Education and Culture

Leonardo da Vinci

Course: 141 - TIG WELDING OF STAINLESS STEEL

Module 6

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MODULE 6

Specific rules and regulations (A3)

Welding Safety (resume)

Hazard	Factors to Consider	Precaution Summary
Electric shock can kill 	Wetness Welder in or on workpiece Confined space Electrode holder and cable insulation	Use dry insulation. Rubber mat or dry wood Wear dry, hole-free gloves. Do not touch electrically "hot" parts or electrode with bare skin or wet clothing. If wet area and welder cannot be insulated from workpiece with dry insulation, use a semiautomatic, constant-voltage welder or stick welder with voltage reducing device. Keep electrode holder and cable insulation in good condition. Do not use if insulation is damaged or missing.
Fumes and gases can be dangerous 	Confined area Positioning of welder's head Lack of general ventilation Electrode types, i.e., manganese, chromium, etc. Base metal coatings, galvanize, paint	Use ventilation or exhaust to keep air breathing zone clear, comfortable. Use helmet and positioning of head to minimize fume in breathing zone. Read warnings on electrode container and material safety data sheet for electrode. Provide additional ventilation/exhaust where special ventilation requirements exist. Use special care when welding in confined area. Do not weld unless ventilation is adequate.
Welding sparks can cause fire or explosion 	Containers which have held combustibles Flammable materials	Do not weld on containers, which have held combustible materials unless procedures are followed. Check before welding. Remove flammable materials from welding area or shield from sparks, heat. Keep a fire watch in area during and after welding. Keep a fire extinguisher in the welding area. Wear fire retardant clothing and hat. Use earplugs when welding overhead.
Arc rays can burn	Process: gas-	Select a filter lens, which is comfortable for you while

eyes and skin 	shielded arc most severe	welding. Always use helmet when welding. Provide non-flammable shielding to protect others. Wear clothing, which protects skin while welding.
Confined space 	Metal enclosure Wetness Restricted entry Heavier than air gas Welder inside or on workpiece	Evaluate adequacy of ventilation especially where electrode requires special ventilation or where gas may displace breathing air. If basic electric shock precautions cannot be followed to insulate welder from work and electrode, use semiautomatic, constant-voltage equipment with cold electrode or stick welder with voltage reducing device. Provide welder helper and method of welder retrieval from outside enclosure.
General work area hazards 	Cluttered area	Keep cables, materials, tools neatly organized.
	Indirect work (welding ground) connection	Connect work cable as close as possible to area where welding is being performed. Do not allow alternate circuits through scaffold cables, hoist chains, or ground leads.
	Electrical equipment	Use only double insulated or properly grounded equipment. Always disconnect power to equipment before servicing.
	Engine-driven equipment	Only use in open, well ventilated areas. Keep enclosure complete and guards in place Turn off engine before refueling.
	Gas cylinders	Never touch cylinder with the electrode. Never lift a machine with cylinder attached. Keep cylinder upright and chained to support.

Electric shock (A3)

<u>The physiological effects of electric current</u>

If electric current passes through the body, it can cause various injuries such as:

- Burns
- Cramp

- Auricular fibrillation
- Damage to the central nervous system.

The effects of electrical current on the human body depend on:
- Circuit characteristics (amount of current, resistance, frequency, and voltage).
- The current's pathway through the body.
- How long the contact lasts.
- Condition of the person's skin (breaks in the skin or wet skin will lower the bodies resistance to the flow of electricity).

In some cases low currents passing through the body can cause contraction of the muscles of the heart and lungs followed by failure of the heart and an inability to breathe.

In normal circumstances gloves and shoes will serve to reduce the risk of shock from the 'low voltage' welding output (that is, 48 to 113 volts). The risk is increased if the contact resistance is lowered (for example, in wet conditions).
Electricity can strike the human body and, depending on the current type, magnitude, duration, and path, produce injuries (damage). The effects of alternating current are presented in table.

Amount of current in Milliamps (mA)	**Response**
0.5-3	Start to feel the energy, tingling sensation
3-10	Experience pain, muscle contractions
10-40	Grip paralysis threshold (can't let go to source)
30-75	Respiratory failure
100-200	Heart fibrillation
200-500	Heart clamps tight
Over 1,500	Tissue and organs burn

Particular danger exists at open circuit source voltage since this is the highest voltage of the welding circuit.
Power sources should have protection for solid foreign objects and water penetration provided by the enclosure (IEC 60529). The degree of protection is indicated by the IP-code (International Protection) on the rating plate. Power sources for outdoor use shall have a minimum degree of protection of IP23.

