This is a guidance document with sample specification language intended to be inserted into project specifications on this subject as appropriate to the agency's environmental goals. Certain provisions, where indicated, are required for U.S. federal agency projects. Sample specification language is numbered to clearly distinguish it from advisory or discussion material. Each sample is preceded by identification of the typical location in a specification section where it would appear using the SectionFormat™ of the Construction Specifications Institute; the six digit section number cited is per CSI Masterformat™ 2004 and the five digit section number cited parenthetically is per CSI Masterformat™ 1995.

SECTION 05 10 00 (SECTION 05100) – STRUCTURAL STEEL

SPECIFIER NOTE:

resource management: Refer to Section 05 05 00 (05050) for general information on mining and metals industries.

The steel industry, the world's largest recycler, utilizes scrap in both of the primary manufacturing processes (Basic Oxygen Furnace and Electric Arc Furnace). The Electric Arc Furnace process, sometimes called minimills, utilizes virtually 100% steel scrap, while the Basic Oxygen Furnace process utilizes approximately 30% steel scrap in making new steel.

Steel in existing buildings may be considered a resource for the future. To date, there is no single organization that provides estimates for potential future supplies of steel scrap. However, the AISI, SRI, and IISI provide estimates for steel production and recycling rates.

Iron is the largest raw material stream in steelmaking. The first record of the use of iron goes back to 2500-2000 BC, and the first deliberate production of iron began around 1300 BC. Small furnaces that burned charcoal were used in iron production. High temperature processes were first introduced in Germany around 1300 AD, using a very similar design to today's modern blast furnaces. Charcoal was the primary fuel used in the furnaces until 1718 when the first use of coke is reported in the United Kingdom. The modern blast furnace was developed after the Second World War and remains the main process used to make iron.

As Per the U.S. EPA Profile of the Iron and Steel Industry, EPA/310-R-95-005, numerous outputs are produced as a result of the manufacturing of coke, iron, and steel, the forming of metals into basic shapes, and the cleaning and scaling of metal surfaces. These outputs, categorized by process (RCRA waste code provided where applicable), include:

Cokemaking

Inputs:
• Coal, heat, quench water

Outputs:
• Process residues from coke by-product recovery (RCRA K143, K148)
• Coke oven gas by-products such as coal tar, light oil, ammonia liquor, and the remainder of the gas stream is used as fuel. Coal tar is typically refined to produce commercial and industrial products including pitch, creosote oil, refined tar, naphthalene, and bitumen.
• Charging emissions (fine particles of coke generated during oven pushing, conveyor transport, loading and unloading of coke that are captured by pollution control equipment. Approximately one pound per ton of coke produced are captured and generally land disposed).
• Ammonia, phenol, cyanide and hydrogen sulfide
• Oil (K143 and K144)
• Lime sludge, generated from the ammonia still (K060)
• Decanter tank tar sludge (K087)

• Benzene releases in coke by-product recovery operations
• Naphthalene residues, generated in the final cooling tower
• Tar residues (K035, K141, K142, and K147)
• Sulfur compounds, emitted from the stacks of the coke ovens
• Wastewater from cleaning and cooling (contains zinc, ammonia still lime (K060), or decanter tank tar (K087), tar distillation residues (K035)
• Coke oven gas condensate from piping and distribution system; may be a RCRA characteristic waste for benzene.

Ironmaking

Inputs:
• Iron ore (primarily in the form of taconite pellets), coke, sinter, coal, limestone, heated air

Outputs:
• Slag, which is either sold as a by-product, primarily for use in the construction industry, or landfilled
• Residual sulfur dioxide or hydrogen sulfide
• Particulates captured in the gas, including the air pollution control (APC) dust or waste treatment plant (WTP) sludge
• Iron is the predominant metal found in the process wastewater
• Blast furnace gas (CO)

Steelmaking

Inputs:
• In the steelmaking process that uses a basic oxygen furnace (BOF), inputs include molten iron, metal scrap, and high-purity oxygen
• In the steelmaking process that uses an electric arc furnace (EAF), the primary inputs are scrap metal, electric energy and graphite electrodes.
• For both processes, fluxes and alloys are added, and may include: fluorspar, dolomite, and alloying agents such as aluminum, manganese, and others.

