HEALTH, SAFETY & ENVIRONMENTAL PROGRAM	**Section: Hot Work**		
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HOT WORK

PURPOSE

The purpose of this policy is to establish hot work safety procedures and to ensure that all hot work operations are performed in the safest manner possible, and in compliance with applicable regulations.

DEFINITIONS

Hot Work defined:

Any work performed that produces an increased risk of fire or explosion from the generation of sparks, flame, ignitable dust or vapour or other sources of ignition and includes welding, flame cutting, soldering, brazing, grinding or other similar work.

Most hot work is performed by staff at the AE maintenance shop in designated welding areas, however some field work may be also be conducted by AE field service.
Hot Work permits may be required in certain locations by Owners and/or Clients.

SCOPE

- General good practices before performing hot work include:
- Making sure that all equipment is in good operating order before work starts.
- Inspecting the work area thoroughly before starting. Look for combustible materials in vicinity of job area.
- Clearing any combustible materials around the work zone.
- Using water ONLY if electrical circuits have been de-energized to prevent electrical shock.
- If combustibles cannot be moved, cover them with shields. Protect gas lines and equipment from falling sparks, hot materials and objects.
- Securing, isolating, and venting pressurized vessels, piping and equipment as needed before beginning hot work.
- Posting a fire watch within the work area, including during breaks, for at least 30 minutes after work has stopped. Depending on the work done, the area may need to be monitored for longer after the end of the hot work.
- Shut down any process that produces combustible atmospheres.

Personal Protective Equipment

Eye and Face Protection

Welding helmets or face shields provide radiation, thermal, electrical, and impact protection for face, neck, forehead, ears, and eyes.

The filtered or shaded plate is the radiation barrier. It is necessary to use a filter plate of the proper lens shade to act as a barrier to the harmful light rays and to reduce them to a safe intensity.

Always ensure that the correct lens shade is selected for the type of welding being conducted.
When gas cutting, use a face shield or goggles and ensure that the proper lens shade is used.

If unsure of the type of lens shade required, ask your supervisor.
When grinding, use safety glasses and a face shield to protect from flying particles.

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Clothing

Clothing should be made of non-synthetic materials such as wool. Woolen clothing is preferable to cotton because it is less likely to ignite. Keep sleeves rolled down and collars buttoned up. Wear shirts with flaps over pockets and pants with no cuffs. Remove rings, watches, and other jewelry. Never carry matches or lighters in pockets. Clothing should be free from oil and grease

Wear flame-proof gauntlet gloves and an apron or leggings. Wear high-cut safety footwear laced to the top to keep out sparks and slag.

Hearing Protection

Ear plugs or ear muffs must be used when welding, cutting or grinding.

Respiratory protection

Fume and exhaust extractors are available in the shop. Protection will not be required for most outdoor welding operations if adequate ventilation is available. However, when ventilation is not adequate, respiratory protection must be worn. Typically, a half-mask respirator with cartridges suitable for welding fume should be used. Consult with your supervisor before work begins to select the proper type.

Welding and Cutting Hazards

Welders are exposed to a wide range of hazards such as radiation, inhalation of toxic fumes and gases, serious burns from hot metal, and electric shocks from welding cable.

There are generally 2 groups: Physical and Chemical Hazards

Physical Hazards

Non-ionizing radiation

A major source is ultraviolet, infrared, and visible light radiation from welding. Radiation produced by the welding process is mainly non-ionizing.

UV

Exposure to ultraviolet (UV) radiation can result directly from the arc or from a reflection off bright objects such as shiny metal or white clothing. It can cause “arc eye” when sight is not adequately protected.

Symptoms of "Arc Eye"

Certain types of UV radiation can produce an injury to the surface and mucous membrane of the eye called "arc eye". The symptoms include:

- pain - ranging from a mild feeling of pressure in the eyes to intense pain in severe instances
- tearing and reddening of the eye and membranes around the eye
- sensation of "sand in the eye" or abnormal sensitivity to light
- inability to look at light sources (photophobia)

Eyes become watery and painful anywhere from 2 to 24 hours after exposure. The condition may last 1–5 days but is usually reversible with no lasting effects. However, repeated exposure may result in scar tissue that can impair

vision. UV exposure may also cause a temporary loss of visual sharpness called “fluorescence.” It may eventually lead to the development of cataracts in the eye if eye protection is not worn.

