أرامكو السعودية
saudi aramco

confined space

a guide to safe entry

Confined spaces

learn how to stay safe

Saudi Aramco conducts many tasks that require entry into confined spaces. A confined space entry (CSE) presents numerous hazards that must be properly identified. Associated risks must be eliminated or controlled. To do this, supervisors and workers who perform CSE tasks must know and follow established CSE procedures, as well as all other safety procedures, to protect themselves, their coworkers, contractors, communities, and assets.

If you are involved in CSE or your job requires you to enter a confined space, you must be fully knowledgeable of CSE hazards and company procedures detailing CSE requirements.

A confined space is an area not normally intended for human occupancy that has limited access, like a tank, vessel, duct, vault, manhole, or pit, with the potential to contain a hazardous atmosphere or any other safety or health hazard.

Fatalities and serious injuries are not only to workers inside a confined space, but also to the rescuers.
In fact, the majority of workers who die after entering confined spaces are those attempting to rescue coworkers.

Review this booklet to learn how to recognize confined spaces, the critical safety procedures to follow when working in confined spaces, and how to ensure that trained persons "stand by" in case something goes wrong.

CSE procedures are detailed in General Instruction (GI) 2.100, *Work Permit System*, and the Saudi Aramco *Construction Safety Manual* (CSM) Volume II, Chapter I-6, Confined Spaces.

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Confined space hazards and controls

Recognize confined spaces and their hazards

Understanding the term confined space is critical in identifying hazards and managing the risks associated with entering, performing tasks inside, and safely exiting any space that is designated as confined.

Saudi Aramco General Instruction (GI) 2.100, *Work Permit System,* defines a confined space as any space or structure that:

- Has limited or restricted means of entry or exit.
- Is not designed for human occupancy.
- Contains or has the potential to contain a hazardous atmosphere.
- Contains any other recognized serious safety or health hazards.

A confined space is not necessarily small and can be above or below the ground. Some confined spaces are easy to identify, such as underground vaults, tanks, pits, sewers, and vessels. Others may be less obvious, such as excavations deeper than 1.2 m (4 ft).

Incident data indicate that atmospheric conditions are the leading cause of death associated with CSE. Oxygen deficiency and the presence of hydrogen sulfide, methane, and inert gases rank as the leading atmospheric hazardous conditions. Asphyxiation resulting from engulfment from loose materials, such as sand, cement, gravel, and catalyst materials, is also a leading hazard.


THIS IS A CONFINED SPACE
All vessel entry procedures and
precautions should be strictly adhered to

Design out hazards

As a first step to CSE safety, supervisors must consider whether entry into a confined space is necessary. For example, is it necessary to authorize a worker to enter a pit or vault to clean it of dangerous chemicals, or can the chemicals be removed through an automated process? It is usually safer to dismantle, open, remove, etc., the equipment/process rather than allow entry.

If it is determined that work must be conducted in a confined space, safety should be incorporated into the design process because design deficiencies can often increase the risk for entrants. Examples of poor design include:

> Means of entry (portals, hatchways, etc.) are too small, improperly located, or complicate/inhibit escape.
> Spaces are confusing, unnecessarily obstructed, or hazardously configured.
> Absence of appropriate devices to isolate all energy sources from the space.
> Lack of features that enhance ventilation effectiveness.
> Structural weakness in walls, floors, ceilings, or pipes.
> Absence of anchor points for retrieval devices.

Designers, manufacturers, and users must address and prioritize confined space design issues when new or modified machinery, equipment, processes, or facilities are in the design phase of construction, by using processes such as process hazard analysis and management of change.

Control confined space risks

When it is not possible to design out confined space hazards, work conducted in a confined space must be appropriately planned and managed. Engineering and administrative controls and, as a last resort, the use of personal protective equipment (PPE) can help manage confined space risks.

