# PROJECT DATA

## Comanche Technologies, LLC - 02GO12060

### A New Direct Pour In-Mold (DPI) Technology for Producing Ductile and Compacted Graphite Iron Castings

| | | | |
|---|---|---|---|
| Recipient: | Comanche Technologies, LLC | Instrument Number: | DE-FG36-02GO12060 |
| Recipient Project Director: | Jay R. Hitchings 610.269.6241<br>1393 Piedmont Drive<br>Downingtown, PA 19335 | CPS Number: | 1832 |
| | | HQ Program Manager: | Lisa Barnett 202.586.2212 |
| | | GO Project Officer: | Glenn Doyle 303.275.4706 |
| Recipient Type: | For-Profit Organization | GO Contract Specialist: | Melissa Wise 303.275.4907 |
| Subcontractor(s): | Donsco Foundry<br>University of Alabama<br>Concurrent Technologies | B&R Number(s): | ED1906020 |
| | | PES Number(s): | 02-2140 |
| EERE Program: | Industrial Technologies | State Congressional District: | PA - 16 |

**PROJECT SCOPE:** This invention combines two proven foundry techniques: in-mold magnesium treatment, and the direct pour method, to produce a unique solution to several problems associated with standard in-mold treatment. It also adds considerable benefits of direct pour. The scope of work is quite broad, combining both the engineering of the container and the marketing work required to understand the optimal launch price as well as best channel(s) to market. DPI containers provide energy savings of 13.3% over comparable treatments, increased mold yields, very high magnesium recovery, zero magnesium fumes, and no post inoculation is required.

**FINANCIAL ASSISTANCE**

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|---|---|---|---|
| Approved DOE Budget: | $200,000 | Approved DOE Share: | $200,000 |
| Obligated DOE Funds: | $200,000 | Cost Share: | $67,779 |
| Remaining Obligation: | $0 | | |
| Unpaid Balance: | $142,746 | **TOTAL PROJECT:** | **$267,779** |

Project Period: 09/01/02 to 08/31/04

# TECHNICAL PERFORMANCE

## DE-FG36-02GO12060

## Comanche Technologies, LLC

## A New Direct Pour In-Mold Technology for Producing Ductile and Compacted Graphite Iron Castings

## PROJECT SYNOPSIS

This invention combines two proven foundry techniques, in-mold magnesium treatment and the direct pour method, to produce a unique new technology, "Direct Pour In-Mold" (DPI). This technology solves several problems associated with standard in-mold treatment, plus it adds considerable benefits of direct pour. The use of a thin cast magnesium treatment alloy assures consistent, repeatable, treated metal that produces quality ductile and Compacted Graphite Iron (CGI) castings. The scope of work in this project is quite broad, combining both the engineering of the container and the marketing work required to understand the optimal launch price as well as best channel(s) to market. It begins after the technology's base design has been proven and ends with the start of the market launch with the primary licensee-partner. DPI benefits include significant energy savings, increased mold yields, very high magnesium recovery with zero fumes emitted, and no required post inoculation. DPI containers provide energy savings of 13.3% over comparable treatments.

## SUMMARY OF TECHNICAL PROGRESS

The DPI project team is close to completing Task 1.1 (Conduct Flow Modeling), and will soon be engaged in test lab metal pouring trials. A newly designed DPI step block casting pattern drawing has been forwarded to a pattern maker for a quotation. The pattern has been approved by Comanche Technologies and is being built. The pattern will then be shipped to the University of Alabama team. Once they receive the pattern, the University will fabricate the proper size flask for the pattern in their own shop.

This new design incorporates a re-designed in-gate, plus the addition of pads to accommodate two chill disk cores. The chill disks are used for spectrometer chemical analysis, and record the magnesium residual in the treated metal during the pour. One disk records the Magnesium in the first metal to enter the casting, and the other disk records the Magnesium residual in the last metal into the casting.

