EXPRO
هيئة كفاءة الإنفاق والمشروعات الحكومية
Expenditure Efficiency & Projects Authority

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Welding Operation Procedure

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IMPORTANT NOTICE

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1.0 PURPOSE

Welding, cutting, grinding, and other hot work operations exist throughout operations and maintenance activities in all Sectors. Although these operations have inherent hazards, they are not necessarily unsafe when carried out with proper consideration to controlling the associated hazards. It is good practice for Entities, and/or their facility management contractors, to implement a procedure giving direction to facilities and operations and maintenance contractors on these operations/activities.

2.0 SCOPE

The scope of this procedure is to provide means to the user to create a custom best-practice procedure outlining and detailing the use and control of hazards welding, cutting, grinding, and other hot work. This should also include the requirements and responsibilities of the Entities and/or facilities or operations and maintenance activity contractors on inspection, control, and training requirements. This procedure applies throughout the Kingdom of Saudi Arabia to Operations and Maintenance functions and activities on government owned facilities and projects where these activities occur.

3.0 DEFINITIONS

Definitions	Description
Competent Person	A person who has acquired through training, qualification, and experience, the knowledge and skills required to do that thing competently
Flashback	The sustained retrogression of the flame back into the mixing chamber resulting in a squealing sound and a characteristic smoky, sharp-pointed flame.
HSE	Health, Safety, and Environment
JHA	Job Hazard Analysis
kPa	This unit is inconveniently small for many purposes, and the kilopascal (**kPa**) of 1,000 newton per square meter is more commonly used. For example, standard atmospheric pressure (or 1 atm) is **defined** as 101.325 **kPa**.
p max	This test measures the maximum rate of pressure rise (Kst value) and the maximum explosion pressure (**Pmax**), plus examples for some common dusts.
UV	Ultraviolet

4.0 REFERENCES

- SASO-336 Industrial safety and health regulations – Welding, cutting and brazing.
- SASO-ISO-15615 Gas welding equipment - Acetylene manifold systems for welding, cutting and allied processes
- SASO-ISO-15012 Health and safety in welding and allied processes - Requirements testing and marking of equipment for air filtration
- OSHA 29CFR 1910 Subpart Q Welding, Cutting and Brazing
- OSHA 29CFR 1910 Subpart H Hazardous Materials
- OSHA 29CFR 1926 Subpart J Welding and Cutting
- EOM-KSS-PR-000001 - Project General Safe Working Requirements Procedure
- EOM-KSS-PR-000003 - Personal Protective Equipment Procedure
- EOM-KSS-PR-000004 - Fire Prevention and Protection Procedure
- EOM-KSS-PR-000007 - Confined Space Entry Procedure
- EOM-KSS-PR-000009 - Compressed Gas Cylinder Procedure
- EOM-KSS-PR-000016 - Hazardous Work Permit Procedure
- EOM-KSS-PR-000020 - Electrical Safety Procedure
- EOM-KSH-PR-000004- Respiratory Protective Equipment Procedure

5.0 RESPONSIBILITIES

5.1 Facility Manager

The Facility Manager is responsible for ensuring the resources and arrangements are available for the implementation and management of this procedure.

5.2 Supervisor

The Supervisor is responsible for monitoring the allocation of resources, people, equipment, and training to facilitate the requirements of this procedure, and for confirming that the requirements of this procedure are properly implemented. The Supervisor demonstrates operational discipline by requiring that the procedure requirements are put in place and properly functioning.

The Supervisor is responsible for planning, permitting, and directing the welding work including the coordinating and monitoring of any subcontractor's scope of work.

The Supervisor is responsible for the development of this procedure.

Permit responsibilities of the Superintendent are as follows:

- Verifying that the proposed work is necessary and risks associated with simultaneous activities, inclusive of specific work site and adjacent work activities, are identified and mitigated prior to reviewing the Permit
- Supporting coordination of applicable area activities
- Performing workplace inspections to ensure permit requirements are being followed.
- Performing a review of work-site conditions and Permit requirements after Permit issuance, this will include:
    - Verifying that Authorized Employees have signed onto the Permit and adhere to the requirements
    - Stopping work due to any Permit non-compliance
    - Coordinating area activities to avoid conflicts or interferences by evaluating the number of work Permits occurring in the same area.
- Ensuring that JHAs are completed.
- Verifying that the personnel assigned to execute the work have the necessary qualifications, experience and have attended training to safely perform their tasks for the permitted work.
- Ensure activities that require a Permit do not commence without a Permit
- Ensuring all persons working on the permit are signed onto the daily Permit workers sign on sheet.
- Ensuring that rescue equipment if required for the task is available and staged for emergency scenarios.