Engineering and administrative controls

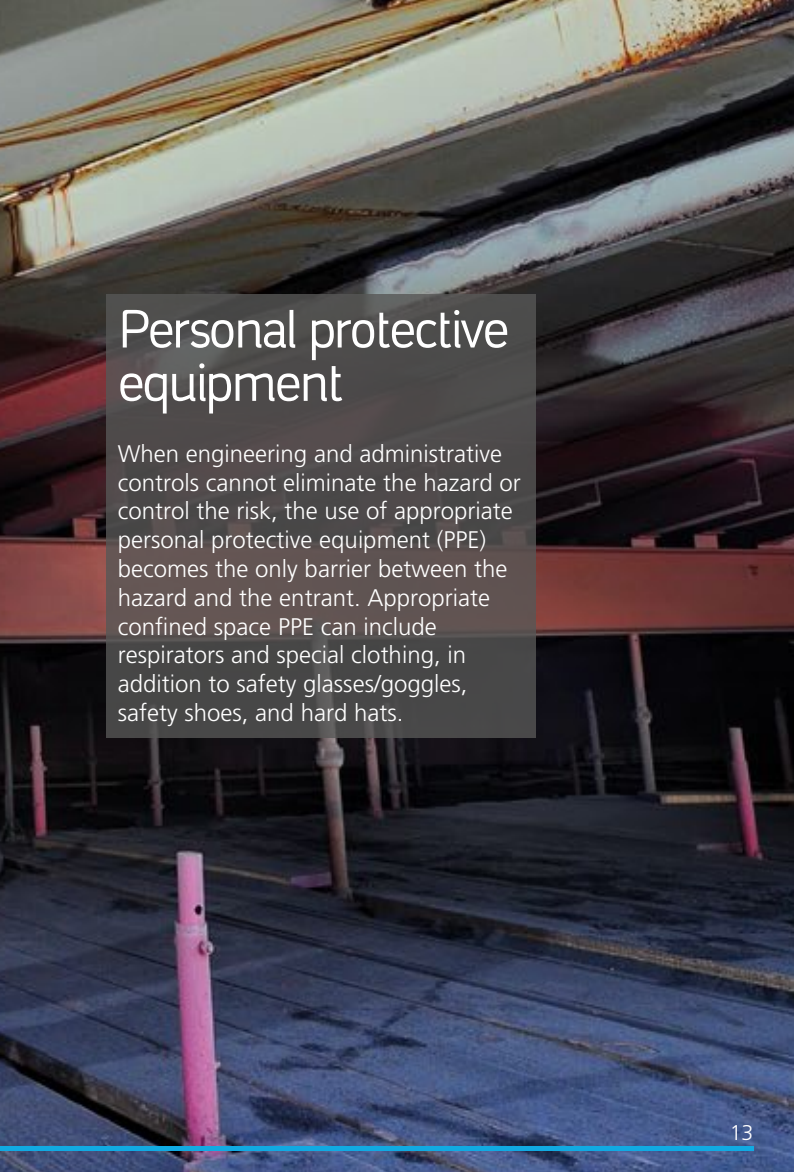
Engineering controls

If entry is unavoidable, common confined space hazard engineering control measures must be implemented, including purging or ventilating the atmosphere inside the space. Purging is the process of clearing the confined space atmosphere of contaminants by displacing them with air or steam. Ventilation, mechanical or natural, is the process of moving uncontaminated, fresh air through the space.

Administrative controls

Administrative controls acknowledge the presence of hazards and attempt to minimize employee contact or exposure to them. They include the use of an entry permit system; gas testing the atmosphere; training; and detailed, written CSE requirements. Entry into a confined space can be done safely if the following precautions are taken:

> Proper training on CSE to all involved personnel is provided.
> Proper CSE procedures are followed.
> A confined space entry permit is issued.
> Proper supervision of CSE is provided.
> An effective confined space entry plan, with a detailed rescue procedure is developed and implemented.



Personal protective equipment

When engineering and administrative controls cannot eliminate the hazard or control the risk, the use of appropriate personal protective equipment (PPE) becomes the only barrier between the hazard and the entrant. Appropriate confined space PPE can include respirators and special clothing, in addition to safety glasses/goggles, safety shoes, and hard hats.


