

Casting for Solutions Readiness

Design and Manufacturing Resources: Standards & Specifications

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Steel Founders' Society of America

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Abstract

The Steel Founders' Society of America (SFSA) is a not-for-profit trade association founded in 1902 to serve the steel foundry industry through advanced research and innovation. SFSA is uniquely positioned through its industry leadership in steel R&D to assume a prominent role in the development of industry-ready, performance-steel technology. SFSA is an approved supplier of steel R&D to the steel industry and the markets they support.

A major obstacle facing designers, purchasers, and producers of cast steel parts is a lack of both availability and accessibility of rapidly updated state-of-the-art technology information. Much of the historical steel casting technology that is relevant today is only available in print which limits the availability of the information and a means to keep it current incorporating new technology.

The objective of this project was to provide an accessible and efficient web-based resource tool in a Wikipedia format for SFSA members, any United States Government or Military personnel, and suppliers to the US Military to access information about steel castings. The Steel Casting Wiki uses an online platform to provide both historical and current steel casting technology in one location.

The framework of the steel casting wiki site is based on the contents of the Steel Castings Handbook 6th edition. As the wiki content and user base evolved, several additional technical reports and training resources were incorporated to make the wiki a robust casting technology resource for Government and industry. Additional resources include:

- SFSA Research Reports, National Technical and Operating (T&O) Conference Papers, and other SFSA Publications
- SFSA Surveys Prompted by Member Questions
- Artisan Program
- Webinar Training Courses
- Steel Castings Handbook Supplement 2 Update
- Technical Summaries

The Wiki currently has over 6,000 pages and approximately 4,800 technical references.

- **Wiki content pages:** 6,493
- **Users:** 428
- **Uploaded files:** 4,808
- **Page edits:** 8,321
- **Carbon & Low Alloy Research Reports:** 120
- **High Alloy Research Reports:** 13
- **Special Reports:** 33
- **Technical Service Reports:** 26

- **SFSA Research Foundation Reports:** 8
- **Steel Founders' Research Journals:** 59
- **Journal of Steel Castings Research:** 94 files containing 871 articles
- **SFSA Technical Folios:** 43
- **Steel Castings Handbook Supplements:** 11
- **Other SFSA Publications:** 31
- **Steel Foundry Facts** (Papers presented at SFSA Technical & Operating Conferences prior to 1983): 2,110
- **Technical & Operating Conference papers 1983-2016:** 1,230
- **Results of SFSA surveys prompted by member questions:** 63 in 16 subject areas
- **SFSA Artisan Program requirements pages:** 30
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Introduction/Background

Castings are essential to weapons systems. While advanced casting technology exists that can fulfill the requirements for defense customers, it has not been readily available to producers or customers, or widely understood by weapons system designers and purchasers. In some cases, the lack of accepted commercial standards and specifications for advanced casting materials has made procurement of parts constructed of these materials virtually impossible.

The objective of this program is to leverage the unprecedented access provided by networks, facilitate organizational involvement with commercial standards and specification bodies, and to make more widely available and accessible new and legacy technology resources to significantly broaden the supplier base, and make casting technology available to defense and commercial customers.

In this program, SFSA expanded on the successes of Phase I, II of the AMC program, PRO-ACT and CIR with a multi-pronged approach to:

1. Establish a steel casting Wikipedia
2. Develop a discussion forum for SFSA producers
3. Establish a blog based on responses to questions from producers and users
4. Digitize unpublished data

The digitizing of technical information is required to enable easier access to technical information for producers and users. This work needs to continue to assist in the decision-making process. In addition, the Steel Founders Society of America (SFSA) website and internet access need to be exploited to ensure that the most up to date information is available easily and interactive

networking can be achieved. The benefit to DLA is the consolidation of technical information and training to educate current and future scientists and design engineers.

