I. **INTRODUCTIONS**

The meeting was called to order by Steve Midson who welcomed the attendees to the meeting. Next, attendee introductions were made and the meeting agenda was displayed. The meeting agenda and attendance list are shown in **Attachments A and B**, respectively.

II. **APPROVAL OF PREVIOUS MINUTES**

Steve Midson asked for a motion to approve the minutes of the June 13, 2012 Committee meeting. A motion was made by Tom Heider and seconded by Joe Price to accept the minutes as written. The motion was passed, approving the minutes without modification.

III. **ADMINISTRATION / NADCA HQ UPDATE**

Steve Udvardy provided the NADCA Headquarters update presentation, shown in **Attachment C**. A summary of the information presented is as follows.

Two die casting related E-SMARRT projects remain, the Thin Wall Zinc and LENS projects. Funds are being made available to finish these projects - $25K for the zinc project and $220K for the LENS project of the $900K remaining for the entire contract. The E-SMARRT Program will end in October of 2013. After being encouraged to submit a full proposal on SHS material for the DOE Innovative Manufacturing Initiative solicitation, the Colorado School of Mines proposal was not selected. In addition, the NADCA concept paper on molten metal on-demand in response to an ARPA-e solicitation resulted in a letter from DOE not encouraging a full proposal. No additional DOE funding has been secured at this point.

Four of the five new projects under the new DOD AMC Program, Castings Solutions for Readiness (CSR), are now under contract and a kick-off meeting was held on July 24 and 25, 2012 in Milwaukee. Approximately $2.2M will be allocated in Year 1 for the entire program. Die casting related projects for Year 1 include: Lube Free Die Casting; Thin Wall Aluminum and Magnesium; SSM and Squeeze Casting of 206 Alloy; and Specifications and Standards. Funding for these projects is approximately $415K. The fifth project related to on-demand melting will not be initiated with Year 1 funds. The Benet Labs related AMC SWC Program, under which the nano-composite project is funded, was extended through the end of September and a review of the SWC projects was held jointly with the CSR kick-off. To influence a future DOD solicitation and attempt to secure more DOD funding, NADCA will respond to an Industrial Base Innovation Fund RFI.

The HyperCAST Program contractually ended on June 30, 2012. A final report was formatted per DOE instructions and submitted. All contractual obligations have now been met.
The first NADCA R&D consortium project is now underway. The project is on modeling of heat removal by die spray and five companies have joined the consortium. One additional company is considering joining. The consortium projects are small focused projects for companies that pay $5,000 per project and for up to 5-6 company participants.

The Technology Administration Group had not met since the last round of proposal selections. There are currently two proposals seeking NADCA funds, one to continue the A380 T5 Heat Treatment work and one for the development of zinc SHS nano-composites. One to two die materials related proposals are anticipated to be received in the very near future. The TAG will meet later this year to select projects that are supported by the technical committees.

The 2012 Die Casting Congress and Exposition was held at the Indiana Convention Center in Indianapolis on October 8-10, 2012. There was 37,000 ft\(^2\) floor space sold to 158 exhibitors. The event attracted over 2,000 attendees from 470 companies (not including exhibitors). Twelve congress sessions were conducted, two of which were special format on die material and computer modeling. The die casting awards luncheon recognized the companies of award winning castings and other awards were distributed at the evening awards banquet. Included in these awards was the Technical Committee Member of the Year, Al Miller, and Best Congress Paper, *T6 Heat Treatment of Real High Pressure Die Castings - An Alternative to the High Cost of Permanent Mold Castings*, by Ray Donahue. The 2013 Die Casting Congress & Tabletop will be held on September 16-18 in Louisville, Kentucky. Abstracts for this congress will be due in January 2013.

Lastly, the scheduled webinar topics for the last quarter of year were shown and it was reported that the 2013 webinar schedule is currently under development.

### IV. CWRU PROJECT REVIEWS

David Schwam provided a presentation on the effect of welding on the toughness of H13 steel. The presentation can be found in Attachment D. This effort is being funded by NADCA in relation to the development of a 3-part webinar series which is being funded by the Harvill Foundation. The webinar series is on die care and maintenance and David will be presenting it later this year. Highlights of the presentation are as follows.