DANGER

Managing and controlling risk

Developing a CSE plan

Requirements for managing and controlling risk in confined spaces include developing a CSE plan prior to entry into the space. The plan should include:

- Conducting CSE hazard evaluation that takes into account the nature of the work that will be performed, the number of people involved, the nature of the substance contained within the space, and the configuration and location of the confined space.
- Ensuring that all personnel involved in CSE are properly trained to perform their roles and responsibilities.
- Location and method of each isolation point of the confined space, as well as the need for lockout/tagout of any equipment and the use of hold tags.
- Procedures for flushing, purging, and/or ventilating the confined space.
- Access/egress requirements, including necessary barriers to prevent unauthorized access.
- Types and frequency of atmospheric testing.
- Types of equipment required for entry (e.g., scaffolding, air movers, communication, and rescue equipment), PPE, and fall protection equipment.
- Potential hazards that could develop as a result of simultaneous operations adjacent to the confined space.
- Emergency response/rescue procedures.
- See CSM Chapter I-6, Confined Spaces, for full details on CSE plans.

Follow the CSE permit process

The purpose of the CSE permit process is to ensure the proper preparation of the confined space; the safe entry of personnel, including plans for rescue; and the proper restoration of the confined space.

Every job that requires a CSE must have a designated CSE supervisor who ensures all preparations for entry have been completed. Other personnel required in a CSE include the work permit issuer, work permit receiver, and confined space standby man. A fire watch, foremen, and technicians (e.g., welders, pipe fitters, engineers, and maintenance personnel) may also be needed to conduct work in the confined space.

The CSE Permit is not limited to restricted areas. Other operations — for example, entry into a sewer manhole inside a company-operated community — require personnel to follow these CSE requirements:

- Ensure a CSE Permit is issued as per the requirements of General Instruction (GI) 2.100.
- Ensure that a designated CSE supervisor has verified the completion of all preparatory activities prior to entry.
- Assign a confined space standby man (assigned by the CSE supervisor) at each designated entry point with sufficient means of communication (e.g., two-way radio) in case of emergency.
- To facilitate nonentry rescue, retrieval systems must be used whenever an entrant enters an enclosed confined space that requires vertical entry, such as a vessel, column, or tank. A retrieval system must comprise a retrieval line, a full-body harness worn by each entrant, and a lifting device.
- Use CSE checklists and logs.

CONFINED SPACE ENTRY PERMIT

Saudi Aramco 9873-4 (12/15) Front
No. 0

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SECTION 1 – WORK DESCRIPTION

Month ____ Day ____ Year ____ Duration ____

A. Identify plant/facility area:

B. Exact work location:

STOP WORK! If job site does not meet work permit conditions and any applicable Saudi Aramco safety and health requirements **at any time.**

SECTION 2 – HAZARD IDENTIFICATION & CONTROL

A. Identify and attach any supplementary forms required to perform/control the work:
Job Safety Analysis ☐ Gas test records ☐ Isolation plan ☐ Blind list ☐ Critical Lift Plan ☐
Excavation Checklist ☐ Hydrotest procedure(s) ☐ Other ____ Other ____

B. Energy Types:
Hydrocarbon/gas/steam/chemicals ☐ Mechanical ☐ Electrical ☐ Hydraulic/pneumatic ☐
Potential energy (spring loaded, gravity) ☐ Automated extinguishing systems ☐ Other ____

C. Isolation Method(s):
Locked switch/breaker ☐ Mechanical block ☐ Block valve ☐ Single block & bleed ☐
Double block & bleed ☐ Blinding ☐ Disconnect ☐

D. Potential Exposures:
High noise level ☐ Hydrogen Sulfide (H_2S) ☐ Flammable liquids/gases ☐ Hazardous/toxic materials ☐
Radioactive materials ☐ Temperature ☐ Other ____ Other ____

E. Protective Equipment:
Personal H_2S monitor ☐ FRC ☐ Goggles/face shield ☐ Chemical suit/coveralls ☐
Fall protection ☐ Barricades/warning signs ☐ Mechanical ventilation/blower ☐ Respiratory protection ☐ *(Explain further in Additional Safety Precautions below)*

F. Confined Space Entry Supervisor (CSES) ☐ Badge No. ____

G. Confined Space Entry Standby Man ☐ Badge No. ____

H. List any Additional Safety Precautions:

IN AN EMERGENCY:

Section 3 – Gas Testing/Monitoring

Periodic monitoring required: Yes ☐ No ☐ If yes, attach a supplemental form

Additional gas tests required prior to entry, after break/interruption of work, if site conditions change, and at periodic intervals (as required). Record below or use a supplemental form.

