Casting Emission Reduction Program

"America's Center of Excellence for Emission Measurement Technology"

January 2004

CERP
Casting Emission Reduction Program

Preface

It is with a great deal of pleasure and pride that this report is presented as a record of an industry in change and a program in change. The Casting Emission Reduction Program began from a meeting in August 1993 where representatives from the American Foundry Society (AFS), The Casting Industry Suppliers Association (CISA), the auto companies and the U.S. government looked to the future and sought ways to prepare an entire industry for increasingly tougher environmental regulation.

The result was an approach to environmental responsibility never before attempted by any industry or country. It was so innovative and 'out-of-the-box' that few outside the attendees believed it had a chance for success. The concept was simple: "…provide a public/private validation laboratory where environmental source reduction could be tested in a full production line setting and use this to create a competitive rationale for improvement." When compared with achieving industry-wide improvements through regulation, this has proven to be far more effective and less costly for all parties. It continues to be a success!

This is the second comprehensive report on the accomplishments of the CERP program, its implementers, stakeholders and supporters.

There are many, across the foundry industry, that have made significant contributions and I would like to thank them all. I would especially like to recognize the first four individuals who called our 1993 meeting: Gary Mosher, AFS; Dennis Schuetzle, formerly with Ford Motor Company; Jerry Rogers, General Motors Corporation; and Mark Bindbeutel, formerly with Daimler Chrysler Corporation. All but Mark have continued to work with the program. In addition, I would like to thank all the past and present chairs of our Steering Committee: Dennis Schuetzle, Keith Soubel and Rebecca Messick, Ford; Ron Cafferty, Bob Wiltse and Brian Smith, General Motors; and Paul Bujalski and Mark Bindbeutel from DaimlerChrysler (DC).

Continued on next page

Other contributors who also deserve a big thank you include:

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William C. Walden
January 2004

Contents

Acronym List

AFS.....American Foundry Society
ARDEC.....U.S. Army Armament Research, Development and Engineering Center
ASAM.....Association for the Standardization of Automation and Measurement Systems
CAAA.....Clean Air Act Amendments of 1990
CARB.....California Air Resources Board
CEMS.....Continuous Emissions Monitoring Systems
CERP.....Casting Emission Reduction Program
CISA.....Casting Industry Suppliers Association
CO.....Carbon Monoxide
COR.....Contracting Officer's Representative
CRADA.....Cooperative Research and Development Agreement
DOD.....Department of Defense
DOE.....Department of Energy
EPA.....Environmental Protection Agency
ERC.....Environmental Research Consortium
FID.....Flame Ionization Detector
GC.....Gas Chromatograph
HAP.....Hazardous Air Pollutant
IVI.....Interchangeable Virtual Instruments
MACT.....Maximum Achievable Control Technology
NIST.....National Institute of Standards and Technology
ODS.....Open Data Systems
RRF.....Relative Response Factor
SCPI.....Standard Commands for Programmable Instruments
SERDP.....Strategic Environmental Research & Development Program
SIVL.....System Integration Validation Lab
TGOC.....Total Gaseous Organic Concentration
THC.....Total Hydrocarbon Concentration
US EPA.....U.S. Environmental Protection Agency
USCAR.....U.S. Council for Automotive Research
VOC.....Volatile Organic Compound
WBS.....Work Breakdown Structure
XML.....Extensible Markup Language

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1. Executive Summary

Introduction

This document serves as a continuing report describing the activities undertaken by the Casting Emission Reduction Program (CERP) under contract to the ARDEC Energetics, Warheads and Environmental Technology Directorate (formerly the U.S. Army Industrial Ecology Center) from August 2000 through December 2003.

Background

The Casting Emission Reduction Program (CERP) is an independent applied research project located at McClellan Park in Sacramento, California (formerly McClellan Air Force Base). CERP's purpose is to help the American metal casting industry meet federal clean air standards by testing foundry product and process improvements in a real-world foundry environment, to advance emission measurement capabilities for stationary sources, and to perform research into leading edge energy technologies that could be used to support casting operations.

CERP is funded and administered by the U.S. Department of Defense (DOD). Leading American automobile manufacturers, under the auspices of the U.S. Council for Automotive Research (USCAR), Environmental Research Consortium (ERC) and foundry industry suppliers have also contributed in-kind resources, experience, and expertise to the program.

Both DOD and USCAR depend on the availability of quality domestically produced cast parts. In recent years many foundries have ceased operations in the country, partially because these foundries have had difficulty complying with increasingly stringent clean air regulations. For this reason, DOD and USCAR

support CERP's effort to identify alternative products and processes that can lead to reductions in foundry air emissions, thereby contributing to the continuing viability of the U.S. metal casting industry.

CERP Program Overview

CERP was created in 1994 by a Cooperative Research and Development Agreement (CRADA) entered into by the following parties:

- U.S. government
- United States Council for Automotive Research (USCAR), a general partnership consisting of:
    - DaimlerChrysler
    - Ford Motor Company
    - General Motors Corporation

In addition, CERP has formed cooperative working relationships with government agencies, trade associations, and educational institutions that share a concern for clean air issues.

In June of 1995 McClellan Air Force Base was added to the Base Closure and Realignment Commission (BRAC) list of military bases to be closed. Consequently, McClellan Air Force base was closed on April 10,

2001 and was privatized as McClellan Park. Additionally, the CERP program, formerly operated in two buildings at McClellan Park, has relocated all of its facilities into one building.

During the military-to-private transition, in August 2000 a significant change occurred. Technikon LLC was formed. Technikon operates the CERP program as a private contractor under contract to the ARDEC Energetics, Warheads and Environmental Technology Directorate; Environmental Technology Group (ARDEC-ETG).

A new CRADA was signed in early 2003. The new CRADA added AFS and CISA as voting members of the Steering Committee.

CERP Achievements Overview

CERP planned, constructed, tested and brought on-line a state-of-the-art sand casting facility consisting of a Production Foundry, a Pre-Production Foundry, and two (2) laboratories used to evaluate various aspects of foundry emissions data. CERP has used these facilities to develop emissions information on existing and new foundry materials and processes. In addition, CERP's research has resulted in refined analytical protocols that should lead to a more consistent approach to air emissions measurement.

Significance of CERP Achievements

The significance of accomplishments of CERP cannot be overstated. Data and reports generated by CERP are being used in foundries across the world to significantly lower HAP emissions, improve productivity and profitability. Methods developed and validated under CERP have increased the accuracy and dependability of air emission measurement. Finally, Federal and State agencies use CERP generated information to develop regulations and to review permits.

Facilities

CERP planned, constructed, tested and brought on-line a state-of-the-art 60,000 square foot casting facility consisting of a Production Foundry, a Pre-Production Foundry, and two (2) laboratories used to evaluate various aspects of foundry emissions data. CERP has used these facilities to develop emissions information on existing and new foundry materials and processes.

The CERP facility also includes offices, a break room, meeting rooms, and a foundry history museum that is currently open to the public by appointment only.

CERP Foundry Air Emissions Testing

CERP continued to test foundry products and processes for air emissions. These tests are grouped in 3 categories:

- Baseline Library
- Product Testing

1. Executive Summary

- Process Testing
-

The results of these tests allow the industry to obtain valuable emissions data required for regulatory or business decisions. These data are available on the CERP website.

Capabilities and Technologies

- Capability to produce ferrous and non-ferrous casting
- Ability to vary casting processes to allow testing that cannot be done in commercial foundry
- Fully operational core room designed for process and environmental testing
- Ability to supply industry with air emission factors needed for environmental compliance
- Air sampling and analytical methods development and validation
- Continuous measurement of criteria gasses
- Real-time logging of parametric data

Joint-Collaboration Programs and Shared Research

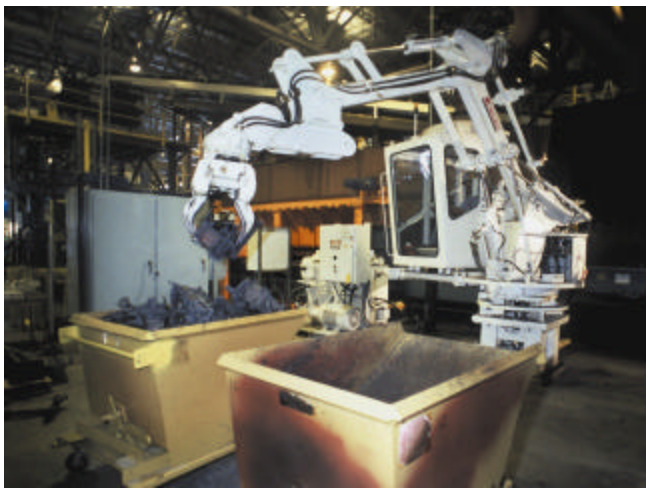
- University of California, Davis – Particulate Measurement
- Pennsylvania State University – Advanced Oxidation
- California Casting Metals Association – Energy Studies
- University of Alabama, Birmingham – Emission Factor Database
- Desert Research Institute – Condensable Particulate Measurement

Summary

The Casting Emission Reduction Program has realized significant achievements in support of its original mission: to improve and/or develop materials and processes in foundry technologies that will allow the U.S. casting industry to be competitive while working to achieve a near-zero effect on the environment, and to integrate advanced emissions measurement technologies.

The program is a unique model for achieving environmental responsibility that translates into industry-wide air emission reductions. It is a platform that will continue to advance emissions measurement technologies that are needed to support environmental improvements.

The results of the first six years of testing were published in August 2000 as a final report on CERP's accomplishments from CERP's inception, starting with a vision, a mission and an empty 60,000 square foot warehouse. This report covers the continuation of CERP accomplishments from August 2000 to December 2003.



CERP's high-tech industrial facility doubles as an air emissions research laboratory.

2. Background

Background and Purpose of CERP

This document serves as a continuing report on activities undertaken by the Casting Emission Reduction Program (CERP) at McClellan Park, Sacramento, California.

CERP was established in 1994 to evaluate ways to reduce air emissions from foundry processes so our nation's metal casting industry can continue to deliver quality products to the defense and automotive industries while meeting new clean air standards. The U.S. Army administers the program as a benefit to the U.S. military and the U.S. economy.

How Important is the U.S. Metal Casting Industry?

- **Ranking**: 6th largest industry in the United States
- **Output**: $23 billion generated annually
- **Jobs**: up to 250,000 employed
- **Percentage of U.S. auto industry manufactured products containing castings**: 100%

How Important is the Industry to the Department of Defense?

- Percentage of DOD manufactured products containing castings: 90%

An Industry in Peril

- Foundry closing/relocations since 1980: more than 1,000
- Jobs lost since 1980: thousands

The metal casting industry is one of our nation's oldest and most productive enterprises. Our military and manufacturing dominance was built, literally, on the strength of foundries, and we still depend on the industry to supply many of the products that define our current high standard of living.

Foundry Industry Under Pressure

In recent years, the foundry industry in this country has faced new pressures on several fronts. Clean air emissions standards imposed by the U.S. Environmental Protection Agency (EPA) and many state governments have grown increasingly stringent, and many of our foundries have found it difficult to meet the new standards. These businesses, particularly the smaller shops, possess neither the technical nor the economic ability to internally test new materials and processes that could reduce air emissions.

At the same time, cheaper foreign labor and production costs have enticed some cast metal manufacturers to relocate beyond our borders. As a result, more than 1,000 U.S. foundries closed or relocated outside the country during the past 20 years. Over 25 percent of the U.S. foundries operating in 1986 are now gone.

Government and industry representatives recognize the critical role played by foundries in this country. Over 90 percent of the manufactured products used by the U.S. Department of Defense contain castings, or are derived from castings. For security reasons, it is imperative that the U.S. military is assured of a reliable, on-going *domestic* supply of quality cast parts.

Proposing a Solution

CERP was conceived as a collaborative effort between private sector and federal government entities concerned with the preservation of the U.S. metal casting industry.

2. Background

The policy-makers who initiated the program foresaw the critical need for an independent applied research facility that would be used to conduct air emissions testing in a real-world foundry environment. The CERP "research campus" facility was proposed as a way to reduce potential risks and economic losses to individual foundries by providing a research service that benefits the industry as a whole.

In 1994, CERP was formed under a Cooperative Research and Development Agreement (CRADA) entered into by the U.S. government (represented by the U.S. Air Force's Sacramento Air Logistics Center) and private automobile manufacturers (under the auspices of the U.S. Council for Automotive Research, or USCAR). Congress authorized appropriations to fund CERP through DOD.

Maximum Achievable Control Technology (MACT) Regulations for Iron and Steel

The 1990 Clean Air Act Amendments, Title III, Air Toxics, requires the EPA to enact Maximum Achievable Control Technology (MACT) regulations by the year 2000. These regulations cover iron and steel foundry emissions of hazardous air pollutants (HAPs). Existing foundries covered under these regulations are required to meet the average air emission levels achieved by the top 12 percent of the industry's least-polluting facilities within three years of the publication of the new rules. New or modified sources will have to meet a "New Source" MACT equivalent to the "Best Controlled" similar source.

The new requirements will be technology based, but can be met either by installing control technology or by making process changes resulting in similar emission reductions. Several research projects (including CERP) are currently evaluating and developing process changes that can reduce foundry HAP emissions. These changes can give foundries the ability to economically meet future regulatory requirements as well as to reduce the environmental impact of foundry processes.

An industry group associated with the American Foundry Society has worked with the EPA at Research Triangle Park in North Carolina to proactively participate in the MACT rulemaking. This "MACT Task Force" has worked with EPA to produce a rule that meets environmental objectives without subjecting U.S. foundries to unreasonable financial burdens.

The final rule was published by the EPA in April 2004. Major Source Foundries will have until April 2007 to be in compliance with the rule.

Additional Federal Regulations Impacting Heavy Manufacturing Industries

- **Resource Conservation and Recovery Act (RCRA):** Regulates hazardous waste generation and disposal
- **Toxic Substances Control Act** (TSCA): Regulates the operation and disposition of PCB-containing items
- **Clean Water Act (CWA):** Regulates discharges from industrial processes and storm water runoff

3. Program Overview

Overview of CERP's Mission and History
Who CERP is, What CERP is Charged to do, and How the Program was Built

Recognizing that a sustainable domestic metal casting industry is vital to national security interests, the U.S. Air Force in 1994 initiated the Cooperative Research and Development Agreement (CRADA) that established the Casting Emission Reduction Program (CERP).

McClellan Air Force Base (AFB) in Sacramento, California was chosen as the site of the new program for several reasons. California air quality regulations set a high standard commensurate with CERP's emission reduction goals. The proximity of the base to the state capitol enables the CERP team to coordinate effectively with representatives from State of California regulatory agencies. In addition, facilities meeting CERP's size and security requirements were available at McClellan AFB.

In July 2000 a significant change occurred. Technikon LLC (Technikon) was formed. Technikon operates the CERP program under contract to the ARDEC Energetics, Warheads and Environmental Technology Directorate; Environmental Technology Division (ARDEC-ETD).

The CERP program has served as a successful cornerstone for the conversion of U.S. military to private dual-use efforts during the 1990's.