Skin reddening, commonly known as sunburn, is another hazard of UV exposure. Blistering may occur in extreme cases.
The intensity of UV radiation varies with the type of welding. Generally, the higher the temperature of the welding process the higher the UV radiation.

Infrared
Infrared radiation is hazardous for its thermal or heating effects. Excessive exposure to the eye may cause damage.

Visible light
Light is released at high intensity by welding. Short-term exposure can produce “flash blindness” in which vision is affected by after-images and temporary blind spots. Repeated exposure to high-intensity visible light can produce chronic conjunctivitis, characterized by red, tearful eyes.

Noise
Sound waves over 85 dBA emitted at high intensity by welding equipment can lead to hearing loss. Noise has also been linked to headaches, stress, increased blood pressure, nervousness, and excitability. Welding noise is produced by the power source, the welding process, and by secondary activities such as grinding and hammering. Ear plugs or ear muffs must be worn when welding, cutting or grinding.

Electric Shock
Electrical shock is the effect produced by current on the nervous system as it passes through the body. Electrical shock may cause violent muscular contractions, leading to falls and injuries. It may also have fatal effects on the heart and lungs. Electrical shock may occur as a result of improper grounding and/or contact with current through damp clothing or wet surfaces. Even if the shock itself is not fatal, the jolt may still cause welders to fall from their work positions.

Electrical burns are an additional hazard. The burns often occur below the skin surface and can damage muscle and nerve tissue. In severe cases, the results can be fatal. The extent of injury due to electrical shock depends on voltage and the body’s resistance to the current passing through it. Even low voltages used in arc welding can be dangerous under damp or humid conditions.
Welders should keep clothing, gloves, and boots dry and stay well insulated from work surfaces, the electrode, the electrode holder, and grounded surfaces.

Chemical Hazards
Chlorinated solvents for degreasing, zinc chromate-based paint for anti-corrosion coatings, cadmium or chromium dusts from grinding, and welding fumes are all classified as chemical hazards.

Arc welders are at particular risk since the high temperatures generated by the arc can release heavy concentrations of airborne contaminants.

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Chemical hazards may injure welders through inhalation, skin absorption, ingestion, or injection into the body. Damage to respiratory, digestive, nervous, and reproductive systems may result.

Symptoms of overexposure to chemicals may include nosebleeds, headaches, nausea, fainting, and dizziness.
The most common chemical hazards from welding are airborne contaminants:
Fumes, Gases and Vapours and Dusts

Fumes
Some of the metal melted at high temperatures during welding vaporizes. The metal vapour then oxidizes to form a metal oxide. When this vapour cools, suspended solid particles called fume particles are produced.
Welding fumes consist primarily of suspended metal particles invisible to the naked eye. Metal fumes are the most common and the most serious health hazard to welders. Fume particles may reach deep into the lungs and cause damage to lung tissue or enter the bloodstream and travel to other parts of the body.

The following are some common welding fumes:

- Beryllium- is a hardening agent found in copper, magnesium, and aluminum alloys. Overexposure may cause metal fume fever. Lasting for 18–24 hours, the symptoms include fever, chills, coughing, dryness of mouth and throat, muscular pains, weakness, fatigue, nausea, vomiting, and headaches. Chronic exposure to beryllium fumes can result in respiratory disease. Symptoms may include coughing and shortness of breath. Beryllium is a suspected carcinogen.
- Cadmium coatings- can produce a high concentration of cadmium oxide fumes during welding. Cadmium-plated or cadmium-containing parts resemble, and are often mistaken for, galvanized metal. Overexposure to cadmium can cause metal fume fever. Symptoms include respiratory irritation, a sore, dry throat, and a metallic taste followed by cough, chest pain, and difficulty in breathing. Overexposure may also make fluid accumulate in the lungs and may cause death.
- Chromium- is found in many steel alloys. Known to be a skin sensitizer, it may cause skin rashes and skin ulcers with repeated exposure. Chromium also irritates mucous membranes in areas such as eyes and nose. Inhaled chromium may cause edema and bronchitis.
- Lead- can be found in lead-based paints and some metal alloys. Lead poisoning results from inhalation of lead fumes from these lead-based materials. The welding and cutting of lead or lead-coated materials is the primary source of lead poisoning for welders. Symptoms include loss of appetite, anemia, abdominal pains, and kidney and nerve damage.
- Nickel- is found in many steel alloys including stainless steel and monel. It is a sensitizing agent and in certain forms is toxic and carcinogenic. Nickel fumes can also produce cyanosis, delirium, and death 4 to 11 days after exposure.
- Zinc- is found in aluminum and magnesium alloys, brass, corrosion-resistant coatings such as galvanized metal, and brazing alloys. Inhaling zinc fumes during the cutting or welding of these metals may cause metal fume fever.