Gas testing frequency: ____

ONLY CERTIFIED GAS TESTERS PERFORM GAS TESTS

	LEL (%)	H_2S (ppm)	O_2 (%)	CO (ppm)	Others	Badge No.	Signature
Initial Test							
Renewed							
Additional							
Additional							

SECTION 4 – PERMIT AUTHORIZATION & CLOSURE

Additional approvals per GI 2.100 or local instructions:

Signature ____ Position ____ Date ____ Time ____

	Receiver Org.:			Issuer Org.:			Countersignature(s) if:	
PERMIT	Badge	Cert.		Badge	Cert.		Org.	Signature
Open								

This permit is renewed Date ____ Duration ____ Counterpart(s) notified of permit renewal ☐

This permit is closed Date ____ Time ____

I HAVE INSPECTED THE WORK SITE AND CONFIRM THAT IT HAS BEEN RETURNED TO A SAFE CONDITION.

Closed

HAZARD ANALYSIS CHECKLIST

Any 'N' (NO) answers below shall initiate a **"STOP"** point where the Issuer and Receiver are to analyze the hazard(s) and develop methods to adequately control the hazard(s) and list the additional precautions on the permit.

	Y	N	N/A
Is the correct type of permit(s) issued for the work?	☐	☐	
Have the Job Safety Analysis (JSA) and other applicable supplementary forms been communicated to the work crew?	☐	☐	☐
Are weather conditions (e.g., wind speed) acceptable to perform the work?	☐	☐	☐
Are slip and trip hazards controlled?	☐	☐	☐
Does the work crew have the correct tools/equipment for the job? Are they in good condition?	☐	☐	☐
Do personnel have the proper certifications to perform the activity and/or operate the equipment?	☐	☐	☐
Is the equipment's inspection sticker valid?	☐	☐	☐
Have all requirements for working at heights (i.e., fall protection) been applied?	☐	☐	☐
Is the scaffold tag completed correctly, signed and with a valid inspection date?	☐	☐	☐
Has the potential for contact with sharp objects, rotating equipment, hot/cold surfaces or live electricity been eliminated?	☐	☐	☐
Is the system/equipment properly isolated and locked out? Did all workers apply their personal locks?	☐	☐	☐
Has the system/equipment been depressurized, drained and/or purged before opening it?	☐	☐	☐
Has the potential for releasing flammable liquids and gases been controlled?	☐	☐	☐
Are all ignition sources eliminated or controlled?	☐	☐	☐
Does the fire watch have firefighting equipment readily available and know how to use the equipment?	☐	☐	☐
Has the potential for exposure to high noise levels, H_2S, hydrocarbons, asbestos, hazardous chemicals or radioactive materials been controlled?	☐	☐	☐
Is the correct personal protective equipment (PPE) available for use by personnel?	☐	☐	☐
If the work may impact others nearby, or vice versa, have the work crews discussed their activities with each other (i.e., simultaneous operations [SIMOPS])?	☐	☐	☐
Is there an emergency contingency plan in place to respond to the work being performed?	☐	☐	☐
Does the work crew knew what to do in the event of an emergency, such as evacuation routes, location of emergency equipment and where assembly areas are located?	☐	☐	☐

Signatures

Issuer or Designated Representative ____

Receiver ____

Preparation phase

Preparing a confined space prior to entry is critical for any safe CSE operation. To ensure safe entry, the following preparations are required:

- Properly isolate the space or vessel from all sources of energy (e.g., process lines and electrical power).
- Remove hazardous contaminants from the space by purging or steam washing as required.
- Remove toxic gases, and ensure positive ventilation through the use of mechanical ventilators.
- Conduct the appropriate tests for combustible/toxic gases, oxygen, and carbon monoxide by a certified gas tester. Results are recorded prior to entry, after breaks or interruptions, and at periodic intervals during the work. Additional atmospheric monitoring must be conducted if other hazards, such as naturally occurring radioactive materials, are suspected.
- Eliminate or control all sources of ignition (e.g., sparks or open flames).
- Ensure that all equipment, including air movers, are properly grounded and bonded. Residual current devices/ground fault circuit interrupters must be used with all electrical-powered equipment inside a confined space, regardless of the electrical classification of the space.
- Control all physical hazards, such as falling overhead objects and the presence of hot surfaces. Ensure any spinning or rotating equipment, e.g., fan blades, remain stationary and movement is prevented by a mechanical method, such as a chock or chain.
- Ensure that fall protection is used if personnel could fall more than 1.8 m (6 ft) when working inside the confined space.
- Ensure the necessary PPE is available on site and used during the entry.

