**Advanced Turbine Systems Program
Conceptual Design and Product Development**

**Topical Report
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**By
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MASTER

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1.0 INTRODUCTION

This report has been prepared by Solar Turbines Incorporated (Solar) in accordance with Task 2 of the Scope of Work (SOW) as described in Part III, Section J, Attachments A and A1 of the Advanced Turbine Systems (ATS) Contract. As directed by the SOW, this report addresses only the work that will be performed under Task 8 (Design and Test of Critical Components) of the Contract. The discussion is divided into four general sections:

- Project Description
- Potential Environmental Impacts
- Required Permits and Licenses
- Environmental, Safety and Health (ES&H) Agency Contact Information

As described in further detail herein, the activities to occur during the project (i.e., Task 8) consist primarily of short duration testing of laboratory-scale components (or portions of components) for the ATS program. All activities contemplated will occur at existing facilities. Solar believes that the information in this report supports the conclusion that no significant environmental impacts will be associated with the project.

2.0 PROJECT DESCRIPTION

Task 8 is described as the design, fabrication and testing of certain critical components of the ATS. The principal activities that will occur under this project consist of short duration testing of laboratory-scale components in various test cells. The testing involved will fall in the following general categories: recuperator, combustor, and blade/airfoil cooling.

Testing will occur in existing test cells located at Solar's Harbor Drive facility and/or at its parent company's facility in Peoria, Illinois (the "Caterpillar Technical Center"). Solar's Harbor Drive facility has 35 permitted test cells, with functions relating to production and development testing of gas turbines and combustion systems. The Caterpillar Technical Center has 134 permitted test cells for similar purposes. Six test cells are located in the building at the Caterpillar Test Center where project testing would occur.

The typical test cell, of the type to be used for this project, is served by supplies of heated, compressed air and natural gas and various distillate fuels. Natural gas will be the fuel involved in all testing relevant to this report.

A general description of the testing to be conducted under the project is given below. Other specific details are given in the appropriate sections of the discussion on potential environmental impacts.

Most test components will be purchased from approved outside vendors. Some assembly and minor fabrication (piping for test rigs, etc.) will occur at the existing experimental machine shop and assembly areas at the facilities. The components fabricated for testing will all be of laboratory scale. The on-site fabrication will be minor and will use the same types of materials currently worked with in existing operations.

2.1 Recuperator Tests

Recuperator testing will include various tests designed to study the heat transfer and pressure loss characteristics of the recuperator section. Two types of recuperator testing that will be involved are "F&J rig" testing and "steady-state performance" rig testing. "F&J rig" testing involves testing these characteristics in a small core matrix (approximately 3" sq.) of the particular heat-transfer surface being investigated. "Performance rig" testing examines the actual performance of a test core of a full-size air cell assembly. This is done by introducing heated compressed air to the recuperator's air inlet and exhaust gas inlet (at differing temperatures) and measuring heat transfer and pressure loss across the cell.

2.2 Combustor Tests

Combustor testing involves the testing of a sub-scale combustor, supplying heated compressed air and fuel, and monitoring emissions and various other parameters. The principal combustor tests currently anticipated are designed to investigate the chemical recuperation of fuel, through autothermal reforming, to meet the low emission and high efficiency goals of the ATS program. This test process will consist of providing high pressure heated air, steam and natural gas to the integrated autothermal reformer and combustor, then monitoring the resultant NO_x, CO and UHC emissions, as well as assessing the stability of the combustor flame and temperature pattern factor.

Other combustor tests may include testing of fuel staging, variable geometry and catalytic combustion. Any of these tests would involve similar test equipment in existing test cells under similar conditions, thus presenting similar potential environmental impacts as the testing of autothermal reformation.

2.3 Blade/Airfoil Cooling Tests

Solar will perform tests to study and confirm advanced cooling technologies that may be used to cool turbine blades and airfoil vanes. This testing will utilize a "hot cascade rig" in test cells at the Solar Harbor Drive facility. Testing will involve supplying heated compressed air and natural gas to a can combustor, with the combustion flow being channeled into the cascade section, where the test blades/airfoils are fixed. Electrically heated cooling air is supplied to the test blades/airfoils, and temperatures across the blades/airfoils are monitored.

3.0 POTENTIAL ENVIRONMENTAL IMPACTS

3.1 Air Quality

Much of the testing will have no associated direct emissions, such as the blade/airfoil cooling and the "F&J rig" (recuperator) testing. The other tests will have minimal emissions. The emissions associated with the "Performance rig" (recuperator) testing are estimated to be less than 2.8 pounds per hour of NO_x and 1.0 pounds per hour of unburned hydrocarbons. The total estimated operating time for this test is less than 60 hours. The combustor testing is estimated to have emissions of less than 0.22 pounds per hour of NO_x and 0.15 pounds per hour of unburned hydrocarbons. A typical combustor test run lasts 2-4 hours, and 25 test runs are planned to be conducted during the project.