Outputs:
• Basic Oxygen Furnace emission control dust and sludge, a metals-bearing waste.
• Electric Arc Furnace emission control dust and sludge (K061); generally, 20 pounds of dust per ton of steel is expected, but as much as 40 pounds of dust per ton of steel may be generated depending on the scrap that is used.
• Metal dusts (consisting of iron particulate, zinc, and other metals associated with the scrap and flux (lime and/or fluorspar)) not associated with the EAF.
• Slag.
• Carbon monoxide.
• Nitrogen oxides and ozone, which are generated during the melting process.

Forming, Cleaning, and Descaling

Inputs:
• Carbon steel is pickled with hydrochloric or sulfuric acid; stainless steels are pickled with hydrochloric, nitric, and hydrofluoric acids.
• Various organic chemicals are used in the pickling process.
• Alkaline cleaners may also be used to remove mineral oils and animal fats and oils from the steel surface. Common alkaline cleaning agents include: caustic soda, soda ash, alkaline silicates, phosphates.

Outputs:

• Wastewater sludge from rolling, cooling, descaling, and rinsing operations which may contain cadmium (D006), chromium (D007), lead (D008)
• Oils and greases from hot and cold rolling
• Spent pickle liquor (K062)
• Spent pickle liquor rinse water sludge from cleaning operations
• Wastewater from the rinse baths. Rinse water from coating processes may contain zinc, lead, cadmium, or chromium.
• Grindings from roll refinishing may be RCRA characteristic waste from chromium (D007)
• Zinc dross

toxicity/IEQ: Metal is considered inert. Factory applied finishes emit considerably less VOCs in situ than field applied coatings because the primary outgassing occurs at the plant under controlled conditions.

performance: Steel is made by reducing the carbon content in iron to levels below 2%. The reduction of carbon reduces the brittleness of the material, making it easier to shape.
Performance is comparable for green methods and standard methods.
Where feasible, use mechanical connections to allow for deconstruction and reuse.

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes:
1. Structural steel.

1.2 SUBMITTALS

A. Product data. Unless otherwise indicated, submit the following for each type of product provided under work of this Section:

SPECIFIER NOTE:
Green building rating systems often include credit for materials of recycled content. USGBC-LEED™ v3, for example, includes credit for materials with recycled content, calculated on the basis of pre-consumer and post-consumer percentage content and it includes credit for use of salvaged/recovered materials.
Green Globes US also provides points for reused building materials and components and for building materials with recycled content.

1. Recycled Content:
   a. Indicate recycled content; indicate percentage of pre-consumer and post-consumer recycled content per unit of product.
   b. Indicate relative dollar value of recycled content product to total dollar value of product included in project.
   c. If recycled content product is part of an assembly, indicate the percentage of recycled content product in the assembly by weight.
   d. If recycled content product is part of an assembly, indicate relative dollar value of recycled content product to total dollar value of assembly.

SPECIFIER NOTE:
Specifying local materials may help minimize transportation impacts; however it may not have a significant impact on reducing the overall embodied energy of a building material because of efficiencies of scale in some modes of transportation.
Green building rating systems frequently include credit for local materials. Transportation impacts include: fossil fuel consumption, air pollution, and labor.
USGBC-LEED™ v3 includes credits for materials extracted/harvested and manufactured within a 500 mile radius from the project site. Green Globes US also provides points for materials that are locally manufactured.

2. Local/Regional Materials:
   a. Sourcing location(s): Indicate location of extraction, harvesting, and recovery; indicate distance between extraction, harvesting, and recovery and the project site.
   b. Manufacturing location(s): Indicate location of manufacturing facility; indicate distance between manufacturing facility and the project site.
   c. Product Value: Indicate dollar value of product containing local/regional materials; include materials cost only.
   d. Product Component(s) Value: Where product components are sourced or manufactured in separate locations, provide location information for each component. Indicate the percentage by weight of each component per unit of product.

