

Health, Safety & Environmental Management System

Hot Work

HSE Guidance No. 3.11.3

Energize

Harmonize

Realize



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The following is a brief summary of the four most recent revisions to this document. Details of all revisions prior to these are held on file by the Document Owner.

Version No.	Date	Scope/Remarks

The use of this Guidance is mandatory and any changes must be controlled as detailed in the Quality Procedure relating to Document Control.

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1.0 INTRODUCTION

When hot work activities are carried out in direct contact or in close proximity to flammable or combustible substances there is the risk of fire, explosion and the production of toxic substances, with the potential consequences of serious injury, ill-health and or damage to property and the environment.

The purpose of this Guidance is to reduce the risks associated with Hot Work to an acceptable level.

2.0 SCOPE

This Guidance applies to all activities under operational control of PetroChina (Halfaya) and shall be applicable to:

- PetroChina (Halfaya) employees while carrying out PetroChina (Halfaya) duties at any locations.
- Contractor/sub-contractor employees performing his/her duties in PetroChina (Halfaya) controlled premises.
- Contractor/sub-contractor employees performing his/her duties in a premise under PetroChina (Halfaya) prevailing influences.
- Contractor/ sub-contractor operations at a place under PetroChina (Halfaya) prevailing influences.

3.0 RESPONSIBILITIES

3.1 Site Manager

The Site Manager will hold the ultimate responsibility for ensuring that the Hot Work Guidance is effectively implemented, and regularly updated and maintained, to ensure that it is applicable to all activities performed.

3.2 Line Managers

Specific responsibilities of the Line Managers include, but are not limited to, the following:

- Ensuring that risk assessments have been carried out for all hot work activities.
- Reviewing risk assessments to ensure that the hazards and risks associated with all non-routine, high risk and hazardous activities have been identified (**Note:** Line Managers shall request a higher level of risk assessment should they consider that risks have not been fully addressed).

- Ensuring that all Employees and Subcontractor employees are trained in the requirements of this Guidance.
- Ensuring that all potential hazards and risks identified are effectively communicated to those involved in the work, and that effective control/mitigation measures are implemented during the execution of non-routine, high risk or hazardous activities.
- Ensuring that hot work activities are safe, and operated in accordance with this Guidance.
- Ensuring the safety of all personnel on the site and the safe execution of all work carried out on the site.
- Providing necessary resources to facilitate the effective implementation of this Guidance and any supporting procedures.
- Ensuring that the responsibilities of key participants under this Guidance are communicated to those personnel under his direction.
- Ensuring that the personnel appointed are competent to carry out the tasks for which they are authorized.
- Segregating areas and assigning the responsibility for control in those areas to a Competent Person.

3.3 Field HSSE Manager

The Field HSSE Manager, assisted by Safety Officers, will oversee the development, implementation, update and maintenance of this Guidance.

Specific responsibilities of the Site HSSE Manager include, but are not limited to, the following:

- Providing hot work safety training to Subcontractor employees.
- Reviewing this Guidance through regular audit and inspection, and making recommendations to update or amend it to ensure that it remains current and effective.
- Ensuring that a thorough investigation is carried out for any accidents or incidents that may be attributable to a breakdown in the hot work safety system or associated controls.

3.4 Safety Officer (Competent Person)

Safety Officers will assist the Field HSSE Manager in implementing, updating and maintaining the Hot Work Guidance. Responsibilities of Safety Officers will include, but not limited to, the following:

- Ensuring that this Guidance is observed and effectively implemented by all employees and Subcontractor employees.

- Assisting the Field HSSE Manager to conduct training to familiarize employees and Subcontractor employees with this Guidance.
- Assisting the Field HSSE Manager to conduct HSE audits and inspections to ascertain the effectiveness of this Guidance.
- Attending toolbox talks to ensure that supporting risk assessments, job hazard analyses and method statements are fully disclosed to, and understood by, the workforce.

3.5 Permit Issuing Authority

The Issuing Authority should ensure a risk assessments is carried out and documented to ensure that all hazards are recognized and mitigation measures identified. Specific responsibilities of the Issuing Authority include, but are not limited to, the following:

- Ensuring that all employees and Subcontractor employees assigned to perform non-routine, high risk and hazardous job tasks receive adequate training and instruction to ensure that they understand what is required of them to perform their work safely.
- Ensuring that non-routine, high risk and hazardous construction activities are executed in accordance with developed procedures and/or work method statement submitted.
- The safety of personnel and the safe execution of all activities undertaken within his area of authority.
- Identifying the impact of tasks and precautions on other areas, and informing the Area Authority of the proposed activities. This includes specifying the precautions that may be necessary as a result of activities in another area, and ensuring that these are disseminated to all affected personnel.
- Ensuring that work site inspections are undertaken before, during and after the performance of each task (some of these inspections may be delegated to an appropriately competent person).
- Organizing toolbox meetings with all parties involved.

Note: Issuing Authorities shall attend approved training courses, and will be formally assessed and confirmed competent before being formally appointed to undertake their responsibilities.

3.6 Performing Authority

The Performing Authority is the person who requires the work to be done (or who will do the work) and is the senior person in charge of the work controlled by a permit. Specific responsibilities of the Performing Authority include, but are not limited to, the following:

- Applying for a PTW, and ensuring that it has been endorsed and approved, prior to commencing any non-routine, high risk or hazardous construction activity.
- Taking part in the risk assessment process and disseminating the resulting output to the personnel who will be doing the work.

