

EXHIBIT A SCOPE OF WORK

TECHNICAL TASK LIST

Task #	CPR	Task Name
1	N/A	Administration
2	X	Phase 1 – Guard Bed Design and Lab Testing
3	X	Phase 2 – Field Demonstration
4	N/A	Technology Transfer Activities

KEY NAME LIST

Task #	Key Personnel	Key Subcontractor(s)	Key Partner(s)
1	Serguei Zelepouga	TBD	
2	Rachid Slimane	TBD	
3	Martin Linck	TBD	Therock Metals, Eclipse Inc
4	Serguei Zelepouga	Magus Consulting	Therock Metals, Eclipse Inc

GLOSSARY

Specific terms and acronyms used throughout this work statement are defined as follows:

Acronym	Definition
Btu	British thermal unit
CO	Carbon monoxide
CO ₂	Carbon dioxide
CPR	Critical Project Review
GGR	Gas Guard Recuperator
HCl	Hydrogen chloride
HF	Hydrogen fluoride
NO _x	Nitrogen oxides
PAC	Project Advisory Committee
PIER	Public Interest Energy Research
ppmv	Parts per million volumetric
UCC.1	Uniform Commercial Code (Financing Statement)

Problem Statement

A number of industrial processes operate at low efficiencies because there are no commercial means available to recover heat economically from hot exhaust gases containing corrosive elements such as chlorine and fluorine. Aluminum remelt furnaces, in particular, are excellent candidates for such a technology. Aluminum remelters typically operate at 30% efficiency with 60% of input energy lost to the exhaust gas without recovery. More than 5 million tons of aluminum are remelted annually in the U.S., and more than 10% of that total is remelted in California. A total of 20 trillion British thermal units (Btu) of natural gas is used to remelt aluminum annually. A recuperation technology to recover 43% of the exhaust gas heat would increase process overall efficiency to 40% and save 5.2 trillion Btu of natural gas annually in the U.S. and more than 0.52 trillion Btu per year in California aluminum remelt furnaces. The savings of 26% of fuel gas results in the same 26% decrease in Carbon monoxide (CO), Carbon dioxide (CO₂), and Nitrogen oxides (NO_x) emissions. This technology may also find application in other industries, which could provide further energy savings.

Goals of the Agreement

The goal of this Agreement is to demonstrate a practical, robust, and affordable technology to recover useful waste heat from corrosive industrial exhaust gases. Since no practical technology exists to recover heat from these exhaust gas streams, this new approach offers a dramatic opportunity to improve energy efficiency for many industrial processes.

Objectives of the Agreement

The objective of this Agreement is to provide a cost effective heat recovery technology which will make it possible to provide a 15% to 30% energy savings to sites using the technology. Gas Guard Recuperator (GGR) technology can be installed on furnaces in the aluminum, glass, and other industries that currently have no potential for waste heat recovery.

TASK 1.0 ADMINISTRATION

MEETINGS

Task 1.1 Attend Kick-off Meeting

The goal of this task is to establish the lines of communication and procedures for implementing this Agreement.

The Contractor shall:

- Attend a “kick-off” meeting with the Commission Contract Manager, the Contracts Officer, and a representative of the Accounting Office. The Contractor shall bring their Project Manager, Contracts Administrator, Accounting Officer, and others designated by the Commission Contract Manager to this meeting. The administrative and technical aspects of this Agreement will be discussed at the meeting. Prior to the kick-off meeting, the Commission Contract Manager will provide an agenda to all potential meeting participants.

The administrative portion of the meeting shall include, but not be limited to, the following:

- Terms and conditions of the Agreement
- CPRs (Task 1.2)
- Match fund documentation (Task 1.7)

- Permit documentation (Task 1.8)

The technical portion of the meeting shall include, but not be limited to, the following:

- The Commission Contract Manager's expectations for accomplishing tasks described in the Scope of Work;
- An updated Schedule of Deliverables
- An updated Gantt Chart
- Progress Reports (Task 1.4)
- Technical Deliverables (Task 1.5)
- Final Report (Task 1.6)

The Commission Contract Manager shall designate the date and location of this meeting.