B. Certifications and Registrations:

SPECIFIER NOTE:
EO 13423 includes a requirement for sustainable building strategies and for agency EMSs. It calls upon federal agencies to:

"implement within the agency environmental management systems (EMS) at all appropriate organizational levels to ensure (i) use of EMS as the primary management approach for addressing environmental aspects … (ii) establishment of agency objectives and targets to ensure implementation of this order, and (iii) collection, analysis, and reporting of information to measure performance in the implementation of this order;"
and, to "ensure that contracts … for contractor operation of government-owned facilities or vehicles require the contractor to comply with the provisions of this order with respect to such facilities or vehicles"

The U.S. EPA and the Steel Manufacturers Association (SMA) are partnering on a program of training and technical resources to help steelmakers implement Environmental Management Systems (EMSs). SMA members produce steel by melting scrap metal and other iron-bearing materials in electric arc furnaces. These Electric Arc Furnaces produce more than half of all new U.S. steel, mostly by recycling scrap steel. The comprehensive environmental management approach taken with an EMS provides a sound framework for pursuing improved environmental performance.

Currently, about one-third of steelmakers that use electric arc furnaces have implemented an EMS. EPA's Sector Strategies Program and SMA have developed technical tools to increase EMS use within the industry. The most common EMS is the International Organization of Standardization (ISO) Standard 14001, Environmental Management Systems -- Requirements with Guidance for Use.

1. Environmental Management System (EMS): Submit evidence of an EMS for the steel manufacturers providing material for work of this section. **[For each steel manufacturing facility, submit copy of registration as per ISO 14001.]**

SPECIFIER NOTE:
The steel industry is one if the largest energy-consuming industries in the world. In North America, iron and steel production represents approximately two percent of energy consumption. The steel industry as a sector (integrated and EAF producers) reported 12.6 million BTUs per ton of steel shipped in 2003. This means it takes the equivalent of 2.07 barrels of oil to produce a ton of steel (using 6.09 MMBTU per barrel of oil). The North American steel industry has achieved tremendous improvements in energy performance in recent decades. Today's modern blast furnace is the product of decades of technological improvements. Energy consumption in blast furnace iron making has decreased by more than 50% since 1950. Still, the blast furnace accounts for nearly 40% of the overall energy use in the steel industry and significant energy opportunities remain.
Manufacturing processes vary significantly in their environmental impacts. Open hearth furnaces are permitted in some areas of the world, including Russia and China. Open hearth furnaces lack efficiency

and produce correspondingly more CO2 emissions than Basic Oxygen Furnaces or Electric Arc Furnaces.

2. Chain-of-custody certification: Submit manufacturer's certification that no open hearth furnaces were utilized in the production of structural steel to be incorporated into the Work. Submit evidence of energy efficiency for steel manufacturers providing material for work of this section. Acceptable certification includes:
   a. Bill of Lading indicating source of manufactured steel as North American facility; or,
   b. Manufacturer's certification that structural steel complies with CO_2 limitations for crude steel production. **[Indicate method for calculating CO_2 emissions.]**; or,
   c. Manufacturer's certification that structural steel complies with energy efficiency requirements for steel production. **[Include description of energy efficient processes utilized.]** ; or,

SPECIFIER NOTE:
The International Iron and Steel Institute (IISI) has initiated the CO_2 Breakthrough Program with the objective of dramatically reducing CO_2 emissions. The focus of the IISI's program is to examine technologies that radically minimize, eliminate or capture carbon emissions from the steel industry. Research projects have been launched in Canada, Europe, Japan, Korea, North America, Australia and Brazil. The CO_2 Breakthrough Programme engages the steel industry worldwide on a multi-phased, regionally diverse approach to achieve significant long-run reduction in CO_2 emissions. The program pools international resources and expertise and shares benefits with all participating members. During the first phase of the IISI program, the feasibility of projects that might cost-effectively reduce CO_2 will be assessed. In subsequent phases, efforts will converge and focus on the most promising research. These will be further identified and pursued through pilot projects leading to demonstration projects. Commercialization of successful projects can be expected to take from 20 to 50 years.

[d. Participation in CO_2 Breakthrough Program: Manufacturer's certification of participation in CO_2 Breakthrough Program.]