Work Performed/Results

Steel Casting Wiki (Appendix 1)

A major obstacle facing designers, purchasers, and producers of cast steel parts is a lack of both availability and accessibility of rapidly updated state-of-the-art technology information. The phenomenal success of the free online encyclopedia, Wikipedia, and other wiki-based sites has demonstrated the value and performance of wiki-based information systems to provide both availability of information and allow ready and easy updating of information available to users.

The wiki itself is an interactive website comprised of a database containing the wiki content and structure, and a web-based user interface which is designed for ease of use and versatility in the types of information and media that can be stored, updated, displayed, and searched. Several wiki software platforms were evaluated and MediaWiki, the software that was developed for and used by Wikipedia, was chosen due to its stability, robustness, extensibility, and cost (free). The MediaWiki software was deployed on a Linux-based virtual server on Amazon's EC2 service. Software extensions were installed and in some cases created in-house by SFSA to manage user sign-ups, handle different types of media, and display objects such as mathematical equations and video.

The basic framework of the wiki content was initially constructed from the contents of the 6th Edition Steel Castings Handbook which was produced by SFSA as a printed book in 1995.

An electronic copy of the Handbook was obtained from the publisher, ASM International. The text of all 27 chapters of the Handbook were converted into the wiki text format used by MediaWiki and then entered into the wiki as articles. The figures and charts were extracted from the electronic copy, adjusted for quality, and uploaded into the wiki system, then placed within the appropriate wiki articles. Data tables in many cases had to be recreated in Excel prior to insertion into the articles however this allowed correction of some errors that had previously not been caught and could not be corrected in the printed Handbook. Math equations were recreated in LaTeX, a programming language designed for typesetting technical data; during this process, a number of errors were corrected and the equations were reformatted for readability. The LaTeX language that describes each equation is stored as simple text notations within the wiki pages and can be readily understood and edited if necessary. Additionally, a working group was formed with steel casting producers to direct the addition of useful information to the wiki and to validate the content for appropriateness and usability.

Once the base wiki content was in place, SFSA launched an outreach program to industry and government stakeholders which began the sign-ups of the wiki's user base. Eligible users include SFSA members, military and government users, SFSA researchers, and suppliers to the US

military who can benefit from technical information related to steel casting design and production. A discussion forum software extension was installed and configured with a wide variety of topic areas. The blog content, comprised of over 1,000 posts (over 200 per year) resulting from 63 surveys that were conducted to answer questions from users and producers of steel castings, was combined with the forum and posted to a series of wiki pages. Also, over 60 formerly unavailable technology document sets including papers presented at SFSA Technical & Operating Conferences and other SFSA publications that were out of print were added and made available for download or view in pdf format.

Artisan Program

The SFSA Artisan Program was designed to specifically cater to the current knowledge and skills required in steel foundries. It is being adopted and used by steel foundries at the plant level to develop the skilled artisans required to keep individual companies adequately staffed and the steel industry vibrant. A set of wiki articles were built for the artisan program detailing the knowledge and skill requirements for qualification under ten types of artisanship. The ten types of artisanship are: Foundryperson, Heat Treater, Investment Caster, Maintenance Craftsperson, Melter, Molder, Patternmaker, Rigging Engineer, Welder, and Finisher. To supplement the knowledge and skills requirements, SFSA staff worked extensively through the wiki content and created a linked the resource pages that addressed a particular Artisan knowledge or skill requirement. Finally, SFSA developed short videos that support the skills and knowledge requirements of each artisanship type. Using basic molder as a starting point, the Society has initiated development of 5-10 minute white board videos along with written content. Topics covered were the effect of temperature, pH, compaction, and permeability of molds, and provided an understanding of draft, shrink, vents, risers, and gates. These preliminary videos and corresponding written reports are reviewed and approved by SFSA members prior to publishing. SFSA plans to continue developing these videos to cover all basic knowledge areas of the Artisan Program and make them available through the Steel Casting Wiki.