- Signing receipt and on completion, clearance of the permit.
- Ensuring that all potential hazards and risks associated with a specific activity have been identified, mitigated against, and effectively communicated to the workforce involved.
- Ensuring that all control / mitigation measures, required by and indicated in the PTW, are implemented.
- Ensuring that only the intended work, as specified in the PTW, is executed.
- Ensuring that all workers / craftsmen involved in the activity fully understand the limitations, restrictions and hazards involved, as advised and indicated in the PTW.
- Safety at the work site.
- Ensuring that only those activities detailed on the PTW are undertaken.
- Ensuring that an applicable PTW (e.g. Hot Work, Excavation, etc.) has been checked and approved by the relevant authorizing party.
- Ensuring that the work environment is safe and suitable for the performance of non-routine, high risk or hazardous work, before a PTW can be issued.
- Ensuring that the work environment is continuously monitored.
- Immediately informing the Issuing Authority of any event which might impact on the safe performance of a task or on the associated precautions, e.g. changes to working conditions and methods.
- Ensuring that adequate handover takes place at shift change, crew change or other change of Performing Authority.
- Ensuring that the work team is withdrawn, and the work site left in a safe and clean condition, on completion (or suspension).
- Ensuring that the PTW is revalidated should the intended activity require continuation to another shift or day.
- Suspending all works in the event that work conditions or environmental conditions change or differ from those expected when the PTW was issued. Such changes in conditions shall be immediately reported to the Permit Issuing Authority.

3.7 Process Isolators

Process Isolators are responsible for:

- The application, removal and recording of process and fire protection and alarm system isolations (appropriate lockout/tag out isolation) in accordance with the permit to work (PTW) Issuing Authority's request on the Isolation Certificate.

- Immediately informing the Issuing Authority of any event which might impact on the security / integrity of the isolations.

3.8 Craftsmen/Hot Work Operator

Specific responsibilities of craftsmen will include, but not limited to, the following:

- Ensuring that a Hot Work permit has been duly endorsed and approved before commencing hot work.
- Ensuring that only the intended work, as specified in the Hot Work permit, is executed.
- Ensuring that all limitations, restrictions and hazards involved are understood, and that associated control/mitigation measures are diligently implemented.
- Suspending all works in the event that work conditions or environmental conditions change or differ from those expected when the Hot Work permit was issued. Such changes in conditions shall be reported to the immediate Supervisor.
- Participation in all meetings to clarify understanding of the Hot Work permit requirements

3.9 Authorized Gas Tester

After appropriate training, the Authorized Gas Tester is authorized to test for the presence of flammable gas or vapour for Hot Work permit compliance purposes.

After appropriate training, the Authorized Gas Tester is authorized to test for the presence of flammable gas or vapour, toxic gas and oxygen, particularly for atmospheres in 'Confined Spaces'.

3.10 Fire Watchers

Personnel appointed as Fire Watchers shall be adequately trained and shall monitor work areas, and the precautionary measures taken in those areas, when specified by the Issuing Authority on the PTW. Fire Watchers shall undertake fire response activities as required.

4.0 DEFINITIONS

Hot Work: A task which involves the use of a flame or other source of ignition. For example:

- Welding.
- Flame cutting.
- Electrical induction pre-heating/stress relieving.
- Use of heat shrink blowers.

- Grinding.
- Use of electrical/electronic equipment which has not been certified as suitable for use in flammable atmospheres (megger, avometer, battery drills, power tools, etc.).
- Opening live junction boxes.
- Use of air or hydraulic powered metal cutting, chipping or caulking tools, and cold cutting.
- Use of electrical soldering irons.
- Use of explosives and perforating guns.
- Use of powered steel wire brushes.
- Dry grit/shot blasting.
- Use of battery powered camera with or without flash.
- Needle gunning

Designated Area: Permanent location designed for or approved for hot work operations to be performed regularly.

Hot Work Permit: A document issued for the purpose of authorizing a specified activity. See Guidance 3.11.1.

Hot Work Operator: An individual designated to perform hot work under the control of a hot work permit to work.

5.0 GENERAL REQUIREMENTS

Hot work is allowed only in areas that are or have been made fire-safe. Hot work may only be performed in either designated areas or permit-required areas.

A designated area is a specific area designed or approved for such work, such as a maintenance shop or a detached outside location that is of noncombustible or fire-resistive construction, essentially free of combustible and flammable contents, and suitably segregated from adjacent areas.

A permit-required area is an area made fire-safe by removing or protecting combustibles from ignition sources.

Note: Hot work operations in confined spaces require additional safeguards and are addressed in document 3.11.5 Confined Spaces Guidance.

A fire watch shall be maintained for at least 30 minutes after completion of hot work operations in order to detect and extinguish smoldering fires.

The Performing Authority shall inspect the job site 30 minutes following completion of hot work and close out the permit with the time and date of the final check.

5.1 Restricted Areas

Hot work operations are restricted in all locations that may contain flammable or combustible materials or hazardous atmospheres. Hazardous locations commonly found on Company property include:

- Production, water injection and chemical storage facilities.
- Areas determined to be hazardous by the supervisor.
- Areas within the plant or facility boundaries.
- Areas containing:
 - Dry vegetation.
 - Tank batteries.
 - Compressors.
 - Pipeline connections, valves or well heads.
 - Portable flammable liquid storage containers.
- In sprinklered buildings if the fire protection system is impaired unless other suitable precautions are in place.

Never perform hot work on vessels, tanks or other enclosures previously in service, regardless of their contents. If circumstances require it, then check with your supervisor before beginning the work.

If hot work must be performed within restricted areas, then supervisors must:

- Determine whether a hot work permit is required.
- Verify that all safety requirements in the hot work permit have been met.
- Hold a safety meeting.
- Verify that the crew has received the proper training and is using the required equipment.
- Approve the commencement of hot work operations after all preparations are complete.

5.2 Preparing for Hot Work

No hot work operations may begin without the supervisor's approval. Before supervisors approve hot work operations, they will fulfil the requirements set by this document for:

- Hot work permits.

- Training.
- Equipment.
- Safety meetings.

5.3 Using Hot Work Permits

If the supervisor requires a hot work permit for a specific operation, then:

- Complete the top portion of the permit.
- Complete all safety checklist preparations listed on the permit.
- Complete the atmospheric testing required (5% LEL or below is required before starting the work).
- Complete the re-test section of atmospheric testing.
- Sign the permit.
- Review the requirements of the hot work permit during the pre-job safety meeting.
- Post the permit near the job site until all work is completed.

5.4 Required Training

The following table outlines the specific training requirements for all personnel involved in hot work operations.

