Pennsylvania Environmental & Energy Challenge (PEEC) Grant

Final Report

Metalcasting Best Practices

ME #3521391

Submitted to the Pennsylvania Department of Environmental Protection
Office of Energy & Technology Deployment
Division of Energy Policy & Technology Deployment

June 30, 2005

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Pennsylvania Environmental & Energy Challenge (PEEC) Grant
Final Report

Pennsylvania Department of Environmental Protection
Office of Pollution Prevention and Compliance Assistance
Technical Services Division

Grant Title: **Metalcasting Best Practice, ME#3521391**

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Project Summary

The Pennsylvania metalcasting industry has been, and continues to be, a key part of the state's industrial backbone. This industry employs 15,000 Pennsylvanians in more than 160 companies and ships more than $2 billion of castings annually impacting almost every other industrial and commercial sector in the state. It is a major recycler of scrap metal, a major energy user, and a key pollution prevention partner in Pennsylvania.

This metalcasting best practices program has addressed critical technology deployment needs that were initially identified through an extensive Pennsylvania metalcasting industry-wide roadmapping process. A sustainable best practices program has been developed and deployed in Partnership with the Pennsylvania Foundry Association (PFA). Best practices to reduce metalcasting industry energy consumption, reduce

environmental impact and improve competitiveness have been identified and are being deployed throughout the Pennsylvania metalcasting industry. The incorporation of best practices activities as part of annual PFA/Penn State Metalcasting meetings is a permanent legacy of this program. In addition, through this program the Pennsylvania metalcasting industry has developed a new working relationship with the Pa DEP's Bureau of Energy, Innovations and Technology Development that promises to assist a key Pennsylvania industry in leveraging technical assistance.

<u>Project Goals</u>

The goals of this Pennsylvania metalcasting industry best practices effort were to:

1-Encourage and leverage participation in existing state and federal energy audit and environmental audit programs to maximize their benefit to the metalcasting industry

2-Conduct hands-on best practices works visits with small groups of non-competing foundry executives to share technical, environmental and management best practices

3-Conduct an annual workshop to widely disseminate best practices information from across Pennsylvania, the US and the world

4-Develop a website highlighting best practices information and providing an interactive roadmapping legacy for metalcasters

5-Respond to requests for energy saving, pollution prevention and technical information from Pennsylvania metalcasters

<u>Project Activities</u>

Table 1 is an overall list of the participating foundry organizations. These companies have been involved in one or more of the metalcasting best practices activities that were conducted under this program.

Table 1: Participating Pennsylvania Foundries

Active Brass Foundry	Durametal Corp.	Piad Precision Casting Corp.
ACP Manufacturing	Effort Foundry Inc.	RH Sheppard Co. Inc.
Advanced Cast Products	Electric Materials Co.	Regal Cast Inc.
Anvil International Inc.	Erie Bronze & Aluminum	Somerset Foundry & Machine
Arrow Castings Co.	Fairmont Foundry Inc.	Spring City Electrical Co.
Ajax X-Ray	Flury Foundry Co.	T B Wood's Inc.
Benton Foundry Inc.	Frog Switch & Manufacturing Co.	Tech Cast, Inc.
Blue Ridge Pressure Castings Inc.	Gupta Permold Corp.	Trinity Rail
Boose Aluminum Foundry	H & H Castings Inc.	Tyler Pipe
Bridesburg Foundry Co.	Hazelton Casting Co.	Unicast Co.
Buck Co. Inc.	Hodge Foundry Inc.	Urick Foundry Co.
Clearfield Machine Co.	J. Walter Miller Co.	US Bronze of PGH Inc.
Cochrane Foundry Inc.	Leed Foundry	US Lock & Hardware
Cornwall Aluminum Foundry Inc.	Littlestown Hardware & Foundry Co. Inc.	Victaulic Company of America
Crescent Brass Mfg. Corp.	Matthews International	Ward Manufacturing
Dent Manufacturing Inc.	McLanahan Corp.	Watsontown Foundry
Dickson Investment Hardware Inc.	Nova Precision Casting Corp.	Wilton Armetale
		Weatherly Casting Co.
Donsco Inc.	Penncast Corp.	West Salisbury

Foundry Best Practices Efforts

Foundry best practices and energy assessment visits were conducted at foundries across the Commonwealth of Pennsylvania. These activities constituted the major portion of the funded activity. The Penn State and PFA staffs were assisted by the following organizations with energy assessment support:

- PaDEP Regional Office staff members under the PaDEP P2E2 program
- the Lehigh University Industrial Assessment Center supported by the US Department of Energy
- the Northampton Community College Energy Efficiency Training Program

Table 2 lists the foundry organizations that have hosted site visits in support of best practices/energy assessment activities.