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Gases and Vapours

A gas is a low-density chemical compound that normally fills the space in which it is released. It has no physical shape or form. Vapour is a gas produced by evaporation. Several hazardous vapours and gases may be produced by welding.

Hydrogen fluoride (HF) gas- can be released by the decomposition of rod coatings during welding and irritates the eyes and respiratory system. Overexposure can injure lungs, kidney, liver, and bones.
Nitrogen oxide (NOx) gas- is released through a reaction of nitrogen and oxygen promoted by high heat and/or UV radiation. It is severely irritating to the mucous membranes and the eyes. High concentrations may produce coughing and chest pain. Accumulation of fluid in the lungs can occur several hours after exposure and may be fatal.
Ozone gas- is formed by the reaction of oxygen in air with the ultraviolet radiation from the welding arc. It may be a problem during gas-shielded metal arc welding in confined areas with poor ventilation. Overexposure can result in an accumulation of fluid in the lungs (pulmonary edema) which may be fatal.
Phosgene gas- is formed by the heating of chlorinated hydrocarbon degreasing agents. It is a severe lung irritant and overexposure may cause excess fluid in the lungs. Death may result from cardiac or respiratory arrest.
Phosphine or hydrogen phosphide- is produced when steel with a phosphate rustproofing coating is welded. High concentrations irritate eyes, nose, and skin.

Asphyxiants are chemicals that interfere with the body's ability to transfer oxygen to the tissues. The exposed individual suffocates because the bloodstream cannot supply enough oxygen for life.

There are two main classes of asphyxiants:
Simple asphyxiants- displace oxygen in air, thereby leaving little or none for breathing. In welding, simple asphyxiants include commonly used fuel and shielding gases such as acetylene, hydrogen, propane, argon, helium, and carbon dioxide. When the normal oxygen level of 21% drops to 16%, breathing as well as other problems begin, such as lightheadedness, buzzing in the ears, and rapid heartbeat.
Chemical asphyxiants- interfere with the body's ability to transport or use oxygen. Chemical asphyxiants can be produced by the flame cutting of metal surfaces coated, for instance, with rust inhibitors. Hydrogen cyanide, hydrogen sulphide, and carbon monoxide are examples of chemical asphyxiants—all highly toxic.

Dusts

Dusts are fine particles of a solid that can remain suspended in air and are less than 10 micrometres in size. This means they can reach the lungs. Dusts may be produced by fluxes and rod coatings, which release phosphates, silicates, and silica. The most hazardous of these is silica which can produce silicosis.

Fires and Explosions

There is always a threat of fire with welding. Fires may result from chemicals reacting with one another to form explosive or flammable mixtures.
In welding, oxygen and acetylene present the most common hazards of fire and explosion. Pure oxygen will not burn or explode but supports the combustion of other materials, causing them to burn much more rapidly than they would in air.

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When exposed to high temperature, excess pressure, or mechanical shock, acetylene gas can undergo an explosive decomposition reaction.

Preventive Measures

Welding hazards must be recognized, evaluated, and controlled to prevent injury to personnel and damage to property.

Types and effects of airborne contaminants produced by welding depend on the working environment, the kind of welding being done, the material being welded, and the welder's posture and welding technique.