Monitoring the magnesium during the pour is important to make sure that the metal stream receives a constant and uniform amount of magnesium until the casting is filled.
It was decided that one more flow simulation should be conducted in order to verify that these modifications to the cores would not affect their performance adversely.
Once the flow simulation of the modified cores is checked, their drawings will be forwarded to a pattern maker for quotation. The completed core boxes will be sent to a core maker to produce a small number of cores so that test containers can start to assemble. Assembled test containers will be shipped to the University of Alabama for actual metal pouring trials.

## SUMMARY OF PLANNED WORK

Comanche Technologies will determine what weight of 4% & 6% MgFeSi (5-18 mesh) treatment alloy will produce the best ductile and compacted graphite iron microstructures in the step-block casting, using the standard base metal chemistries. Once the parameters that produce the best castings are determined, they will remain constant, except that the base metal sulfur level will

then be varied to determine what the lowest and highest values are before unacceptable castings are produced. All of the data to be recorded, listed above, will be required for this series of trials, plus the addition of a coupon cut out of each casting for metallographic examination.
All of the data collected from these trials will be collected, analyzed, and reported in a technical paper to be presented at a national foundry conference.

This data will also be used to file for both domestic and foreign patents. Before attempting extended trials at commercial foundries, Comanche will approach several licensee companies to determine their interest in producing larger quantities of test containers.

## PROJECT ANALYSIS

An initial lack of progress by Comanche's project partners has significantly delayed the project schedule. Fabrication of the prototype containers is only now beginning, but it expected to progress more smoothly in the coming months. Spending has been slow in accordance with the slow progress. It is expected that the project will require a no-cost time extension later this fiscal year.

## ACTION REQUIRED BY DOE HEADQUARTERS

No action is required from DOE Headquarters at this time.

# STATEMENT OF WORK
## DE-FG36-02GO12060
## Comanche Technologies, LLC
## A New Direct Pour In-Mold Technology for Producing Ductile and Compacted Graphite Iron Castings

## DETAILED TASK DESCRIPTIONS

### Task 1. Finalize DPI Unit Internal Design Structure

Computer flow modeling, using special software, will be used to fine-tune the internal chokes and runner dimensions, in order to achieve a 10 lb per second molten metal flow rate. Each different size container will probably require a modeling session, because as the weight of metal poured increases, so does the required flow rate. For example, a 1000 lb pour weight would probably need a 20 lb per second flow rate to achieve production requirements, and a 50 lb pour weight would need 10 lbs per second. Once computer modeling determines the correct internal dimensions for the particular size container, dies to produce those cores will be needed. Comanche will assemble these initial containers for testing, after which they would be sub-contracted to sleeve manufacturers for larger quantities.

*Subtask 1.1 Conduct Flow Modeling with Software*
Utilizing Flow-Modeling software, Comanche will determine the optimum internal dimensions for the next set of DPI unit prototypes. This task will tentatively be conducted by Concurrent Technologies.

*Subtask 1.2 Build Prototype Units Based on Modeling*
Construction of DPI unit prototypes will be done based on software modeling outcome. This task will be completed by Comanche Technologies.

*Subtask 1.3 Foundry Prototype Testing*
Prototype DPI units will be tested in partner foundries to determine performance. This task will be completed by Donsco Foundry.

*Subtask 1.4 Modifications / Retesting*
Modifications will be made on DPI unit internal design based on actual performance, then rerun tests to confirm changes. This task will be completed by Comanche personnel at Donsco Foundry.

### Task 2. Calibrate Treatment Alloy Weights

To achieve the proper microstructures in ductile and compacted graphite iron castings, certain ratios of residual magnesium to sulfur percentages are required. These ratios are achieved by manipulating the chemistry (% magnesium) in the magnesium ferrosilicon treatment alloy, the percent sulfur in the base metal, and the molten metal flow rate through the DPI containers. These are complex calculations, and also require special laboratory equipment, therefore University metal casting facilities are required.