Webinar Training Courses

SFSA has created 26 training course webinars covering information such as what steel actually is, the latest research into design and production of steel castings, design of experiments for measurement and control of manufacturing and other processes and factors, improving the quality of the castings produced, and conformance with environmental and safety regulations. These are presented once or twice a month and the video and slides can be viewed and downloaded at any time on the wiki. SFSA will continue to add to the library of webinars.

A list of the topics that have been covered is summarized below.

- What is Steel?
- What Makes Steel Strong?

- Heat Treating Steel
- What Makes Steel Stainless?
- Introduction to Steel Melting Practices
- Pouring and Gating Steel
- Induction Melting Steel
- Design of Experiments - Part 1 – Measurements
- Design of Experiments - Part 2 – Experiments
- Design of Experiments - Part 3 – Analysis
- Clean Steel - Part 1 – Why clean steel?
- Clean Steel - Part 2 - Reoxidation
- Clean Steel - Part 3 - Pouring
- Clean Steel - Part 4 – Metal Treatment
- Clean Steel - Part 5 - Gating 1
- Clean Steel - Part 6 - Gating 2 - Lip Pour
- Clean Steel - Part 7 - Gating 3 - Bottom Pour
- Baghouse / Dust Collector Webinar
- Key EHS Topics and Compliance Resources Webinar
- Entry Policies for Your Foundry
- New OSHA Requirements Important to Your Foundry
- Determining Feasibility of Compliance with OSHA
- The ABCs of Form R
- Responsibilities and Liabilities with HAZCOM
- Auditing your Safety & Health Program
- Important Interpretations or Exemptions that Affect Steel Foundries

Steel Castings Industry Supplement 2

SFSA's staff and specification committee reviewed and revised the Steel Castings Handbook Supplement 2, "Summary of Standard Specifications for Steel Castings," which was updated in 2009. Supplement 2 is a summary of standard specifications that should be used when designing and ordering castings from suppliers. The document was revised to reflect current military and commercial specifications used for the production of cast steel components. Updates include changes in phosphorus and sulfur limits for some ASTM casting alloys, addition and removal of some cast steel grades in ASTM, and re-activation of a MIL standard. Upon completion of the revision of the documents and approval by the SFSA specification committee, the PDF file was made available for public download via the Steel Casting Wiki.

Technical Summaries

SFSA provides support for technical inquiries from the steel casting industry and the government. The society developed summary technical reports on topics most commonly inquired about that are not covered in greater detail in the Steel Castings Handbook 6th edition. Topics chosen were:

- Temper Embrittlement and Tempered Martensite Embrittlement
- Basic Steel Metallurgy
- Alloying Elements in Melting and Heat Treatment
- Effect of Alloying on Properties of Carbon and Low Alloys
- Effect of Alloying on Properties of High Alloys

These reports were published on the steel wiki website. These technical summaries were written for Wiki users with limited foundry experience or non-metallurgy background. SFSA plans to identify other topics and write similar articles to continuously expand the Wiki's content.

Summary of Work / Conclusions

The Steel Casting Wiki provides an extensive steel castings resource for SFSA members, any United States Government or Military personnel, and suppliers to the US Military. Digitizing the Steel Castings Handbook allows easy and timely update of information to reflect the latest technologies and advancements in the industry. Other SFSA technical references which include research reports, conference papers, and survey results were also made available. Additional learning media such as webinars were incorporated. The capability to search keywords and related pages being cross-linked add to the accessibility and ease of use of the Wiki.

The wiki is recognized as a key technical resource for steel casting technology among industry and government casting designers and manufacturers. The site has a growing population of more than 420 user accounts with access to more than 6,000 pages and 4,800 technical references. (Appendix 2) Furthermore, usage has increased as new content has been added. Over the past twelve months, the website received an average of 1,200 unique page loads per month. SFSA anticipates that this trend will continue as the wiki is at the center of the Society's outreach activity to government and industry.

