Trade of Metal Fabrication	
Module 1:	Basic Fabrication
Unit 1:	Introduction to the Metal Fabrication Trade
	Phase 2

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Document Release History

Date	Version	Comments
03/08/06	First draft	
13/12/13	SOLAS transfer	

Module 1 – Basic Fabrication

Unit 1 – Introduction to the Metal Fabrication Trade

Duration – 2 Hours

Learning Outcome:

By the end of this unit each apprentice will be able to:

- Describe the background of the Metal Fabrication industry in Ireland
- Describe the most common forms of stock sizes and materials
- Describe the contents of the metal fabricator's tool box

Key Learning Points:

P	Craft unions and employer organisations.
Rk	History, size, scope and trends of the industry -Standard forms of materials -Safe use and handling of tools -Type of work - Platework - Pipework - Structural - Light Fab - Welding - Drawing
H	Occupational hazards.
Rk	Materials and methods of production.

Training Resources:

Lectures, videos, slides, photos, handouts and texts.

Exercise:

Questions and answers.

Key Learning Points Code:

M = Maths D= Drawing RK = Related Knowledge Sc = Science
P = Personal Skills Sk = Skill H = Hazards

Standard Sections

Metals are produced and supplied in many different forms, as shown in Figure 1.

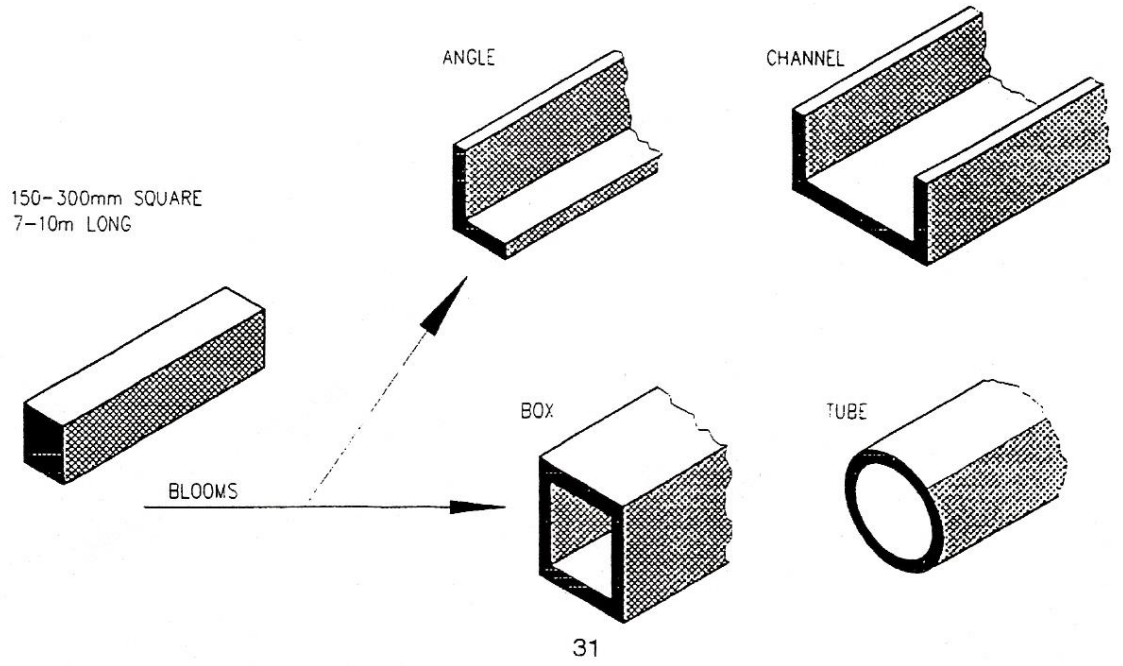


Figure 1 - Different Materials/Steels available for Metal Fabrication 1

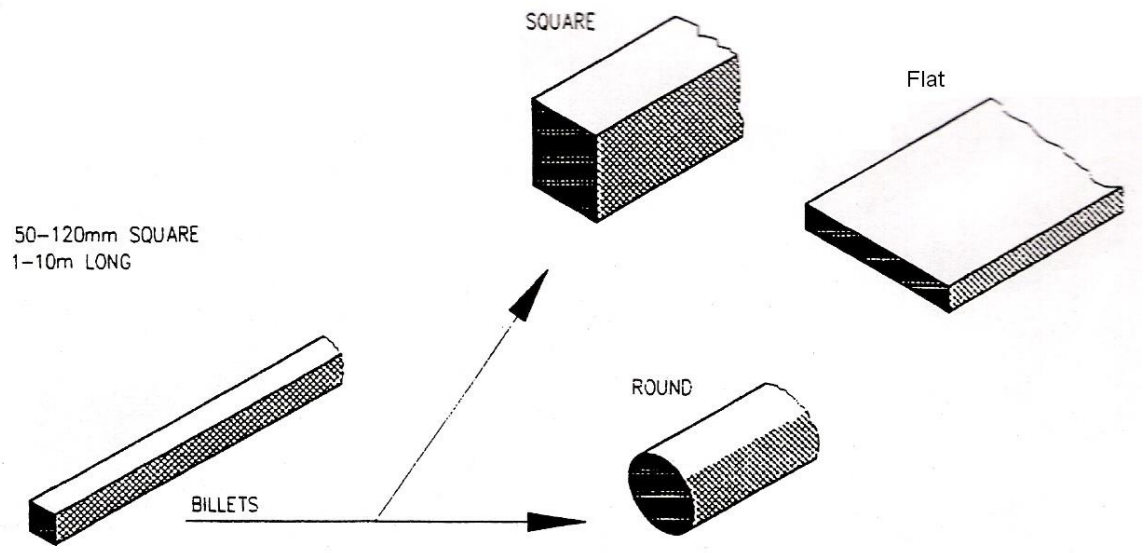