Personnel	Required Training
Supervisor.	<ul style="list-style-type: none"> ▪ Hot work requirements in this document. ▪ Specific operation being performed.
Fire watch person.	<ul style="list-style-type: none"> ▪ Use of fire extinguishers. ▪ Location of fire points and alarms.
Welder/Pipefitter.	<ul style="list-style-type: none"> ▪ Appropriate certification and training for the task to be performed.

5.5 Required Equipment

Hot Work operations require the use or presence of the following safety equipment:

- Fire extinguishers.
- Gas detector.
- Water hose (only if appropriate for the type of potential fire and no fire extinguisher is available).

- Access to adequate first-aid supplies.

5.6 Preventing Fires

The primary hazard during hot work operations is the risk of fire. To prevent fires, crews will:

- Isolate all sources of fuel or ignition.
- Designate a fire watch person and provide appropriate fire extinguishers.
- Use gas detectors during hot work operations.
- Observe restrictions on cutting operations.

5.7 Isolating

Isolate all flammable and combustible materials as described in the table below.

Source	Isolation method
Dry vegetation.	<ul style="list-style-type: none"> ▪ Soak the vegetation with water.
Production, water injection and chemical storage facilities.	<ul style="list-style-type: none"> ▪ Check for leaks. ▪ Clear the area of any spilled flammable or combustible materials. ▪ Lockout/tagout all sources of energy.
Portable flammable storage containers or equipment.	<ul style="list-style-type: none"> ▪ Check for leaks. ▪ Clear the area of any spilled flammable or combustible materials.
Valves, well heads and pipeline connections.	<ul style="list-style-type: none"> ▪ Shielding or covering with a fire blanket. ▪ Blind the lines. ▪ Tighten valve stem packings.
Compressors and other equipment.	<ul style="list-style-type: none"> ▪ Lockout/tagout all sources of energy.

5.8 Fire Protection

Always have a suitable fire extinguisher within reach when welding. If no fire extinguishers are available, then have a water hose handy. Wet the area before welding, cutting and/or grinding. The following table summarizes additional requirements for specific welding operations.

IF you are welding...	THEN...
On a rig.	Use a gas detector or sniffer on the welding pipe.
In a confined space.	Have a trained fire watch person present with a fire extinguisher.
Near combustible material.	Have a fire extinguisher within reach and prevent sparks from contacting the combustible material with welding blankets or other appropriate means.
In the field or anywhere outside of a controlled shop environment.	Have a fire watch person present during welding and cutting with a fire extinguisher.

5.9 Fire Watch Personnel

Appoint a fire watch person to patrol the area for fires.

During this time, the fire watch person will:

- Inspect the grounds for fires, paying particular attention to the area immediately surrounding the hot work.
- Verify that no sparks or heat have ignited fires on the property.
- Verify that the facility is ready to return to normal operations.
- If safe to do so, extinguish a fire if one does occur

The fire watchperson will remain on-site for at least 30 minutes after the operation is completed.

5.10 Using Gas Detectors

Periodically monitor the atmosphere while performing hot work operations.

Document all results. If the combustible/flammable gas exceeds 5% LEL, then stop the job immediately until the cause for the increased LEL is determined and corrected.

5.11 Required Personal Protection

Refer to section 9.0 of this document.

General information regarding required personal protective equipment may be found in document 3.16.3: Personal Protective Equipment Provision Guidance.

Activity	Required Equipment
Arc welding.	<ul style="list-style-type: none"> ▪ Approved head protection. ▪ Leather gloves up to the elbow. ▪ Hood with the filter lens.
Using a cutting torch.	<ul style="list-style-type: none"> ▪ Leather gloves up to the elbow. ▪ Approved dark goggles that seal around the eyes alone, tight fitting welding spectacles (Safety Glasses designed for such use including close fit and shaded lens appropriate to task) with a full face shield or a standard welder's hood over prescription glasses.
Observing welding.	<ul style="list-style-type: none"> ▪ Welding goggles OR a shaded shield.
Brazing or welding alloys or other exotic metals.	<ul style="list-style-type: none"> ▪ Approved head protection. ▪ Leather gloves up to the elbow. ▪ Respirator approved for use with welding fumes or vent hood or proper ventilation

5.12 Safety Meetings

Supervisors will conduct a pre-job safety meeting to plan the job and discuss all relevant safety aspects.

5.13 Performing Welding

5.13.1 Preparing the Equipment

Follow these steps to prepare the welding equipment.

Step	Action
1	Inspect personal protective equipment. Helmet, gloves and clothing must be in good repair and must cover exposed parts of the body.
2	Wash, clean and purge air vessels.
3	Inspect welding cables for damage or wear. Ensure that no cables with splices are within 3 metres (10 feet) of the welder.
4	If the welding cable is coiled, then spread it flat.
5	Make sure you are not welding over cables, electric cords or hoses.
6	Inspect pipes, hoses and fittings. If they are leaking, then do not use them. Have them repaired or changed immediately.
7	If you are using a cutting torch, then inspect the torch for damage or wear. Never use a leaky hose or torch.
8	Attach a ground lead to the object being welded with an approved clamp.
9	Secure fuel-gas and oxygen cylinders with the valve end up.
10	Perform a gas vapor check.
11	Ask your supervisor for a hot work permit to begin work.
12	If there are any safety questions, then contact the HSSE department.

5.13.2 Opening Cylinders

Never open a valve near welding work, sparks or flammable materials. Follow these steps to open the oxygen and fuel-gas cylinders before welding.

Step	Action
1	Release tension on the regulator adjusting screws by turning them counter-clockwise.
2	Stand so the cylinder valve is between you and the regulator. Never stand directly in front of or behind a regulator when opening the cylinder valve.
3	Open the oxygen cylinder valve completely to seal the valve packing.
4	If the welding cable is coiled, then spread it flat.
5	Repeat Steps 1-4 with the fuel-gas regulator and cylinder.

5.13.3 Checking for Leaks

Check for leaks in the hose and the valve every 3 to 6 months or as needed.

If the cylinders don't last as long as they should, you hear oxygen hissing or you smell acetylene, then there may be a leak. Use leak detect spray to check for it. Squeeze one drop at a time on the hose, regulator valve and/or cylinder valve. If you see bubbles, then the hose or valve is leaking.

