The Stainless Steel Specialist Course

The BSSA's Stainless Steel Specialist Course was developed by the Australian Stainless Steel Development Association (ASSDA) and is published in the UK under licence. The UK version of the course has been harmonised with European standards.

Anyone involved in the design, specification, procurement, manufacture or selling of anything made from stainless steel should benefit from the course. No assumptions have been made in designing the course about the level of background knowledge of students. Usually the course material is explained from first principles and no science or engineering background knowledge is needed or assumed.

The course consists of 16 individual, self-study modules with accompanying training notes. To gain an Intermediate Certificate requires the successful completion of a minimum of 5 modules, of which 4 are compulsory. To gain a Full Certificate requires the completion of 12 modules, of which 7 are compulsory.

The aim of the compulsory training notes is to provide the essential grounding that the stainless steel professional needs, whilst leaving the course flexible enough to provide some scope for individual students to select additional papers, reflecting their own particular training interests.

The training notes vary in length from 8 to 36 pages and the accompanying question papers provide a series of multi-choice answers, intended to assess the understanding gained in reading the associated training note.

The full range of the 16 training notes is summarised in the table below:

1	An Introduction to Stainless Steel
2	Stainless Steel vs Corrosion
3	The Mechanical Properties of Stainless Steel
4	The Surface Finish on Stainless Steel
5	Fabricating Corrosion Resisting and Stainless Steels
6	The Cutting of Stainless Steels
7	The Metallurgy of Stainless Steels
8	The Welding and Joining of Stainless Steels
9	Machining Stainless Steels
10	Practical Considerations for Designing in Stainless Steel
11	Stainless Steel and Stainless Alloy Castings
12	Forging Stainless Steels
13	Stainless Steel Pipe and Tube
14	Cold Forming Stainless Steel
15	Deep Drawing of Stainless Steels
16	Stainless Steel and Stainless Alloys at High Temperatures

The compulsory Intermediate Certificate subjects are shown in **blue** and the additional compulsory Full Certificate subjects in **red**. The remaining subjects are optional ones.

The approach of the questions make the student think about what they have read, as many of the proposed answers are a best-fit, rather than merely a straightforward crib from the training note.

1. An Introduction to Stainless Steel

The module provides a well laid out introduction that first of all defines stainless steels and leads onto an outline of the types (or families) of stainless steels and their basic properties and corrosion resistance. Each family is then discussed in more detail with useful tables showing the most common grades including the EN steel numbers, typical compositions and applications. The families discussed include:

- Austenitic (including heat resisting and super austenitics)
- Ferritic
- Duplex
- Martensitic
- Precipitation Hardening

The module is accompanied by a set of 45 questions which test the basic understanding of corrosion resistance, the role of alloying elements and the grades in each of the stainless steel families. The understanding of specific properties and applications of each family is also explored and a good grasp of these introductory essentials is important in choosing the best answers.

2. Stainless Steel vs Corrosion: How Stainless Steel is Affected by and Resists Corrosion

The second module builds on the introduction to corrosion resistance outlined in Note 1 by identifying and then describing the range of low temperature or wet corrosion mechanisms that are potential hazards to stainless steels. (High temperature or gaseous mechanisms are covered separately in optional Training Note No. 16). Short sections on passivity and some of the environmental factors that influence whether corrosion is a likely threat precede longer discussions on specific mechanisms that include:

- General corrosion
- Galvanic corrosion
- Intergranular corrosion
- Pitting corrosion
- Crevice corrosion
- Microbiologically induced corrosion (MIC)
- Stress corrosion cracking

Each section also discusses ways of avoiding or preventing corrosion.

This module and the accompanying questions should develop a good basic understanding of the range of corrosion problems that are possible in stainless steels.

