throughout the day</td>
<td>Tandem truck load (12 yd)</td>
<td></td>
</tr>
<tr>
<td>Trailer delivery – 12 trailers x 2 x 24 trips (1 week)</td>
<td>Week 1</td>
<td>Throughout the day</td>
<td>Tractor Trailer</td>
<td></td>
</tr>
<tr>
<td><strong>2. SHAFT, Months 3-6</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Workforce – 3 rigs x 6 workers per rig = 18 people x 5 days x 52 weeks = 56 x 2 ways = 5600 trips</td>
<td>Full duration of phase</td>
<td>Daily peak hours</td>
<td>Passenger Car</td>
<td>No carpooling assumed</td>
</tr>
<tr>
<td>Shaft cuttings for disposal – 15,000 cu yd / 12y per truck = 1563 trucks</td>
<td>Week 1</td>
<td>Throughout the day</td>
<td>12 yd dump truck</td>
<td></td>
</tr>
<tr>
<td>Shaft liner delivery – 2000 ft deep shafts / 40' shaft steel = 50 loads per shaft x 4 shafts = 200 loads (30 weeks in, tractor trailer)</td>
<td>Week 46</td>
<td>Throughout the day</td>
<td>Tractor trailer</td>
<td></td>
</tr>
<tr>
<td>Rig delivery – 3 rigs x 8 loads per rig = 24 loads x 2 (mode in and out) = 48 loads (24 mode, 24 demobil)</td>
<td>Week 16</td>
<td>Throughout the day</td>
<td>Tractor trailer</td>
<td></td>
</tr>
<tr>
<td><strong>3. MINING, Months 10-60</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Workforce</td>
<td>Rosamond – 50 people/day x 2 trips/day x 1170 days = 139,700 trips</td>
<td>Full duration of phase</td>
<td>Daily peak hours</td>
<td>No carpooling assumed</td>
</tr>
<tr>
<td>Mine of mining infrastructure –</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Surface equipment – mom x 50 loads = 50 loads (tractor trailers)</td>
<td>Month 19</td>
<td>Throughout the day</td>
<td>Tractor Trailer</td>
<td></td>
</tr>
<tr>
<td>Surface equipment – demobil x 50 loads = 50 loads (tractor trailers)</td>
<td>Month 51</td>
<td>Throughout the day</td>
<td>Tractor Trailer</td>
<td></td>
</tr>
<tr>
<td>Subsurface equipment – mom x 35 loads = 35 loads</td>
<td>Month 19</td>
<td>Throughout the day</td>
<td>Tractor Trailer</td>
<td></td>
</tr>
<tr>
<td>Subsurface equipment – demobil x 35 loads = 35 loads</td>
<td>Month 51</td>
<td>Throughout the day</td>
<td>Tractor Trailer</td>
<td></td>
</tr>
<tr>
<td>Ground support – 1 load every 14 days = Rosamond – 91 loads. (wire mesh, etc – ribbed tractor trailer (open))</td>
<td>Biweekly, 6/4 duration</td>
<td></td>
<td>Ribbed tractor trailer</td>
<td></td>
</tr>
<tr>
<td>Drilling – 1 load every 14 days – Rosamond – 91 loads</td>
<td>Biweekly, 6/4 duration</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rosamond – 3.8 MBbl = 790,200 c yd x 1.4 swell x 100% = 1,106,280 truck cy</td>
<td>Full duration (months 28-60)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>On road trucks at 12 cy/truck = 32,190 loads</td>
<td>Full duration (months 28-60)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>2. SURFACE WORKS, Months 13-36</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Workforce, average 184 workers per month @ 2 trips per day x 24 months x 20 days = 356,048 trips</td>
<td>Full duration</td>
<td>Daily peak hours</td>
<td>Passenger Car</td>
<td>No carpooling assumed</td>
</tr>
<tr>
<td>Site clearing - overburden - 112,526 cu yd (5 ft depth) x 1.12 swell = 128,029 cu yd @ 12 yd trucks = 10,562 trucks</td>
<td>Months 13-16</td>
<td>Throughout the day</td>
<td>12 yd dump truck</td>
<td>Assuming &gt; overburden depth; possible opportunity to re-use some for landscaping and other construction tasks</td>
</tr>
<tr>
<td>Excavation, flagstones, 4883 cu yd @ 12 yd dump trucks = 394% allowance = 4883 loads</td>
<td>Month 14, 15, 16</td>
<td>Throughout the day</td>
<td>12 yd dump truck</td>
<td>Preliminary estimates</td>
</tr>
<tr>
<td>Cement Trucks, 332/3 cu yd @ 12 yd cement trucks = 2,771 loads</td>
<td>Months 17-18</td>
<td>Throughout the day</td>
<td>Cement truck</td>
<td>Preliminary estimates</td>
</tr>
<tr>
<td>Equipment and material delivery, 1050 loads (equipment, pipe, building, etc)</td>
<td>Months 10-11</td>
<td>Throughout the day</td>
<td>Railed</td>
<td></td>
</tr>
<tr>
<td><strong>4. WATER IMPORT, full duration</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Potable water</td>
<td>Full duration</td>
<td>Throughout the day</td>
<td>5,000 gal water truck</td>
<td>Average rate over full construction duration</td>
</tr>
<tr>
<td>Assumed trucked to site</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Average trucks per month = 13</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Peak trucks per month = 20</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Non-potable water</td>
<td>Full duration</td>
<td>Throughout the day</td>
<td>5,000 gal water truck</td>
<td>Average rate over full construction duration</td>
</tr>
<tr>
<td>Assumed 50% of demand is provided by groundwater wells on site, 50% purchased from wholesaler (i.e. AVEX) and trucked to site (5 mile distance, 1 way)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Average trucks per month = 375</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Peak trucks per month = 1563</td>
<td></td>
<td></td>
<td>Peak during reservoir fill and cold tank fill - assumed 24 month duration for fill, values estimated without cover</td>
<td></td>
</tr>
</tbody>
</table>