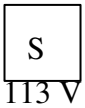
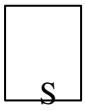
In order to minimize the chance of electric shocks, the highest open-circuit voltage value for the power source has to be defined. Some cases are distinguished:
- normal workshop conditions, with good insulation for welder and welded parts,

- conditions with "higher electric shock danger".

Higher shock danger appears: in forced contact of electricity conducting parts with unprotected human body (e.g. when kneeling, sitting or leaning) if the free movement distance between the electric conducting components is less than 2 m when working sites are wet, damp or hot, as well as for working outside.

The allowed open circuit voltage for the welding power source are shown in a simple table:

<table>
<tr><td rowspan="2">Transformer</td><td colspan="2">Workshop</td><td colspan="2">Higher danger of shock</td></tr>
<tr><td>net entrance
220 V</td><td>net entrance
380 V</td><td colspan="2">  </td></tr>
<tr><td></td><td>55 V</td><td>80 V</td><td colspan="2">48 V</td></tr>
<tr><td>Transducer</td><td colspan="2">113 V</td><td colspan="2">S
113 V</td></tr>
<tr><td>Commutation</td><td colspan="2">113 V</td><td>with collector

113 V</td><td>without collector
 
113 V</td></tr>
<tr><td>Inverter</td><td colspan="2">113 V</td><td colspan="2"> 
113 V</td></tr>
<tr><td colspan="5">The symbol  replaces the former symbols 42V and K.</td></tr>
</table>

Power sources for use in spaces with increased electrical danger (e.g. boilers) must be identified by the  (for “safety”) mark. However, the power source should not be in such rooms.

Steps to Prevent Electrical Shock

There are few steps that can be taken to prevent electrical shock.

To prevent electrical shock:

- Use well insulated electrode holders and cables.
- Make sure welding cables are dry and free of grease and oil.
- Keep welding cables away from power supply cables.
- Wear dry hole-free gloves.
- Clothing should also be dry.
- Insulate the welder from the ground by using dry insulation, such as a rubber mat or dry wood.
- Ground frames of welding units.
- Never change electrodes with bare hands or wet gloves.

Emergency Procedures:

If someone is being shocked, follow these procedures:

1. Shut off the power immediately. The longer the person is in contact with the electricity, the more damage will be done.
2. Do not try to touch or approach the person until the power has been shut off, or you too will become a part of the circuit. Use a dry wood broom, leather belt, plastic rope, or something similar that is non-conductive such as wood or plastic to free the person from the energy source.
3. An electrical shock victim must go to the hospital even if they claim they are not hurt. Internal damage cannot be seen; only a physician can determine if the victim has been injured or not.
4. If the victim is unconscious, check to see that they have a pulse and are breathing. Initiate CPR or mouth-to-mouth resuscitation if necessary and if you are trained to do so.
5. Keep the person lying down and keep them warm to prevent shock.
6. Do not move the victim unless they are in immediate danger. Moving the victim could aggravate internal injuries or paralyze them since severe muscle contractions caused by electricity have been known to break bones in the victim.

UV- and heat radiation (A3)

Radiation arises from arc welding that the welder must be protected from this radiation, by wearing proper clothing and protective glasses (with filter). Radiation can be classified in three groups:
- ultraviolet radiation (UV) (causes eyesight blurring, skin burns).
- visible radiation (visible light) (blindness at long exposure).
- infrared radiation (IR, heat radiation) (leads to eye lid inflammation, and eyesight nerve damage in extreme cases (cataracts), as well as skin burns).

UV radiation is the predominant danger. Eyes and skin can both be damaged if not protected with a welding shield, gloves and suitable clothing. The UV radiation from an arc is so strong that even reflections can cause eyesight blurring and skin burns. Short wave length UV radiation (130–175 nanometers) causes also the breakdown of oxygen to form ozone

The cornea in the eyes is affected by UV radiation. The eyes start to chafe a few hours after being exposed to UV radiation. Usually this happens during the night. In this case, they are weld flash burns. Normally, weld flash burns will disappear after a couple of days without leaving any permanent damage. Repeated weld flash burns can cause permanent eye damage.

The skin can react to UV radiation in the same way as sunburn, that is to say the skin becomes red

and sore and will eventually start to peel. Therefore, it is essential you use gloves and button up your clothing around your neck so that no bare skin is exposed to radiation.

Eye protection from electric arc radiation is accomplished by EN 169 filter with protection factor of 8 (low energy processes), up to 15 (high energy processes).