IF the leak is in the...	THEN...
Hose.	Replace the defective hose.
Regulator valve.	Tighten the connection.
Cylinder valve.	Place the cylinder outdoors and notify your supervisor immediately. Do not tighten a cylinder valve.

5.13.4 Lighting the Torch

Use a friction lighter or other approved device to light the torch. Do **not** use a match or a cigarette lighter.

5.13.5 Using Portable Welding Machines

Use the 110-120 volt electrical outlet.

Ground portable welding machines.

5.13.6 After Welding

When you have finished welding:

- Close the valves of:
 - Acetylene cylinders.
 - Oxygen cylinders.
 - Supply lines.
- Check the area for smoldering fires and extinguish them.
- Roll up the cables.
- Clean the area.

6.0 HOT WORK SYSTEM OVERVIEW

Hot work is allowed only in areas that are or have been made fire-safe. Hot work may only be performed in either designated areas or permit-required areas.

A designated area is a specific area designed or approved for such work, such as a maintenance shop or a detached outside location that is of non-combustible or fire-resistive construction, essentially free of combustible and flammable contents, and suitably segregated from adjacent areas.

Statutory and local authority regulations or PetroChina (Halfaya) recommendations (whichever are the more stringent) relating to the storage of gas cylinders should always be observed.

6.1. Welding and Cutting Hazards

Many hazards are associated with welding and cutting, but as in other operations they can be controlled by appropriate preventive measures. Unless these measures are taken, the hazardous situations can easily give rise to personal injury and/or material damage. Some typical examples are:

- The brilliant light of an arc (exposure to which can result in eye injuries).
- The heat of an arc, molten metal, sparks, hot objects, etc. (causing burns, fires / explosions).
- Toxic fumes released during the welding/cutting process
- Electrical hazards.
- Mishandling of gas cylinders.
- The welder at his work seldom being able to see, hear or smell what happens around or behind him.

6.2 Preparation for Work

At all locations and installations a written work permit should be obtained from the appropriate authority prior to the start of a welding or cutting job, unless the work is to be done in an unrestricted area or one specially designated for the purpose. For welding or cutting inside new vessels, or on or in old vessels and equipment, a special permit should be obtained even if the work is being carried on inside a designated area.

The work permit should specify any stand-by safety and fire-fighting equipment which should be on the spot before the start of work. Special precautions should be taken regarding screening, scaffolding (ramps and toe boards), location of welding sets, and the position, handling and use of gas cylinders.

Look for concealed spaces and openings into adjacent areas, and spaces below, adjacent or above. Seal any openings tightly with non-combustible or fire retardant materials. Plug wall, floor and ceiling openings with an appropriate fire-stop material.

Non-combustible tarpaulins or fire blankets should be used to fully shield items that cannot be removed from the work area due to their size or method of fixing. This may include combustible wall covering, ceiling panels or floor coverings.

Pipework that may contain flammable materials should be sealed. Shut off and seal nearby drains and duct work.

Where the risk of ingress of flammable vapours or gases into the work area cannot be completely eliminated, monitor the work area using a flammable gas meter or explosimeter to give early warning of danger that will allow appropriate action to be taken.

Do not allow hot work in battery charging areas unless the risk from hydrogen gas has been eliminated.

Welders and burners should be skilled tradesmen. Apprentices and helpers should work under the supervision of a qualified person.

7.0 GAS WELDING AND FLAME CUTTING

7.1 Cylinders

Valves on empty cylinders should be closed and fitted with valve protection caps.

Cylinder valves should be closed, and the valve protection cap should be in place, hand-tight, when cylinders are not in use.

Under no circumstances should oil or grease be used to lubricate any valves or connections with which oxygen under pressure may come in contact, as an explosion may result.

7.1.1 Cylinder Storage

- Cylinders should be stored in areas specially defined for the purpose, outdoors, away from all sources of heat and away from elevators, gangways and other traffic hazards. Oily rags, waste and other refuse should not be allowed to accumulate on or near stored cylinders.
- Cylinders should be stored chained upright in a well ventilated external area, and be protected against extremes of weather and direct radiation from the sun or hot equipment.
- Full cylinders of oxygen and fuel gas should be used in rotation as they are received from the supplier.

7.1.2 Handling and Use of Cylinders

- Oxygen should never be used to 'blow' dust off clothing.
- Fuel gas cylinders should be placed with valve end up whenever they are in use.
- A cradle, boat or similar platform closed on all sides, should be used when cylinders are transported by crane or derrick. Slings or electric magnets should never be used for this purpose.
- When cylinders are moved by hand, they may be tilted and rolled on their bottom edges. Dragging, sliding and laying them down and rolling them along the floor should be avoided. When cylinders are transported by vehicle they should be secured in position. Cylinders should not be dropped nor should they be permitted to strike violently against anything.

- Valve-protection caps should not be used for lifting cylinders from one vertical position to another.
- Bars should not be used under valves or valve protection caps to prize cylinders loose when they have become frozen to the ground or otherwise fixed. The use of warm (not boiling) water is recommended for this purpose.
- When cylinders are moved by means of a cylinder trolley, specially designed for the purpose, it is not necessary to remove the regulators and replace the valve-protection caps.
- Cylinders which are not mounted on such a trolley during use should be secured with a suitable steadying device to prevent their being knocked over.
- Cylinders in use should be kept far enough away from the welding or cutting operation to prevent their coming into contact with sparks, hot slag, hot metal or flame.
- Cylinders should be placed where they might become part of an electric circuit. Contact with radiators, piping systems or layout tables which may be used as ground return circuits for arc welding machines should be avoided, as also should contact with third rails or trolley wires. Never strike an arc against a cylinder.
- Cylinders should not be placed under structures where valves could be damaged by falling objects.
- The numbers and markings stamped on cylinders should not be tampered with. Oxygen and fuel cylinders should be color coded to prevent misidentification.
 - Note: Cylinders which are pre-color coded by the suppliers must not be re-painted.
- Empty cylinders should be marked and segregated from full cylinders for return to the supplier.
- Cylinders whether full or empty should not be used as rollers or supports.
- The contents of a cylinder should not be used for any purposes other than those intended by the supplier.
- Cylinders should only be re-filled by authorized persons or suppliers. No person other than the gas supplier should attempt to mix gases in cylinders.
- If a valve develops, the cylinder should be removed from service, suitable tagged, placed outdoors, with an appropriate warning sign, away from any source of ignition, and the supplier notified.