Mission: Summary of CERP's CRADA

CERP was conceived as a five-year $50 million effort to be funded primarily through congressional appropriations.

The mission of CERP under the CRADA is "…to improve and/or develop materials and processes in foundry technologies that will allow the U.S. automotive casting industry to be competitive while working to achieve a near-zero effect on the environment, and to integrate advanced emissions measurement technologies…"

The CRADA set the following goals and objectives for CERP:

- Measure the hazardous air pollutant (HAP) emissions from foundry processes.
- Provide objective data that may be used in establishing U.S. Environmental Protection Agency (EPA) Maximum Achievable Control Technology (MACT) standards for HAP emissions from foundries.
- Rank foundry processes targeted for HAP reduction.
- Measure new/modified casting processes that reduce HAP emissions.
- Develop low-level emissions measurement technology and instrumentation needed to measure compliance to new federal and

state low emission vehicle emissions standards.

In 2003 a new CRADA was signed with the US Army. The new CRADA maintained the previously stated goals and objectives for the CERP and added emphasis on improving casting processes and energy usage.

Forming Key Partnerships

Uniquely, the CERP program is open to forming cooperative working relationships with organizations that share an interest that aligns with the CERP goals. Relationships were formed with:

- Industry
- Vendors to the Casting Industry
- Governmental Agencies
- Trade Associations
- Educational Institutions
- Individuals

CERP's joint-collaboration and shared research programs are discussed further in the section on achievements.

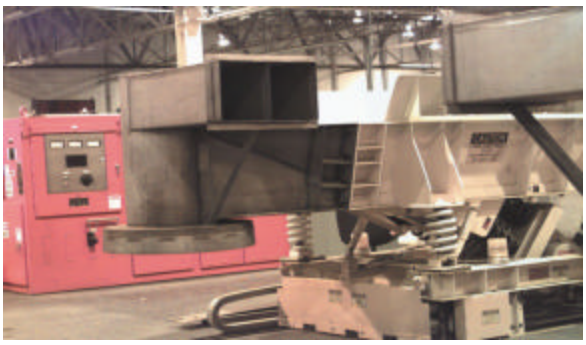
History of CERP Testing Activities

The CERP facility was officially opened on 28 October 1996 at a Project Dedication Ceremony honoring U.S. Secretary of Commerce Ron Brown. Mr. Brown, who had worked tirelessly to strengthen America's industrial base, lost his life while on an official visit to Bosnia during that conflict.

An initial test pour of gray iron was made in April 1997, only 16 months after initiation of construction. Completion and testing of plant auxiliary systems and automatic tilt functions for the pouring furnace took one more year, with the full plant complete and operational by June 1998. Significant air emissions testing activities were initiated in August 1998.

The following section provides details about CERP's testing activities and other achievements.

Construction of CERP's state-of –the-art facility began in 1996



3. Program Overview

CERP Milestones

1994 - Cooperative Research and Development Agreement (CRADA) signed
- Appropriations approved

1995 - Design start-up

1996 - Foundry equipment installed
- CERP dedication held

1997 - First mold poured
- Standard Commands for Programmable Instrument (SCPI) initiated

1998 - Pre-Production and Production Foundries operational
- Mexico foundry emissions report published
- Emission bench SCPI published
- Dynamometer SCPI published

1999 - Baseline air emissions report published
- Product and process modifications tests conducted
- Emission bench SCPI approved
- Dynamometer SCPI approved

2000 - Sampling system SCPI approved
- Additional facilities installed and operational
- Technikon LLC formed, which operates CERP program

2001 - McClellan Air Force Base is closed and privatized as McClellan Park
- Production foundry baseline; Core and un-cored completed

2002 - Relocation of pre-production to Building 238 started
- Supplied American Foundry Society (AFS) with HAP Emissions Factors for approximately 80% of the processes used in foundries
- EPA's Maximum Achievable Control Technology (MACT) standards requiring foundry emission reductions proposed

2003 - New CRADA signed including: Army's Environmental Technology Division (formerly Industrial Ecology Center), AFS and CISA as voting members of the Steering Committee.
- Contract language expanded to include studies in energy technologies

3. Program Overview

Developing a State-of-the-Art Facility

CERP planned, constructed, tested and brought on-line a state-of-the-art casting facility consisting of a Production Foundry, a Pre-Production Foundry, and four laboratories used to evaluate various aspects of foundry emissions data. CERP has used these facilities to develop emissions information on existing and new foundry materials and processes. In addition, CERP's research has resulted in refined analytical protocols that should lead to a more consistent approach to air emissions measurement.

Most foundries are not capable of conducting research at this level. Because CERP is performing the research as a service to the industry as a whole, individual foundries can better control costs and preserve jobs for U.S. workers. CERP is a cost-effective program designed to keep domestic foundries at the forefront of the worldwide casting industry.

The CERP program formerly operated in two buildings at McClellan Park has relocated all of its facilities into one building containing a full-scale research foundry and all supporting facilities *(the current layout is shown the on following page).*

Production Foundry

The CERP Production Foundry is housed in a 60,000-square-foot converted warehouse located at McClellan Park. The Production Foundry is able to produce green sand molds at a nominal molding rate of up to 50 molds per hour. Horizontally parted tight flasks, 24" x 36" x 14/14", are used in the indexing mold line, manufactured by Georg Fischer Disa. The mold line uses a single molding station with air impact squeeze molding and two pattern shuttles, allowing quick exchange of patterns during operation. The molds are conveyed on steel bottom pallet cars with complete automatic mold line control, linked to continuously updated mold tracking software. The mold line includes four enclosed cooling lines, mold transfer lines, automatic core setting, adjustable sprue and vent drilling, and complete sand recovery using under floor conveyors and elevators.

A Service to American Industries

Without credible emissions information, federal, state and local regulations could drive emission control requirements beyond the foundry industry's scope and ability to economically implement these regulations.

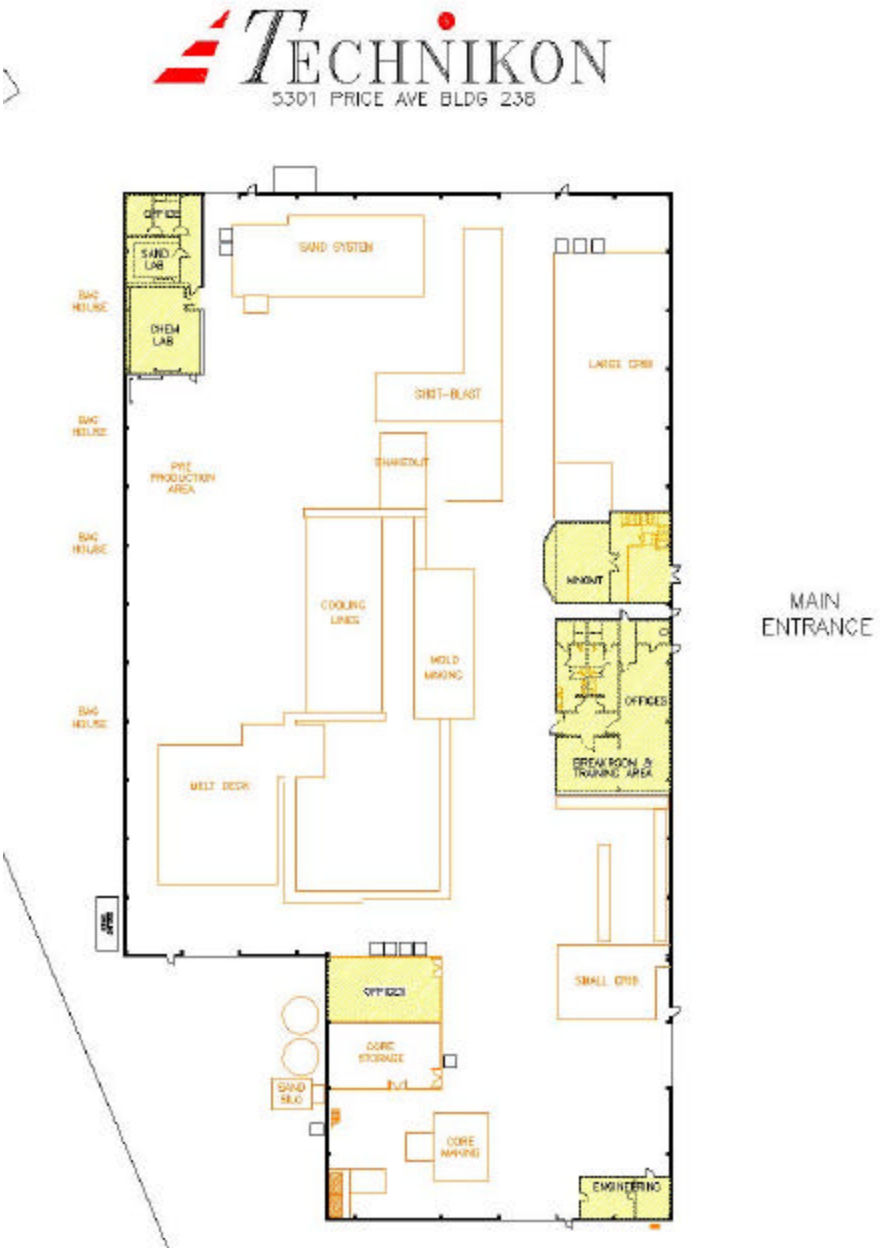
Foundries that experiment with new products and processes may risk significant production and economic losses.

The Casting Emission Reduction Program bridges these gaps by providing research data from a real-world foundry.

The green sand system is designed for 50 tons per hour processing of sand from the molding process and shake-out. The mold shake-out system includes a high frequency shake-out, casting feeder, and fully articulated casting manipulator to load casting on a cooling conveyor. A cooling feeder bin, Simpson Multi cooler, redundant screening, and second sand storage

4. CERP Achievements

hopper comprise the main parts of the system. A Simpson muller can prepare 50 tons per hour of green sand with complete automatic control for the sand and bond addition system, linked to local operator interface panel using Wonderware software.



The core-making machines include Georg Fischer Disa horizontally parted machine, a Simpson 670-pound core mixer, and a small test core machine, by Redford Carver. The main core machine is equipped for hot and cold box core making, fully enclosed for emissions control and capture, with triethylamine (TEA) and sulfur dioxide gas scrubbers. A TEA gas generator, core unload conveyor, and fully temperature and humidity controlled core storage area are provided. Core coating and core drying ovens have also been installed. The core making sand system includes a truck dump hopper that delivers the sand to either core or green sand systems via a dense-phase air conveyor system. Two 100-ton sand silos, located near the truck dump hopper, offer manual selection of the sand delivery destination.

The iron melting system consists of two 5,500-pound coreless induction melting furnaces with 1,500 KW power supplies. The metal is transferred via an automatic ladles transfer car system and then loaded into a heated pouring furnace. The bottom pour (stopper rod) furnace includes an automatic control for sprue cup monitoring and metal control.

All foundry processes are close-captured for the most complete emission control possible. Using top, bottom, and side draft hoods, the casting process emissions are directed to one of four baghouses: 1) melting; 2) pouring, cooling, and shake-out; 3) shot blast; or 4) green sand system. Due to the nature of the program, the emission controls are extensive and provide complete capture of emissions and the ability to measure emissions from specific equipment or total processes. Building makeup air is provided by passive air vents and forced ventilation fans. Over 150,000 standard cubic feet per minute (scfm) of air is controlled through the baghouses during normal operations.

Pre-Production Foundry

The CERP Pre-Production Foundry is now housed in the same building as the Production Foundry. The Pre-Production Foundry evaluates the emissions from materials and processes on discrete molds under tightly controlled conditions. This research foundry site performs preliminary screening and emission characterization to determine whether the new process or material is promising enough to undergo full-scale experimentation in the Production Foundry. While green sand molds are produced and poured, primarily with cast iron under an emission collection hood, the emissions are sampled, analyzed, and evaluated.

4. CERP Achievements

A No-Bake sand system is used for rapid mixing and molding of self-curing sand. The No-Bake system includes a fully adjustable resin addition system, sand hopper and elevator, a mold shaker table to assist with sand packing, and a gravity conveyor. The No-Bake molds are poured and sampled within the same hood system as the greensand molds.

The iron melting system consists of a 1,000-pound coreless induction melting furnace with a 250 kW power supply. The metal is poured into the mold inside a completely enclosed pouring station. The stainless steel pouring station encloses the mold during cooling, allowing the exhaust fan ducting to be sampled for emissions. A built-in shake-out table ensures continuous emissions monitoring capability during mold shake-out. The exhaust ducting is fitted with an automatic sampling line system, which continuously draws sample emissions into the emissions laboratory for analysis in real time. After a test is complete, the flask, casting and sand are removed from the enclosure.

Laboratories

The CERP Foundry includes two (2) laboratories. Each laboratory is used to evaluate either process or emissions data and to verify the qualities associated with the total casting process. The two (2) laboratories include: the sand laboratory, and analytical/stationary emissions laboratory.

The sand laboratory has scales, chemical reagents, screens, ovens and a computer for evaluating green sand, "new" sand, and core sand characteristics. The sand parameters, which impact the quality of castings, are verified in order to evaluate the requirements for replacement clay (bond) and other mineral and chemical additions.

The analytical/stationary emissions laboratory is equipped with gas chromatography and gas chromatography/mass spectrometry instrumentation for evaluating air samples and includes continuous emissions monitoring equipment for total gaseous organic concentrations, carbon monoxide, carbon dioxide, and nitrogen oxides. This laboratory provides CERP with the capability to perform in-house sample analysis and methods development. It also provides a "clean" environment for equipment calibration, validation, and data analysis.

Supporting Programs

The casting emissions research projects cannot be successful without appropriate and efficient support from internal and external programs. Health and safety concerns are integral to that support. The Casting Emission Reduction Program (CERP) staff has devised an effective health and safety plan and operating instructions that protect workers and enable the operation to proceed safely and productively.

Environmental Health and Safety Plan

Protecting the workers' health and the

environment, while operating this complex industrial facility, requires a well structured approach and constant monitoring. The management team considers safe operations to be equally important to the overall mission as the development of data. The facility's environmental and safety record contributes to the overall success of CERP.

The CERP Production Foundry operates at McClellan Park in Sacramento, California. The facility employs approximately 25 personnel. The program's management, supervisors, and employees are all committed to upholding state and local environmental, health, and safety (EH&S) regulations.

The program has been developed and operated consistent with the proven and successful EH&S program employed by General Motors at their foundries and the industry guidelines provided by the American Foundry Society (AFS).

Operating and Safety Instructions

Each department (e.g. pre-production, core-making, charge, melt, pour) in the foundry contains from one to several individual processes and pieces of equipment. Each piece of equipment has a unique operating and safety instruction (OSI) developed by the CERP Foundry Engineer.

The OSIs describe the operation, safe work practices, maintenance procedures, and emergency response procedures for equipment and operations at the CERP foundries. The OSIs also are used as reference guides and training tools for operators working at the foundry. Detailed information and specifications for each type of equipment are available in the relevant operation and maintenance manuals that are maintained in the CERP foundry office.