- Identify the means of egress and communication, including notifying emergency rescue services.
- Post signs, barricades, and the CSE permit outside the confined space, to notify personnel that a CSE is in progress and to prohibit unauthorized entry.
- Station a properly trained and equipped confined space standby man outside the confined space during work to remain in contact with those inside.
- Ensure proper rescue equipment — such as lifelines, harnesses, and hoists — is available when entering a confined space. At least one 13.6 kg (30 lb) fire extinguisher must be provided near each designated CSE, if the space is within process equipment, or where combustible or flammable material may be present. Carbon dioxide (CO_2) type fire extinguishers should not be used inside enclosed confined spaces.
- Communicate the CSE plan to all entrants and the standby man.

Confined space entry plan

A critical part of the CSE preparation phase is the proper isolation of all equipment and sources of kinetic and potential stored energy, such as electrical, mechanical, hydraulic, chemical, and pneumatic systems. As per CSM Chapter I-6, during job planning, an isolation plan must be developed identifying all locations to be isolated, types of isolating devices to be used, and site/job specific procedures for isolating the equipment.

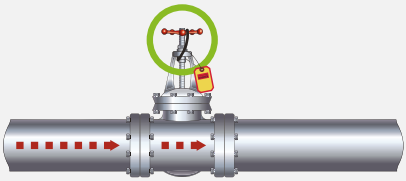
Requirements for managing and controlling hazards in confined spaces include developing a CSE plan prior to entry into the space. The CSE checklist in the CSM Chapter I-6 can be used to assist with this.

blinding

is a method of positive isolation

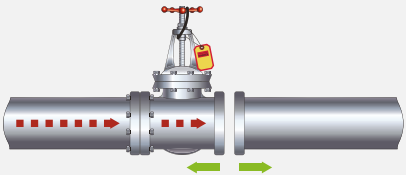
1

Lock and tag the valve in the closed position. All contents must be depressurized, vented and flushed/purged before any work is performed.



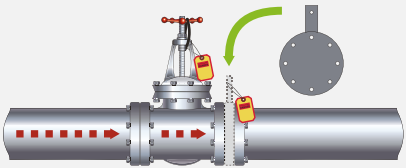
2

Unbolt the flange and separate the flange faces.



3

Insert the blind at the isolated side of the valve, and tag the blind.



For more information, refer to Saudi Aramco G.I. 6.012

Methods of isolation

Only positive methods of isolation are acceptable for CSE. There are two different methods of isolating process piping and equipment in preparation for CSE. They are, in order of the protection they provide (least to most):

1. Blinding
2. Disconnection

Blinding is the installation of a solid metal plate between pipe flanges or at the end of a disconnected pipe to prevent the release of hazardous materials, and is considered positive isolation.

Disconnection is the physical disconnection of piping, such as dropping a spool piece. This method may be used for long-term maintenance, and is considered positive isolation.

Atmospheric gas testing

Because one of the main causes of death during CSE operations is hazardous atmospheric conditions, gas testing requirements must be followed as outlined below:

> Gas tests of the atmosphere inside the confined space must be performed and immediately recorded:

- Prior to entry.
- After breaks or other interruptions in the work.
- If there is any reason to believe that conditions inside the confined space have changed.
- At periodic intervals (e.g., every two hours) as necessary to determine whether acceptable atmospheric conditions are being maintained during the course of the CSE.

- Atmospheric gas tests must only be conducted by a Saudi Aramco certified gas tester per the requirements of GI 2.709, *Gas Testing Using Portable Gas Monitors.*
- Continuous gas testing must be used if the atmosphere inside the confined space is subject to change, or if the CSE involves combustion activities, such as welding or torch cutting.
- Initial gas testing prior to entry must be performed with all mechanical ventilation shut down at least 15 minutes prior to performing the gas tests. This is to ensure that the gas test results are not affected by the ventilation and the atmosphere meets the required gas test limits without the benefit of air movement, dilution, etc., that mechanical ventilation provides.
- Additional gas testing (e.g., after breaks or on a periodic basis) must be conducted with the ventilation system turned on to ensure that contaminants are being removed and that the ventilation system is not a source of contamination.
- Initial entry is prohibited if gas testing indicates an oxygen deficiency or the presence of unacceptable levels of flammable or toxic materials within the confined space. Initial entry is allowed only after mechanical ventilation or purging has rendered the space free of hazardous concentrations (as verified by continuous gas testing inside the confined space).

