Greenhouse Gas Regulations and the North American Die Casting Industry

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NADCA
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1. Introduction

The die casting industry in North America is an important segment of the larger metal casting industry, and produces over one-third of all metal castings. Over 500 die casters manufacture thousands of non-ferrous castings: from automobile engine and transmission parts to intricate components for computers and medical devices, or even for a desk stapler. In fact, castings are used in 90% of all finished manufactured products.

Die casters contribute over $7.3 billion to the nation’s economy annually and provide over 63,000 jobs directly or indirectly. A microcosm of American business, 58% of die casting companies have fewer than 100 employees, while the larger firms are world leaders. To meet the challenges posed by today’s global marketplace, the North American die casting industry is leading the rest of the world with new technology, higher productivity, innovative applications and superior quality.

The die casting industry has a unique environmental position. The metal alloys used by die casters are produced from primarily recycled raw materials, created with far less energy than is required for virgin alloys. Over 95% of the aluminum die castings produced in North America are made of post-consumer recycled aluminum, helping to keep the aluminum content of municipal solid waste to less than 1%. Die castings are not hazardous waste and pose no problems in handling or reprocessing. At the end of a casting’s life cycle, a metal reclamation infrastructure exists to reclaim, re-alloy and recycle these parts back into high performance manufactured components and ensure the availability of yet unimagined die castings for tomorrow.

The North American Die Casting Association (NADCA) is the sole trade and technical association of the die casting industry. Membership in NADCA consists of personnel from over 950 companies located in every geographic region. These companies include custom die casters (who produce die castings for sale to others), captive die casters (who produce castings for their own use in manufacturing a product), and suppliers to the die casting industry. NADCA members can be found in every type of community, representing both rural and urban interests.

One of the primary objectives of NADCA is the development technical information for the benefit of its members and member companies. This report on Greenhouse Gas Regulations and the North American Die Casting Industry is directed at this objective. For several years now, discussions concerning Global Warming and the need to regulate greenhouse gas (GHG) emissions have been heard from environmentalists, scientists, and politicians. Since the Kyoto Protocol, negotiated in 1997, various other efforts to regulate the GHG emissions have been proposed. This report provides for the die cast-
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Introduction

...ing industry in North America an overview of these proposals and how they might affect member die casting companies. While the final requirements of such regulations are unclear at this time, this report provides information for die casting companies on the potential requirements and suggests steps that the industry can take to prepare for these requirements. The report also suggests strategies that could be used to comply with any proposed regulations that would also reduce operating costs both now and in the future.

This report is divided into five text sections plus an Appendix, which contains a Bibliography of references for further study by those who may be interested. Following this Introduction, Section II presents an Executive Summary of the report. Section III presents The Global Warming Debate. This section will discuss the different scientific positions on whether global warming is occurring, its potential causes, and what actions are being proposed to mitigate it. Section IV presents a summary of the various regulations and legislative proposals that have been offered to reduce GHG emissions, which many suggest is a major cause of global warming. Section V discusses the potential impact of these proposed GHG regulations on the die casting industry. Information is provided to help individual die casting plants or companies measure the effects of proposed regulations on their operations and to identify potential improvements that could be made in their production processes.

The author wishes to express his appreciation to James F. Schifo of Keramida, Inc., in Indianapolis, Indiana, for his assistance with this project. In particular, his report entitled, “Theoretical/Best Practice Energy Use in Metalcasting Operations,” which was prepared in May, 2004, for the U.S. Department of Energy was very helpful. This report provides an excellent analysis of energy consumption and resulting CO₂ emissions for metalcasting operations, including die casting facilities.
2. Executive Summary

Global warming has received much attention in recent years. There seems to be a general consensus in the scientific community that global warming is occurring. The average global surface temperature has risen about 1.2 °F since 1880. The dispute arises over whether this increase in global temperature is due to natural variation or caused by the burning of fossil fuels. Many scientists believe that this global temperature increase is due to an increase in greenhouse gas (GHG) concentrations in the atmosphere. These gases regulate temperature by holding in heat from the sun.

Greenhouse gases are 97% water vapor. About half of the remaining gases are carbon dioxide (CO\textsubscript{2}). It is an increase in CO\textsubscript{2} concentration that is of most concern to some scientists. Recent legislation proposals to reduce CO\textsubscript{2} levels include the Kyoto Protocol, the 2007 Lieberman-Warner Climate Security Act (S. 2191), and H.R. 2764, which directed the EPA to publish a mandatory greenhouse gas reporting rule by June 2009. The U.S. has not ratified the Kyoto Protocol and the Lieberman-Warner bill never came to a vote. However, both 2008 presidential candidates endorsed the adoption of some form of climate change legislation.