Table 2: Best Practices/ Energy Assessment Participants

Advanced Cast Products Meadville PA	Durametal Corp Muncy PA	RH Sheppard Co. Inc. Hanover PA
Benton Foundry Inc. Benton PA	J. Walter Miller Co. Lancaster PA	Spring City Electrical Spring City PA
Boose Aluminum Foundry Reamstown PA	Leed Foundry Inc. St. Clair PA	Tech Cast Inc. Myerstown PA
Buck Company Inc. Quarryville PA	Littco Littlestown PA	Trinity Rail Pittsburgh PA
Donsco Inc. Wrightsville PA	Piad Precision Casting Corp. Greensburg PA	Victaulic Co. of America Alburtis PA
Wilton Armetale Mount Joy PA		

Proprietary energy assessment reports were prepared by the auditing organizations for each energy assessment visit.

Best Practices Deployment

Annual Best Practices workshops hosted jointly by the PFA and Penn State Metalcasting were conducted in 2003, 2004 and 2005. These best practices workshop sessions were presented not only by Penn State and PFA staff members, but also by participating foundries. Table 3 lists the workshop topics that were presented at these meetings.

Table 3: Best Practices Presentations from Annual Workshops

2003	2004	2005
"Production Scheduling in the Jobbing Foundry" *Jeff, Wilt, Benton Foundry*	"Casting Customer Requirements-A Mack Truck Perspective" *Wayne Vaupel, Mack Trucks*	"Oil Sand Core Conversion" *Dave Mahan, Buck Co.*
"Plastic Tooling for High Pressure Green Sand Molding" *Dan Mayton, Urick Foundry*	"Operating Experiences With an Aluminum Stack Melting Furnace" *Leonard Potter, Littco*	"Energy/Technology Best Practices in the Foundry Industry" *Angela Wollenburg & Bob Voigt, Penn State*
"Robotic Arm CMM for Casting Inspection" *Mike Maxeiner, Trinity Rail*	"Benefits and Costs of ISO 14001 Certification" *Chris Buck, Donsco Inc.*	"Management Best Practices in the Foundry Industry" *Rajiv Nag, Penn State*
"Penn State/PFA Partnership for Technology Deployment" *Bob Voigt, Penn State*	"Best Practices Technology Deployment in the Metalcasting Industry" *Bob Voigt, Penn State*	"Sand Beneficial Use Update" *Paul Tikalsky, Penn State*

In addition, poster summaries of other metalcasting best practices ideas were exhibited at the annual meetings.

A Pennsylvania Metalcasting website was also developed in 2003 (www.ie.psu.edu/pmc). Since that time the website has undergone significant modifications to reflect the changes that have occurred in the use of website information. The website includes the 2003 Pennsylvania Metalcasting Industry Vision and Roadmap document as well as on-line roadmapping capabilities to facilitate continual updates of the roadmap. In addition to website information available to the general public, the website includes more detailed password-protected best practices reports in the PaDEP/PFA members-only section.

Complementary Management Best Practices Activities

In addition to the best practices activities described above, complementary management best practices visits and interviews with foundry executives were conducted at 14 foundries including 38 face-to-face interviews with foundry CEOs, technical directors and plant managers.   This pioneering effort to evaluate the role of management in the identification, adaption and adoption of best practices is being coordinated by Penn State's Smeal College of Business. These activities are ongoing. The preliminary findings of this study were presented at the 2005 Best Practices Workshop.

Summary of Metalcasting Best Practices Findings

Best practices observations and recommendations based on site visits of foundries across Pennsylvania are summarized in Tables 4, 5 and 6. The specific cost and energy savings indicated may not be achievable by all foundries. The estimates indicated reflect the savings that could be expected by a 'typical' medium-sized foundry. Recommendations regarding compressed air, lighting, motors, etc. apply to all foundries. However, energy savings opportunities for high energy use activities such as melting and heat treating are very foundry and process dependent.

