Advanced Battery Concepts
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Proposed Agency-Industry Cooperative Pilot Projects for the California Community Protection and Hazardous Waste Reduction Initiative

Advanced Battery Concepts LLC

Advanced Battery Concepts is installing a prototype (development) production line for advanced lead batteries in its Clare, Michigan facility. The prototype line will be utilizing the exact manufacturing unit operations as our customers who have licensed our GreenSeal® technology. Licensing targets include California companies which may be good testing facilities for full scale production. The prototype battery manufacturing line will be small scale, but representative of full scale production methods and, hence, lead utilization. All learnings will be shared with DTSC and licensees as part of the technology development and transfer to full production package. Because this technology is intended to become a best practice for lead battery production, the learnings and operational standards will not only reduce the use of lead in California, but the rest to the United States and globally as well.

ABC proposes that the company engage with DTSC to conduct two related, but distinct pilot projects:

1. ABC proposes that DTSC review the technology and supplied data and write an official opinion of ABC's GreenSeal® battery technologies with respect to reductions in lead utilization and "source reduction" compared to traditional battery designs.

2. ABC proposes that DTSC review the technology and supplied data and write an opinion of the GreenSeal® manufacturing process with respect to reductions in employee and community exposure compared to traditional battery manufacturing techniques.

Each proposed project is described in detail below.

I. Lead Source Reduction Through GreenSeal® Battery Technology

Advanced Battery Concepts can reduce the lead utilization of a given battery type using our patented bipolar battery technology. ABC is producing the world's first large-format, bipolar, sealed AGM, valve-regulated lead-acid battery. The battery's patented component design and manufacturing methods allow for a safer, high power, high energy long life battery. The batteries have improved environmental and consumer safety profile than current lead batteries.

Exposure to lead is reduced in two ways. First, the lead in the battery is reduced by 46% total in the manufacturing of a battery compared to standard dual-purpose Advanced Glass Mat (AGM) batteries. Second the lifetime is significantly longer than that of standard dual purpose AGM using the 100% DoD Testing at 2H Rate (BCIS-06). The combination of less lead in the product and longer lifetime is the equivalent of reducing by 95% of the lead in circulation. The environmental benefits include decreasing the number of lead batteries in circulation, reduced lead smelting and processing, less lead exposure in manufacturing and less lead in battery recycling.

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In addition to the effective lead reduction, the bipolar batteries are better for society by decreasing consumer cost, improved life, and contribute to greater automotive fuel efficiency in electric vehicles, hybrids and stop starts.

ABC proposes to partner with DTSC to set up a program to monitor actual lead utilization from a prototype production line on a GC2 format battery. The initial data immediately supplied are from a development production line on ABC's GC2 Mod 2 lead batteries. ABC is installing a low volume production line in Clare Michigan which will include all the unit operations representative of full scale production. The next phase is to produce GC-2 Mod 3 batteries on this production line by the end of the 3Q 2017.

ABC produced batteries will be lab tested for exact lead content per unit power by using a suite of industry standard testing methodologies including:

- DOD 2H (BCIS-06)
- Cycle Life 100% DOD C/2 to 50% capacity
- Energy Density at C20 rate to 1.75 VPC
- Power Density 30S at 1.2 VPC RT
- Vibration Life SAEJ 930 Level 2
- Stand Loss %ΔV/month 25^{o}C.

The results of the battery testing will allow an accurate calculation of effective lead reduction based on scale of deployment.

Additional testing will be performed to calculate effective lead reduction in more situations. Cycle testing will be performed using a suite of industry standard testing methodologies, including:

- IEC 61056
- JIS D 5302
- BCIS06 100%DOD
- EN50342-1
- SAE J2801 Life Test
- ABC 1C 100% DOD
- VDA 17.5% DOD.

To validate lab testing results and the viability of our design and manufacturing technology, ABC also proposes to conduct real world, in-use testing. The GC-2 batteries will be put in service in golf carts, floor scrubbers or the like in a side-by-side test with conventional technology for a period of one year.

A combination of actual in-use data and the standard lab testing will allow calculations of the expected performance across the full range of use and total effective lead reduction. All the data will be shared with DTSC. ABC proposes that DTSC would publish a report based on review and evaluation of the data.

Phase I:

1) ABC will promptly submit to DTSC public and confidential data (via secure server access) regarding our new-spec bipolar batteries GC-2 Mod 2, which deliver improved performance relative to flooded or AGM lead batteries using approximately one-half the amount of lead.

2) DTSC will evaluate that data, and if it believes it is a viable technology, produce a report confirming such conclusion.