The objective of proposed climate change regulations is to reduce the emission of GHGs to the atmosphere in order to mitigate their alleged impact on global warming. This would be accomplished by setting baseline emissions targets and then establishing mandatory reductions in future years. The impact of proposed regulations on die casting companies will be increased energy costs and additional reporting requirements, at a minimum.

An analysis of the Lieberman-Warner bill by the National Association of Manufacturers\textsuperscript{7} estimated that natural gas costs would increase 26% to 36% in 2020, and 108% to 146% in 2030. Electricity costs were estimated to increase 28% to 33% in 2020, and 101% to 129% in 2030. In addition, CO\textsubscript{2} credits might be required for companies not able to meet their emission targets. These credits were estimated to cost $55 to $64 per metric ton of CO\textsubscript{2} emitted, and would rise to $227 to $271 per metric ton of CO\textsubscript{2} in 2030.

The metalcasting industry is estimated to contribute 1.9% of total CO\textsubscript{2} emissions by the U.S. annually. Die casting CO\textsubscript{2} emissions for 2003 have been estimated at 6.2 million tons for aluminum die casters and 0.5 million tons each for magnesium and zinc die casters. These emissions come primarily from the direct combustion of natural gas and from indirect emissions resulting from purchased electricity. For magnesium die casting plants, the use of sulfur hexafluoride (SF\textsubscript{6}) as a cover gas may also be significant.
At present, there is no consensus around any particular proposal to regulate GHG emissions. The Lieberman-Warner bill proposed limiting GHG emissions from electric power, transportation, and manufacturing sectors to 2005 levels by 2012 and then 70% below 2005 levels by 2050. What the level of emissions would be that would cause a plant to receive a GHG target is difficult to predict. However, the EPA is required to develop a reporting system for GHGs by the middle of 2009 and the level of emissions that could require reporting may be as low as 25 tons of CO$_2$ per year. Shipments of only 12,600 pounds per year for aluminum die castings, 11,000 pounds per year of magnesium die castings, or 33,000 pounds per year for zinc die castings would place a plant over the emissions limit and require reporting to the EPA.

A form to calculate CO$_2$ emissions from a die casting plant was developed and is included in this report as Figure 8. It permits a plant to compute its CO$_2$ emissions from either its energy use or its casting shipments. More complete procedures have been developed to assess the GHG inventory of a plant or company. These are called the “Corporate Accounting and Reporting Standard” and are available from the World Resources Institute at www.ghgprotocol.org.

There are several opportunities that die casting companies have in the area of GHG regulations. First, collecting relevant GHG emission data and documenting past emission levels is important. With mandatory reporting required perhaps as early as June, 2009, it is important to establish baseline data. Without such data, targets may not recognize improvements already implemented.

Second, die casting companies should review current energy efficiency company-wide. The NADCA Energy Saving Manual, available at www.diecasting.org, provides the structure and methods to examine energy use across each plant. This will become essential if and when additional regulations are implemented around GHG emissions.

Third, die casting companies should implement energy reduction projects. These projects could be in areas such as more efficient melting and holding of metal, lighting improvements, heat recuperation, reduction of compressed air losses, electrical power factor management, or the use of more efficient electric motors. These projects offer the potential of cost savings as well as providing a reduction in GHG emissions. The industry should not wait for government mandated GHG emissions targets to make energy efficiency improvements that are cost justified.
3. The Global Warming Debate

The Issues

Global warming is a topic of much discussion in recent years. In 2006, former U.S. Vice President Al Gore presented global warming as an imminent threat to the planet in his Oscar-winning documentary *An Inconvenient Truth*. Global warming is defined as an increase in the average temperature of the Earth’s near-surface air and oceans since the mid-20th century and its projected continuation. According to the Intergovernmental Panel on Climate Change (IPCC), the global surface temperature increased 1.33 ± 0.32 °F during the 100 years ending in 2005.\(^2\) Figure 1 shows a plot of the global mean surface temperatures from 1961 to 1990.

![Figure 1: Global mean surface temperature anomaly relative to 1961-1990.](source: globalwarmingart.com/wiki)

This global warming trend is a concern to many scientists who believe that it will cause sea levels to rise and will change the amount and pattern of precipitation, likely including an expansion of the subtropical desert regions. Other effects considered likely include increases in the intensity of extreme weather events, changes in agricultural yields, modifications of trade routes, glacier retreat, species extinctions, and increases in the propagation of diseases.
There does seem to be a general consensus about whether global warming is occurring. In the strictest definition, the average global surface temperature has risen about 1.2 °F since 1880, as shown in Figure 1. The dispute arises over whether this increase in global temperature is a natural variation or is caused by the actions of humans, and whether it poses a threat to either the planet or to human beings. This is discussed further in the next section.