Table 4: Energy Savings Best Practices Opportunities for Foundries

Energy Saving Opportunities*	**Potential Savings**
Upgrade drive belts on motors: Replace drive belts with energy efficient cog belts. Cogged belts can run on existing v-belt pulleys, but at cooler temperatures.	Up to $1,600 /yr for a medium-sized foundry.
Install variable frequency drives on motors: Elimination of voltage imbalances can reduce losses in vibrations, torque pulsations, mechanical stresses and overheating.	Up to $8,000/yr for a medium-sized foundry.
Turn off equipment and lighting when not in use: Specifically identify a shut-down and start-up procedure to control energy consumption spikes. Identify comfort heat, burners, lights and unused motors such as compressed air when idle.	Up to $6,000/yr for a medium-sized foundry.
Reduce compressed air pressure set point by 10%: Maintaining excess air system pressure is very costly; set points can often be reduced with adequate system maintenance and continual repair of air system leaks.	Up to 5% energy savings
Use high efficiency lighting: Use fluorescent lighting with magnetic ballasts; replacement of older ballasts is always cost effective. Do not over-light. Use targeted lighting at inspection stations instead of less efficient ceiling lighting.	Up to 2-3% energy savings
Improve melting practices: Specific recommendations are dependent on the melting system used by the foundry. Furnace manufacturers can be very helpful in helping to identify melting energy savings. The use of preheated air /oxygen and optimized burner designs and settings are helpful for gas-fired furnaces.	Up to 40% melting energy savings depending on furnace type. Heated air may improve energy consumption by 13-50% over unheated air.
Short cycle heat treatment: Common heat treatment practice guidelines used by many foundries are overly conservative and waste energy; high efficiency furnaces and furnace linings are often cost effective.	Up to a 30% energy savings on heat treatment
Improved compressed air practices: Compressor should not be oversized; limit idling of compressors by using air storage systems. Reduce leaks at couplings, valves and pipe joints	$60/leak/shift/year or 20%-30% of energy input to compressors

*More details on many of these energy savings opportunities are included in the Best Practices Summaries in the Appendix.

Table 5: Low Cost/ No Cost Technology Best Practices Opportunities for Foundries

Technical Area	Opportunity
Molding	Improve sand testing quality assurance – more precise control of sand systems insure mold quality and scrap reduction; use sand supplier testing capabilities on a regular basis; in many cases improvements in molding practices can reduce the largest single contribution to casting scrap
Molding	The cleaning room should control the sand system – do not control your sand system based on molder feel, the sand with the best molder feel is often a sand that is too high in moisture; instead control your sand system to minimize scrap and cleaning room costs
Melting	Melt cold, pour hot, pour fast – this will minimize melting energy consumption and at the same time increase melt quality and reduce mis-run; it is often much cheaper in the long run to fully preheat ladles than to melt hot and accept large temperature drops during metal transfer
Scrap Reduction	Improved scrap reporting & analysis – the only way to reduce scrap is to properly identify scrap and its root causes; lack of attention to detail in scrap reporting doubly affects the bottom line; for example, it is important to identify ‘sand’ or ‘slag’ as the scrap cause rather than simply grouping both causes together as ‘dirt’
Data Collection	Make decisions based on sound data collection – make sure that the data that you collect has adequate gage R&R; don’t collect data if you are not going to use it to improve your operation; employees will be much more accurate in data collection if they can see how that data is being used
Lighting	Good housekeeping & lighting lead to improved quality – a few extra kilowatts of energy use, especially in inspection areas, actually saves money; good housekeeping leads to worker pride and improved product quality; taking pride in maintaining a neat molding area usually means that greater pride is taken in the quality of the molds made at the workstation
Training	Training, Training, Training!!! – use all internal and external training resources at your disposal to raise the skill level of your employees; production employees are part of the solution to any foundry problem, if they are better trained, then they are better problem solvers.
Profitability	Improve costing & pricing systems – this is certainly a challenge in the jobbing foundry in particular, but essential to insure the long term success of the organization

Table 6: Management Best Practices Perspectives (Based on interviews of foundry managers)

Management Area	Foundry Management Perspectives
Costs	We differentiate ourselves by controlling costs
Melting Practice	The way we melt our iron has been a cult secret for fifty-something years. That is our niche.
The Customer	I don't want a happy customer. I want a contented customer.
Knowledge	In our foundry there is a tremendous exchange of knowledge
Information	I think all of my competitors have tendency to have an overkill with information. They have so damn much information that it actually slows them down.
Openness	We openly share information with other foundries.
Openness	We do not share information with other foundries.

Continuing Innovation Activities

Ultimately the future success of the Pennsylvania metalcasting industry depends on continuing innovation and continuing identification and adoption of best practices. PEEC support for this three-year Metalcasting Best Practices effort by Penn State and the Pennsylvania Foundry Association has become an effective catalyst for continuing innovation that promises to continue to strengthen the Pennsylvania metalcasting industry.

PFA has been participating in the Pa. Manufacturing Workforce Partnership since May 2004 to help fulfill the Partnership's charge to assist the Administration in identifying areas of opportunities to strengthen Pa.'s manufacturing sector by deploying or changing state policy and aligning resources to meet workforce needs.