Testing performed at Solar's Harbor Drive facility will be exempt from permit requirements of the San Diego Air Pollution Control District (SDAPCD) since the operations are considered bench scale laboratory equipment. Even were these activities not exempted, they would fall well within the current permit conditions for the test cells where the testing will occur.

Air permits for Solar's Harbor Drive test cells are written such that there is an overall facility fuel limit of 434,000 million BTU per year. Solar estimates that fuel usage from project testing will be 1,500 million BTU. The air permit for the Caterpillar Technical Center allows emissions (rounded to the nearest 1 tons per year) of: CO - 136 TPY; NO_x - 431 TPY; SO₂ - 64 TPY; volatile organics - 28 TPY; PM₁₀ - 22 TPY. The amount of the total project emissions will not significantly impact other testing requirements at either facility.

3.2 Water Quality

No water discharges will be associated with any of the testing undertaken. Water will be used in the combustor tests to provide steam for autothermal reforming and to cool the combustor. All water used in combustor testing will be converted to steam. Any steam that does not react with the natural gas to form the secondary fuel will either be condensed and recycled or will be exhausted as steam to the atmosphere. (H₂O and CO₂ are the end products of the autothermal reformation process.) No water will be used in the recuperator testing. Some water may be used in the blade/airfoil cooling tests; however, this would be supplied from existing cooling tower systems, which involve fully closed systems.

Should any fabrication involve processes generating waste water requiring treatment under applicable pretreatment standards, this waste water would be pretreated and recycled or discharged in accordance with the permits described below.

Solar has been issued an Industrial User Discharge Permit by the City of San Diego, Water Utilities Department for the Harbor Drive facility (Industry No. 09-0023). This permit authorizes the discharge of industrial wastewaters into the POTW from operations covered under EPA categorical standards for metal finishing.

Solar has a wastewater pretreatment system in place that treats manufacturing process wastewaters. The vast majority of Solar's process wastewater is recycled. Any waters discharged to the POTW comply with discharge standards set forth in the Industrial User Discharge Permit.

Effluents from the Caterpillar Technical Center are conveyed by underground piping to Caterpillar's Mossville plant (less than 1/2 mile distant) where they are treated and discharged in accordance with the requirements of NPDES Permit No. IL0001414.

3.3 Land Use

Solar's Harbor Drive facility is located on approximately 27 acres of land leased from the San Diego Unified Port District (Port). The permitted land use is designated as "Airport Related Industrial" in the Port's Master Plan. Surrounding Port lands include Lindbergh Field (San Diego's international airport) and parcels designated for airport related industrial, industrial business park, commercial fishing and commercial recreation uses. Lands proximately located to the east of the facility that are within the jurisdiction of the City of San Diego are zoned for mixed use under the applicable (Centre City) community plan.

The Caterpillar Technical Center is located on a parcel of approximately 843 acres in an area zoned for heavy industrial use (I-3). Approximately 227 of those acres are currently developed for industrial use.

No new facilities or modifications to the current facilities (other than other minor piping alterations and test cell setup adjustments) will be required for the project.

3.4 Waste Management

The testing to be undertaken under the project is not expected to generate any hazardous wastes and minimal solid wastes. The minor fabrication that may be involved could result in small quantities of the same types of hazardous waste that are generated as part of the facilities' daily activities. Solar and Caterpillar have programs in place to assure compliance with the Resource Conservation and Recovery Act and other federal, state and local laws pertaining to the proper handling, transportation, treatment, storage, and disposal of hazardous wastes. Both companies provide appropriate hazardous materials training for employees and conduct routine internal audits to assure compliance with its environmental and occupational safety programs.

3.5 Ecological Impacts

The project requires no new facilities or modifications to existing facilities at either Solar's Harbor Drive plant or the Caterpillar Technology Center. Also, as described throughout this report, the project will not generate significant air emissions, water discharges, hazardous waste or solid waste streams. However, Solar and Caterpillar have spill prevention control and countermeasure (SPCC) plans and contingency plans in place to minimize the potential for spills or releases of hazardous materials, hazardous waste, and similar substances and to minimize the ecological impacts should they occur.

3.6 Socioeconomical Impacts

It is currently anticipated that all project activities will be performed by available Solar and Caterpillar employees (for activities occurring at the Caterpillar Technical Center). It is possible that additional personnel could be hired to assist in work required by the project. Both companies have a diverse workforce and comply with all federal, state and local antidiscrimination laws.