**The Causes**

The IPCC has concluded that most of the global temperature increase since the mid-twentieth century is “very likely” due to an increase in greenhouse gas concentrations in the atmosphere. Greenhouse gases regulate the earth’s temperature by holding in heat from the sun, and as such, these gases are necessary for life. Naturally occurring greenhouse gases have a mean warming effect of about 59°F, without which Earth would be uninhabitable.

Greenhouse gases are mostly water vapor, as shown in Figure 2. This figure is from a presentation made to the AFS GHG Task Force by Jim Schifo, from Keramida, Inc. It shows that 97% of greenhouse gases are water vapor. Half of the remaining gases are CO$_2$, with the rest made up of methane (CH$_4$), nitrous oxide, halocarbons, and ozone.

Many scientists suggest that human activity since the industrial revolution has increased the concentration of carbon dioxide, methane and nitrous oxide in the atmosphere. The increase in CO$_2$ concentration over the last 250 years can be seen in Figure 3. While the data indicate an increase in the CO$_2$ concentration, other scientists maintain that CO$_2$ has only a minor effect on the greenhouse warmth that makes our planet livable. They contend that it is the water vapor that actually stabilizes our climate. If it gets too hot, evaporation will increase and clouds will cool the climate by reflecting sunlight from the tops of the white clouds. It also works the other way; cooler temperatures result in less cloudiness and more absorption of solar radiation at the surface.
Proposed Solutions

There is a great deal of political momentum in many countries, including in the United States, around the belief that the warming of the earth has been caused by the increased levels of CO₂ in the atmosphere, and that this increase is the result of the combustion of fossil fuels since the Industrial Revolution. The solution proposed is to achieve significant reduction in CO₂ emissions worldwide through the use of binding targets for reduced CO₂ emissions with penalties for non-attainment worldwide. Several of the proposals to accomplish this objective are discussed in the next section.

Opponents of proposals to arbitrarily reduce CO₂ emissions argue that CO₂ is released to the atmosphere by a variety of natural sources, and over 95% of total CO₂ emissions would occur even if humans were not present on Earth. For example, the natural decay of organic material in forests and grasslands, such as dead trees, results in the release of over 8 times the amount of CO₂ emitted by humans. Also, the oceans contain much more CO₂ than the atmosphere and serve as a “CO₂ sink.” These massive bodies of water release or absorb CO₂ based upon climatic changes. This group of scientists contends that programs to reduce global warming will not work and will only serve to increase the cost of energy worldwide, and will be especially harmful to those in poor and undeveloped countries.

Unfortunately, the most common positions on this issue are diametrically opposed. One group takes the position that global warming due to increases in CO₂ in the atmosphere caused by human beings is destroying the Earth. The other group feels that global warming is due to natural Earth cycles and will correct itself. Significant scientific effort is being expended on both sides. This is dangerous because scientists should let discovery lead scientific conclusions, not the other way around. It is likely that both natural and human causes contribute to increased CO₂ concentrations in the atmosphere. Whether reducing human CO₂ emissions is needed and will appreciably slow the progress of global warming must be supported by science.
4. Proposals to Regulate Greenhouse Gas Emissions

Whether a person agrees with the premise that human beings have caused changes in greenhouse gas (GHG) concentrations and this is the reason for global warming or not, there is significant scientific and political momentum at present to develop and adopt regulations to address this issue. In order to familiarize the die casting industry with the general theme of these regulations, they are summarized in this section. It is important to recognize that no such regulations have been adopted by the United States through the end of 2008. However, both 2008 U.S. presidential candidates endorsed the adoption of some form of climate change legislation.

This section is divided into two parts. First, the various proposals that have been offered are discussed. These include the Kyoto Protocol, congressional proposals, and proposals by the U.S. Environmental Protection Agency (EPA). Second, a summary of the general provisions of proposals being considered are presented. This discussion will provide the industry perspective on what some of the likely requirements could be. At this time, it is difficult to predict the final outcome of what will certainly be a lively debate.

GHG Proposals

The Kyoto Protocol treaty was negotiated in December 1997 in Kyoto, Japan, and came into force on February 16, 2005. It is a legally binding agreement under which industrialized countries must reduce their collective emissions of greenhouse gases by 5.2% compared to the year 1990. (Note, however, that when compared to the emission levels that would be expected by 2010 without the Protocol, this target represents a 29% cut.) The goal is to lower overall emissions from six greenhouse gases – carbon dioxide, methane, nitrous oxide, sulfur hexafluoride, HFCs, and PFCs – calculated as an average over the five-year period of 2008-12.