Three partnership meetings have already been held with PFA's participation. In late September, Pa.'s Dept. of Labor & Industry issued the Manufacturing Sector Incumbent Worker Training Program Guidelines to help groups of small manufacturers and their workforces to implement innovation-based strategies through upgrading the skills of existing workers.

PFA is forming an industry partnership with Penn State, Workforce Investment Boards, Industrial Resource Centers, Pa. foundries and key supply-chain firms to obtain support from this program to improve the skills of metal casting workers. Consultations have already occurred with more than ten Pennsylvania foundries.

To date, six Workforce Investment Boards have agreed to participate: Lancaster, Northern Tier, Luzerne/Schuylkill, Southcentral, Lehigh/Northampton and Northwest. Among the Industrial Resource Centers, the IMC and the MRC have expressed interest.

In advance of completing a proposal, PFA is cataloging foundry-related curriculum elements that would facilitate the implementation of innovation-based strategies and identifying appropriate training providers. To date, over two dozen training modules have been catalogued and numerous course providers identified. By year-end, an industry partnership steering committee will be finalized and the elements of an incumbent worker training program for metal casters will be drafted.

PFA has also been working with DEP's headquarters, Pottsville office and the owners of Blackwood, Inc. to convert the disposal of foundry sand into the beneficial use of roadway construction materials at the Blackwood coal mine in Schuylkill County. PFA has been working with over 20 foundries to implement best management practices to qualify them for beneficial use permits for the acceptance of their material at Blackwood. To date, almost 100 tons/day of foundry sand has been diverted from disposal to beneficial use at Blackwood, at a savings of approximately $15/ton. On an annualized basis, the economic benefit alone will be $375,000 at the current level of participation. PFA anticipates the approval of additional sources of foundry sand to double the beneficial use at Blackwood within the next six months.

Among the foundries participating in this beneficial use opportunity are Benton Foundry, Aluminum Alloys, Tyler Pipe, Fairmount Foundry, Hazleton Casting, Weatherly Casting and Machine, Spring City Electrical and Machine, Hamburg Manufacturing, Boyertown Foundry, Effort Foundry, Leed Foundry, Precision Technology, Penncast Corp., Unicast Company, McConway and Torley, Kulp Foundry, Post Precision, Pa. Precision Casting, Domestic Casting and Crescent Brass.

PFA is awaiting a decision from the Sustainable Energy Funds in the Met Ed and PenElec regions on our proposal for training workshops for foundries to participate in load response programs and for a feasibility study into aggregating load response participants for maximum economic and environmental benefits. PFA's June 28 proposal anticipated load reduction by participating foundries of nearly 10,000 MWh for economic savings of nearly $6 million (based on PJM's 2002 experience) and emissions reductions of nearly 130,000 lbs. by generating facilities and almost 98,000 lbs. by foundries.

Dr. Voigt also continues to be active on the technical committees of the American Foundry Society. This includes membership on the Ductile Iron Research Committee (5-I), Molding Methods and Materials Division Committees (4-H and 4-M) and the Environmental Division Air Quality Committee (10-E). His participation on technical committees and on the national and international technical meetings continues to be a vital source of best practices technology deployment to the Pennsylvania Metalcasting industry.

Administrative Summary

Project Task Summary	%Completed
Energy/Environmental Assistance Coordination	100%
Conduct Best Practices Works Visits	100%
Conduct Annual Best Practices Workshops	100%
Develop Best Practices/Best Resources Website	100%
Metalcasting Extension Agent Support Activities	100%

Final Budget Summary

All project funds have been spent. See “Application For Reimbursement” submitted separately by Penn State Research Administration.

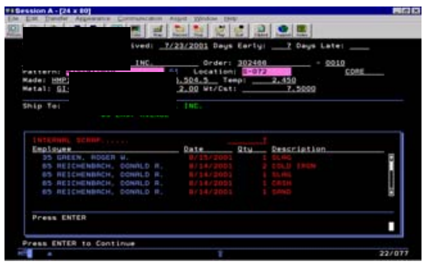
Acknowledgements

The Penn State Metalcasting Team would like to thank the staff of the Pennsylvania Foundry Association, the Pennsylvania Department of Environmental Protection, the Penn State Smeal College of Business, the Lehigh University IAC, the Northampton Community College Energy Efficiency Training Program, the Penn State Metalcasting Industrial Advisory Committee and especially to the many participating Pennsylvania foundries for their active participation in this program. Special thanks go to Chris Moyer, George Boyd and Mark Klempner, PFA; Dave Althoff, Scott Gebhardt and Ric Illig, PaDEP, and Angela Wollenburg and Rajiv Nag, Penn State for their dedicated efforts to make this program a success.