DANGER

Danger Confined Space
No Unauthorized Entry
منطقة محصورة خطرة
الدخول ممنوع لغير المصرح لهم

Entry phase

Once the confined space is properly prepared, ensure the following:

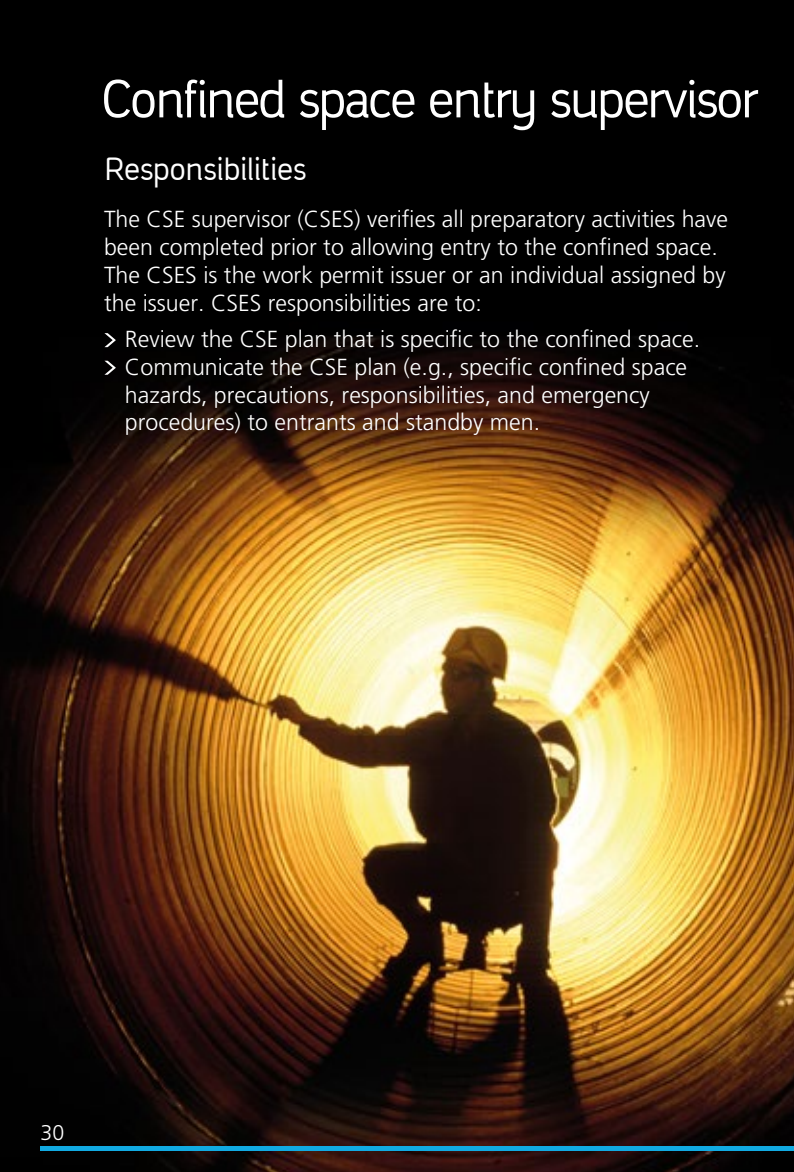
- The CSE Permit has been completed and signed.
- Only trained personnel are permitted to enter the confined space.
- All personnel must be accounted for by having the names of all entrants recorded on a log sheet upon entering and exiting the confined space.
- Gas test logs are maintained as indicated on the CSE plan and/or permit.
- Atmospheric gas tests are conducted as required per the CSE Permit. Continuous monitoring must be performed when atmospheric conditions are subject to change, or if the activities involve combustion, or if there is an emergency.
- Entry is terminated if conditions change, if the activities involve combustion, or there is an emergency.
- If the CSE is suspended, the entrances to the confined space must be blocked or barricaded and "No Entry" signs must be posted.
- Hazardous conditions and activities outside the confined space must also be identified, controlled, and evaluated for their potential impact on the confined space.