The relative effect of various GHGs on the environment is quantified by the term Global Warming Potential (GWP). GWP is a scale which compares the gas in question to that of the same mass of carbon dioxide (whose GWP is by definition 1). A GWP is calculated over a specific time interval and the value of this must be stated whenever a GWP is quoted or else the value is meaningless. Often the GWP of various gases is compared by regulators at a time interval of 100 years. The GWP of the various GHGs are shown in Figure 4. Magnesium die casters should take note that the GWP of sulfur hexafluoride (SF$_6$), which is often used as a cover gas, is 22,800 times that of CO$_2$. Since GHG emissions are often reported as CO$_2$-equivalent emissions, a small amount of SF$_6$ emissions becomes a high level of CO$_2$-equivalent emissions.
Greenhouse Gas Regulations

National emissions targets in the protocol ranged from 8% reductions for the European Union and some others to 7% for the U.S., 6% for Japan, 0% for Russia, and it permitted increases of 8% for Australia and 10% for Iceland. The parties signing the Protocol agreed to a set of “common but differentiated responsibilities.” They agreed that:

1. The largest share of historical and current global emission of greenhouse gases has originated in developed countries;
2. Per capita emissions in developing countries are still relatively low, and
3. The share of global emissions originating in developing countries will grow to meet their social and developmental needs.\(^5\)

In other words, China, India, and other developing countries were not included in any numerical limitation because they were not the main contributors to the GHG emissions during the pre-treaty industrialization period.

As of May 2008, a total of 181 countries and the European Union have ratified the agreement. The United States, although a signatory to the Kyoto Protocol, has neither ratified nor withdrawn from the Protocol. The United State was, at least as of 2005, the largest per capita emitter of carbon dioxide from the burning of fossil fuels. On July 25, 1997, the U.S. Senate signed a resolution which stated that the United States should not be a signatory to any protocol that did not include binding targets and timetables for developing as well as industrialized nations. On November 12, 1998, Vice President Al Gore symbolically signed the protocol. Both Gore and Senator Joseph Lieberman indicated that the protocol would not be acted upon in the Senate until there was participation by the developing nations. The Clinton Administration never submitted the protocol to the Senate for ratification.

During 2000-2008, President George W. Bush indicated that he did not intend to submit the treaty for ratification, not because he does not support the Kyoto principles, but because of the exemption granted to China (now the world’s largest emitter of carbon dioxide, although emission is very low per capita). China is building on average one coal-fired power plant every week, and plans to continue doing so for several years.\(^5\)
Several states and cities within the U.S. have adopted various regulations which embrace the terms of the Kyoto Protocol. So far, the states of Maine, New Hampshire, Vermont, Connecticut, New York, New Jersey, Delaware, Massachusetts, and Maryland, as well as 850 cities in all 50 states and the District of Columbia and Puerto Rico, have signed on as in support of the protocol.

The Kyoto Protocol is a “cap and trade” system that imposes national caps on the emissions of industrialized countries. Although these caps are national-level commitments, in practice most countries will assign their emissions targets to individual industrial entities, such as a power or paper factory. The European Union has already developed a “cap and trade” system.

This means that the ultimate buyers of credits are often individual companies that expect their emissions will exceed their assigned quota. Typically, they will purchase credits directly from another party that has excess allowances, from a broker, or on an exchange. Since allowances and carbon credits are tradeable instruments, financial investors can buy them on the spot market for speculation purposes, or link them to futures contracts. A high volume of trading in this secondary market is said to help price discovery and liquidity, and in this way help to keep down costs and set a clear price signal in CO₂, which helps businesses to plan investments. This market has grown substantially, with banks, brokers, funds, arbitrageurs and private traders now participating in a market valued at about $60 billion in 2007.

**America’s Climate Security Act of 2007**, or the Lieberman-Warner Climate Security Act (S. 2191), also commonly referred to as the “Cap and Trade Bill”, was proposed for greater U.S. alignment with the Kyoto Protocol standards and goals. The bill is almost 500 pages long, and provides for establishment of a federal bureau of Carbon Trading, Regulation, and Enforcement, with mandates which some authorities suggest will amount to the largest tax increase in the history of the United States. The bill aims to reduce total U.S. GHG emissions, with the goal of lowering emissions 63% below their 2005 levels by the year 2050. These reductions would be achieved through a system that would call for companies to cap their emissions, and then to have them trade emissions rights with each other.