7.1.3 Cylinder Connections

Before an oxygen cylinder is put into service, the valve should be opened slightly then closed immediately. This action is known as 'cracking' (sniffing) the valve and is intended to clear the valve of dust or dirt which might otherwise enter the regulator. Valves on gas cylinders should

not be cracked near welding work, sparks, flames or other sources of ignition. The operator should stand on the far side of the cylinder from the outlet when cracking the valve.

7.2 Pressure Reducing Regulators

Regulators should be used only for the type of gas indicated by the supplier and should be of a design pressure appropriate to the pressure of the filled cylinders on which they are to be used. If regulators or their parts have to be repaired, the work should be performed by skilled and properly instructed mechanics only. In general it is recommended that regulators be returned to the supplier for repair, calibration or adjustment.

To ensure their accuracy, gauges attached to the regulators should be tested periodically. Oil should never be used to test the accuracy of gauges used on oxygen cylinders. Faulty seats in the unions on regulators may result in gas leaks. Damaged unions should be removed and replaced.

7.2.1 Connecting the Regulators

After the cylinder valve has been 'cracked' the regulator should be connected to the cylinder and tightened with the correct size open-end spanner. Adaptors are required to attach some acetylene regulators to the valves. Soapy water may be used to ascertain that a tight connection exists between the regulators, adaptors, and cylinder valves. Care should be taken to avoid getting oil or grease on the fittings when connecting an oxygen regulator.

To avoid error when connecting hoses, the oxygen regulator connections have right-hand threads; fuel gas regulator connections have left-hand threads. Connections should be tight to avoid leakage.

Unless special means have been provided to protect the regulators, the pressure-adjusting screw of the regulator should be released, i.e. turned counter clockwise (to the left), before the cylinder valve is opened.

The fuel-gas cylinder valve should be opened slowly with the special key or handle provided for that purpose. The valve should be opened more than $\frac{1}{2}$ turns, and the key should be kept in place. The pressure in the cylinder will then be shown on the high-pressure or cylinder-contents gauge.

The oxygen cylinder valve should be opened slightly so that the high-pressure gauge hand will move up slowly. The valve should never be opened suddenly, and the operator should not stand directly in front of the gauge faces. After the high-pressure gauge hand has stopped moving, the oxygen-cylinder valve should be opened fully.

7.2.2 Regulator Maintenance

If the low-pressure gauge on the regulator shows a continuous and steady increase in pressure when the torch valves are closed, the cylinder valve should be closed immediately and the regulator repaired.

When regulators are to remain out of service for an extended period internal valve seats should be protected by relieving the pressure on the seat by means of the pressure adjusting screw.

Care should be taken to re-set the pressure adjusting screw before the regulator is again put into service.

7.3 Hoses and Hose Connections

Hoses are manufactured in distinctive colors for ready identification. Red is the generally recognized color for fuel-gas hoses, and green for oxygen hoses, though this is not an internationally accepted standard and may vary from country to country. Hose connections on the regulator should be similarly marked for identification.

Only hoses manufactured to standard specifications should be used.

If parallel lengths of oxygen and gas hose are taped together to prevent tangling, not more than 25 mm out of each 150 mm should be covered with tape.

Hose should be connected by means of approved fittings and securely fastened with clamps in such a manner as to withstand a pressure of twice the maximum delivery pressure downstream of the regulator without leakage.

Long lengths of hose should be avoided. Hoses should be protected from kinking or tangling and from being stepped on, run over by trucks, or otherwise damaged.

Hoses should be protected from flying sparks, hot slag, hot and falling objects.

Contact of the hoses with oil or grease should be avoided to reduce deterioration of the rubber.

Spare hoses should be stored in a cool place, and away from direct sunlight.

Before a new hose is put into service, the fine talc dust on the inside should be blown out.

A 'flashback arrester' should be installed between the cylinder and fuel-gas hose immediately after the pressure regulator.

7.3.1 Hose Maintenance

Hoses should be inspected frequently for leaks, wear, and loose connections. Leaks may be detected by immersion of the hose in water under normal working pressure.

Leaks should be repaired immediately. This may be done by cutting out the defective portion of the hose and inserting a splice, e.g. inserting a tube with two hose clamps. Taping of frayed or worn hose or the use of any makeshift clamps or bands should be not permitted.

If a hose shows wear at a connection, the worn portion of the hose should be cut off.

A flashback renders a piece of hose unsafe due to the burning of the inner walls. Any hose in which a flashback has occurred should be discarded.

Only a limited number of repairs per hose should be made (e.g. 1 repair per 6 metre).

7.4 Blow Pipes or Torches

Torch connections for hoses should comply with the standards.

7.4.1 Mixing Valves, etc.

The proper welding head, mixer, tip, or cutting nozzle should be selected in accordance with the chart or table furnished by the torch manufacturer.

The cutting tip or nozzle should be screwed into the torch just tight enough to prevent leakage. Excessive force may damage the seat.

7.4.2 Oxygen Pressure Adjustment

The fuel gas valves should always be closed before the oxygen valve on the torch is to be opened for adjustment of pressure. The oxygen regulator is adjusted until the low-pressure gauge indicates the pressure shown on the manufacturer's welding and cutting chart. This is done while the oxygen valve on the torch is open and oxygen is passing through the tip. When a cutting torch is used, both the oxygen valve and the cutting valve on the torch must be open while oxygen pressure is being regulated. Thereupon the oxygen valve on the torch should be closed. Oxygen pressures should not exceed those recommended by the manufacturer of the equipment.

7.4.3 Acetylene Pressure Adjustment

For the adjustment of pressure in the case of a low-pressure torch operated in conjunction with a low-pressure acetylene generator, the acetylene valve on the torch should be closed, and the shut-off valve at the nearest hydraulic back-pressure valve on the system should be open.