Figure 2 - Different Materials/Steels available for Metal Fabrication 2

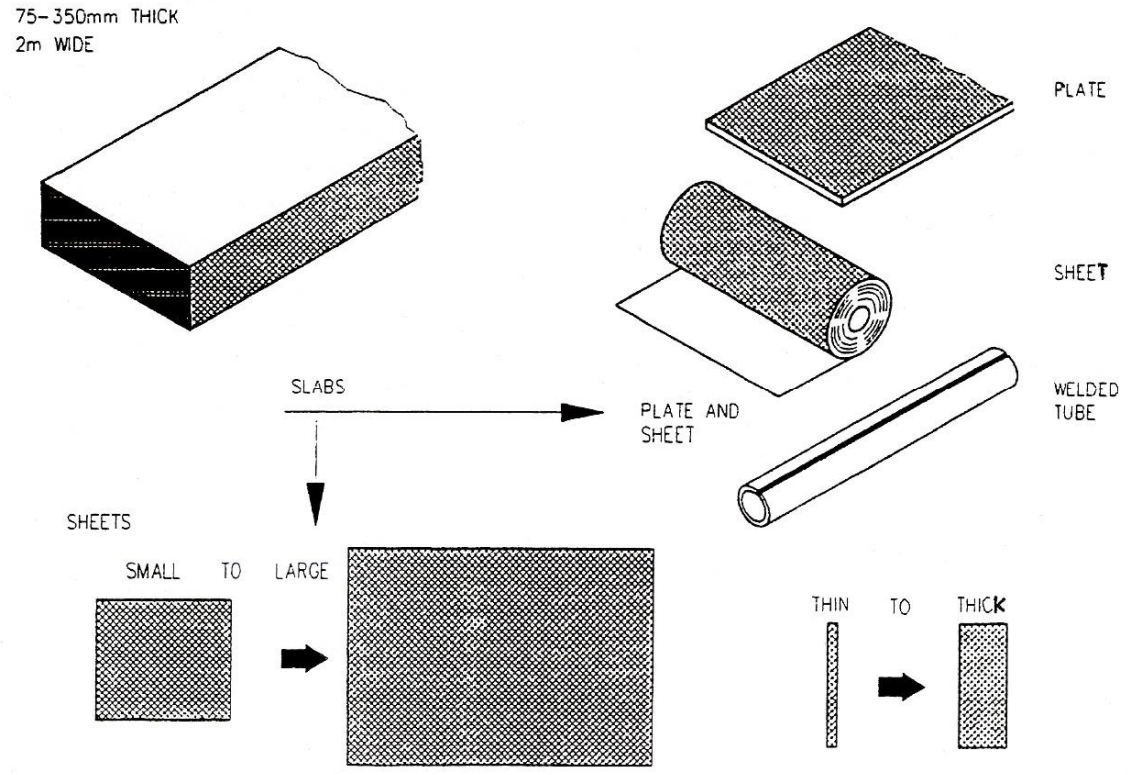


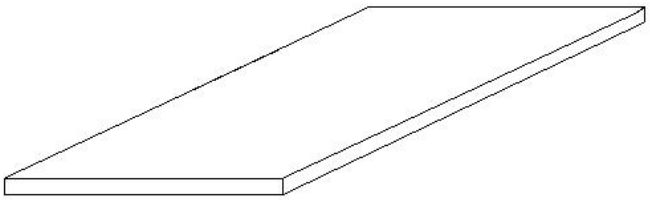
Figure 3 - Different Materials/Steels available for Metal Fabrication 3

Common Steels used in the Workshop

150mm *x* 6mm FB (Flat Bar)

100 *x* 6 FB

50 *x* 6 FB



All flat bars listed above are available in different thickness 3mm/5mm etc.

They are known as low carbon steel (LCS).

Standard sheet steel (mild steel plate) is normally available in 8ft. *x* 4 ft. (2500mm *x* 1250mm) sections 2mm/3mm, 5mm/6mm, 10mm/12mm etc.

Stainless steel and aluminium are available in the same sizes.

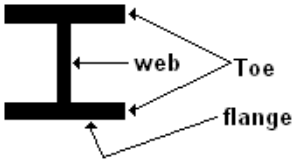
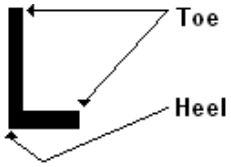
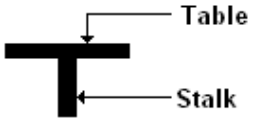
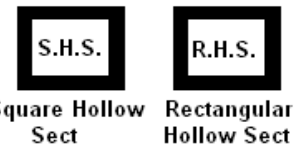
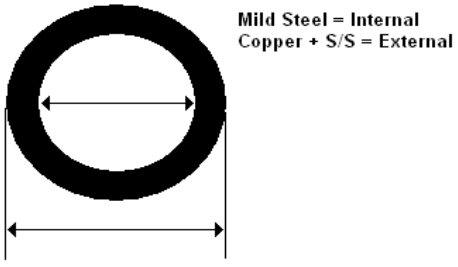
RSJ = Rolled Steel Joist	
BSUB = British Std. Universal Beam	
BSUC = British Std. Universal Column	
RSC = Rolled Steel Channel	
BSEA = British Std. Equal Angle	
BSUA = British Std. Unequal Angle	
RST = Rolled Steel Tees	
Zed Beams (Z Channel)	
Rolled Hollow Section	
Round Hollow Section	

Table 1 - Common Steels used in the Workshop

Back Marks and Cross Centres

A ‘back mark’ is the distance from the heel of an angle or channel section to the centre of a hole in a flange.

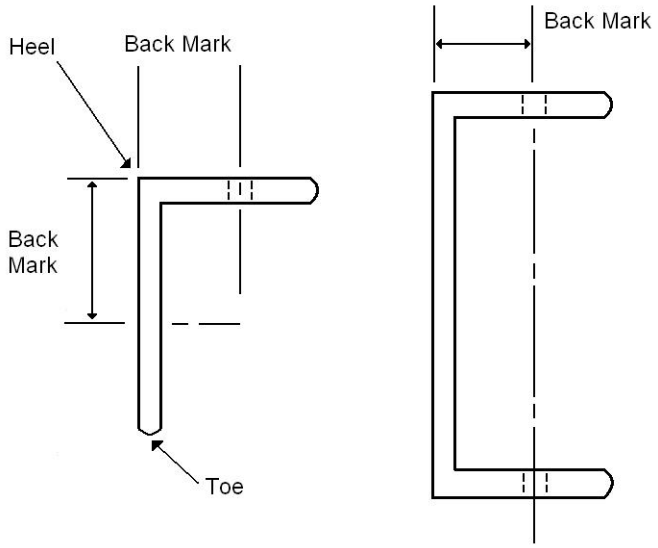


Figure 4 - Back Marks

A ‘cross centre’ is the distance between two holes in a flange of a Universal column, beam, rolled steel joist or Tee section.