Contractor Deliverables:

- An Updated Schedule of Deliverables
- An Updated Gantt Chart
- An Updated List of Match Funds
- An Updated List of Permits

Commission Contract Manager Deliverables:

- Final Report Instructions

Task 1.2 CPR Meetings

The goal of this task is to determine if the project should continue to receive Energy Commission funding to complete this Agreement and if it should, what modifications need to be made to the tasks, deliverables, schedule or budget.

CPRs provide the opportunity for frank discussions between the Energy Commission and the Contractor. CPRs generally take place at key, predetermined points in the Agreement, as determined by the Commission Contract Manager and as shown in the Technical Task List above and in the Schedule of Deliverables. However, the Commission Contract Manager may schedule additional CPRs as necessary, and any additional costs will be borne by the Contractor.

Participants include the Commission Contract Manager and the Contractor, and may include the Commission Contracts Officer, the PIER Program Team Lead, other Energy Commission staff and Management as well as other individuals selected by the Commission Contract Manager to provide support to the Energy Commission.

The Commission Contract Manager shall:

- Determine the location, date and time of each CPR meeting with the Contractor. These meetings generally take place at the Energy Commission, but they may take place at another location.
- Send the Contractor the agenda and a list of expected participants in advance of each CPR. If applicable, the agenda shall include a discussion on both match funding and permits.
- Conduct and make a record of each CPR meeting. One of the outcomes of this meeting will be a schedule for providing the written determination described below.

- Determine whether to continue the project, and if continuing, whether or not to modify the tasks, schedule, deliverables and budget for the remainder of the Agreement, including not proceeding with one or more tasks. If the Commission Contract Manager concludes that satisfactory progress is not being made, this conclusion will be referred to the Energy Commission's Research, Development, and Demonstration Policy Committee for its concurrence.
- Provide the Contractor with a written determination in accordance with the schedule. The written response may include a requirement for the Contractor to revise one or more deliverable(s) that were included in the CPR.

The Contractor shall:

- Prepare a CPR Report for each CPR that discusses the progress of the Agreement toward achieving its goals and objectives. This report shall include recommendations and conclusions regarding continued work of the projects. This report shall be submitted along with any other deliverables identified in this Scope of Work. Submit these documents to the Commission Contract Manager and any other designated reviewers at least 15 working days in advance of each CPR meeting.
- Present the required information at each CPR meeting and participate in a discussion about the Agreement.

Contractor Deliverables:

- CPR Report(s)
- CPR deliverables identified in the Scope of Work

Commission Contract Manager Deliverables:

- Agenda and a List of Expected Participants
- Schedule for Written Determination
- Written Determination

Task 1.3 Final Meeting

The goal of this task is to closeout this Agreement.

The Contractor shall:

- Meet with the Energy Commission to present the findings, conclusions, and recommendations. The final meeting must be completed during the closeout of this Agreement.

This meeting will be attended by, at a minimum, the Contractor, the Commission Contracts Officer, and the Commission Contract Manager. The technical and administrative aspects of Agreement closeout will be discussed at the meeting, which may be two separate meetings at the discretion of the Commission Contract Manager.

The technical portion of the meeting shall present findings, conclusions, and recommended next steps (if any) for the Agreement. The Commission Contract Manager will determine the appropriate meeting participants.

The administrative portion of the meeting shall be a discussion with the Commission Contract Manager and the Contracts Officer about the following Agreement closeout items:

- What to do with any state-owned equipment (Options)
- Need to file UCC.1 form re: Energy Commission's interest in patented technology

- Energy Commission’s request for specific “generated” data (not already provided in Agreement deliverables)
- Need to document Contractor’s disclosure of “subject inventions” developed under the Agreement
- “Surviving” Agreement provisions, such as repayment provisions and confidential deliverables
- Final invoicing and release of retention
- Prepare a schedule for completing the closeout activities for this Agreement.

Deliverables:

- Written documentation of meeting agreements and all pertinent information
- Schedule for completing closeout activities

REPORTING

See Exhibit D, Reports/Deliverables/Records.

Task 1.4 Monthly Progress Reports

The goal of this task is to periodically verify that satisfactory and continued progress is made towards achieving the research objectives of this Agreement.