5.3 HSE Representative

The Health, Safety, and Environment HSE Representative is responsible to provide support and for the assessment of the compliance with its requirements.

5.4 Engineering Representative

The Engineering Representative is responsible to provide technical support consistent with the requirements of this procedure.

5.5 Personnel

Personnel who are engaged in Welding activities shall have the required training and qualifications by Authorized third party and have been deemed competent prior to commencing work. Personnel shall be engaged in the JHA process.

6.0 REQUIREMENTS

6.1 General Requirements

- Hot work activities shall be carried out under Permit to work system.
  - Refer to EOM-KSS-PR-000016 Hazardous Work Permit Procedure for further information.
- Welding or cutting torches and hoses shall not be connected to cylinders when stored in any enclosure.
  - When work is shut down and equipment is unattended, valves at the gas and oxygen cylinders shall be closed.
- When not in operation, torches shall be kept in proper operating condition.
- Gas and oxygen cylinders:
  - Shall be handled with care, properly supported in an upright position away from any source of heat or flame and securely tied-off.
  - Shall have the protective cap in place, stored vertical and outside the work area.
  - Oxygen cylinders in storage and not in use shall be separated from gas cylinders.
  - Refer to: EOM-KSS-PR-000009 Compressed Gas Cylinders Procedure for further information.
- Safety Watches (e.g., Fire Watches) shall be stationed and/or used where and when required.
- Welding equipment, cables, and gas and oxygen hoses shall be inspected regularly and before use.
  - Damaged equipment shall be removed from use and tagged out of service.
- The ground cable shall be attached as close as possible to the work piece, by means of a clamp.
- Concrete reinforcing bars shall not be used as grounding.
- Welding equipment shall, in general, not be located at elevated structures.
- Welders and welder helpers shall use adequate eye and face protection (i.e. welding PPE) during welding, burning, grinding and cutting activities.
  - Refer to: EOM-KSS-PR-000003 Personal Protective Equipment Procedure for further information.
- Welding generators, machines, and transformers:
  - When not in use, shall be turned off.
  - When in use appropriate protective covers (fire blanket) shall protect the equipment.
  - Refueling shall be done with the machines turned off.
- Hoses and cables shall be kept clear of passage ways, ladders and stairs.
- When welding, burning and cutting are performed in a workshop or other enclosed building adequate ventilation shall be provided.

6.2 Gas Welding and Flame Cutting

- Personnel working with welding equipment shall be qualified and provided with personnel protection equipment.
- Welding goggles, helmets, screens and similar equipment shall be provided to workers around the work area.

6.2.1 Common Gases

Oxygen (O):

- Odorless
- Promotes and accentuates rapid combustion
  - Grease and oil shall not be used near oxygen as this could cause an explosion and fire

Acetylene (C2H2):

- Distinct odor (sour apples)
- It is explosive when mixed with oxygen over a wide range of levels (2.5 % to 81 %)
- The gas is toxic and does not support life.

- Inside the cylinder, acetylene is dissolved in acetone to prevent internal explosion; it is therefore essential that acetylene cylinders are stored, handled and used in the vertical position to avoid the liquid acetone from escaping and damaging the valves and other equipment.

Argon (Ar):

- Odorless
- Unreactive gas
- Used as an inert shielding gas in welding, and other environments where displacement of oxygen or other gases is required (e.g., laboratory)
- Is denser than breathing air (heavier).
    - As Argon is denser, it will displace breathing air and cause an environment prone to asphyxiation. This is very important safety hazard when welding/cutting activities are being performed in enclosed areas, confined spaces, vaults, manholes, or any low areas in which personnel or public work or reside. This also includes any area adjacent to where argon is used.

6.2.2 Storage and handling of Cylinders

Storage of gas cylinders should be in accordance with EOM-KSS-PR-000009 Compressed Gas Cylinder Procedure.

- Gas cylinders shall be stored in a safe, dry, well-ventilated area and reserved for that purpose.
- Cylinders shall be stored in an upright position (banks excluded).
- Secure gas cylinders against tumbling.
- Do not store or put up gas cylinders in passages, passes, corridors, staircases and nearby heat sources.
- Smoking and naked flames shall be prohibited nearby the storage area, and proper signs must be placed to communicate this requirement.