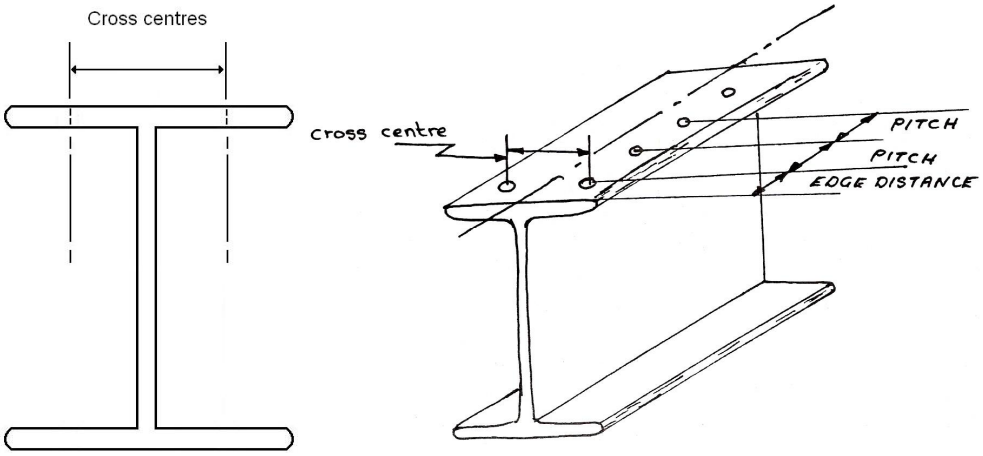


Figure 5 - Cross Centres

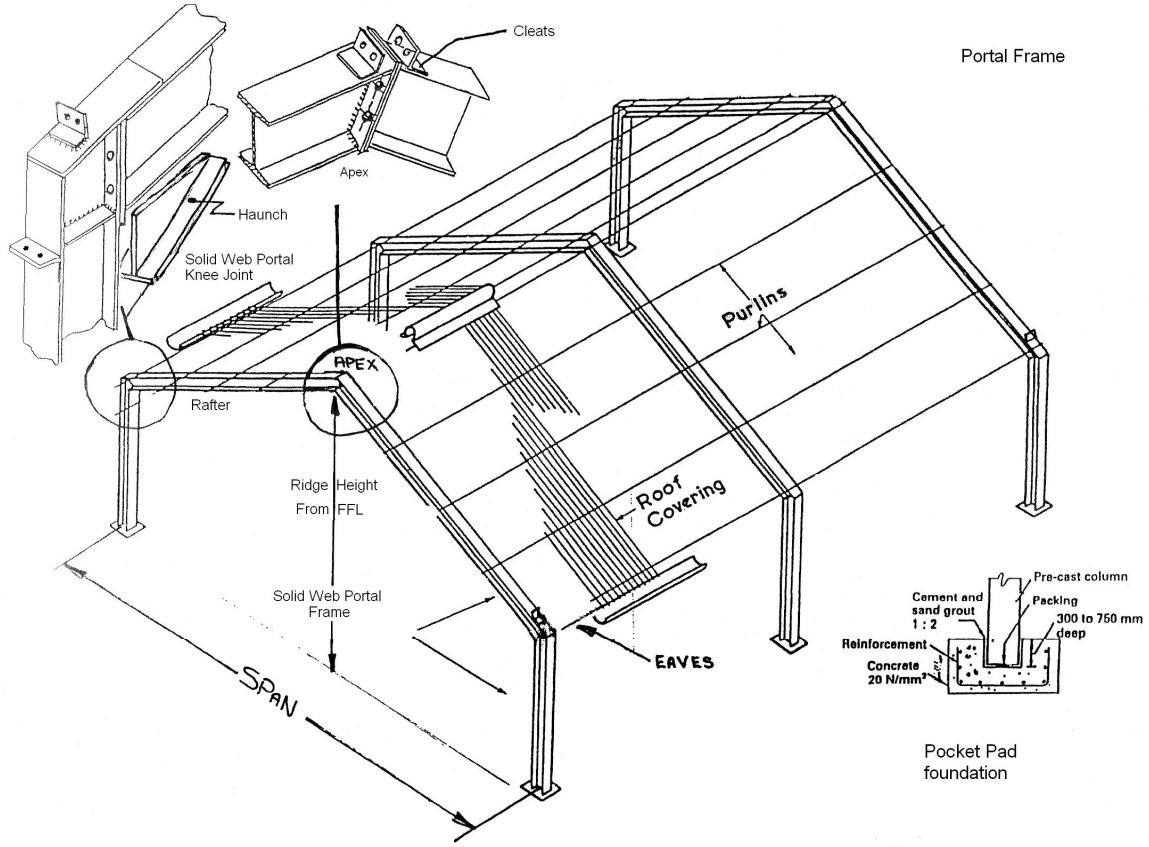


Figure 6 - Pocket Pad Foundation

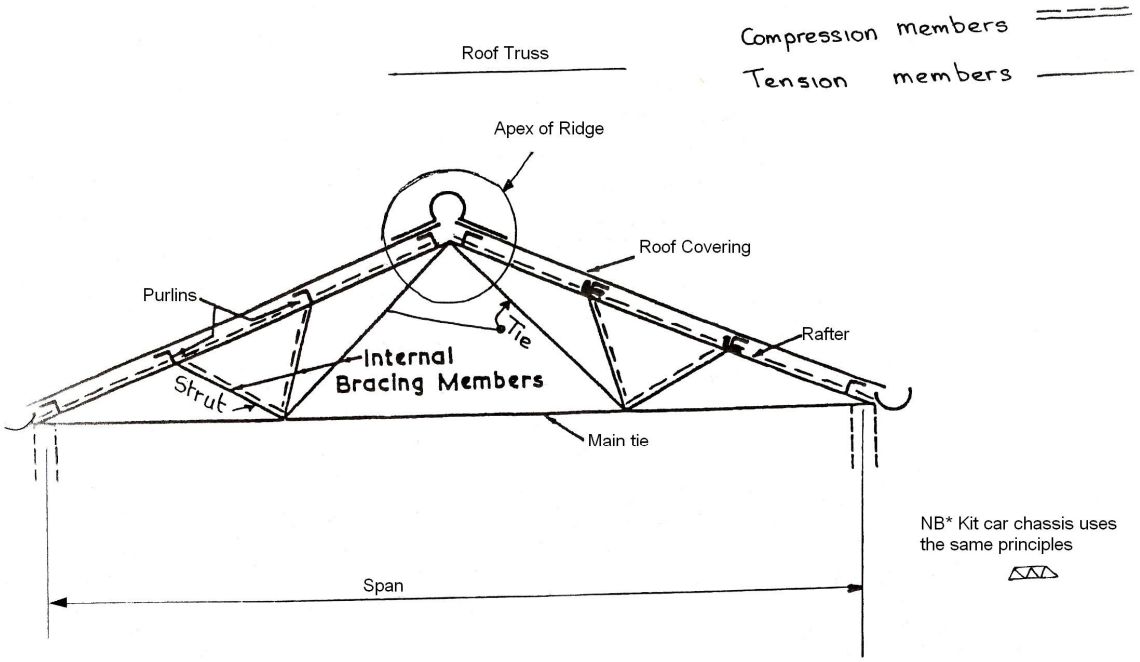
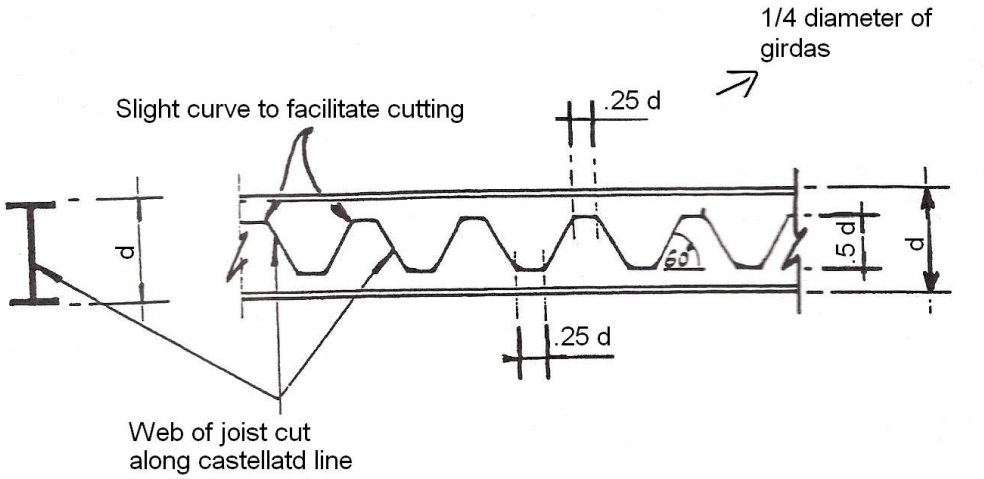


Figure 7 - Roof Truss

Castella Beams

This open web beam section is made by cutting the web of a hot rolled joist along a castellated line. The two halves produced are then welded together to form the section illustrated in Figure 8.