Confined space entry supervisor

Responsibilities

The CSE supervisor (CSES) verifies all preparatory activities have been completed prior to allowing entry to the confined space. The CSES is the work permit issuer or an individual assigned by the issuer. CSES responsibilities are to:

- Review the CSE plan that is specific to the confined space.
- Communicate the CSE plan (e.g., specific confined space hazards, precautions, responsibilities, and emergency procedures) to entrants and standby men.

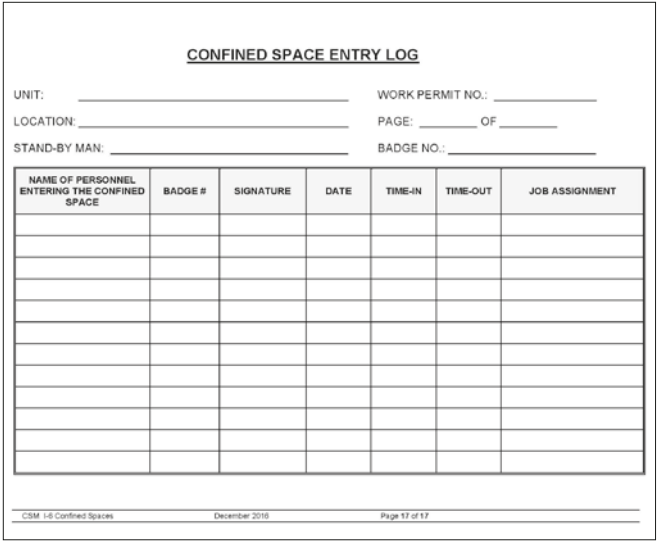


- Ensure proper work permits (confined space entry, hot work, etc.) are issued prior to allowing work to commence.
- Verify all precautions of the CSE plan and applicable work permits are properly implemented.
- Designate qualified confined space standby men who are fluent in the language needed to communicate with the CSES and rescue team.
- Verify entrants and confined space standby men are properly trained.
- Coordinate confined space operations when employees of more than one crew or contractor will be working simultaneously inside or adjacent to the confined space.
- Provide sufficient manpower and equipment for safe CSE and work inside the space.
- Verify the confined space is properly isolated per GI 6.012, purged, and the atmosphere is safe to enter as part of the CSE permit issuance process.
- Ensure the atmosphere within the confined space is monitored as indicated on the CSE Permit and/or the CSE plan.
- Ensure CSE and gas test logs are properly completed.
- Ensure the proper PPE is provided to personnel entering the confined space and to each confined space standby man.
- Ensure adequate means of communication (e.g., two-way radio) and a fire extinguisher (non-CO_2 type) are available for each confined space standby man.
- Verify rescue equipment and a rescue team are readily available in the event of an emergency requiring evacuation of the confined space.
- Ensure the confined space entrance is barricaded/blocked and a "No Entry" sign posted if the CSE is suspended.
- Terminate CSE and cancel work permit(s) as necessary (e.g., unsafe conditions develop).

Confined space standby man

Responsibilities

The confined space standby man has the responsibility to monitor the CSE while entrants are inside the confined space. Their responsibilities are to:



CONFINED SPACE ENTRY LOG

UNIT: _____ WORK PERMIT NO.: _____

LOCATION: _____ PAGE: _____ OF _____

STAND-BY MAN: _____ BADGE NO.: _____

NAME OF PERSONNEL ENTERING THE CONFINED SPACE	BADGE #	SIGNATURE	DATE	TIME-IN	TIME-OUT	JOB ASSIGNMENT

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- Review the CSE plan and applicable work permits to understand the confined space hazards, precautions, responsibilities, and emergency procedures.
- Understand the effects of exposure to potential hazardous substance(s) in the confined space.
- Maintain a CSE log and maintain a continuous count of entrants.
- Prevent unauthorized personnel from entering the confined space.
- Monitor activities inside and outside the confined space to determine if it is safe for entrants to enter and/or remain inside the space.
- Maintain two-way communication with entrants to monitor entrant status (e.g., behavioral effects of hazard exposure) and alert entrants of a need to evacuate the confined space.
- Have communications equipment readily available on-site and immediately notify proper personnel (e.g. CSES, rescue team) in the event of an emergency.
- Remain at the CSE entry point until relieved by another designated confined space standby man or until all entrants have exited the confined space.
- Never attempt to enter the confined space, even in an emergency.
- Perform nonentry rescues as specified by the rescue plan.
- Perform no other duties that could interfere with the primary responsibilities of a confined space standby man.
- Order entrants to evacuate the confined space under any of the following conditions:
  - An unsafe condition develops inside or outside the confined space.
  - An entrant displays abnormal behavioral effects of hazard exposure.
  - If the confined space standby man must leave the area and no relief is provided.