3. The Mechanical Properties of Stainless Steel: How these are Determined and the Factors Which Influence their Values

The first half of this module describes mechanical properties such as yield and tensile strength, elongation, hardness and toughness and how these are measured. These will be familiar to any metallurgist or materials engineers but are useful background to non-engineering students who have not previously carried out any studies such as metallurgy for non-metallurgists. The module then discusses these and other mechanical properties such as fatigue and creep in the context of the various stainless steels families. The notes are well illustrated with diagrams, graphs and tables of typical values for these mechanical properties.

The understanding developed during answering the questions on this module should however give the answers to anyone who has ever struggled to understand the information shown on a mill test certificate.

4. The Surface Finish on Stainless Steel

One of the principal messages of this module is the importance of surface finish on the service performance of stainless parts and fabrications. The definitions for surface finish for mill products including flat, tube and pipe, bar and wire products are described or tabulated and surface roughness measurements shown. A wide range of post fabrication finishing techniques is covered as well as special finishes including colouring, electropolishing and surface blackening, used on stainless items. There is also a comparison of pickled with passivated finishing and a discussion on final surface cleaning and routine in-service cleaning and maintenance. An understanding of these issues should help students hopefully avoid the all too common below expectations in-service performance noted for some poorly designed, fabricated or finished stainless steel installations.

Students completing this module should have a sound working knowledge of specifying and applying finishes to stainless steels both as ex-mill products and finally fabricated parts.

5. Fabricating Corrosion Resisting and Stainless Steels

This module reinforces the basic message of Training Note No. 4 by examining various stages in supply, fabrication and installation where damage and contamination can result in subsequent in-service staining or corrosion. The supply chain stages covered, where potential problems can occur include storage, handling, forming and cutting, welding and fabrication. The importance of removing weld heat tint is discussed and there is more detail on passivation. This is a good summary of the issues for any student involved in the fabrication of stainless steel items.

6. The Cutting of Stainless Steels

This module, like number 5, should be of particular interest to fabricators and manufacturers but may also be usefully combined with Training Notes Nos. 14 and 15. It deals entirely with intermediate product cutting methods, as applied to stainless steels, including mechanical methods:

- Mechanical sawing
- Shearing
- Banking, perforating and piercing
- Nibbling
- Friction cutting
- Abrasive cutting

Thermal methods are also covered:

- Powder (flux) cutting
- Arc cutting
- Plasma arc cutting

Laser and water-jet cutting are covered as new technology methods.

Engineers may find this module easier than commercial students; however, the understanding developed should help them when dealing with fabricators or engineering customers.

7. The Metallurgy of Stainless Steels

This module complements and reinforces the material in Training Note No. 1 by giving more fundamental information at the atomic structure level that is useful for a better understanding of some of the terms like ferrite, body centred cubic, austenite, face centred cubic, martensite, duplex etc. The relationship of stainless steels to plain carbon steels is described and developed to show how the crystal structures of stainless steels affects their properties.

The way in which the alloying elements such as chromium, carbon and nickel affect structure and hence properties is then covered as each of the family groups are systematically covered in turn. The hardening/strengthening mechanisms in heat treatable precipitation hardening and martensitic types is also discussed. This is not a practical part of the course but essential for helping sweep away some of the metallurgical mysteries surrounding stainless steels.

A few of the topics covered are quite demanding for anyone with little science background, but the technical terms usually encountered by commercial people should not be as intimidating once you reach this stage!

8. The Welding and Joining of Stainless Steels

If there is anyone more passionate about stainless steel than a metallurgist it's got to be a welding engineer! This module is the longest and arguably most technically demanding of the whole course. Most of the paper is devoted to welding of stainless steel but brazing, soldering, adhesive bonding and bolting (mechanical fixing) joining methods are also covered.

A brief review of the stainless steel family types is followed by a review of welding standards and processes and a detailed and practical review of joint design to avoid corrosion and distortion. Post weld cleaning and passivation is covered in detail revisiting the discussion of Training Note No. 5 but with particular emphasis here on weld related problems to avoid. The fusion joining processes are next covered in some detail with a very useful discussion on welding electrodes. The types of defects that can be problematic in stainless steel welds are discussed before a more detailed section on specific issues concerning the welding of the various stainless steel family groups (including castings). The final, by no means least important, subject covered is dissimilar metal i.e. stainless to carbon steels welding.