*Subtask 2.1 Magnesium to Sulfur Testing*
Base metals will be prepared with different percentages of sulfur that correspond to various grades of iron and then adjust the treatment alloy to produce the desired Mg residuals. This task will be conducted via contract work by the Penn State University Metalcasting Laboratory.

*Subtask 2.2 Step Casting Analysis*
Step castings made during testing will be analyzed for Mg residuals and microstructures. Physical testing to determine casting properties will be performed. This task will be conducted via contract work by the Penn State University Metalcasting Laboratory.

*Subtask 2.3 Plot Optimum Alloy Packet Input Amounts*
Analysis data will be plotted to show the optimum range of alloy packet weight to % base metal sulfur for both ductile and CG Iron. This will determine our optimum input levels. This task will be conducted via contract work by the Penn State University Metalcasting Laboratory.

## Task 3. Apply DPI Technology to Other Applicable Casting Techniques

Typically the DPI container supplier will also supply pattern prints to the customer to modify the molds for container placement into the mold. All initial testing has used a common step-block test pattern with attached pads for setting a container on it, and then sand is placed around the container. Rough or "tree bark" outside surface containers are used for hand-placement in resin coated or no-bake sand molds, where the sand is rammed up around them, and smooth outside surface containers are required for mold insertion into a pre-formed cavity such as on a DISAMATIC vertically parted mold.

*Subtask 3.1 Alternate Casting Process DPI Integration Modeling*
The best methods of placing DPI containers in various mold-types such as Green Sand, Flaskless, and Chemical Bonded Sand will be determined. This task will be completed by Comanche Technologies.

*Subtask 3.2 Create Pattern Inserts and Run Extended Tests*
Comanche will create pattern inserts and run extended tests in both horizontal and vertically parted molds. This task will be completed by Comanche Technologies and one or more of the test facilities.

*Subtask 3.3 Analyze Test Metal Castings*
Analyze DPI metal castings created to ensure desired quality. This task will be completed by Comanche Technologies and one or more of the testing facilities.

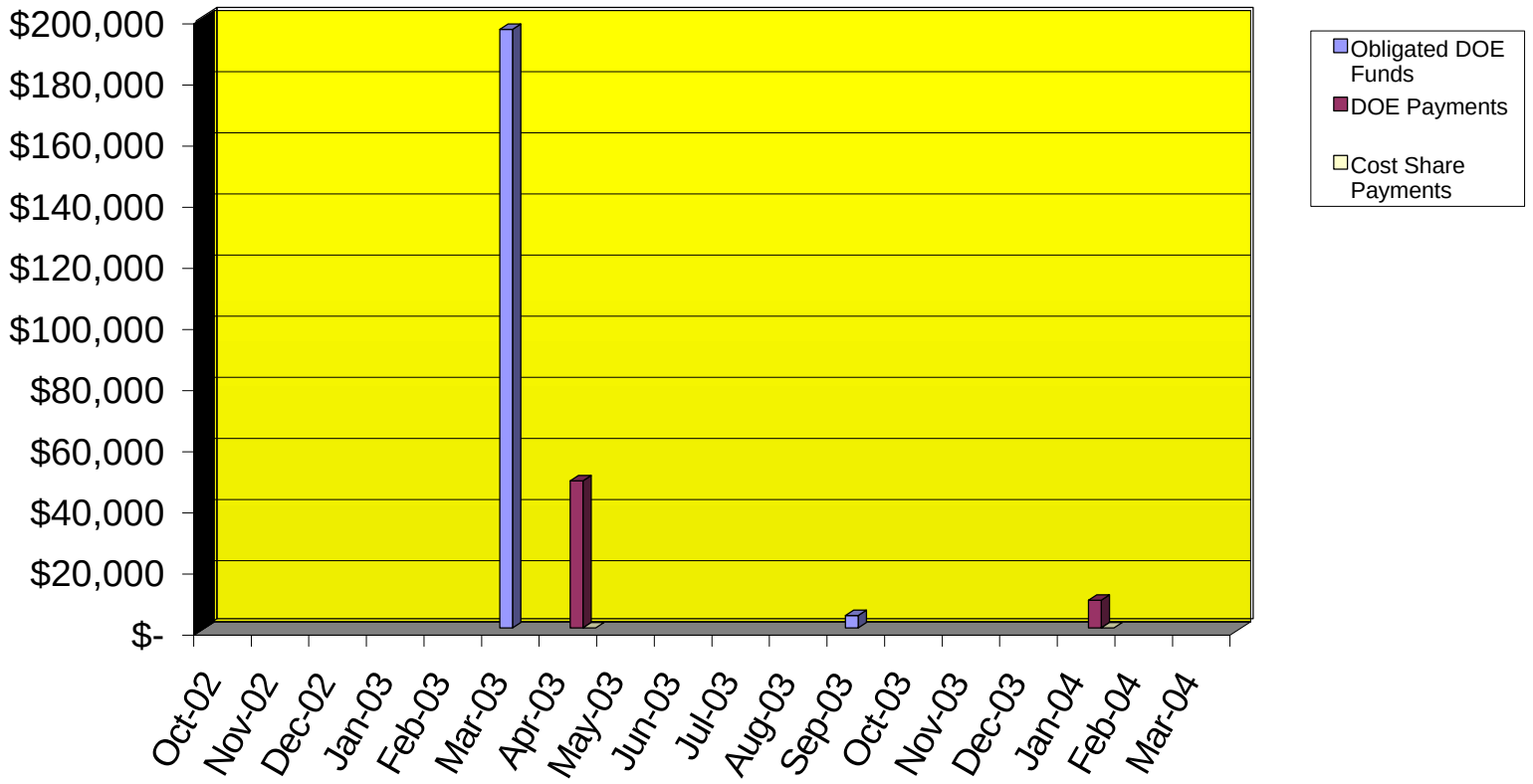
## Task 4. Project Management and Reporting