This bill did not make it to the Senate floor for a vote and has been withdrawn. However, it was approved 11-8 by the Senate Environment and Public Works Committee, the first comprehensive global warming bill to make it through any committee in Congress. Several similar bills are being drafted in both houses of Congress. It is expected that some of them will be proposed when the new Congress meets in early 2009.

**U.S. EPA Requirements** have also been developed to address global warming. In April 2007, the U.S. Supreme Court ruled that the EPA has the discretion to decide when and how to best respond to international environmental threats, including global warming. The Court stated, “Under the clear terms of the Clean Air Act (CAA), EPA can avoid taking further action only if it determines that greenhouse gases do not contribute to climate change or if it provides some reasonable explanation.”
In 2008, Congress (H.R. 2764; Public Law 110-161) directed EPA to publish a mandatory greenhouse gas reporting rule, using the Agency’s existing authority under the Clean Air Act. The rule requires mandatory reporting of greenhouse gases “above appropriate thresholds in all sectors of the economy.” EPA is responsible for determining those thresholds, as well as the frequency of reporting. A final rule is required by June 2009.

EPA is being pressured to actually “regulate” CO₂ emissions as they do criteria pollutants. This would require Title V permitting, prevention of significant deterioration (PSD), and other criteria pollutant requirements.

On July 30, 2008, the EPA issued an Advance Notice of Proposed Rulemaking (ANPR) on “Regulating Greenhouse Gas Emissions Under the Clean Air Act.” The proposed rule document solicited comments from the public until November 28, 2008. EPA said that GHGs do not fit the existing regulatory framework developed for other pollutants. They contend that they are unsure of how to regulate GHGs. Industry comments (including comments from the American Foundry Society) have suggested that EPA regulate GHGs by implementing whatever bill Congress passes rather than duplicating their efforts.

Global warming and GHGs are not short term or local exposure issues so permitting specific point sources does not address the problem. A national long term strategy is required. Even so, some states, such as Kansas, have denied permits to build new power plants because the permits did not address or limit CO₂ emissions. They are claiming that increased CO₂ emissions pose a threat to humans and the environment. Therefore, potential EPA action cannot be ignored even though USEPA does not want to handle it.

Analysis of the proposal by the National Association of Manufacturers states: “Using provisions of the Clean Air Act, which was enacted by Congress to reduce local and regional emissions of air pollutants such as Particulate Matter (PM) and ozone, to regulate carbon, defies common sense. The NAM favors a modern, comprehensive, federal climate policy – debated by Congress – that will address the climate issues without exacerbating the current energy crisis.” NAM President, John Engler, said, “Several economic analyses – including a 2008 study commissioned by the NAM – conclude that misguided approaches to federal climate policy can result in significant job losses across our nation and would reduce Gross Domestic Product, lower household income, and increase the cost of gasoline and electricity.”

Summary of Proposed Regulations

The objective of every proposed climate change regulation is to reduce the emission of GHGs to the atmosphere in order to mitigate their alleged impact on global warming. This would be accomplished by setting baseline emissions and mandatory reductions in future years. Since the primary way that GHGs are generated is through the combustion of fossil fuels, more efficient use of those fuels or their replacement with renewable energy sources would be required. It is important to realize that emissions targets would likely be set industry by industry and are not tied to production levels. Increased production would only be permitted through offsetting emissions reductions or by the purchase of credits. The cost of credits will be market driven.
An analysis of the Climate Security Act by the National Association of Manufacturers had the following findings:

- The CO₂ emissions allowance price needed to reduce energy use to meet the S.2191 targets is estimated at $55 to $64/metric ton CO₂, rising to between $227 to $271/metric ton CO₂ in 2030.

- The cost of the allowances raises energy prices for residential consumers by:
  - Natural gas: 26% to 36% in 2020, and 108% to 146% in 2030.
  - Electricity: 28% to 33% in 2020, and 101% to 129% in 2030.

An example of how this is being implemented in Europe can be seen in an Associated Press article on December 13, 2008, entitled, EU approves deal to fight climate change. It stated: “EU leaders have agreed to cut GHG emissions at least 20% and raise the use of renewable energy to 20% by 2020. There will be a mandatory emission target for each EU nation, ranging from minus 20% to plus 20%, so that rich EU nations contribute disproportionately to combat climate change. Major polluters will eventually pay about $66.1 billion a year in emissions trading charges. The cost of the pollution permits will hike electricity prices by up to 15%. Wind, solar, and energy crops must account for 20% of EU energy use by 2020, up from 8.5% today.”

Another example of a national CO₂ emission strategy is that practiced by France. They shut down their last coal mine in 2004. They now get 80% of their electricity from nuclear power.