The castella beam is one and a half times the depth of the member from which it was cut, and therefore suffers less deflection under load. This section is economical for lightly loaded floors and the openings in the web are convenient for electrical and heating services.



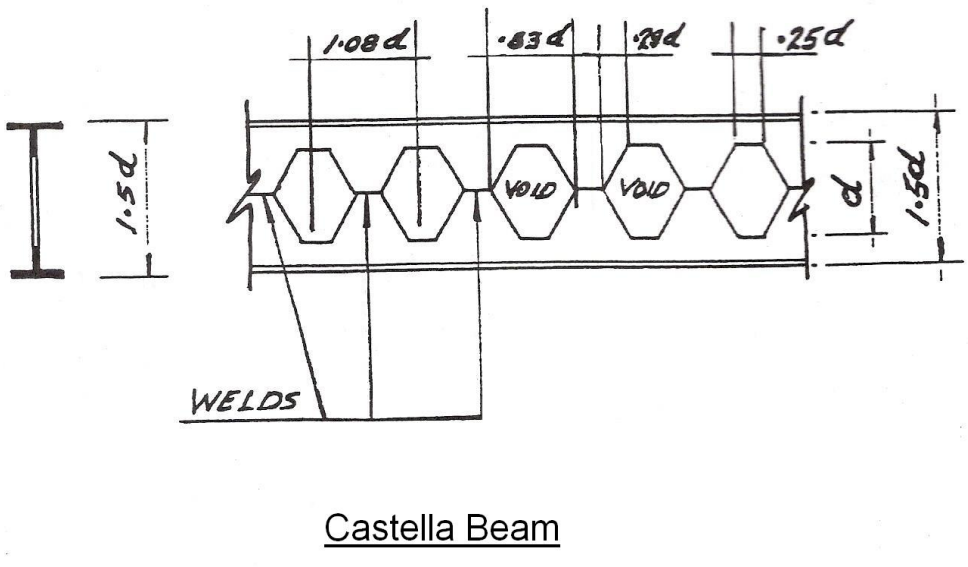


Figure 8 - Castella Beam

Serial Size – Actual Size

When referring to beams, columns, joists and channels the depth/overall distance from flange to flange is given first followed by the breadth/width of the flange, followed by the mass per metre and finally the length required.

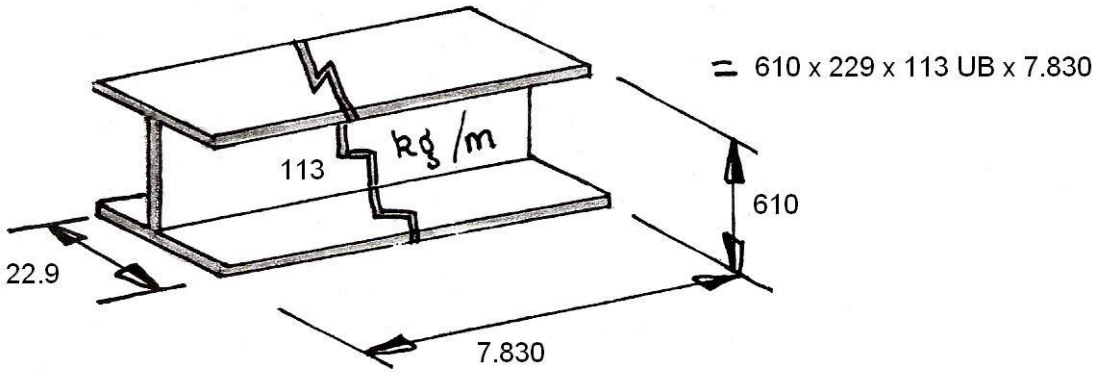


Figure 9 - Serial Size

Although the serial sizes are always referred to on drawings, the actual size of beams, columns etc. can vary considerably. BS41 gives dimensions for serial sizes of sections with mass per metre, actual depth and breadth and thickness of web and flange.

It will be seen that up to seven variations of a serial size is rolled and that the dimensions inside the flanges are constant, while the thickness of the web and flanges vary, hence the variation in serial size and actual size.

Methods of Production

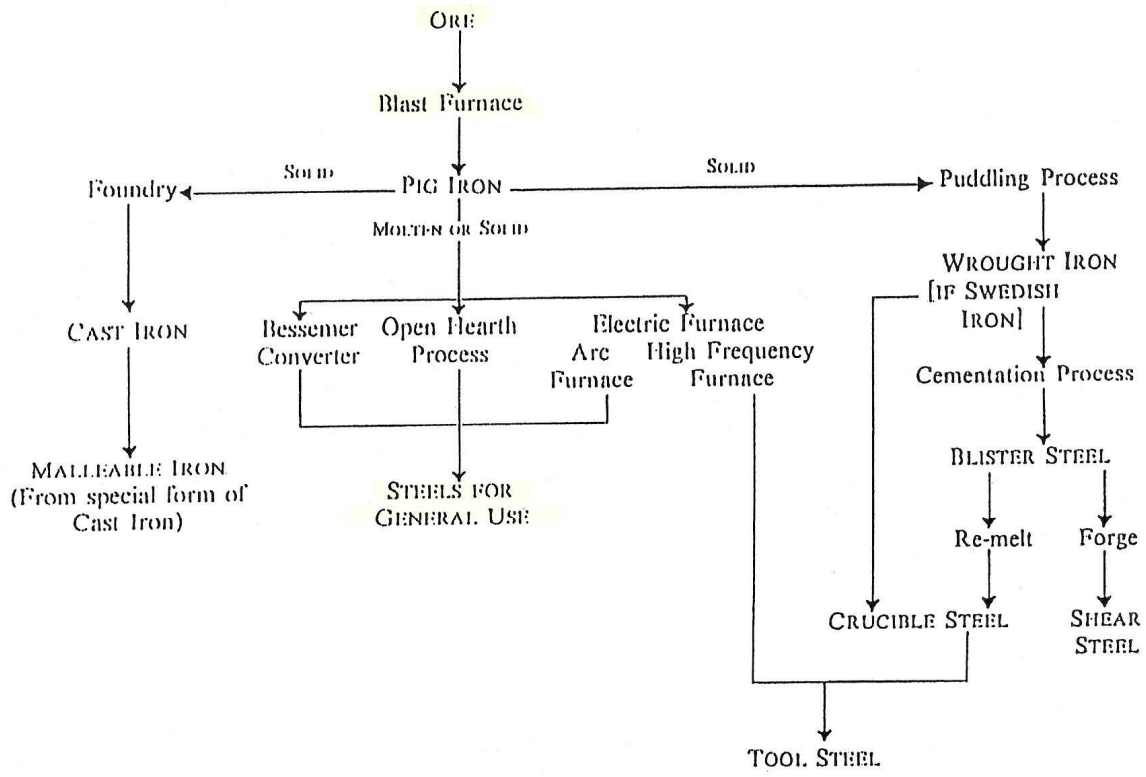


Figure 10 - Diagram showing production of the materials in the iron and steel group

(The production of tool steel from the Cementation process is now mainly of historical interest only.)