The OSIs were based on a review of the equipment manufacturer's operating manual(s), the CERP Engineer's knowledge and experience in foundry operations, and a review of the equipment/process during operation.

The OSIs are intended to provide CERP staff with instructional safety procedures and equipment operating information directly applicable to the operation of one or more specific foundry processes. All CERP workers required to be involved in these processes or equipment received this training and the appropriate documentation prior to beginning the job. Refresher training is provided periodically as warranted by changes in staff, equipment, or processes.

The structured approach ensures that the CERP facility operates in a safe and environmentally conscious manner in compliance with applicable health, safety, and environmental regulations.

Additional Supporting Programs

CERP is also served by the following supporting programs:

- Accounting

4. CERP Achievements

- Contract Management
- Materials Procurement and Delivery
- Engineering
- Management and Administration

Testing Teams

To supply input to the CERP testing plans, four (4) teams report to the Steering Committee:

The Production Foundry is the Core of CERP's Operations

- Casting Quality Team
- Emission Measurement Team
- Modeling Team
- Test Design Team.

The Casting Quality Team was established to determine the effects of material and process changes on the quality of the castings. As most foundries use core and mold coatings and addi-

tives in the sand, a work plan will be developed to determine their effects on emissions. Casting quality will certainly improve when coatings are used. Currently casting quality is determined by comparing castings side by side and observing defects. Photographs are taken to provide a historical record. In the future the team may request CERP to run a surface prophylometry measurement. This is an ASTM standard that measures surface roughness. The recently installed green sand preproduction foundry will provide excellent quality testing. The Osborne molding machines will provide consistency and the star pattern is good for examining surface area and casting quality. This setup will allow more turns of the green sand and stabilization in a shorter time period.

The Emission Measurement Team was established to develop the foundry emission program and to select the analytical and sampling methods. Where there are gaps in existing emission information, they will be identified and measurement plans developed. This team works very closely with the Test Design Team to insure that test plans are accurate and complete. In the move to one building, the following changes were made:

- A new stainless steel insulated hood was designed and installed with a six-inch insulated duct. This is designed to improve run-to-run repeatability through improved target analyte transport.
- A new instrumentation setup that gives real time measurement of TGOC, CO, CO2, and NOx. This instrumentation is located in an e-bench in the emissions laboratory.
- Gas dilution and gas mixing are in place so that CERP can custom mix its calibration standards.
- A new dedicated HC analyzer will be used to develop the relative response factors of organic HAPs and VOCs.
- A plan is in place to develop a System Integration and Validation Lab (SIVL) for foundry applications.
- The number of target analytes was reduced from 70 to 56. The analytes eliminated had not been seen in 90 % of the testing and represented a small fraction of the results.
- A study was conducted of PUCB systems that used conventional naphthalene-containing solvents and systems that used naphthalene-depleting solvents. This work was conducted for a response to the proposed Iron & Steel Maximum Achievable Control Technologies (MACT). The results showed there was no difference in pouring, cooling and shakeout emissions of naphthalene and substituted naphthalenes.
- One core room optimization test was completed on the variables relative to core mixing, making and storage emissions.
- Testing was conducted to establish core room emissions from various No – Bake systems.

The Modeling Team purpose is to provide the foundry industry with the resources that can be used to accurately predict air emissions. This was accomplished by testing various foun-

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dry processes and materials to develop better baseline emission factors and by identifying major emission variables particular to specific processes in Aluminum and Iron.

- Emission testing for VOCs has been proven at CERP to provide excellent correlation with real foundry data.
- A review of all CERP testing to date and what is required to fill data gaps is part of this team's mission.

The Test Design Team mission provides equipment selection and installation input for all facility decisions. Additionally, the team has input in all scheduled emission tests. The Test Design Team also evaluates current and cutting-edge technologies for selection and inclusion in the research. The technologies evaluated included core making, molding, melting, pouring and emission control.

- A major accomplishment of this committee was the relocation of the preproduction foundry. This included the rebuild of two Osborne 716 jolt squeeze molding machines and the sand hopper system, the relocation of four furnaces, No-Bake mixer hood and roller conveyor, and 8200 CFM baghouse and ductwork.

Testing Protocols

Prior to the consolidation of facilities in 2002, the testing protocol for most binders consisted of two parts. In the first part, the effect of any binder replacement on air emissions (compared to the baseline) was tested in the Pre-Production Foundry. This consisted of nine one-hour tests with an 8-on mold of the American Foundry Society (AFS) step core.

If a significant reduction in any HAP was detected in the Pre-Production test, the binder qualifies to run in the Production Foundry, the second part of the testing protocol. This test consisted of six one-hour tests on 4-cylinder engine block castings.

Since the consolidation, all testing has been conducted under four (4) general test protocols:

1. Core room emissions are measured for core making and core storage using an AFS step core pattern.

2. Greensand replacement products and mold releases are tested in the new hood system using a "star" pattern.

3. Core testing is conducted in a coal-less greensand mold in the new collection hood using the AFS step core cores.

4. No-Bake binders are also tested in the new hood using a 4-on AFS gear mold pattern.

Emissions Database

The emissions database that CERP is developing is posted on the CERP web site in the form of technical reports (www.cerp.us). The database consists of various sources of emissions data: the National Center for Manufacturing Sciences (NCMS) da-

tabase compiled by the University of Alabama at Birmingham; CERP's Mexico report; and CERP's baseline and vendor reports. The database allows users to choose various process types and parameters to approximate emissions from the foundry processes.

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CERP Foundry Air Emissions Test Achievements

Report Library

CERP published results of the Baseline tests, which provide the information for establishing emissions factors necessary for MACT calculations and permitting calculations.

The objective is to develop Baseline HAP emission levels for standard products and processes. These baselines would be used as the comparison for low emission products.

Baseline test were performed on a variety of processes:

- Emissions from No-Bake molds poured in both iron and aluminum
- Production Foundry emissions with phenolic urethane cores
- Core room emissions from making cores in phenolic urethane
-

Testing breaks new ground

CERP's Baseline Pre-Production Emission Report published in 1999 is, to date, the most comprehensive emission report ever produced for iron green sand emissions. This report is the first research report to quantifiably differentiate between green sand and core emissions as well as quantify background emissions from raw materials.

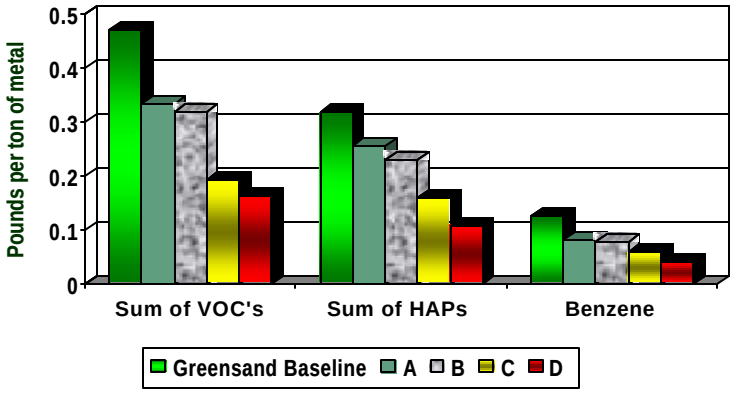
The first complete baseline foundry emissions data ever developed were provided by CERP to the EPA in November 1998. This report summarizes five weeks of emission testing performed at Ford and General Motors foundries in Mexico during 1997

Product Testing

The following charts represent the major emission testing results over the past two (2) years. The bar to the left is the baseline result for that series of tests.

Greensand Seacoal Replacement Products – Pouring, Cooling Shakeout

CERP has tested four (4) products that can replace Seacoal in standard iron greensand formulas. These products reduced air emissions from pouring, cooling, and shakeout as compared to the baseline levels. The chart below illustrates these products emissions in pounds of emissions per ton of iron poured.



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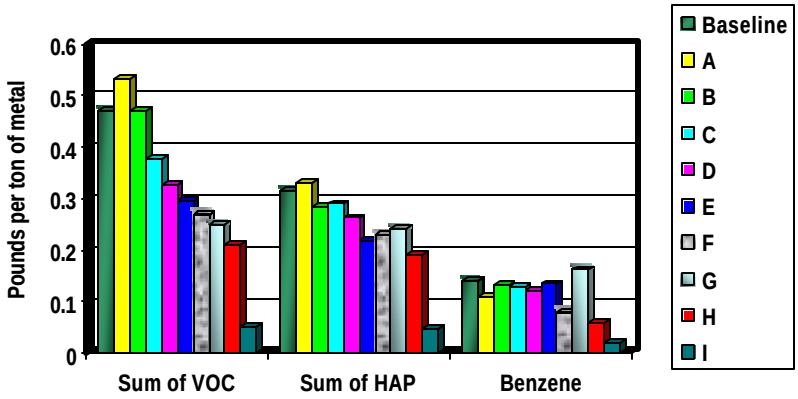
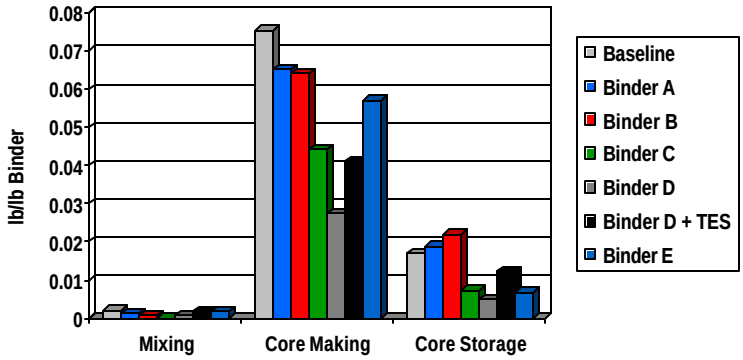
Core Replacement Products – Pouring, Cooling Shakeout

CERP has tested nine (9) Core Binder systems, Eight (8) of which reduced air emissions from pouring, cooling and shakeout, as compared to the baseline (Phenolic Urethane) Pre-production levels. The chart below illustrates these product's emissions in pounds of emissions per ton of iron poured.



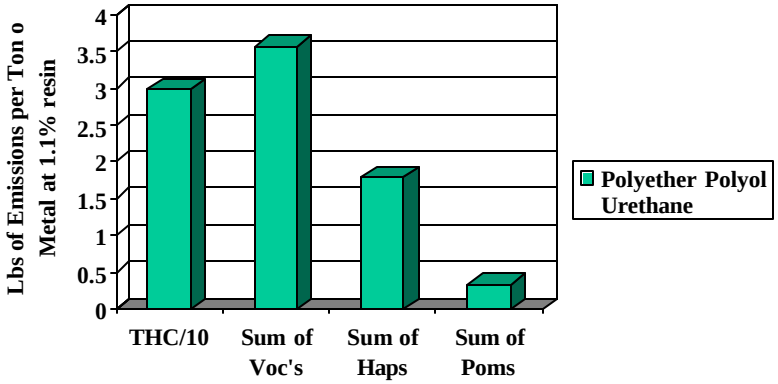
Core Replacement Products – Core Sand Mixing, Blowing, Storing

CERP has tested six (6) Phenolic Urethane Core Binder systems that reduced air emissions from core sand mixing, core making and core storage as compared to the baseline levels. The chart following illustrates those products emissions in pounds of THC emissions per pound of binder.



No-Bake Replacement Products – Aluminum – Pouring, Cooling Shakeout

CERP has tested one (1) No-Bake Binder system (Polyether Polyol Urethane) to establish baseline air emissions from pouring, cooling and shakeout of casting in No-Bake molds in aluminum.



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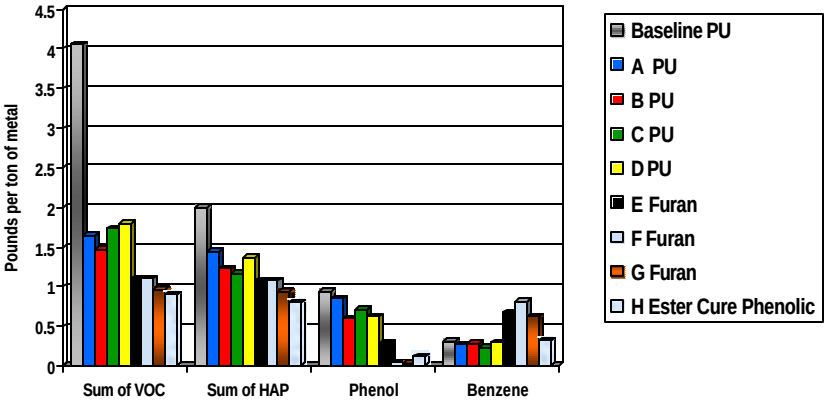
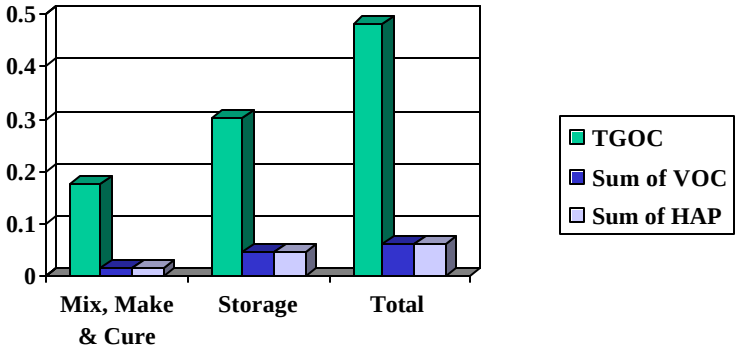


No-Bake Replacement Products – Iron – Pouring, Cooling, Shakeout – Emissions

CERP has tested eight (8) No-Bake Binder systems. Seven (7) of which, reduced air emissions from pouring, cooling, and shakeout in iron, as compared to the baseline (Phenolic Urethane) levels. The chart following illustrates these products emissions in pounds of emissions per ton of iron poured.



No-Bake Mold Sand Mixing, Making and Storage Emission

CERP has tested one (1) No-Bake Binder System for one (1) Mold Sand Mixing, Making and Storage Emissions.