For the adjustment of pressure in the case of a low-pressure torch operated in conjunction with a medium pressure acetylene generator, the acetylene valve on the torch should be closed. The pressure is adjusted to 0.21 kg/cm² and the acetylene valve on the torch is opened 2 turns. Thereupon the gas is lighted at the tip. The pressure is then readjusted until it is just barely above zero. The flame is extinguished by closing the acetylene valve on the torch.

For the adjustment of pressure in the case of a medium-pressure torch (or a low-pressure cutting torch equipped with a medium-pressure mixer valve) operated in conjunction with an acetylene cylinder or with a medium-pressure acetylene generator, the acetylene valve on the torch should be closed. The pressure should be adjusted in accordance with the welding and cutting chart. The acetylene valve on the torch is then opened, and after all air has been expelled from the hose, the gas is lighted at the tip. The pressure is then re-adjusted as necessary, and the flame is extinguished by closing the acetylene valve on the torch.

When the supply of oxygen or acetylene becomes so low that adequate delivery pressure cannot be maintained, work should be stopped at once and full cylinders obtained.

7.4.4 Lighting and Extinguishing the Torch

After the pressure has been adjusted, the manufacturer's directions for lighting the torch should be followed.

Only a friction lighter, stationary pilot flame, or other similar source of ignition should be used to light the torch. No attempt should be made to light or relight a torch from hot metal.

The flame is extinguished by closing the oxygen valve and then the fuel-gas valve.

7.4.5 To Stop the Work

If welding or cutting is to be stopped for a **few minutes only** it is permissible to close the torch valves only.

If welding or cutting is to be stopped for a longer period - such as during lunch, overnight, or while torches are being changed - the following procedure should be adopted:

- Close oxygen and fuel-gas cylinder valves.
- Open torch valves momentarily to release all gas pressure from the hose.
- Close torch valves.
- Release pressure adjusting screws on the regulator.

7.4.6 Torch Maintenance

If leakage develops around the torch valve stems, the packing nuts should be tightened and, if necessary, the valve should be repacked. Manufacturer's recommended packing only should be used - care being taken to avoid oil contamination of the packing.

A torch which does not shut off completely indicates improper seating of the valve stem, and this may necessitate cleaning of the seat or replacement of associated parts.

To clear a clogged orifice, the tip should be removed from the torch and cleaned with the special tool supplied by the manufacturer. Drills or copper wire should not be used to clear a clogged orifice.

7.4.7 Backfire or Pre-ignition

Momentary retrogression or burning back of the flame into the torch tip may result in backfire or pre-ignition which causes the flame to go out with a loud snap or pop. Usually no adjustment of the torch valves is required. This backfiring is usually the result of improper handling of the torch, such as touching the tip against the material being welded, overheating the tip, operating the torch at other than recommended gas pressures, or a loose tip.

7.4.8 Flashback

Retrogression or burning back of the flame into or beyond the mixing chamber is identified by a hissing or squealing sound and smoky sharp-pointed flame. When such flashbacks occur, it is necessary to cut off the gas supply immediately to prevent the possible destruction of the torch head and the hose. A torch should not be relighted after a flashback until it has been thoroughly examined for damage.

A flashback indicates that the torch is defective or that it is not being operated properly. Flashbacks can be prevented by maintaining correct delivery pressures of both acetylene and oxygen.

The use of a 'flashback arrester' gives a considerable improvement on safety.

7.5 Acetylene

Acetylene gas in its free state at a pressure of more than 0.5 kg/cm² decomposes violently and may cause an explosion. Higher pressures should never be used for gas welding and cutting. Acetylene may also form acetylides with copper, mercury or silver, therefore copper alloys with more than 63% Cu should not be used for manifolds, etc.

7.5.1 Acetylene Generators

When using semi-automatic generators, the generating water should be changed each time the carbide hopper is filled.

An acetylene generator, whether used with an acetylene compressor or not, should be situated in a room which is intended exclusively for this apparatus and which does not communicate with a workroom. The room should satisfy the following specifications:

- The roof shall be adjacent to the outside air.
- The dimensions of the room and the location of the apparatus should be such that the apparatus can be easily reached from all sides.
- The room should be well lighted and well ventilated.
- It should be possible to seal off the rooms in such a way that acetylene cannot escape to the surrounding area or work places.
- The walls and ceiling should be made of non-flammable material.
- The material of the door(s) and door-frame(s) should be such that no sparks can occur when the door is opened and closed; the composition of the floor should also make sparking impossible.
- The separating wall between the room and any other room acts as a blast wall. It should therefore be fire-proof, gas-tight and of adequate structural strength to withstand the pressure generated by an acetylene explosion. There should be no doors or windows in this wall.
- One of the outer walls or the roof will need to provide explosion relief and should be so constructed that in the event of an explosion at least 1 m² of the wall or roof per 6 m³ volume of the room offers only a slight resistance to the blast.
- The doors should open outwards.

- Any holes made in walls, which are not outside walls, to allow pipes to pass through should be rendered gas-tight.
- The electric motor, preferably explosion-proof, for driving the acetylene compressor should be set up outside the room; the shaft should have a gas-tight passage through the wall.
- For interior artificial lighting only explosion-proof lamp fittings should be used. Alternatively lamp fittings which are installed outside the room behind gas-tight windows may be used.
- The room should be protected against frost unless the apparatus can be suitably heated without danger.
- Only steam or hot water should be used for heating.
- A carbon dioxide fire extinguisher should be hung in the room within easy reach of the inside of the door and preferably another near the door outside the room.
- Only explosion-proof switches or plug sockets may be installed in the room.
- Both the inside and outside of the doors should bear the following notice in clearly legible letters:

**DANGER ACETYLENE
VERY HIGHLY FLAMMABLE
NO SMOKING
DO NOT APPROACH WITH A NAKED LIGHT**

7.5.2 Carbide

Carbide should be kept in airtight containers which should be resealed each time part of contents is removed. Hacking open carbide containers is dangerous and should therefore be prohibited.