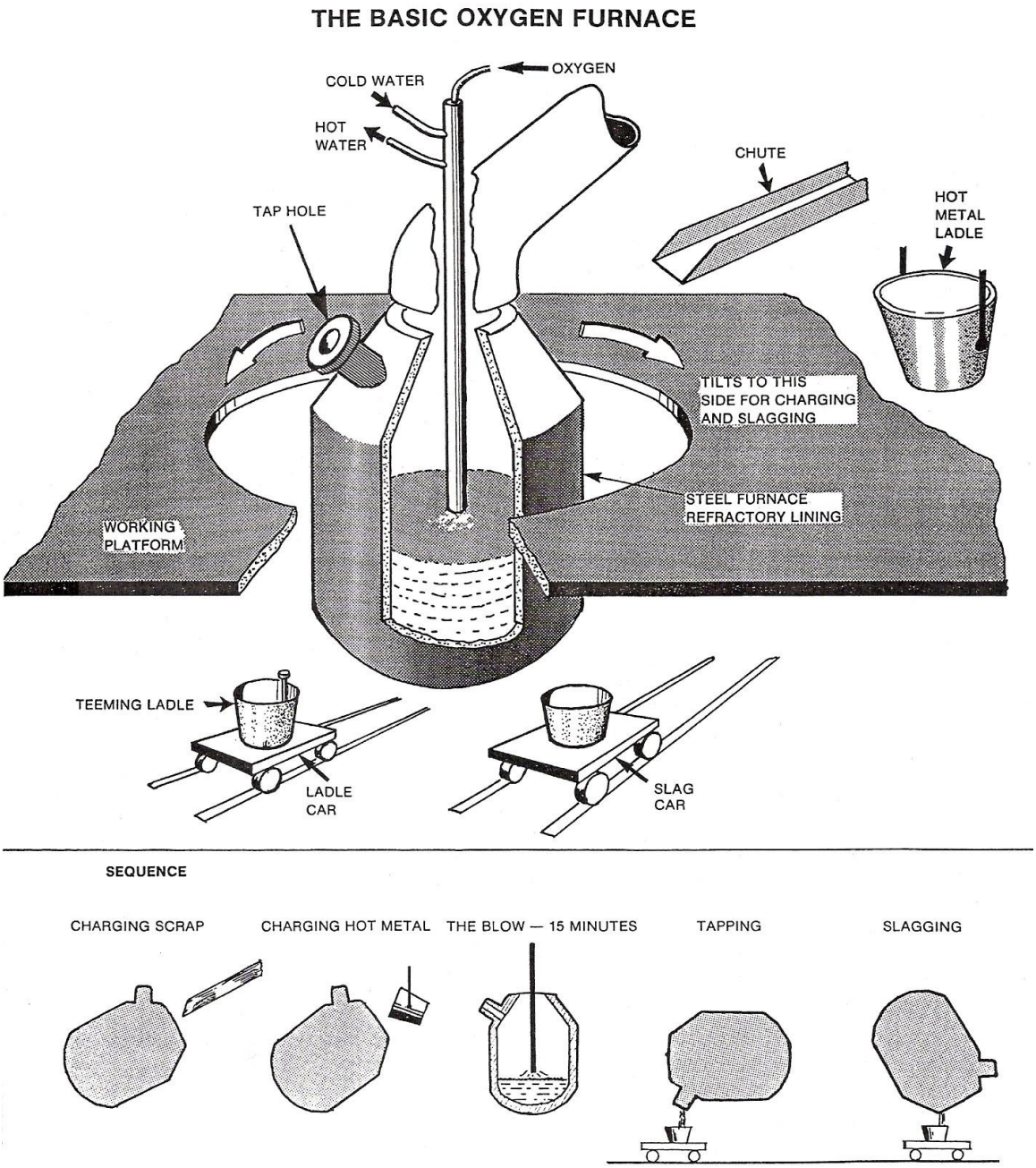


Figure 11 - The Basic Oxygen Furnace

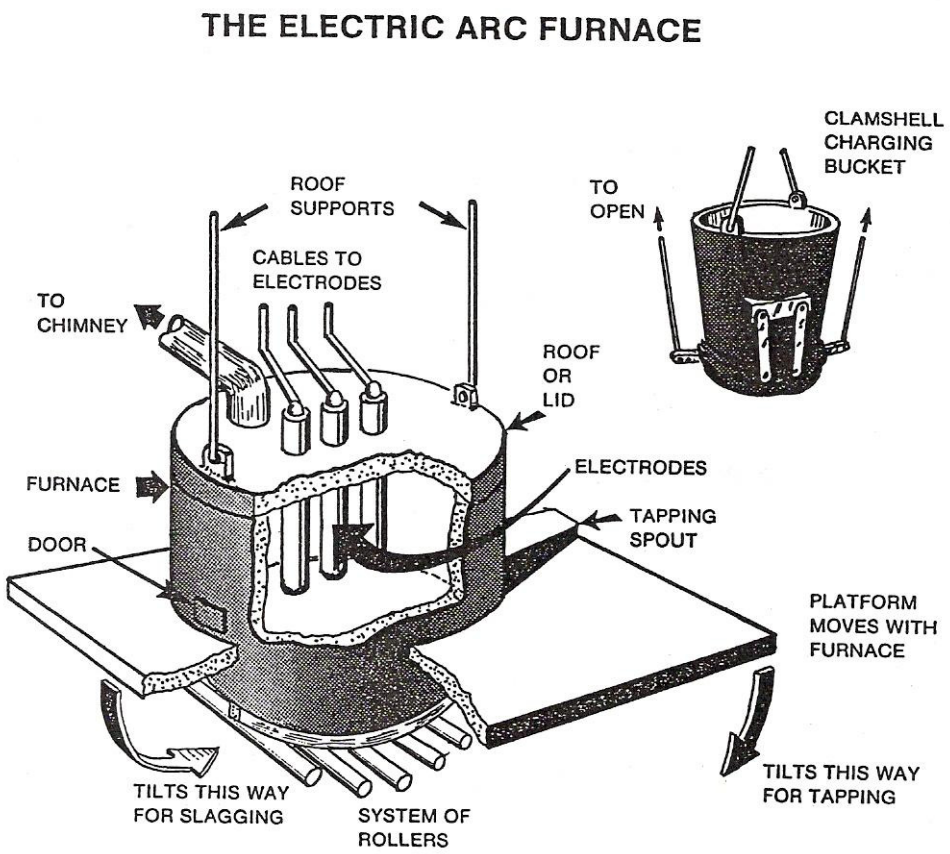


Figure 12 - The Electric Arc Furnace

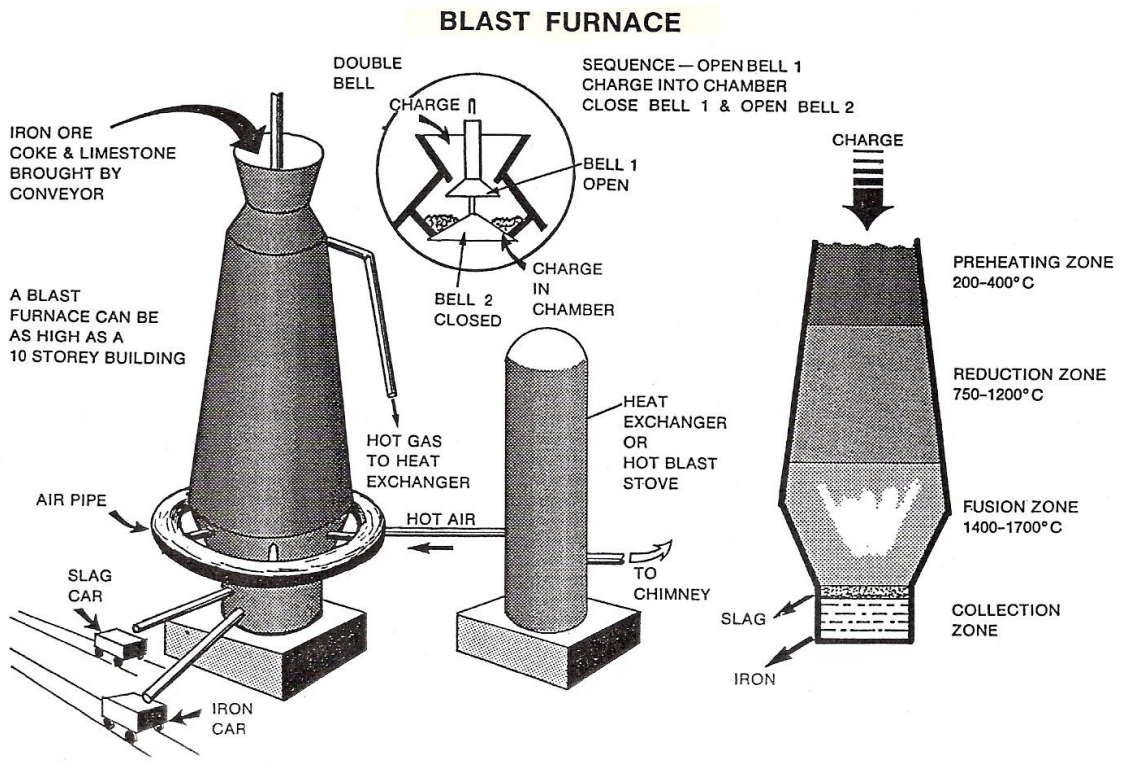


Figure 13 - Blast Furnace

Name	Group	Carbon Content %	Some Uses
Wrought Iron	Wrought Iron	Less than 0.05%	Chain for lifting tackle, crane hooks, architectural ironwork.
Dead Mild Steel	Plain Carbon Steels	0.1 to 0.15	Sheet for pressing out such shapes as motor-car body, panels, thin wire, rod and drawn tubes.
Mild Steel		0.15 to 0.3	General purpose, workshop bars, boiler plate, girders.
Medium Carbon Steel		0.3 to 0.5 0.5 to 0.8	Crankshafts, forgings, axles, leaf springs, cold chisels.
High Carbon Steel		0.8 to 1.0 1.0 to 1.2 1.2 to 1.4	Coil springs, wood chisels, files, drills, taps and dies, fine edge tools.
Grey		-	Machine castings.

Table 2 - Method of Production

Occupational Hazards

(***Note:*** For further information on Occupational hazards, refer to the *Welder on Site…Be Aware* video.)

Noise

A new Statutory Regulation concerning noise at work came into operation on July 1st, 1990.

The full title of this regulation is:

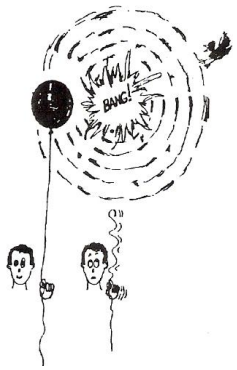
European Communities (Protection of Workers) (Exposure to Noise) Regulations, 1990.

Under this regulation FAS (The Training and Employment Authority) is required to provide information to staff, trainees and apprentices on:

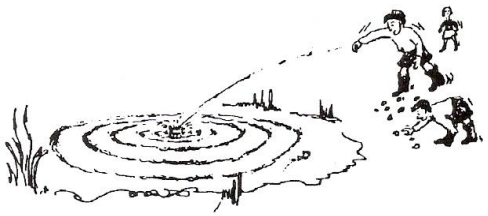
- what noise is,
- the type of damage it can cause,
- how it is measured,
- what are the safe limits of exposure?

This section attempts to achieve this objective without going into a lot of unnecessary technical data.

What is Sound?



If we burst a balloon, we cause a disturbance in the surrounding air which may be likened to the effect of throwing a stone in a pond. When the ripples caused by the explosion reach our ears we hear the sound of the balloon burst. It is these ripples travelling through the air that we generally regard as sound.