Process Studies

The objective of these studies was to test new processes developed by foundry vendors or engineering firms that could reduce Hazardous Air Pollutants (HAPs) emissions from metal casting by at least 50%. Testing of these processes is first conducted in the Pre-Production Foundry for initial testing. If major HAP reductions are validated, the process is scheduled in the Production Foundry where air emissions can be measured in a full-scale production process. Those processes were selected for evaluation. These were:

- Advanced Oxidation Testing in Greensand – Core and None Cored – PCS
- GMBOND® Test Project for Aluminum Block Cores
- Acoustic Stimulation of Molten Metal

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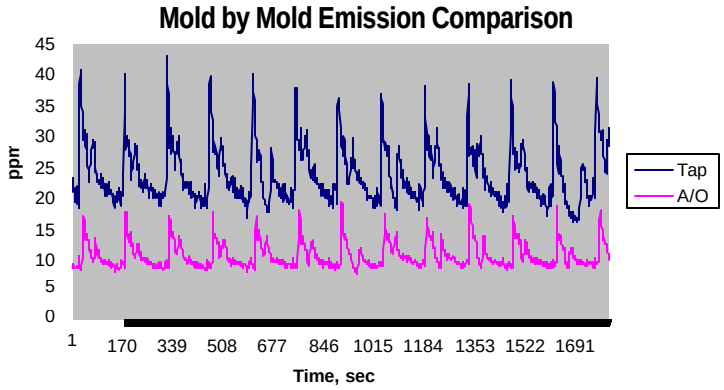
Advanced Oxidation Testing in Greensand

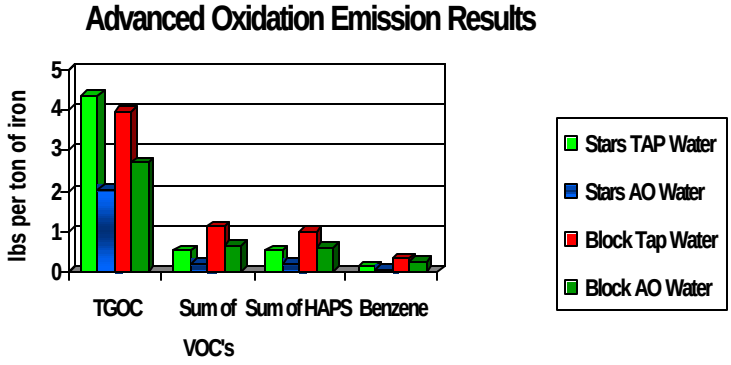
The specific term "Advanced Oxidation" is a generic title used to describe a family of processes that have been in use in the industry for many years.

- Oxidation is a chemical process that uses an oxidizing agent (an oxidant) to change the chemical nature and /or properties of materials. A common example would be the use of laundry bleach such as CLOROX® to bleach (oxidize) the materials that cause stains on white clothing. The stains, the colored materials, are decolorized by the bleach and may also be destroyed by the bleach.
- Advanced oxidants are very strong oxidizing agents that are designed to destroy (oxidize) any organic compound that they encounter.
- One specific advanced oxidant is a chemical called a "hydroxyl radical" that forms spontaneously when hydrogen peroxide and ozone are added to water. The formation of the hydroxyl radical is enhanced by exposing the water to ultraviolet light. Other forms of energy such as ultrasonics have also been used.

Six tests were performed in the Pre-Production foundry using various combinations of greensand clay additives with and without Advanced Oxidation (AO) water. This series involved making new sand mixes (virgin, immature sand) and pouring a series of greensand molds. There were no major air emission differences noted between tests conducted with AO water and tests conducted without AO water. This was attributed to the fact that virgin materials did not have the capacity to absorb the AO water.



One test was run in the Production Foundry with AO water and a mature sand system. The decision to run this test in the Production Foundry was based on results from a Pre-Production Foundry test (performed under a prior US Air Force contract) that showed a 30% reduction in HAPs. The figure above shows mold by mold emission reduction between Tap and AO in Pre-Production Foundry tests. The Production Foundry test showed a 64% reduction in HAP emissions compared to tests conducted with tap water with no cores and a 30% reduction with block cores. The figure following illustrates the tap water vs. AO



4. CERP Achievements

real time test results during pouring, cooling and shakeout in the Production Foundry.

GMBOND® - Development of New Product

The requirement was the development of low air emission binder system that presently is not commercialized. A unique core blower, designed for GMBOND®, was purchased for this subtask and installed at General Motors Saginaw Malleable Iron plant.

Testing on the largest core in the GEN IV precision sand package was started to improve production capability of the process.

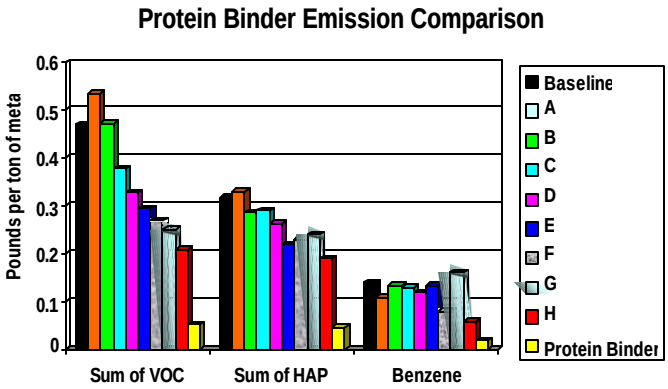
It required the development of a low air emission binder system that presently is not commercialized. The first binder system selected is a protein based binder system that required the purchase of a special purpose Core Blowing System. A Core Blower produces the sand cores that are used to produce the inside or outside surfaces of a casting during the pouring of molten metal. Previous emission testing at CERP showed that protein binder to be the lowest emitting system tested to date. The chart below shows the emission results of the protein binder compared to other conventional binders.

To resolve the production problems, a complete new process needed to be developed. The components of equipment required to perform this project begin as standard equipment designs. However the process required design modifications and operating parameters not utilized by any existing equipment manufacturer. This Core Blowing system consists of the following pieces of equipment integrated together and modified for testing:

- Sand receiving hopper
- Mixing equipment with sand cooling system
- Mixed sand aging hopper
- Seacoal sand mixer prior to charging core blower
- Actual Core Blower, with chilled storage hopper and hot air purge

The process being tested is unique because it uses a heated core box and hot air to dry a water-based binder versus the usual solvent-based chemical binders commonly utilized in cold box core production.

The CERP Steering Committee recommended that the development would be best if done at an operating foundry that would be able to test the new protein binder core packages against the standard core packages. Since GM has both cold-box-binder



tooling (which would not fit Technikon core blower) plus the Cosworth pouring furnace needed, GM volunteered to allow this equipment to be installed and tested at its Saginaw Malleable Iron (SMI) foundry. This testing will require multiple phases over the period of performance (up to 2 years) to refine this low emission innovative binder technology so that it is competitive with existing manufacturing methods. Parameters that need to be determined between cold box process and the low emission protein binder are: a) casting quality, b) production cycle time, c) process operating cost, and d) environmental impact.

GM Bond Machine during testing

The Core Blower was purchased from FATA, delivered to SMI in Mid-August of 2003 and installed by the end of November '03. Testing of the equipment and first phase of production testing were started under the 2003 Army contract but actual results will be reported later in 2004.

Acoustic Stimulation of Molten Metal

A study was completed to determine the results of acoustic stimulation of aluminum castings as they are solidifying. The castings were poured in phenolic urethane No-Bake molds as shown below. The objective of this test was to determine if acoustic stimulation during solidification promoted improved feeding of the metal to remote portions of the casting or improved internal feeding of the casting from the riser to reduce porosity.

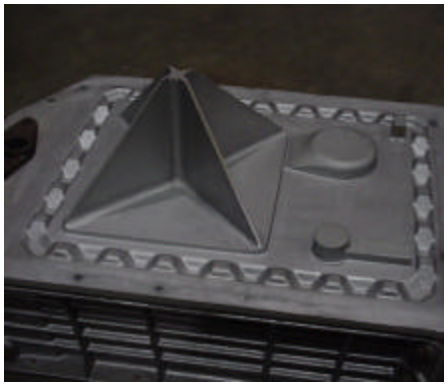
A pattern was made as a star casting that had progressively thinner fin sections on the drag (bottom) pattern half. Eight (8) pairs of No-Bake molds were poured with A-356 aluminum. One (1) of each pair was stimulated with resonant frequency acoustic energy while the other was not. Eight (8) pairs of the molds were poured to develop a methodology that, based on the results, optimized the opportunity to provide acoustic energy at critical periods of cavity filling and solidification.

Stimulation of Mold

The metal was poured at a temperature where success would be marginal

4. CERP Achievements

so as to demonstrate whether the acoustic stimulation was having an effect on the filling and feeding characteristics.



Variable Wall thickness Star Pattern

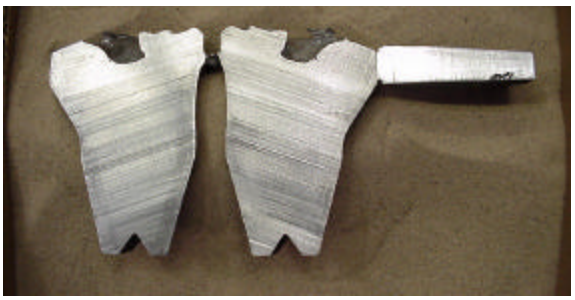
The castings were instrumented with thermocouples to monitor the solidification. The pairs of molds were poured sequentially from the same heated ladle in order to make the pouring conditions as identical as possible. The castings were sectioned through the various riser configurations and along the casting feed path leading to the heavier section in the center of the casting. There was some indication that the solidification in the casting was delayed by acoustic stimulation.

This testing failed to demonstrate that acoustic stimulation promoted better metal feeding capability by acoustic thermal pumping and/or acoustic breakdown of dendrite growth.

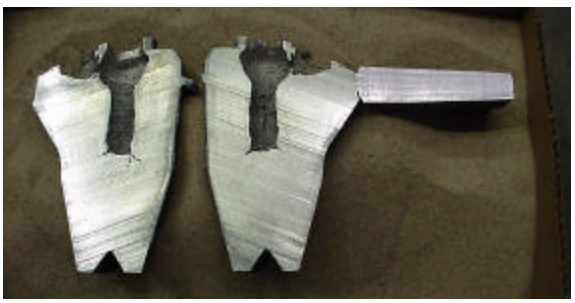
The risers on the acoustic stimulated casting contained less metal – indicating metal was displaced by the acoustic stimulation probe. This displaced metal translates to less energy being used to produce the test casting. All castings were free of internal porosity throughout the feeder to the casting center, showing this decrease in metal in riser didn't affect the casting quality.

FG006P (top) had a vented riser. The cavity for the tip of the stimulating rod is apparent in FG006S (bottom) and demonstrates where the rod was at the end of the riser solidification. This demonstrates the potential of using stimulation to reduce the amount of metal in risers, therefore saving energy used in melting. At the end of pouring the riser cavities were initially full. Except for the small shrinkage cavity, the porosity free nearby casting, neck, and riser are evidence of the correct solidification order. The shrinkage in the castings, however, is evidence that the up-side-down riser, as the metal source, had inadequate head pressure. The risers froze off from the center of the castings before

Risers and Gating Connections to Castings



FG006P



FG006S

the casting completely froze causing the castings to feed upon their selves.

Conclusion: Acoustic stimulation showed promise in reduction of riser size on aluminum casting which would reduce the energy and air emissions from melting excess metal.

Process Variability Study

Testing was done to determine the "Effects of Foundry Process Variables on Organic Emissions from Greensand Molds". The goal of this study was to determine the main drivers of air emissions in greensand molding. A report was issued in December 2001, co-authored by Technikon and KERAMIDA Environmental. Items having major effects included: combustibles in the system, pouring temperature, and the surface area of casting. The following variables were tested:

- Shape/surface area
- Volume to surface area ratio
- Weight of sand
- Weight of casting
- Temperature and type of metal poured
- LOI of the mold
- Moisture content
- Clay content

The test series results determined that:

- The emissions are driven by the sand temperatures reached throughout the mold (Figure A).
- The pattern geometry contributes to the amount of emissions (Figure B).
- The emissions are increase with cooling time in the mold (Figure D).
- The emissions are proportional to the metal-mold surface area of the casting (Figure B).
- The emissions are proportional to the amount and type of organic material in the mold; LOI in greensand (Figure C).
- The sand to metal ratio is not a driver, but a rough index of the more fundamental sand temperature mold-metal contact surface area, and metal weight.

The following charts show some of the results of this testing:

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Figure A - THC Emissions for: Metal Pouring Temperature for

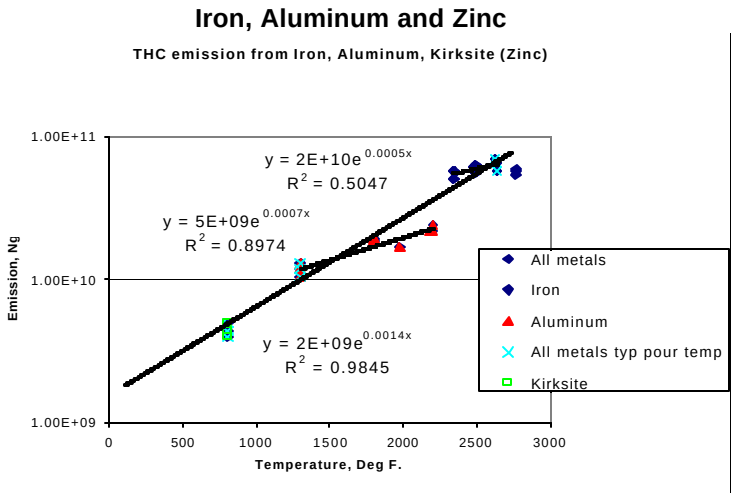

Figure B - Emissions Relative to Surface Area with Constant Casting Weight

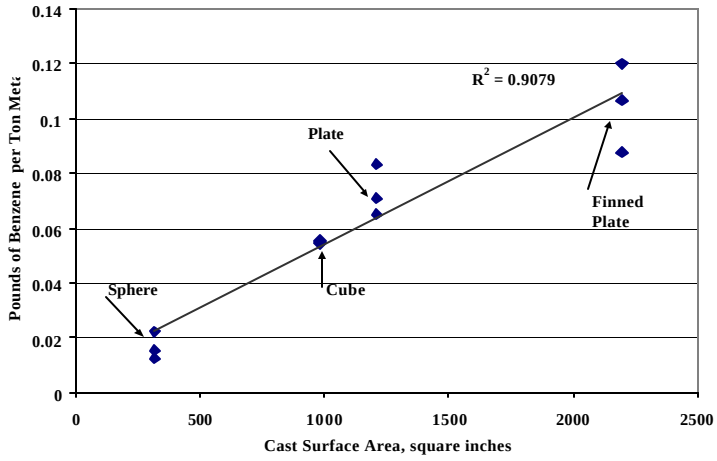

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Figure C - Mass 78 (Benzene Emissions for Variable % LOI