1.3 QUALITY ASSURANCE

A. Toxicity/IEQ:

SPECIFIER NOTE:
Under EO 13423, Federal Agencies are required to "… improve energy efficiency and reduce greenhouse gas emissions … by (i) 3 percent annually through the end of fiscal year 2015, or (ii) 30 percent by the end of fiscal year 2015, relative to the baseline of … year 2003"

The International Iron and Steel Institute (IISI) published the first sustainability report of the world steel industry in 2004 and its second in 2006. Forty-two steel companies worldwide, including the world's top five steel producers in 2003, reported voluntarily on 11 sustainability indicators. The IISI assessed the steel industry's economic performance by four of the 11 indicators: Investment in Processes and Products, Operating Margin, Return on Capital Employed, and Value Added. IISI assessed environmental performance by: Greenhouse Gas Emissions, Material Efficiency, Energy Intensity, Steel Recycling, and Environmental Management Systems. Social performance was measured through the final two indicators, Employee Training and Lost Time Injury Frequency Rate.
According to the IISI 2004 report, the average CO_2 emissions for production of crude steel, excluding mining, oil production, etc., is 1.6 tons of CO_2 per 1 ton of crude steel produced.
Consider restrictions, if any, that project may require on method for calculating CO_2 emmissions.

1. Carbon Dioxide Emissions: Not to exceed 1.6 tons of CO_2 per 1 ton of crude steel produced.

SPECIFIER NOTE:
According to the Lawrence Berkeley National Laboratory's November 2002 Report on International Trends in Energy-Efficiency Technologies and Policies (Subreport 11), total global energy consumption for steelmaking is estimated at 20 EJ. The worldwide average energy intensity of steelmaking is

estimated at 24 GJ/ton, although large variations occur between countries and plants. Today the most energy efficient process would use 19 GJ/ton for integrated steelmaking, and 7 GJ/ton for making steel out of scrap.

2. Energy Efficiency:
   a. Integrated Steel Making: Not to exceed **[19] [xxxx]** GJ/ton.
   b. Steel produced from scrap: Not to exceed **[7] [xxxx]** GJ/ton.

PART 2 - PRODUCTS

SPECIFIER NOTE:
EO 13423 includes requirements for Federal Agencies to use "sustainable environmental practices, including acquisition of biobased, environmentally preferable, energy-efficient, water-efficient, and recycled-content products"

Specifically, under the Sustainable Building requirements per Guiding Principle #5 Reduce Environmental Impact of Materials, EO13423 directs Federal agencies to "use products meeting or exceeding EPA's recycled content recommendations" for EPA-designated products and for other products to "use materials with recycled content such that the sum of post-consumer recycled content plus one-half of the pre-consumer content constitutes at least 10% (based on cost) of the total value of the materials in the project."

Executive Order 13514; *Federal Leadership in Environmental, Energy, and Economic Performance*; was signed on October 5, 2009. http://www.ofee.gov/execorders.asp It expands upon the environmental performance requirements of EO 13423.
http://www1.eere.energy.gov/femp/regulations/printable_versions/eo13423.html

EO 13514 sets numerous Federal requirements in several areas, including sustainable buildings and communities. Federal agencies must implement high performance sustainable Federal building design, construction, operation and management, maintenance, and deconstruction, including:

- Ensuring all new Federal buildings, entering the design phase in 2020 or later, are designed to achieve zero net energy by 2030.
- Ensuring all new construction, major renovations, or repair or alteration of Federal buildings comply with the Guiding Principles of Federal Leadership in High Performance and Sustainable Buildings http://www1.eere.energy.gov/femp/pdfs/mouhighperfsustainfedfacs.pdf
- Ensuring at least 15% of existing agency buildings and leases (above 5,000 gross square feet) meet the Guiding Principles by fiscal year 2015 and that the agency makes annual progress towards 100% compliance across its building inventory.

2.1 MATERIALS

A. Structural Steel:

SPECIFIER NOTE:
Each year, more steel is recycled than aluminum, paper, glass and plastic combined. In a year, the North American steel industry saves the equivalent energy, from recycling alone, to power about 18 million households for a year. When one ton of steel is recycled, 2500 pounds of iron ore, 1400 pounds of coal and 120 pounds of limestone are conserved. For further information, refer to: www.steel.org

US-EPA Comprehensive Procurement Guidelines (CPG) discusses steel manufactured in either a Basic Oxygen Furnace (BOF) or an Electric Arc Furnace (EAF). Recommendations for recycled content in steel reinforcing are not stated.

Steel from the BOF process contains 25-30 percent total recovered materials, of which 16 percent is post-consumer steel. Steel from the EAF process contains a total of 100 percent recovered steel, of which 67 percent is post-consumer. The Steel Recycling Institute (SRI) provides annual post-consumer and pre-consumer recycled content values for BOF and EAF with its fact sheet, "Steel Takes LEED With Recycled Content".