The human ear is sensitive to noise at frequencies or ripples between 20 times per second and 20,000 times per second. The unit of frequency is the Hertz (Hz). We then speak of the audible range as frequencies or ripples between 20 Hz and 20,000 Hz. We do not use the entire range of frequencies 20-20,000 Hz continuously. A stereo player will emit sound in a range of frequencies from 40-16,000 Hz, whereas a transistor radio covers the range 200-4,000 Hz. In normal speech the frequency range is 125-8,000 Hz but 500-3,000 Hz is the most important area. (20 Hz is a very low bass note, while 20,000 is a very high trebly note).

Loudness is the other factor that is important. We are all aware of it how quiet a whisper is and how loud a jet aircraft engine is. The loudness of a sound is measured in Decibels and this is written as dB(A). The quietest sound the average person can hear is assigned a loudness level of 0 dB(A). The loudest sound we can tolerate without pain is 120 dB(A). Table 3 gives some examples of the loudness of sounds.

Sound Loudness Level dB(A)	Typical Environment	
140	30m from military aircraft at take-off.	Intolerable
130	Pneumatic chipping and riveting (operator's position).	Intolerable
120	Boiler shop (maximum levels). Ship's engine room (full speed).	Intolerable
110	Automatic punch press (operator's position) sheet metal shop – hand grinding.	Very noisy
100	Automatic lathe shop. Printing press room.	Very noisy
90	Heavy lorries at 6m. Construction site – pneumatic drilling.	Very noisy
80	Kerbside of busy street. Office with tabulating machines.	Noisy
70	Loud radio (in average domestic room).	Noisy
60	Restaurant. Department store.	Noisy
50	Conversational speech at 1m. General office.	Quiet
40	Average suburban area, whispered conversation at 2m. Residential area at night.	Quiet
30		
20	Background in TV and recording studios.	Very Quiet
10		
0	Normal threshold of hearing.	Very Quiet

Table 3 - Examples of the Loudness of Some Noises

How Does the Ear Work?

The ear is generally considered to have three main sections, the outer, middle and inner ear (see Figure 14). The outer ear consists of the external parts of the ear canal. The middle ear comprises the ear drum and the three bones connecting it to the inner ear. The middle ear can be damaged by traumatic events such as explosion but may be surgically repaired in some cases. The inner ear converts the mechanical (ripples) world of sound to the electrical world of brain. It is the inner part of the ear, called the cochlea, which can be damaged by prolonged exposure to excessive noise.