- This effort on welding is assessing weld rod type, pre-heating practice and post-heating practice.
- Charpy specimens are being removed from a 10”x6”x3” block of H13 (provided by Bohler-Uddeholm) with the notch in the ST direction. The specimens are autenitized, air quenched and tempered to 44-46 HRC. Some specimens have been welded and impact tested. More will be prepared in the future.
- The sides of specimens were TIG welded with H13, a maraging steel, and Anvilloy. All electrodes were 1/16 inch.
- Pre-heat temperature was 400°F and post-heat temperature was 850°F. These temperatures were selected but are not per the NADCA 207 specification. It is suggested that temperatures per the spec be followed for some of the future specimens as well as no pre or post heating since this is the practice of some plants.
Some of the specimens were just pre-heated, some were just post-heated and some were pre-heated and post-heated.

Impact testing of the specimens revealed little difference between just pre-heating, just post-heating, and pre-heating plus post-heating. However, all of the values were lower than the un-welded condition. It was mentioned that Charpy Impact may not be the best choice for testing welded H13.

Future work will entail repeating the experiments with micro-welding and bending fatigue will be considered as an assessment test.

David mentioned that CWRU will be participating in a national additive manufacturing innovation institute (NAMII) activity. There is a potential that a project related to die castings die could be funded through NAMII.

V. TASK FORCE ACTIVITY REPORTS

Updates on the following Task Force Activities were provided.

1. Die Surface Engineering Task Force, Chairman, Peter Ried

Peter Ried displayed notes from the last task force meeting/telecom which took place on October 19. The notes can be found as Attachment E and are summarized as follows.

- Peter will be contacting David Bell to reaffirm Phygen’s support of the task force’s activities.
- One long core pin (detail 37) has been coated by CSM with a non-optimized CrN-AlN superlattice using the hybrid MPP+PMS deep oscillation system. This pin will soon run at Airo as in-plant Trial #4.
- A visual comparison of wear patterns on pins from Trial #3 with the MAGMA modeling predictions is pending.
- Dynaflow is willing to work together with the group on the cavitation investigation. The Purdue ultrasonic test will be used as a part of this investigation.
- The pins being run at Twin City in the Harley-Davidson Rocker Cover (Trial #5) are now up to 22,000 shots.
- Nine groups of pins are being tested at Purdue with the ultrasonic tester and Harley is doing some evaluation on their own. Pins treated with the DynaBlue FeNC and Thermallife FeNC processes are part of the test matrix.
- The task force is trying to assess the market potential for new coatings.
- Blue Ridge Pressure Casting may be interested in running some trials on coated core pins.
- Task force goals were revisited in June. The two main goals are: 1) development of improved, application-specific coatings & substrate systems, and; 2) a 10-fold increase in mean time between failures.
- The next task force web meeting is scheduled for Friday, November 16, 2012.

Next, Peter provided an overview of CSM’s portion of the new AMC Lube-Free Die Casting Project which was initiated mid-2012. This overview can be found in Attachment F and highlights are shown below.
To achieve a lube-free die casting process semi-permanent to permanent non-sticking self-lubricating coatings are required. These are the types of coatings CSM will be investigating under this project. Bo Wang is the graduate student that has been selected for the project.

A literature review has been initiated and candidate coatings have been identified. These include AlN, Al$_2$O$_3$, CrN, CrAlN, TiBCN, AlBN, AlBN-Ag, AlN-Ag, AlN/Al$_2$O$_3$ (or AlON), AlN-Ag/Al$_2$O$_3$, AlON-Ag/Al$_2$O$_3$, AlBN-Ag/Al$_2$O$_3$, and AlBON-Ag/Al$_2$O$_3$. Some of the Ag containing compounds are amorphous matrix.

The Sessile drop test is being used to assess non-wetting of coatings. As a preliminary measure, contact angles for a water drop on AlN and TiBCN coatings have been measured. The angles were $79.5\pm2.0^\circ$ and $87.8\pm1.9^\circ$, respectively. It is concluded that TiBCN provides better non-wetting than AlN at room temperature.

Work planned for the future entails finishing the literature review, selecting 2-3 coating candidates for development, and conducting high-temperature Sessile drop testing.

2. **Die Materials Development Task Force**, Chairman, Steve Midson

Steve Midson provided the presentation shown in Attachment G and highlights are as follows.

The goals of the task force were shown as a reminder. These include collecting data on closer cooling line placement for new die steels, composite cores, and niobium cores.

The last task force meeting took place on June 13, 2012 and the task force members defined characteristics of an “ideal die” for in-plant trials. The characteristics are: a high running tool of about 100,000 shots per year; a multi-cavity tool so H13 can be run side-by-side with new die steels, and; a tool that runs on a regular basis to allow periodic collection of data and castings.

In addition, the task force members listed the recommended data that die castings plants should collect during trials. Castings, when collected, are to be sent to CWRU for evaluation.