Protection factor	Application
3	brazing and resistance welding
4 & 5	auxiliary welding operation
6 to 8	arc welding I=30-75 A
9 & 10	arc welding I=30-200 A
11 & 12	arc welding I=200-400 A
13 & 14	arc welding I over 400 A
15	arc welding with extremely high I

What measures can you use for skin protection from welding radiation?
- wear tightly woven work-weight fabrics to keep UV radiation from reaching your skin.
- button up your shirt to protect the skin on the throat and neck.
- wear long sleeves and pant legs.
- cover your head with a fabric cap to protect the scalp from UV radiation.
- protect the back of your head by using a hood.
- protect your face from UV radiation by wearing a tight-fitting, opaque welder's helmet.
- make sure that all fabric garments are resistant to spark, heat and flame. Keep the fabrics clean and free of combustible materials that could be ignited by a spark.
- what are some tips to know when using protective clothing?

You should:
- wear clothing made from heavyweight, tightly woven, 100% wool or cotton to protect from UV radiation, hot metal, sparks and open flames. Flame retardant treatments become less effective with repeated laundering.
- keep clothing clean and free of oils, greases and combustible contaminants.
- wear long-sleeved shirts with buttoned cuffs and a collar to protect the neck. Dark colors prevent light reflection.
- tape shirt pockets closed to avoid collecting sparks or hot metal or keep them covered with flaps.
- pant legs must not have cuffs and must cover the tops of the boots. Cuffs can collect sparks.
- wear high top boots fully laced to prevent sparks from entering into the boots.
- use fire-resistant boot protectors or spats strapped around the pant legs and boot tops, to prevent sparks from bouncing in the top of the boots.
- remove all ignition sources such as matches and butane lighters from pockets. Hot welding sparks

may light the matches or ignite leaking lighter fuel.
- wear gauntlet-type cuff leather gloves or protective sleeves of similar material, to protect wrists and forearms. Leather is a good electrical insulator if kept dry.
- direct any spark spray away from your clothing.
- wear leather aprons to protect your chest and lap from sparks when standing or sitting.
- wear layers of clothing. To prevent sweating, avoid overdressing in cold weather. Sweaty clothes cause rapid heat loss. Leather welding jackets are not very breathable and can make you sweat if you are overdressed.
- wear a fire-resistant skull cap or balaclava hood under your helmet to protect your head from burns and UV radiation.
- wear a welder's face shield to protect your face from UV radiation and flying particles.

You should not:
- wear rings or other jewelery.
– wear clothing made from synthetic or synthetic blends.
–

Eye hazards
Why is eye protection important?
- Eye injury can occur from the intense light and radiation from a welding arc and from hot slag that can fly off from the weld during cooling, chipping or grinding.
- Protect your eyes from welding light by wearing a welder's helmet fitted with a filter shade that is suitable for the type of welding you are doing.
- ALWAYS wear safety glasses with side shields or goggles when chipping or grinding a work piece if you are not wearing a welding helmet.

What are the various components of eye protection for welders?
- eye protection is provided in an assembly of components:
- helmet shell - must be opaque to light and resistant to impact, heat and electricity.
- outer cover plate made of polycarbonate plastic which protects from UV radiation, impact and scratches.
- filter lens made of glass containing a filler, which reduces the amount of light passing through to the eyes. Filters are available in different shade numbers ranging from 2 to 14. The higher the number, the darker the filter and the less light passes through the lens.
- clear retainer lens made of plastic prevents any broken pieces of the filter lens from reaching the eye.
- gasket made of heat insulating material between the cover lens and the filter lens protects the lens from sudden heat changes, which could cause it to break. In some models the heat insulation is provided by the frame mount instead of a separate gasket.
- choose a tight fitting helmet to help reduce light reflection into the helmet through the space between the shell and the head.
- wear the helmet correctly. Do not use it as a hand shield.

- protect the shade lens from impact and sudden temperature changes that could cause it to crack.
- use a cover lens to protect the filter shade lens. Replace the cover lens if it gets scratched or hazy.
- make sure to replace the gasket periodically if your helmet uses one.
- replace the clear retaining lens to protect your eyes from broken pieces.
- clean lenses periodically.
- discard pitted or damaged lenses.

For Arc welding, the correct filter shade is selected according to the welding process, wire diameter, and operating current.
ALWAYS use suggested shade numbers instead of minimum shades.
For gas cutting, welding and brazing, the intensity of the light is much less than from arc welding. Lighter shade filter lenses are used with goggles in place of a helmet.