9. Machining Stainless Steels

This module is quite a challenge packed with 23 pages of information that should be of particular interest to engineers and fabricators. Best tackled along with Modules 5 and 6, it should provide most of what fabricators or jobbing machine shop engineers need to know, in order to have a sound insight into stainless steels. The paper is divided into two parts. Part 1 reviews the classification and mechanical properties of the stainless steel families with tables of grade compositions and family properties. Cutting tools and cutting fluids are next outlined. Part 2 then systematically describes mechanical machining methods with tables of cutting feeds and speeds. The methods covered include:

- Drilling
- Turning
- Tapping (thread cutting)
- Die Threading
- Thread Rolling
- Reaming
- Milling

Finally work piece cleaning, pickling and passivation are reviewed to complete this engineers' guide.

10. Practical Considerations for Designing in Stainless Steel

If Modules 1, 2, 3 and 4 have been studied beforehand this module completes the picture for design engineers both in industrial and building applications. A review of the stainless steel family properties is firstly outlined before the paper works through selection factors under the heading of Design Considerations. This includes a review of the corrosion mechanisms that can affect stainless steels both at normal temperatures and at high temperatures which can be found in some process plant environments and how corrosion or oxidation can be designed out of most products and fabrications. A review of mechanical properties, referring back to Module 3, is followed by economic considerations, which also act as a reminder of the importance of life cycle costing in stainless steel design.

Some interesting design scenarios are tested as part of the 40-question section. These cover marine, process plant and building situations, emphasising the approach to designing corrosion out of finished products. As most design engineers can't get by too long without using their calculators, there are a few numerate questions to grapple with. These are worth the effort to get a better picture of the design issues; the multi-choice answers providing clues for the less numerate!

11. Stainless Steel and Stainless Alloy Castings

This module thoroughly covers the classification, selection, application and manufacture of stainless steel castings. Certainly of value to anyone involved in the design, manufacture, procurement or sales of cast products but only of passing interest to those only involved in wrought stainless steel products. The castings manufacturing section explains the common casting defects and how these occur and can be avoided. Casting methods described include:

- Sand casting
- Shell-mould casting
- Investment (precision) casting
- Ceramic mould casting
- Spun castings (pipe/tube)

The American (ACI) grade classification system is explained and compared to the European system with illustrative tables of grades and sections describing the role of alloying elements and the resulting microstructure of the various types of castings. Castings specific fabrication issues, including machining, welding and mechanical properties can be read in conjunction with Modules 3, 8, and 9 for a fuller understanding.

12. Forging Stainless Steels

This module provides insight into one of the major methods of hot forming stainless steels. Certainly of value to those involved in the design, manufacture, procurement or sales of forgings, and of more relevance to suppliers of wrought products than Module 11.

A brief introduction to stainless steel forging grades, where AISI and EN 10250 grades are compared, followed by a look at forging processes that include:

- Open die forging
- Closed die forging
- Drawing out
- Upset forging
- Ring forging and ring rolling
- Piercing and core forging

The various forms of starting material (cast ingot, billets etc) and control of heating during and after forging are then thoroughly reviewed. Finally the heat treatment, descaling and pickling of forgings for optimum in-service corrosion resistance is discussed.

13. Stainless Steel Pipe and Tube

This module will be of particular interest to anyone involved in the manufacture, procurement or selling of stainless steel pipes or tube products. These product forms find a wide range of application in sectors such as process plant, water treatment and supply, and construction.

Standards and grades are dealt with in appendices to this module, comprehensively covering the American ASTM and British standards, dimension and allowable working pressures. A useful glossary of terms concerning pipes and tubes is also appended.