In simple terms, the impact of regulations to reduce GHG emissions, whatever the details of the plan, will result in increased energy costs and increased reporting requirements for many businesses. Energy intensive industries will be the targets of such regulation in order for countries to meet their GHG emission targets. How such regulations might be implemented in the U.S. remains to be seen. Significant debate and discussion will certainly take place beginning in 2009.
5. Greenhouse Gas Emissions & the Die Casting Industry

Global greenhouse gas emissions have been increasing in recent years as the result of fossil fuel burning. This can be seen by country for the years 1752 to 2002 in Figure 5. This figure shows that as of 2002, the U.S. was the largest emitter of CO$_2$, closely followed by China. The scale on the left is millions of metric tons of CO$_2$.

Since the U.S. is a major contributor to GHG emissions, there is increasing pressure both inside and outside the U.S. for instituting some program to reduce these emissions. In this section the contribution of the die casting industry to these emissions and the impact of proposed regulations on the die casting industry are discussed. Finally, several opportunities that exist for the die casting industry in this area are discussed.

Die Casting Industry GHG Emissions

The U.S. metalcasting industry is estimated to contribute 1.9% of total CO$_2$ emissions annually. By comparison, in 2000, light-duty vehicles contributed 18% of total U.S. CO$_2$ emissions. The metalcasting contribution is broken down by metal in Figure 6. This figure is from a presentation made by Jim Schifo from Keramida, Inc. to the AFS GHG Adhoc Committee.
For die casting, CO\textsubscript{2} emissions for 2003 have been estimated at 6.2 million tons for aluminum die casters and 0.5 million tons each for magnesium and zinc die casters.\textsuperscript{1} These emissions come primarily from the direct combustion of natural gas and indirect emissions resulting from purchased electricity. For magnesium die casting plants, the use of sulfur hexafluoride (SF\textsubscript{6}) as a cover gas may also be significant. (The International Magnesium Association has committed to a goal of eliminating the use of SF\textsubscript{6} by 2010, but many die casters may be unaware of this.) Since metalcasting is a significant contributor to total U.S. GHG emissions, it should be expected that the industry will be impacted by proposed regulations to reduce GHG emissions.

The Potential Impact of Proposed GHG Regulations

Since there is currently no consensus around any particular proposal to regulate GHG emissions, it is somewhat difficult to predict the outcome of the many draft proposals being prepared for the 2009 U.S. Congress. If regulations similar to the Lieberman-Warner Climate Security Act (S. 2191) were approved, GHG emissions from electric power, transportation, and manufacturing sectors would be limited to 2005 levels by 2012 and to 70% below 2005 levels by 2050. Already in effect are requirements for the U.S. EPA to set up a reporting structure by June 2009. The impact of any regulations to limit GHG emissions from die casting plants are likely to occur in two main areas: reporting requirements and energy costs.

EPA reporting requirements, scheduled to begin in mid-2009, may extend to plants emitting as little as 25 tons per year of CO\textsubscript{2}. Using simple emission factors from a report done for the U.S. Department of Energy in 2004\textsuperscript{1}, aluminum die casting produces on average 3.95 tons of CO\textsubscript{2} per ton of casting shipments. This means that a plant shipping as little as 12,600 pounds of castings annually would fall under the reporting requirement. For magnesium die casters, the average emission factor is 4.56 tons of CO\textsubscript{2} per ton of casting shipments. This would cause a plant with annual shipments of as little as 11,000 pounds of magnesium casting shipments to be required to report. Zinc die casting has an average emission factor of 1.50 tons of CO\textsubscript{2} per ton of casting shipments. A zinc die casting plant with shipments of 33,000 pounds per year would exceed a 25 TPY reporting requirement.
While the emission factors above are based upon actual die casting plant data, they should be used only to estimate the GHG emissions from a plant with a known level of casting shipments. The data that will be required for reporting relates more to actual energy consumption. This is divided into direct and indirect energy use. Figure 7 provides a graphical description of these energy uses.

**Figure 7: Overview of Scopes and Emissions of an Operation**

Scope 1 is the direct energy used by the manufacturing facility, and includes fuel consumed by and other GHGs emitted during production operations and by its company owned vehicles. Scope 2 is indirect energy used by the facility in the form of electricity, steam, or chilled water purchased for its use. Scope 3 is other indirect energy use attributable to the facility for things like contractor owned vehicles, outsourced activities, waste disposal and employee business travel. An accounting procedure has been established for determining these emissions by the World Resources Institute (WRI) and the World Business Council for Sustainable Development (WBCSD). They have developed a “Corporate Accounting and Reporting Standard” which can be used to develop a GHG inventory for organizations or plants. They recommend that companies determine their current GHG inventory and establish good historical data in preparation for possible GHG regulations. The entire standard can be downloaded at: [www.ghgprotocol.org/](http://www.ghgprotocol.org/).