Dust particles or chemicals that can irritate the eyes may be present in many welding areas.
Wearing contact lenses is not being advisable in such workplaces.

Welding fumes

Definition

Hazardous substances in welding and allied processes are repairable air polluting substances generated by welding, cutting and allied processes, which at an intolerable concentration may be injurious to health.

Classification

Hazardous substances generated by welding and allied processes operations can be classified with respect to their occurrence and effects.

Occurrence

Hazardous substances are generated by welding and allied processes in the form of gases and/or particles. Particulate substances are dispersed as minute solid particles in the air.

Inhalable fraction – The fraction of particles, which is inhaled through the mouth and nose into the body: it comprises particle sizes up to and exceeding 100 m . In the past this fraction was called "total dust".

Respirable fraction – The fraction of particles capable of penetrating into the alveoli (air sacs); it

comprises particle sizes up to 10µ . In the past this fraction was called "fine dust".

Airborne particles generated by welding are very small. In general, they have a diameter of less that 1µ m (in most cases less that 0.1 µm), are therefore respirable and called "welding fume".
During thermal cutting and some allied processes the airborne particles generated are only partially respirable.

Effects
Gaseous and particulate substances generated by welding, cutting and allied processes can be classified according to their effects on different organs of the human body as follows:

Lung-stressing (inert) substances – long-term intake of high concentrations leads to a restricted lung function which is due to a decrease in the exchange of oxygen, due to dust deposited in the lungs.

These dust deposits are generally not pathogenic, they are reversible. Iron oxides and aluminum oxides are part of this group, for example:

Toxic (poisonous) substances – have a toxic effect on the body, if a certain dose (=amount per unit weight of the body) is exceeded. This is a dose-effect-relationship. Slight poisoning leads to mild health disorders; high concentrations of these substances in the inhaled air may cause very serious poisoning which results in death.

Toxic substances are, for example, gases such as carbon monoxide, nitrogen oxide and dioxide, ozone, as well as oxides of metals such as copper, lead, zinc in the form of fume and dust.

Carcinogenic (cancer-causing) substances – are substances that are known to cause malignant tumors.

Welding and cutting operations create hazardous fumes and gases. In order to minimize inhalation of hazardous substances:

- ventilation.
- portable fans to create air currents that take fumes away from your face.
- don’t get too close to an arc welder’s arc.
- l eave the area immediately and get medical help if you feel sick.

Generation
Hazardous substances generated by welding and allied processes may arise from:
- filler materials
- parent materials
- shielding gases
- coatings

- contamination
- ambient air

At high temperature (due of arc or flame) by physical and/or chemical processes such as:

- evaporation
- condensation
- oxidation
- decomposition
- pyrolysis
- combustion

Influencing factors

The amount and kind of hazardous substances are also influenced - apart from the processes and materials used - by surface coatings and contamination as well as by the following factors:

Current, voltage

Higher welding current and welding voltage lead - for identical processes and materials to higher emission rates of hazardous substances.

Type of current

Higher emission rates are observed with a.c. current than with d.c. current.

Diameter of the electrode

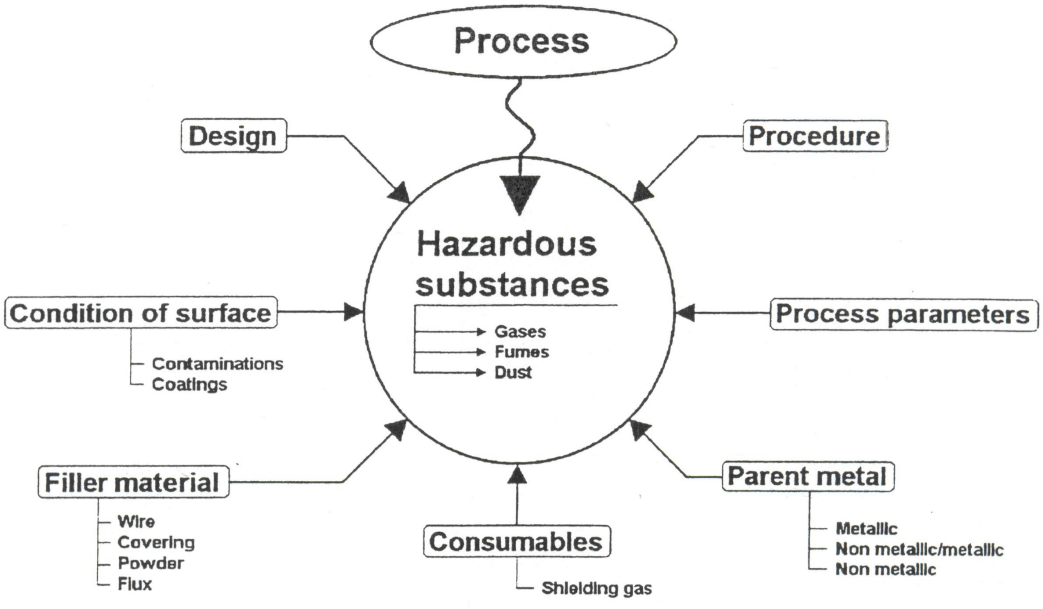
Emission of hazardous substances increases with the electrode diameter.