The containers should be stored in a dry, well ventilated place away from any source of ignition. There should be no electrical switches or lights in the area; any artificial lighting necessary should be installed outside the windows. No other material should be stored in the same place as the carbide.

7.5.3 Acetylene Cylinders

The cylinders should be kept in a well ventilated storehouse in which no other materials are stored.

The protective hoods should always be screwed on the cylinders during transport or storage.

Damaged cylinders and those with leaking valves should not be accepted from the supplier. Cylinders with a pressure of more than 17 kg/cm² should not be put into service.

Cylinders should be handled carefully and prevented from knocking against or falling on other objects.

Overheating of the cylinders should be avoided under all circumstances.

The cylinders should be readily accessible under all circumstances and quickly removable if necessary.

The key for opening and closing the cylinder valve should always be on the cylinder attached by a suitable chain.

The sealing surfaces of the cylinder valve, and the reducing device, and the packing ring should be inspected before installing the reducing device.

The regulating screw of the reducing device should be turned off completely before opening the cylinder valve.

The cylinder valve should be opened slowly to its fullest extent and the connection checked for leakage.

A water flame trap should be fitted between the reducing device and the hose.

The reduced pressure should not be adjusted to a level higher than is necessary for the work.

The cylinder valve should be closed during temporary interruptions of work.

7.5.4 Batteries of Acetylene Cylinders

No copper or alloys containing more than 63% copper should be used for connections, pipes, shut-off valves, reducing valves, etc.

The cylinder connections of the high-pressure piping should be such that no cylinders other than those intended for acetylene can be connected to this piping.

Only acetylene cylinders with practically equal pressures should be connected to a manifold.

The collecting pipe should be as short as possible. The inside diameter of this pipe should not exceed 10 mm and that of the flexible connecting line 4 mm. The high pressure piping should be able to withstand an internal pressure of 185 kg/cm². A shut off valve for each cylinder should be fitted on the collecting pipe.

In the room where the manifold is set up a reducing valve with a maximum downstream pressure of 0.5 kg/cm² should be installed in the high pressure pipe to prevent over-pressure in the distribution system.

A battery with an acetylene capacity of more than 25 kg should not be set up in a work place or in any other room directly connected to a work place.

When a battery has an acetylene capacity of more than 25 kg it should be set up in a separate room which is adequately ventilated and has no other closed space above it.

The connected cylinders should be easily accessible and quickly removable along with any spare cylinders present.

7.5.5 Distribution Line for Medium Pressure (0.14-0.5 kg/cm²) Acetylene

The medium pressure acetylene should be taken from acetylene batteries, medium pressure generators or low pressure (below 0.14 kg/cm²) generators with compressor. For the distribution lines:

- A shut-off valve should be installed in the distribution line in the workroom as near as possible to the place where it enters the workroom.
- The line should be fixed securely to the fabric of the building and be welded throughout as far as is possible.
- All take-offs from the distribution line should be provided with the following items of equipment coupled in the order given:
 - Shut-off valve.
 - Pressure regulator.
 - Flashback arrester additional to the flashback arrester on each torch to prevent the flame from penetrating into the acetylene pipe.
- The inside diameter of the distribution line should not exceed 30 mm.
- Ring mains should be used as far as possible.
- Sharp bends in the line should be avoided.
- All systems should be pressure-tested with nitrogen or carbon dioxide at 5 kg/cm² after assembly and before commissioning. Periodic inspection of the network of piping is also necessary.
- Acetylene lines should be color-coded red to distinguish them from other pipes.
- Service and maintenance should be carried out by suitably trained, skilled and responsible personnel.

7.5.6 Explosion Hazard

Since acetylene forms an explosive mixture with air when the concentration of acetylene reaches about 2.5%, there is a definite explosion hazard. Careful attention should therefore be given to the prevention of escapes of acetylene gas into the air. Valves, cylinder fittings, gas hoses and connections should be carefully inspected for leaks at frequent intervals. If acetylene cylinders become hot the acetylene may then polymerize and an explosion could result.

7.6 Propane

As propane vapour is heavier than air, it may tend to collect in the lowest part of a structure. When cutting in enclosed spaces, for example in tanks. This may lead to an explosive mixture of

air and propane when leakages from hoses or hose connections are present. It is correct practice to ignite and extinguish the cutting flame outside the tank. An excess of oxygen will ensure that significant amounts of carbon monoxide will not be formed in the exhaust gas.

8.0 ELECTRIC WELDING

ELECTRIC WELDING has its own set of hazards. The main ones and how to avoid them are:

- **Burns:** Wear suitable protective clothing (see 9.0 Personal Protective Equipment). Cool down or clearly mark hot objects.
- **Eye hazards:** Use only a suitable helmet or hand-shield which is in good condition. Always wear approved safety spectacles with side shields, goggles or a visor when chipping or grinding. Ensure that adequate welding screens are erected where practicable.
- **Fumes, vapors, dust, and gases:** Make sure the work area is well ventilated. TIG and MIG weld shield gases are asphyxiants, and there are health risks from the toxic substances in fluxes, filler rods, coatings, and cleaning agents, and the by-products of heat and ultra violet radiation from the arc.
- **Dangerous substances:** Some dangerous substances to note are:
 - BERYLLIUM. Used mainly as an alloy with other metals, beryllium is deadly and extreme precautions must be taken. This metal must be welded in inert atmospheres, inside airtight enclosures, with the welder outside.
 - CADMIUM. Used in electroplating and as an alloy with metals, cadmium is also an ingredient in some paints. A single exposure to cadmium oxide fumes can cause a severe lung irritation that may be fatal.
- **Heat:** Heat from welding and grinding activities can start a fire or explosion. Do not allow an electric weld arc to strike a compressed gas cylinder. Never connect earthing connections to electrical equipment or pipework containing flammable materials. Suitably dispose of used welding rods, electrodes and hot metal. Screen grinding or welding operations which may throw sparks or spatter a considerable distance.
- **Electric shock:** Check the insulation of all cables regularly. Electrical work should be carried out only by a registered electrician. The voltages of a part of an electrical system which are generally accepted as unlikely to have harmful effects if touched by a person under normal dry conditions are:
 - 42 volts in the case of alternating current, and
 - 110 volts in the case of direct current.