The Contractor shall:

- Prepare progress reports which summarize all Agreement activities conducted by the Contractor for the reporting period, including an assessment of the ability to complete the Agreement within the current budget and any anticipated cost overruns. Each progress report is due to the Commission Contract Manager within 10 working days after the end of the reporting period. Attachment A-2, Progress Report Format, provides the recommended specifications.

Deliverables:

- Monthly Progress Reports

Task 1.5 Test Plans, Technical Reports and Interim Deliverables

The goal of this task is to set forth the general requirements for submitting test plans, technical reports and other interim deliverables, unless described differently in the Technical Tasks.

The Contractor shall:

- Submit a draft of each deliverable listed in the Technical Tasks to the Commission Contract Manager for review and comment in accordance with the approved Schedule of Deliverables. The Commission Contract Manager will provide written comments back to the Contractor on the draft deliverable within 10 working days of receipt. Once agreement has been reached on the draft, the Contractor shall submit the final deliverable to the Commission Contract Manager. The Commission Contract Manager shall provide written approval of the final deliverable within 5 working days of receipt. Key elements from this deliverable shall be included in the Final Report for this project.

Task 1.6 Final Report

The goal of this task is to prepare a comprehensive written Final Report that describes the original purpose, approach, results and conclusions of the work done under this Agreement. The Commission Contract Manager will review and approve the Final Report. The Final Report must be completed on or before the termination date of the Agreement. The Contractor shall follow the latest version of the PIER Final Report guidelines published on the Energy Commission's Web Site at <http://www.energy.ca.gov/contracts/index.html#pierreports> at the time the Contractor begins performing this Task unless otherwise instructed in writing by the Commission Contract Manager.

The Final Report shall be a public document. If the Contractor has obtained confidential status from the Energy Commission and will be preparing a confidential version of the Final Report as well, the Contractor shall perform the following subtasks for both the public and confidential versions of the Final Report.

Task 1.6.1 Final Report Outline

The Contractor shall:

- Prepare a draft outline of the Final Report.
- Submit the draft outline of Final Report to the Commission Contract Manager for review and approval. The Commission Contract Manager will provide written comments back to the Contractor on the draft outline within 10 working days of receipt. Once agreement has been reached on the draft, the Contractor shall submit the final outline to the Commission Contract Manager. The Commission Contract Manager shall provide written approval of the final outline within 5 working days of receipt.

Deliverables:

- Draft Outline of the Final Report
- Final Outline of the Final Report

Task 1.6.2 Final Report

The Contractor shall:

- Prepare the draft Final Report for this Agreement in accordance with the approved outline.
- Submit the draft Final Report to the Commission Contract Manager for review and comment. The Commission Contract Manager will provide written comments within 10 working days of receipt.

Once agreement on the draft Final Report has been reached, the Commission Contract Manager shall forward the electronic version of this report to the PIER Technology Transfer Group for final editing. Once final editing is completed, the Commission Contract Manager shall provide written approval to the Contractor within 5 working days.

- Submit one bound copy of the Final Report with the final invoice.

Deliverables:

- Draft Final Report
- Final Report

MATCH FUNDS, PERMITS, AND ELECTRONIC FILE FORMAT

Task 1.7 Identify and Obtain Matching Funds

The goal of this task is to ensure that the match funds planned for this Agreement are obtained for and applied to this Agreement during the term of this Agreement.

The costs to obtain and document match fund commitments are not reimbursable through this Agreement. While the PIER budget for this task will be zero dollars, the Contractor may utilize match funds for this task. Match funds shall be spent concurrently or in advance of PIER funds during the term of this Agreement. Match funds must be identified in writing, and the associated commitments obtained before the Contractor can incur any costs for which the Contractor will request reimbursement.