A simpler form is provided in Figure 8 (see page 16) to assist a plant in estimating its CO\(_2\) emissions. The form does not capture all possible sources of emissions, but should provide a simple way to estimate the level of emissions from a particular operation. The form permits calculations by two methods. Emissions can be estimated from either actual energy used or from product shipments by using the average emission factors discussed earlier.

To use the form to calculate emissions from actual energy used, insert the quantity of energy used to support manufacturing operations by listing the quantities of natural gas, gasoline, and diesel fuel used in a given year. For magnesium die casting facilities, the use of SF\(_6\) as a cover gas should also be included. The emission factor for SF\(_6\) appears high because each pound of SF\(_6\) has the global warming impact of 22,800 pounds of CO\(_2\). Once the annual usage is listed, multiply by the appropriate emission factor to get the annual pounds of CO\(_2\) emitted. This number is then divided by 2000 to get the tons of equivalent CO\(_2\) emitted.


### Annual CO\(_2\) Emissions Calculation Sheet

## I. Calculations from Energy Use

### Direct Emissions:

<table>
<thead>
<tr>
<th>Fuel</th>
<th>Annual Usage</th>
<th>Emission Factor</th>
<th>Pounds CO(_2)</th>
<th>Tons CO(_2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Natural Gas (Mcf)</td>
<td></td>
<td>120 lb CO(_2)/Mcf</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gasoline (Gal)</td>
<td></td>
<td>19.37 lb CO(_2)/Gal</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Diesel Fuel (Gal)</td>
<td></td>
<td>160.30 lb CO(_2)/Gal</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SF(_6) (Cu. Ft.)</td>
<td></td>
<td>8778 lb CO(_2)eq/Cu. Ft.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Total Direct Emissions**

### Indirect Emissions:

| Purchased Electricity (MWh) | See Table |

**Total Emissions**

### Purchased Electricity Factors*

<table>
<thead>
<tr>
<th>State</th>
<th>Emissions Factor (lb CO(_2)/MWh)</th>
</tr>
</thead>
<tbody>
<tr>
<td>California</td>
<td>527.83</td>
</tr>
<tr>
<td>Illinois</td>
<td>1,125.88</td>
</tr>
<tr>
<td>Indiana</td>
<td>2,087.75</td>
</tr>
<tr>
<td>Kentucky</td>
<td>2,057.35</td>
</tr>
<tr>
<td>Michigan</td>
<td>1,329.85</td>
</tr>
<tr>
<td>Minnesota</td>
<td>1,558.20</td>
</tr>
<tr>
<td>Ohio</td>
<td>1,771.77</td>
</tr>
<tr>
<td>Wisconsin</td>
<td>1,708.95</td>
</tr>
<tr>
<td>U.S. Average</td>
<td>1,313.51</td>
</tr>
</tbody>
</table>

* Data from U.S. EPA (www.epa.gov/cleanenergy/energy-resources/egrid

## II. Calculations from Product Shipments

<table>
<thead>
<tr>
<th>Material Shipped</th>
<th>Annual Shipments (lbs)</th>
<th>Emission Factor (lb CO(_2)/lb shipped)</th>
<th>Pounds CO(_2)</th>
<th>Tons CO(_2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aluminum</td>
<td></td>
<td>3.95</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Magnesium</td>
<td></td>
<td>4.56</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Zinc</td>
<td></td>
<td>1.50</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Total Emissions**
To calculate the indirect emissions resulting from the purchase of electricity by the plant, the emission factor varies by state. The factors are available from the U.S. EPA eGRID system at [www.epa.gov/cleanenergy/energy-resources/egrid](http://www.epa.gov/cleanenergy/energy-resources/egrid). A state like Indiana has a high factor, since most electricity generated there comes from coal-fired power plants. California, on the other hand, has a relatively low emission factor for electricity because its electricity comes from a mixture of hydroelectric and fossil fuel power plants. If data for a specific state is not included, consult the eGRID website listed above or use the U.S. average emission factor for electrical power, which is 1,313.51 pounds of CO$_2$ per MWh.

To use the lower portion of the form to estimate CO$_2$ emissions from annual casting shipments, the emission factors by type of metal are at the bottom of the sheet. Insert the pounds of shipments for each metal type and then multiple them by the appropriate emission factor. Again, this will provide the pounds of equivalent CO$_2$ emitted. This must be divided by 2000 to get tons of equivalent CO$_2$ emitted.