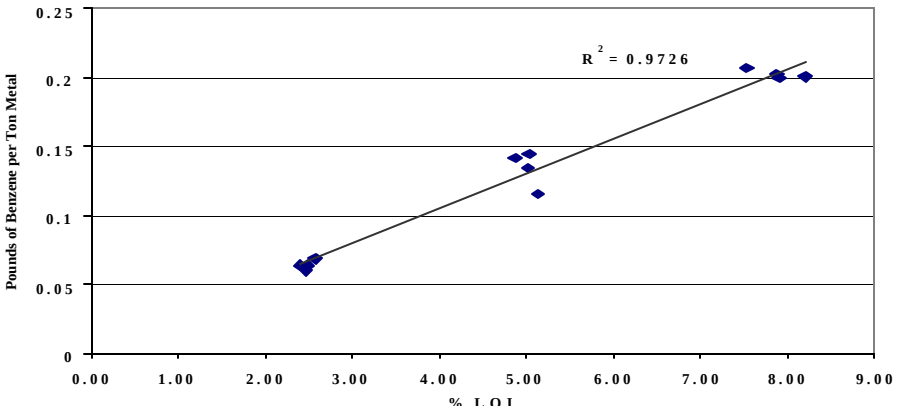
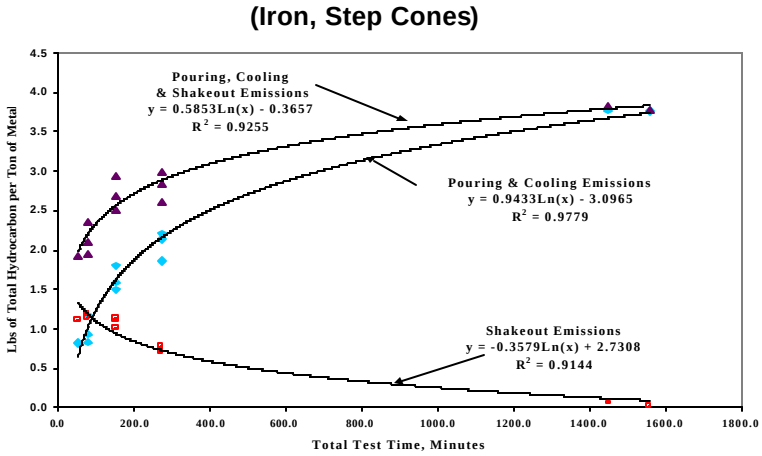


Figure D - Total Hydrocarbon Emissions for Variable Cooling Times



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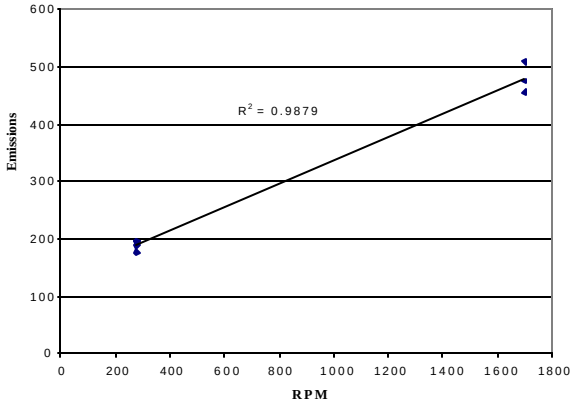
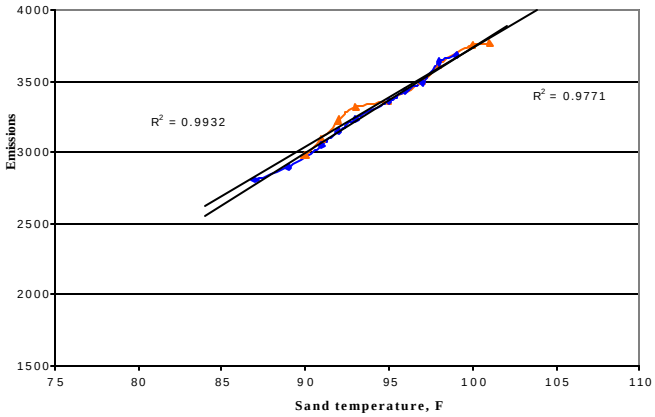
Core Room Variability Study

Cold Box is the term given to those core - making processes that use dry sand, a chemical binder and a gaseous chemical catalyst instead of heat to initiate the cure of the binder system. The predominant binder chemistry used involves the reaction of a phenolic resin with a polymeric isocyanate. This reaction of a phenolic resin with a polymeric isocyanate produces a polymer that is referred to as a phenolic urethane. The primary Cold Box catalyst used is triethylamine although other tertiary amines such as dimethylethylamine and dimethylisopropylamine are also used.

Variable Mixer Speed



Variable Sand Temperature

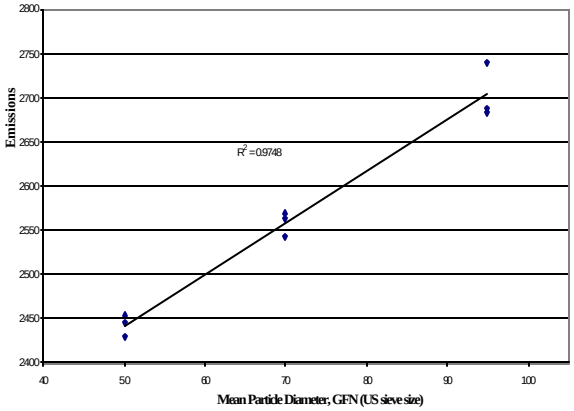


from phenolic urethane binder sand mixing are proportional to the sand temperature, the mixer speed that affects the velocity of the air movement over the uncured binder coated sand particles, and the surface area of the coated surface represented by the sand particle size.

Sand Mixing

The following three (3) figures show that the emissions

Variable Sand Particle Size



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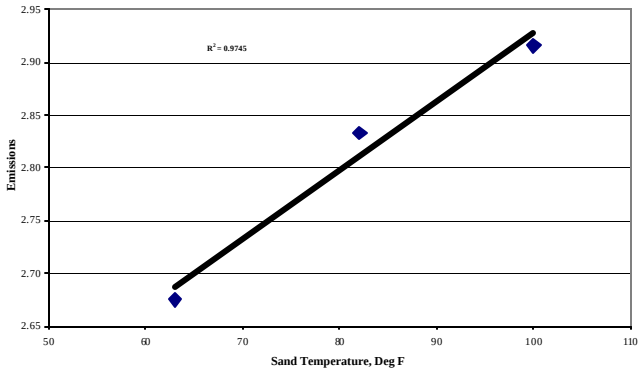
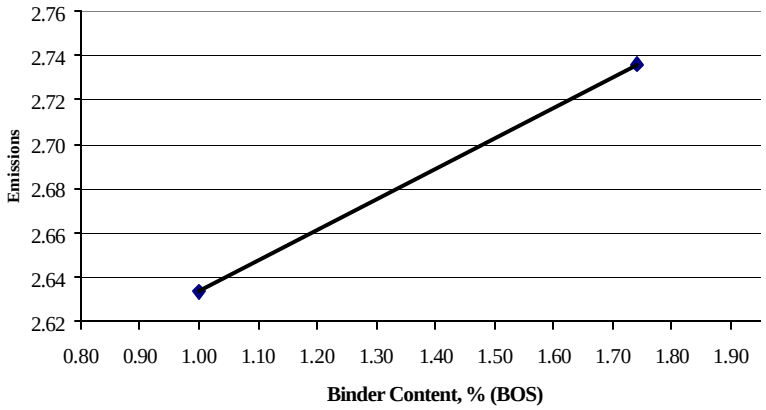
Core Making

The following figures show that emissions during core making are proportional to the temperature of the sand in the core box, the amount of binder that is coating the sand, and the grain fineness of the sand (particle size). The blow and purge temperatures, pressures and durations do not have a significant effect on the core making emissions because the sand is contained in the core box in such a manner as to restrict the blow and purge flow rates.

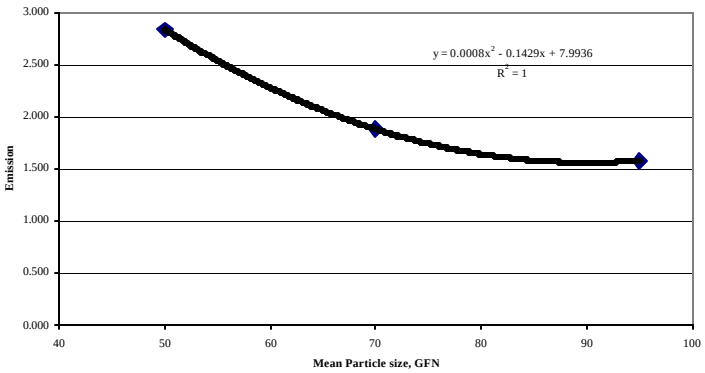
Variable Sand Temperature



Variable Binder Content



Variable Sand Particle Size



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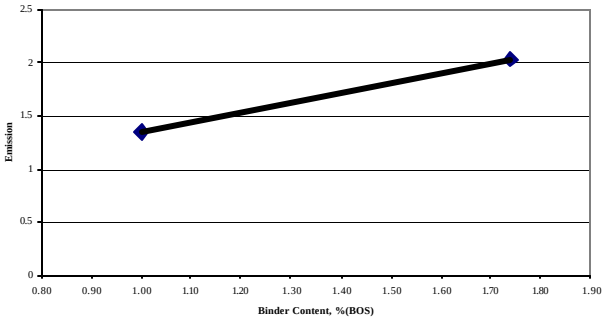
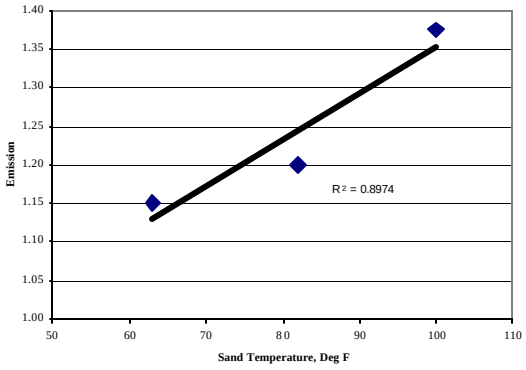
Core Storage

The following Figures show that the emissions during core storage are proportional to the amount of binder in the core and the temperature of the core. However, the increase in emissions due to higher sand temperatures in core storage (0.6%/deg.) is approximately one third (1/3) of the increase that might be predicted by the emissions increase measured during the mixing portion of this study (1.7%/deg). This suggests that emissions during core storage may be controlled by mechanisms other than the vapor pressure of the binder organic solvents. Further testing showed that sand particle size also affected emission rates during storage.

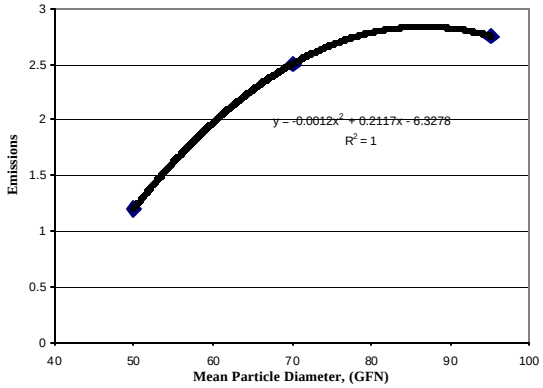
Variable Binder Content



Variable Sand Temperature



Variable Sand Particle Size



Knowledge Transfer and Outreach

The objective of this subtask sought to develop and deploy key information and knowledge that was gained as a result of CERP activities. The following was accomplished under this task.

- An introductory training program for air emission measurement was developed. The program was presented to students, government and industry representatives.
- Several articles were written to deploy information from selected research activities from other Subtasks, and submitted to the Contracting Organization for approval to publish.
- Under this task, a World Wide Web site was established, updated, maintained and populated with reports and presentations that were produced under this Task Number.
- Also under this task, numerous presentations on Emission Measurement were produced to present at conferences.

The CERP program sought to proactively provide Technology Transfer, Knowledge Transfer and Outreach to the Department of Defense (DOD), the Environmental Protection Agency (EPA), the Department of Energy (DOE), the metal casting industry, and other stakeholders to share the results of the CERP research effort. Technikon personnel presented papers at Industry and DOD conferences (such as the American Foundry Society (AFS) Environmental Health and Safety Conference and the Defense Manufacturing Center), exhibited at conferences, and participated in Industry and DOD workshops, seminars, technical conferences, and standards committees. Technikon also provided access to results of the research effort by maintaining a website with both secure and public sections on the World Wide Web.

With input from the Contracting Officer's Representative (COR) and the CERP Steering Committee, Technikon identified opportunities for outreach so that the CERP would be better and more widely known among potential stakeholders.

The availability to the public of technical reports delivered under this and previous contracts has also widened the understanding and knowledge of ERP. To date, numerous professionals that have not been involved in CERP have accessed the public web site and downloaded the reports. New stakeholders have been identified and added to the CERP mailing list, resulting in more participation in the CERP meetings and its research activities.

Technology and Knowledge on the Web

In its implementation of CERP, Technikon updated the Technikon worldwide web site (www.cerp.us.com) which hosts the repository for publicly available technical papers, reports, results and test data, and other information pertaining to the CERP and its activities.

Forty-two reports were approved for unlimited public distribution through a

4. CERP Achievements

process recommended by the CERP Steering Committee and approved by the Contracting Officer's Representative.

Other activities also occurred on the Technikon web site. These included the following:

- Completely redesigned and reformatted the web site to allow more updatable pages for current events, articles and related outreach information.
- Updated the format to make the web site more user-friendly.
- Advertised the 2003 Casting Requirements Forum and provided on-line registration capability.
- Posted 2003 Casting Requirements Forum Presentations.
- Updated links to related web sites.
- Advertised upcoming CERP Quarterly meetings.
- Added space in secured area for FY2002 Task deliverables.
- Added space under downloads for unlimited public access to approved reports delivered under Task N256, FY2002 Tasks, and future Tasks.
- Finally, Technikon conducted seminars, made presentations and attended conferences and workshops regarding CERP and its research.

Casting Requirements Forum: The Future of the Casting Industry

CERP held a Casting Requirements Forum in January 2003 in Sacramento, California. The purpose of the Forum was to bring together diverse groups of users and manufacturers of castings. The Forum sought to gain insight into the future casting needs of the casting industry and the requirements of the Department of Defense and to discuss where there might be gaps in research and technology.

The Forum identified the following needs and challenges:

- ***Competition*** from other countries, especially developing countries, and the uneven environmental regulations that are costly to US foundries.
- ***Education*** and awareness of the general public of the importance of the casting industry to the US economy
- ***Environment*** issues and pressures from OSHA and US EPA, especially the Iron & Steel MACT, will put the American casting industry at a disadvantage to offshore castings. What are needed are rational solutions and ways to reduce compliance costs.
- ***Image*** of the casting industry must be improved through public relations regarding the applicability and importance of our industry. The casting industry needs better lobbying in Washington to promote the long term success of the industry in the United States.
- ***Production*** needs to be improved to make castings at lower cost and improved processes that increase quality and profitability.
- ***Research an Development/Technology Transfer*** will require more collaboration between researchers and industry. Partnerships need to be developed with research organizations, universities and trade associations

- ***Lightweight Casting Efforts*** are needed for the Department of Defense with titanium. Other efforts should be in improved aluminum alloys, magnesium and thin wall iron.

Capabilities and Technologies

This section presents the Casting Emission Reduction Program's technical capabilities and discusses some of the technical process and products developed as part of CERP's activities.

CERP has conducted pioneering research regarding molding processes and emissions reduction.

During the course of the program CERP has assembled an elite team of engineers, chemists, scientists, managers, production workers, maintenance staff, and other experts. Their skills and abilities effectively interface with program needs and contribute at every level to the overall success of CERP.