Type of coating

Rutile coated electrodes have the lowest emission rates of hazardous substances while cellulose covered electrodes have the highest.

Type of welding

Overlaying produces higher emission rates of hazardous substances than joint welding.



Allowed values and recommended values
In order to reduce the exposure of the welder to dangerous material, the allowed values are named:
- OEL - values, or
- MAC - defined values.
OEL: these limit values specifies the average concentration, which does not normally represent a health risk during eight hours of work a day (level limit value).
MAC is the highest allowed concentration of material that develops cancer, but does not lead to disease. MAC is the maximum permissible concentration of a chemical compound present in the air within a working are a which generally does not impair the health of the employee. That are scientifically backed criteria of health protection are definitive here, not the technical and economical feasibility of realizing them in practice. In general, the MAC-value applies only to single substances (pure substances) and is a long-term value, e.g. a time-weighted average concentration for an 8 hour exposure and a 40 hour working week (in four-shift operations for an 40 hours per week average over four successive weeks). Due to the fact that the concentration of different substances in the workplace atmosphere may fluctuate, short-term limit values have been laid down to allow evaluation when the time-weighted average' concentration (peak exposures) is exceeded over a short period. They are limited according to dose, duration, frequency and time intervals.
The OEL value is also a medium value that refer to 8-hour daily working cycles, or 40-hours/ week. Short exposures can in some limited time have higher values. This is determined by the character of dangerous material, and duration and frequency of work in shafts.

Hazardous substances

Gaseous hazardous substances

Argon (Ar) Non-toxic. Used as a shielding gas, alone or mixed with other gases. Heavier than air and can accumulate at the base of any closed vessel being welded and can form layers at the bottom of the welding operation in a badly ventilated welding shop. Essential to have extraction and circulation of the atmosphere around the welding point.
Helium (He) Non-toxic. Used generally mixed with other gases (e.g. 50% helium 50% argon). Helium is not produced in this country but is imported from the United States and is therefore much more expensive than argon.
Oxygen (O_2) Non-toxic but it promotes rapid oxidation especially in the pure state. Atmosphere roughly 4 parts nitrogen to I part oxygen (the proportions required by the human body to enable it to function). Used in small quantities (1 % to 2%) mixed with argon for stainless steel welding.

Carbon monoxide (CO) is generated in critical concentrations during 132 MAG welding with carbon dioxide or during metal-active-gas welding with mixed gases (with a high concentration of carbon dioxide) by thermal decomposition of carbon dioxide (CO_2). Furthermore carbon monoxide is generated during any form of combustion with an inadequate oxygen supply.
Nitrogen oxides (NO_x = NO, NO_2) are generated by oxidation of the atmospheric nitrogen (from

the oxygen (O_2) and the nitrogen (N_2) of the air) at the edge of the flame or the arc. Nitrogen monoxide is generated at temperatures exceeding 1000 ^{0}C. Nitrogen monoxide oxidizes to nitrogen dioxide in the air at room temperature.

Phosgene ($COCl_2$) is generated, in addition to hydrogen chloride (HCl), by heating or by UV-radiation of degreasing agents containing chlorinated hydrocarbons.

Gases from coating materials are generated by welding of workpieces with shop primers (surface coatings preventing corrosion) or with other coatings (paints, lacquers). Depending on the chemical composition of these coatings, not only metal oxides are generated, which are particulate, but also gases, e.g. carbon monoxide (CO), formaldehyde (HCHO), toluylene disocyanate, hydrogen cyanide (HCN), hydrogen chloride (HCl).

Particulate hazardous substances

Chromium-VI-compounds

Hexavalent chromium compounds are generated in critical concentrations when using high-alloy covered electrodes for manual metal arc welding and also when welding with high-alloy flux- cored wires containing chromium.