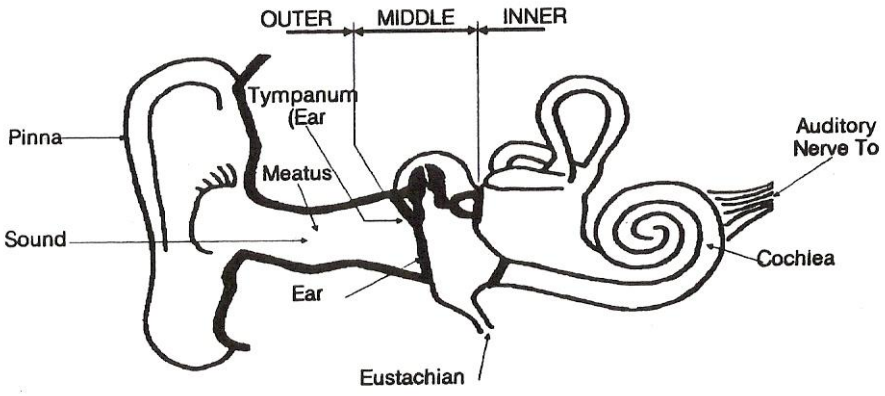


Figure 14 - The Ear

How noise damages your hearing, when levels are too high. Excessive noise overstimulates the cochlea of the ear which translates sound frequencies into impulses which the brain can interpret. Repeated overstimulation impairs this organ and the damage cannot be repaired.

Effects of too Much Noise

Most of us have had the experience of being temporarily deafened by exposure to loud noise, whether it is at work, or at a disco. Given a few hours rest, the ear recovers and no permanent damage is done. When exposure is continuous or repeated, however, a gradual hearing loss may result. This hearing loss is permanent and irreversible and is known as "Noise Induced Hearing Loss (NIHL)". It cannot be corrected by surgical or any other means. Even the use of a hearing aid is generally considered unsatisfactory, because of the nature of the hearing loss.

Safe Exposure Level

Most countries have set a limit of 90 dB(A) for continuous exposure. Ireland adapted this approach in the Noise Regulations 1975 and 1990. It is permissible to have exposures above 90 dB(A), but if so then the duration of such exposure must be limited such that the total anise dose equivalent (Leq) remains below 90 dB(A) aver 8 hours. Table 4 shows such equivalent times.

Sound Pressure dB(A)	Allowable Exposure Time (per day)
90	8 hours
93	4 hours
96	2 hours
99	1 hour
102	30 minutes
105	15 minutes
108	7.5 minutes
111	3.75 minutes
114	112 seconds
117	56 seconds
120	28 seconds
123	14 seconds
126	7 seconds
129	3.5 seconds
132	1.75 seconds
135	Less than 1 second

Table 4 - Noise Levels and Exposure Times
(Equivalent to 90 dB(A) for 8 hours)

Protective Clothing and Equipment

Figure 15, Figure 16 and Figure 17 illustrate examples of the use of protective clothing and equipment.

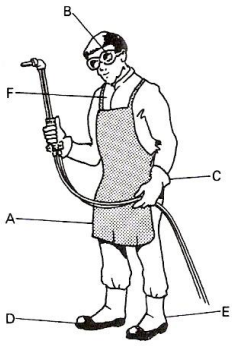


Figure 15 - Protective Clothing

Name	Main use
A. Flame-resistant apron	Prevents burning of clothes.
B. Gas welding/cutting goggles	Protects eyes from sparks.
C. Gauntlets	Prevents skin burn.
D. Safety boots (steel toecap)	Prevents crushing of toes.
E. Spats	No molten metal down boots.
F. Boilersuit	Protects neck and chest.

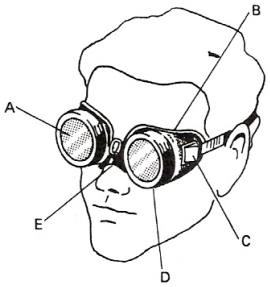


Figure 16 - Protective Eyewear

Name	Use
A. (i) Clear glass	Protects tinted lens.
A (ii) Tinted lens	Limits glare.
B. Goggle body	Stops sparks.
C. Air vent	Prevents misting up.
D. Lens holder	To change broken lens.
E. Strap adjustor	Adjust for size

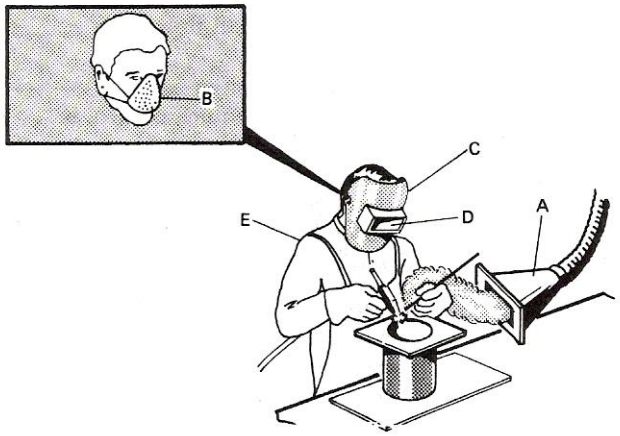


Figure 17 - Protective Equipment

Name	Use
A. Extractor fan	Takes away fumes.
B. Filter mask	Dust and fumes.
C. Head shield	Prevents skin burn.
D. (i) Renewable clear glass	Takes spatter etc.
D. (ii) Renewable tinted	Prevents arc eye.
E. Leather cape with sleeves	For overhead work.

The filter mask (Figure 17B) is no protection from dangerous gases such as phosgene (which is formed from degreasing agents such as trichloroethylene) or nitrous fumes (caused when large areas of plate are heated) or any other poisonous gases. See safety precautions for TAGS and MAGS.

Note: For more information read *Basic Welding and Fabrication*.