When handling gas cylinders, the following recommendations shall be taken into consideration:

- Cylinders shall not be lifted by their valves and when the cylinder is not in use the valve shall be protected by the valve cap.
- Valves shall be fully closed before a cylinder is moved.
- If cylinders are to be lifted, bottle holders with lifting eyes should be used or by means of belts.
    - Wire ropes or chains shall be avoided.
- Empty cylinders shall be returned with the valves closed and the valve protection cap in place.
- Cylinders should be treated with care when they are empty because they still contain some gas.
- Transit:
    - Cylinders in transit shall have the valve caps in place.
    - Cylinders should be secured to avoid any violent contact which could weaken the cylinder walls.
    - Loading and unloading shall be done carefully. Cylinders shall not be dropped, thrown, dragged, used as rollers or as supports. Defective cylinders shall be removed.

Please refer to: SASO-ISO-15615 Gas welding equipment - Acetylene manifold systems for welding, cutting and allied processes for further information.

6.2.3 Inspecting Equipment

- Equipment shall be inspected before used and regular maintained.
- Valve sockets shall be kept free of grit, dirt, grease, oil or dirty water.
- Hoses shall be kept for one type of gas and preferable color coding of hoses shall be used.
- Hoses shall be examined on leaks and pressure test and fitted with appropriate clips.
- Use only safe hose couplings (tube nozzles with clamps or patented coupling).
- Acetylene and oxygen hoses shall not be interchangeable.
- Protect flexible gas tubes from mechanical damaging and from scorching.
    - Do not coil the tubes over the fittings of gas bottles.
- Regulators:
    - Equipment shall be regular checked to ensure correct pressure regulators are fitted

  - A regular check shall be made to ensure that the regulator is working properly
  - Attach welding regulators to the cylinder such that persons are not injured when the emergency valve is actuated.
- An acetylene cylinder valve wrench shall always be available, for the cylinder in use
- The torch nozzle shall be kept tight.
- Do not jerkily open the valves of the cylinders.
  - Before opening valve, screw back the adjusting screw at welding regulator until unloading of the spring.
- A safe means of ignition shall be readily available (i.e., a friction lighter should be used).

6.2.4 Faults

It is not uncommon for minor “explosions” to occur during welding or cutting.
Some are more frightening than harmful, but some can lead to very dangerous conditions. A flashback is the most dangerous of the occurrences, the cause being mixed gases in the hose(s). Using this mixing of the gases occurs when the hoses have been disconnected from regulators or torches or when a new hose is being used for the first time. Blow through new gas tubes before first use. Sometimes it is due to loose connections. Such occurrences should be reported to the supervisor.

6.2.5 Electric Arc Welding

Arc welding is a process for joining metals by heating with an electric arc. The process includes shielded welding, using an inert gas (e.g., argon) to blanket/shield the weld. For arc welding two welding leads - the electrode lead and the work lead - are required.

6.2.6 Voltage

The voltage across the welding depends on the technique used. In situations where the effect of electric shock is likely such as in damp or confined spaces (tanks, boilers, vessels) a direct current voltage technique shall be used for welding.

6.3 Flashback Arresters

***NOTE**: It is essential that a flashback arrester continues to perform at the manufacturer’s rated flow rate. Flashback arresters that perform outside this (due to blockages) may not supply the required flow rate for the equipment being used and can be the cause of an accident.*

6.3.1 Testing

- Flashback arresters shall be type-tested by an independent qualified third party.
- Periodic Testing on flashback arresters in service shall be carried out at a minimum interval of 12 months.
- Testing shall be carried out on a machine built for that purpose and approved by the manufacturer for testing of the flashback arrester to determine suitability for continued use as a gas safety device.
- Tests shall be carried out using oil-free air or nitrogen. A means of identifying the last test date shall be permanently shown on the flashback arrester.
- Flashback arrestors to be removed from use if the inspection/test date has expired.

Tests shall be carried out for the following:

- **Through flow** to compare the flow rate of gas through the flashback arrester against manufacturer’s specifications to ensure it is still performing at the rated capacity.
- **Reverse flow** to subject the flashback arrester to a reverse flow of gas to ensure that the non-return valve is operating correctly.
- **Leak tightness** to check the leak tightness of the flashback arrester, for example by immersing in water or application of a leak-detecting solution.