The paper starts by comparing the methods of manufacturing seamless and welded products which include:

- Rotary piercing
- Extrusion
- Centrifugally cast
- Longitudinally welded
- Spirally welded
- Press brake formed
- Roll form fabricated

The welding processes (and their abbreviations) used in pipe and tube manufacture are described as well as finishing operations. Inspection and testing is covered in a way that will be useful to non-technical students, reinforced with a section on procurement issues of interest to commercial students. The forming (bending and expanding) of pipe and tube is described in a discussion of applications with a short section on heat transfer, frequently a topic of interest in heat exchanger applications.

14. Cold Forming of Stainless Steels

Modules 14 and 15 are allied to each other in their scope and should appeal equally as optional papers, particularly to engineers and fabricators, along with Module 6. Module 14 may also be useful additional study material for commercial students involved with selling sheet products to engineering or construction industry customers.

The module is mainly concerned with the forming of sheet products, tube forming having been covered in Module 13. The properties of the various stainless steel families i.e. austenitic, ferritic, martensitic and duplex, that affect formability, are first described followed by specific issues that are important in stainless steel forming, including:

- Enhanced power requirements
- Lubrication
- Spring back

The forming processes are then described, including:

- Press brake forming
- Press forming
- Spinning
- Three-roll forming
- Stretch forming
- Explosive forming
- Cold heading

This module is not specifically technical and should help commercial students understand the issues as well as materials or manufacturing engineers.

15. Deep Drawing of Stainless Steels

Modules 14 and 15 are allied to each other in their scope and should appeal equally as optional papers, particularly to engineers and fabricators along with Module 6. Module 15 may also be useful additional study material for commercial students involved with selling sheet products to engineering or construction industry customers.

The module deals with how sheet metals flow during deep drawing operations and how the properties, particularly of the austenitic stainless steels, enable deep shapes to be drawn. Practical drawing parameters important in deep drawing are also discussed including:

- Die clearance
- Die and punch radii
- Blank Design
- Lubrication

Like Module 14 the material covered is not specifically technical and should help commercial students understand the issues as well as materials or manufacturing engineers.

16. Stainless Steels and Stainless Alloys at High Temperature

This final module includes a comprehensive reference list and table of wrought and cast, stainless steel and nickel heat resisting alloy grades. The role of stainless steels as heat resisting alloys is discussed in terms of their alloy compositions. This complements the discussion in Module 2 that covers aqueous corrosion. High temperature corrosion mechanisms discussed in some detail include the influence on stainless and heat resisting alloys of:

- Oxygen
- Sulphur, sulphur dioxide and hydrogen sulphide
- Carbon
- Hydrogen
- Halogens
- Ammonia & nitrogen
- Liquid metals
- Molten salts
- Flue gasses
- Fuel ash

The influence of properties such as thermal expansion and creep strength on high temperature performance is concluded by a discussion on the issues of precipitate formation and embrittlement of these alloys during high temperature service. The information is presented, as most of the information in the course is, in a non-technical way that is within the grasp of most people working in the stainless steel industry.

FURTHER INFORMATION

Benefits

The course enables students to:

- Improve their knowledge and understanding of stainless steel
- Tailor their learning to those aspects of stainless steel with which they are most directly involved
- Study in their own time and at their own pace
- Achieve a recognised standard of knowledge, which can be included in a personal CV, as well as in company literature
- Improve the level of customer service and advice to buyers and specifiers
- Obtain a valuable reference book, to which they can refer on an ongoing basis

Fee

Registration fee	£20	
Intermediate Certificate	£125	(£75 BSSA members)
Full Certificate	£300	(£180 BSSA members)
Additional Titles	£25 each	(£15 BSSA members)

The cost of the course includes course materials, examination questions and assessment and certification. **Prices are exclusive of VAT.**

Workshops

For companies wishing to use the Stainless Steel Specialist Course as a training programme for a number of staff, the BSSA is able to offer an introductory workshop and on-going support, tailor made to company requirements.

For more information

To receive further information about the Stainless Steel Specialist Course or an application form contact the Association Administrator.

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