Chromium-VI-compounds may also occur in repair welding of materials coated with shop primers containing zinc chromates, a practice followed in the past. It can cause cancer and asthma-like problems.

Nickel oxides (NiO, NiO_2, Ni_2O_3) are mainly generated by:

- welding with pure nickel and nickel-base alloys (from the filler material)
- plasma cutting of high-alloy steel containing nickel (from the parent material)
- thermal spraying with nickel-base spraying materials (from the spraying material).

Can cause cancer and asthma.

Toxic gaseous (hazardous) substances

Carbon monoxide (CO)

Very poisonous, odorless gas. In higher concentrations the oxygen-carrying capacity of the blood is impeded by the great affinity of carbon monoxide to hemoglobin (hemoglobin is necessary for transporting oxygen in the body). The result is a lack of oxygen in the tissues.

Dizziness, lassitude and headache occur at a concentration of 150 *ml/ m^3* in the breathing zone. A level of 700 *ml/ m^3* causes fainting, increased pulse and breathing rates, ending in unconsciousness, respiratory paralysis, cardiac arrest and death.

MAC value = 33 *mg/ m^3*, 30 *ml/m^3*.

Nitrogen oxides (also called nitric oxides or nitrous gases)

Nitrogen monoxide (NO) is a colorless, poisonous gas. Nitrogen dioxide ($N0_2$) is a brown-red, poisonous gas causing oxidation. Nitrogen dioxide is much more toxic than nitrogen monoxide and acts even in relatively low concentrations as an insidious irritant gas. At the beginning there is an irritation of the air passages and dyspepsia, followed for several hours (in general 4 to 12 hours) by

an asymptomatic state, which in severe cases, ends in fatal pulmonary edema (accumulation of fluid in the lungs).
MAC value for $N0_2$ = 9 *mg/ m^3;* 5 *ml/ m^3* MAC value for NO = 30 *mg/ m^3;* 25 *ml/ m^3*

Ozone (O_3)

Ozone is a colorless gas having a penetrating smell and being strongly toxic that is formed during arc welding when oxygen in the air is exerted to ultraviolet radiation. O_2 molecules (oxygen) are converted into O_3, which is the chemical formula for ozone. Ozone is a strong corrosive and can damage mucous membranes. Characteristic effects of ozone are a pungent or burning feeling in the throat, chest pains and difficulty in breathing. The risk of troublesome ozone levels is greatest when 141 - TIG and 13| MIG welding aluminum.
Ozone (O_3) is formed when oxygen is exposed to ultra violet (UV) radiation in the wavelength range from 130 to 175 nanometers. The oxygen required may be part of the gas mixture used, may be entrained from the atmosphere or the UV irradiation may reach the area just outside the shielding gas envelope.
Ozone is an extremely active, oxidizing gas and will react with many other materials in the immediate area of the arc. Whilst its activity makes it particularly damaging to the respiratory system, its concentration in the breathing zone is usually reduced by its reactions with other materials. Since its generation depends on the intensity of UV radiation, the amount generated increases with current but may decrease with increasing amounts of particulate fume. High levels of ozone can be found however in high current gas metal arc welding of aluminum and high current gas tungsten arc welding.
Ozone levels in the arc area may also be controlled by nitric oxide (NO) gas additions. It acts as an irritant gas on the respiratory organs and eyes. It causes an irritation of the throat, dyspepsia and possibly a pulmonary edema.
MAC value = 0,2 *mg/ m^3;* 0,1 *ml/ m^3*

Phosgene ($COCl_2$) (Carbonyl chloride or carbon dichloride oxide)

Is an odorless, extremely poisonous gas with a musty smell. Initially (3 to 8 hours) there are slight symptoms, which may be followed by heavy irritations of the respiratory tract ending in pulmonary edema (accumulation of fluid in the lungs).
MAC value = 0,4 *mg/ m^3;* 0,1 *ml/ m^3*

Removal of hazardous welding dust

Protection from dangerous material (Ventilation)

Ventilation is mostly the only way to dispose dangerous material, and these procedures are common:
- natural ventilation (welding shop should be as large, airy and high as possible)
- forced ventilation
- vacuuming in the area of origination
- wearing gas masks.

The type of ventilation depends on the:
- procedure
- material
- duration of operation with electric arc and/or flame torch
- size of working surface.

Certain procedures can diminish the concentration level of dangerous material as:
- alteration of the process - so that less dangerous material is emitted
- good positioning of the working object- or the proper position of the human body relative to welding
- proper choice of parameters for welding and cutting
- optimal working conditions, for example, use of special cleaning equipment, devices that save gas, water resistance.