Steel Casting Wiki Statistics

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Acknowledgements

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Appendix

Appendix 1

The screenshot shows the homepage of the Steel Casting Wiki. At the top, there is a navigation bar with links for 'Main page', 'Discussion', 'Read', 'View source', 'View history', and a search box labeled 'Search Steel Casting Wiki'. A user profile icon is visible in the top right corner with links for 'Log in', 'Request account', and 'Sandbox'. Below the navigation bar is a large banner image showing industrial machinery. The main content area is divided into several sections:

- Welcome to the Steel Casting Wiki**: A central heading with a sub-heading '6,504 pages, 433 users'.
- General information about steel castings**: A list of links including 'Introduction to steel castings', 'Industrial applications of steel castings', and 'Advantages of steel castings'.
- Purchasing castings**: A list of links including 'Specifying steel castings', 'Purchasing policy', and 'SFSA Directory of Steel Foundries® - steel casting supplier database'.
- Designing castings**: A list of links including 'Design for function', 'Manufacturing design considerations', 'Concurrent engineering', 'Engineering drawings for casting production', 'Redesign as steel castings', 'Cast-weld construction', and 'Examples in Metalcasting Design® - a set of design study tutorials'.
- Manufacture of castings**: A list of links including 'Pattern equipment', 'Casting and molding processes', 'Melting', 'Finishing, heat treatment and inspection', 'Process capability and tolerances', and 'Quality control and quality assurance'.
- Getting started**: A list of links including 'Get an account - if you're a new user, you'll need to do this before you can use the wiki', 'How to contribute to the wiki', and 'The SFSA website, <http://www.sfsa.org>'.
- Resources**: A list of links including 'SFSA reports and other publications in PDF format', 'Technical & Operating Conference papers', 'Journal of Steel Castings Research archive', 'SFSA Artisan Program', 'Environmental Health and Safety', 'SFSA Webinars', 'Steel Casting Technology Videos', and 'Results of SFSA Surveys'.
- Material selection - mechanical and chemical properties**: A list of links including 'Carbon and low alloy steels for pressure containing and structural parts', 'Wear resistant steels', 'Corrosion-resistant high alloy steels', 'Nickel base castings', 'Heat-resistant high alloy steels', and 'Low temperature and cryogenic steels'.
- Material selection - processing properties**: A list of links including 'Hardenability and heat treatment'.

On the left side of the page, there is a sidebar with a 'Tools' section containing links for 'What links here', 'Related changes', 'Special pages', 'Printable version', 'Permanent link', and 'Page information'.

<http://wiki.sfsa.org>

Appendix 2



Steel Founders' Society of America is developing the "SFSA Wiki" under AMC's Casting Solutions for Readiness (CSR) Program that will provide SFSA members, any United States Government or Military personnel, and suppliers to the US Military access to extensive steel castings resources. Published general references are not always readily available to designers and users of steel castings and most do not reflect the advancements and knowledge developed over the past few years. The goal of the SFSA Wiki is to take advantage of the accessibility and efficiency of an online platform to gather historical and the latest resources in one location. The Wiki also supports the SFSA Artisan Program which provides extensive resources specifically designed to enhance the knowledge and skills in specific areas of foundry employees.

SUCCESS STORY

Problem: Published literature and information on current steel casting technologies are not always readily available to users and designers of steel castings.

Solution: SFSA created the Wiki so steel castings literature and other learning media can be easily accessed in one location. These references are arranged by topics and cross-linked to related pages.

Benefits: SFSA Wiki which currently has 5500 pages and contains approximately 4500 technical references serves as an accessible and easy to use resource on steel castings.



"I support the USAF in the development of penetrating munitions, and had a need to consider casting as a way of producing some of the more complex component parts. I was introduced to the SFSA organization, and soon after the SFSA website, and ultimately the SFSA Wiki. This allowed me the opportunity to learn about casting operations, its applicability to my particular problem, and all at my leisure. I was able to gain a significant amount of information from the site. It is a tremendous asset to the community. I highly recommend the site to anyone wanting to get up to speed on casting operations. It is well organized, easy to use, and contains a wealth of information."

Gene Estep, Engineer, USAF



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