Comanche Technologies is responsible for submitting both Semi-Annual Progress Reports and a Final Report to DOE. The Semi-Annual Reports are due every April 30 and October 31. The Final Report is due 90 days after the project completion date as specified in the agreement. This task also includes other DOE requirements for market assessments, fact sheets, benefits analyses, workshops, etc.

# Project Cost Performance in DOE Dollars for Fiscal Year 2003

**DE-FG36-02GO12060** **Comanche Technologies, LLC**

**A New "Direct Pour In-Mold" (DPI) Technology for Producing Ductile and Compacted Graphite Iron Castings**




| | Oct-02 | Nov-02 | Dec-02 | Jan-03 | Feb-03 | Mar-03 | Apr-03 | May-03 | Jun-03 | Jul-03 | Aug-03 | Sep-03 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Obligated DOE Funds | $0 | $0 | $0 | $0 | $0 | $195,881 | $0 | $0 | $0 | $0 | $0 | $4,119 |
| DOE Payment | $0 | $0 | $0 | $0 | $0 | $0 | $48,124 | $0 | $0 | $0 | $0 | $0 |
| Cost Share Payment | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |

| | Oct-03 | Nov-03 | Dec-03 | Jan-04 | Feb-04 | Mar-04 | PFY* | Cumulative |
|---|---|---|---|---|---|---|---|---|
| Obligated DOE Funds | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $200,000 |
| DOE Payment | $0 | $0 | $0 | $9,130 | $0 | $0 | $0 | $57,254 |
| Cost Share Payment | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |

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|---|---|
| Approved DOE Budget: | $200,000 |
| Approved Cost Share Budget: | $67,779 |
| Total Project Budget: | $267,779 |

* Prior Fiscal Years

# Comanche Technologies, LLC - 02GO12060

| ID | Task Name |
|---|---|
| 1 | Task 1: Finalize DPI Unit Internal Design Structure |
| 2 | Task 2: Calibrate Treatment Alloy Weights |
| 3 | Task 3: Apply DPI Technology to Other Applicable Casting |
| 4 | Task 4: Project Management and Reporting |