Purchase Order System and Part Tracking

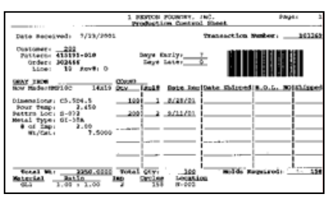
Computer Tracking Aids Quality, Customer Support and JIT Delivery

Benton Foundry pours more than 8,000 types of grey and ductile iron castings, ranging from coreless to highly cored, in green and synthetically bound sand systems using automatic and manual molding lines. This facility is a job shop which is capable of producing 300 tons of iron per day where many orders are less than 250 pieces. More than 75 pattern changes can occur per day. To track all of the patterns, orders, pattern modifications, and quality, Benton Foundry has incorporated a customized computer software package, Widows Based on an AS 400 Platform.



Opportunities
- •Controlled order process flow
- •Reduce order process time by 60%+
- •Track quality in each step of process
  - •Core Production
  - •Mold Production
  - •Iron Distribution
  - •Lab Functions
  - •Grinding- Finishing
- •Lower scrap and rework cost due to improved quality
- •Goal: customer service oriented software system providing superior customer service.
- •Results: 95%+ on time delivery month in and month out.

Limitations
- •Requires experienced database programmer with complete understanding of business, facility and product flow
- •Time to develop and implement system
- •Initial Cost



Process Details
- •Widows Based AS400 Platform
- •Information and data entry screens include
  - •Order transaction number, processing and tracking ticket
  - •Customer number
  - •Pattern/Part # and location and cycles per pattern
  - •Special customer requirements/ requests
  - •Process requirements
  - •Core and mold operators names and date of processing
  - •Internal scrap
  - •Shipments
  - •Item change log for pattern

Contact
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This fact sheet has been prepared under a PEEC grant from the PaDEP by the Pennsylvania State Metal Casting Program and the Pennsylvania Foundry Society for Metal Casting Best Practices.

Penn State Metalcasting

PFA

Donsco Inc., Belleville Div.

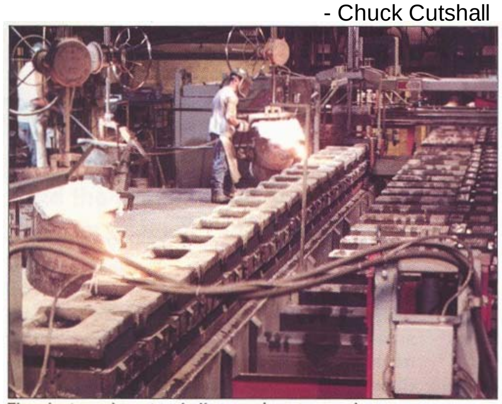
One of the Best in Matchplate Molding

Donsco was founded in 1972 as a captive facility to New Holland. In 1993 it became a job shop requiring renovations in operating philosophy and equipment. Its current 125 employees pour gray and ductile iron. There was nearly a complete turnover in workforce during the transition period. Donsco now runs 3 green sand molding lines with cold box and shell cores. The castings, weighing between 5 and 80 lbs, are sold to the agricultural, truck and automotive industries.

Opportunities
•Average 100 molds per hour
•Increased surface finish
•1300 psi squeeze pressure
•Improved dimensional stability
•Improved grinding efficiencies in cleaning room

Challenges
•Systems designed to eliminate human variables
•Installation led to 3.3% internal scrap rates
•Current scrap rates dropped to 2.2%

"Attention to detail is what makes us successful"
- Chuck Cutshall



Process Details
•Three 20x24 matchplate green sand molding lines
- •HMP-20 (Hunter Automated Machinery Corp.)
- •HLH-20 linear mold handling system featuring double-row pouring/cooling lines (Hunter)
  - •Self storing mold conveyor
  - •Automatic Weight and jacket setter
  - •Cooling Conveyor

•Electronic monorail for efficient iron transport
•Good green sand for molding

Contact
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Reference: "The Best of Matchplate Molding", Modern Casting, August 2003, pp. 28-29

Energy Use in Selected Metalcasting Facilities - 2003

Energy Report Summary

•Defective castings and customer returns totaled between 0.5 percent and 25 percent
•Customer returns and scrap rate reduction represent the easiest path to increased profitability
•All the metalcasters experienced wide swings in scrap rate due to as-yet unidentified variables
•Scrap reductions can be obtained with attention to process control procedures