Solar's Harbor Drive facility is located in downtown San Diego. Ample access exists by freeways and arterial roadways from the residential areas in the San Diego region. The San Diego area is also covered by a public transportation system that includes bus and trolley services.

The Caterpillar Technical Center is located approximately 15 miles north of the center of the Peoria, Illinois metro area. Access from residential areas, both in Peoria and other neighboring towns, is available by state highways. Public transportation by bus is also available.

Since no new facilities or modifications to the current facilities would be required, the aesthetic and visual qualities of these facilities will not be impacted.

3.7 Archaeological, Cultural, and Historical Resources

No new facilities or modifications to existing facilities are required that could impact archeological, cultural or historical resources. All of the testing and any fabrication that may be required will

occur in currently existing facilities in areas that have been used for industrial purposes for many years.

Agencies that may be contacted regarding any potential archaeological, cultural or historical resource impacts include:

Office of Historic Preservation
1416 Ninth Street
Sacramento, CA 95814
Tel: (916)653-6624

San Diego Historic Site Board
1010 Second Avenue, Suite 600
San Diego, CA 92101
Tel: (619) 533-3683

Illinois Historic Preservation Agency
500 East Madison
Springfield, IL 62701
Tel: (217) 785-7930

3.8 Noise

All testing required under the project will be of relatively short duration and the cumulative test time is not expected to exceed 200 hours. The testing will not involve tests that are more noise-intensive than routine testing that currently occurs in those facilities, within applicable noise standards and restrictions. The test cells in which the project testing will occur have sound suppression panels and acoustic ceilings.

Solar's Harbor Drive facility is located in an industrially and commercially zoned area adjacent to San Diego's international airport, Lindberg Field. The Caterpillar Technical Center is a developed industrial area that is a portion of a larger industrial zoned parcel.

3.9 Occupational Health & Safety

The materials handled and procedures followed during the testing and any fabrication involved in the project do not differ from those undertaken routinely at Solar's experimental machine shop and test cells and the Caterpillar Technical Center.

Both companies contain programs to assure occupational health and safety, in compliance with all applicable laws. Training programs have been developed to maintain employee awareness about good environmental, health and safety practices. These programs include hearing conservation, respiratory protection, hazard communication and emergency and evacuation procedures, among others. Internal audits are performed routinely to assure compliance with occupational health and safety programs.

3.10 Cumulative Impacts

As discussed above, the project principally entails short duration testing of laboratory-scale test components in existing test cells. Very minor fabrication associated with the test rigs and

assembly of components will occur in existing machine shop and assembly areas. The cumulative project activities, together with the normal daily (non-project) activities at these sites will fall within currently permitted activities, within the conditions and limits set forth therein.

4.0 REQUIRED PERMITS AND LICENSES

All project activities fall within activities that are currently permitted. No additional permits or licenses will be required. The activities will not cause an exceedence of any standards, restrictions or limitations contained in existing permit conditions.

5.0 ES&H AGENCY CONTACT INFORMATION

Solar has contacted no agencies to collect information pertaining to ES&H, since all activities under the project are very small scale and fall within currently permitted activities. None of the activities constitute a departure from the normal types of activities that take place on a daily basis at the subject facilities.

Further information regarding Solar's ES&H programs at the Harbor Drive Facility may be obtained from Robert D. Bush, Environmental Affairs Manager, at (619) 544-5191. Further information regarding Caterpillar's ES&H programs at the Caterpillar Technical Center may be obtained from Brad L. Davis, Safety and Environmental Engineer, at (309) 578-2209.

Agencies that may be contacted regarding ES&H information include:

CAL OSHA
Department of Industrial Relations
Division of Occupational Safety & Health
7807 Convoy Court, Suite 140
San Diego, CA 92111-1287
Tel: (619) 637-5534

Air Pollution Control District
County of San Diego
9150 Chesapeake Drive
San Diego, CA 92123
Tel: (619) 694-3307

County of San Diego
Department of Health Services
Hazardous Materials Management Division
1255 Imperial Ave., 3rd Floor
P.O. Box 85261
San Diego, CA 92138-5261
Tel: (619) 338-2222

California EPA
Department of Toxic Substances Control
245 West Broadway, Suite 350
Long Beach, CA 90802
Tel: (310) 590-4868

USEPA Region V
77 West Jackson Boulevard
Chicago, IL 60604
Tel: (312) 353-2000

Chillicothe Fire Dept.
Box 107
Chillicothe, IL 61423
Tel: (309) 274-3567

Peoria IEPA
5415 N. University
Peoria, IL 61614
(309) 693-5460

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