New Emissions Capture and Sampling System

A new Emission Capture and Sampling System was developed to replace the unit that was in Building 243. This hood is made of two layers of stainless steel and the hood is insulated. This design has improved efficiency and requires fewer man-hours for cleaning. The hood touches the ground, but has six-inch channel plenum that controls airflow. This enables the CERP team to see smaller differences in airflow and temperature and have better control.

New Hood & Sampling Site

4. CERP Achievements

Pre-Production Green Sand Molding

When the preproduction foundry moved to one building, major changes were made in the green sand mold system. Two Osborne 716 jolt squeeze machines were obtained and rebuilt. Star patterns were built 4-on. The flask size is 24”x24” 10”/10”. This pattern will be used to evaluate green sand mixes. A 4-on step cone pattern was built for core binder evaluations. This new preproduction foundry more closely duplicates foundry operations and with the smaller green sand requirements, more sand turns per time frame will be possible.

Jolt Squeeze Machine

New Testing Equipment

- For testing support
  - Total Hydrocarbons (THC)
  - Carbon Monoxide and Carbon Dioxide Monitors
  - Three (3) Sampling Trains
  - Electronic Micro Manometer, National Institute of Standard Technology (NIST) traceable
- Method development, Enhancement, Validation
  - Gas Chromatograph (GC) with Auto Sampler
  - GC with Mass Selective Detector and Auto Sampler
  - Total Hydrocarbons (THC)
  - Gas Dilution/Mixing System, NIST traceable

Total Hydrocarbon Analyzer

Emissions Measurement Review

The Clean Air Act Amendments (CAAA) of 1990 promulgated a list of 188 organic and inorganic compounds and identified them as Hazardous Air Pollutants (HAPs). The CAAA also required the USEPA to promulgate regulations that limit the amount of HAP emissions from a facility. The accurate measurement of HAP emissions from facilities, including foundries, depends on sampling and analysis methods accepted by the USEPA. Accurate measurement is critical in order for facilities to comply with permit limits and for regulatory agencies to enforce requirements. Emission test procedures used by foundries need to be verified for accuracy and repeatability.

The key accomplishment of this task is the identification of organic HAPs of interest to the foundry industry and the determination that none of the methods have been verified in the foundry environment. The following table below forms the basis for the methods the emissions measurement team would develop and or validate. It was necessary to identify HAPs important to the foundry industry before HAP methods could be selected.

4. CERP Achievements

Hazardous Air Pollutants of Interest to Foundries

CAS #	Compound	Method*
75-07-0	Acetaldehyde	V1
107-02-8	Acrolein	N
79-10-7	Acrylic acid	N
62-53-3	Aniline	P
71-43-2	Benzene	V1
92-52-4	Biphenyl	V1
117-81-7	Bis(2-ethylhexyl)phthalate	V2
463-58-1	Carbonyl sulfide	P
120-80-9	Catechol	P
1319-77-3	Cresols/Cresylic	V1
95-48-7	o-Cresol	V1
108-39-4	m-Cresol	V1
106-44-5	p-Cresol	V1
98-82-8	Cumene	V1
132-64-9	Dibenzofuran	V1
84-74-2	Dibutyl phthalate	V1
121-69-7	N,N-Dimethylaniline	V2
131-11-3	Dimethyl phthalate	V1
140-88-5	Ethyl acrylate	P
100-41-4	Ethylbenzene	V1
50-00-0	Formaldehyde	Y/P
110-54-3	Hexane	V1
7647-01-0	Hydrogen Chloride	V1
7664-39-3	Hydrogen fluoride	P
78-59-1	Isophorone	V1
67-56-1	Methanol	V1
78-93-3	2-Butanone	P
108-10-1	Methyl isobutyl ketone	V1
624-83-9	Methyl isocyanate	V1
101-68-8	4,4'-Methylenediphenyl diisocyanate	P

4. CERP Achievements

Hazardous Air Pollutants of Interest to Foundries

CAS #	Compound	Method*
101-77-9	4,4'-Methylenedianiline	P
91-20-3	Naphthalene	V1
108-95-2	Phenol	V1
106-50-3	p-Phenylenediamine	P
75-44-5	Phosgene	P
123-38-6	Propionaldehyde	V1/P
100-42-5	Styrene	P
1746-01-6	2,3,7,8-Tetrachlorodibenzo-p-dioxin	V1
108-88-3	Toluene	V1
121-44-8	Triethylamine	N
1330-20-7	Xylenes	V1
95-47-6	o-Xylene	V1
108-38-3	m-Xylene	V1
106-42-3	p-Xylene	V1
	Polycyclic Organic Matter4	P

*__Y__=yes, __N__=no, __P__=proposed,
__V1__=verified ±30% RSD, __V2__=verified ±50% RSD

4. CERP Achievements

Related Foundry Process Improvement

Large quantities of spent sand are sent to a local landfill from the CERP foundry operations. This results in increased impact to the environment from the transportation and disposal of spent sand to a landfill. This "Alternate Uses of Sand" research and its accompanying report evaluated the foundry's spent sand under current California and Federal regulations, identified options and local markets for beneficial reuse of the sand, and chose one beneficial reuse option, daily cover for a landfill, to fully develop as a reuse strategy.

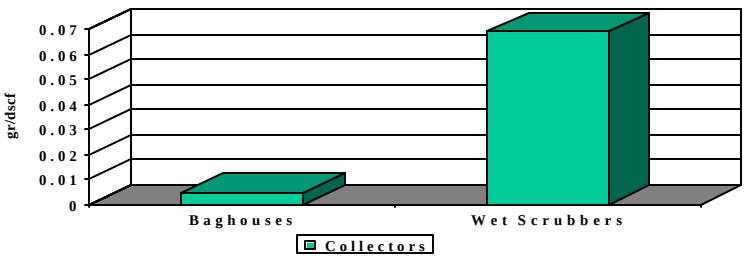
This research resulted in a greater understanding of the regulatory requirements and local options for beneficial reuse of foundry sand. This research will aid the CERP Foundry in determining its options to beneficially reuse its spent sand. In addition, other foundries will find the research useful in establishing or evaluating their own beneficial reuse program for sand.

Additionally, worker exposure sampling was performed in the core production area of the CERP Production Foundry. The monitoring was conducted while making cores using the baseline resin (the "typical" resin used by many foundries in the United States). Sampling was performed for selected organic contaminants of concern for all job functions in the core room. This was done to establish a baseline exposure to organic and inorganic irritants against which future "low emission binders" can be compared.

Emission Control Technology

During April 2001 CERP evaluated existing and new emission control technologies for the reduction of air emissions. The complete report is posted on the CERP website. The CERP team collected data and conducted a literature review to determine the ability of wet dust collectors and dry dust collectors on Cupola melting facilities to meet the new MACT regulations for Iron and Steel Foundries, as required in the 1990 Clean Air Act. Information gathered from this subtask indicates that wet collection systems on Cupolas cannot meet the MACT standards set by the 1990 Clean Air Act. A majority of the dry collectors could meet this standard. The figure below shows the average particulate emissions from Baghouses

Average Cupola PM Emission by type of Control Technology



EPA Proposed limit is .005 gr/dscf

compared to Wet Scrubbers.

Additionally, the CERP team conducted a literature review of alternative collections systems that have the potential to meet the new MACT air emission limits. The Cloud Chamber Technology utilizes a mist chamber that contains electro statically charged water particles to remove fine particulates and gasses associated with pouring, cooling and shakeout operations. This system may need to be accompanied by pre-filter to remove large particles (above 30 microns), which are associated with foundry operations. The Cloud Chamber Technology is an alternative that needs further review and testing to determine its viability.

System Integration and Validation Lab Cost/Benefit Analysis

The objective of this Cost Benefit Analysis (CBA) was to evaluate the costs vs. benefits for establishing a systems integration and validation laboratory (SIVL) for the casting industry that would, 1) provide the industry with low cost and accurate emissions monitoring techniques as necessary to effectively meet current and future emissions standards and, 2) establish a centralized capability for the development, systems integration, validation and certification of emissions measurement techniques.

The results of the cost-benefit analysis encompass fiscal years 2004-2007. The industry benefit accrued during 2004-2006 was determined by totaling the estimated industry cost with SIVL and the successful implementation of 2nd generation Continuous Emissions Monitoring Systems (CEMS) and subtracting that total from the costs associated with current CEM systems. It is concluded from this analysis that the industry could save up to $21.3 million/year during 2004 – 2006 if the benefits for the establishment of the SIVL are fully realized. If 3rd generation CEMS capabilities can be successfully developed and implemented by 2007, then the savings to the industry could be as high as $36.9 million.

CERP is setting the new standard for air emissions measurement technology.

4. CERP Achievements

Real-Time Emissions Measurement

The goal of this study was to begin the development of an empirical database relating the molecular structure of a volatile organic compound (VOC) with its response in a flame ionization detector (FID). A FID was set up and calibrated in accordance with Method 25A with propane in air. A series of aliphatic and aromatic hydrocarbons standards and one tertiary amine standard of known concentrations were then analyzed by the FID in replicate. Average responses were converted to relative response factors with propane assigned the value of one (1.00). Relative response factors for the compounds studied ranged from 0.36 to 2.97.

Values greater than one (1.00) show the magnitude of the over estimation (positive bias) if the samples gas streams is comprised the specific compound listed. Values less than one (1.00) show a corresponding under estimation.

Additional work must be conducted to determine the interactions in mixtures, if any, and to expand the empirical Relative Response Factor (RRF) database to include other compounds of interest to the metal casting industry such as phenols, alcohols, other aliphatic amines, aromatic amines, aldehydes, esters, and carboxylic acids.

The results clearly show the dependence of FID response on the molecular structure of the organic compounds in the samples emissions. Correcting Method 25A data collected at working foundries will result in more accurate estimates of the VOC content of their stack emissions.

California Foundry History Museum

Located alongside CERP's Production Foundry at McClellan Park (*formerly McClellan AFB*) is the California Foundry History Museum. The museum was developed by the California Foundry Institute in cooperation with the California Cast Metals Association and CERP. It presents a view of the role foundries played in American history, while focusing on the casting industry's role in shaping California.

Exhibits include:

- The four basic steps in the casting process: pattern making, molding, pouring, and finishing
- The industry's role in the transportation industry, from wood burning locomotives to autos, trains and planes, to the space shuttle
- How the industry contributed to the Gold Rush by making mining equipment and perfecting new methods of water-powered energy
- How metal castings helped Californians control water for flood protection, drought, agriculture, and hydroelectric power
- How foundries, the nation's first recyclers, converted millions of tons of scrap into useful castings while saving valuable landfill space

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Appendix A CERP in the News

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BASE WELCOMES CLINTON

McClellan AFB Newspaper
Published October 3, 1993

Thousands Attend Rally

By SSgt. Becky Leviner
Assistant editor

Applause and sign-waving greeted President Clinton as a crowd of about 7,000 base and community members welcomed him to Sacramento Sunday.

President Clinton spoke briefly to the standing room only audience at McClellan AFB's aircraft maintenance hangar, in an address punctuated often by cheers and applause.

"It's wonderful to be here in Sacramento and it's great to be here at McClellan AFB," he said, acknowledging the enthusiastic crowd of base and community members.

In his remarks, he noted the important and vital research being done at McClellan, both singularly and in partnership with civilian industry, particularly in the environmental arena.

"We have had a groundbreaking ~ research plan involving our research labs, military facilities and the big three automakers to triple the fuel efficiency of our automobiles in the next decade," he said.

The president also touted a "technology reinvestment program to convert defense technology to either dual defense and commercial or purely commercial uses.

"This is something you are doing here," he told the crowd. He pointed to the recent new joint partnership to develop electric cars, "and taking advantage of dual use technology right here at McClellan."

The president also cited the clean -up efforts at McClellan. He acknowledged the partnership formed between the base, state and federal environmental protection agencies. "By streamlining government and
working together, you have performed a clean-up that under the old rules would have lasted six years and cost $10 billion, but you did it in eight weeks and at a fifth of the cost.

"And we intend to do that allover: -America," he said.

"I see some of the work being done here at McClellan is to develop dual use technologies. That means the people here have decided that change will be our friend and not our enemy," he said.

Gen. Ronald Yates, AFMC commander, (left) and his wife Constance, along with Maj. Gen. John. F. Phillips, SM-ALC commander, (below) with his wife, Blanche, and Rep. Vic Fazio, D-West Sacramento, greet President Clinton upon his arrival to McClellan Sunday.

Maj. Gen. John F. Phillips, Sacramento Air Logistics Center commander, said his base shares the
President's vision of a strong defense and a strong economy.

"We at McClellan and the Sacramento community are aggressively pursuing your vision for we are indeed a team," he said.

Gen. Ronald W. Yates, commander, Air Force Materiel Command, briefed the president on innovative technologies being developed here and at other centers. Yates also presented the president with a replica of the F-117 Stealth fighter.

Yates said AFMC's commitment to meeting advanced technology goes "beyond building and sustaining the world's most respected Air Force; it means taking up the president's challenge to solve the tough problems facing our society today.

"We're doing this by working closely with partners in industry and academia, to transfer into the civilian sector technology that the Air Force has developed which can be applied to- ward solving nonmilitary problems," Yates said.

Following his speech, Clinton viewed displays showcasing McClellan's technology and programs.

Congressional representatives accompanied the president on Sunday included Rep. Vic Fazio D-West Sacramento; Rep. Robert Matsui: Sacramento; and Rep. Dan Hamburg, D-Ukiah.

Congressman Fazio represents the majority of McClellan's; employees who live within district.

Clinton in Capital

Sacramento Bee
Published on October 4, 1993.

Tells McClellan State will be Key

By Cynthia Hubert
Bee Staff Writer

President Clinton tossed an economic life jacket to Californians Sunday at McClellan Air Force Base, pulled just a few months ago from the brink of closure.

In a sweltering hangar with a Stealth fighter in the background, Clinton spoke from a makeshift wooden platform to about 6,000 people, telling them the government will look toward California as it studies ways of jump-starting the nation's economy.

He praised the successful campaign to spare McClellan from the most recent round of base closures, but made no direct references to its future.

Instead, he drew on a general theme of "security."

"I am reminded on this day, because of the events in Moscow and in Somalia, that we still live in a dangerous world," Clinton said.

"One of the hardest things we have had to learn as a people in the last few years is that there is now no longer an easy division between our national security at the end of the Cold War abroad and our economic and social security here at home."

Foundry Emissions Target of Joint Program

By Robert Parker
Staff Writer

Americans can expect cleaner air around traditionally noxious foundries If Congress approves $40 million to fund a history making government-industry research program.

Big Three automakers, Chrysler, Ford and General Motors have agreed to work with engineers and scientists at the Air Force Advanced Manufacturing Technology Center (AMTC) in California to develop new procedures, processes and materials in the foundry casting process.

America's foundries represent a $30 billion industry and 300,000 jobs, but their numbers are shrinking due to restrictive legislation and foreign competition. More than 1,000 foundries have been forced to close or move offshore in the past two decades, and over 40 percent of the nation's casting needs are imported.

Ford Motor Co.'s Dr. Dennis Schuetzle, a research laboratory manager, was a key part of the Big Three team which worked to forge an agreement with government.