Exhibit i
Summary of Data From Ferrous Facilities Visited

Facility Type	Molding Process	Annual Production in Tons	Total Compressed Air (hp)	Electric Btu per ton (x 10^6)	Natural Gas Btu per ton (x 10^6)	Btu per ton Coke (x 10^6)	Other Btu	Compressed Air hp/ton	Total Energy Btu per ton (x 10^6)	Total Tacit Energy Btu (x 10^6)
Gray Iron-Cupola	Green Sand	87,500	3,150	2.07	2.37	5.100	0.04	0.036	9.6	13.4
Gray Iron-Induction	Green Sand	13,250	1,300	11.8	6.59	N/A	N/A	0.098	17.7	33.7
Ductile Iron-Cupola	Green Sand	103,000	2,750	2.23	1.97	5.87	0.04	0.027	10.1	14.3
Ductile Iron-Induction	Green Sand	5,500	250	8.54	6.12	N/A	N/A	0.045	14.5	30.4
Ductile Iron (Pipe)-Cupola	Centrifugal	206,000	1,050	0.46	2.65	2.79	0.08	0.005	6.0	6.8
Steel-Induction (Primarily Stainless)	Airset	900	450	22.4	26.7	N/A	N/A	0.500	49.1	90.8
Steel- Arc	70% Green Sand, 30% Airset	3,230	650	9.22	11.48	N/A	N/A	0.201	20.7	37.8
Steel-Induction	Airset	2,700	225	6.89	10.36	N/A	N/A	0.083	17.3	30.1

Note: Tacit energy is a term used to describe an energy value that equals the combination of onsite energy consumption, the process energy required to produce and transmit/transport the energy source, and feedstock energy. Tacit energy for electrical generation is 2.86 times the measured usage. It's been assumed that the tacit energy for coke and natural gas is "1" or unity because a marginal amount is lost in the transportation and transmission of these fuels. This report does not include the energy used to make equipment or buildings that house the process steps.

•In general, the cleaner the facility, the lower the scrap rate
•Natural gas savings were available at non-ferrous facilities by updating to stack melters
•Energy savings are available through
  •The rigorous use of ladle, trough, and furnace covers
  •The use of engineered ladle preheating systems, rather than torches
  •The improved compressed air systems
•Opportunities for improvement in
  •Energy
  •Productivity
  •Waste
•Improved compressed air systems offer
  •Increased productivity
  •High casting quality
  •Reduced water in lines
  •Fewer line leaks
  •Appropriate applications
  •Air driers must be selected for operating efficiency, not capital cost

Exhibit ii
Summary of Data From Non-Ferrous Facilities Visited

Facility Type	Molding Process	Annual Production in lbs.	Total Compressed Air (hp)	Electric Btu per lb.	Natural Gas Btu per lb.	Btu per lbs. Coke	Compressed Air hp/lb.	Total Energy Btu per lb.	Total Tacit Energy Btu per lb.
Die Casting Aluminum – 1	High – Pressure	3,424,000	175	6,121	16,801	N/A	0.00005	22,922	34,307
Die Casting Aluminum – 2	High – Pressure	2,203,130	100	3,301	12,640	N/A	0.00004	15,941	22,080
Permanent Mold/Sand Aluminum	Permanent Mold/ Green Sand	2,783,638	390	6,061	29,892	N/A	0.00014	35,953	47,226
Lost Foam-Aluminum	Lost Foam	33,792,000	4,200	9,420	27,610	N/A	0.00012	37,030	54,551
Die Casting-Magnesium[1]	High – Pressure	4,122,088	300	9,815	3,015	N/A	0.00007	12,830	31,085
Copper-Base-Induction	Green Sand	4,322,840	100	4,113	1,227	N/A	0.00002	5,340	12,990
Copper-Base-Induction	Green Sand	3,268,944	250	6,434	2,894	N/A	0.00008	9,328	21,296
Die Casting-Zinc	Hot Chamber	13,869,000	250	2,102	4,954	N/A	0.00002	7,056	10,966

Reference: Eppich, Robert, "Energy Use in Selected Metalcasting Facilities – 2003", U.S. Department of Energy, Industrial Technologies Program, February 2004

LITTCO Installs Horizontal Disa Line and Saves

LITTCO in Littestown PA is an aluminum foundry with 70 employees, producing commercial castings in ranges from 1 oz to 20 pounds. They were founded in 1916 and support the industrial and transportation markets. Their three green sand molding lines use automatic matchplate units. They have 1 Roberts Sinto FBM moldng line (14" x 19" flask size). LITTCO utilizes a fully integrated production system, eliminating maold handling delays. Trim dies are employed, which eliminates the need for grinding in some cases. A stack melter and two new holding furnaces with permanent degassing and filtering offer efficient melting.