During this meeting, the committee was asked if any additional information should be added to the list. The suggestions were: a process sheet, thermal images of the die, die spray details, die temperature excursion (maybe a video), indication of disruptions and shutdowns, start-up procedure, initial die hardness, and whether vacuum is used.

It was mentioned that an ad will be placed in the DCE magazine to solicit for more die casters willing to run trials.

3. **Die Material Specification & Heat Treat Task Forces**, Gene Hainault, Chairman

Gene Hainault could not be present at the meeting but asked Mark Goodyear to provide information on the study of austenitizing time for impact specimens. The information provided by Mark is shown in Attachment H and a summary follows.

The last task force meeting was held yesterday afternoon to review details of the study which was conducted due to concern about austenitizing time for impact specimens.
Die Materials Committee Meeting
October 24, 2012 - p. 5

- The details of the sample preparation, including sectioning, heat treating, final machining, and testing were provided.
- Three sets of five impact specimens, all from the same block of Grade B H13, were austenitized at each of 30, 45 and 60 minutes. (Exova has always used 45 minutes.) The austenitizing time was started when the thermocouple in the specimen block hit 1875°F. This took about 25 minutes.
- The test results from the three sets of specimens showed average values of 18.2 ft-lb, 18.5 ft-lb, and 16.6 ft-lb for the 30, 45, and 60 minute soak times, respectively. The drop in toughness at 60 minutes may be due to grain growth and/or more solutionizing.
- It is suggested that the specification be changed to allow a range for austenitizing time of 30-45 minutes. It currently states 30 minutes.

VI. SPECIAL PRESENTATION

A special presentation on Hitachi and their DAC-MAGIC die steel was provided by Mr. Motoi Yamaguchi. Highlights from the presentation are as follows and information on the DAC-MAGIC can be found in Attachment H.

- The Hitachi Company was founded in 1956. Sales for all business units were $7.4B in 2010.
- The Specialty Steel Division, Hitachi Metals Yasugi Works, employs 1550 people, produces 9100 tons/month, for sales of about $125M/month. Material produced is for forging dies, aircraft, die casting dies, and other products. About 35% is tool steel.
- The DAC-MAGIC steel is used for die casting dies. Toyota and Honda use this material. It runs about $7/pound and the current maximum size is 15” x 36” x 95”.
- The material has better impact and thermal fatigue strength than H13. The composition is: 0.35-0.42 C, 0.5-0.8 Mn, 0.015 P, 0.005 S, 0.30-0.45 Si, 0.25 Ni, 5.0-5.6 Cr, 2.4-2.75 Mo, and 0.5-0.8 V.
- The recommended heat treatment is an austenitize at 1020+/−10°C (1868+/−18°F) for 30 minutes, gas or oil quench, and temper a minimum of 2 times at 1049°F or greater for a minimum of 2 hours. The recommended hardness range is 45-52 HRC.
- At 44-46 HRC, the DAC-MAGIC can achieve a minimum impact capability of 10 ft-lb average and 8 ft-lb average after heat treatment to 44-46 HRC.
- The response to nitriding is the same as H13 and its strength at elevated temperature is better than H13 although the temperature strength is the same as H13.
- The DAC-MAGIC material is being presented as a candidate for the NADCA 207 specification.

VII. DISCUSSION - NEW/OTHER BUSINESS

A brainstorming session was held to develop a list of ideas for future research projects. The ideas generated were for both short term low risk and long term high risk projects that are intended to foster continued technological advancements in die casting. The list of ideas will be distributed under separate cover after being compiled with the brainstorming list from the R&D Committee meeting.

No other new business was discussed.
VIII. NEXT MEETING DATES

The meetings next year will be again held back-to-back with the R&D Committee. The tentative sets of dates are February 5-7, June 11-13 and October 15-17, 2013. The first day in the set of dates will be for task force meetings, the second day will be for the full Die Materials Committee meeting and the third day will be for the full R&D Committee meeting. Therefore, contingent upon agreement by the R&D Committee on the set of dates, the next Die Materials Committee meeting will be on February 6, 2013 at NADCA in Wheeling, IL. The June meeting will be off-site at a location yet to be determined.

IX. ADJOURNMENT

With no other topics suggested for discussion, the meeting was adjourned by Steve Midson.

Submitted by:      Approved by:
STEPHEN P. UDVARDY    STEPHEN P. MIDSON
Acting Secretary & Staff Liaison   Chairman
NADCA Die Materials Committee   NADCA Die Materials Committee

Prepared by: SPU

\DMC Minutes 10 24 ’12