Base metal- is an important factor in the production of fumes, vapours, and gases. The base metal will vaporize and contribute to the fume.
Coatings- such as rust inhibitors have been known to cause increased fume levels which may contain toxic metals. All paints and coatings should be removed from areas to be welded as they can contribute to the amount and toxicity of the welding fume.
Welding rod- is responsible for up to 95% of the fume. Rods with the fewest toxic substances can't always be used because the chemistry of the rod must closely match that of the base metal.
Shielding gas- used can affect the contaminants produced. Using a mixture of argon and carbon dioxide instead of straight carbon dioxide has been found to reduce fume generation by up to 25%.
Welding process variables- can have a big effect on the fume levels produced. Generally, fume concentrations increase with higher current, larger rods, and longer arc length. Arc length should be kept as short as possible while still producing good welds.

Ergonomics

Here are some tips for a good working posture while welding:

- Learn to recognize symptoms of work-related musculoskeletal disorders. Repeated uncomfortable postures and tasks can cause injury.
- Avoid awkward body positions which cause fatigue, reduce concentration and lead to poor welds which may need to be repeated.
- Always use your hand to lower your helmet. Do not use a "jerking" motion of your neck and head.
- Position yourself in a stable, comfortable posture.
- Avoid working in one position for long periods of time.
- Always store materials and tools within normal reach.

Ventilation

Ventilation is required for all welding and cutting. Adequate ventilation is defined as:

- the use of air movement to reduce concentrations of airborne contaminants below the acceptable limits in the worker's breathing zone and the work area
- prevent the accumulation of combustible gases and vapours
- prevent oxygen-deficient or oxygen-enriched atmospheres.

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Natural dilution ventilation — When using natural dilution ventilation, you must make sure to "keep your head out of the fume". A portable fan can also be used if necessary to keep fumes out of your work area.

Fire Prevention

Sparks and slag from welding, cutting and grinding can travel great distances and may contact flammable materials or electrical equipment. Fires have started in smoldering materials that went undetected for several hours after work was done. Take the following steps to prevent fires and explosions:

- Keep welding area free of flammable and explosive material
- Provide fire extinguishers suitable for potential types of fire. Know where the extinguishers are and how to use them
- Provide a firewatch where necessary—a worker to watch for fires for at least thirty minutes afterward

Handling, Storing and Using Cylinders

Handling

- Do not accept or use any compressed gas cylinder which does not have proper identification of its contents
- Transport cylinders securely
- Protect cylinders and any related piping and fittings against damage
- Never drop cylinders or let them strike each other violently
- Chalk EMPTY or MT on cylinders that are empty
- Close valves and replace protective caps
- Secure transported cylinders to prevent movement or upset
- Always regard cylinders as full and handle accordingly

Storage

- Store cylinders upright in a safe, dry, well-ventilated location
- Never store flammable and combustible materials such as oil and gasoline in the same area
- Do not store cylinders near walkways, exits, or in places where they may be damaged or knocked over
- Do not store oxygen cylinders within 6 m (20 ft) of cylinders containing flammable gases unless they are separated by a partition at least 1.5 m (5 ft) high
- Store empty and full cylinders separately
- Prohibit smoking in the storage area

Using

- Open cylinder valves slowly. Only use the handwheel, spindle key, or special wrench provided by the supplier
- Always use a pressure-reducing regulator with compressed gases
- Before connecting a regulator to a cylinder, crack the cylinder valve slightly to remove any debris or dust that may be lodged in the opening
- Never allow sparks, molten metal, electric current, or excessive heat to come in contact with cylinders
- Never use oil or grease as a lubricant on the valves or attachments of oxygen cylinders
- Release pressure from the regulator before removing it from the cylinder valve
- When gas runs out, extinguish the flame and connect the hose to the new cylinder
- Purge the line before re-igniting the torch

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- When work is finished, purge regulators, then turn them off. Use a proper handle or wrench to turn off cylinders.

Hoses and hose connections for oxygen and acetylene should be different colours. Red is generally used to identify the fuel gas and green the oxygen. Protect hoses from traffic, flying sparks, slag, and other damage. Avoid kinks and tangles. Repair leaks properly and immediately.

REQUIREMENTS

- Industrial Regulations 851, Section 49, 127-128, 130