Schuetzle believes that control of this basic industry is critical for) U.S. competitiveness - especially in the U.S. auto industry.

"We worked for five years during the '70s looking for ways to control foundry casting emissions with only limited success," he r said. "This new agreement will reinvent the entire process."

Currently, there are no cost-competitive, environmentally safe, foundry casting processes that will meet the needs of the '90s.

According to Schuetzle, the program will approach the problem by concentration on new processes,, identifying target sources of emissions, evaluation existing technologies to control gaseous and particulate emissions while optimizing new processes and material to approach zero impact on the environment.

The agreement breathes new life into McClellan Air Force Base, where most of the research will take place. The base was on the Clinton Administration's list of military facilities to be closed this year, and the five-year project has the potential for creating 180 jobs.

Schuetzle believes the agreement is an example of the govemment's effort to redirect the Department of Defense toward private industry. "McClellan is a key facility in this country for the development of this technology," he said.

After numerous meetings during the past year, we are convinced that McClellan has the technical capability, facilities and; personnel required to support this development project."

Currently, McClellan operates a foundry under the increasing environmental statutes of the California Air Resources Board (CARB).

Schuetzle sees several benefits resulting from the project including increased competitiveness of the domestic auto industry through more efficient foundries. This competitiveness, he points out, will result in a reduced flow of work offshore and loss of domestic jobs.

Schuetzle said overall program costs are expected to be lower because of the use of an existing operational Air Force foundry.

Also involved in the project are Dr. Jerry Rogers, a research laboratory manager for GM and Chrysler Pollution Prevention Manager Mark Bindbeutel.

THE PRESIDENT IN SACRAMENTO

Forging alliance for pollution-free future

Sacramento Bee

Published on October 4, 1993

Compiled by Public Affairs

McClellan AFB and U.S. auto industry forged an alliance in a ceremony held Monday to research and develop methods for producing pollution-free metal castings.

The Memorandum of Understanding was signed at McClellan's foundry by members of the U.S. Council for Automotive Research, Sacramento Air Logistics Center and the California Office of Research and Technology Application.

The partnership's objective is to produce a cost-effective steel foundry at McClellan with -near zero impact on the environment, and then to apply the techniques and technologies to the domestic automobile industry. In addition to the facilities on base, McClellan also provides a skilled workforce and a link to Air Force and other federal laboratories.

Officials view this casting emission reduction program as a strong impetus toward reducing the country's reliance on foreign nations that are currently producing more than 40 percent of U.S. domestic casting needs because the nation's foundry industry has been unable to conform to environmental requirements.

"This Memorandum of Understanding establishes the basis for joint research and development efforts which could help to reignite the metal-casting industry in the United States while meeting the tough environmental standards needed to preserve air quality," said Dr. Dennis Schuetzle, spokesperson for the Environmental Research Consortium, a subsidiary of USCAR.

Schuetzle explained that private-sector time and facilities for laboratory research and development operations are limited. But, "McClellan AFB's technology and facilities are ideally suited to support this effort."

Since McClellan has the research and development capability to produce environmentally acceptable foundry products, development costs would be minimized.

This type of alliance between industry and defense at McClellan is an ongoing goal of both the commander of Air Force Materiel Command, Gen. Ronald W. Yates, and Sacramento Air Logistics Center Commander, Maj. Gen. John F. Phillips.

"This is another step forward in McClellan's aggressive pursuit of the dual use of our unique facilities, skills and technologies with civilian industry ," said Keith Dumas, center executive director. "I am convinced that if we continue to seek out opportunities to develop our plans for defense conversion along these dual-use lines, we will cultivate skills and abilities within our own communities for our mutual advantage."

Schuetzle and Dumas were joined in Monday's ceremony by numerous base, local and state government officials, including Rep. Vic Fazio, D-West Sacramento, who was instrumental in spearheading through Congress funding totaling $13.5 million in support of the joint venture. The amount is included in the Fiscal 1994 Defense Appropriations Bill.

"This joint venture not only represents another important link between the high-tech capabilities at McClellan and our nation's industrial competitiveness, but also the continuation of a critical mission," noted Fazio.

"This project demonstrates the unique capabilities that McClellan possesses and symbolizes the trend toward greater public-private cooperation in sharing resources and technology to benefit our national security as well as our industrial base," he added. "Ultimately, these combined efforts will lead to a brighter future for McClellan, its employees and the entire Sacramento area."

MCCLELLAN'S PROSPECTS PERK UP

Base May Get Research Effort, 180 Jobs

Sacramento Bee

Published on October 2, 1993

By Clint Swett
Bee Staff Writer

A consortium of major U.S. automakers and the Defense Department plans to set up a $40 million metal manufacturing research project at McClellan Air Force Base that could result in up 180 new jobs over the next five years.

Financing for the first year of the program amounting to $13.5 million is included in the House version of the defense budget. It must still be approved by a House-Senate conference committee but is expected to face no significant opposition, according to a spokesman for Rep. Vic Fazio, D-West p Sacramento.

Fazio, who inserted the appropriation into the budget, plans to of announce the program at a news conference at McClellan on Monday.

The project is seen as a way to make McClellan more valuable as both a military and commercial facility, bolstering local arguments for sparing the base during the next round of base-closure decisions.

The appropriation would finance research into ways to reduce air pollution generated by the metal casting process, which is used to make engines, transmissions, axles and other heavy auto components.

Industrial emissions must be reduced dramatically 1996 to comply with federal clean-air laws, said Tim Terry, a legislative aide to Fazio.

Reducing those emissions and making foundry and casting work more efficient were among 14 technologies identified by the Big Three automakers - Ford Motor Co., Chrysler Corp. and General Motors Corp. - as critical to auto industry competitiveness, Terry said.

He said the automakers had begun to set up their own facility to conduct such research, but it proved unsuccessful.

"They began looking for other places, and the only other place they found with the equipment, the know-how and the personnel was McClellan," Terry said.

The consortium, called the Joint Casting Emissions Reduction Project, would operate out of McClellan's Advanced Technology Manufacturing Center, using both military and civilian workers, and providing new jobs for up to 180 engineers, metallurgists, chemists and foundry workers over the life of the project, Terry said.

It wasn't immediately clear how many jobs might be generated by the first year of appropriations. Approval of funding in future years would be needed bring the total expenditure to $40 million.

The program will be administered by the California Office of Research and Technology Application, nonprofit entity set up specifically to run the project.

In a statement, Fazio said that the foundry business employs more than 30,000 people in the United States, but that during the last 20 years, more than l00,000 foundry jobs have been lost to foreign competition.

"The joint venture will make our domestic producers more competitive and reverse the trend of casting jobs moving overseas," he said.

Fazio already has arranged defense funding for s electric-car research facility at McClellan that could bring up to 600 jobs to the base within the next two years.

McClellan Becoming Smog Buster

The Union

Published on October 2, 1993

.By TAMARA CHUANG
Union Staff Writer

Hundreds of jobs in a politically correct business may be coming to McClellan Air Force Base.

On Monday, govemment and auto industry officials will sign an agreement to research and develop pollution-free automobile castings.

A future with such an automobile would not only augment McClellan's ongoping electric car project, but would fight smog and reduce US reliance on foreign nations for oil, officials said.

About 40 percent of US domestic casting needs are produced in foreign nations because the nation's foundry industry has not met environmental requirements, officials said.

An agreement to begin researching automobile casting will be signed during the ceremony by members from the US Council for Automotive Research -which represents Ford, General Motors and Chrysler - and officials from the Sacramento Air Logistics Center and the California Office of Research and Technology Application.

"This (signing) establish the basis for joint research a development efforts which could help to reenergize the metal casting industry in the United Slates while meeting the tough environmental standards needed to preserve air quality," said Dr. Dennis Schuetzle spokesperson of USCAR.

"But private-sector time and facilities for laboratory research and development operations are limited. McClellan Air Force Base's technology and facilities are ideally suit to support this effort."

Rep. Vic Fazio, D-West Sacramento, who has been instrumental in obtaining federal funding for the project, will oversee the ceremony. Fazio could not be reached for comment.

McClellan in the Car Business

The Union

Published on October 5, 1993

By JOANNE BOYD.. .
UNION Staff writer

An agreement between the big three auto makers and the government to begin development' of pollution-free automobile castings met with enthusiasm at McClellan Air Force "Base.

Locally, the joint research and development project may create as many as 18O Jobs at. McClellan over the next five years. The project also will augment the base's fledgling electric car industry and serve as another step to bring .priv ate industry to the base.

“This, is going to be very good for McClellan,” said Willie Matlock, one of nearly 100 base employees who gathered at the base's foundry to witness the formal signing ceremony, Monday. Matlock works as a molder in the base foundry; casting aluminum into aircraft parts destined for jets such as the A-10, F-111 and F-16.

"Instead of doing all military work, we'll be doing civilian work too. Of course I'll feel like I've been grounded,” he said, alluding to the fact the new project involves automobiles rather than aircraft.

Officials say the agreement between the Air Force and the US Council for Automotive Research, - representing Ford, General Motors, and Chrysler - is essential to reduce reliance on foreign nations in this industry. Although the industry represents, $30 billion and 300,000 jobs in the United States, more than 40 percent of the domestic casting demands are currently supplied by foreign sources - due to US environmental restrictions - and the import percentage is growing.

Rep. Vic Fazio, D-West Sacramento said he was confident the venture would succeed developing not only low emissions metal castings, but also much needed jobs. Most of these jobs will be high-paying positions for metallurgists, chemical engineers, industrial engineers, chemists and foundry workers.

“As for McClellan's future, I believe we need to continue to aggressively pursue dual-use initiatives.. The more work we can pump into McClellan for whatever source, the better we can utilize the facility and increase efficiently,” he said. Ultimately, this will, lead to a brighter future for McClellan, its employees and the entire Sacramento area.

Fazio added funding for the project – an estimated $40 million over five years – looked promising. The first appropriation of $13.5 billion should be signed into law by the president in a couple of weeks. "We're well on our way to proving the resilience and capability of McClellan and that we can make (a product) and still do it in an environmentally sound way."

Joint Effort Cleans Foundry Air with Federal Funds

Oakland Tech News

Published on October 18, 1993

By Robert Parker
Staff Writer

Americans can expect cleaner air around traditionally noxious foundries if Congress approves $40 million to fund a history making government-industry research program.

Big Three automakers Chrysler, Ford and General Motors have agreed to work with engineers and scientists at the Air Force Advanced Manufacturing Technology Center (AMTC) in California to develop new procedures, processes and materials in the foundry casting process.

America's foundries represent a $30 billion Industry and 300,000 jobs, but their numbers are shrinking due to restrictive legislation and foreign competition. More than l,000 foundries have been forced to close or move offshore in the past two decades, and over 40 percent of the nation's casting needs are imported.

Ford Motor Co.'s Dr. Dennis Schuetzle, a research laboratory manager, was a key part of the Big Three team which worked to form an agreement with government. Schuetzle believes that control of this basic Industry is critical for US competitiveness – especially in the US auto Industry. "We worked for five years during the 70s looking for ways to control foundry casting emissions with only limited success," he said. This new agreement will reinvent the entire process.

Currently, there are no, cost competitive, environmentally safe foundry casting processes to meet the needs of the '90s.

According to Schuetzle, the program will approach the problem by concentrating on new processes, identifying target sources of emissions, evaluating existing technologies to control gaseous and particulate emissions, while optimizing new processes and material to approach zero impact on the environment.

The agreement breathes new life Into McClellan Air Force Base, where most of the research will take place. The base was on the Clinton Administration's list of military facilities to be closed this year, and the five-year project has the potential for creating 180 jobs.

Schuetzle believes the agreement is an example of the government's effort to redirect the Department of Defense toward private industry. "McClellan is a key facility in this country for the development of this technology," he said.

"After numerous meetings during the past year, we are convinced that McClellan has the technical capability, facilities and personnel required to support this development project."

Currently, McClellan operates a foundry under the increasing environmental statutes of the California Air Resources Board (CARB).

Schuetzle sees several benefits resulting from the project including increased competitiveness or the domestic auto industry through more efficient foundries. This competitiveness, he points out will result in a reduced flow of work off-shore and loss of domestic jobs.

Also involved in the project are Dr. Jerry Rogers, a research laboratory manager for GM and Chrysler Pollution Prevention Manager Mark Bindbeutel.

Foundry Emissions Target of Joint Program

U.S. Auto Scene

Published on October 18, 1993

By Robert Parker
Staff Writer

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Environmentally Conscious Businesses Get Recognition

Sacramento Business Environmental Resource Center

http://sacberc.org/Recognition.html

Published, November 27, 2000

Terrie Mitchell

What could the U.S. Postal Service have in common with an architectural firm like Mogavero Notestine Associates? Or how could the operations of Chrome Craft, a plating company, and Kaufman and Broad, one of the areas largest homebuilders, be similar? Well, these firms along with three others, Casting Emission Reduction Program, Polyclad Laminates, and Pacific Powder Coating, are all recipients of the Sacramento County Pollution Prevention Award for 2000. This year's award winners demonstrated that all types of businesses could make smart environmental choices and end up better off for it.

For six years, the Business Environmental Resource Center (BERC) has presented awards to local businesses that have demonstrated environmental excellence and proactive leadership all in the course of conducting their business. And a common theme that all of these recipients have found is that sound environmental decisions pay off - indeed, implementing pollution prevention measures can significantly increase a company's bottom line! This year's award winners and a summary of their pollution prevention accomplishments are highlighted below:

To ensure that foundries operate profitably in the U.S. and are in compliance with environmental regulations, the Casting Emission Reduction Program (CERP) researched cleaner ways of casting metal parts. Their research-efforts will help foundries reduce the amount of hazardous air pollutants emitted while at the same time create a healthier work environment for employees.

Chrome Craft, a family-owned welding, plating, and parts machining company, is a giant in the small business community. Their pollution prevention efforts have involved every aspect of their operations. Not only have they installed a highly - advanced, computerized plating system that reduces the amount of materials used and waste generated, but they also recycle rinse water on site, and installed control equipment that lowered air emissions 5,000%.

Kaufman & Broad, a well-known local developer has demonstrated their leadership in the housing development industry. Their pollution prevention efforts at the new Independence at Mather housing redevelopment project included the on-site reuse of 725,000 tons of concrete demolition debris as road base; the off-site recycling of 20 tons of wood waste into particle board; and utilizing unique landscaping strategies designed to protect surrounding surface waters and sensitive environments.

Mogavero Notestine Associates stands out as a great environmental role model in the architectural, planning, and development industry. In their work, they not only utilize energy efficient strategies, but they also mandate the use of recycled products during building construction. They also design systems to conserve water and eliminate storm water runoff, as well as construct extraordinary projects within metropolitan areas to reduce commuter-generated air pollution.

Even with increasing production, Pacific Powder Coating's pollution prevention efforts have saved them more than $100,000 annually. This quality metal finisher has managed to reduce the use of raw materials, natural gas, electricity, and water, as well as minimize their wastewater discharges. In addition, this industry leader has helped organize other local powder coating companies so they can share general business and environmental knowledge.