Phase II: (assuming step I.2 results in a positive review)

1) ABC will produce new-spec (half-weight) GC-2 Mod 3 motive-power batteries at their Michigan pre-production facility.
2) ABC will lab test batteries as described above.
3) ABC will sponsor an in-situ test of those batteries by installing them in floor scrubbers and/or golf carts at a real-world use facility (type of use may depend on test facility availability).
4) ABC can today be confident of a test-location in Michigan, but believes their California partner manufacturer would likely support a test location in California.
5) ABC will monitor the performance of those new-spec batteries in comparison to same-location traditional design batteries over the course of one year.
6) Comparative performance data will be made available to DTSC during and at the completion of the test.
7) Comparative and lab performance data will be validated so real in-use results may be projected to markets beyond the performance testing.
8) DTSC will review the comparative data and publish a public review of that data.

II. Workplace and Environmental Manufacturing Emissions Reduction Through GreenSeal® Battery Manufacturing Techniques

Areas of interest for lead exposure include the lead oxide handling, lead paste mixing, lead foil electrode cutting, lead foil electrode assembly, electrode soldering, electrode pasting, electrode stacking, electrode cure and dry, and electrode stack handling. After the electrode assembles are molded in a battery, direct exposure to lead is unlikely. The fill and formation potential exposure is to sulfuric acid, during acid mixing, acid filling, battery formation and acid top off.

ABC proposes to partner with DTSC to set up a program to monitor exposure in each unit operation, the entire battery manufacturing process, the entire plant, and the outside air surrounding the manufacturing site. The testing will continue for two years, with a first year review and modification as necessary. The main testing instrumentation will include freestanding air samplers, backpack worker monitors, lead surface tests, waste water lead analysis, acid vapor monitors and employee blood level monitoring.

Freestanding air monitoring will be conducted pursuant to NIOSH test method 7082 or 7300 to a confidence level of 95% and not less than $\pm$ 20% accuracy. A NIOSH IH Pump Kit for lead NIOSH 7082/7300 will be purchased. These tests are designed to give a good background and overall indication of exposure. Test locations to include:

1. Outside the plant, 50 meters up wind.
2. Outside the plant, 50 meters down wind.
3. Office hall way.
4. Locker Room.

5. Lunch room
6. Shipping receiving area.

Backpack air monitoring will be conducted pursuant to NIOSH test method 7082 to understand the exposure from each of the unit operations of the battery manufacturing line. Tests will include workers in the following operations:

1. Paste mixing
2. Paste area.
3. Lead foil cutting.
4. Lead electrode soldering.
5. Electrode stack, cure and drying.
6. Battery over-molding.

Lead surface dust monitoring will be conducted pursuant to NIOSH test method 9100 on surfaces of all the areas where air quality is monitored.

Waste water monitoring: All formation water is tested to establish consistent mineral content/pH levels. Once this standard is proven, testing will be moved to quarterly checks (state requirements are 2x per year). Formations with defective or leaking batteries will be segregated to separate waste disposal using our waste recycler. All other water exposed to lead via cleaning, will also be segregated and contained for separate waste recycling.

Acid vapor monitoring will be conducted pursuant to NIOSH test method 7908 in the battery forming station.

Employee blood and ZPP monitoring will occur on the following schedule pursuant to OSHA Standard 29 CRF 1926.62

Employees	Annual	Semi-Annual	Quarterly	Monthly
Office Workers	x			
Engineers	x	x		
Lab Personnel	x	x	x	
Paste Mixing Room	x	x	x	x
Lead metal handling	x	x		
Lead pasting	x	x	x	
New Employees	x	x	x	x
Employee w/ Pb>16µg/dL	x	x	x	x

ABC will provide PPE for all groups of employees appropriate to the presumed exposure level for a particular task. ABC will also provide protective work clothing and equipment, change areas, hand-washing facilities, training, and the initial medical surveillance prescribed by paragraph (d)(2)(v) of the standard (29 CFR 1926.62, or an applicable state counterpart).

References:

https://www.cdc.gov/niosh/docs/2003-154/pdfs/7082.pdf

https://www.cdc.gov/niosh/docs/2003-154/pdfs/9100.pdf
https://www.cdc.gov/niosh/docs/2003-154/pdfs/7908.pdf
Permissible Exposure: The Permissible Exposure Limit (PEL) set by the standard is 50 micrograms of lead per cubic meter of air (50 ug/m(3)), averaged over an 8-hour workday.

Action Level: 30 micrograms per cubic meter of air (30 ug/m^3), TWA, based on an 8-hour work-day.
From the CA Code of Standards:
Action level means employee exposure, to an airborne concentration of lead of 30 micrograms per cubic meter of air (30µg/m^3) calculated as an 8-hour time-weighted average (TWA).