Typical BOF products include: hollow structural sections, steel studs, steel deck, plate, purlins, and wall studs. Typical EAF products include: beams and columns, channels, angles, plate, steel deck, and piling.
The amount of recycled content in steel products varies over time, both as a function of the cost of steel scrap and its availability.

Typically, the amount of recycled content for given products will be verifiably higher for North American (Canada, United States, Mexico) steel construction. In addition, steel made in the United States must comply with the clean air, water, and soil environmental regulations of the US EPA, assuring Maximum Achieveable Clean Technologies are employed. Foreign steel-producing nations, in contrast, often operate with minimal or negligible environmental controls, thus contributing to world-wide emissions problems, while not directly visible within our own borders.

BOF Steel Recycled Content Value for Typical Product Using Annual Values from the SRI:
Steel Stud Framing
Value = ($XXXX) (24.6 % post-consumer + ½ 6.6 % pre-consumer) = ($XXXX) (27.90 %)

EAF Steel Recycled Content Value for Typical Product Using Annual Values from the SRI:
Wide Flange Structural Steel Framing
Value = ($XXXX) (56.6 % post-consumer + ½ 32.7 % pre-consumer) = ($XXXX) (72.95 %)

For more information, refer to SRI at www.recycle-steel.org for detailed information on the annual recycled content for BOF and EAF, product recycling rates, national recycling database, and the environmental benefits of steel for homes building, steel roofing, and bridges. The American Institute of Steel Construction at www.aisc.org/sustainability includes detailed information on how steel factors into the LEED rating system, steel mill recycled content documentation, and articles about the use of steel in sustainable projects.

1. Recycled Content:
   a. BOF steel: Minimum **[20] [xxxx]** percent post-consumer recycled content and minimum **[10] [xxxx]** percent pre-consumer recycled content.
   b. EAF steel: Minimum **[55] [xxxx]** percent post-consumer recycled content and minimum **[30] [xxxx]** percent pre-consumer recycled content.

2.2 CASTELLATED or CELLULAR STRUCTURAL STEEL BEAMS

SPECIFIER NOTE:
Castellated or cellular beams can reduce the weight of structural steel required and they can lower floor-to-floor height by allowing ductwork and utilities to pass through openings further reducing overall materials utilized in construction.
The International Institute of Cellular Beam Manufacturers (IICBM), founded in 2004, was formed to develop, establish, and maintain standards for the design and manufacture of cellular beams world wide.

A. Design: Design in accordance with the *AISC Manual of Steel Construction, Allowable Stress Design,* Ninth Ed. or *Load and Resistance Factor Design Second Ed.* and per the design procedures outlined in "*The Design of Welded Structures"* by Omar W. Blodgett.

2.3 FACTORY FINISHING

SPECIFIER NOTE:
Specify factory finishing rather than field-coating where possible. Plant fabrication/finishing handles raw materials and by-products at a single location that typically allows greater efficiency and better pollution prevention than job site fabrication/finishing.
Powder coating is preferable to solvent based coating application systems. Powder coating uses an electrostatic charge to adhere colored powder to metal. The powder remaining in the electrostatic chamber is 'vacuumed' out and reused.

Consider factory finishing that utilizes mechanical process rather than chemical. Mechanical processes such as abrasive blasting, grinding, buffing, and polishing do not generate as much hazardous waste as chemical and electrical processes.
When electroplating is necessary, select one of the available replacement technologies listed by the US EPA. The EPA has identified as toxic and/or polluting cadmium plating materials, chromium plating materials, cyanide-based electroplating, and copper/ formaldehyde-based electroless copper solutions. Available replacement technologies include the following: Non-cyanide copper plating, metal stripping and zinc-plating; ion vapor deposition (IVD); Physical vapor deposition (PVD); Chromium-free substitutes for selected immersion processes; Metal spray coating; and Trivalent chromium plating for decorative applications.

A. Finishing System:
   1. Toxicity: **[Solvent coating systems are not permitted.] [Electroplated coating systems are not permitted.]**
   2. Anti-Corrosive Paint: Comply with GS-11.

PART 3 - EXECUTION

3.X SITE ENVIRONMENTAL PROCEDURES

A. Waste Management: As specified in Section 01 74 19 (01351) – Construction Waste Management.

END OF SECTION