Process Details
•(2) Disa GFD Match 130 molding machines (20" x 24" flask size)
•Automatic coresetters

Opportunities
•Increase mold production by 35%
•Increased repeatability
 •Virtually able to eliminate mold shift, crush and sand inclusions
•90% Uptime on line (including 4-7 job changes/shift)
•Core setting time 5-8 sec, down from 12-15 sec
•No sand spillage – cleaner foundry – less maintenance required on machine
•Reduced scrap
•Reduced manpower by 50% on mold line

Challenges
•Full installation took over a year to install and debug

Ref: "The Best of Matchplate Molding", Modern Casting, August 2003, pp. 28-29

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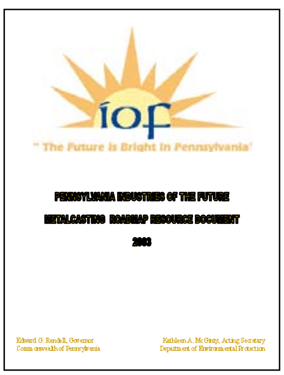
Pennsylvania Metalcasting Industry Roadmap

Guiding Research and Technology Opportunities into 2020 and beyond

The Industries of the Future Pennsylvania Metalcasting Roadmap includes a Vision of the Metalcasting Industry into the year 2020. The Roadmap itemizes research, technological advances, government programs and training programs which will improves process control, quality and reduce environmental impact. The Vision and Roadmap consists of a consolidated effort between Pennsylvania Metalcasters, the PA Department of Environmental Protection and Pennsylvania State University Metalcasting Group. The Roadmap identifies research and projects that have been completed as well as the opportunities for future research. The Roadmap provides a decision making tool for those funding research. Work should positively enhance the environmental impact and competitiveness of Pennsylvania Metalcasters according to the priorities listed in the Vision and Roadmap.

Opportunities

•Continue Metalcasting Networking started by Pennsylvania Foundry Association (PFA)
•Fund research applicable to environmental and competitive concerns
•Utilizing the interactive website, ability to keep document living and not become stagnant
•**Members Only** Section shares information easily to password holders



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" The Future is Bright in Pennsylvania"

PENNSYLVANIA INDUSTRIES OF THE FUTURE

METALCASTING ROADMAP RESOURCE DOCUMENT

2003

Edward G. Rendell, Governor
Commonwealth of Pennsylvania

Kathleen A. McGinty, Acting Secretary
Department of Environmental Protection

Limitations

•Student Involvement for Ongoing Link Updates
•Communicating its web address

Process Details

http://www.psu.edu/pmc

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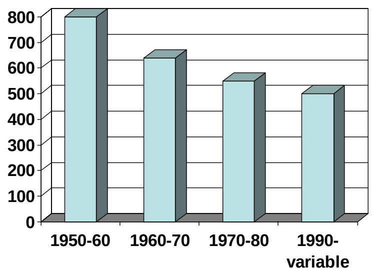
Theoretical/Practical Energy Use in Metalcasting Operations: Minimum Energy Study

Induction Melting Improvements for Iron (38% over 40 yrs)



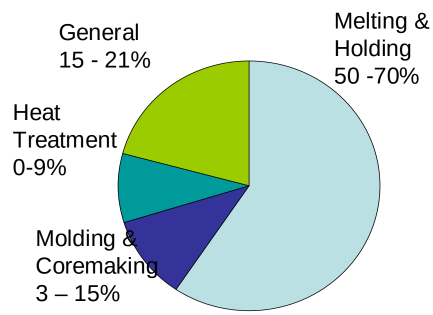
Best Practices Aluminum Melting

	10^6 btu/T	Basis
Gas Reverb Furnace	4.18	100%
Gas Stack Melter	1.42	34%

Metalcasting Industry Yields

	Scrap	Yield	Yield + Scrap Opportunity
Iron	5%	65%	38%
Steel	4%	55%	47%
Aluminum	4%	65%	38%
Copper	5%	50%	53%

Foundry Energy Usage



Reference: Shifo, J.F., and J.T. Radia, US Department of Energy publication, January 2004

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Plastic Tooling for High Pressure Green Sand Molding

Reducing Lead Time Pattern Costs

The Urick Foundry Company uses plastic tooling for nearly all of its products. They currently pour ductile iron using an inmold process with a stop plate to treat the alloy on a vertical parting line DISA. The facility runs between 50-250,000 parts per year on each pattern. Cassette DISA plates with standard gating are maintained with known approximate pour weight for easy pattern introduction of plastic inserts for a quick start-up. A short to medium run jobbing foundry is the ideal candidate for this type of tooling, especially if the sand is sufficiently cool.