The Contractor shall:

- Prepare a letter documenting the match funding committed to this Agreement and submit it to the Commission Contract Manager at least 2 working days prior to the kick-off meeting:
 1. If no match funds were part of the proposal that led to the Energy Commission awarding this Agreement and none have been identified at the time this Agreement starts, then state such in the letter.
 2. If match funds were a part of the proposal that led to the Energy Commission awarding this Agreement, then provide in the letter:
 - A list of the match funds that identifies the:
 - Amount of each cash match fund, its source, including a contact name, address and telephone number and the task(s) to which the match funds will be applied.
 - Amount of each in-kind contribution, a description, documented market or book value, and its source, including a contact name, address and telephone number and the task(s) to which the match funds will be applied. If the in-kind contribution is equipment or other tangible or real property, the Contractor shall identify its owner and provide a contact name, address and telephone number, and the address where the property is located.
 - A copy of the letter of commitment from an authorized representative of each source of cash match funding or in-kind contributions that these funds or contributions have been secured.
- Discuss match funds and the implications to the Agreement if they are significantly reduced or not obtained as committed, at the kick-off meeting. If applicable, match funds will be included as a line item in the progress reports and will be a topic at CPR meetings.
- Provide the appropriate information to the Commission Contract Manager if during the course of the Agreement additional match funds are received.
- Notify the Commission Contract Manager within 10 working days if during the course of the Agreement existing match funds are reduced. Reduction in match funds may trigger an additional CPR.

Deliverables:

- A letter regarding Match Funds or stating that no Match Funds are provided
- Letter(s) for New Match Funds
- A copy of each Match Fund commitment letter
- Letter that Match Funds were Reduced (if applicable)

Task 1.8 Identify and Obtain Required Permits

The goal of this task is to obtain all permits required for work completed under this Agreement in advance of the date they are needed to keep the Agreement schedule on track.

Permit costs and the expenses associated with obtaining permits are not reimbursable under this Agreement. While the PIER budget for this task will be zero dollars, the Contractor shall show match funds for this task. Permits must be identified in writing and obtained before the Contractor can incur any costs related to the use of the permits for which the Contractor will request reimbursement.

The Contractor shall:

- Prepare a letter documenting the permits required to conduct this Agreement and submit it to the Commission Contract Manager at least 2 working days prior to the kick-off meeting:
 1. If there are no permits required at the start of this Agreement, then state such in the letter.
 2. If it is known at the beginning of the Agreement that permits will be required during the course of the Agreement, provide in the letter:
 - A list of the permits that identifies the:
 - Type of permit
 - Name, address and telephone number of the permitting jurisdictions or lead agencies
 - Schedule the Contractor will follow in applying for and obtaining these permits.
- The list of permits and the schedule for obtaining them will be discussed at the kick-off meeting, and a timetable for submitting the updated list, schedule and the copies of the permits will be developed. The implications to the Agreement if the permits are not obtained in a timely fashion or are denied will also be discussed. If applicable, permits will be included as a line item in the progress reports and will be a topic at CPR meetings.
- If during the course of the Agreement additional permits become necessary, then provide the appropriate information on each permit and an updated schedule to the Commission Contract Manager.
- As permits are obtained, send a copy of each approved permit to the Commission Contract Manager.
- If during the course of the Agreement permits are not obtained on time or are denied, notify the Commission Contract Manager within 5 working days. Either of these events may trigger an additional CPR.

Deliverables:

- A letter documenting the Permits or stating that no Permits are required
- Updated list of Permits as they change during the Term of the Agreement
- Updated schedule for acquiring Permits as it changes during the Term of the Agreement
- A copy of each approved Permit

Task 1.9 Electronic File Format

The goal of this task is to unify the formats of electronic data and documents provided to the Energy Commission as contract deliverables. Another goal is to establish the computer platforms, operating systems and software that will be required to review and approve all software deliverables.

The Contractor shall:

- Deliver documents to the Commission Contract Manager in the following formats:
 - Data sets shall be in Microsoft (MS) Access or MS Excel file format.
 - PC-based text documents shall be in MS Word file format.
 - Documents intended for public distribution shall be in PDF file format, with the native file format provided as well.
 - Project management documents shall be in MS Project file format.
- Request exemptions to the electronic file format in writing at least 90 days before the deliverable is submitted.

Deliverables:

- A letter requesting exemption from the Electronic File Format (if applicable)

TECHNICAL TASKS

Unless otherwise provided in the individual Task, the Contractor shall prepare all deliverables in accordance with the requirements in Task 1.5.

Task 2: Phase 1 – Guard Bed Design and Lab Testing

The goal of this task is to develop the necessary information to design a suitable gas/solid guard bed contactor (low pressure drop and sufficient residence time) to optimize sorbent utilization and contaminant removal efficiency.