Entrants

Responsibilities

Entrants are personnel — proponent, maintenance, or contractor — who have been designated to enter a confined space to perform work. Their tasks include entering for inspection, taking a sample, performing a maintenance activity, or supporting operations. The entrants have the responsibility for conducting work in a confined space as per the requirements of the CSE Permit. Entrant responsibilities include:

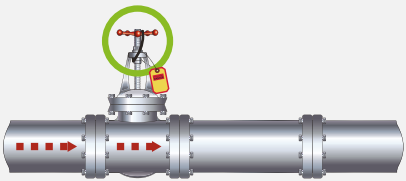
> Review the CSE Permit and CSE plan and verify that all precautions have been properly implemented.
> Understand the effects of exposure to potential hazardous substance(s) in the confined space.
> Understand the proper use of PPE inside the confined space.
> Not enter a confined space until they are satisfied that all necessary precautions have been properly taken to ensure their safety, including isolation procedures (see GI 6.012 and CSM Chapter I-5, Isolation, Lockout, and Use of Hold Tags), and they clearly understand their work assignment within the space.
> Communicate with the confined space standby man to enable the standby man to monitor the entrants' status (e.g., behavioral effects of hazard exposure).
> Promptly alert the confined space standby man and other entrants, and/or exit from the confined space as quickly as possible, whenever:
  - An order to evacuate is given by the confined space standby man or the CSES.
  - The entrant recognizes any warning signs or symptoms of exposure to a hazardous condition or substance.
  - An emergency alarm is activated.

disconnection

is a method of positive isolation

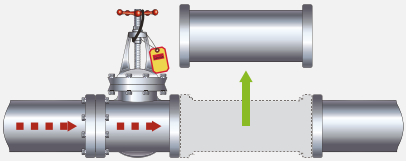
1

Lock and tag the valve in the closed position. All contents must be depressurized, vented and flushed/purged before any work is performed.



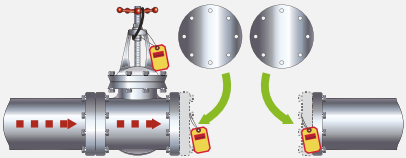
2

Unbolt the flanges and remove the section of pipe to ensure isolation.



3

Insert blinds at both ends of the open piping and tag both blinds.



For more information, refer to Saudi Aramco G.I. 6.012

Restoration phase

Once the work has been completed and the confined space is ready to be returned to service, the confined space must be inspected to ensure the following:

- All personnel have safely exited the confined space.
- All tools and equipment have been removed.
- All manways and flanges are closed and sealed.
- All isolation points have been restored to their operating position.
- All blinds have been removed using the blind list.
- CSE Permit has been properly closed after conducting the closing joint site inspection.

References

Saudi Aramco General Instructions (GIs)

GI 2.100, *Work Permit System.*
GI 2.709, *Gas Testing Using Portable Gas Monitors.*
GI 6.008, *Restriction of Portable Electrical/Electronic Devices.*
GI 6.012, *Isolation, Lockout and Use of Hold Tags.*
GI 430.001, *Implementing the Saudi Aramco Hazardous Waste Code.*
GI 1780.001, *Atmosphere-Supplying Respirators.*

Saudi Aramco Engineering Standards (SAESs)

SAES-B-068, *Electrical Area Classification.*
SAES-P-123, *Lighting.*

Saudi Aramco *Construction Safety Manual*

Volume II, Chapter I-3, Personal Protective Equipment (PPE).
Chapter I-4, Work Permit System and Stop Work Authority.
Chapter I-5, Isolation, Lockout and Use of Hold Tags.
Chapter I-6, Confined Spaces.

Saudi Aramco *Safety Handbook*

Operational Safety Processes.