In summary, it is not clear how EPA will address the reporting requirements. They may just say that a facility is required to report their “direct” emissions just like they do now and pick up the power plant emissions from the power plant, so the plant would not be required to report emissions related to the electricity purchased. It is still an important issue for the die casting industry, however, since carbon emissions and/or any taxes charged, will ultimately be paid by the consumer. So reporting might only require direct emissions to be reporting but future cost increases related to cap and trade programs will affect both sources of CO$_2$ emissions. Plants should still track both Direct and Indirect emissions since they will pay for the emissions from both in one way or another.

**Energy costs** are certain to increase significantly as the result of proposed GHG regulations. These costs may take the form of increased costs for fossil fuels and electricity, a direct tax on CO$_2$ emissions, or the costs of emissions credits to permit emissions above a specified target, or maybe even all of these. One study$^7$ estimated that the price of gasoline would increase between 60% and 144% by 2030, while electricity prices would increase by 77% to 129%. The Congressional Budget Office (CBO) has endorsed a carbon tax of $15 per ton of CO$_2$. The cost of emissions credits are estimated at $10-$20 per ton of CO$_2$ in the short term, but perhaps as high as $70-$100 per ton of CO$_2$ if emission targets are not achieved.

**Opportunities for Die Casting Companies**

While the potential regulation of GHGs will certainly affect all Americans, the die casting industry, because of its use of significant quantities of energy for metal melting and holding, will need to examine its operations carefully. The threat of mandatory reporting as early as mid-2009 makes it imperative that die casting companies review their energy conservation programs and plans. There are three main areas that all die casters should become involved in. These are: completing a GHG inventory, reviewing their current energy efficiency, and developing projects to reduce energy consumption. These activities will provide the information, vision, and strategies to comply and compete in the future.
Completing a GHG inventory is really establishing an accounting system for GHGs. Just like physical assets, a GHG inventory establishes a way of measuring the emissions from manufacturing operations. The simple form included in Figure 8 is a first step. Beyond this, the Corporate Accounting and Reporting Standard previously provides the procedures for obtaining the detailed information that is needed.

It is important to assess the historical data, because regulations may establish a baseline date, 2005 is often discussed, from which increases and reductions will be measured. Without historical data, operations will not be able to take credit for energy efficiencies already achieved. Also, without specific plant data, industry averages may be applied which may not be appropriate for that plant or company.

Reviewing current energy efficiency is critical to the die casting industry. For example, the theoretical minimum amount of energy needed to melt a ton of aluminum is 288.7 kWh, as shown in Figure 9. The industry average reported for aluminum reverberatory melt furnaces in 2004 was 1,399.8 kWh, or 79% more than the minimum. In reviewing the best practice of the industry, the minimum actually in use was 510.5 kWh per ton, which was still 43% more than the theoretical minimum, but only 36% of the industry average. This represents a tremendous opportunity for die casters to not only reduce their GHG emissions, but reduce their cost as well. Industry-wide improvement in melting energy could also reduce CO$_2$ emissions by over 633,000 tons per year.

Once energy efficiency is measured, projects can be developed to reduce energy use. The “NADCA Energy Saving Manual,” available from NADCA outlines how to develop a plant-wide energy conservation program and improve the efficiency of many energy uses in die casting plants. The type of metal melting system and the efficient operation of the system chosen are crucial to the energy efficiency of the plant.

The 2004 study of metalcasting for the U.S. Department of Energy showed that even though aluminum reverberatory furnaces were considered 36% efficient, many of them actually operated as low as 20% to 25%. Stack melter furnaces, a more recent concept in aluminum melting, operated at 68% efficiency. They utilize heat from the molten bath to heat the solid material as it approaches the melting area of the melter.

Another finding of the study is that die casters often fail to manage their operation for energy efficiency. The relatively low cost of natural gas may be a contributor. Melting furnaces are most efficient when operated near full capacity on a continuous basis. Intermittent operations at low melt capacity are very inefficient but quite common in the industry.
Many other energy reduction projects, such as lighting improvements, heat recuperation, reduction of compressed air losses, electrical power factor management, peak demand management, and the use of efficient electric motors should be examined by die casting operations. These projects offer the potential of cost savings as well as providing reduced GHG emissions. The industry should not wait for government mandated emissions targets to make energy efficiency improvements that are cost justified.

In fact, die casting plants should consider future energy increases into their cost savings calculations. Many projects that could not be justified in the past are likely to become viable projects. It is quite probable that the proposed legislation that has been reviewed will have the effect of doubling future energy costs through direct charges to the facilities as well as increased costs for electrical power and natural gas.
Appendix

Bibliography