A method of eliminating fumes consists of a suction unit fitted with a filter, from the suction side of which a large diameter, fixed, rigid tube is fitted (spot extractor). This tube passes down the shop (well above head height) and over every welding position or bench. Flexible tubes of a similar large diameter are fitted, which reach down to the welding position or bench. At the lower end of the flexible tube a collecting head is fitted (see Figs. l and 2).

Spot extractor

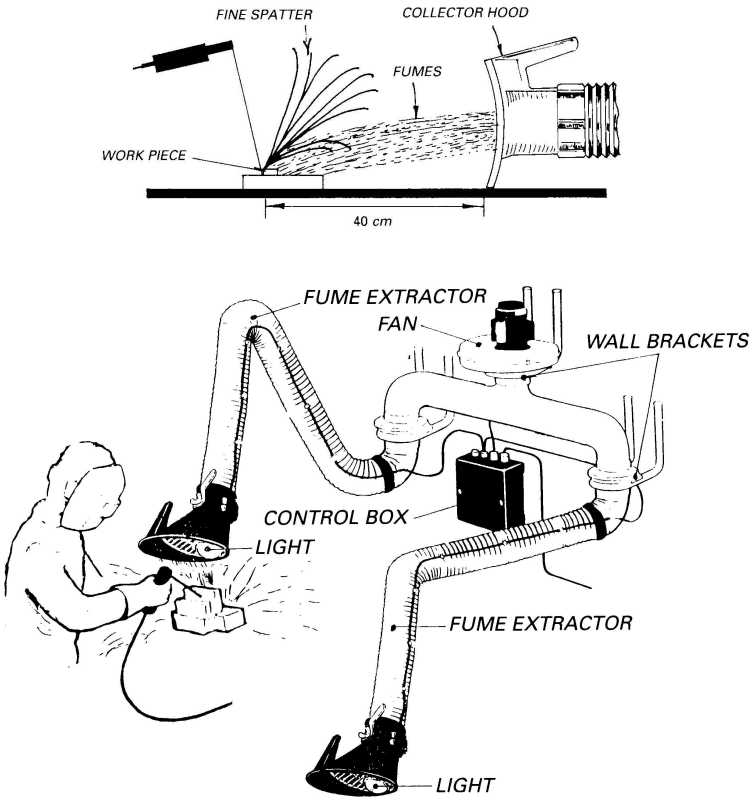
An efficient method of ventilating weld smoke is to use a spot extractor to collect the smoke as close to the arc as possible. There are a number of types of spot extractor
- spot extractor arms
- portable suction vents
- welding guns with integrated extractor
- fixed extractors (in welding table and fixtures).

The spot extractor can be either a central ventilation unit or portable weld smoke filters.

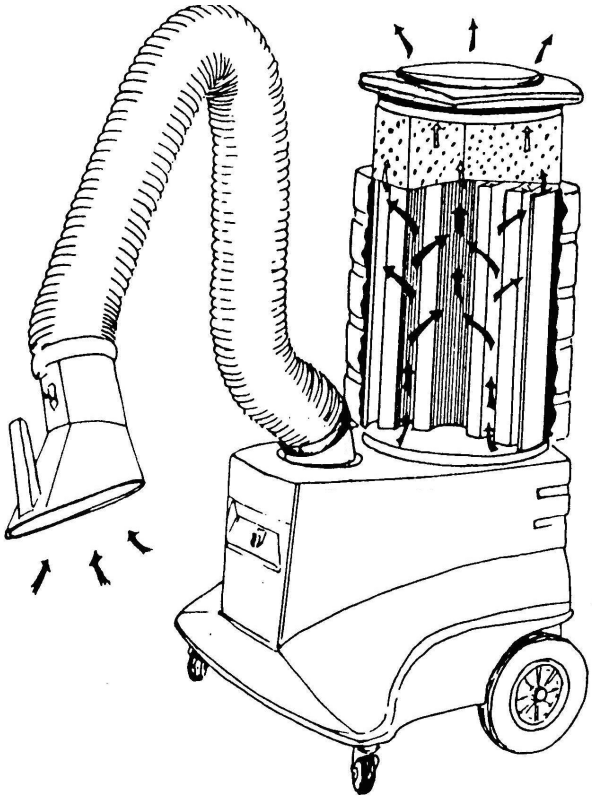
Portable weld smoke filters usually only take away solid particles while gas is allowed to pass through. Therefore, it is important that the weld smoke filter is located outdoors when welding in confined spaces so that the gas is transported out.