With alternating current welding, the voltage between the electrode holder and the job is only about 25 volts during welding. However, when there is no load on the welding transformer the voltage rises to between 70 and 80 volts. Therefore welding transformers should be equipped with an automatic device which effectively limits the secondary voltage to a maximum of 42 volts if the welding current (arc) is interrupted.

Note: With both types of relays humidity and dust cause the full voltage at the transformer to return too slowly when the arc is struck, thereby creating inferior spots in the weld known as start-porosity. In practice it often happens that the welder by-passes the relay to avoid a bad weld and re-introduces a potentially hazardous situation. It is therefore essential that the relays are regularly checked for reliable performance by an authorized engineer. With direct current welding, voltages are normally below 110 Volts. Therefore direct current welding is highly recommended, particularly for welding in confined, warm or humid places.

8.1 Control Electric Shock Hazards

- Ensure electric arc welding cables, cable connections and electrode holders are maintained in good condition.
- Ensure welding equipment is suitably earthed.
- Do not weld in wet conditions unless suitable precautions have been taken, and do not change electrodes with wet hands or gloves.
- Never touch live metal parts with bare skin or wet clothing during arc welding.

9.0 PERSONAL PROTECTIVE EQUIPMENT (PPE)

Ventilation and / or respiratory protection respirators are required when welding or burning on galvanized metal, painted surfaces containing lead, cadmium, zinc, copper / nickel pipe, and any hot work in confined spaces where there is insufficient ventilation.

Respiratory protection may be upgraded to breathing apparatus if ventilation is insufficient in confined spaces.

Mandatory half-face negative pressure P100 cartridge respirator must be worn while performing hot work on galvanized metals or on nonferrous metal alloys.

Other PPE required:

- Eye protection (full face with double lenses to protect against glare and flying fragments (replaceable outer lens to be clear and the inner lens tinted).
- Hand and arm protection.
- Flame retardant protective clothing.
- Safety footwear.
- Flame retardant head protection when overhead welding.

10.0 COMMUNICATING THE HOT WORK PERMIT REQUIREMENTS

Everyone working on the task needs to know the safe system of work and understand why the specified precautions need to be taken.

For this reason the Issuing Authority should explain and communicate what precautions are specified on the permit and why they are needed. This communication is helpful to re-enforce any training the staff may have already had and put it into a relevant context.

The Issuing Authority should re-emphasize the procedures to be followed should any changes in the work method or practices be needed. It is also a further chance to re-emphasize the procedures to be followed in case of emergency.

11.0 ACTION IN AN EMERGENCY

The Hot Work permit system should make provision for actions in an emergency. Normally this will consist of an instruction that all work is to cease in the event of an emergency. However, on some occasions, particularly following an actual alarm condition, the Issuing Authority may require formal revalidation to control the type and location of activities that are re-started.

Consideration should be given to measures required to detect a fire and the actions required should a fire start. Often hot work may mean that fire detection systems are impaired because the work itself gives off smoke and fumes. A system should be in place that ensures the following:

- Early detection of a fire should one start.
- Warning and evacuating the affected areas.
- Contacting the emergency response team and emergency services.
- Appropriate emergency response to the incident.

This should include the following aspects.

- The use of automatic fire detection systems where possible or alternatively the use of a fire watch system where a person remains present in the work area or makes very regular checks for signs of fire. The fire watch should remain in place for at least 30 minutes following cessation of the work to identify any materials that may have been left smoldering.
- The use of fire alarm systems to alert site occupants of danger or an alternative method of alerting occupants such as an air horn if the automatic alarm system is impaired.
- A briefing to all site occupants on the temporary emergency arrangements that are in place during the work.
- A nominated person should be appointed should ensure contact is made with the emergency services should the fire alarm sound.

- Appropriate fire-fighting equipment is made available local to the work area. This may include the provision of additional or alternative fire extinguishers, the deployment of charged fire hoses or the priming of sprinkler systems if dry pipe systems are installed. The level of fire response would be dependent on the risk assessment for the work.

Post-emergency actions should include a reassessment of work, subject to permits, to ensure that conditions have not altered as a result of the emergency and that the permit remains valid.

12.0 MONITORING

The Hot Work permit system should be monitored continuously to ensure that the conditions under which the permit was issued remain unaltered, and that the precautions specified on the permit are being complied with.

13.0 TRAINING AND CERTIFICATION

The extent of training required will vary according to types of activity to be performed, as well as the responsibilities of appointment holders, training needs for the following categories of employees will be considered:

- Line manager/Area Authority.
- Performing Authority.
- Issuing Authority.
- HSSE / Safety Officers.
- Authorized Gas Testers.
- Workers / Craftsmen.
- Fire Watchers.

14.0 RECORDS

A record of actual Hot Work permits should be maintained to enable auditing of completed permits and supporting certificates and other documents over a specified period.

The period for retention of records is typically 3 years unless local legislation requires retention for a longer period.

15.0 RELATED DOCUMENTS

15.1 PetroChina (Halfaya) Level 3 Guidance Documents

This Guidance is supported by:

- Document 3.6.1: Risk Assessment Guidance.
- Document 3.6.2: Job Hazard Analysis Guidance.
- Document 3.11.1: Permit To Work Guidance.
- Document 3.16.3: Personal Protective Equipment (PPE) Provision Guidance.
- Document 3.19.1: Emergency Preparedness and Response Guidance.
- Document 3.19.3: Fire Control and Recovery Guidance.

15.2 PetroChina (Halfaya) Level 2 Procedures

This Guidance is related to:

- Document 2.6: Risk Assessment Procedure.
- Document 2.11: Permit To Work Procedure.

15.3 PetroChina (Halfaya) Level 1 HSE-MS

This Guidance supports the 'Evaluation and Risk Management' section of the PetroChina (Halfaya) HSE-MS Document.

15.4 External Sources of Information

Further information is available from:

- The U.S. Department of Labor OSHA website (USA) www.osha.gov
- The Health and Safety Executive (UK) www.hse.gov.uk
- The International Association of Oil and Gas Producers (OGP) www.ogp.org.uk