Work will involve: a comprehensive review of the literature to guide the selection of effective sorbent materials and suitable gas-solid contactor designs; thermodynamic and kinetic analyses of the Gas Guard Recuperator (GGR) guard bed stage; and laboratory testing of several selected, commercially-available materials as suitable sorbents for Hydrogen chloride (HCl) and Hydrogen fluoride (HF) removal from simulated flue gas at very high temperatures.

The Contractor shall:

- Conduct a comprehensive literature search to:
 - Identify candidate sorbent materials for HCl and HF removal under conditions representative of the aluminum remelt furnace exhaust: 1400 to 1800°F, low-pressure, and low HCl and HF contaminant levels (up to 25 ppmv or parts-per-million by volume for HCl and up to 10 ppmv HF).
 - Assess practicality of candidate materials for commercial application, such as availability, cost, and any disposal requirements.
 - Identify potentially suitable gas-solid contactor designs for field demonstration of the GGR process concept in Phase 2.
- Plan and carry out a laboratory testing program:
 - Perform comprehensive thermodynamic analyses to predict gas cleaning performance of selected materials.

- Procure sufficient quantities of selected candidate sorbents. These will be characterized at the contractor's Analytical Laboratory to determine their chemical and physical properties, and will then be prepared for testing either as fine granules suitable for injection or as bigger particles, depending on the selected configuration for the gas-solid contactor.
- Design and construct a laboratory-scale reactor facility equipped with the necessary analytical instruments for feed gas analysis and assessment of the contaminant removal efficiency achieved.
- Perform shakedown testing of the facility to confirm validity of testing and gas sampling procedures, calibration of equipment, and sensitivity of gas analysis instruments.
- Develop a Test Plan for the entire program. This will involve screen testing of all candidate sorbent materials as well as parametric testing of promising materials to evaluate effects of key gas cleaning process parameters, such as temperature, contact time (space velocity), sorbent-to-contaminant ratio, etc.
- Perform long-term testing of top HCl and HF removal sorbents to determine their ultimate or effective contaminant removal capacity (i.e., grams of HCl or HF removed per 100 grams of sorbent). This will be further confirmed by HCl and HF analyses using spent sorbent samples.
- Characterize selected spent sorbent samples to assess any requirements for disposal.
- Develop a full report of calculations, analyses, test results, and projections for the demonstration unit to be built and tested in Phase 2.
- Participate in the CPR.

Deliverables:

- Phase 1 Report on GGR Development, Experimental Results, and Phase 2 Design Considerations (no draft)
- Test Plan

Task 3: Phase 2 – Field Demonstration

The goal of this task is to assemble a GGR demonstration unit. ~~This unit will be installed at Thoreck Metals and used to preheat some or all the air needed for one or two of the furnace burners.~~ **This unit will be installed at a site to be chosen by the Contractor and approved in writing by the Commission Contract Manager. The unit will be used to preheat some or all of the air needed for one or more furnace burners.**

The Contractor shall:

- **Select a host site for the GGR demonstration unit and obtain written approval of this site selection from the Commission Contract Manager.**
- Design a GGR demonstration unit.
- Assemble the GGR demonstration unit.
- Install the GGR demonstration unit at ~~Thoreck Metals in Compton, California~~ **the demonstration site.**
- Gather data at ~~Thoreck Metals~~ **the demonstration site** and analyze results.

- Prepare a preliminary engineering design and estimate the cost of a commercial GGR system, based on demonstration unit results.

Deliverables:

- Phase 2 Report on Results of GGR Field Demonstration (no draft)
- Copy of GGR demonstration unit design

Task 4 Technology Transfer Activities

The goal of this task is to develop a plan to make the knowledge gained, experimental results, and lessons learned available to key decision-makers.

The Contractor shall:

- Prepare a Technology Transfer Plan. The plan shall explain how the knowledge gained in this project will be made available to the public. The level of detail expected is least for research-related projects and highest for demonstration projects. Key elements from this report shall be included in the Final Report for this project.
- Conduct technology transfer activities in accordance with the Technology Transfer Plan. These activities shall be reported in the Monthly Progress Reports.

Deliverables:

- Technology Transfer Plan