Opportunities

- Reduce Lead Time by 50%
    - Produced 10,000 castings within 14 days of quoting job
- Can also purchase machinable plastic for quick CNC tooling production
- Easy to replace parts with wear
- Saves start-up time
- Can be 50% cheaper than metal
- Light patterns can reduce pattern changes by 30%

Limitations

- Castings with deep draw have more wear: check 6,000-8,000 cycles

Process Details

- Plastic tooling is mounted to iron match plate
- Steel pins and bushings are used on matchplate to reduce shift
- Two plastic methods available
    - Curing plastic poured into negative and cured for 12 hours
    - Machinable plastic is available for CNC use
- Must keep sand below 145° F to prevent excessive wear and plastic remelt
- Preheating the pattern to 110° F reduces pattern sticking
- Plastics options are polyurethane and/or epoxy
    - Epoxies are quicker curing, but wear faster, good for prototyping
    - Polyurethanes take longer (12 hours) to cure, have some shrinkage issues in thick sections but wear much better

Contact

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Portable Coordinate Measuring Machine (CMM) Use in the Foundry

Improving Tolerances and Dimensional Control

The McConway & Torley Group manufactures large steel castings for the railroad industry, using a combination of green sand, cold box and no bake resin binder systems. Use of a portable CMM has enabled measuring accuracy to 0.007" on castings which otherwise do not fit onto a traditional CMM. Data from the CMM can automatically enter into AutoCAD 14, allowing complete profiling of a casting and aiding reverse engineering.

Opportunities

•Improve dimensional tolerances: know accurate casting dimensions
•Scanning/digitizing capabilities create drawings and models for CAD
•Create a solid model in the software
•"Leap frog" ability to measure an infinitely large feature.

Products Measured

•Casting layouts
•Pattern equipment
•Production gages
•Core machine platens
•Machining fixtures
•Equipment base plates
•Ductwork

Limitations

•Initial equipment reliability, but many improvements have been made.
•Laptop, software and equipment are continuously improving. Upgrades can be costly.
•Cost: $19,500 for refurbished to $95,000 for new

Process Details

•Portable system, with minimal set-up.
•Laptop control and output.
•Arm sizes range from 2' to 12'.
•Accuracy 0.0010" to 0.007."
•Built-in calibration routine.
•Wide variety of probe tips available.
•Light weight aluminum construction with counterbalances.
•Multiple base configurations including threaded and magnetic.
•Rugged plastic shipping containers.
•Brands: FARO and Römer

Contact

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Useful Rules of Thumb for Energy Conservation and Waste Minimization

1. High Pressure Steam Leaks (125 psig) = $150 to $500 / leak / shift/ year
2. Low Pressure Steam Leaks (15 psig) = $30 to $110 / leak / shift/ year
3. Compressed Air Leaks (100 psig) = $30 to $90 / leak / shift / year
4. Submetering an Evaporative Cooling Tower can result in sewage treatment savings
    1. Assume 1% water loss to evaporation
    2. $9 / ton / shift / year Based on size of tower in tons
    3. $3 / gpm / shift/ year Based on gpm of water through tower
5. Typical Motor Operating Cost = $62 / hp / shift / year
6. High Pressure Compressed Air System Reduction
    1. Assume 100 psig system
    2. 10 psi compressor discharge reduction = 5 % reduction in energy consumption
7. Cost of heat lost through hot, uninsulated pipes
    1. 25 psig steam: $375 / 100 feet / shift / year
    2. 50 psig steam: $430 / 100 feet / shift / year
    3. 75 psig steam: $480 / 100 feet / shift / year
    4. 100 psig steam: $515 / 100 feet / shift / year
8. Installing Insulation can reduce 90% heat loss on a hot, uninsulated surface
9. Average Heating and Cooling Costs

	Comfort Cooling Costs (per ft^2 / year)	Comfort Heating Costs (per ft^2 /year)
Michigan	$0.12	$0.26
Tennessee	$0.30	$0.35
Texas	$0.52	$0.24

10. Combustion Efficiency of typical Boiler or Furnace is 80%
11. Upgrading to an energy efficient motor can result in savings of about 5% over the operating costs of a standard motor. A typical standard motor has an efficiency of 90%.
12. Benefit of Fuel Switching:
    1. Switching from electric heat to natural gas or #2 fuel oil can reduce heating costs by 78%. (1996)
13. Cost Saving for Demand Reduction (or Load Shifting)
    1. Move Operating Shift to Off-peak times: $75 / hp / year
    2. Move “Other Electric Equipment” to Off-Peak: $120 / kW / year
14. Average Solid Waste Costs
    1. $30 / cubic yard for municipal solid waste
    2. Landfill tipping fees are $45 to $64 / ton

Assumptions:
Electricity: $0.05 / kWh
Natural Gas: $0.350 / ccf
Manhours: 2,000 hours / year/ shift