6.3.2 Marking

Each flashback arrester shall be marked with the following information:

- The name or trademark of the manufacturer and or the distributor.
- The model or code number relating to the manufacturer's installation instructions.
- The direction of gas flow, normally an arrow.
- Name of gas.
- The maximum working pressure, 'p max', expressed in bars or kPa.
- The date of manufacture and batch number, by coding, if necessary.
- The country of manufacture.
- Safety devices shall be color coded Blue for oxygen and Red for fuel gas service.

6.3.3 Manufacturer's Instructions

The manufacturer shall supply appropriate instructions with each flashback arrester, which shall contain as a minimum:

- The function of the flashback arrester.
- Operational data inclusive of nameplate data, such as maximum working pressure, minimum working pressure and connection details.
- Permissible types of gas.
- Instructions for installation of equipment.
- Procedures to be carried out prior to operation.
- Procedures for safe operation.
- Instructions in case of malfunction.
- Recommendations for inspection, testing and maintenance.

6.4 Welding and Cutting: Tanks and Vessels

Careful tests shall be made to establish that the tank is free from explosive and flammable vapours or substances. It is of major importance that past contents of the tank or vessel be identified. When in doubt or if the tank or vessel is known to have any kind of flammable or explosive content, it shall be cleaned and purged thoroughly prior to any welding, cutting or burning. The use of oxygen for cleaning containers or small tanks is not permitted.

6.5 Confined Space

- Adequate ventilation shall be maintained in confined spaces at all times (continues).
- Supplied breathing air may be needed for workers working inside such confined places.
- Gas cylinders are not allowed inside the confined space.
- The hoses and equipment used inside shall be checked for leaks and shall be in excellent condition.
- Where work must be performed over several days, the hoses and equipment shall be taken outside over night to prevent build-up of gas in case of any small leakage.

Refer to EOM-KSS-PR-000007 Confined Space Entry Procedure for more information.

6.6 Personal Protective Equipment and Protective Measures

The following PPE and protect measures shall be considered before each task is started, and identified in the JHA:

- Helmets, welding hand gloves, Respiratory and face shields are required to protect eyes and face against heat and the effect of the intense light emitted by an electric arc.
- Goggles or spectacles are required to protect the eyes form the pieces of flying slag when chipping takes place. Approved side pieces shall be fitted on spectacles.
- Screens shall be installed as required to protect nearby personnel from heat and harmful light radiation.
    - Screens shall not interfere with installed flow of air for ventilation.

- Gloves are necessary to protect hands against heat, sparks, hot metal and radiation.
    - Gloves shall be long enough to protect wrists and forearms.
    - IF long gloves are not possible, THEN protective sleeves of similar materials shall be worn.
- Safety boots are essential to provide effective protection against heat, sparks, and falling metal.
- Provide sufficient ventilation.
- Wear leather welder protection gloves during welding and electrode change.
- Wear flame resistant protective suit or welding apron and welder protection gloves while welding.
- Wear high-necked working clothes to be protected from Ultraviolet (UV) radiation.
- Screen work places of welders against other work places by installation of movable walls or curtains.
- Use suitable face shields equipped with welder protective filters protection class 9-15, for helpers a lower protection class may be sufficient (1.2 to 1.7)
- Never hold welding rod fixtures or welding torches under the arm. Place them on isolated bases only.

Refer to: EOM-KSS-PR-000003 Personal Protective Equipment Procedure for further information.

6.7 Health Hazards

Health hazards in welding operations fall into two classes: Radiant energy and Respiratory (i.e., dust and fumes).

Radiant Energy: The risk of radiant energy harming the welder or other personnel can be minimized by the proper use of protective clothing and shielding. The risk of exposure is lessened by wearing protective clothing, shielding and distance. The effect normally wears off within two days and generally no permanent damage is caused. The condition is however painful and can easily be avoided by the use of eye protection or shields.

Respiratory Effects: The risk of gassing in normal welding operations is slight; however, when working in confined areas adequate ventilation shall be provided to remove any build-up of hazardous gases. There are many other dangers which can arise when welding or cutting under specific conditions or on particular metals. Hazardous operations are welding on galvanized materials, manganese steel and materials which have been painted with lead, copper or other toxic components.

Appropriate measures shall be taken prior to commence welding activities. Please refer to: SASO-ISO-15012 Health and safety in welding and allied processes - Requirements testing and marking of equipment for air filtration for further information.