Before starting construction of their new facility, Polyclad Laminates addressed potential environmental issues associated with its circuit board laminate manufacturing operations right up front. Their pollution prevention efforts spanned process flow alterations, as well as the design and purchase of special equipment. As a result, the toxicity and quantity of hazardous materials used significantly decreased and air emissions and waste generation were also reduced.

When the U.S. Postal Service (USPS) - Sacramento District realized that they were responsible for disposing of over 100 tons of undeliverable mail, they searched for an alternative to land filling this waste. They not only found a recycling option for this waste stream, but they also turned it into a moneymaking enterprise earning USPS over $45,000 per year. Since they also operate a large fleet of vehicles, USPS evaluated other pollution prevention measures. As result, they opted to purchase more than 100 alternatively-fueled vehicles and service them using less hazardous materials.

This year's award winners have discovered that successful businesses are ones that continually examine and improve their operations. When implemented, pollution prevention measures can not only decrease a business' regulatory requirements and compliance costs, but increase process efficiency, improve workplace health and safety, reduce waste disposal costs, and enhance environmental quality. For all their efforts, BERC and all of Sacramento County recognizes the recipients, past and present, of this prestigious environmental honor.

Seven Sacramento Businesses Honored For Environmental Efforts

County agency offers help navigating environmental laws and regulations

Sacramento Business Environmental Resource Center
/Sacramento Municipal Utilities District
http://sacberc.org/SMUDrelease.html

Published November 27, 2000

Terrie Mitchell, BERC
Gregg Fishman, SMUD

Protecting the environment can also mean saving money, and seven Sacramento County businesses are proving that point. The seven organizations are receiving the annual Pollution Prevention Awards from the Business Environmental Resource Center (BERC) for their efforts to improve the environment. BERC wants more business people to know that reducing pollution is the right thing to do for the environment, and for their bottom line.

BERC, an agency of Sacramento County, helps almost 1,000 businesses a year navigate through Federal, State and Local environmental laws. "We provide a free and confidential consulting service to business people who want to do the right thing for the environment, but might have trouble sorting out all the different rules and regulations," said BERC Manager Terrie Mitchell. "We know the rules and regulations, and we know how they apply to businesses in Sacramento."

BERC also teams with the Sacramento Municipal Utility District (SMUD) to offer classes and workshops through SMUD's Energy and Technology Center. "SMUD is reaching out to the business community, offering energy conservation programs that save money too," said Mike Weedall, Manager of SMUD's Energy Services. "Working with BERC, we can help show business people how to use less energy, reduce waste, and improve the environment in their workplace and in the community.

BERC's annual Pollution Prevention Awards honor local companies that have demonstrated environmental excellence and proactive leadership in preventing pollution. The Awards are sponsored by SMUD and co-sponsored by the Sacramento Business Journal, Sacramento Metropolitan Air Quality Management District, Sacramento County Regional Sanitation District and the Sacramento Storm water Management Program.

"We give these awards to local firms to highlight the fact that doing the right thing for the environment can also be the right thing for your business," said Mitchell. "BERC can help businesses that are facing environmental issues reduce pollution, comply with the law, and save money at the same time."

This year the winners of the BERC Pollution Prevention awards range from the U.S. Postal Service in Sacramento, which recycles more than 100 tons of undeliverable material, scrap metal, cardboard and pallets, to Pacific Powder Coating, which saves $38,000 a year through various pollution prevention efforts.

"We have increased production, reduced costs and received income from our recycling program," said Dave Sunderland of Pacific Powder Coating. "The most important benefit from these efforts is that our workplace became a safer and healthier environmental. BERC was also directly responsible for reducing compliance costs and regulatory fees."

The 2000 BERC Pollution Prevention award winners include the Casting Emission Reduction Program, Chrome Craft, Kaufman and Broad-Independence at Mather, Mogavero Notestine Associates, Pacific Powder Coating, Inc. Polyclad Laminates, inc. and the U.S. Postal Service-Sacramento District. Each of these companies will be honored at a breakfast presentation on September 19. Comedian Jack Gallagher will emcee the award presentations.

Operationally Efficient While Friendly To Environment

Business and Industry Additional Issue Articles

http://www.busindmag.com/industrial_news_story3.html

Sacramento Business Journal

http://www.bizjournals.com/sacramento/stories/2003/07/07/daily26.html

By Jeremy D. Eastman

Today's chemical-based sand binders for core making, while effective, present costly environmental and operational problems for foundries.

The costs associated with sand waste and reclamation, emissions of pollutants, energy, difficult shakeout, scrapped cores and meeting worker health and safety mandates when using such binders add up quickly, adversely affecting a foundry's bottom line. Austin, Minnesota's Hormel Foods, however, is now producing a new environmentally safe sand binder that helps foundries address these issues.

The roots of the new sand binder can be traced to the General Motors (GM) Research and Development Center where technicians evaluated new sand binder materials for foundry operations.

GM researchers looked for an alternative that had to be environmentally safe and as strong as existing binders systems. After testing several materials, GM scientists determined that protein-based biopolymers had the most promise as a high-performance and environmentally safe sand binder material.

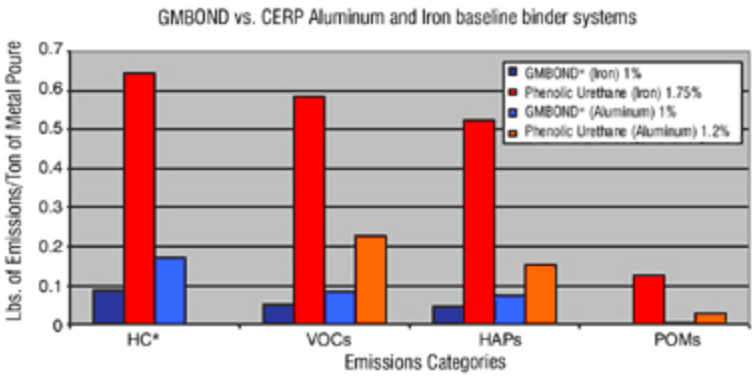
During the development of the binder system, GM consulted Hormel for help with the science and nature of the protein material. GM intended to use the protein-based binder with several casting applications to include low-melting alloys like aluminum and magnesium-it needed to have better collapsibility than other binder systems available. GM researchers discovered that by combining the organic protein with varying amounts of a metallic oxide catalyst, faster thermal breakdown would occur even at lower temperatures.

Over the next several months the scientists further developed the core making process.

In 1996, GM researchers completed the preliminary work on the GMBOND® Sand Binder process, a combination of heat-activated (hotbox) and catalyst-activated (ColdBox) technologies.

The manufacturing of cores and molds proved to be both productive and environmentally safe.

The following year, GM worked closely with a casting supplier, Teksid S.p.A., Italy, to conduct casting trials to prove the core making process and evaluate casting quality and shakeout improvements. GM conducted internal casting trials as well. Processes that incorporated magnesium, aluminum and iron greensand, and high-pressure die casting proved that the GMBOND® binder provided excellent casting properties for various automotive castings like brake rotors, gear blanks, cylinder heads and engine blocks.



In 1999, General Motors Corporation granted Hormel a license to administer the evaluation phase of the product's licensing program and supply the foundry industry with the new binder system.

GM chose to work with Hormel because of the latter's extensive background in protein science.

Since that time, Hormel has dedicated research, development and customer support to the commercialization of the process. Casting trials have been performed at various foundries in both North and South America and Europe.

The Environment

In September of last year, Hormel participated in the Casting Emission Reduction Program (**CERP**), a joint research project of the U.S. Department of Defense and the U.S. Council for Automotive Research.

CERP's mission is to perform the testing of new products and processes that can have a positive affect on environmental compliance in the U.S. foundry industry.

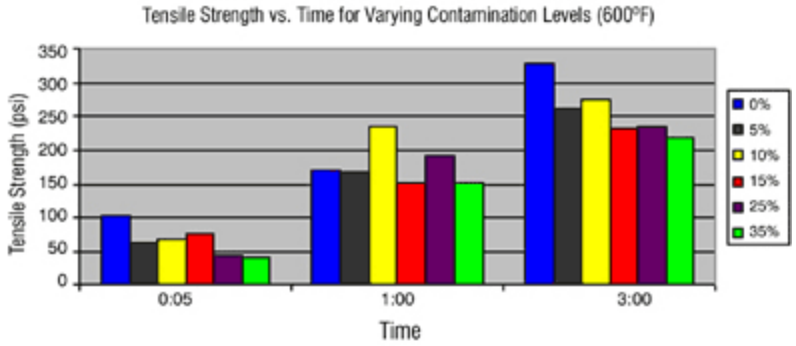
Cores were produced at the CERP test facility with GMBOND® and placed into green sand molds containing bentonite clay and water only. The only organic materials from which emissions could be formed in the assembled mold came from the protein-based binder. Emissions were generated for aluminum and cast iron and compared against an industry baseline. These results show a dramatic decrease in air emissions when compared to the baseline, which can lower the environmental impact from pouring, cooling and shakeout operations.

Another benefit of the binder is its

reversible bond. This allows for the reuse of scrap cores and core butts without adding additional binder, thereby reducing the amount of binder and sand consumed.

However, it is likely that a reasonable amount of semi decomposed binder could make its way into the sand system as a result of recycling core butts.

An experiment was conducted at the University of Northern Iowa Metal Casting Center to investigate the possible interactions between the semi decomposed binder and raw binder.



Three samples of coated sand were exposed to varying temperatures and added to raw, coated sand at different percentages of tensile properties.

There was no known or observed chemical interaction between the raw, unburned binder and the decomposed binder. Nonetheless, its is likely that strength losses occur as a result of reduced binder quantities that have the capacity to make and hold bonds.

Production Trials

Hundreds of castings were produced in production trials using the low-pressure semi permanent mold process, including cylinder heads and suspension arms produced by Teksid S.p.A.

The main purpose of these tests was to determine the shakeout advantages of GMBOND® in the semi permanent mold process. All castings produced with the GMBOND® cores showed a significant decrease in shakeout cycle times. For one particular part, a suspension arm, the conventional hotbox core had to be removed with a 12-hour heat treatment prior to the metallurgical heat treatment.

The GMBOND® core fell out by gently rapping the casting after the casting had cooled down. They also removed cores with a water quench directly out of the mold.

Conclusion

Investing in pollution prevention technologies can be a significant contributor to the long-term profitability of the foundry industry.

New technology like the protein-based sand binder has been proven to reduce the amount of waste generated by various metal casting operations, and which has a positive impact on a foundry's bottom line.

As the cost of government-mandated compliance continues to escalate, it is the choice of the foundry whether to invest in abatement or preventative technologies.

Although GMBOND® may not be the answer for everyone, foundries now have another process to choose from that can help lower operating costs.

Appendix B List of Reports

The following listings are CERP test reports that have been posted to the web site for public distribution:

Test or ID	Contract Number	WBS #	Report Title	Date Posted to web site
--	Air Force	--	Baseline Emissions Report from the CERP Production Foundry	Feb. 13, 2003
--	Air Force	--	Baseline Emissions Report from the CERP Pre-Production Foundry	Feb. 13, 2003
--	Air Force	--	Mexico Report	Feb. 26, 2003
--	Air Force	--	UC Davis Study of Aerosol Emissions at the CERP Foundry	Mar. 12, 2003
--	N256	--	Power Point Presentation on Foundry Processes and their Effects on Hazardous Air Emissions	Mar. 12, 2003
--	N256	1.1.4	Test Information Management System	May 6, 2003
DG	N256	1.2.1.1	Phenolic Urethane Iron No-Bake Baseline Test	Apr. 10, 2003
DN	N256	1.2.1.3	Phenolic Urethane AluminumGreensand Baseline Test Without Seacoal	Apr. 10, 2003
DD	N256	1.2.2	Production Baseline Test	Apr. 10, 2003
EC	N256	1.2.3	Core Making Emissions Study-Pre and Post Scrubber	Apr. 10, 2003
EE	N256	1.2.4.1	Iron Melting HAP Test	Apr. 10, 2003
DB	N256	1.2.GSA.1	Core Wash Quality Baseline Study	Apr. 10, 2003
DQ	N256	1.3.1.1	20-80 Western-Southern Bentonite Baseline	May 30, 2003
--	N256	2.1.1	Scrubbers Technology	May 3, 2003
BT	N256	2.2.1	Spatial Distribution Emissions Study	Apr. 15, 2003
CQ	N256	2.3.1.1	No-Bake Urethane Aluminum Capability Study	Apr. 15, 2003
DJ	N256	2.3.1.2	No-Bake Furan Iron Capability Study	Apr. 15, 2003
CP	N256	2.3.GSA.1	No-Bake Iron Capability Study-1	Apr. 15, 2003
CW	N256	2.3.GSA.2	No-Bake Iron Capability Study-2	Apr. 15, 2003
--	N256	3.1.1	Emission Measurement Procedure 2	Apr. 16, 2003
--	N256	3.1.1	Emissions Measurement Procedure 1	May 6, 2003
--	N256	3.1.3	Verify Method 1	May 6, 2003
--	N256	3.2.1	HAP Identification	Apr. 17, 2003
--	N256	3.2.2	Methodology Evaluation	Apr. 16, 2003
--	N256	3.3.3	ASAM Validation Test 1	May 6, 2003
--	N256	3.4.1	SCPI Protocol for Facilities	May 6, 2003
--	N256	3.4.2	ASAM Instrument Driver Progress Report	May 6, 2003
--	N256	3.4.3	ASAM IVI Evaluation	May 6, 2003
--	N256	3.4.4	ASAM ODS XML Progress Report	May 6, 2003

Test or ID	Contract Number	WBS #	Report Title	Date Posted to web site
--	N256	3.4.5	Provide Support of ASAM Technical Efforts	May 6, 2003
--	N256	3.5.1	Progress Report for Adapt Standards	May 6, 2003
--	N256	4.1	Alternate Use of Sand	May 6, 2003
--	N256	4.2.1	Core Room Monitoring	May 6, 2003
--	N256	GSA.R3.3	Phase 1 SIVL Executive Software and Re-port	May 6, 2003
CO	N256	1.2.GSA.3	Melting Emissions from Gray, Ductile and Compacted Flake Irons	Aug. 19, 2003
DA	N256	1.3.GSA.1	Addendum to 20 Western/80 Southern Bentonite Clay Ratio	Aug. 19, 2003
DA	N256	1.3.GSA.1	AO Process Test in Iron	Aug. 19, 2003
DC	N256	1.2.GSA.2	Core Box Cleaner Study	Aug. 19, 2003
DR	N256	1.3.1.3	50 Western/50 Southern Bentonite and Tap Water	Aug. 19, 2003
DS	N256	1.3.1.2	50 Western/50 Southern Bentonite Clay Ratio	Aug. 19, 2003
DT	N256	1.3.1.4	80 Western/20 Southern Bentonite and Tap Water	Aug. 19, 2003
DU	N256	1.3.1.5	80 Western/20 Southern Bentonite – Advanced Oxidation	Aug. 19, 2003

Casting Emission Reduction Program (CERP)

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Casting Emission Reduction Program