Permanent welding positions (welding tents, etc.) are best equipped with an extractor arm that is connected to a central ventilation unit and can be set to the desired position anywhere in the working zone. Remember to place the vent so that the weld smoke does not pass the breathing zone.

When erection welding on large structures, a suction hose with vent can be used that the welder is able to place above the weld joint. It is essential that the vent is placed as close to the weld joint as possible as the suction capacity decreases considerably as the distance increases.



Electrostatic precipitation can be utilized where it is inconvenient to install a fixed collector. Upon entering the precipitator, fume particles are charged electrostatically and then pass through an insulated sleeved tube to plates of opposite polarity to that of the particles. They are deposited on the plates, which are part of the filtering elements, and the air issuing from the unit is fume less and is returned to the atmosphere. Figure 17 shows a sectional view of a filter.



Efficient extraction of fumes is essential to the long-term health of the welder, as it may be many years until the effects of fumes inhaled over a long period are apparent. Almost all the toxic substances in the table above have a long-term effect on the respiratory tract and lungs, and in time seriously affect the health of the operator.
Ventilation is considered to be sufficient if:
- the ceiling height is not less than 5 m.
- cross ventilation is not blocked by partitions, equipment, or other structural barriers.
– welding is not done in a confined space.
–

Detectable of internal imperfections of welds (B8)

Tack welding

When welding the parts must be fixed in correct positions before welding is started. This can be achieved by tack welding.
The tack weld should be strong enough to prevent the forces caused by expansion and contraction from deforming the weld joint more than is allowed.
Tack welding depends on the task and is governed by following factors:
- quality requirements
- customer requirements
- single or series production
- permitted imperfect shape of the weld

- workpiece dimensions.

Tack welding fillet welds.

Tack welding for fillet welds is usually performed directly in the joint in one of the following ways:
- permanent tack welds that are covered and fully or partially re-melted by the final welding.
- permanent tack welds that are included as a component of the finished weld.
- tack welds that are removed as the welding progresses.

Tack welds are usually permanent. They are either welded over or the weld ceases in front of one tack weld and continues after it. The effective throat of a tack weld that is being welded over should be smaller than that of the finished weld to facilitate fusion of the tack weld. If the finished weld is to have an effective throat of 5 mm, it is a good idea that the tack weld has an effective throat no greater than 3 mm. For 111 - SMAW welding, the slag must be thoroughly cleaned from the tack welds to prevent slag inclusions in the finished weld. The requirements on the finished weld naturally also apply to the tack weld if the tack weld is permanent and to be included in the finished weld. Tack welding with temporary stays is also used for large steel structures.

Length of tack welds and their relative distances

Sometimes, the tack welds are specified in detail in welding plans and WPS. For large structures a minimum length of 50 mm for tack welds is often specified. For small workpieces the length of tack weld should be 5-20 mm.

The distance between tack welds can also be specified. The reason for specifying the minimum length of tack welds and their relative distance is that they have been calculated and tested to withstand a certain load. These instructions must be followed to avoid unnecessary imperfect shape. There may also be metallurgic reasons to specify a certain length for tack welds on steel. A long tack weld cools slower than a short one. If a tack weld cools too quickly, the material in the HAZ may become too hard and crack. Welding parameters used for the rest of the welding are normally used for tack welding if no special instructions have been specified.

Tack welding butt welds:

- Permanent tack weld in the root. Tack welding in the root will be included in the finished weld and must therefore fulfil the same requirements as the finished weld. The length of the root tack weld, depending on the thickness of the material and the constraint conditions, is from 5-10 mm up to the maximum length of 100-200 mm using a coated wire electrode. A minimum length of 50 mm for all kinds of tack welds is prescribed for large structures.
- Tack welding with round bar or wedge in the joint is a common method of tack welding both plate and pipe. The round bar being used must be of the same quality as the parent material. If this is not available, a round bar with the same, or preferably lower, carbon equivalent than the parent material can be used. This will prevent the material in the HAZ becoming too hard and cracking. The round bar must not contain higher levels of contaminants such as sulphur than the parent material. If wedges are used, they must have the same angles as the joint. The pieces of round bar or wedges are ground away as the root bead is welded.
- Tack welding straps is a common method used for erection welding. Similarly to tack welding with round bar or wedges, this method means the perpendicular edge is not damaged. These tack

welds are removed as welding proceeds in the same way as tack welding with round bar or wedges. The arc is ignited on one of the joint surfaces and a strap is formed by welding on each surface alternately.