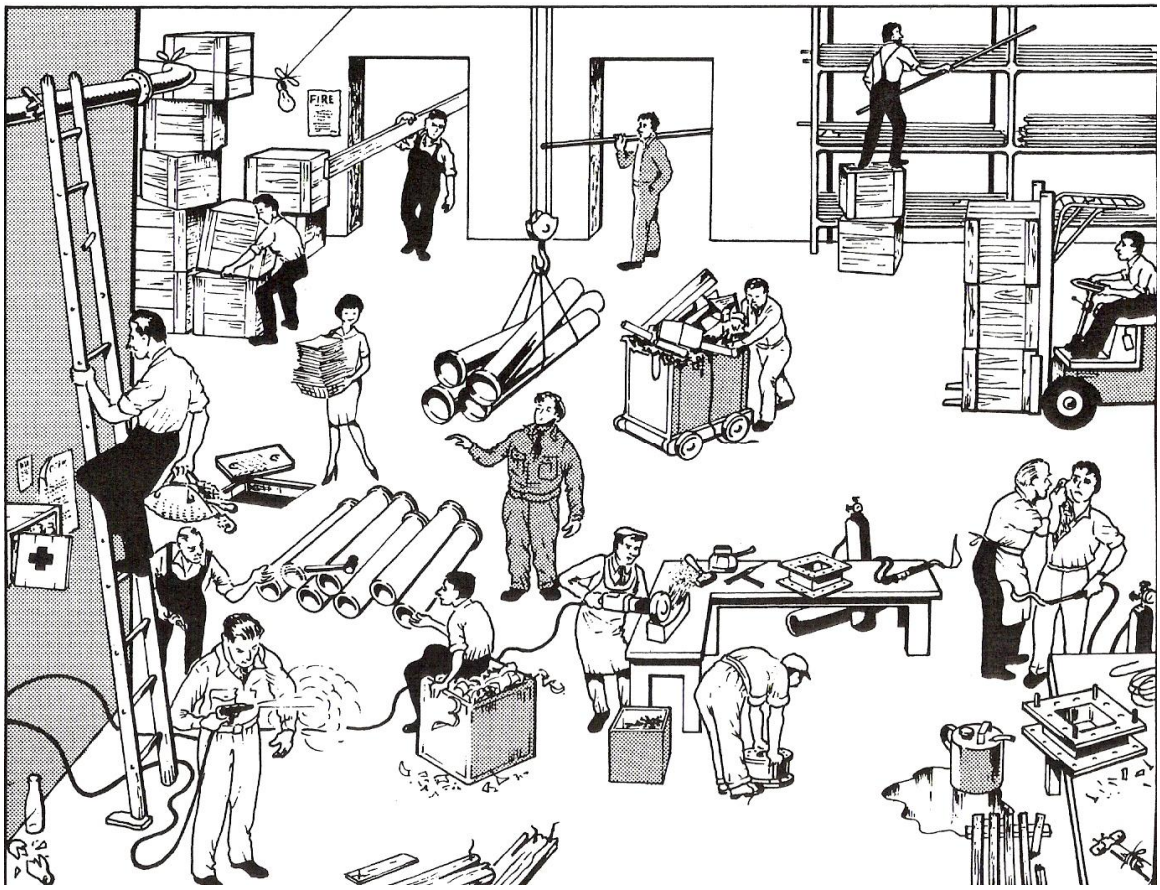


Figure 18 - List all instances of unsafe practice that you can detect. (*Courtesy of "What's Wrong" Safety Posters*)

Body Protection

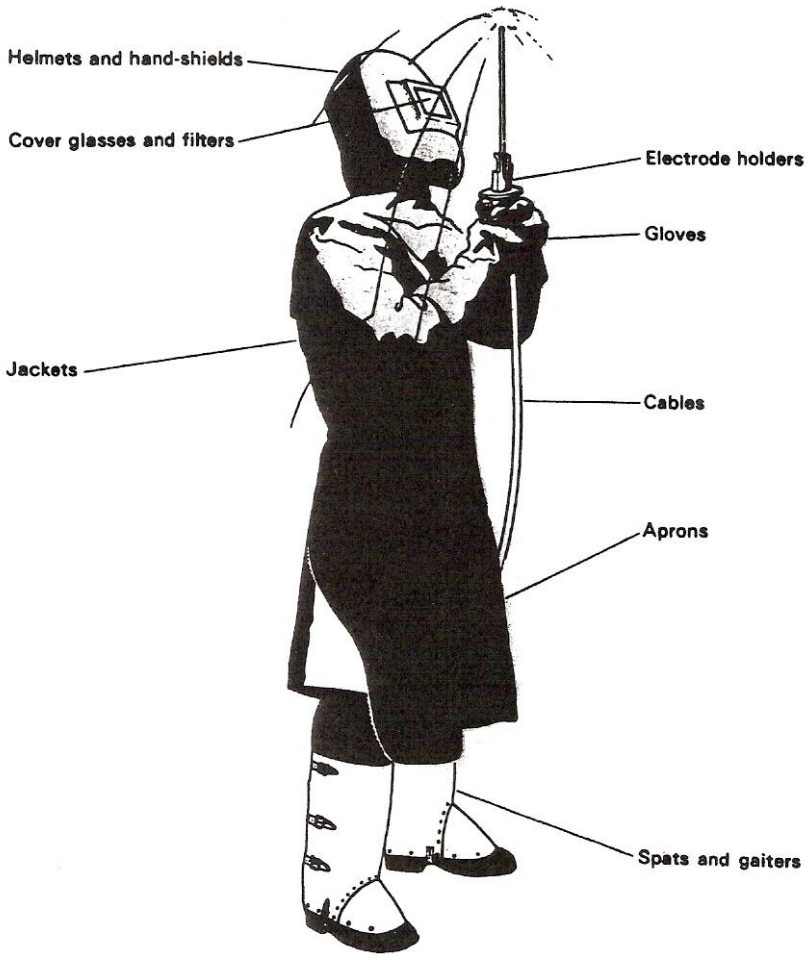


Figure 19 - Body Protection

Figure 19 shows a welder fully equipped with protective clothing. The welder's body and clothing must be protected from radiation and burns caused by flying globules of molten metal. It may be necessary for a welder to wear an apron, usually of asbestos or thick leather, to protect his trunk and thighs whilst seated at a bench welding. An apron should also be worn if the welder's clothing is made of flammable material.

When deep gouging or cutting is carried out using metal-arc processes, the amount of 'spatter' is considerably greater than that experienced with normal arc welding, and therefore it is necessary to protect the feet and legs in the same way as the hands and forearms. Suitable leather leggings and spats are available and should be used to prevent burns to the legs, feet, and ankles.

Note: For more information read *Fundamentals of Fabrication and Welding Engineering*.

Self- Assessment

Questions on Background Notes – Module 1.Unit 1

1. List three occupational hazards associated with the METAL FABRICATION TRADE?

2. Name two industries that use pipework and structural steel extensively?

3. Give one example of what threaded rod is used for?

4. With the aid of a diagram sketch a section of

a. British Standard Equal Angle (B.S.E.A)
b. British Standard Unequal Angle (B.S.U.A)

5. In diagram form, show

a. Rolled Steel Channel (R.S.C)
b. Universal Beam (U.B)

6. Taking the method of production into account, give two examples of uses, of both high carbon steel and dead mild steel.

Answers to Questions 1-6. Module 1.Unit 1

1.

Noise / Fumes / Arc Flash

2.

a. Pharmaceutical.

b. Gas Industry.

3.

Suspended Ceilings:

Bolting a steel frame section to a cavity wall, where you would have to thread the nut and washers from outside the block.

4.

Figure 1. (B.S.E.A)

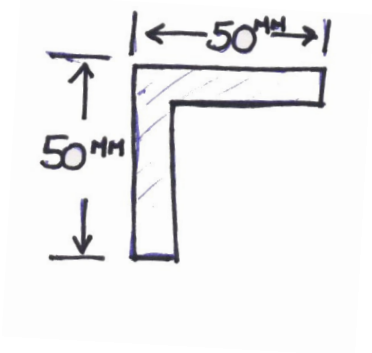
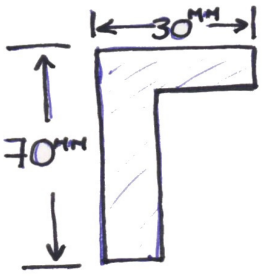


Figure 2. (B.S.U.A)



5.

Figure 3. (R.S.C)

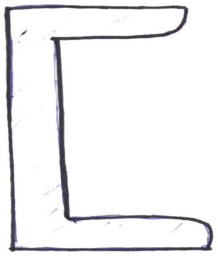
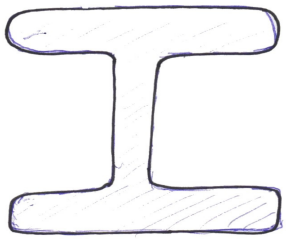


Figure 4. (U.B)



6.

a. High Carbon Steel: Files / Drills / Coil Springs

b. Dead Mild Steel: Motor Vehicle Body's / Thin Wire / Panels

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Fundamentals of Fabrication and Welding Engineering
by FJM Smith — *ISBN 0-582-09799-1*
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